Maternal and Child Health

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HEALTH AND HUMAN DEVELOPMENT

INDIA

HEALTH AND HUMAN DEVELOPMENT ASPECTS

JOAV MERRICK

EDITOR

New York

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INTRODUCTION

In: India: Health and Human Development Aspects
Editor: Joav Merrick
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Chapter 1

INDIA AND HEALTH ISSUES

Joav Merrick, MD, MMedSc, DMSc [1,2,3,4*]
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ABSTRACT

India or the Republic of India is a large country in South Asia, in fact the seventh-largest country by area, the second-most populous country with over 1.2 billion people, and the most populous democracy in the world. India is still struggling with malnutrition, high infant mortality rate, diseases such as dengue fever, hepatitis, tuberculosis, malaria and pneumonia with diarrhoeal diseases the primary causes of early childhood mortality. Maternal mortality in rural areas is among the highest in the world. In this book we have gathered research papers from India published over the past three years in several Nova Science journals and it is our hope that you will find this research of interest and give you a small picture of health issues in modern India.

INTRODUCTION

India or the Republic of India is a large country in South Asia, in fact the seventh-largest country by area, the second-most populous country with over 1.2 billion people, and the most populous democracy in the world (1). Home to the ancient Indus Valley Civilisation and a

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region of historic trade routes and vast empires, the Indian subcontinent was identified with its commercial and cultural wealth for much of its long history. Four world religions—Hinduism, Buddhism, Jainism, and Sikhism—originated here, whereas Zoroastrianism, Christianity, and Islam arrived in the 1st millennium CE and also helped shape the region's diverse culture (1).

India was under the administration of the British East India Company from the early 18th century and administered directly by the United Kingdom from the mid-19th century, but an independent nation in 1947 after a struggle for independence that was marked by non-violent resistance led by Mahatma Gandhi (1869-1948).

India is the world's tenth-largest economy by nominal GDP and third-largest by purchasing power parity (1), but challenged by poverty, corruption, malnutrition, inadequate public healthcare and terrorism. A nuclear weapons state and a regional power, it has the third-largest standing army in the world and ranks seventh in military expenditure among nations. India is a federal constitutional republic governed under a parliamentary system consisting of 28 states and seven union territories (1).

Health

India has a universal health care system run by the constituent states and territories of India. The Constitution charges every state with raising the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties (2). The National Health Policy was endorsed by the Parliament of India in 1983 and updated in 2002 (2).

Besides the public health sector, there is also a more popular private medical sector in India and both urban and rural Indian households tend to use the private medical sector more frequently than the public sector (2). India has a life expectancy of 64 year for males and 67 years for females and an infant mortality rate of 61 per 1,000 live births (2).

India is still struggling with malnutrition, high infant mortality rate, diseases such as dengue fever, hepatitis, tuberculosis, malaria and pneumonia with diarrhoeal diseases the primary causes of early childhood mortality. Maternal mortality in rural areas are among the highest in the world.

An expert group has recently made recommendations for improved universal health coverage (3):

- Increase public expenditure on health to at least 2.5 percent of GDP and to at least 3% of GDP by 2022.
- Ensure availability of free essential medicines by increasing public spending on drug procurement.
- Purchase of all health care services under the Universal Health Coverage (UHC) system should be undertaken either directly by the Central and state governments through their Departments of Health or by quasi-governmental autonomous agencies established for the purpose.

- All government funded insurance schemes should, over time, be integrated with the UHC system. All health insurance cards should, in due course, be replaced by National Health Entitlement Cards.
- Develop a National Health Package that offers, as part of the entitlement of every citizen, essential health services at different levels of the health care delivery system.
- Reorient health care provision to focus significantly on primary health care.
- Strengthen District Hospitals.
- Ensure adequate numbers of trained health care providers and technical health care workers at different levels by
  a) giving primacy to the provision of primary health care
  b) increasing Human Resources for Health (HRH) density to achieve WHO norms of at least 23 health workers (doctors, nurses, and midwives).
- Establish District Health Knowledge Institutes (DHKIs).
- Establish the National Council for Human Resources in Health (NCHRH).
- Transform existing Village Health Committees (or Health and Sanitation Committees) into participatory Health Councils.
- Ensure the rational use of drugs.
- Set up national and state drug supply logistics corporations.
- Empower the Ministry of Health and Family Welfare to strengthen the drug regulatory system.
- Introduce All India and state level Public Health Service Cadres and a specialized state level Health Systems Management Cadre in order to give greater attention to public health and also strengthen the management of the UHC system.
- Establishment of National Health Regulatory and Development Authority (NHRDA).
- National Drug Regulatory and Development Authority (NDRDA): The main aim of NDRDA should be to regulate pharmaceuticals and medical devices and provide patients access to safe and cost effective products.

The document has received criticism for its limited understanding of universal health care and failure to increase public expenditure on health and concern that public funds will end up in the private sector (2).

THIS PUBLICATION

I have not had the opportunity to visit India so far in my life and my image is still an India from my childhood from the novel and movie “Kim” by Joseph Rudyard Kipling (1865-1936) the first English-language recipient of the Nobel Prize for Literature in 1907.

In this book we have gathered research papers from India published over the past three years in various journals by Nova Science of which I am the editor. It is our hope that you will find this research of interest and give you a small picture of health issues in modern India.

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SECTION ONE: CHILD HEALTH

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Chapter 2

MULTI-LEVEL DETERMINANTS OF REGIONAL VARIATIONS IN INFANT MORTALITY IN INDIA

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ABSTRACT

This chapter attempts to identify the key factors determining the interregional variations of infant mortality in India at different levels of operations and examine some of the relevant relationships between those factors based on a cross-section analysis of NFHS III data. Appropriate Bi-Variate analyses were conducted to see the effect on infant mortality. Multivariate analysis was performed to show the net effect of selected individual, household and community level factors on infant mortality. Here a distinction was made between neonatal and post neonatal mortality to demonstrate that the determinants of these two types of mortality were different, and that the use of the overall infant mortality rate masked some of these important differences. Results show that the gross effect of all the individual level factors like percentage women having all kinds of recommended antenatal care or index of vaccination have higher gross effect on infant deaths, although the net effects of all these factors were lower because many were linearly related to the next level, i.e., household or community level factors. Both gross and net effect of the household level factors, like mother's empowerment and poverty, was very high over infant deaths as many of these factors often controls household's access to different community level facilities as well as individual's ability to shield against infant deaths. Hence, the study concludes that the interplay of both kinds of factors at different levels of child birth can take major role in reducing infant mortality.

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INTRODUCTION

The health status of new-born children has been regarded as one of the premier ingredients of the human development achievements in a developing country like India. Clearly, children have not benefitted to the same extent as adults from the improvements in food supply, and from the preventive and curative measures implemented so far. Identification of effective strategies to reduce infant mortality requires a better understanding of the determinants of infant mortality, and of factors responsible for the observed regional variations in infant mortality levels in India.

The present study attempts to identify the key factors determining the interregional variations of infant mortality in India at different levels of operations and examines some of the relevant relationships between those factors based on a cross-section analysis of state level data. An attempt has been made to build an analytical framework, which shows infant mortality as a function of multi-level factors operating at different stages of child birth, namely prenatal, peri-natal and postnatal periods.

The present study attempts to enquire the effect of multi-level (individual, household and community level) factors over infant death during different periods of child birth as the independent effect of all the factors are not equal at different periods of child birth.

Another major objective to observe the independent effect of all the different level factors differently over neonatal (the probability of dying at the first month of life) and post neonatal mortality (the probability of dying after the first month of life but before the first birthday) that will trace out the fact that the determinant of these two types of mortality are different, which is often shaded by infant mortality. However, the study attempts to develop an analytical framework on the basis of segmenting the wide range of factors affecting infant mortality and by measuring their partial and independent effects.

The proposition of the present study primarily based on the objective statements mentioned above. The central question would be how the interplay between multi level factors may influence infant mortality at different stages and what would be the relative importance of these factors?

THIS STUDY

In the analytical framework used in the present analysis factors are distinguished at three different levels: *Community, household and individual* (see figure 1). They are arranged in ascending order according to their proximity to the dependent variable of interest- in the present case, the death of an infant. The individual-level factors are closest to the dependent variable. Next come the household-level factors, and the community level factors are the most distant. (Insert Figure 1 here)

Individual level factors

Excluding endogenous genetic factors at the individual level, it is assumed that the chances of infant survival depend upon the degree of care with which the infant is brought up.

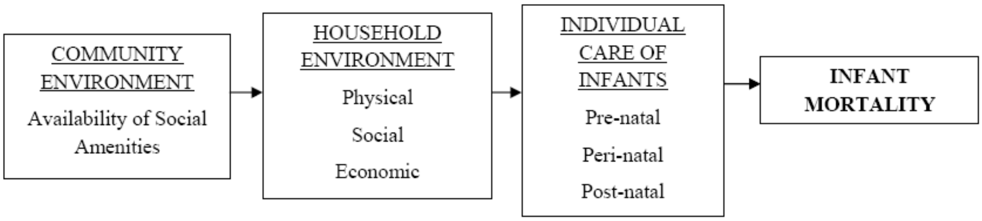


Figure 1. Schematic Representation of relationships among Multi-Level Factors and IMR.

Broadly visualized, care, starting from conception to the first birthday, i.e., during 21 months of life, is important for an understanding of the determinants of infant mortality. Pre-natal care, for example vaccination of the pregnant mother against tetanus, can virtually eliminate deaths from neo-natal tetanus. Proper medical care at delivery can reduce the risk of death from birthday injury and tetanus. Post natal care in the form of breastfeeding, immunization, and timely and appropriate medical treatment in case of illness can reduce the risk of death during infancy. Hence, two important dimensions of individual level factors affecting infant mortality are:

- Timing
- Type of Care

Timing can be divided into three categories:

- Pre-natal
- Peri-natal
- Post-natal

Type of care can be divided into two main groups:

- Medical
- Non-medical

Medical care includes immunization, treatment of illness and medical attention at birth. Non-medical care includes feeding practices, protection from environmental insults and general cleanliness. The two main dimensions of care yield the following six individual-level factors which determine the levels of infant mortality in a population.

1. Pre-natal Medical Care- immunization of pregnant mothers and treatment of infections during pregnancy.
2. Pre-natal non-medical care- maternal health including nutrition during pregnancy.
3. Peri-natal medical care- general hygiene including the deliveries occurred under trained health personnel.
4. Post-natal non-medical child care- infant feeding practices, for example breastfeeding for at least six months.
5. Post-natal preventive medical child care- immunization.

6. Post-natal curative medical child care- incidence and treatment of illness and effectiveness of treatment.

These factors are not arranged in any order of priority. Their relative importance may vary from population to population and for the same population at different times. But we put forward the hypothesis that household and community level factors would affect the chances of infant survival through one or more of these proximate determinants.

Household level factors

The second group of factors consists of the physical, social and economic environment of the household. Physical environment is reflected by the condition of the house, toilet facilities, crowding, quality of drinking water and source of fuel and lighting; social environment factors include mother's empowerment in terms of decision making and maternal education or intervals between birth; and economic conditions by factors such as household income.

Community level factors

The third group of factors concerns physical, social and economic environment at the community level. These are basically institutional laden factors, reflected the availability of Government medical facilities, ICDS services, schools and adult literacy centres, contact with health workers etc. The use made of these facilities varies in different households within the same community. For this reason, the primary effects of these factors on infant mortality will be transmitted through changes in household level factors.

The effect of community level factors on infant mortality will be transmitted through individual level factors, if all households in a community are equally affected- for example, if all pregnant women or infants in a community were immunized in a programme organized at the community level, or if all members of the community were to drink contaminated (or clean) water from the same source. If a community-level factor were to affect infant mortality independently the model is not completely specified, i.e., it does not include some of the relevant factors at the household and individual levels.

It is notable that even under the worst conditions; there are considerable variations at the individual level in the probability of an infant's survival. The reasons for these variations are not known. Within a community, they could reflect differences between households, but they are most probably due to genetic differences between individuals. The individual factors mentioned above thus cannot explain all the differences in individual's chances of survival; their *relative contributions* would depend upon the level of infant mortality in a population; and would vary in different populations.

Databases required for the present study have been taken from the National Family Health Survey III Reports, published at 2005-'06. The databases regarding combined poverty estimates have been collected from the Planning Commission URP (Uniform Recall Period) poverty estimates of 2004-'05.

Table 1. Levels and trends in infant mortality in India during three NFHS rounds

STATES	IMR per thousand live births			CHANGES	
	NFHS I	NFHS II	NFHS III	NFHS I & II	NFHS II & III
Andhra Pradesh	70.4	65.8	53.5	-4.6	-12.3
Arunachal	40	63.1	60.7	**23.1**	-2.4
Assam	88.7	69.5	66.1	-19.2	-3.4
Bihar	89.2	72.9	37.5	-16.3	**-35.4**
Chhattisgarh	-	-	70.8	-	-
Delhi	65.4	46.8	39.8	-18.6	-7.0
Goa	31.9	36.7	15.3	4.8	-21.4
Gujarat	68.7	62.6	49.7	-6.1	-12.9
Haryana	73.3	56.8	41.7	-16.5	-15.1
Himachal Pradesh	55.8	34.4	36.1	-21.4	**1.7**
Jammu & Kashmir	45.4	65	44.7	19.6	-20.3
Jharkhand	-	-	68.7	-	-
Karnataka	65.4	51.5	43.2	-13.9	-8.3
Kerala	23.8	16.3	15.3	-7.5	-1
Madhya Pradesh	85.2	86.1	69.5	0.9	-16.6
Maharashtra	50.5	43.7	37.5	-6.8	-6.2
Manipur	42.4	37	29.7	-5.4	-7.3
Meghalaya	64.2	89	44.6	**24.8**	**-44.4**
Mizoram	14.6	37	34.1	**22.4**	-2.9
Nagaland	17.2	42.1	38.3	**24.9**	-3.8
Orissa	112.1	81	64.7	**-31.1**	-16.3
Punjab	53.7	57.1	41.7	**3.4**	-15.4
Rajasthan	72.6	80.4	65.3	**7.8**	-15.1
Sikkim	-	43.9	33.7	-	-10.2
Tamilnadu	67.7	48.2	30.4	-19.5	-17.8
Tripura	75.8	N.A.*	51.5	-	-
Uttar Pradesh	99.9	86.7	72.7	-13.2	-14
Uttaranchal	-	-	41.9	-	-
West Bengal	75.3	48.7	48	**-26.6**	-0.7
India	**78.5**	**67.6**	**57**	-10.9	-10.6
CV	**29.1**	**32.5**	**32.3**		

Source: NFHS I, II and III.
*N.A. refers to Data not available.

i. Selection of indicators at the individual level

The individual level factors, as mentioned above, can be categorized into six different subsets determining their timing and type of care. However, the present study attempts to take into consideration five out of these six factors. In the case of pre-natal medical care, percentage of women who received all kinds of antenatal care has been taken into consideration. Percentage of mothers got supplementary foods from ICDS centres during pregnancy reflects the extent of pre-natal care within the individuals, whereas it can be denoted as an important community level factor reflecting institutional measure for infant care which is transmitted through the individuals at different rates. The peri-natal factor is represented through percentage of deliveries assisted by trained health personnel, which reflects the awareness of individuals for safe medication during the delivery processes. Post-natal non-medical care is represented by percentage of children (less than six months of age) breastfed six plus times in 24 hours. The post-natal preventive medical care is represented by an index of immunization, which is composed of percentage of children received all kinds of basic vaccinations (BCG, Measles, and three doses each of DPT and polio vaccine).

ii. Selection of indicators at the household level

As noted earlier, the physical and social environment of the household and its economic conditions strongly influence the probability of infant death. These factors are larger in number and the relative contribution of any them on infant death is not negligible. Hence, it is better to measure the association of these of these factors with infant death in an aggregative manner rather than considering them individually. Hence, a physical infrastructure index of household have been constructed which represents the physical status of living of the household with the help of a number of indicators, namely percentage of households having electricity, improved source of drinking water, toilet facility, percentage household using solid fuel for cooking, percentage household living in pucca house, and the mean number of persons per room used for sleeping as separate rooms and enough space is required during delivery and post-natal phases to prevent infections to the child.

Like the physical infrastructure index of the household, a separate mother’s empowerment index have been constructed representing the currently married women’s autonomy and decision making ability within the household which have quantum effect in controlling birth preferences in terms of number of children to have, birth interval and gender preferences in child birth, all of which have significant association with infant mortality. The adult literacy rate for women is the most crucial element of this index as, according to Caldwell and Mcdonald (1), ‘schooling brings in a new family system in which children (and women) are awarded higher priorities in terms of care and consumption than in the traditional system.’ Other elements of the index are percentage of adult women having exposure to some kind of mass media which increases the married women’s awareness regarding the process of child birth in a healthy and hygienic environment and increases their decision making power regarding preferences in child birth. The other indicators all pertain to currently married women’s decision making ability, namely percentage of currently married women who alone or jointly with their husbands decide how their own earnings are used, percentage men who say that wives should have the final say alone or jointly with the husband in five major decisions (major household purchases, purchases for daily household needs, visits to the wives’ family or relatives, what to do with the money the wife earns, and how many children to have), percentage of female headed households, and percentage of mothers allowed going to market alone. The economic condition of the household is reflected by the percentage of people existing above the poverty line in both rural and urban India. It may be mentioned that the percentage of people above the poverty line has been taken into consideration instead of percentage of people below the poverty line, because of making the indicators unidirectional.

iii. Selection of indicators at the community level

Association of institutional factors with infant mortality have been worked out with reference to the indicators reflecting the Government initiatives in developing infant, maternal and child care like percentage of lactating mothers getting health and nutritional education from ICDS, percentage of households using Government health facilities, and percentage of women having any contact with a health worker, i.e., the initiatives of Government health workers to have contact with pregnant and lactating mothers.

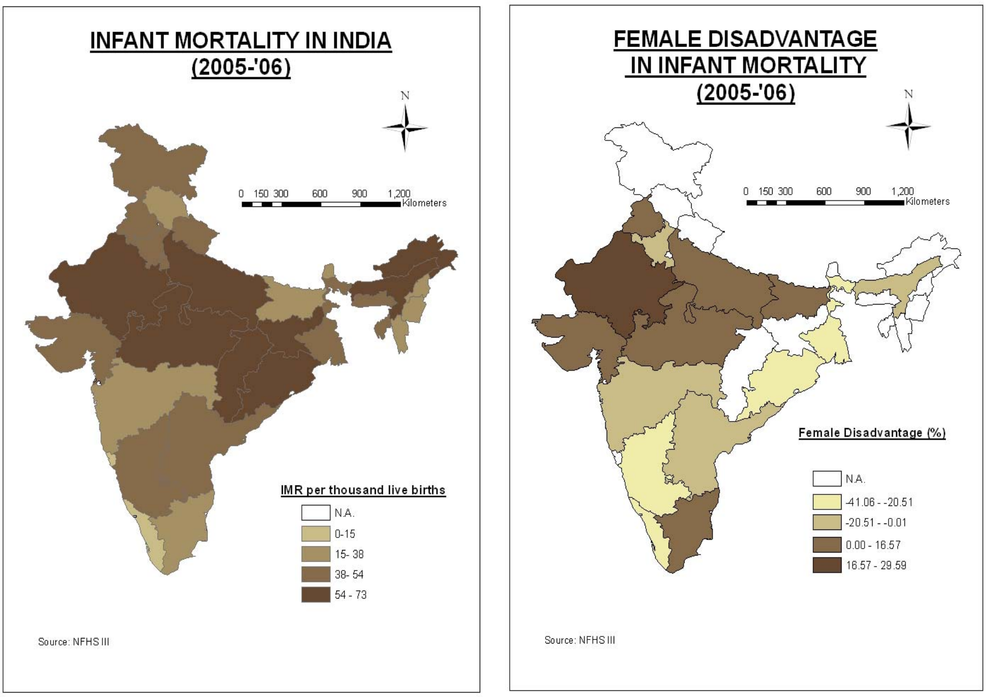
In terms of methodology, the First Principal Component Analysis (PCA) have been taken into consideration for creating the composite index of household physical infrastructure and mother's empowerment, which represents the maximum sum of square of correlations of all the aggregated values (i.e., index values) with the indicators taken. The process, thus, creates an index value for each observation which is the best representative of all the indicators taken. PCA assigns weigh to each indicator depending upon the correlations within them, i.e., the higher the correlation, the higher will be the weigh provided to an indicator. In this way, it removes all kinds of indicators which does not show much association with other indicators, i.e., not so relevant to the context. The percentage of variations explained by the first principal component essentially depends upon the degree of correlations between the indicators, i.e., higher the correlations, higher will be the variation explained by the first principal component.

Appropriate bi-variate analyses worked out to see the gross effect of different level factors over infant mortality. Separate correlation matrices have been worked out to show the inter association among IMR and other factors pertained to individual, household and community level. Multivariate analysis like multiple regression model worked out to show the net effect of selected individual, household and community level factors over infant mortality. Here a distinction was made between neo-natal and post neo-natal mortality to demonstrate that the determinants of these two types of mortality were different, and that the use of the overall infant mortality rate masked some of these important differences. For example, some factors of individual level were much more important than any other community or household level factors for neo-natal mortality. To capture the net or independent effects of all these factors separately on neo-natal, post neo-natal mortality and gross IMR and to measure their differential contributions in each of the kind of infant death, separate models were worked out for neo-natal, post neo-natal and aggregative IMR.

FINDINGS

Cross-sectional analysis of NFHS III data

This analysis have been carried out for twenty nine states (unlike only 16 major states) using NFHS III data of 2005-'06. In case of total IMR, at the all India level 57 infant deaths were used to be caused in per thousand live births, out of which 39 occurred within one month of birth (neo-natal deaths) and the remaining 18 occurred between the first month and first birthday of the child (post neo-natal death). The third quartile calculated for total IMR, neo-natal and post neo-natal mortality for all India revealed the fact that 25% of the states still had an IMR of nearly 61 per thousand live births during NFHS III, where the neo-natal mortality accounted 40 per thousand live births and the post neo-natal mortality accounted for the rest 21 infant deaths. Highest IMR can be found in U.P. (72.7 per thousand live births), followed by Chhattisgarh, M.P, Jharkhand and Assam. Lowest infant deaths were characteristic of the states Kerala (15.3 per thousand live births), followed by Goa, Manipur, Tamilnadu, Sikkim, Mizoram, Himachal Pradesh and Maharashtra. Figure 2a represents the spatial variation in infant mortality across the Indian states during NFHS III.



a b

Figure 2.

In terms of male IMR, highest infant deaths were found in Orissa (71.4 per thousand live births), followed by U.P., Assam, M.P. and Bihar. (ranging from 58-72 per thousand live births). The third quartile calculated for male IMR is 60.1 per thousand live births, indicating that 25% of the states had a male IMR of 60 or more.

In terms of female IMR, highest female IMR was found in Rajasthan (77.4 per thousand live births), followed by U.P., M.P., Bihar, Assam (63-75 per thousand live births); lowest occurrence was found in Kerala (12 per thousand live births), associated by Tamilnadu, Himachal, Maharashtra, and Karnataka (ranging from 12-39 per thousand live births). (Insert Figure 2a and 2b here). In terms of female disadvantage in IMR, the highest discrimination against female children showed in Rajasthan (29.59%), followed by Tamilnadu, M.P., Punjab, Gujarat and Bihar. The lowest female disadvantage was evident in West Bengal (-41.06%), followed by Kerala, Orissa, Karnataka and Assam. During NFHS III, in terms of female disadvantage in infant deaths, nine states had more female disadvantage than the national average, whereas seven states had lesser female disadvantage than the national average. Figure 2a and 2b shows the regional distribution of IMR as a whole and female disadvantage of IMR across India during NFHS III.

Individual level factors and IMR

Out of the five factors (representing five possible subsets of determinants at the individual level, Table 2a) used to show the gross effect of individual level determinants on infant deaths, three have shown strongly negative and statistically significant association with IMR, namely the percentage women who received all recommended kinds of antenatal care, percentage deliveries assisted by health personnel and the percentage of children received all kinds of basic vaccinations.

Table 2a. Individual Level Factors and IMR (2005-'06)

STATES	IMR per Thousand Live Births	a	b	c	d	e	Ranking of States According to IMR
Uttar Pradesh	72.7	4.1	9.6	27.2	96.5	23	1
Chhattisgarh	70.8	11.3	64.1	41.6	96.5	48.7	2
Madhya Pradesh	69.5	7.2	31	32.7	98.8	40.3	3
Jharkhand	68.7	7.5	34.7	27.8	96.6	34.2	4
Assam	66.1	9.6	12.7	31	99.3	31.4	5
Rajasthan	65.3	8.6	17	41	94.6	26.5	6
Orissa	64.7	18.4	44.6	44	98.5	51.8	7
Bihar	61.7	5.8	0.6	29.3	98	32.8	8
Arunachal	60.7	6.5	9	30.2	98.8	28.4	9
Andhra Pradesh	53.5	28.2	22.9	74.9	99.8	46	10
Tripura	51.5	10.6	6.8	48.8	96.8	49.7	11
Gujarat	49.7	25.6	19.1	63	95.5	45.2	12
West Bengal	48	12.3	23.1	47.6	95.6	64.3	13
Jammu & Kashmir	44.7	17.5	6.3	56.5	92.1	66.7	14
Meghalaya	44.6	8.1	36.1	31.1	98.5	32.9	15
Karnataka	43.2	29.6	30.3	69.7	95.9	55	16
Uttaranchal	41.9	16.1	18.9	38.5	88.7	60	17
Haryana	41.7	14.7	11	48.9	97.8	65.3	18
Punjab	41.7	19.6	7.5	68.2	95.9	60.1	19
Delhi	39.8	29	5.3	64.1	89.4	63.2	20
Nagaland	38.3	1.9	5.4	24.7	97.2	21	21
Maharashtra	37.5	21.6	25.8	68.7	95.5	58.8	22

Table 2. (Continued)

STATES	IMR per Thousand Live Births	a	b	c	d	e	Ranking of States According to IMR
Himachal Pradesh	36.1	17.4	33.6	47.8	93.4	74.2	23
Mizoram	34.1	8.7	54.5	65.4	98.4	46.5	24
Sikkim	33.7	27.2	24.6	53.7	98.1	69.6	25
Tamilnadu	30.4	34	50.4	90.6	99.2	80.9	26
Manipur	29.7	10.5	3.7	59	97.1	46.8	27
Goa	15.3	55.7	46.4	94	89.9	78.6	28
Kerala	15.3	63.6	15.8	99.4	100	75.3	29

Definition of indicators:
a % of women who received all recommended kinds of antenatal care
b % of mothers got supplementary foods from ICDS centres during pregnancy
c % of deliveries assisted by health personnel
d % of children got breastfed 6+ times in 24 hours
e % of children received all kinds of basic vaccinations
Source: NFHS III Report.
Ranking done in a descending manner, e.g., higher IMR, higher ranking.

Table 2b. Association between the individual level factors and IMR

CORRELATION MATRIX						
INDICATORS	IMR	a	b	c	d	e
IMR	1	-.681**	-0.032	-.740**	0.231	-.697**
a		1	0.193	.879**	-0.167	.726**
b			1	0.231	0.085	0.261
c				1	-0.101	.748**
d					1	-0.328
e						1

**Correlation is Significant at 1% level (Two-tailed).

All these factors have shown strongly negative correlation (-0.681 for percentage of women, who received all recommended kinds of antenatal care, -0.740 for percentage of deliveries assisted by health personnel and -0.697 for percentage of children who received all kind of basic vaccinations), all of which were statistically significant at 1% level of significance.

These factors, however, have higher inter-association within them, and hence their gross effect on IMR is also very high. However, all of these factors are at some level determined by household or community level factors, which will be evident in later discussions. Results of association between individual level factors and infant deaths are represented in table 2b.

Household level factors and IMR

The factors at household level, as explained above, are discussed in a more aggregative manner rather than the individual or community level factors in order to trace out their gross effect on infant deaths (table 3a). These household level factors usually transmit their effects on IMR through the operation of individual level factors. For example, the effect on pre, peri or post natal care on infant deaths would be more or less controlled by the mother's level of education or level of empowerment. On the other hand, household level factors strongly depend upon the community level factors to operate, such as the level of maternal education in any village are determined by the availability of schools or adult literacy centres in the village. Basically, household level factors lead the most crucial role in determining infant deaths by acting as a bridging gap between the individual and community level factors.

Table 3a. Household level factors and IMR (2005-'06)

STATES	IMR per thousand live births	a	b	c	Ranking of states according to IMR
Uttar Pradesh	72.7	-0.933	-0.979	67.2	1
Chhattisgarh	70.8	-1.066	-1.445	59.1	2
Madhya Pradesh	69.5	-0.895	-1.241	61.7	3
Jharkhand	68.7	-1.826	-1.765	59.7	4
Assam	66.1	-1.193	-0.618	80.3	5
Rajasthan	65.3	-0.415	-1.364	77.9	6
Orissa	64.7	-1.328	-0.704	53.6	7
Bihar	61.7	-1.436	-0.248	58.6	8
Arunachal	60.7	-0.204	-0.285	82.4	9
Andhra Pradesh	53.5	0.479	-0.001	84.2	10
Tripura	51.5	-0.755	0.634	81.1	11
Gujarat	49.7	0.907	-0.365	83.2	12
West Bengal	48	-0.459	0.152	75.3	13
Jammu & Kashmir	44.7	0.452	-0.132	94.6	14
Meghalaya	44.6	-0.606	0.088	81.5	15
Karnataka	43.2	0.408	-0.086	75	16
Uttaranchal	41.9	0.299	-0.251	60.4	17
Haryana	41.7	0.626	-0.873	86	18
Punjab	41.7	1.234	-0.206	91.6	19
Delhi	39.8	2.480	0.400	85.3	20
Nagaland	38.3	-0.635	-0.149	81	21
Maharashtra	37.5	0.817	0.121	69.3	22
Himachal Pradesh	36.1	0.439	0.727	90	23
Mizoram	34.1	0.780	1.727	87.4	24

Table 3a. (Continued)

STATES	IMR per thousand live births	a	b	c	Ranking of states according to IMR
Sikkim	33.7	0.653	0.197	79.9	25
Tamilnadu	30.4	0.776	1.014	77.5	26
Manipur	29.7	-0.647	1.406	82.7	27
Goa	15.3	1.381	1.797	86.2	28
Kerala	15.3	0.669	2.445	85	29

Definition of variables:
a Physical Infrastructure Index of Household;
b Mother's Empowerment Index;
c % People Above the Poverty Line(URP estimates).
Source: NFHS III Report & Planning Commission Poverty Estimates, 2005.
Ranking done in a descending manner, e.g., higher IMR, higher ranking.

Table 3b. Association between the Household Level Factors and IMR

CORRELATION MATRIX				
INDICATORS	IMR	a	b	c
IMR	1	-.692**	-.864**	-.588**
a		1	.518**	.631**
b			1	.535**
c				1

**Correlation is Significant at 1% level (Two-tailed).

Table 3c. Components of Physical Infrastructure Index of Household

INDICATORS	WEIGHTAGES
% of Households having ELECTRICITY	0.839
% of Households having IMPROVED SOURCE OF DRINKING WATER	0.471
% of Households having TOILET FACILITY	0.448
% of Households using SOLID FUEL FOR COOKING	-0.895
% of Households living IN A PUCCA HOUSE	0.833
MEAN NUMBER OF PERSONS PER ROOM USED FOR SLEEPING	-0.09

The index of physical infrastructure of the household created to show the physical standard of living of the household consists of a set of six highly correlated indicators. Out of the six indicators, two shows negative correlations with others, namely percentage households using solid fuel for cooking and mean numbers of persons per room used for sleeping. Except the last one, rest of the indicators has shown high correlations among them (as most of them are same kind of indicators). The weights provided to the indicators have been shown in table 3c. The first principal component in the index explains 45.1% of variance.

The mother's empowerment index created to show the decision making power of the married women in the household in terms of child care and child birth consisted of six different kinds of factors including adult women literacy, percentage of adult women's exposure to mass-media, percentage of female headed households, percentage of mothers allowed going to market alone, percentage of currently married women having independent decision making ability for using their own earnings and percentage of married men's allowance to their wives to take five major decisions. Out of all these six factors, excluding the last two indicators, the rest of the indicators showed moderate to high correlation among themselves in determining an aggregative measure of mother's empowerment. Weight assigned to all these indicators depending upon the degree of correlations between them have been depicted in table 3d. Adult women literacy and women's exposure to mass media are regarded two most important indicators in determining the mother's empowerment, which were assigned higher weigh. The percentage of variance explained by the first principal component is 46.31%.

Table 3d. Components of Mother's Empowerment Index

INDICATORS	WEIGHTAGES
Adult Women Literacy(15-49 years)	0.852
% of Adult women having exposure to some kind of mass media (15-49 years)	0.808
% of Currently married women who alone or jointly with their husbands decide how their own earnings are used	0.324
% of Men who say that wives should have the final say alone or jointly with the husband in five major decisions**	-0.197
% of Female headed households	0.621
% of Mothers allowed going to market alone	0.544

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
**Decisions include major hh purchases, purchases for daily hh needs, visits to the wives' family or relatives, what to do with the money the wife earns, & how many children to have.

Correlation matrix worked out to show the inter-association among the infant deaths and the indicators of household's economic and social well-being (physical infrastructure index, mother's empowerment index, and percentage of people above the poverty line) shows very good relation between the dependent and the independent variables (table 3b). All the three determinants showed strongly negative correlations with infant deaths, all of which were statistically significant at 1% level of significance. The importance of household's physical infrastructure and general hygiene situation is undisputedly one of the proxies for households' standard of living, which also reflects households' general awareness regarding the hygiene during the pre and peri-natal care of new born babies and pregnant mothers as well as prevention of ailments and morbidity of the children initially after birth. The index of physical infrastructure, however, transmits its effects to the individual level by the pre, peri and post-natal cares of the child such as usage of sterilized instruments to cut the umbilical cord.

Out of the three household level determinants, the mother's empowerment index calculated to show the decision making ability of women regarding child birth and infant care have the most strong negative correlation to infant mortality. The strongest element of this index was the adult women literacy, which was the chief determinant of married women's autonomy in the household and their decision making ability regarding child birth. At a general level, it is useful to distinguish between the influences of female education on: 1) desired family size, 2) the relationship between desired family size and planned number of births, and 3) ability to achieve the planned number of births. According to Dyson and Moore (8), educated women are most likely to voice resentment at the burden of repeated pregnancies and to take action to lighten that burden. This may occur because educated women have other sources of prestige and fulfillment besides reproductive performance, more control over household resources and personal behavior, and greater involvement in reproductive decisions.

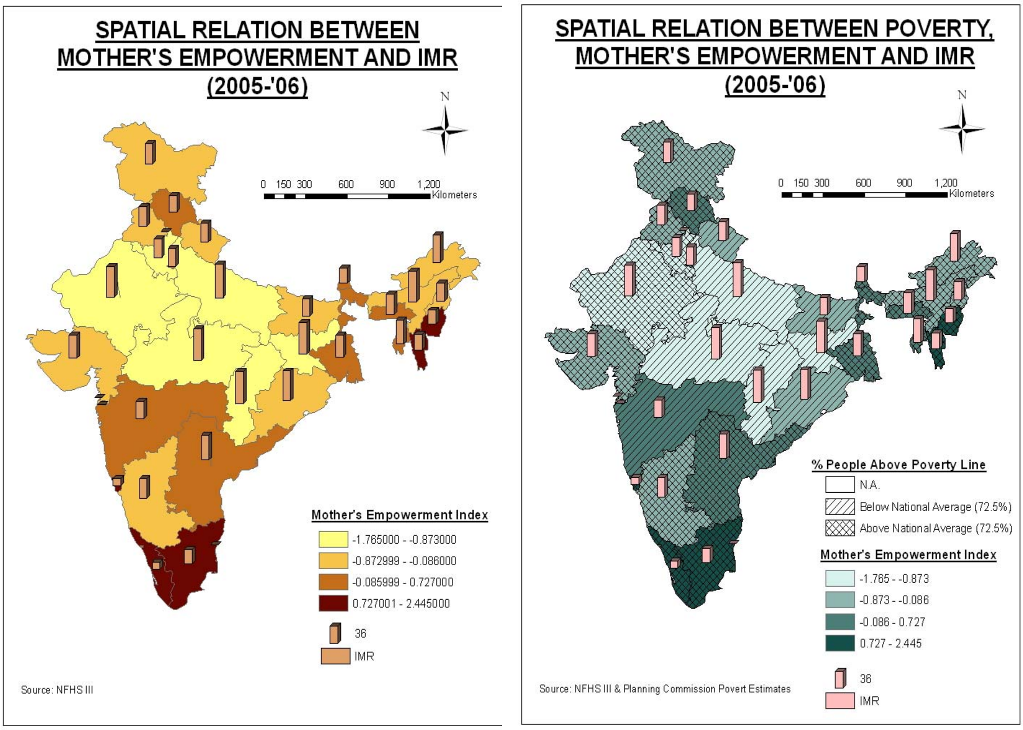
The correlation between all these factors have been represented by the correlation matrix prepared for creating the mother's empowerment index through PCA (0.794 with media exposure by current women, 0.457 with women's decision making ability to spend their own earnings, 0.594 with mother's who are allowed to go to market alone, the first and the last is significant at 1% level, whereas the other is significant at 5% level).Second, educated women have higher aspirations for their children, combined with lower expectations from them in terms of labour services provided (United Nations, 1993). This may reduce the number of births if there is a perceived tradeoff between the number of children and their personal achievements. Third, the opportunity cost of time tends to be comparatively high for educated women, and this creates an incentive to minimize such time-intensive activities as childbearing and childrearing, as opined by Dreze, Guio and Murthi (7), especially in urban areas.

Moreover, educated women are likely to be more knowledgeable about nutrition, hygiene, and health care, and this awareness is transmitted through the individual level pre, peri and post natal care. In addition, basic education can be important in helping mothers to demand adequate attention to children's needs by other members of the household, to take advantage of public health care services, and generally to pursue their aspirations (including the wellbeing of children) in the family and society in a more informed and effective way.

The final household level factor found to be associated with infant deaths is poverty, and the relationship between the duos requires careful examination. It can be noted that although poverty has a moderately strong positive relationship on IMR, there is also a good deal of colinearity between poverty and similar kinds of factors like a households' physical standard of living, number of earning women or female literacy. The multivariate analysis can only reveal the independent effect of poverty on IMR.

However, figure 3a represents a very good picture of spatial correlation between levels of mother's empowerment and infant mortality. The problem regions of infant death, mainly centered on the Mid-Indian belt, comprising the states of Rajasthan, Bihar, U.P., M.P., Chhattisgarh and Orissa, have also shown very low level of female autonomy and decision making abilities. However, such kind of low level of mother's empowerment can be ascribed to poverty and low access to resources, which can also be signified when plotting the poverty condition over the composite picture of IMR and mother's empowerment level.

The figure 3b clearly represents the fact that states which have more number of people below the national average of above poverty line estimates (i.e., poorer states) have lower level of mother's empowerment, thus resulting higher level of infant deaths and vice-versa. (Insert Figure 3a and 3b here)



a b

Figure 3.

Community level factors and IMR

Availability of amenities in the community level appears to make a difference in infant mortality because they are the sole determinants of all kinds of factors discussed above. The availability of well-organized government health facilities and Anganwadi services, for example, are more acceptable and affordable to those people who are below the poverty line, thereby affecting the quality of pre, peri and post natal cares at the individual level.

Table 4b shows the correlation between three community level factors and infant mortality. None of the relationships are found to be significant, even at 10% level. No correlations were found at all between the community level determinants and IMR, which is a little bit confusing.

This suggests that the effect of community level factors has been overshadowed to some extent by the factors at individual and household level.

Table 4a. Community Level Factors and IMR (2005-'06)

STATES	IMR	a	b	c	RANKING OF STATES ACCORDING TO IMR
Uttar Pradesh	72.7	0.7	15.3	19.8	1
Chhattisgarh	70.8	24.6	36.3	19.4	2
Madhya Pradesh	69.5	17.5	37.4	16.9	3
Jharkhand	68.7	12.2	22.3	14.7	4
Assam	66.1	2.1	65.2	8.9	5
Rajasthan	65.3	3.2	70.2	11.7	6
Orissa	64.7	16.7	76	22.6	7
Bihar	61.7	0.3	6.7	19.2	8
Arunachal	60.7	1.4	82.5	9.6	9
Andhra Pradesh	53.5	12.8	25.7	9	10
Tripura	51.5	4.6	79.9	14.4	11
Gujarat	49.7	8.4	27.5	27.3	12
West Bengal	48	10.8	28.8	23.3	13
Jammu & Kashmir	44.7	1.7	62.9	4.1	14
Meghalaya	44.6	25.7	64.8	7.6	15
Karnataka	43.2	12.5	36	19.9	16
Uttaranchal	41.9	4.8	44.4	18.7	17
Haryana	41.7	2.7	27.7	11.2	18
Punjab	41.7	2.5	19.2	11.9	19
Delhi	39.8	2.7	29.3	2.9	20
Nagaland	38.3	0.1	52.1	4.5	21
Maharashtra	37.5	10.4	29.7	16.5	22
Himachal Pradesh	36.1	12.5	82.7	9.1	23
Mizoram	34.1	14.4	90.6	6.2	24
Sikkim	33.7	9.9	91.8	13.2	25
Tamilnadu	30.4	29.1	53	15.2	26
Manipur	29.7	0.9	79	4.6	27
Goa	15.3	20.8	29.6	14.5	28
Kerala	15.3	6.8	50	22.6	29

Definition of Indicators:

a % of Mothers got health & nutritional education from ICDS during breastfeeding;

b % of households using Govt. health facilities;

c % of Women have any contact with a health worker.

Source: NFHS III Report.

Ranking done in a descending manner, e.g., higher IMR, higher ranking.

Table 4b. Association between the community level factors and IMR

CORRELATION MATRIX				
INDICATORS	IMR	a	b	c
IMR	1	-0.1	-0.178	0.2
a		1	0.045	0.225
b			1	-.395**
c				1

** Correlation is Significant at 5% level (Two-tailed).

The multivariate model

In order to trace out the independent effects of three different level factors separately on IMR, neo-natal mortality and post neo-natal mortality, three separate multivariate models were used. Indicators were selected from all the three levels depending upon their gross pattern of relationship with infant mortality done in the previous sections. This exercise was mainly carried out to investigate the relative and independent contributions of all these different level factors at infant death as a whole as well as at different levels of infant death, i.e., neo-natal and post neo-natal mortality (as it is previously hypothesized that the effect of different level factors are different in the case of neo-natal and post neo-natal mortality, which is often shadowed by the gross IMR estimates). The model is based on the analytical framework presented above and described by the following set of equations:

$$Y = y_1 + y_2 \quad (1)$$
$$y_1 = \alpha_1 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + u_1 \quad (2)$$
$$y_2 = \alpha_2 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + u_2 \quad (3)$$

where,

Y= Overall Infant Mortality
y_1= Neo-natal Mortality
y_2= Post neo-natal Mortality
α_1, α_2= Intercept
$\beta_1 \ldots\ldots \beta_7$= Slope Co-efficients
x_1= % of women who received all recommended kinds of antenatal care
x_2= % of deliveries assisted by health personnel
x_3= Mother's Empowerment Index
x_4= % People above the Poverty Line (URP estimates)
x_5= % of mothers got health & nutrition education from ICDS during breastfeeding
x_6= % of children received all kinds of basic vaccinations
x_7= % of household using Government health facilities

Results of all the equations have been displayed in table 5. In case of IMR as a whole, independent relations are depicted in the first column of the table. It can be observed that in case of the model as a whole, the R^2 value is 0.855, with an adjusted R^2 of 0.806, i.e., the independent variables explains almost 85.5% variation of the infant death, or the explanatory power of the independent variables is very high.

Table 5. Summary of Multiple Regression Analysis of the Effect of Individual, Household and Community Level Factors on Infant Mortality and Its Components, NFHS III (2005-'06)

BACKGROUND VARIABLES	DEPENDENT VARIABLE		
	IMR	NEO-NATAL MORTALITY	POST NEO-NATAL MORTALITY
CONSTANT	33.916 (0.674)	0.145 (.004)	46.738 (1.493)***
a	-0.057 (-0.359)	-0.040 (0.367)	-0.123 (-1.248)
b	-0.446 (0.905)	-0.507 (1.488)***	-0.152 (-0.495)
c	-9.884 (-4.774)*	-7.821 (-5.460)*	-1.081 (-0.840)
d	-0.276 (-1.825)**	-0.117 (-1.121)	-0.114 (-1.211)
e	0.015 (0.077)	0.041 (0.311)	-0.051 (-0.437)
f	-0.191 (-1.528)**	-0.215 (-2.491)*	-0.087 (-1.117)
g	0.031 (0.486)	0.026 (0.594)	-0.024 (-0.145)
R^2	0.855	0.873	0.598
ADJUSTED R^2	0.806	0.830	0.464
F	17.640*	20.553*	4.468*
N	29	29	29
DURBIN-WATSON d STATISTIC	2.480	2.272	1.623

t-ratios in parentheses.
* Significant at 1% level (Two-tailed).
** Significant at 5% level (Two-tailed).
*** Significant at 10% level (Two-tailed).
Definition of Variables:
a % of women who received all recommended kinds of antenatal care
b % of deliveries assisted by health personnel.
c Mother's Empowerment Index.
d % People Above the Poverty Line(URP estimates).
e % of mothers got health & nutrition education from ICDS during breastfeeding.
f % of children received all kinds of basic vaccinations.
g % of households using Government health facilities.

The F-statistic, for the first model is significant at 1% level, i.e., the model is overall significant at 1% level. Results showed that the mother's empowerment level had very significant and highly negative effect over the infant deaths, or more precisely, the independent effect of the levels of mother's empowerment was much higher on infant deaths than any other factors. The slope coefficient for the mother's empowerment is -9.884, referring to the fact that about nine fold increase in the autonomy of married women is beneficial to reduce one unit variation in infant deaths. Apart from the mother's empowerment level, the poverty indicator at the household level also had significant independent effect on infant mortality as a whole (-0.276). The negative independent effect of poverty on infant mortality can be observed probably due to the different dietary habits of mothers, which influence their nutrition level during pregnancy and also affects the nutritional and curative care of the child after the birth. However, the net effect of these factors on neo-natal and post neo-natal mortality separately will be able to illustrate the different roles of poverty in different levels of infant deaths. Moreover, the levels of female autonomy have also shown to be positively associated with the levels of poverty (correlation co-efficient calculated between the duo is 0.534, significant at 1% level), suggesting the indirect role of poverty to determine some of the individual level factors like child vaccination through a higher enhancement of female autonomy. Effect of vaccination was found also to be significant on infant deaths; it had a negative independent effect on gross estimate of infant deaths (-0.191). The Durbin-Watson d statistic calculated for the first model was 2.480 for all 29 observations and seven independent variables, which lies within the 'zone of indecision' (between 4-d_u and 4-d_l); hence no conclusion can be made regarding the autocorrelation parameter of the model.

The second model analyses the independent relationship between the selected multi-level factors with neo-natal mortality, which used to occur within the first month of the child birth and constitutes almost 60% of the infant deaths. It is previously hypothesized that the factors affecting neo-natal mortality at different levels of childhood care is different from post neo-natal mortality, which is often shaded by the gross estimation of infant mortality. It is found that one of the important peri-natal factors like deliveries assisted by the trained health personnel had a negative significant effect on neo-natal mortality (-0.507), which was not evident when we discussed the infant death as a whole. However, the effect of the mother's empowerment level also had a negative and statistically significant effect on the variations in neo-natal mortality (-7.821). Such a factor can ve ascribed to the fact that the negative effect of adult women literacy and other empowerment measure is transmitted to neo-natal mortality by an increase in the percentage of births attended by trained health personnels. However, the poverty indicator which was found to have an significant negative effect on total infant deaths, also had a negative effect on neo-natal mortality, although not statistically significant, indicating the fact that as a whole it can be an important determinant of infant mortality, but judging at the neo-natal level the independent effect of poverty was not so much evident, although it transmits some of its influence through the dietary practice of the mothers during pregnancy, i.e., non-medical pre-natal care or through vaccination of the child or percentage of deliveries assisted by the health personnels (correlation co-efficient calculated between poverty indicator and index of vaccination is 0.320, significant at 5% level). Another factor which affected the neo-natal death significantly was the index of vaccination, which had a negative effect on neo-natal mortality (-0.215), i.e., the neo-natal mortality decreased by 0.215 units with a unit increase in vaccination, which in turn reflected the mother's awareness in post natal medical childhood care that had been ascribed through a higher level of female autonomy (the correlation coefficient calculated between mother's empowerment level and index of vaccinations is 0.551, significant at 1% level, supports the argument). The three significant indicators along with others explain almost 87.3% variation in neo-natal mortality. The F- statistic calculated for the model was significant at 1% level, referring to a fairly well-explanation of the model by the explanatory variables, which is statistically significant. The Durbin-Watson d statistic calculated to trace out the autocorrelation parameter of the model is

2.272, which also falls within the ‘zone of indecision’; hence no comment can be made regarding the autocorrelation parameter of the model.

The third and final model explains the effect of the multi-level determinants on post neo-natal mortality. Here the result was a little bit confusing, because no significant effect was found in case of any of the factors on post neo-natal mortality. However, the independent effect of the mother’s empowerment index on post neo-natal mortality was very high, although not significant. No significant effect of post-natal nutritional education of the mothers or index of vaccination could be found on post neo-natal mortality, although the gross effect of all these factors on post neo-natal mortality was very high (correlation coefficient calculated between post neo-natal nutritional education of mothers and post neo-natal mortality is -0.420, significant at 5% level, the same calculated between index of vaccination and post neo-natal mortality is -0.643, significant at 1% level). Such factors signify low independent effects of all these factors on post neo-natal mortality. The explanatory variables together are able to explain about 60% regional variation in post neo-natal mortality, with an significant F-statistic at 1% level, referring the joint effect of all independent variables were statistically significant. The Durbin-Watson d statistic calculated to trace out the autocorrelation parameter of the model is 1.623, lies within d_u and d_l, referring to the ‘zone of indecision’; hence no conclusion can be made regarding the autocorrelation parameter of the model.

In summary, the mother’s empowerment level, poverty and index of vaccination were the three important determinants of infant mortality as a whole, whereas the role of percentage deliveries assisted by the trained health personnels along with mother’s empowerment level and index of vaccination was regarded as two important determining factors having their independent effect on neo-natal mortality. The independent effect of poverty indicator on neo-natal mortality was not evident, although the gross and independent effect was much higher. In the case of post neo-natal mortality, none of the factors had significant independent effect, but the gross effect of some of the post natal factors like vaccination or mother’s nutritional education from ICDS remained important. Factors like poverty and mother’s empowerment continued to remain their higher independent effect on post neo-natal mortality, although not significant.

DISCUSSION

The crucial findings traced out from the study were:

- Most of the states which had recorded positive changes between NFHS I and NFHS II had recorded negative changes between NFHS II and NFHS III and vice versa. Notable changes were observed in the case of Himachal Pradesh (-21.4 points changes between NFHS I and II, but recorded 1.7 point change between NFHS II and III), Meghalaya, Punjab etc.
- Regarding male, female and female disadvantage in IMR, conditions have been much improved between NFHS II and NFHS III, rather significant changes can be observed between the first two rounds.

- The gross effect of individual level factors like percentage of women having all kinds of recommended antenatal care, percentage deliveries assisted by trained health personnel or index of vaccination had higher gross effect on infant deaths, although the net effects of all these factors were lower, because many of them were linearly related to the next level, i.e., household or community level factors.
- The gross effect of household level factors like mother's level of empowerment or poverty was high on infant deaths, whether the net effect of mother's empowerment was also very high as it largely controls the individual's decision making regarding pre, peri and post natal care as well as the availability of basic social amenities at the community level, i.e., number of schools in the community or Government health facilities taken by households. The same argument for poverty, which had a high linear association from the demand side, i.e., it's a large controlling variable of the demand side constraints like household's awareness during pre-natal dietary practices for pregnant women or general standard of living of the household.
- In terms of the supply and demand side viewpoint, both supply and demand side factors were found to be significant in determining infant deaths as a whole and at different levels. Demand side constraints like poverty or mother's empowerment level had significant effects, either directly or indirectly over infant deaths in the form of individual care or medical attentiveness, whereas supply side factors like facility indicators of government health facilities, Anganwadi services or household's physical infrastructure had direct effects that often worked in response to the demand side indicators.
- Clear-cut regional differentiation could be found in the distribution of IMR level over India. However, well-marked spatial correlations could be traced between the major determinants of IMR, like levels of mother's empowerment or poverty levels, which signified the fact that regional differentiation in infant death was ascribed to poorer social and economic conditions in the same places.
- There were significant differences observed between factors affecting neo-natal mortality and the determinants of post neo-natal mortality, especially at the individual level. Pre and peri-natal factors had a higher effect on neo-natal deaths, whereas post-natal medical and non-medical cares had a larger effect on post neo-natal deaths.

As discussed above, some research has suggested the fact that the interplay of three different level factors determines the levels and trends of infant deaths and its components in any spatial context. It has been suggested that in the absence of modern health and education services, the levels of female autonomy may influence the patterns of child care, and hence infant mortality. However, the present analysis partially supported this hypothesis as far as mother's empowerment level was concerned. The levels of the mother's empowerment directly and indirectly through its association with the individual level care determined the levels of infant deaths during both pre and post natal period. However, the effect of economic development indicators cannot be overlooked as it is already shown that poverty seemed to have an independent effect on infant mortality as a whole. Household's social and economic circumstances, e.g., level of maternal education or general standard of living largely captured the family resources that affected child survival. Hence, the present analysis clearly demonstrated the importance of both medical and non-medical factors at different levels in explaining the observed regional differences in infant mortality in India. However, the relative importance of these two types of factors varies from state to state, but only an effective interplay of both kinds of factors at different levels of child birth can have a major role in reducing infant mortality. Simultaneous improvements in women's education and general economic conditions of the household would enhance the effect of preventive medical interventions by making them more acceptable and by improving the use made of available medical services for curative purposes.

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Chapter 3

INTER-TEMPORAL PATTERN OF GENDER BIAS IN INFANT MORTALITY IN INDIA

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ABSTRACT

Health being one of the most basic capabilities, the removal of gender bias in child health can go a long way in achieving gender parity in many other dimensions of human development. This chapter examines the inter-temporal pattern of gender bias in infant mortality for sixteen major states in India. It calculates state-wise infant mortality rate (IMR) for both the sexes from three rounds of unit level National Family Health Survey (NFHS) data. These rates are compared with the published data based on Sample Registration System (SRS). Children under age one year are the unit of the analysis. The study found that any consistently robust state-wise pattern of gender bias against girls in infant mortality is not present among all the sixteen major Indian states over the three rounds of NFHS and SRS. However, there is a strong inter-temporal pattern exists in girl children's mortality status. By the Rawlsian theory of justice, to reduce gender bias in infant mortality, the policy makers should try to raise health achievement of girl children more attentively in the states with high IMR for girls.

INTRODUCTION

Advancement of health care services is of utmost importance for its intrinsic value. The provision of public health is a basic human right and a crucial merit good. With the inception of the Human Development Index (HDI), the Human Poverty Index (HPI), and the Gender-related Development Index (GDI) by the United Nations Development Programme (UNDP),

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governments are required to redefine development. Universal access to health together with safe drinking water, sanitation, nutrition, basic education, information and employment are essential to balanced development. If India, like China, is to glean the gains of a demographic dividend and become an economic superpower by 2030, it will have to guarantee that her people are healthy, live long, generate wealth and dodge the tag of a 'high risk country'.

Since the Bhore Committee Report (1) and the Constitution of India, the Government of India (GoI) has corroborated many times its aim of improving the average health of its citizens, reducing inequalities in health, and fostering financial access to health care, particularly for the most destitute. In the Directive Principles of State Policy of the Constitution of India, Articles 38-2 and 41 stress the need for equitable access and assistance to the sick and the underserved and, right to employment, education, while Article 47 stresses on improving nutrition, the standard of living and, public health. Article 39 and Article 45 directs for gender equality and protection of children rights including education (2:84-91). A World Bank report on gender and development begins with the statement: 'Large gender disparities in basic human rights, in resources and economic opportunity…are pervasive around the world… these disparities are inextricably linked to poverty' (3).

The dual causality between health and wealth is well documented. Health and mortality status of infants and gender bias in health are 'synoptic indicators' of a society's present condition. A study of gender bias in child health is relevant as an area of research in its own right since children are helpless and, solely depend on the social settings in which they are born. Health being one of the most basic capabilities, removal of gender bias in child health can go a long way in achieving gender parity in many other dimensions of human development. Gender-specific health policies would make women more independent and empowered and thus achieve some of the goals laid by Millennium Development Declaration (declared in Sep, 2000 by 189 countries).

BACKGROUND AND HYPOTHESES

On a biological basis, women tend to have a lower mortality rate than men at nearly all age groups, ceteris paribus (4). Owing to the gender bias against women in many parts of the world, women receive less attention and care than men do, and particularly girls often receive far lesser support as compared to boys. As a consequence, mortality rates of females often exceed those of males (4-11). Gender discrimination prevails regardless of the realisation that prejudice in morbidity, nutritional status, or use of health care will probably contribute to greater gender bias in mortality (12-22).

Gender bias, even when it is not disastrous, may still generate greater debility among surviving girls and its effect may be perpetuated over generations (4, 11, 23-25). If the 'Barker thesis' (i.e., fetal origin of adult diseases hypothesis) (26, 27) is true, there is a possibility of a causal connection 'that goes from nutritional neglect of women to maternal undernourishment, and from there to fetal growth retardation and underweight babies, thence to greater child undernourishment' and, to a higher incidence of permanent disadvantages in health much later in adult life (28, 29). 'What begins as a neglect of the interests of women ends up causing adversities in the health and survival of all—even at advanced ages' (28). Thus, gender bias not only hurts women, but inflicts a heavy economic cost on the society by harming the health of all, including that of men (29). Gender bias can be a blend of ‘active’ bias (e.g., ‘intentional choice to provide health care to a sick boy but not to a sick girl’), ‘passive’ neglect (e.g., ‘discovering that a girl is sick later than that would be the case for a boy, simply because girls may be more neglected in day-to-day interactions than are boys’), and ‘selective favouritism’ (‘choices made by resource-constrained families that favour those children that the family can ill afford to lose’) (11).

Women in India face discrimination in terms of social, economic and political opportunities because of their inferior status. Gender bias prevails in terms of allocation of food, preventive and curative health care, education, work and wages, and fertility choice (30-33). A large body of literature suggests son preference and low status of women as the two important factors contributing to the gender bias against women. The patriarchal intra-familial economic structure coupled with the perceived cultural, religious and economic utility of boys over girls based on cultural norms, have been suggested as the original determining factors behind the degree of son preference and the inferior status of women across the regions of India (11,30). Daughters are considered as a net drain on parental resources in patrilineal and patrilocal communities (34). Intra-household gender discrimination has primary origins not in parental preference for boys but in higher returns to parents from investment in sons (35).

On an empirical note, son preference in India has endured for centuries. The 1901 census noted ‘there is no doubt that, as a rule, she (a girl) receives less attention than would be bestowed upon a son. She is less warmly clad, … she is probably not so well fed as a boy would be, and when ill, her parents are not likely to make the same strenuous efforts to ensure her recovery’ (20). Population sex ratios from censuses almost steadily stepped up, from 1,030 males per 1,000 females in 1901 to 1,072 males per 1,000 females in 2001 (36-41). Due to unequal treatment of women, India now has the largest share of ‘missing women’ in the world (42). ‘A strong preference for sons has been found to be pervasive in Indian society, affecting both attitudes and behaviour with respect to children and the choice regarding number and sex composition of children (12,43-50). Son preference is also an obstructing factor for maternal and child health care utilisation (51, 52).

Existing empirical literature on inter-state (or regional) pattern of gender bias suggests that boys are much more likely than girls to be taken to a health facility when sick in both north and south India (6, 17, 53-59). Girls are more likely to be malnourished than boys in both northern and southern states (6, 12, 29, 54, 60-63). ‘The states with strong anti-female bias include rich ones (Punjab and Haryana) as well as poor (Madhya Pradesh and Uttar Pradesh), and fast-growing states (Gujarat and Maharashtra) as well as growth-failures (Bihar and Uttar Pradesh)’ (28).

Gender bias in child health prevails even today when India is shining or Bharat Nirman is going on. ‘For India the infant mortality rate is marginally higher for females (58) than for males (56). However, in the neonatal period, like elsewhere, mortality in India is lower for females (37) than for males (41). As children get older, females are exposed to higher mortality than males.

Females have a 36 percent higher mortality than males in the post-neonatal period, and a 61 percent higher mortality than males at age 1-4 years (50). Boys are (seven percent) more likely than girls to be fully vaccinated. Boys are also somewhat more likely than girls to receive each of the individual vaccinations (50). Among the children under age five years with symptoms of acute respiratory infection (ARI), treatment was sought from a health facility or provider for 72 percent of the boys but 66 percent of the girls (50). Among the children under age five years with fever, treatment was sought from a health facility for 73 percent of the boys but 68 percent of the girls (50). Boys are also (seven percent) more likely than girls to be taken to a health facility for treatment in case of diarrhoea (50). Among children under five years, girls are three percent more likely to be underweight than boys (50). Among the last-born children, boys are 11 percent more exclusively breastfed than girls (50). For the children age 6-59 months, girls are more anaemic than boys (50).

The above discussion provides ample evidence of gender bias in child health indicators that ultimately transforms itself into gender imbalance in many other dimensions of human development. In this paper, infant mortality rate (IMR) is taken as a proxy for child health conditions. The IMR is an important measure of the well-being of infants, children, and pregnant women because it is associated with a variety of factors, such as maternal health, quality and access to medical care, socioeconomic conditions, and public health practices. IMR is the number of infants dying under one year of age in a year in a given geographical region per thousand live births in the same year and geographical region. IMR is treated as the most sensitive and commonly used indicator of general health and medical facilities available in a community as well as of the social and economic development of a population. The causes of infant mortality are ‘strongly correlated to those structural factors like economic development, general living conditions, social wellbeing, and the quality of the environment, that affect the health of entire populations’ (64). If mortality conditions improve, the IMR is immediately affected. Many health experts see the IMR as a sentinel indicator of child health and the well-being of a society over time. IMR also reflects the general standard of living of the people and effectiveness of interventions for improving maternal and child health in a country (65). Changes in specific health interventions affect IMR more rapidly and directly (65). The 2005 United Nations’ Human Development Report states: ‘no indicator captures the divergence in human development opportunity more powerfully than child mortality’ (66).

IMR is calculated as a probability measure only after adjusting for year of birth and year of death (67).

The direct method uses data collected on birth histories of women of childbearing age and produces the probability of dying before age one for children born alive, among women of childbearing age, during five year periods before the survey [0-4, 5-9, etc.]. Direct methods require each child’s date of birth, survival status, and date or age at death. This information is typically found in vital registration systems and in household surveys that collect complete birth histories from women of childbearing age. Birth histories include a series of detailed questions about each child a woman has given birth to during her lifetime, including the date the child was born, whether the child is still alive, and if not, the age at death.

This paper attempts to answer the following questions. First, is there evidence of gender bias in infant mortality? Second, if gender bias is there, what is the inter-state pattern of gender bias in infant mortality in India? Third, has this inter-state pattern of gender bias remained unchanged over the study period of almost one-and-a-half decades? If we can identify a robust pattern of gender bias, it is possible to focus on the particular state(s) to reduce and remove gender bias.

METHODS

The present study used unit-level record (individual recoded data file) from National Family Health Survey (NFHS)-III (2005-06), NFHS-II (1998-99), and NFHS-I (1992-93). 'NFHS-III collected information from a nationally representative sample of 109,041 households, 124,385 women age 15-49, and 74,369 men age 15-54 years. The NFHS-III sample covered 99 percent of India's population living in all 29 states' (50). 'The NFHS-II survey covered a representative sample of more than 90,000 eligible women age 15-49 from 26 states that comprise more than 99 percent of India's population' (68). The NFHS-I survey covered a representative sample of 89,777 ever-married women aged 13-49 years from 24 states and the National Capital Region of Delhi, which comprise 99 percent of the total population of India (10). It is worth to note that NFHS-II (1998-99), the second round of the series, is regarded as 'storehouse of demographic and health data in India' (69). State-wise IMRs are computed from the unit-level record for the major sixteen states of India for five-year period preceding the survey for both boys and girls separately as well as for all children. The IMRs by state and gender from three rounds of NFHS data is provided in table 1.

To check for robustness of the results, this study also uses state-wise IMR by sex of children from Sample Registration System (SRS) data published by Registrar General of India (RGI), Government of India. With a view to generate reliable and continuous data on these indicators, RGI initiated the scheme of sample registration of births and deaths in India popularly known as SRS in 1964-65 on a pilot basis and on full scale since 1969-70. The SRS is a large scale demographic survey for providing reliable annual estimates. The IMRs by state and gender from the three SRS rounds corresponding to the three NFHS rounds is shown in table 2. From tables 1 and 2, it is clear that the IMR estimates from both NFHS and SRS for all-India has declined over time. So is the case for most of the sixteen major states. Kerala is the only state that witnessed a rise in IMR for girl children which is evident from both NFHS and SRS data. Rajasthan is the only state that witnessed a rise in IMR in NFHS-II for both boys and girls. Punjab, Madhya Pradesh (in NFHS-II) and Himachal Pradesh (in NFHS-III) are the states where an increase in IMR for all children is actually due to rise in girl children's IMR. In Maharashtra and Andhra Pradesh (in NFHS-II), there is an increase in girl children's IMR without any corresponding rise in all children's IMR. However, the two states of Gujarat (NFHS-II) and West Bengal (NFHS-III) witnessed a rise in IMR for boys without any such increase in IMR for all children.

As IMR from NFHS data is calculated for the five-year period preceding the survey, we would expect that IMR from NFHS will be higher than the corresponding IMR from SRS annual data (as generally, IMR declines over time). State-wise differences in IMR for all children between NFHS and SRS are shown in table-3. Only for West Bengal and Bihar, the IMR estimate from NFHS is higher than that of SRS. But NFHS gives a consistently lower estimate than SRS for Rajasthan, Haryana, Himachal Pradesh, Madhya Pradesh, Orissa and Karnataka. State-wise difference in IMR for girl children between NFHS and SRS is shown in table-4. Again, NFHS gives a consistently lower IMR estimate than SRS for Haryana, Himachal Pradesh, Madhya Pradesh, Orissa, Maharashtra and Karnataka.

Children under age one year are the unit of the present analysis. Gender gap is calculated using the following formula: Gender Gap= $(X_g/X_b)*100$[1]. The state with the least value will have a rank of one (i.e., least gender bias against girl infants). In case of a tie (i.e., more than one states with equal value of gender bias), we allot the average rank to each of the states in that tie. Spearman rank correlation is used to check if the ranking pattern of state-wise gender bias in infant mortality remains consistent over time or not. Spearman's rho is a rank-order correlation coefficient which measures association at the ordinal level. This is a nonparametric version of the Pearson correlation based on the ranks of the data rather than the actual values.

State-wise gender bias in infant mortality calculated from various rounds of NFHS and SRS data are shown in the maps 1-6. It is evident from these maps that there is huge difference in the estimates of gender bias from NFHS data and the corresponding SRS data.

FINDINGS

Gender bias in infant mortality calculated from NFHS and SRS data is presented in tables 1 and 2 respectively. A lower value of gender bias is better from the perspective of girl children. In India, it is evident from both NFHS and SRS data that the gender bias in infant mortality increases over time. However, for the selected states both data do not provide us any robust trend and there are lot of ups and down in the value. Tables 3 and 4 presents the state-wise difference in IMR estimates between NFHS and SRS for all children and girl children respectively. Now we rank the states according to the value of gender gap (given in tables 1 and 2) for various NFHS and SRS rounds in table 5. The state with the least value will have a rank of one (i.e., least gender bias against girl infants). From table 5, one can see that there are lot of fluctuation in the state-wise rankings as we move over time either through NFHS or SRS data. Over almost the one-and-a-half decades of the study period of the three NFHS rounds, only West Bengal improves its relative rank but the states of Himachal Pradesh, Rajasthan, Madhya Pradesh and Tamil Nadu slide down the relative ladder. Over the same period of comparable SRS rounds, the states of Uttar Pradesh, Bihar, Orissa, West Bengal and Gujarat improve their relative ranks whereas the states of Haryana, Madhya Pradesh, Karnataka, Tamil Nadu and Kerala loose their relative rank[2].

For the third question of consistency of inter-state pattern of gender bias in infant mortality over time, we calculate the Spearman rank correlations. Table 6 provides the rank correlation matrix for each pair of gender bias in IMR rankings (of table 5) of the states in three NFHS rounds. It shows that the pattern of gender bias does not remain consistent over time (except NFHS-II and NFHS-III). Table 7 shows the rank correlation matrix for each pair of gender bias in IMR rankings (of table 5) of the states in three comparable SRS rounds. As before, it also shows that the pattern of gender bias does not remain consistent over time (except SRS-1992 and SRS-1998). Table-8 checks for comparability between state-wise gender bias in IMR rankings from each set of NFHS and SRS rounds. It shows that the rankings are consistent only for NFHS-III and SRS-2005.

Pattern of infant mortality for girl children

Along with the gender gap one should also look at the absolute level of health achievement for both boys and girls. There may be untoward cases of low gender gap with low absolute achievement level for both sexes. By the Rawlsian theory of justice (70), which gives complete priority to the worst-off group's (girls) gain (71), one should focus on the health achievement by the girl children only, as the reduction in gender bias in infant mortality being the ultimate motto. An attempt has been made to see if there is any state-wise pattern in absolute level of IMR for girl children only over the three rounds of NFHSs and SRSs. For this we use state-wise IMR for girl children from NFHS and SRS given in tables 1 and 2. Now we rank the states according to the absolute value of IMR for girl children (given in tables 1 and 2) for various NFHS and SRS rounds in table 9. The state with the least value will have a rank of one (i.e., best performing state as far as IMR is concerned). From table 9, one can see that there are a lot of fluctuations in the state-wise rankings as we move over time either through NFHS or SRS data. From both sets of data it is evident that Kerala is and has remained the state with lowest IMR for girls. Over almost the one-and-a-half decades of the study period of the three NFHS rounds, only Haryana and Karnataka improve their relative ranks but the states of Rajasthan, Orissa and Maharashtra slide down the relative ladder. Over the same period of comparable SRS rounds, the only state of Uttar Pradesh improves its relative rank whereas the states of Madhya Pradesh and Punjab loose their relative rank. Overall, the states with poor ranks[3] (i.e., high IMR for girls) are Uttar Pradesh, Orissa, Madhya Pradesh, Rajasthan, Bihar, Assam, Haryana, Andhra Pradesh and Gujarat.

Table 10 shows that the (Spearman) rank correlations of each pair of ranking of states for various NFHS rounds are strongly significant now. Also table 11 shows that the rank correlation coefficients for each pair of ranking of states for three SRS rounds are strongly significant. Thus there is a consistent inter-temporal state-wise pattern in girl infants' mortality status. This finding may be interpreted as, overall, girl children's mortality status in different states moved more or less in the same direction, but girl children's relative mortality status compared to boys has not moved in the same direction for all the states over the study period. Again when we look at the state-wise rankings based on girl infants' mortality status, the ranking by each round of NFHS data is strongly consistent with the ranking by each comparable round of SRS data (see table 12). This shows that irrespective of the data we use, the inter-temporal pattern in girl children's mortality status remains consistent over time.

DISCUSSION

The study used IMR as a proxy for child health status from the three rounds of National Family Health Survey and three comparable rounds of Sample Registration System data. Children under one year are the unit of the analysis. It analyses the data for sixteen major Indian states. The study found that any consistently robust state-wise pattern of gender bias against girl children in child health is not present among the states over the study period of one-and-a-half decades. However, the absence of any consistent state-wise pattern in gender bias does not mean that there is no gender bias in child health in the Indian states. Overall, there are high gender bias in infant mortality in the states of Punjab, Rajasthan, Haryana, Tamil Nadu, Uttar Pradesh, Gujarat, Maharashtra and Madhya Pradesh. However, the study found that there is a consistent inter-temporal state-wise pattern in girl infants' mortality status. Concentrating on the consistent state-wise pattern of girl children's mortality status is fairly justified on the Rawlsian premise as in the social valuation function it assumes the degree of inequality aversion tending to infinity. By the Rawlsian theory of justice, to reduce gender bias in infant mortality, the policy makers should try to raise health achievement of girl children more attentively in the states with high IMR for girls. Thus, to reduce gender bias in infant mortality, the policy makers should try to raise health achievement of girl children more carefully in the states of Uttar Pradesh, Orissa, Madhya Pradesh, Rajasthan, Bihar, Assam, Haryana, Andhra Pradesh and Gujarat.

The scope of the present study is rather limited. It does not address the questions like why a specific state-wise pattern in gender bias exists in a particular time period or is such pattern related to the state-wise public health expenditure or, why such pattern changes inconsistently over time. The study can be extended further along these lines.

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APPENDIX

Table 1. IMR by state and gender, three NFHS rounds

Number of infant deaths under one year of age per thousand live births for the five-year period preceding the survey by selected states

	Total			**Boy (X_b)**			**Girl (X_g)**			**Gender Gap**		
	NFHS-I (1988-92)	NFHS-II (1994-98)	NFHS-III (2001-05)	NFHS-I (1988-92)	NFHS-II (1994-98)	NFHS-III (2001-05)	NFHS-I (1988-92)	NFHS-II (1994-98)	NFHS-III (2001-05)	NFHS-I (1988-92)	NFHS-II (1994-98)	NFHS-III (2001-05)
India	**78.5**	**67.6**	**57.0**	**81.1**	**68.1**	**56.3**	**76.2**	**67.3**	**57.7**	**94.0**	**98.8**	**102.5**
Haryana	73.3	56.8	41.7	64.9	59.4	42.4	82.5	53.6	40.9	127.1	90.2	96.5
H.P.	55.8	34.4	**36.1**	64.6	37.2	36.1	45.8	31.2	**36.1**	70.9	83.9	100.0
Punjab	53.7	**57.1**	41.7	57.5	50.3	39.1	49.5	**65.0**	45.3	86.1	129.2	115.9
Rajasthan	72.6	**80.4**	65.3	66.3	**76.4**	54.5	79.7	**84.8**	77.4	120.2	111.0	142.0
M.P.$	85.2	**86.1**	69.5	91.1	86.6	64.4	79.2	**85.6**	74.8	86.9	98.8	116.1
U.P.$	99.9	86.7	72.7	99.4	85.2	70.3	100.5	88.4	75.3	101.1	103.8	107.1
Bihar$	89.2	72.9	61.7	92.4	76.8	58.7	86.0	68.8	65.2	93.1	89.6	111.1
Orissa	112.1	81.0	64.7	123.6	83.6	71.4	99.4	78.2	57.6	80.4	93.5	80.7
W.B.	75.3	48.7	48.0	70.3	53.8	**56.0**	80.6	43.0	39.7	114.7	79.9	70.9
Assam	88.7	69.5	66.1	95.6	75.2	68.8	82.0	63.1	63.3	85.8	83.9	92.0
Gujarat	68.7	62.6	49.7	62.0	**69.5**	46.8	75.6	55.2	52.9	121.9	79.4	113.0
Maharashtra	50.5	43.7	37.5	57.7	43.7	38.4	42.6	**43.7**	36.5	73.8	100.0	95.1
Andhra P.	70.4	65.8	53.5	77.1	64.5	54.8	63.5	**67.3**	52.0	82.4	104.3	94.9
Karnataka	65.4	51.5	43.2	71.6	52.3	47.0	58.8	50.6	39.0	82.1	96.7	83.0
Kerala	23.8	16.3	15.3	25.6	21.9	16.6	22.0	8.8	**12.0**	85.9	40.2	72.3
Tamil Nadu	67.7	48.2	30.4	79.9	43.3	27.7	56.7	53.2	33.2	71.0	122.9	119.9

Note: $: For 1992 and 1998, MP includes Chhattisgarh, UP includes Uttarakhand and Bihar includes Jharkhand.. For states, an increase in IMR from the previous time-period is marked in bold in table-1 and -2. Gender Gap= $(X_g/X_b)*100$.

Table 2. IMR by state and gender, three SRS rounds

Number of infant deaths under one year of age per thousand live births in a year in a given geographical region												
	Total			**Boy (X_b)**			**Girl (X_g)**			**Gender Gap**		
	SRS-1992	**SRS-1998**	**SRS-2005**	**SRS-1992**	**SRS-1998**	**SRS-2005**	**SRS-1992**	**SRS-1998**	**SRS-2005**	**SRS-1992**	**SRS-1998**	**SRS-2005**
India	**79***	**72***	**58**	**79***	**70***	**56**	**80***	**73***	**61**	**101.3**	**104.3**	**108.9**
Haryana	75	70	60	73	61	51	78	**81**	70	106.8	132.8	137.3
H.P.	67	**68**	49	67	60	47	66	**77**	51	98.5	128.3	108.5
Punjab	56	54	44	54	53	41	60	56	48	111.1	105.7	117.1
Rajasthan	90	83	68	88	83	64	92	84	72	104.5	101.2	112.5
M.P.$	104	98	76	109	99	72	98	97	79	89.9	98.0	109.7
U.P. $	98	85	73	92	79	71	105	93	75	114.1	117.7	105.6
Bihar$	73	67	61	71	67	60	74	66	62	104.2	98.5	103.3
Orissa	115	98	75	114	98	74	116	97	77	101.8	99.0	104.1
W.B.	65	53	38	67	59	38	62	48	39	92.5	81.4	102.6
Assam	82	76	68	86	85	66	78	67	69	90.7	78.8	104.5
Gujarat	67	64	54	66	63	52	69	66	55	104.5	104.8	105.8
Maharashtra	59	49	36	61	42	34	57	56	37	93.4	133.3	108.8
Andhra Pr.	71	66	57	73	65	56	68	68	58	93.2	104.6	103.6
Karnataka	73	58	50	77	61	48	67	56	51	87.0	91.8	106.3
Kerala	17	16	14	21	18	14	12	13	**15**	57.1	72.2	107.1
Tamil Nadu	58	53	37	58	48	35	59	58	39	101.7	120.8	111.4

Source: RGI (72) and RGI (73). Note: *: excluding J & K.

Table 3. State-wise difference in IMR between NFHS and SRS for all children

	(NFHS-I)-(SRS-1992)	**(NFHS-II) - (SRS-1998)**	**(NFHS-III) - (SRS-2005)**
W.B.	**10.3**	**-4.3**	**10**
Maharashtra	-8.5	-5.3	1.5
Kerala	6.8	0.3	1.3
Bihar$	**16.2**	**5.9**	0.7
U.P.$	1.9	1.7	-0.3
Assam	6.7	-6.5	-1.9
Punjab	-2.3	3.1	-2.3
Rajasthan	**-17.4**	-2.6	-2.7
Andhra Pr.	-0.6	-0.2	-3.5
Gujarat	1.7	-1.4	-4.3
M.P.$	**-18.8**	**-11.9**	**-6.5**
Tamil Nadu	**9.7**	**-4.8**	**-6.6**
Karnataka	**-7.6**	**-6.5**	**-6.8**
Orissa	-2.9	**-17**	**-10.3**
H.P.	**-11.2**	**-33.6**	**-12.9**
Haryana	-1.7	**-13.2**	**-18.3**

Table 4. State-wise difference in IMR between NFHS and SRS for girl children

	(NFHS-I)-(SRS-1992)	(NFHS-II) - (SRS-1998)	(NFHS-III) - (SRS-2005)
Haryana	4.5	**-27.4**	**-29.1**
H.P.	**-20.2**	**-45.8**	**-14.9**
Punjab	-10.5	9	-2.7
Rajasthan	-12.3	0.8	5.4
M.P.$	**-18.8**	**-11.4**	-4.2
U.P.$	-4.5	-4.6	0.3
Bihar$	12	2.8	3.2
Orissa	**-16.6**	**-18.8**	**-19.4**
W.B.	**18.6**	-5	0.7
Assam	4	-3.9	-5.7
Gujarat	**6.6**	**-10.8**	-2.1
Maharashtra	**-14.4**	**-12.3**	-0.5
Andhra Pr.	-4.5	-0.7	-6
Karnataka	**-8.2**	**-5.4**	**-12**
Kerala	**10**	**-4.2**	-3
Tamil Nadu	-2.3	-4.8	-5.8

Table 5. State-wise rank in gender bias in IMR

	NFHS-I (1992-93)	SRS-1992	NFHS-II (1998-99)	SRS-1998	NFHS-III (2005-06)	SRS-2005
Haryana	16	14	7	15	8	16
H.P.	1	8	4.5	14	9	10
Punjab	9	15	16	11	13	15
Rajasthan	14	12.5	14	8	16	14
M.P.$	10	3	10	5	14	12
U.P. $	12	16	12	12	10	6
Bihar$	11	11	6	6	11	2
Orissa	4	10	8	7	3	4
W.B.	13	5	3	3	1	1
Assam	7	4	4.5	2	5	5
Gujarat	15	12.5	2	10	12	7
Maharashtra	3	7	11	16	7	11
Andhra Pr.	6	6	13	9	6	3
Karnataka	5	2	9	4	4	8
Kerala	8	1	1	1	2	9
Tamil Nadu	2	9	15	13	16	13

Table 6. Rank-Correlation (Spearman) Matrix of IMR Rankings in Three NFHS Rounds

	NFHS-I (1992-93)	NFHS-II (1998-99)
NFHS-II (1998-99)	**-0.19**	—
NFHS-III (2005-06)	**0.18**	**0.56****

Note: **: significant at 5% level (two tail).

Table 7. Rank-correlation (Spearman) matrix of IMR rankings in three SRS rounds

	SRS-1992	SRS-1998
SRS-1998	**0.63***	—
SRS-2005	**0.27**	**0.49**

Note: *: significant at 1% level (two tail).

Table 8. Rank-correlation (Spearman) matrix of IMR rankings in three SRS and three NFHS rounds

	SRS-1992	SRS-1998	SRS-2005
NFHS-I (1992-93)	**0.42**	—	—
NFHS-II (1998-99)	—	**0.44**	—
NFHS-III (2005-06)	—	—	**0.57****

Note: **: significant at 5% level (two tail).

Table 9. State-wise rank in IMR for girl children

	NFHS-I (1992-93)	**SRS-1992**	**NFHS-II (1998-99)**	**SRS-1998**	**NFHS-III (2005-06)**	**SRS-2005**
Haryana	13	11.5	7	12	7	12
H.P.	3	6	2	11	3	6.5
Punjab	4	4	10	4	8	5
Rajasthan	10	13	14	13	16	13
M.P.$	9	14	15	15.5	14	16
U.P. $	16	15	16	14	15	14
Bihar$	14	10	12	7.5	13	10
Orissa	15	16	13	15.5	11	15
W.B.	11	5	3	2	6	3.5
Assam	12	11.5	9	9	12	11
Gujarat	8	9	8	7.5	10	8
Maharashtra	2	2	4	4	4	2
Andhra Pr.	7	8	11	10	9	9
Karnataka	6	7	5	4	5	6.5
Kerala	1	1	1	1	1	1
Tamil Nadu	5	3	6	6	2	3.5

Table 10. Rank-correlation (Spearman) matrix of IMR rankings in three NFHS rounds

	NFHS-I (1992-93)	NFHS-II (1998-99)
NFHS-II (1998-99)	**0.66***	—
NFHS-III (2005-06)	**0.74***	**0.92***

Note: *: significant at 1% level (two tail).

Table 11. Rank-correlation (Spearman) matrix of IMR rankings in three SRS rounds

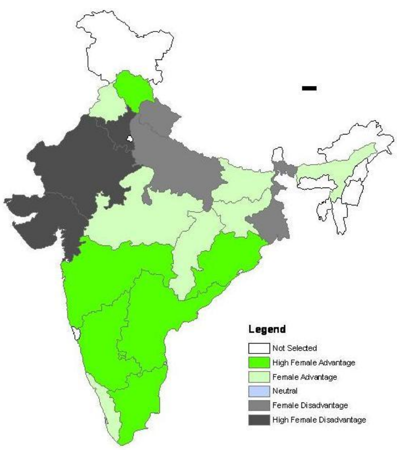
	SRS-1992	SRS-1998
SRS-1998	**0.88***	—
SRS-2005	**0.98***	**0.92***

Note: *: significant at 1% level (two tail).

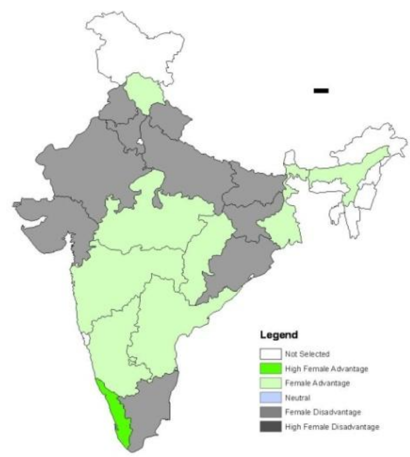
Table 12. Rank-correlation (Spearman) matrix of IMR rankings in three NFHS and three SRS rounds

	SRS-1992	SRS-1998	SRS-2005
NFHS-I (1992-93)	**0.84***	—	—
NFHS-II (1998-99)	—	**0.74***	—
NFHS-III(2005-06)	—	—	**0.85***

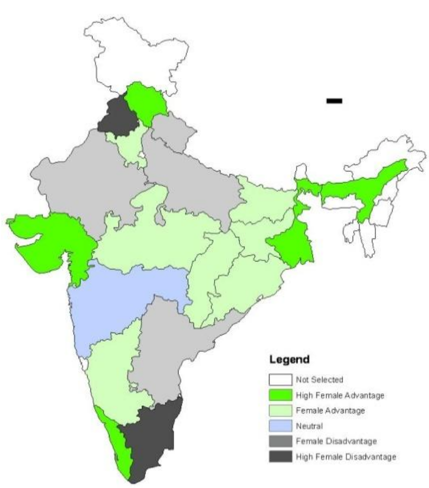
Note: *: significant at 1% level (two tail).



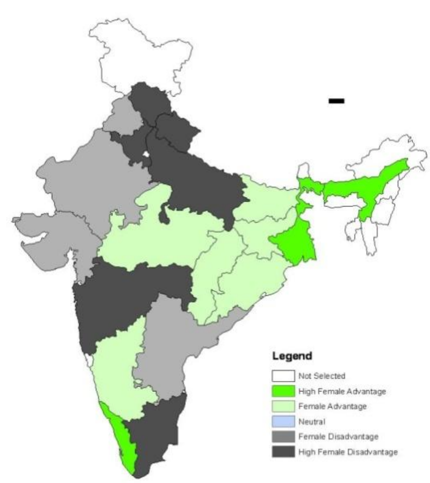
Map 1. Gender bias in IMR, NFHS-I (1988-92).



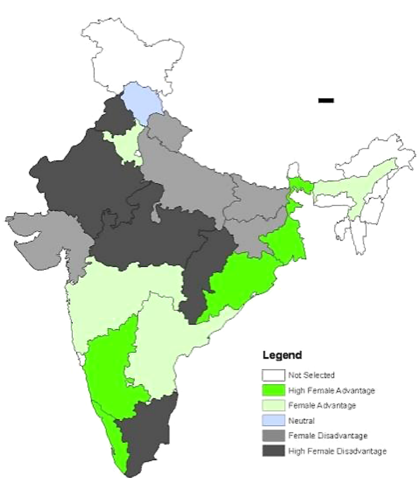
Map 2. Gender bias in IMR, SRS (1992).



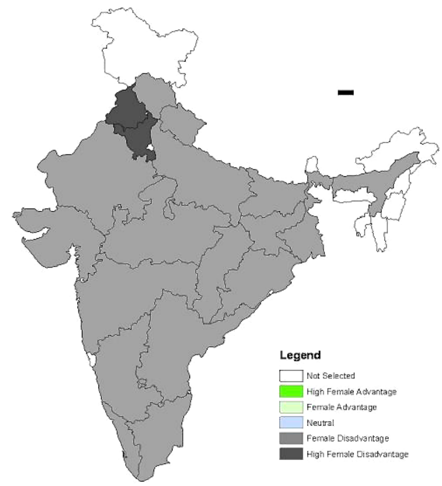
Map 3. Gender bias in IMR, NFHS-II (1994-98).



Map 4. Gender bias in IMR, SRS (1998).



Map 5. Gender bias in IMR, NFHS-III (2001-05).



Map 6. Gender bias in IMR, SRS (2005).

Legend Key: x<=85: High Female Advantage, 85<x<=99: Female Advantage, x=100: No Female Advantage (neutral), 100<x<115: Female Disadvantage, 115=<x: High Female Disadvantage.

Note: [$]: For 1992 and 1998, MP includes Chhattisgarh, UP includes Uttarakhand and Bihar includes Jharkhand. Gender Gap= $(X_g/X_b)*100$.

End notes

[1]This measure of gender gap is the relative gap between girl and boy and then taken in per cent (used in 11:403). Such a measure captures both the levels of coverage and gender equality. The value of gender gap decreases as coverage rates increase for both boys and girls with same absolute gap between them and it decreases as coverage rates increases for both boys and girls with lower absolute gap between them. A gender-equity sensitive indicator (GESI) would have been a better measure though the choice of degree of inequality aversion equal to two is questionable.

[2]Increase in gender bias in Kerala in latest time is due to the low absolute value of IMR for boys and girls and hence a relative increase in IMR for girls will have much greater impact on the measure of gender bias.

[3]It is based on simple average of the ranks in three rounds of NFHSs and three rounds of SRSs.

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Chapter 4

CHILD HEALTH AS COUNTRIES DEVELOP

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ABSTRACT

The future of any nation hinges on the health and nutrition status of its children. Over the last few decades, despite the reduction in infant mortality rate and improvement of child health in general, it is largely debated whether there has been gross inequity in this achievement. As a country develops it is expected that its development would have a rippling effect across the entire population. This chapter considers different arguments and counter arguments regarding the causes of inequality in child health. Methods: Extensive review of literature during 1976-2011 was conducted. Results: There seems to be no clear cut relationship between the development of a country and inequalities in child health due to the complexity in measuring both these areas. Any relationship is complicated by context and this can be seen in the literature which is at many times contradictory. Determinates that influence child health and mortality discussed are not only complex but are also overlapping and it is often a combination of contextual factors that influence a child health. Conclusion: Overall, critical child health indicators, particularly child survival, have improved globally but improvements in some countries or particular regions of countries have not been seen. The absolute differences have come down but the relative difference still remains the same. It is evident that people who have the greatest need are often the ones that receive the least as stated in the 'inverse care law'.

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INTRODUCTION

The future of any nation hinges on the health and nutrition status of its children. Over the last few decades, despite the reduction in infant mortality rate (IMR) and improvement of child health in general, it is largely debated whether there has been gross inequity in this achievement. One could argue, this inequity is evident when the huge disparity in child mortality between countries is observed. This is demonstrated by the fact that every day as many as 25,000 children die and the vast majority are from developing countries (1). Disparities within countries are also largely debated among researchers. Large variations have been recorded among different sub-groups (2). Whatever the situation may be, it is often the poor people who find themselves in disadvantageous bargaining positions and are the most susceptible to ill health. Often with poor immune systems, resulting from perennial under-nutrition, thus they are more susceptible to infectious diseases (3). In worst case scenario this contributes to death in early childhood.

Health, is defined by the WHO as “A state of complete physical, mental and social well-being and not merely the absence of diseases or infirmity” (4). This paper will consider this broad definition of health in reference to child health. There are multiple determinants which influence the health of a child that can be broadly classified as social, cultural, economic and political determinants. These cover all aspects of physical, psychological and mental health. Mother’s literacy levels were recorded as being the strongest determinant in societies where services were not widely available and dispersed (5). Educated mothers were thought to have been able to seek better health care for their children. Other determinants which need consideration are water and sanitation, access to health services, gender and environmental factors which includes housing (6).

As defined by Braveman (7), “Equity in health is the absence of systemic disparities in health (or in the major social determinants of health) between groups with differential levels of underlying social advantage/disadvantage- that is, wealth, power or prestige”. Inequity can be looked at as absence of equity. The issue of inequalities in child health has often been an area of keen interest, not only among researchers but also among policy makers. As a country develops it is expected that its development would have a rippling effect across the entire population. However, whether or not the economic development has contributed to improvement of health indicators in general and more importantly if the bread of development has been shared equally is often debated. The gap that exists between rich and poor countries is wide and some researchers argue that the gap is increasing (8). Inequality, with respect to child mortality, in different ethnic groups has also been studied in the past (9) where child health status in Africa was seen to vary between different ethnic groups.

There seems to be no clear cut relationship between the development of a country and inequalities in child health due to the complexity in measuring both these areas. Any relationship is complicated by context and this can be seen in the literature which is at many times contradictory. This essay will look at the different arguments and counter arguments regarding the causes of inequality in child health that haves been presented by different scholars. It will discuss some of the determinants of health and explore how context is important. Furthermore, the “inverse equity hypothesis” will be discussed which proposes an explanation for why some public health interventions contribute, decrease, or have no effect on child inequalities (10). The influence policy can have on these inequalities will also be considered.

OUR STUDY

A systematic review methodology was adopted to identify published evidence of the inequalities in child health in the global context. While the search was international, inclusion criteria limited the material to a period of thirty five years (1975 to 2011) and only evidence that was relevant to children up to 6 years were included. The key areas of search are the combination of key words i.e., Child Health; Inequality; Determinants; Equity. Majority Search has been done using Pub-Med and Web of Science while additional report and papers were extracted from London school of hygiene and tropical medicine and senate house library, London. From an initial pool of 78 full text articles, a total of 30 articles published in the black literature met the inclusion criteria. The systematic review process is shown in each paper was read by three reviewers with articles included on the basis of relevance to the study. The inclusion and exclusion criteria for the search are shown in table 1.

Table 1. Inclusion and exclusion criteria

CRITERIA	INCLUSION	EXCLUSION
Time Period	Within the time period 1975–2011	Any text out of this period
Language	English	Non- English
Place of study	Global Context	No exclusion
Geographical dimensions	No limitations	No limitation
Study population	Children up-to 6 years.	Any participants out of the inclusion criteria.
Aspects to be covered in the study	Child health inequity and equality	

DISCUSSION

Child mortality is often considered to be one of the prime and sensitive indicators of child health globally. Technological advancement has brought down the level of child death, particularly during the second half of 20th Century. The median under five mortality has reduced from 150 per 1000 live births during 1950s to about 40 per 1000 live births during 1990s (11). However, there has been an increasing international concern because child-health inequalities are growing. The gap is widening between the richer and poorer countries (10). This give rises to a vital question; are the socioeconomic differences between countries, with respect to child health, widening or narrowing? Often, issues relating to child health are set aside due to the lack of comparable data which can be analyzed (12). There are conflicting views in favour and against common arguments. The study conducted by Whitehead and Drever “Narrowing social inequalities in health?” provides some evidence that the reduction in inequalities was achievable especially in developed countries (13). However, existing evidence by Minujin and Delamonica in "understanding socio-economic inequalities in mortality and health in developing world" (12) highlighted that child mortality disparity remained constant in developed countries and worsened in most of the developing countries.

Forty years ago, Hart stated (14) the "inverse care law" in his pioneering work. He highlighted the inverse relationship between need of medical care and its availability. This law still holds true in many of the developing as well as some developed countries where invariably the heath model is centered around places where it has a lesser demand/need. As a corollary to the "Inverse Care Law" the "inverse equity hypothesis" was framed by Victora and her team. (10). This explains the inequalities between the rich and the poor and how the rich and the poor respond differently to public health programs. Their work further explained how it is the rich who benefit first, before the poor. Any intervention first reaches the higher socioeconomic society before reaching the poor. It is only when the rich receive a particular level of care from an intervention that the poor tend to benefit the same intervention. Interpreting inequalities is often a complex process and people in this process have been cautioned by Razzaque (15): "Before interpreting results, the following points should be kept in mind. Measuring the impact of (a) health intervention on time trend data is complex because some interventions might reach the poor after a certain period and can reduce the poor-rich differences while at the same time a new intervention that might be used more by rich than the poor and might have increased the poor-rich differences".

When considering the determinants of child health, maternal education has been found to be a more decisive determinant compared to the husband's occupation when child survival is considered (16). Multiple studies have highlighted that a mother's education plays a very important role in determining their child's health and survival. During 1985 the United Nations analyzed data from 15 countries and notices a linear relationship between maternal education and childhood mortality. With each extra year of education a mother has, child mortality came down by an average of 7-9% (17). However, Cladwell (16) pointed out that the influence of education should not be considered in isolation from the wider context. Cooksey and colleagues (18) argued that the effect of maternal education has been exaggerated. Nevertheless, equalizing education equalizes inequality. Understanding and applying the "inverse care law" (14) is particularly difficult. Resources often struggle to reach the places where they are need the most, that is, in areas with poor child health. If an appropriate program focusing on elementary or primary education can be designed, this could benefit the poor. The rich would have already achieved this level education; therefore solely the poor would be targeted. Considering the present level of low education among the poor they would utilize this opportunity, which in turn, would influence child morbidity and mortality while decreasing the inequalities that exist between the rich and the poor. Better education has often been found to have created am increased demand for (health) services and hence influence the service delivery mechanism (19).

Water, sanitation and environment are already considered some of the most important determinants of child health universally. Preston and Van (20) during 1978, pointed out that the improvement in urban environment appeared to have played a major role in the decline of mortality in many European cities during the 19th century. The relationship is complex and depends on a wide range of other contextual factors. A child's health may vary from one child to another with respect to sanitation level, immunity (21), maternal education (5), feeding practices (22) and maternal attitudes (23). Ian and Lush argued the importance of housing on child health. They argued that the reason for better child health in Thailand than Brazil was attributed to better housing. Children in Egypt who shared toilets with other children and families were found to have been 60% more likely to suffer from diarrhoea than children whose families had their own toilet (24).

Socioeconomic status is yet another well known determinant of child health. Last three decades has witnessed substantial reduction in child mortality in most developing nations. Despite this reduction analysis of Demographic Health survey (DHS) and World Fertility Survey (WFS) shows that socioeconomic inequality in child survival chances have not narrowed between 1970s data and 1980s, in some cases it has actually widened (25).

Brockerhoff argued that there is a link between ethnicity and child health in his paper on child survival among different ethnic groups in African countries (9). His study further stated how child mortality is directly linked with economic inequalities, differential use of health services and less directly linked with intergroup variations in geographical settings and cultural status of women.

A rural-urban inequality is also seen, with respect to child health. Before the sanitation revolution the urban child mortality rate was slightly higher than rural. This was understood to be due to the overcrowding living conditions and poor sanitation. Reduction in Child mortality happened after the 1st world war when access to clean water, sanitation facilities and child nutrition improved (26). In general, in developing countries it was not until after World War II that the urban child mortality rate dropped below the rural rate. However, in some major cities in developing countries have witnessed increases in urban child mortality, which have been linked to extreme poverty, family disintegration, lack of hygiene and infectious diseases such as HIV (26).

As a country develops, urbanization seems to be an unavoidable factor, which leads to increasing rural to urban migration. In Some countries rural to urban migration has detrimental effects on child health and mortality. As Antai pointed out that children of rural non-migrant mothers were at lower risk of child mortality when compared to children of rural-urban migrant mothers in Nigeria (27). Disruption of family and community ties, low socioeconomic status and vulnerability were found to be the reasons contributing to increased child mortality.

Social determinates influencing child health are highly contextual and vary from region to region and between countries. Moisi (28) in her paper, highlighted that geographical access to health care is not a determinant of child mortality in rural Kenyan settings with good health care facilities. DeFriese (29) contradicted Moisi and believed that poor access to health care is associated with poor child health.

Determinates that influence child health and mortality discussed are not only complex but are also overlapping and it is often a combination of contextual factors that influence a child health. The huge complexity of the issue therefore merits more understanding before formulation of a response. Inappropriate policy formulation and implementation without much understanding of the issues runs the risk of targeting the wrong people, such as those who are already better off in the community and leaving behind those who are relatively more needy.

To transform a plan into action, right of kind approaches is key. Cesar and his colleges (8) stated that there are two basic approaches which can raise coverage in poor population groups. The first one approach is the targeted approach, to focus on particular programs or interventions that are mainly targeted towards the poor. The other approach is to aim for universal coverage, which covers all segment of the society (both poor and the rich). However while universal programming, emphasis would be to addresses conditions important for disadvantaged groups. Alongside these approaches politics has a role to play. Strong political will that advocates for more egalitarian policies, including the strengthening of health care services, cannot be avoided. This should also be regarded as important in not only improving but also maintaining a nation's health (30).

CONCLUSION

Overall, critical child health indicators, particularly child survival, have improved globally but improvements in some countries or particular regions of countries have not been seen. The absolute differences have come down but the relative difference still remains the same. There are multiple determinates that influence child health. These vary depending on the context and often overlap. Maternal education has been the most widely discussed determinant and was seen to have a direct negative linear effect on child health. As no single program can be effective for all contexts, there is a large need to evolve individual policies to attend to the desired goal of, not only improving child health, but also to bridge down the gap, the gap of inequality that exists in different forms. Inappropriate understanding of the origin of inequality may result in the creation of a program that benefits the better in society rather than the poor. This can therefore widen the gap of inequalities. As a country develops, the best approach is one that benefits the poor and marginalized members of communities, benefited out of different health care programs. Right targeting towards the poor or designing programs which reaches universal coverage quickly benefiting all segments of the society seem to increase the success of interventions. It is evident that people who have the greatest need are often the ones that receive the least as stated in the 'inverse care law'. However, it must be remembered that reaching out to this segment of the society can be challenging. It becomes challenging, because there is often no demand for service from this segment of the society. Therefore, reaching out to these individuals can be costly. Caldwell, in his paper, (16) argues powerfully, "the key to low mortality at the societal level may be a synergy between mass education and egalitarian politics which lead to demands for a health service that caters to the needs of all".

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Chapter 5

PATTERNS AND DETERMINANTS OF GENDER BIAS IN CHILD HEALTH IN INDIA

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ABSTRACT

In this chapter an attempt will be made to identify patterns of gender gap in child health in India and their determinants, and examine the possible role of female education and women's agency in reducing the gap. With the help of 21 selected indicators of health-seeking behaviour and health outcome, it is shown that there is ample evidence of varying level of gender gap. It is found that the gender gap in various health outcomes are not much related to the gender gap in various indicators of health-seeking behaviour. However for the girl children's health achievement, the indicators of health-seeking behaviour are significantly related to the indicators of health outcome. It is also shown that any consistently robust pattern of gender bias against girl children in child health is *not* present in India. But there is a consistent pattern of girl children's absolute health achievement. Hence we focus on the girl children exclusively and tried to identify the determinants of health achievements for girl children. Given the Rawlsian theory of justice, the same determinants will, in turn, be able to reduce gender bias. We analyse the effects of some selected demographic and socioeconomic variables on the chance of full immunisation, chance of medical treatment in diarrhoea and medical treatment in fever/ cough, chance of breastfeeding, chance of malnutrition and chance of mortality for girl children. Except for a few cases, the results are consistently robust.

INTRODUCTION

Provision of public health is a basic human right and a crucial *merit* good, defined as an activity with very high positive externalities. Universal access to health together with safe

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drinking water, sanitation, nutrition, basic education, information and employment are essential to a balanced development. If India is to glean the gains of a demographic dividend and become a major economic power by 2030, it will have to guarantee that her people are healthy, live long and generate wealth.

Ever since the Bhore Committee Report (1) and the Constitution of India, the Government of India (GoI) has reiterated many times its aim of advancing the average health of its citizens, reducing inequalities in health, and fostering financial access to health care, particularly for the most destitute. In the Directive Principles of State Policy (2) of the Constitution of India, Articles 38-2 and 41 stress the need for equitable access and assistance to the sick and the underserved, along with the rights to employment and education, while Article 47 stresses improving nutrition, the standard of living and public health. Article 39 and Article 45 point to gender equality and the protection of children rights including education and Article 42 asks for just and humane work environment and maternity relief. Article 14 suggests that men and women have equal rights and opportunities in the political, economic and social spheres and Article 15-1 prohibits discrimination against any citizen on the grounds of religion, race, caste, sex, etc. Nevertheless, roughly by any benchmark, India's triumph in achieving these goals can at best be reckoned as varied (3).

Inequality between women and men can come out in many diverse forms—it has many faces, e.g., survival inequality, natality inequality, unequal facilities, ownership inequality, unequal sharing of household benefits and chores and domestic violence and physical victimisation (4). Gender disparity is, in fact, not one hardship but a multitude of problems. Gender inequality of one type tends to encourage and sustain gender inequality of other kinds (4). In most nations women have failed to 'hold up half the sky'. There are extensive inequalities even in morbidity and mortality in substantial parts of Asia and North Africa (5). In family behaviour, inequalities between men and women (and between boys and girls) are often accepted as 'natural' or 'appropriate' (5). Gender inequality takes the brutal form of remarkably high mortality rates of women and a subsequent predominance of men in the total population (4). Gender inequality is evident not just in the old form of mortality asymmetry, but also in the new form of sex-selective abortions aimed at eliminating female foetuses as many parents want the newborn to be a boy rather than a girl (4). Given equal nutrition and health care, women live on average slightly longer than men, even allowing for a modest level of maternal mortality. However, discrimination against females in many parts of the world meant that there were more than 100 million 'missing women' in the world in 1986 (6, 7). Daughters are likely to be put to work for the household at a very young age, are much less likely to be educated and to attain literacy than sons of the same households and, worst of all — being less valued than their brothers — they have less chance of staying alive, because they are more deprived of food or of healthcare (8-10). Women in both rich and poor countries also suffer from severe 'time poverty', since they are carrying the 'double burden' of domestic and breadwinning responsibilities (11). Along with these doubly burdened productive works women are also burdened with unpaid reproductive work.

Almost all over the world, cultural traditions pose obstacles to women's health and empowerment. Many traditions have portrayed women as less important than men, less deserving of basic life support, or of fundamental rights that are strongly correlated with quality of life, such as health, education, self-respect, right to work, social and political liberty and participation (4, 6). According to the 1995 UN Human Development Report, there is no country in the world in which women's quality of life is equal to that of men, according to a complex measure that includes longevity, health status, educational opportunities, employment and political rights.

The Constitution of India promises women equal employment opportunities (as men) and equal pay for equal work. But still today there is a significant degree of gender inequality in work opportunities and remuneration, and an astonishing range of variation in female labour force participation (12). The social barriers on the lifestyles of women tend to become more rigid as one moves up in the caste hierarchy (13). Generally, there is more seclusion of females in North India than in the South, and among upper castes and classes than among lower castes and classes (14).

There is a need to study gender as it deals with ‘emancipation of women from their subordination, and their achievement of equality, equity and empowerment’ (15). The United Nations Decade for Women (1976-85) played an essential role in highlighting the ‘important but often previously invisible role of women in the social and economic development of Third World countries and communities, and the particular ‘plight’ of low-income women’ (15). During this decade ‘policy-makers began to shift their focus from a universal concern with welfare-oriented, family-centred programmes which assumed motherhood as the most important role for women in the development process, to a diversity of approaches emphasising the productive role of women’ (15). Women are increasingly seen as active ‘agents’ of development from the earlier view of passive ‘patients’.

Health policies are aimed at the betterment of all children—boys and girls. But, as we will see later, the persistent seemingly gender-blind health policies have resulted in a situation where boys’ achievements outperform that of girls’ in almost all indicators of health. Thus it is important to look at the extent by which girls are lagging behind boys in the indicators of health. It is not only the absolute level of achievement of girls but the relative achievement of girls to boys which is important to study. As reduction and removal of gender bias in health can go a long way in achieving gender parity in many other dimensions of human development, not only for the present generation but also over the generations, studying gender bias is of utmost importance.

Preference for sons is prominent in Asia and North Africa (16) and it is particularly strong in the Indian subcontinent (17). In India, son preference endured for centuries. Population sex ratios from censuses almost steadily stepped up, from 1030 males per 1000 females in 1901 to 1064 males per 1000 females in 2011 (18-23). Sex ratios for children under age 10 years became more masculine in India over 1961-1991 (19, 24-28). ‘A strong preference for sons has been found to be pervasive in Indian society, affecting both attitudes and behaviour with respect to children and the choice regarding number and sex composition of children (29-37). Son preference is an obstructing factor for maternal and child health care utilisation (38, 39).

Mortality rates of females often exceed than those of males (40-47). Gender discrimination prevails regardless of the realisation that prejudice in morbidity, nutritional status, or use of health care will probably contribute to greater gender bias in mortality (14, 30, 48-56).

Gender bias in India was traced as early as the 1901 Census, which notes ‘there is no doubt that, as a rule, she (a girl) receives less attention than would be bestowed upon a son. She is less warmly clad, … she is probably not so well fed as a boy would be, and when ill, her parents are not likely to make the same strenuous efforts to ensure her recovery’ (14). Due to unequal treatment of women, India now has the largest share of ‘missing women’ in the world (57). Female infanticide has been widely recorded in India, especially in North and North-western India (58, 59). Such a practice has also been noted recently in South India, in Tamil Nadu (60, 61). Also the advanced technology to determine sex of the foetus helps in female foeticide (16).

Gender bias, even when it is not disastrous, may still create greater debility among surviving girls and its effect may be perpetuated over generations (46, 47, 62-64). If the 'Barker thesis' (i.e., foetal origin of adult diseases hypothesis) (65, 66) is true, there is a possibility of a causal connection 'that goes from nutritional neglect of women to maternal under-nourishment, and from there to foetal growth retardation and underweight babies, thence to greater child under-nourishment' and to a higher incidence of permanent disadvantages in health much later in adult life (4, 67). 'What begins as a neglect of the interests of women ends up causing adversities in the health and survival of all—even at advanced ages' (4). Thus, gender bias not only hurts women, but inflicts a heavy economic cost on the society by harming the health of all, including that of men (67). Gender bias can be a blend of 'active' bias (e.g., 'intentional choice to provide health care to a sick boy but not to a sick girl'), 'passive' neglect (e.g., 'discovering that a girl is sick later than that would be the case for a boy, simply because girls may be more neglected in day-to-day interactions than are boys'), and 'selective favouritism' ('choices made by resource-constrained families that favour those children that the family can ill afford to lose') (46).

Women in India face discrimination in terms of social, economic and political opportunities because of their 'inferior' status. Gender bias prevails in terms of allocation of food, preventive and curative health care, education, work and wages and, fertility choice (68-71). A large body of literature suggests that son preference and the low status of women are the two important factors contributing to the gender bias against women. The patriarchal intra-familial economic structure coupled with the perceived cultural, religious and economic utility of boys over girls based on cultural norms have been suggested as the original determining factors behind the degree of son preference and the inferior status of women across the regions of India (16, 46, 68). Daughters are considered as a net drain on parental resources in patrilineal and patrilocal communities (72). Intra-household gender discrimination has primary origins not in parental preference for boys but in higher returns to parents from investment in sons (73).

Gender bias in child health prevails even today when India is *shining* in terms of aggregate economic growth indicators or *Bharat Nirman* is going on. There are several conflicting findings in the literature on the issue of gender bias. For example, gender bias tends to diminish with higher female literacy (74) and lower female literacy (75); with higher levels of poverty (8, 76, 77) and lower levels of poverty (78); with higher levels of fertility (8, 79) and lower levels of fertility (75, 80). Other household opportunities (e.g., urbanisation, higher household standard of living, better parental education, mother's empowerment, etc.) can also affect gender bias. Female household headship can also affect female disadvantage. The reasons behind women household headship may be economic, sociological, geographical or ecological (81).

It is found that enhanced employment opportunities for adult women tend to raise the relative survival chances of girls (82). Some studies also show that the relative survival chance of girls is positively related to female labour force participation (51, 52). 'Higher levels of female literacy and (female) labour force participation are strongly associated with lower levels of relative female disadvantage in child survival' (4). Gender bias in child survival could also be affected by some other variables, *e.g.*, mortality, fertility, development indicators, geographical location, *etc*. It is evident that gender bias in child survival tends to be relatively low among poor households, among backward castes, and among households with high levels of female labour force participation (83).

Given that there is a strong preference for sons in India, there are significant variations in the extent of this preference within the country (16). Prevalence of ‘female disadvantage’ is evident in large parts of India, particularly in the large northern states rather than the southern states (16, 41, 51, 80, 83-88). There exists a ‘Bermuda Triangle’ for the female child in India in a zone of 24 districts consisting parts of Rajasthan, Haryana, western Uttar Pradesh and Madhya Pradesh (89).

The country can be roughly divided into two by a line that resembles the contours of the Satpura hill range, extending eastward to join the Chota Nagpur hills of southern Bihar. To the north of this line sex ratios are high and to the south sex ratios are comparatively low (16, 90). One study have explained the North-South demographic divide in terms of female autonomy, i.e., decision-making ability regarding personal matters, with low female autonomy in the North compared to higher female autonomy in the South (90).

Boys are much more likely than girls to be taken to a health facility when sick in both north and south India (41, 51, 80, 83-88). Again, girls are more likely to be malnourished than boys in both northern and southern states (30, 41, 67, 80, 91-94). ‘The states with strong anti-female bias include rich ones (Punjab and Haryana) as well as poor (Madhya Pradesh and Uttar Pradesh), and fast-growing states (Gujarat and Maharashtra) as well as growth-failures (Bihar and Uttar Pradesh). It is thus clear that we have to look beyond material prosperity or economic success or GNP growth into broadly cultural and social influences’ (4). ‘… variables that relate to the general level of economic development and modernisation turn out, in these (83, 95) statistical studies, to have no significant effect on gender bias in child survival, and can sometimes—when not accompanied by empowerment of women—even strengthen, rather than weaken, the gender bias in child survival. This applies *inter alia* to urbanisation, male literacy, the availability of medical facilities, and the level of poverty. In so far as a positive connection does exist in India between the level of development and reduced gender bias in (child) survival, it seems to work mainly through variables that are directly related to women’s agency, such as female literacy and female labour force participation’ (4).

OBJECTIVE AND RESEARCH QUESTIONS

The study will make an attempt to identify the pattern of gender gaps in child health in India, to find out its socioeconomic and demographic determinants and explore the possible role of female education and women’s agency in reducing the gender gap. It will focus on selected indicators of health outcomes (e.g., post-neonatal mortality, child mortality, prevalence of malnutrition) and health-seeking behaviour (e.g., immunisation coverage [preventive health care], medical treatment in diarrhoea and medical treatment in fever/ cough [curative health care] and breastfeeding [feeding practice]). Here neonatal mortality is not considered because it is least affected by socioeconomic and demographic indicators and is mostly due to biological reasons.

On the basis of exploratory data analysis, the study intends to address the following questions:

- Is there evidence of gender gap in various indicators of health-seeking behaviour (e.g., immunisation coverage, medical treatment in diarrhoea, medical treatment in fever/cough and breastfeeding), and if so, how does the gender gap vary between different regions?
- Is there evidence of gender gap in various health outcomes (e.g., post-neonatal mortality, child mortality, malnutrition), and if so, how does the gender bias vary between different regions?
- Can the gender gap (if any) in various health outcomes be related to a corresponding gender gap in various indicators of health-seeking behaviour?
- If gender gap exists, what is the regional pattern of gender gap in child health in India? How has this regional pattern of gender gap changed over the study period of almost one-and-a-half decades?
- What are the socio-economic and demographic determinants of gender gap in health outcomes and health-seeking behaviour?
- How does female education and women's agency affect the gender gap in health outcomes and health-seeking behaviour?
- Are the results of previous analyses robust?

OUR STUDY

The present study uses secondary data from National Family Health Survey (NFHS)-III (2005-06), NFHS-II (1998-99), and NFHS-I (1992-93) (37, 45). These surveys provides state-level estimates of demographic and health parameters as well as data on various socioeconomic and demographic factors that are critical for bringing about desired changes in India's demographic and health situation. NFHS-I was a 'landmark in the history of collection of demographic data through surveys' (96). 'It is widely recognised that the NFHSs play a pivotal role in providing valuable conventional and non-conventional demographic and health information on India' (97). It is worth noting that the NFHS series is regarded as 'storehouse of demographic and health data in India' (97). The NFHS is 'unique' (or 'unprecedented') because of—uniformity of its questionnaires, sampling method, data collection, analysis of data; a representative sample in the north-eastern states for the first time; in-depth uniform training of interviewers and strict supervision (98, 99). The NFHS sampling design followed a systematic, multi-stage stratified random sample of households, all over the country (98). A post-survey check (with five percent of samples) of NFHS-I also confirmed its 'high quality data' (100).

Children under age three years are the unit of the present analysis. A child data file is created by merging selected household and mother's characteristics from household and women's data files respectively. The predictor variables could be birth order of the child [1, 2, 3, 4 and above], residence (rural, urban), mother's education (illiterate, primary, secondary, higher), mother's age [19 or less, 20-24, 25-29, 30-49 years], antenatal care (no, yes), religion (Hindu, Muslim, Christian and other religious minorities), caste/ tribe (general, other backward class, scheduled caste, scheduled tribe), standard of living index (low, medium, high) or wealth index (poorest, poorer, middle, richer, richest), media exposure[1] (no, yes), sex of household head (female, male), mother's empowerment index[2] (low, medium, high), zone of states (Central, North, East, Northeast, West, South), electricity (no, yes).

The study identifies patterns of gender gap in post-neonatal mortality, child mortality, and prevalence of malnutrition, immunisation coverage, diarrhoea treatment, fever / cough treatment, and breast-feeding. The gender gap is calculated as a relative gap between the achievement of boys and girls (first two questions). For the third question, state-level OLS regression is undertaken. The study uses the Borda rule and Principal Component Analysis to see the regional pattern in gender gap in child health for the fourth question. For the fifth question, binary bivariate and multivariate logit regression analyses are performed. Structural estimation of the full model is beyond the scope of the present study, which estimates a few reduced form models examining the magnitude of gender bias in child health after controlling for socioeconomic and demographic factors that could influence gender bias. Logistic regression results are presented in multiple classification analysis (MCA) form. This involves calculating unadjusted and adjusted values of the response variable for each category of every predictor variable. Unadjusted values are calculated from logit regressions incorporating only one predictor variable. Adjusted values are calculated from logit regressions incorporating all predictor variables simultaneously. When calculating the adjusted values for a particular predictor variable, all other predictor variables are controlled by setting them to their mean values in the underlying regression (101). The effectiveness of female education and women's empowerment (sixth question), can be seen from the adjusted effects of the logistic regression results. The robustness of the results is tested using the first and second round of the NFHS dataset.

FINDINGS

Gender gap in health-seeking behaviour for children in India

Here we will explore if there is any evidence of gender gap in the selected indicators of health-seeking behaviour for children in the states of India. The selected indicators of health-seeking behaviour are: childhood immunisation, childhood diarrhoea, childhood fever/cough and childhood breastfeeding. We will see the extent of gender gap in these indicators in the Indian states and how this gender gap changes over the study period of almost one-and-a-half decades.

The state-wise gender gap for all the indicators is calculated using the following relative gap formula: $\text{Gender Gap} = \dfrac{X_{Boy} - X_{Girl}}{X_{Girl}} \times 100$. This measure of gender gap is the relative gap between boy and girl minus one and then taken in per cent (6, 46, 68, 83, 102-105). Some studies measure gender gap as the absolute gap (106, 107) or as the relative gap (108—simple arithmetic average of relative gaps) or both (109, 110). These studies use a particular gap (or more than one gap) without giving much rationale for the choice.

A relative gap measure captures both the levels of coverage and gender equality. The value of gender gap decreases as coverage rates increase for both boys and girls with same absolute gap between them and it decreases as coverage rates increases for both boys and girls with lower absolute gap between them. A gender-equity-sensitive indicator (GESI) would have been a better measure, though the choice of degree of inequality aversion equal to two is questionable.

This relative gap formula satisfies all the four principles of an inequality index, namely, *principle of population symmetry*, *principle of transfer*, *principle of scale invariance* and *principle of constant addition*. An absolute gap formula, however, does not satisfy *principle of scale invariance* and *principle of constant addition*. Moreover, the absolute gap formula is not unit-free but a relative gap formula is free of any units.

State-wise gender gap in full immunisation is shown in figure-1. There exists a positive gender gap in immunisation in India in all three rounds of NFHS (more than five percent). The states witnessing a reduction in gender gap over time are: Delhi, Haryana, Himachal Pradesh, Rajasthan, Uttarakhand, Uttar Pradesh, Orissa, Nagaland, Sikkim and Tamil Nadu. Bihar is the only state where gender gap remains almost stagnant at above 40 percent over the thirteen year period. Meghalaya is the only state that has a gender gap favourable to girl children in all three rounds of NFHS though its extent is decreasing over time. Maharashtra is the only state where gender gap consistently increased over time.

For all three indicators of childhood diarrhoea, state-wise gender gap in three rounds of NFHS is presented in figures 2-4. There exists a positive gender gap in all three indicators of childhood diarrhoea in India in favour of boys in all three rounds of NFHS. In case of diarrhoea, girls received no treatment at least eight percent more than boys and boys received medical treatment at least five percent more than girls in India. Boys are also more likely receive ORS than girls.

Gender gaps in these two indicators of childhood fever/cough across the states are presented in figures 5 and 6. There exists a positive gender gap in both the indicators of childhood fever/ cough in India in favour of boys in all three rounds of NFHS. In case of fever/ cough, girls received no treatment at least ten percent more than boys and boys received medical treatment at least six percent more than girls in India.

It clearly shows that in most of the states there is a decrease in medical treatment in public health facility over the years (figure 7)[3]. Gender gap in childhood fever/ cough treatment in public and private health facility across the states are presented in figures 8 and 9 respectively.

State-wise gender gaps in childhood breastfeeding for five indicators (never breastfed, less than six months breastfed, at least six months breastfed, currently breastfeeding and exclusively breastfed for first six months) are shown in figures 10-14.

So it is evident that there is strong evidence of gender gap in the selected thirteen indicators of health-seeking behaviour in immunisation, diarrhoea, fever/ cough and breastfeeding for children in all the states of India. For a particular state, it might so happen that for a particular variable, gender gap (and/or its sign) changes over time and the gender gap (and/or its sign) changes for different variables in a particular time period.

Gender gap in health outcome for children in India

Here we will explore if there is any evidence of gender gap in the selected indicators of health outcomes for children in the states of India. The selected indicators of health outcomes are childhood malnutrition and childhood mortality. Gender gap in childhood malnutrition is shown in figures 15-20.

Post-neonatal death rate is calculated as the percentage of children age 1-11 months who died among the children ever born for boy and girl children separately for each state. Gender gap in post-neonatal death is shown in figure 21. Child death rate is calculated as the percentage of children age 12-35 months who died among the children ever born for boy and girl children separately for each state. Gender gap in child death is shown in figure 22. From figures 21 and 22 one can argue that as children grow older, girl children receive more harshly biased treatment.

So it is evident that there is strong evidence of gender gap in the selected eight indicators of health outcome in malnutrition and mortality for children in the states of India. For a particular state it might so happen that for a particular variable gender gap (and/or its sign) changes over time and gender gap (and/or its sign) changes for different variables in a particular time period.

Impact of gender gap in health-seeking behaviour on gender gap in health outcome[4]

Here we will examine whether the gender gap in various health outcomes is related to a corresponding gender gap in various indicators of health-seeking behaviour. Ordinary least square (OLS) method will be used for state-level reduced-form regressions. The selected dependent variables are gender gap in post-neonatal survival, gender gap in childhood survival and gender gap in childhood nutrition. Independent variables are gender gap in full immunisation, gender gap in medical treatment in diarrhoea, gender gap in medical treatment in fever/ cough and gender gap in breastfeeding with at least six months breastfed. In addition we incorporate two dummy variables for major states and southern states. We run OLS regression for three separate statistical models for each round of NFHS as well as for the pooled data of all three rounds.

The study found that the gender gaps in various health outcomes are not much related to the gender gaps in various indicators of health-seeking behaviour. So the gender gap in health-seeking behaviour does not really transform into the gender gap in health outcome for the children in the states of India.

However for girl children’s health achievement, the indicators of health-seeking behaviour are significantly related to the indicators of health outcome. Full immunisation rate for the girl children has a consistently significant impact on all the indicators of health outcome. An increase in full vaccination coverage rate for girl children reduces post-neonatal mortality, childhood mortality and childhood malnutrition rates for the girl children. Girl children’s health outcome is worse in the major states compared to other non-major states.

Pattern of gender gap in child health in India

Here we will try to see if there is any pattern of gender gap in child health exists in India. Also we will try to explore whether this pattern of gender gap in child health remained consistent over the study period of almost one-and-a-half decades. If we can identify the consistent pattern of gender gap, it is possible to focus on those particular areas to reduce and remove gender gap.

***State-wise pattern of gender gap in child health in India*[5]**

The selected 21 indicators of health-seeking behaviour and health outcome are: for childhood immunisation—A: childhood full vaccination; for diarrhoea—B: childhood diarrhoea with 'no treatment', C: childhood diarrhoea with 'medical treatment', D: childhood diarrhoea with 'given ORS'; for breastfeeding—E: childhood breastfeeding with 'never breastfed', F: childhood breastfeeding with 'less than six months breastfed', G: childhood breastfeeding with 'at least six months breastfed', H: childhood breastfeeding with 'currently breastfeeding', I: childhood breastfeeding with 'exclusively breastfed for first six months'; for malnutrition—J: severely stunted (height-for-age, -3 SD), K: stunted (height-for-age, -2 SD), L: severely underweight (weight-for-age, -3 SD), M: underweight (weight-for-age, -2 SD), N: severely wasted (weight-for-height, -3 SD), O: wasted (weight-for-height, -2 SD); for fever/ cough—P: childhood fever/ cough with ‘received no treatment’, Q: childhood fever/ cough with ‘received medical treatment’, R: childhood fever/ cough with ‘received medical treatment in public health facility’, S: childhood fever/ cough with ‘received medical treatment in private health facility’; and for mortality—T: post-neonatal death, U: child death.

The 21 dimensions will be reduced by some ordinal measure. As an ordinal aggregator, the study used the well-known Borda rule (named after Jean-Charles de Borda who devised it in 1770). The rule gives a method of rank-order scoring, the method being to award each state a point equal to its rank in each indicator (A-U) of ranking, adding each state’s scores to obtain its aggregate score, and then ranking states on the basis of their aggregate scores (111), separately for each round of NFHS.

Each state is ranked for each of the chosen indicators to capture the relative position of the Indian states in gender bias against girl children. A higher rank (number) indicates higher gender bias against girl children. Ranking is done in ascending order (a higher value indicates higher gender bias against girls) for the following indicators—A, C, D, G, H, I, Q, R, and S. For the rest of the indicators, ranking is done in descending order (a lower value indicates higher gender bias against girls). Borda rank is calculated for each state on the basis of their aggregate scores for each round of NFHS. State-wise Borda rank in gender bias against girl children in child health is presented in table-1. Again, a higher rank (number) signifies higher gender bias against girls. For any NFHS round, a Borda rank of one signifies lowest gender bias against girls in that state for that period.

From table 1, one can see that there are lot of ups and down in the state-wise rankings as we move from NFHS-I to NFHS-III. Over almost the one and a half decades of the study period, Gujarat, Himachal Pradesh, Uttarakhand, Jharkhand, Chhattisgarh and Meghalaya consistently improved their ranks, i.e., gender bias against girl children has consistently reduced relative to the other states. But the picture is just the reverse for Punjab and Mizoram where gender bias against girl children in child health has consistently increased over time relative to the other states. Table 2 provides the rank (Spearman) correlation coefficient for each pair of Borda rankings from the three rounds of NFHSs (given in table 1). The rank correlation coefficients are not significant even at 10 percent level, suggesting that the state-wise pattern of gender bias against girl children in child health is not consistent.

To check the robustness of the absence of a consistent state-wise pattern in gender bias in child health, the analysis needs further calibration. First, instead of all the 21 indicators we took only six indicators (A, C, G, L, Q and U) for all the 29 states. Doing the same exercise as above, the (Spearman) correlation coefficients for each pair of Borda rankings from the three rounds of NFHSs are not significant even at 10 percent level as before (table 3). Second, we do the same exercise for the major 19 states with the same six indicators (A, C, G, L, Q and U). Again the correlation coefficients are also not significant (see tables 4 and 5).

To check robustness of the results the study also uses Principal Component Analysis (PCA) technique as a second tool to reduce dimensions. PCA reduces a large set of variables to a much smaller set that still contains most of the information about the large set. It reduces the variation in a correlated multi-dimension to a set of uncorrelated components. Principal components (defined as a normalised linear combination of the original variables) are constructed from the 21 indicators. The principal components with Eigen value greater than one are considered. Then a composite index is constructed as a weighted average of the principal components or factors, where the weights are (Eigen value of the corresponding principal component)/ (sum of all Eigen values) (112). On the basis of the values of the composite index all the states are ranked in ascending order separately for each round of NFHS.

For calculation of PCA, all the 21 indicators were made *unidirectional*. Say, for b, we used the B: childhood diarrhoea with ‘no treatment’. We deducted the percentages of boys and girls who received ‘no treatment’ from 100 to get percentages of boys and girls who received ‘any treatment’. Then the gender gap is calculated using the previously mentioned formula. The same method is applied for b, e, f, j, k, l, m, n, o, p, t, and u also. With the values of composite index, states are ranked in ascending order, separately for each round of NFHS. A higher rank (number) indicates higher gender bias against girls. With the values of composite index, states are ranked in ascending order, separately for each round of NFHS. A higher rank (number) indicates higher gender bias against girls.

Here we consider six principal factors with Eigen values greater than one in both NFHS-I and –II; and in NFHS-III, seven principal factors with Eigen values greater than one are considered. The cumulative variance explained by these principal factors is 83 percent for NFHS-I, 78 percent for NFHS-II and 82 percent for NFHS-III. With these principal factors, we construct a composite index and rank the states accordingly. Table-6 presents the state-wise composite index and the ranks of the states. From table-6 one can see that there are lot of ups and down in the state-wise rankings as we move from NFHS-I to NFHS-III. Over the study period of thirteen years, Gujarat, Himachal Pradesh, Rajasthan, Karnataka and to some extent Orissa, consistently improved their ranks, *i.e.*, gender bias against girl children has consistently reduced relative to the other states. But the picture is just reverse for Punjab, Bihar and Mizoram where gender bias against girl children in child health has consistently increased over time. For the entire picture of state-wise pattern of gender bias over the three rounds of NFHSs, we need table 7. Table 7 provides the (Spearman) correlation coefficient for each pair of rankings from the three rounds of NFHSs (given in table 6). The correlation coefficients are not significant even at 10 percent level suggesting that there is no consistent state-wise pattern of gender bias against girl children in child health.

To check the robustness of the absence of a consistent state-wise pattern in gender bias in child health, the analysis is calibrated further. First, we consider only one principal component that explains the largest proportion of total variation in all the 21 indicators. The total variance explained by the first principal component is only 24 percent for NFHS-I, 23 percent for NFHS-II, and 20 percent for NFHS-III. But the (Spearman) correlation coefficients are not significant except for the correlation coefficient between the ranks in NFHS-I and NFHS-II (significant at five percent level). As the total explained variance is quite low, we should not place much weight on this solitary exception.

Secondly, we considered only the 19 major states. Now, we are considering only two principal factors with Eigen values greater than one in NFHS-I and three principal factors with Eigen values greater than one for both NFHS-II and -III. The cumulative variance explained by these principal factors is 57 percent for NFHS-I, 79 percent for NFHS-II and 76 percent for NFHS-III. With these principal factors, we construct a composite index and rank the states accordingly. Again, the correlation coefficients of the ranks are not significant as before.

The study found that any consistently robust state-wise pattern of gender bias against girl children in child health is *not* present among all the 29 Indian states over the three rounds of NFHSs. However, the absence of any consistent state-wise pattern in gender bias does not mean that there is no gender bias in child health in the Indian states. Among the 19 major states, overall, there is high gender bias in three Empowered Action Group of states (namely, Uttar Pradesh, Madhya Pradesh, and Bihar) and in Andhra Pradesh, Punjab, and Gujarat as well. The states which succeeded in reducing gender bias against girl children in child health over the years as compared to the other states are Gujarat, Himachal Pradesh, Rajasthan, West Bengal, Uttarakhand, Chhattisgarh, and Jharkhand. But for the states of Jammu and Kashmir, Punjab, Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu gender bias against girl children has consistently increased over time relatively.

Along with the gender gap one should also look at the absolute level of health achievement for both boys and girls. There may be untoward cases of low gender gap with low absolute achievement level for both sexes. By the Rawlsian (113) theory of justice[6] which gives complete priority to the worst-off group's gain (116), one should focus on the health achievement by the girl children only with reduction in gender bias in child health being the ultimate motto.

An attempt has been made to see if there is any state-wise pattern in health status for girl children only over the three rounds of NFHSs. For this we selected only six indicators (A, C, G, L, Q and U) of health-seeking behaviour and health outcome for girl children only. Based on these six indicators, the Borda ranks of the states are presented in table-8 for three rounds of NFHSs. Table 9 shows that the (Spearman) rank correlations of the ranks of states for various NFHS rounds are strongly significant now. Thus there is a consistent state-wise pattern of girl children's health status. This finding may be interpreted as, overall, girl children's health achievement in different states moved more or less in the same direction, but girl children's relative achievement compared to boys in health has not moved in the same direction for all the states over the study period.

Concentrating on the consistent state-wise pattern of girl children's health achievement is fairly justified on the Rawlsian premise as in the social valuation function it assumes the degree of inequality aversion tending to infinity. As a policy measure, to reduce gender bias in child health, we need to focus on the states with low health achievement by girls (i.e., lower Borda ranks in table-8), *viz.*, Rajasthan, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, Orissa, Assam and Andhra Pradesh.

***Regional pattern of gender gap in child health in India*[7]**

Here six indicators, one from each dimension, are chosen: health-seeking behaviour— childhood full vaccination, childhood diarrhoea with 'medical treatment', childhood breastfeeding with 'at least six months breastfed', childhood fever/ cough with 'received medical treatment'; health outcome— childhood nutrition (weight-for-age, above -2 SD), childhood survival. For the variable region of states, *North* includes Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab and Rajasthan; *Central* includes Madhya Pradesh, Chhattisgarh, Uttar Pradesh, and Uttarakhand; *East* includes Bihar, Jharkhand, Orissa and West Bengal; *Northeast* includes Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura; *West* includes Goa, Gujarat and Maharashtra; *South* includes Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

A gender-equity-sensitive indicator (GESI) is used to measure gender inequality which is simply the Atkinson index. Lesser the value of the index, lesser will be the gender inequality, i.e., a lower value implies better status (118). For robustness of the results, in addition to this, gender gap is also calculated using the previous relative gap formula. The six dimensions are reduced by the Borda rule and PCA technique.

The study found that any consistently robust region-wise pattern of gender bias against girl children in child health is *not* present among the six Indian regions of states over the three rounds of NFHSs. However, there is a consistent region-wise pattern of girl children's health status.

***Pattern of gender gap in infant mortality in India: Evidence from NFHS and SRS Data*[8]**

Here infant mortality rate (IMR) is taken as a proxy for child health conditions. The causes of infant mortality are 'strongly correlated to those structural factors like economic development, general living conditions, social wellbeing, and the quality of the environment, that affect the health of entire population' (121). State-wise IMR is computed from the unit-level records for the major sixteen states of India for five-year period preceding the survey for both boys and girls separately as well as for all children for three NFHSs. For robustness, IMR data is also taken from the published Sample Registration System (SRS) data. Gender gap is calculated as a relative gap as before. From figures 23-28, it is evident that there is gender bias in IMR though its extent differs across surveys.

The study found that any consistently robust state-wise pattern of gender bias against girl children in IMR is *not* present among the sixteen major states. But, there is a consistent inter-temporal state-wise pattern in girl infants' mortality status. This result remains valid irrespective of the data we use.

Thus it is evident that any consistently robust pattern of gender bias against girl children in child health is *not* present in India. But there is a consistent pattern of girl children's health achievement. This is true irrespective of the number of indicators we use or the number of states we select or the measurement of gender bias or the method to reduce dimensions. As a policy measure, to reduce gender bias in child health, we need to focus on the states with low health achievement by girls *viz.*, Rajasthan, Punjab, Haryana, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, Orissa, Assam, Andhra Pradesh, Tamil Nadu and Gujarat.

Determinants of gender gap in child health in India

A consistently robust inter-temporal pattern of girl children's health achievement emphasises the need to focus exclusively on the girl children. If we can identify the factors which can improve girl children's health achievements, the same factors will, in turn, be able to reduce gender gap in child health on the Rawlsian premise. To find out the determinants of girl children's health achievement, the study will use logistic regression technique to examine only girl children's health achievements. Logistic regressions are performed (a) for all India level, (b) for rural areas in India, (c) for demographic factors only in India and (d) for socioeconomic factors only in India. The dependent variables[9] are—full immunisation, and malnutrition.

Determinants of full immunisation for girl children

The analysis of immunisation coverage focuses on living girl children age 12-23 months during the Survey. This age group is selected because full immunisation (BCG, three doses each of DPT and Polio and measles) is recommended for all children by the age of one year. Multicollinearity problem is not there as the correlation coefficients are much less than the threshold magnitude.

Table 10 shows the unadjusted and adjusted effects on full immunisation coverage in India for three rounds of NFHS. There is a consistently inverse relationship between immunisation coverage and birth order of a girl child in India. The majority of first-order births occur to younger women who are more likely to utilise maternal and child health care services than older women. One can think of two countervailing effects of increasing birth-order on likelihood of vaccination. The positive one could be some kind of *learning effect* about immunisation which almost does not vary with higher birth-order. The negative one could be some kind of *negligence effect* to the higher order births and this effect perhaps increasingly increases with higher birth order. Thus for higher order births, it seems that the *negligence effect* more than offset the *learning effect*.

The unadjusted likelihoods of residence suggest that it has a positive effect on the girl children from urban areas. After controlling for other variables the rural- urban disparity almost vanishes (except for NFHS-II). When we control for the demographic factors only, urban girl children are significantly more likely to be fully immunised in all three rounds of the data. This implies that the unadjusted likelihoods for residence in baseline regressions capture mainly the effects of the selected socioeconomic variables. Hence it can be argued that the rural-urban disparity is not due to demographic factors but to socioeconomic factors. High immunisation coverage in urban areas is however supported by many researchers (122, 123).

There is a strong positive relationship between mother's education and girl children's immunisation coverage. The adjusted effects are lower than unadjusted ones but still strongly significant. Such positive effect of maternal education is also hypothesised by many researchers (64, 122-126) though some researchers find a spurious effect (127).

The chance of immunisation of girl children increases with the mother's age only up to the age group of 25-29 year and then decreases. A positive relationship is also noted by researchers (128). In the context of rural Bangladesh, researchers show that the likelihood of vaccination decreases for the mothers older than 28 years (125).

Antenatal care during pregnancy has a strong positive direct effect on vaccination. Antenatal care increases the possibility of meeting health-care personnel who help mothers to raise their awareness by disseminating information regarding immunisation. Such a positive relationship is also noted by researchers (125).

The likelihood of immunisation also varies with religion. Girl children from Muslim households are less likely to be fully vaccinated and girl children from Christian and other religious minority households are more likely to be fully vaccinated, compared to girl children from Hindu households. Caste/tribe also affect full immunisation. The chance of being fully vaccinated is consistent with the relative traditional social hierarchy of castes/ tribes. So girl children from the backward caste/ tribe households are less likely to be fully immunised even if vaccines are available to all for free.

The chance of immunisation increases with the standard of living index or wealth index of girl children's households (except for the adjusted ones in NFHS-II). Researchers also argue for household income as a proximate determinant of immunisation coverage (64, 125). Though vaccines are freely available under UIP, household income (as measured by SLI or wealth index) does have a positive effect on childhood immunisation.

Girl children of mothers with some exposure to mass media are more likely to be fully vaccinated than their counterparts whose mothers do not have any exposure to mass media. This indicates that media exposure has a significantly positive effect on immunisation. However, some researchers do not find any significant effect of media (127).

After controlling for the other included variables, the sex of household head does not have any significant effect on full vaccination (except in NFHS-II). However, in the context of rural Orissa, studies show that children from male headed households are more likely to be immunised than those from female headed households (129). Moreover, he shows that the gender inequality (boys are more likely than girls) in preventive health care persists regardless of the gender of the household head.

Mother's empowerment index has a positive effect on full immunisation in NFHS-III but it does not have any significant effect in NFHS-II. The immunisation rate varies widely across different zones too. Girl children from northeast zone are the least likely to be fully vaccinated. Household electrification has also a significantly strong positive role on full immunisation in India. Such a positive effect possibly works through availability of electronic mass media, establishment of an institutional health facility in the vicinity, higher wealth index, etc. Some studies also noted such a positive relationship (125).

The effects of the variables remain same in case of rural India or for demographic factors only or for socioeconomic factors only as in the all-India regression model.

Determinants of malnutrition for girl children

The analysis of childhood malnutrition focuses on the living girl children age below 36 months. Here malnutrition refers to underweight. Children whose weight-for-age is below minus two standard deviations from the median of the international reference population are considered to be underweight. Multicollinearity problem is not there as the correlation coefficients are much less than the threshold magnitude.

Table 11 shows the unadjusted and adjusted effects on malnutrition in India for three rounds of NFHS. The unadjusted likelihoods suggest that as a girl child's birth order increases she will be more and more likely to be malnourished. After controlling for other variables, the effect of birth order almost vanishes. When we control for demographic factors only, birth order does have a positive effect on malnutrition. This implies that the unadjusted likelihoods for birth order in all-India regressions capture mainly the effects of the selected socioeconomic variables. Thus the effect of birth order is not due to the demographic factors but due to selected socioeconomic factors.

Adjusting for other variables girl children from urban areas are not less likely to be malnourished than their rural counterparts. When we control for demographic factors only, girl children from urban areas are strongly less likely to be malnourished than their rural counterparts in each round of NFHS. Hence the rural-urban gap is not due to the demographic factors but due to the socioeconomic factors.

Girl children of educated mothers are less likely to be malnourished than their counterparts of illiterate mothers. Girl children of more aged mothers are more likely to be malnourished than girl children of mothers' aged 19 years or less. Antenatal care during pregnancy reduces the likelihood of malnutrition for a girl child. Girl children from backward caste households are strictly more likely to be malnourished than girl children from general caste households. The chance of being malnourished strongly decreases with the standard of living index or the wealth index of the girl children's household. Mothers' exposure to mass media also reduces the likelihood of malnutrition. The chance of being malnourished varies significantly across different zones too. Household electrification reduces the likelihood of malnutrition for girl children after controls.

The effects of the variables remain same in case of rural India or for demographic factors only or for socioeconomic factors only as in the all-India regression model.

CONCLUSION

Gender inequality is a far-reaching societal impairment, not merely a special deprivation of women (4: 250). Gender inequality of one type tends to encourage and sustain gender inequality of other kinds (4: 220). Health being one of the most basic capabilities, the reduction and removal of gender bias in child health can go a long way in achieving gender parity in many other dimensions of human development, not only for the present generation but also over the generations.

The study selected thirteen indicators of health-seeking behaviour in immunisation, diarrhoea, fever/ cough and breastfeeding and eight indicators of health outcome in malnutrition and mortality for children age less than three years. It was shown that there is ample evidence of varying levels of gender gap in all the states of India over almost one-and-a-half decades. For a particular state it might so happen that for a particular indicator, gender gap (and/ or its sign) changes over time and gender gap (and/ or its sign) changes for different indicators in a particular time period.

The gender gap in health-seeking behaviour does not transform much into the gender gap in health outcome for the children in the states of India. However for girl children's health achievement, the indicators of health-seeking behaviour are significantly related to the indicators of health outcome. Full immunisation rate for the girl children has a consistently significant impact on all the indicators of health outcome. Increases in vaccination coverage rates for girl children will reduce post-neonatal mortality, childhood mortality and childhood malnutrition rates for girl children. Girl children's health outcome tends to be worse in the major states compared to other (non-major) states.

It was shown that any consistently robust pattern across states of gender bias against girl children in child health is *not* present. But there is a consistent pattern of girl children's absolute health achievement. This is true irrespective of the number of indicators we use or the number of states we select or the measurement of gender bias or the method to reduce dimensions. The result remains valid even when it is performed at the regional level instead of state level. Assuming the Rawlsian theory of justice, which gives complete priority to the worst off group's gain, one should focus on the absolute health achievement by the girl children only, even when reduction in gender bias in child health is the ultimate motto. As a policy measure, to reduce gender bias in child health, we need to focus on the states with low health achievement by girls, *viz.*, Rajasthan, Punjab, Haryana, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, Orissa, Assam, Andhra Pradesh, Tamil Nadu and Gujarat.

On the determinants of child health achievement, except for a few cases, the results were consistently robust across the different models as well as across different dependent variables.

Robust Results

- Increase in birth order of a girl child reduces the likelihood of health achievement. It seems that the *negligence effect* more than offsets the *learning effect*. The result perhaps shows greater apathy on the part of parents to take care of subsequent children. Also higher order birth children are more and more constrained by household resources.
- The likelihood of health achievement is higher for girl children from urban areas. The rural-urban disparity in child health is not due to demographic factors but due to socioeconomic factors.
- The likelihood of health achievement for girl children increases with mother's education level, mother's empowerment index, mother's age and mother's exposure to mass media. These variables tend to enhance the mother's autonomy or agency within the household and raise the value ascribed to girl children, which in turn helps mothers to take greater care of girl children.
- Some antenatal care during pregnancy raises the chance of health achievement for girls significantly. Having antenatal care increases the possibility of meeting health personnel who help mothers to raise their awareness by disseminating information regarding child health. This information spill-over or learning-by-doing raises health care for girl children.
- Among the religious groups, Muslim girl children are the least likely to be fully immunised and the most likely to be malnourished, in comparison with girl children from Hindu households.
- The likelihood of health achievement is less for girl children from backward caste/ tribe households compared to girl children from general caste households.

- Household income measured either by the standard of living index or wealth index raises the likelihood of health achievement for girl children. With higher household income, parents are more likely to spend more money and time for girl children.
- The gender of the household head has no effect on the likelihood of health achievement for girl children.
- The likelihood of health achievement for girl children increases in households with electricity. Household electrification indirectly raises awareness about the value of girl children and helps parents to take greater care of them.

These findings support Sen's claim that 'we have to look beyond material prosperity or economic success or GNP growth…' (4). The non-existence of any consistent pattern of gender bias in child health implies that there are many pathways of gender injustice. However, the consistent pattern in girl children's health achievement calls for some policy interventions to reduce and hopefully to remove gender bias in child health on the Rawlsian premise.

The above results suggest that a synergistic effort incorporating a number of other sectors is needed to reduce the gender gap in child health. The need of the hour is an equitable, participatory and intersectoral approach to health and health care (130). Policies and programmes in other sectors such as education, welfare, industry, labour, information, environment, etc. have also to be informed and influenced by public health considerations (131). To bring gender justice, we need coordination and convergence in the programmes of various Ministries of the Government. The policy managers should also try the following means to reduce gender gap in child health in India:

- Focus on female education and raising the female literacy rate.
- Step up information, education and communication (IEC) to enhance media exposure of mothers.
- Generate enough gainful employment opportunities to raise household's standard of living. Also there is a need to create jobs for women to raise empowerment of mothers.
- Ensure quality antenatal care focusing on supply-side issues.
- Promote small family norm and discourage early marriage.
- Focus on girl children from Muslim households and backward castes.
- Provide electricity to every household particularly in rural areas.
- Provide basic facilities that are commonly available in urban areas universally in rural areas.

In the new millennium, nations are judged by the well-being of their people; by levels of health, nutrition and education; by the civil and political liberties enjoyed by their citizens; by the protection guaranteed to children and by provisions made for the vulnerable and the disadvantaged. Here we will discuss the extent of concern of Government policies about gender bias in child health and how they can remove it. In the various schemes and policies of Ministry of Health and Family Welfare and the Planning Commission of Government of India there is hardly any mention of gender bias in child health, leave alone the elaboration of policies to reduce and remove it. The focus appears to be on mothers and children generally rather than specifically on girl children. In the 'shining' India, a Judge of Supreme Court of India has noted that 'the fact is that women's exploitation is a reality and gender justice a fragile myth' (132).

The persistent gender bias in an array of indicators of child health in almost all the states of India over one-and-a-half decades calls for devising a gender-aware child health policy. To reap the benefits of the demographic dividend, first we have to ensure that our children are healthy and capable of being healthy human capital. We need to ensure that girl children are effectively benefited by the government health schemes that would penetrate the problem that has roots in social behaviour and prejudices in large parts of the country. We need to raise awareness of the people to make them understand that women are no longer 'patients', but the 'agents' of growth and development of a country. Such an awareness campaign will help parents to demand healthcare facilities for their children; not only for their sons but for their daughters too. We have to ensure gender-justice in child health by ensuring that there is no discrimination on the basis of gender. Government as well as the civil society has to oversee the enforcement of gender justice in health schemes and also ensure that they effectively reach all children irrespective of their class, caste and religion. Removal of gender bias in child health is one of the early hurdles that the country needs to overcome. Universal access to the health schemes will hopefully put India on a double-digit growth path in a foreseeable future.

The study shows that it is high time that policy makers acknowledge gender bias in child health and act to curb this menace. It pleads the policy makers to design health policies by taking note of some of the way outs mentioned here to reduce gender bias in child health in India. The policy makers must keep in mind that improvement in the lives of girl children will actually be able to improve lives of all—men, women and children. They should ensure that the girl children are not left unattended by the health policies so that in future they are able to 'hold up half the sky'.

End notes

[1] It includes whether a child's mother reads newspaper/ magazine at least once a week or almost every day or listens to radio at least once a week or almost every day or watches TV at least once a week or almost every day or go to cinema hall/ theatre at least once a month.

[2] It shows decision-making power of mothers' within a family. The following recoded variables are chosen for its construction: permission to get medical help for self, who decides how to spend money, mother's type of earnings for work, final say on health care, final say on making large household purchases, final say on making household purchases for daily needs, final say on visits to family or relatives, final say on deciding what to do with money husband earns, allowed to go to market, allowed to go to health facility, allowed to go to places outside this village/ community, have bank or saving account, has money for her own use. The method of *unweighted aggregation* is followed by which the scores of the above-mentioned thirteen recoded variables are simply added to get the scores of MEI.

[3] Percentage of the children (also for boy and girl children separately) who were sick and taken to any *public* health facility steadily declined over time from 27 percent in 1992-93 to 18 percent in 2005-06. But percentage of the children who were sick and taken to any *private* health facility steadily increased over the same time from 80 percent to 90 percent. This raises serious concern about the quality and acceptability of the public health facilities in India.

[4] Tables will be provided on request.

[5] For details, see (114).

[6] Compared to the Utilitarian approach, the Rawlsian theory of 'justice as fairness' has many decisive advantages. The Rawlsian theory also has merits in terms of scope and reach over more relativist and less universalist approaches that have sometimes been proposed. The concern with equity in addition to efficiency as reflected in Rawl's principles of justice puts equity at the centre of disputes about justice in a way that utilitarianism (peripherally concerned with equity) fails to do (see 115).

[7] For details, see (117).

[8] For details, see (119, 120).

[9] Logistic regression results for medical treatment in diarrhoea, medical treatment in fever/cough, at least six months breastfeeding and child death are almost similar and hence not shown in this paper.

ACKNOWLEDGMENTS

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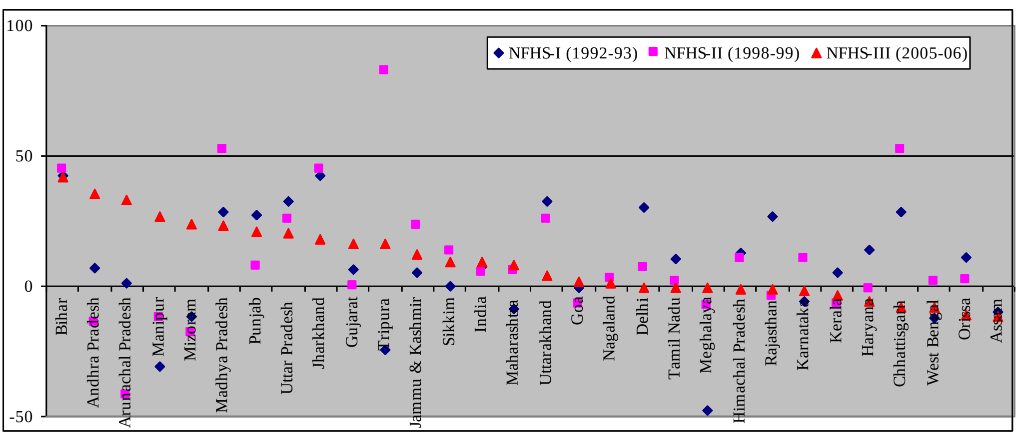
APPENDIX



Note: Figure excludes two outliers for Nagaland in NFHS-I (555) and Assam for NFHS-II (139).

Figure 1. State-wise Gender Gap in Full Immunisation, Various NFHS Rounds.

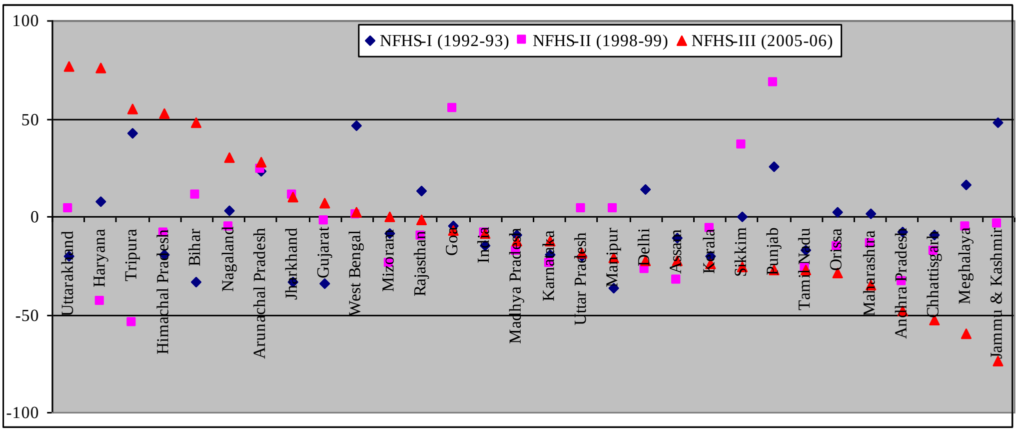


Figure 2. Gender Gap in Childhood Diarrhoea with 'No Treatment' by State.

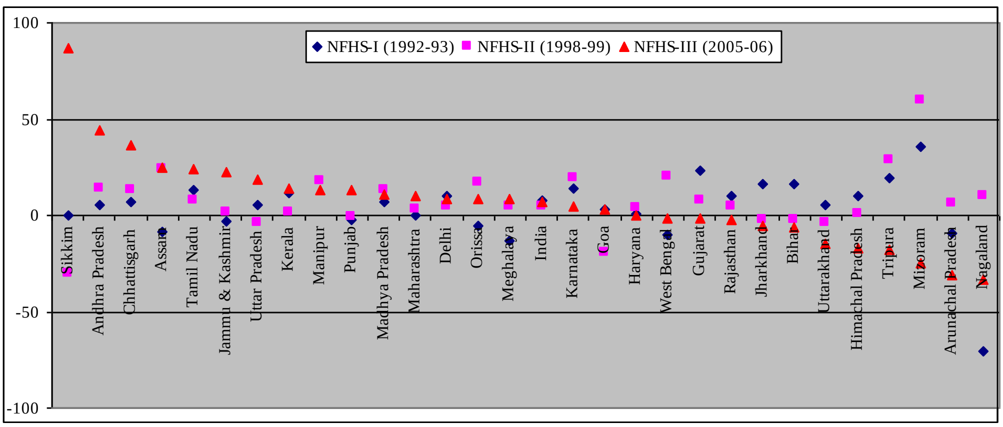
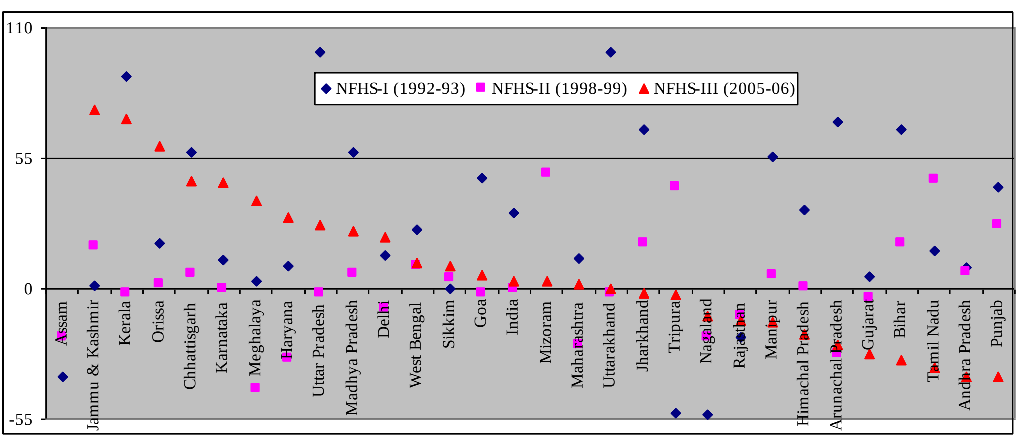


Figure 3. Gender Gap in Childhood Diarrhoea with 'Medical Treatment' by State.



Note: Figure excludes two outliers for Mizoram (139) in NFHS-I and Assam (382) for NFHS-III.

Figure 4. Gender Gap in Childhood Diarrhoea with 'Given ORS' by State.

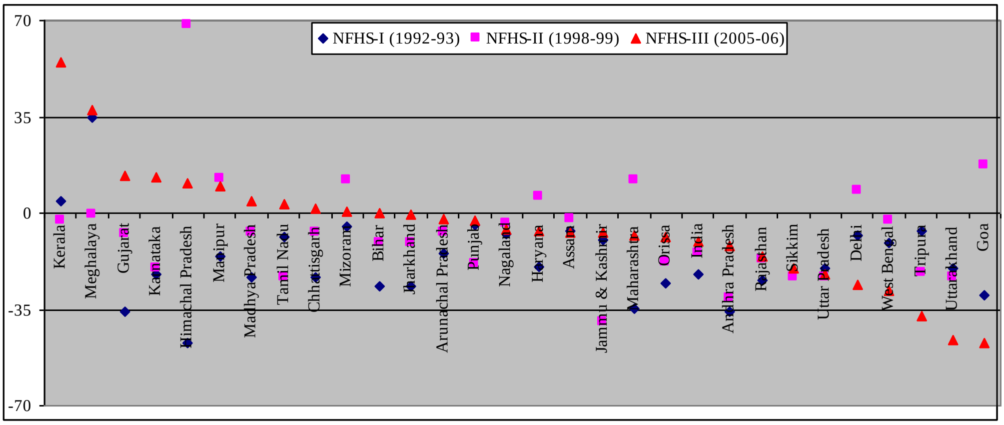


Figure 5. Gender Gap in Childhood Fever/ Cough with ‘Received No Treatment’.

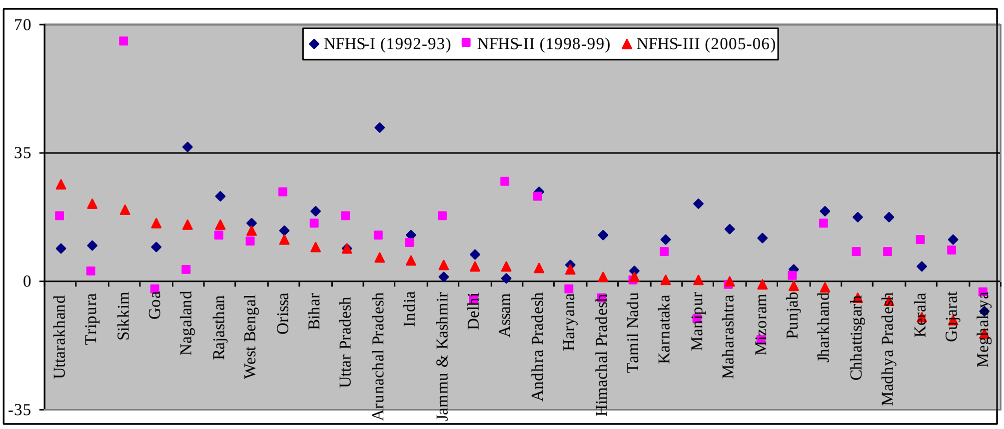


Figure 6. Gender Gap in Childhood Fever/ Cough with ‘Received Medical Treatment’.

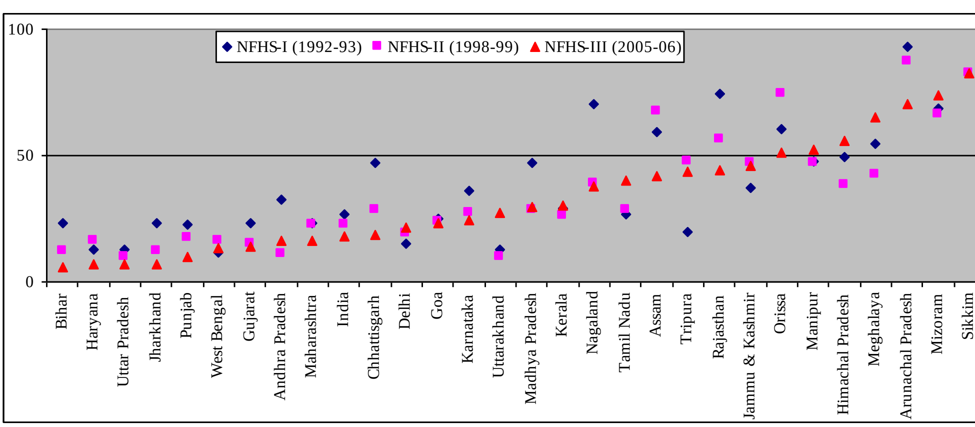
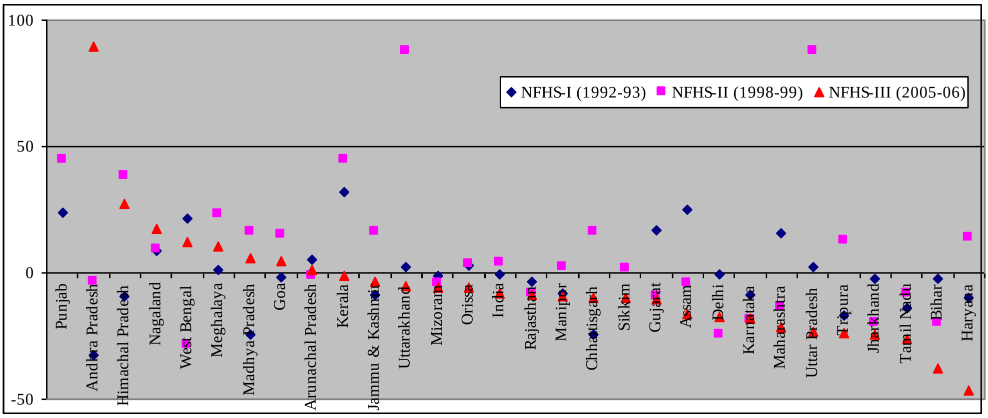


Figure 7. Fever/ Cough with ‘Received Medical Treatment in Public Health Facility’.



Note: Figure excludes the outlier Punjab (189) in NFHS-III.

Figure 8. Gender Gap in Childhood Fever/ Cough with 'Received Medical Treatment in Public Health Facility'.

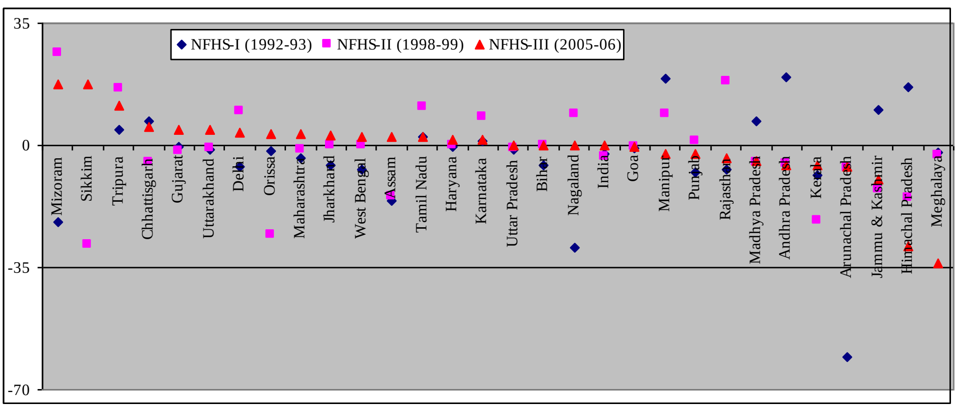
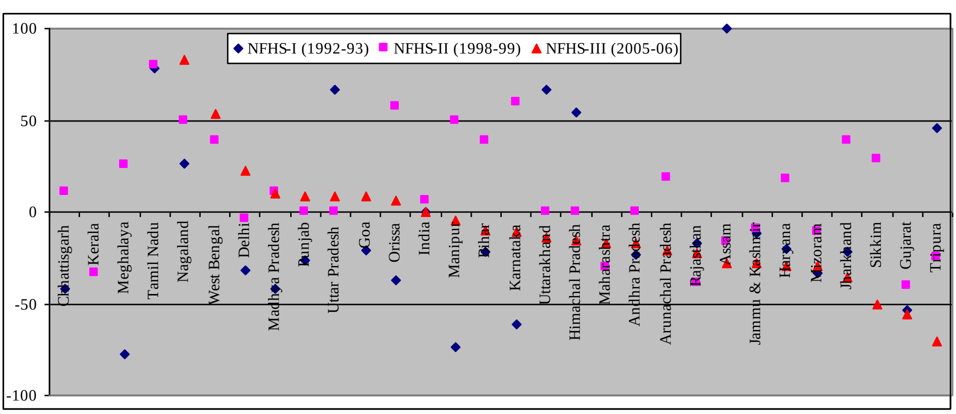


Figure 9. Gender Gap in Childhood Fever/ Cough with 'Received Medical Treatment in Private Health Facility'.



Note: Figure excludes the outliers for Kerala (233), West Bengal (129) and Arunachal Pradesh (178) in NFHS-I and Meghalaya (173), Tamil Nadu (160) for NFHS-III.

Figure 10. Gender Gap in Childhood Breastfeeding with 'Never Breastfed' by State.

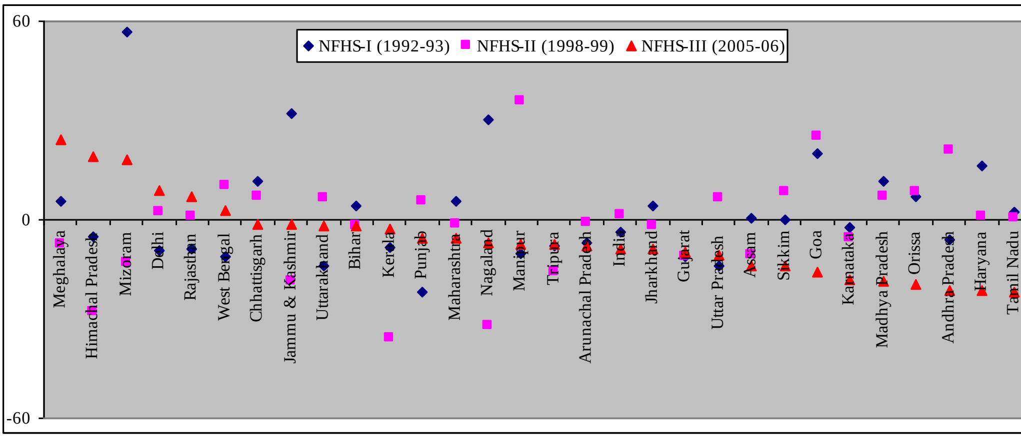


Figure 11. Gender Gap in Breastfeeding with ‘less than Six months Breastfed’ by State.

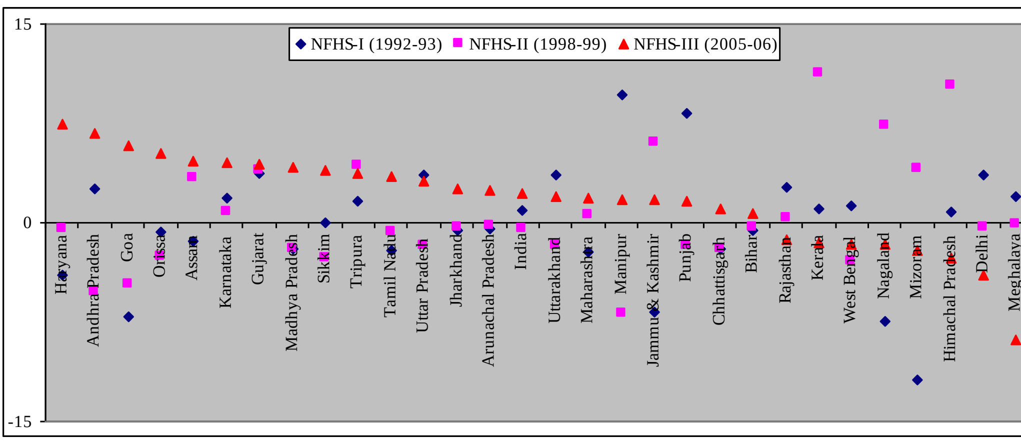


Figure 12. Gender Gap in Childhood Breastfeeding with ‘at least six months Breastfed’.

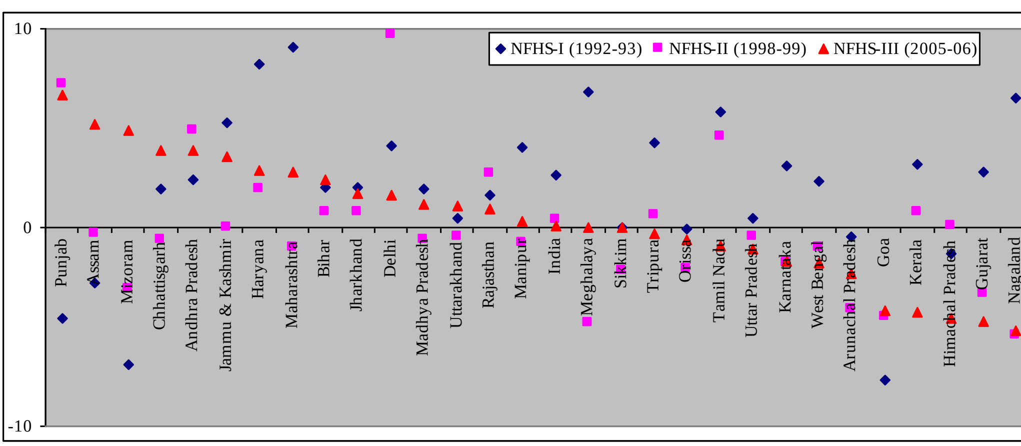


Figure 13. Gender Gap in Childhood Breastfeeding with ‘Currently Breastfeeding’ by State.

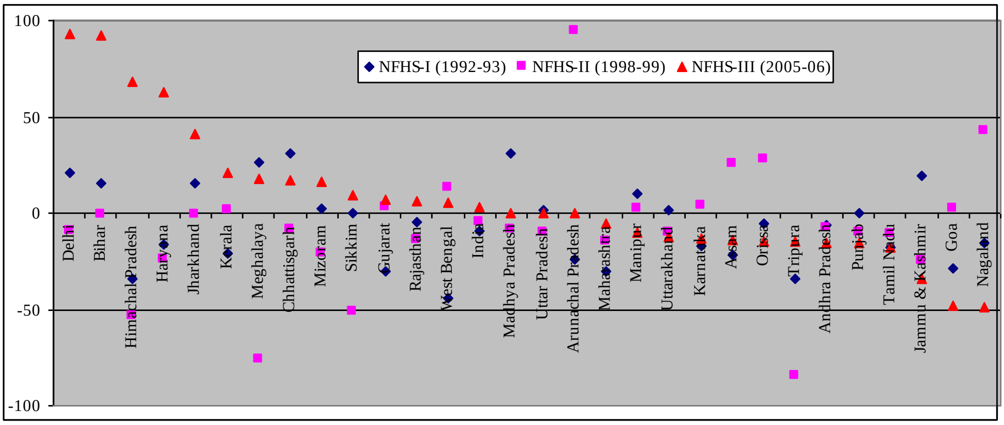
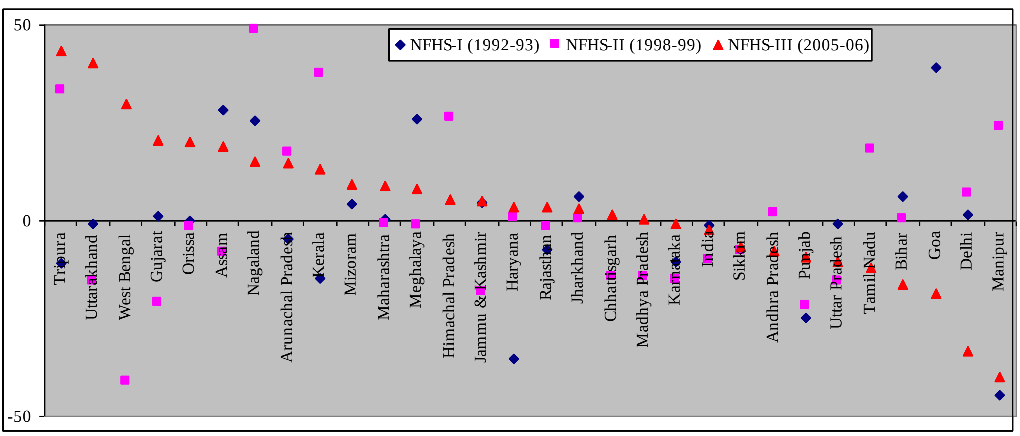
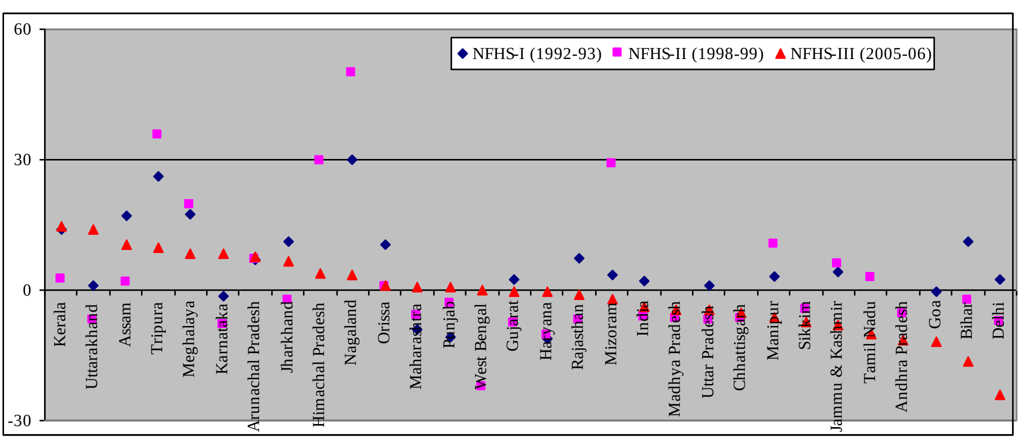


Figure 14. Gender Gap in Breastfeeding with ‘Exclusively Breastfed for first Six months’.



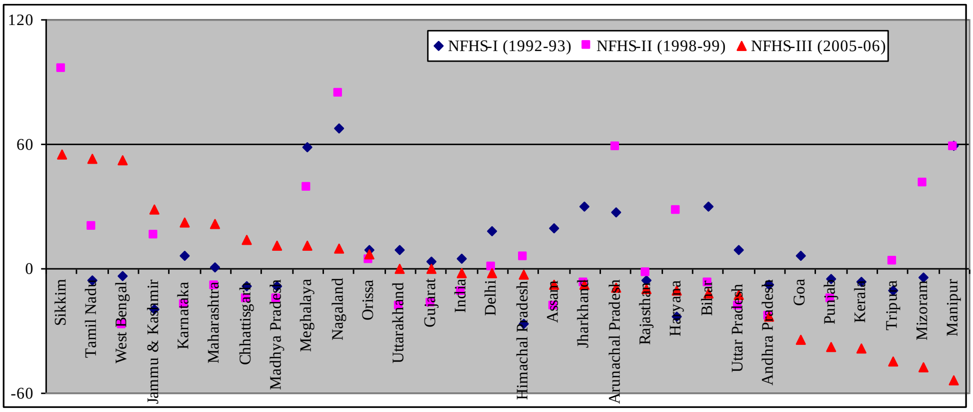
Note: Figure excludes the outliers for Mizoram (116) and Goa (344) in NFHS-II.

Figure 15. Gender Gap in Childhood Malnutrition (Severe Stunting).



Note: Figure excludes the outlier Goa (118) in NFHS-II.

Figure 16. Gender Gap in Childhood Malnutrition (Stunting).



Note: Figure excludes the outlier Goa (183) and Kerala (311) in NFHS-II.

Figure 17. Gender Gap in Childhood Malnutrition (Severely Underweight).

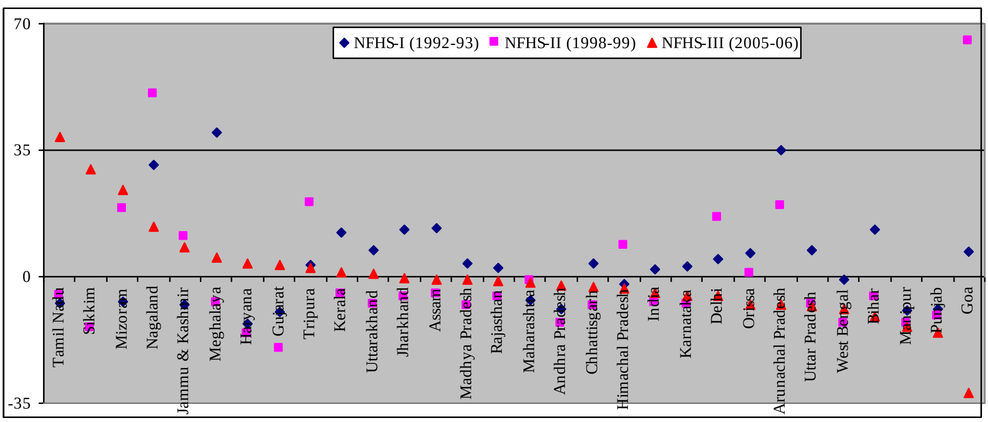
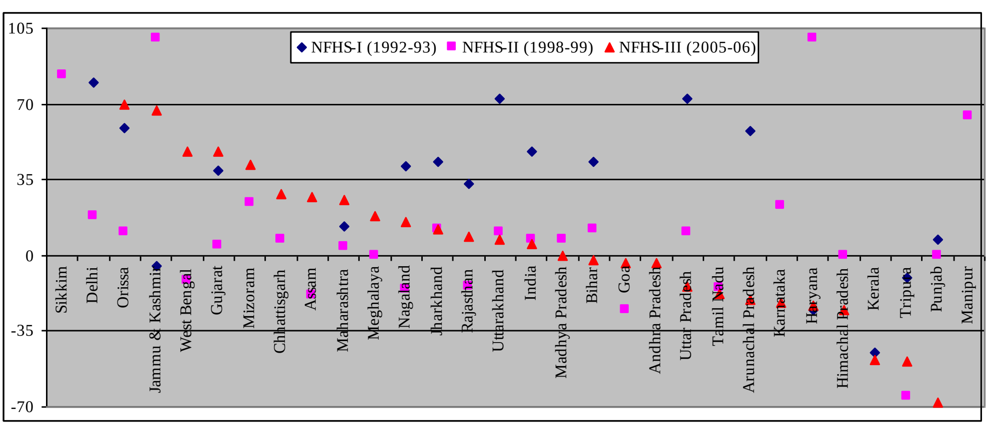
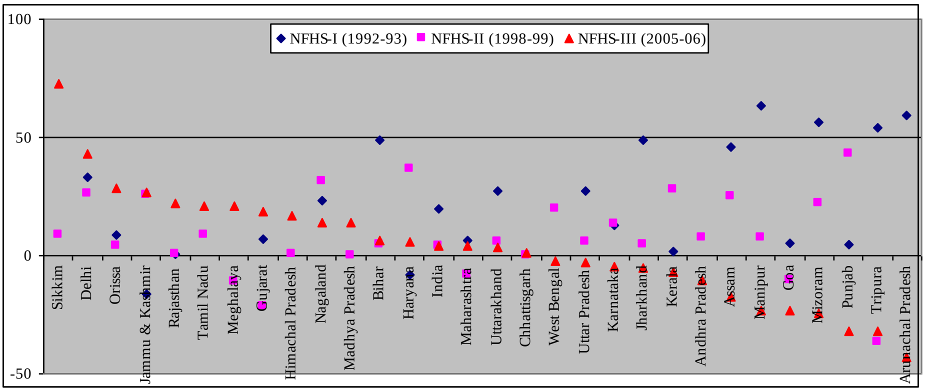


Figure 18. Gender Gap in Childhood Malnutrition (Underweight).



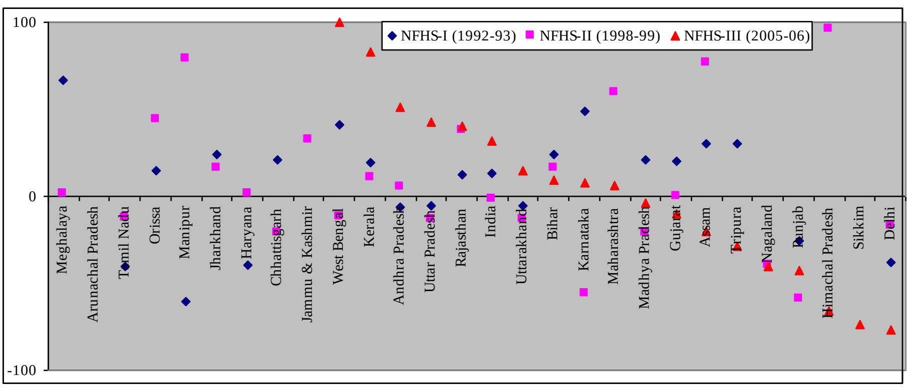
Note: Figure excludes the outliers Assam (136), Meghalaya (179), Goa (119), Karnataka (269) and Manipur (217) in NFHS-I, Andhra Pradesh (156), Arunachal Pradesh (433) and Kerala (150) in NFHS-II and Sikkim (125), Delhi (119) in NFHS-III.

Figure 19. Gender Gap in Childhood Malnutrition (Severe Wasting).



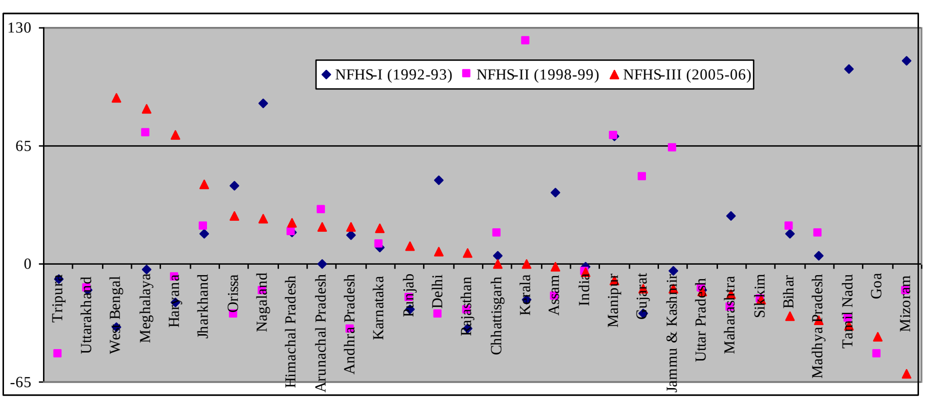
Note: Figure excludes the outliers Meghalaya (137) in NFHS-I and Arunachal Pradesh (126) in NFHS-II.

Figure 20. Gender Gap in Childhood Malnutrition (Wasting).



Note: Figure excludes the outliers J & K (115), Maharashtra (129) and HP (227) in NFHS-I, Arunachal Pradesh (181) in NFHS-II and Meghalaya (644), Arunachal Pradesh (238), TN (182), Orissa (155), Manipur (125), Jharkhand (122), HR (122), Chhattisgarh (113) and J & K (111) in NFHS-III.

Figure 21. Gender Gap in Post-Neonatal Death.



Note: Figure excludes the outliers Goa (457) and Mizoram (112) in NFHS-I, WB (139) and Kerala (122) in NFHS-II and Tripura (347) and Uttarakhand (217) in NFHS-III.

Figure 22. Gender Gap in Child Death.

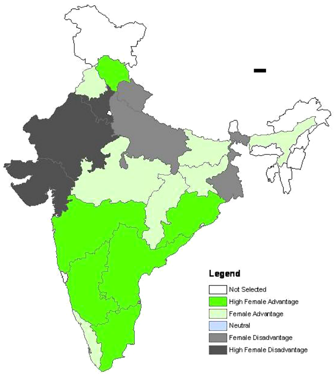


Figure 23. Gender Bias in IMR, NFHS-I (1988-92).

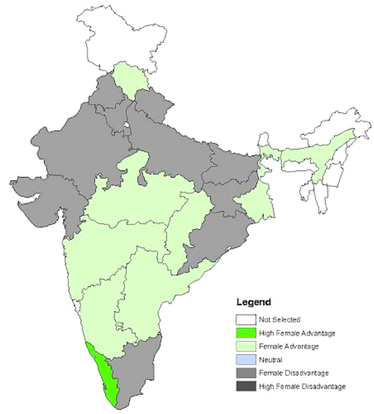


Figure 24. Gender Bias in IMR, SRS-1992.

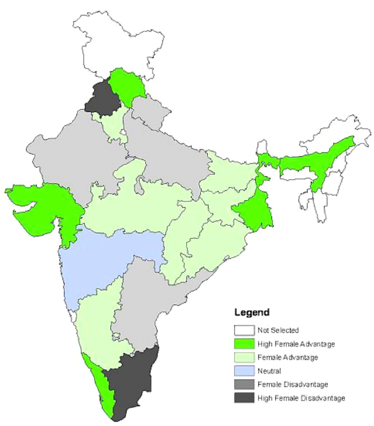


Figure 25. Gender Bias in IMR, NFHS-II (1994-98).

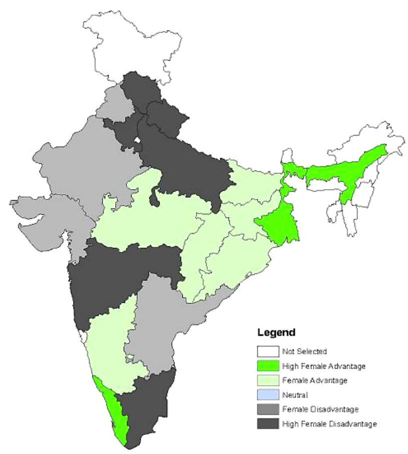


Figure 26. Gender Bias in IMR, SRS-1998.

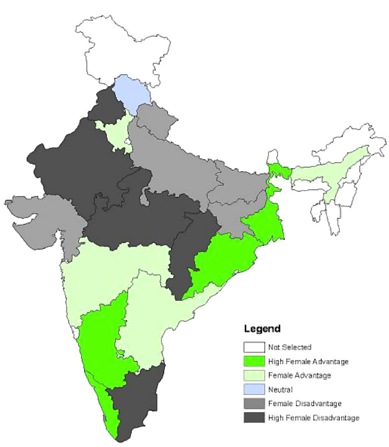


Figure 27. Gender Bias in IMR, NFHS-III (01-05).

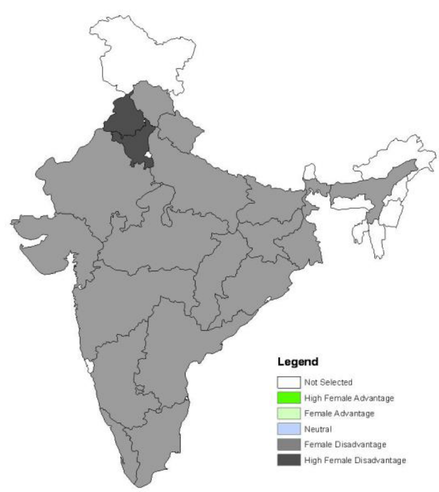


Figure 28. Gender Bias in IMR, SRS-2005.

Legend key: x<=85: High Female Advantage, 85<x<=99: Female Advantage, x=100: No Female Advantage (neutral), 100<x<115: Female Disadvantage, 115=<x: High Female Disadvantage. Gender Gap $(x) = (X_g / X_b) * 100$.

Table 1. State-wise Borda Rank in Gender Bias against Girl Children

	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
Nagaland	**2**	**10**	**1**
Meghalaya	**5**	**4**	**2**
H.P.	**17**	**8**	**3**
Gujarat	**28**	**26**	**4**
W.B.	**8**	**17**	**5**
Uttarakhand	**24**	**18**	**6**
Rajasthan	**21**	**25**	**7**
Kerala	**14**	**5**	**8**
Jharkhand	**19**	**13**	**9**
Karnataka	**18**	**27**	**10**
Arunach. P.	**4**	**1**	**11**
Tamil Nadu	**10**	**23**	**12**
Tripura	**8**	**29**	**13**
J.& K.	**7**	**16**	**14**
Orissa	**10**	**15**	**14**
Maharashtra	**12**	**11**	**16**
Haryana	**13**	**9**	**17**
Mizoram	**6**	**7**	**18**
Delhi	**15**	**11**	**19**
Chhattisgarh	**22**	**20**	**20**
Assam	**1**	**28**	**21**
M.P.	**22**	**20**	**22**
Bihar	**19**	**13**	**23**
Sikkim	**NA**	**6**	**24**
Punjab	**16**	**22**	**25**
Manipur	**27**	**3**	**26**
U.P.	**24**	**18**	**27**
Andhra P.	**26**	**24**	**28**
Goa	**3**	**2**	**29**

Note: Total excludes the ranks obtained in the indicators—for NFHS-I: J, K, N, O, and T due to non-availability of data for some of the states other than Sikkim; for NFHS-II and III: E, and T due to non-availability of data for some of the states. States are ordered according to NFHS-III rankings.

Table 2. Rank-Correlation (Spearman) Matrix of Borda Rankings

	NFHS-I	NFHS-II
NFHS-II	**0.3**	—
NFHS-III	**0.2**	**-0.01**

Note: none significant at 10% level (two tail).

Table 3. Rank-Correlation (Spearman) Matrix of Borda Rankings

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.26**	—	
NFHS-III	**0.10**	**0.04**	—

Note: None significant at 10% level (two tail).

Table 4. Borda Rank in Gender Bias against Girl Children, Major 19 States

	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
W.B.	**8**	**7**	**1**
H.P.	**15**	**4**	**2**
Chhattisgarh	**16**	**11**	**3**
Kerala	**5**	**3**	**4**
Karnataka	**5**	**19**	**4**
Uttarakhand	**9**	**16**	**6**
Jharkhand	**11**	**9**	**7**
Rajasthan	**19**	**14**	**8**
Maharashtra	**1**	**6**	**9**
Orissa	**1**	**18**	**10**
Gujarat	**18**	**8**	**11**
Haryana	**5**	**1**	**12**
M.P.	**16**	**11**	**13**
Tamil Nadu	**4**	**4**	**14**
Punjab	**13**	**2**	**15**
J.& K.	**1**	**11**	**16**
Bihar	**11**	**9**	**17**
U.P.	**9**	**16**	**18**
Andhra P.	**14**	**15**	**18**

Note: States are ordered by NFHS-III rankings.

Table 5. Rank-Correlation (Spearman) Matrix of Borda Rankings

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.045**	—	
NFHS-III	**-0.059**	**0.084**	—

Note: none significant at 10% level (two tail).

Table 6. State-wise Composite Index and Rank in Gender Bias against Girl Children, Various NFHS Rounds

	Composite Index			Rank		
	NFHS-I	**NFHS-II**	**NFHS-III**	**NFHS-I**	**NFHS-II**	**NFHS-III**
Meghalaya	-0.54	-0.40	-1.18	**3**	**5**	**1**
H.P.	0.30	-0.06	-0.49	**24**	**12**	**2**
Nagaland	-0.48	-0.34	-0.41	**4**	**6**	**3**
Kerala	-0.39	-0.08	-0.33	**7**	**10**	**4**
Gujarat	0.37	0.33	-0.33	**26**	**22**	**5**
W.B.	-0.11	0.39	-0.33	**11**	**23**	**6**
Assam	-0.59	0.97	-0.16	**1**	**29**	**7**
Uttarakhand	-0.03	0.50	-0.16	**16**	**27**	**8**
Rajasthan	0.34	0.06	-0.15	**25**	**15**	**9**
J.& K.	-0.13	0.15	-0.14	**8**	**21**	**10**
Maharashtra	0.05	-0.13	-0.14	**19**	**9**	**11**
Orissa	-0.05	0.03	-0.14	**14**	**14**	**12**
Karnataka	0.16	0.11	-0.12	**20**	**17**	**13**
Tamil Nadu	-0.04	-0.08	-0.1	**15**	**10**	**14**
Jharkhand	-0.12	0.12	-0.08	**9**	**18**	**15**
Chhattisgarh	0.26	0.48	-0.08	**22**	**25**	**16**
Mizoram	-0.58	-0.44	-0.07	**2**	**4**	**17**
Haryana	0.03	-0.25	-0.01	**16**	**8**	**18**
M.P.	0.26	0.48	0.04	**22**	**25**	**19**
Delhi	-0.08	-0.34	0.06	**12**	**6**	**20**
Arunach. P.	-0.41	-0.99	0.08	**6**	**1**	**21**
Sikkim	NA	0.13	0.28	**NA**	**20**	**22**
Tripura	0.21	0.39	0.31	**21**	**23**	**23**
Manipur	1.51	-0.78	0.4	**28**	**3**	**24**
U.P.	-0.03	0.5	0.48	**16**	**27**	**25**
Goa	-0.45	-0.95	0.59	**5**	**2**	**26**
Punjab	-0.07	0.06	0.65	**13**	**15**	**27**
Bihar	-0.12	0.12	0.73	**9**	**18**	**28**
Andhra P.	0.77	0.02	0.77	**27**	**13**	**29**

Note: Total composition excludes the following indicators—NFHS-I: j, k, n, o, and t; NFHS-II & -III: e, and t —due to non-availability of data for some of the states. States are ordered according to NFHS-III rankings.

Table 7. Rank-Correlation (Spearman) Matrix of Rankings in Three Rounds of NFHS

	NFHS-I	**NFHS-II**
NFHS-II	**0.25**	—
NFHS-III	**0.18**	**-0.07**

Note: none significant even at 10% level (two tail).

Table 8. Borda Rank of Health Achievement for Girl Children

	NFHS-I	NFHS-II	NFHS-III
Kerala	**27**	**28**	**29**
W.B.	**17**	**14**	**28**
Goa	**26**	**29**	**27**
Haryana	**23**	**25**	**26**
H.P.	**25**	**26**	**25**
Maharashtra	**21**	**27**	**24**
Tamil Nadu	**19**	**24**	**23**
Delhi	**22**	**22**	**22**
Karnataka	**18**	**20**	**21**
Punjab	**23**	**23**	**20**
J.& K.	**28**	**20**	**19**
Sikkim	**NA**	**12**	**18**
Meghalaya	**16**	**4**	**17**
Tripura	**7**	**18**	**16**
Uttarakhand	**2**	**9**	**15**
Mizoram	**20**	**13**	**14**
Manipur	**9**	**18**	**13**
Gujarat	**14**	**15**	**12**
Orissa	**8**	**6**	**11**
Chhattisgarh	**10**	**6**	**9**
Nagaland	**13**	**11**	**9**
Andhra P.	**12**	**17**	**8**
M.P.	**10**	**6**	**7**
Bihar	**2**	**1**	**6**
Jharkhand	**2**	**1**	**5**
Rajasthan	**1**	**5**	**4**
Arunach. P.	**15**	**16**	**3**
U.P.	**2**	**9**	**2**
Assam	**6**	**3**	**1**

Note: The chosen indicators are A, C, G, L, Q and U. Ranking is done in ascending order (a higher value indicates better status of girls) for the following indicators— A, C, G, and Q. For L and U, ranking is done in descending order (a lower value indicates better status of girls). A higher rank (number) indicates better status of girl children. States are ordered according to NFHS-III rankings.

Table 9. Rank-Correlation (Spearman) Matrix of Borda Rankings

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.81***	—	
NFHS-III	**0.79***	**0.78***	—

Note: Level of significance (two tailed) — *: 1%.

Table 10. Summary of Effects (P in %) on Full Immunisation Coverage in India

Background Variables		NFHS-I (1992-93)		NFHS-II (1998-99)		NFHS-III (2005-06)	
		Unadj	Adj	Unadj	Adj	Unadj	Adj
Birth Order	1#	**45***	**36**	**53****	**46**	**54***	**48**
	2	**39***	**31***	**49****	**42**	**48***	**42***
	3	**33***	**28***	**36***	**30***	**32***	**33***
	4 & +	**20***	**22***	**23***	**28***	**24***	**31***
Residence	Rural#	**29***	**29**	**35***	**36**	**37***	**40**
	Urban	**52***	**28**	**61***	**40*****	**56***	**39**
Mother's Education	Illiterate#	**22***	**25**	**27***	**32**	**24***	**30**
	Primary	**42***	**31***	**51***	**41***	**45***	**44***
	Secondary	**62***	**38***	**63***	**50***	**61***	**51***
	Higher	**77***	**49***	**73***	**49***	**83***	**63***
Mother's Age	19 or less#	**35***	**23**	**36***	**25**	**38***	**32**
	20-24	**36**	**26**	**43***	**34***	**43****	**36*****
	25-29	**37**	**33***	**46***	**45***	**44****	**43***
	30-49	**26***	**32***	**31****	**43***	**35**	**44***
Antenatal Care	No#	**10***	**15**	**17***	**27**	**23***	**30**
	Yes	**47***	**39***	**56***	**45***	**49***	**44***
Religion	Hindu#	**35***	**30**	**41***	**39**	**43***	**42**
	Muslim	**25***	**22***	**31***	**27***	**34***	**30***
	Christ &	**50***	**30**	**63***	**53***	**50****	**38**
Caste/ Tribe	General#	**37***	**30**	**46***	**39**	**53****	**44**
	OBC	—	—	**42****	**36**	**39***	**38***
	SC	**26***	**24***	**39***	**41**	**36***	**38****
	ST	**24***	**29**	**24***	**26***	**32***	**38*****
Standard of Living Index	Low#	**22***	**25**	**31***	**38**	—	—
	Medium	**34***	**29****	**41***	**36**	—	—
	High	**60***	**37***	**63***	**39**	—	—
Wealth Index	Poorest#	—	—	—	—	**23***	**34**
	Poorer	—	—	—	—	**34***	**39*****
	Middle	—	—	—	—	**45***	**42***
	Richer	—	—	—	—	**51***	**38**
	Richest	—	—	—	—	**72***	**49***
Media Exposure	No#	**21***	**26**	**24***	**36**	**28***	**37**
	Yes	**49***	**32***	**55***	**39**	**54***	**42***
Sex of HH-Head	Female#	**43****	**31**	**42***	**32**	**40***	**39**
	Male	**34***	**29**	**41**	**38*****	**42**	**40**
MEI	Low#	—	—	**40***	**39**	**37***	**36**
	Medium	—	—	**41**	**36**	**43***	**41***
	High	—	—	**42**	**35**	**46***	**44***
Zone	Central#	**19***	**20**	**19***	**22**	**27***	**31**
	North	**38***	**32***	**41***	**34***	**44***	**39***
	East	**22*****	**22**	**26***	**29***	**43***	**53***
	Northeast	**21**	**19**	**16**	**14*****	**34****	**29**
	West	**61***	**51***	**70***	**64***	**51***	**35*****
	South	**53***	**40***	**71***	**60***	**57***	**42***
Electricity	No#	**21***	**27**	**22***	**31**	**26***	**35**
	Yes	**50***	**31****	**56***	**42***	**53***	**44***

Note: Unadj: unadjusted, Adj: adjusted.
#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Table 11. Summary of Effects (P in %) on Malnutrition in India

Background Variables		NFHS-I (1992-93)		NFHS-II (1998-99)		NFHS-III (2005-06)	
		Unadj	**Adj**	**Unadj**	**Adj**	**Unadj**	**Adj**
Birth Order	1#	**48***	**52**	**42***	**47**	**40***	**47**
	2	**51***	**53**	**47***	**50****	**44***	**48**
	3	**51***	**50**	**51***	**48**	**49***	**47**
	4 & +	**57***	**51**	**57***	**50**	**58***	**46**
Residence	Rural#	**54***	**52**	**52***	**49**	**50**	**47**
	Urban	**43***	**51**	**40***	**47**	**37***	**48**
Mother's Education	Illiterate#	**58***	**56**	**57***	**52**	**57***	**51**
	Primary	**51***	**52***	**46***	**49***	**48***	**48****
	Secondary	**36***	**42***	**38***	**43***	**37***	**44***
	Higher	**25***	**32***	**28***	**37***	**19***	**30***
Mother's Age	19 or less#	**49**	**47**	**46***	**43**	**46***	**43**
	20-24	**52*****	**52***	**48*****	**50***	**45**	**45**
	25-29	**51**	**53***	**48**	**48***	**47**	**48****
	30-49	**54***	**53***	**53***	**50***	**53***	**51***
Antenatal Care	No#	**59***	**53**	**58***	**51**	**57***	**52**
	Yes	**48***	**51****	**43***	**47***	**42***	**45***
Religion	Hindu#	**52***	**52**	**50**	**49**	**48***	**48**
	Muslim	**54**	**53**	**50**	**51**	**45****	**44****
	Christ &	**42***	**50**	**33***	**40***	**39***	**45**
Caste/ Tribe	General#	**51**	**52**	**43***	**45**	**38***	**44**
	OBC	—	—	**49***	**49***	**47***	**46****
	SC	**57***	**54****	**55***	**51***	**54***	**50***
	ST	**55***	**50**	**57***	**54***	**57***	**51***
Standard of Living Index	Low#	**60***	**56**	**58***	**54**	—	—
	Medium	**52***	**52***	**48***	**49***	—	—
	High	**36***	**44***	**29***	**37***	—	—
Wealth Index	Poorest#	—	—	—	—	**61***	**53**
	Poorer	—	—	—	—	**54***	**51**
	Middle	—	—	—	—	**45***	**47***
	Richer	—	—	—	—	**38***	**44***
	Richest	—	—	—	—	**25***	**34***
Media Exposure	No#	**59***	**53**	**57***	**49**	**56***	**48**
	Yes	**45***	**50****	**42***	**48**	**39***	**46****
Sex of HH-Head	Female#	**45***	**49**	**47**	**49**	**48**	**47**
	Male	**52***	**52*****	**49**	**49**	**47**	**47**
MEI	Low#	—	—	**48***	**47**	**46**	**45**
	Medium	—	—	**50****	**50****	**48*****	**47****
	High	—	—	**49**	**49**	**48*****	**49***
Zone	Central#	**56***	**54**	**55***	**53**	**52***	**49**
	North	**43***	**44***	**43***	**46***	**40***	**43***
	East	**57**	**55**	**54**	**50**	**55*****	**51**
	Northeast	**43***	**42***	**34***	**31***	**38***	**33***
	West	**52***	**56**	**50***	**54**	**43***	**49**
	South	**46***	**49***	**39***	**42***	**35***	**42***
Electricity	No#	**58***	**51**	**57***	**50**	**58***	**49**
	Yes	**46***	**52**	**42***	**48*****	**41***	**45***

Note: Unadj: unadjusted, Adj: adjusted; (0: not malnourished, 1: malnourished).
#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

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Chapter 6

FAMILY SIZE TRANSITION AND ITS IMPLICATION FOR CHILD CARE

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ABSTRACT

This chapter seeks to highlight the family size transition in Andhra Pradesh as a mechanism of twin process of fertility decline and nuclearisation of families impacting the levels and quality of child care through a longitudinal analysis from NFHS I, II and III unit level data. Appropriate bivariate and multivariate analysis such as binary logistic regression models have been worked to show the net effect of the selected demographic and socio-economic predictor variables impacting the probability of the betterment of children's post natal care. The summary results of the analysis points out that the small family norms which has been incepted in Andhra as an exception to the usual discourse of socio-economic development, have not seen to intensify the discrimination in child care to a greater level like its north Indian counterparts, rather portrays significant differential in quality and nature of child care. Small or nuclear households are reported to have performed better in terms of medical care like immunization whereas non medical care such as breastfeeding is higher among non-nuclear households. The other proximate determinants of child care like mothers' occupational structure or their educational attainment are also seen to have similar effects where mothers' having lower level of education or those who are employed in agriculture are reported to perform better in terms of the time- intensive care of the child such as breastfeeding. However, in the nuclear families, lack of baby care owing to rising opportunity costs of the working and educated women are responsible for it. Hence the differential effect of the modernization factors is needed to be handled judiciously.

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INTRODUCTION

The size of the family is of great importance not only for the country as a whole but also for the welfare and health of the individual. India adopted the goal of universalizing the 'two child family norm' lately by the end of this century, which has consequences both at the micro (individual) as well as the macro (community) level. A norm in relation to family size, according to sociologists, implies a pattern which sets limits for any community's fertility behavior. The size of the family affects greatly the quality of life of human beings. Recently, the decline in family size in most parts of India is controlled not only by the family planning initiatives, such as contraceptive use and sterilization of young fetus, but also the disintegration of the joint family system assumes another important mechanism. In this context Atinson (1) pointed out the rural-urban differentials in child care and the importance attached to the non-familial care particularly in rural areas.

The selection of the study area requires judicious and careful examinations of the family size transition across India as well as the extent of decline in the recent period in order to enquire the impact arising out of this negative change. Two criteria have been chosen, 1) The mean household size should be at a considerably low level and 2) An appreciable decline in mean household size in the recent period (NFHS III). Among all the states of India, Andhra Pradesh has recorded the steepest decline in average household size amounting to -1.19 points between 1998-99 and 2005-06 as compared to the national average decline of -0.69 (Table. 1). The mean household size in 2005-06 was 5.62 ranking third at the national level. Hence, the southern state of Andhra Pradesh has been taken under consideration for the further analysis of the mechanisms of such steep decline and impact on child care.

Inequity in child care is a composite outcome of a number of social, economic, cultural and environmental factors. In most cases it is controlled by all these factors wherein the change in family size acts as a catalyst to differentiation in child care. The main research enquiry in the present study is therefore to examine how much and to what extent the change in family size have *intensified* the inequity in child care at intra state level of Andhra Pradesh.

The principle aims of the study conform to: to highlight the transition of family size and the twin process of family planning and disintegration of families conjointly operating to cause the decline in family size; to check the paradox of family size transition and the conventional measures of socio-economic development and finally trace out the implications of small families on child care both in terms of curative and non-curative child care across the socio-economic dimensions.

OUR STUDY

In the analytical framework (Figure 1) presented a linear association is sought to explain the underlying mechanisms of small families and its direct influences upon child care. In India, the recent National Family Health Survey depicts that 12 out of 29 states have achieved the replacement level or below replacement level of fertility. The decline in fertility is often associated with the 'desire for small families'. This context becomes significant in the case of Andhra Pradesh which has recorded Total Fertility Rate as low as 1.8 in 2005-06 (NFHS III) as compared to 2.25 in 1998-99 (NFHS II).

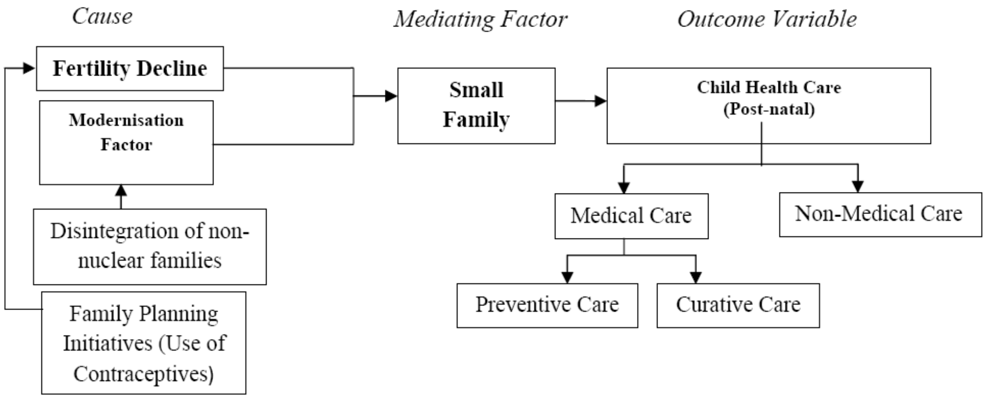

Figure 1. Schematic Representation of the Mechanism of Small Family Size over the Dimensions of Child Care.

Such a dramatic decline in fertility calls for the underlying mechanisms operating for which contraceptive usage has been used to check the desired result. One cannot merely overlook the modernisation factors possibly the increasing prevalence of nuclear families which often acts as a positive impetus on the overall development of the child. The above argument has been sought to check to bring out the relative variations of nuclear versus non-nuclear households at the intra-state level as well as according to place of residence in Andhra Pradesh.

Excluding endogenous genetic factors at the individual level, it is assumed that the chances of infant survival depend upon the degree of care in which the infant is brought up. Broadly visualized, care, starting from conception to the first birthday, i.e., during 21 months of life, is important for an understanding of the determinants of child's health status. The two dimensions of individual level factors which have a direct bearing on child care are:

- Timing
- Type of care

Timing may be divided into three categories namely,

1. Pre-natal
2. Peri-natal
3. Post-natal

Type of care accrues to

1. Medical
2. Non-medical care.

Medical care includes immunization, treatment of illness and medical attention at birth. Non-medical care includes feeding practices, protection from environmental insults and general cleanliness. However, in the present analysis, only the post-natal care of the child has been considered since the aim is to enquire how family size affect child care after the child is born. Thus, the two main dimensions of care yield the following three main individual-level factors:

1. Post-natal non-medical child care- infant feeding practices, for example breastfeeding for at least six months.
2. Post-natal preventive medical child care- immunization.
3. Post-natal curative medical child care- incidence and treatment of illness and effectiveness of treatment.

These factors are not arranged in any order of priority. Their relative importance may vary from population to population and for the same population at different times. But we put forward the hypothesis that household and community level factors would affect the chances of child care through one or more of these proximate determinants.

Table 1. Average Household (HH) Size of Andhra Pradesh and India

Rounds	Average HH Size		Changes	
	Andhra Pradesh	India	Andhra Pradesh	India
NFHS I (1992-93)	6.75	7.92	-	-
NFHS II (1998-99)	6.81	7.68	0.06	-0.24
NFHS III (2005-06)	5.62	6.99	-1.19	-0.69

Source: NFHS I, II and III Rounds, Unit Level Records.

i. Selection of indicators for analyzing family size

The decline in family size can be sought as a joint mechanism for breakdown of joint families and fertility decline. Hence different indicators have been taken under these two broad heads for the overall analysis.

a. Indicators selected for modernization

The two basic indicators which depict the modern regime of small family size are of:

1. Mean Household Size (a proxy for small families)
2. Percentage of households by structure (nuclear/non-nuclear)

b. Indicators selected for family planning

Family Planning or conscious efforts of the family to limit its size are an important outcome of fertility decline. Indicators sought under it are

1. Percentage of families having two living children
2. Percentage of currently married women (aged 15-49) who have ever used any kind/method of contraceptives

ii. Selection of indicators to depict child care

As already mentioned Child Care includes both medical as well as non-medical care.

a. Indicators selected for child medical care

Post Natal Preventive Child Care: Percentage of children of 1-2 years who received universal immunization by birth order, sex of the child, place of residence and household structure.

Post Natal Curative Child Care: Percent of Children (0-2 years) who have received any kind of medical treatment in last two weeks (diarrhea, fever, cold or cough) according to background characteristics.

b. Indicators selected for child non-medical care

Post Natal Non-Medical Care: Percentage of children below 1 years of age who are currently breastfed by household size and household structure and place of residence. Appropriate Bi-Variate analyses are worked out to see the gross effect of different level factors over child care. However, the net or independent effects of all the factors have been captured by the binary logistic regression models. Two separate models have been used according to each of the dimensions of child care as described above, i.e., Medical care and Non-medical care.

FINDINGS

Family size transition in andhra pradesh: Emerging trend of small families

The glaring decline in mean household size accompanied by the havoc decrease in the levels of fertility have ushered a wave of serious concerns of the socio-economic mechanisms and the demographic consequences of Andhra Pradesh. In this context, this subset of analysis gives a causative outline of the small family size by focusing on two important issues in the present context of development studies. As such the process of family transition in Andhra Pradesh has been faster than many other states of India, especially the North Indian states, the growing desire for small families in the emerging context of ‘small family norms’ and the breakdown of joint family system with modernization, the following analysis become more focused in emphasizing the two of the above issues.

Family planning initiatives

The recent ‘revolution in family life’ especially that of Southern India may not correspond to the classical theories of fertility where a decline in fertility is associated with changes in material conditions of the people. Recording a considerably higher birth rate than the other southern states, Andhra Pradesh has witnessed a steep decline in fertility rate in the recent periods. The small family norm which came out as an initiative on the Government front to reduce the Total Fertility Rate at the replacement level has been very much effective in Andhra Pradesh recording a much higher value of percent of families having two or less than two children than the all India level.

At the national level, slightly more than half of the total households of the country have a tendency to adopt the two child family norm (Figure 2) whereas the corresponding figures for Andhra Pradesh almost constitute three fourths of the total households who desire for two children. More interestingly, the two child norm is more a recent phenomenon which have shown a dramatic increase from 1992-'93 to 1998-'99.

The possible decline in fertility rate and the progressive adoption of the two child family norm in Andhra Pradesh may be partially related to the use of contraceptives (any kind/method) of currently married women in the reproductive age group (Figure 3).

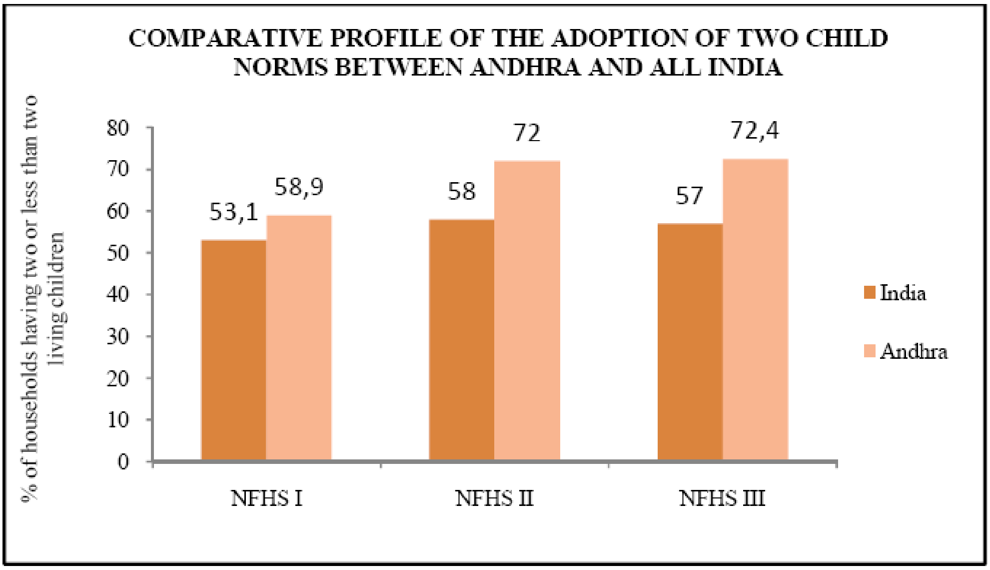

Figure 2.

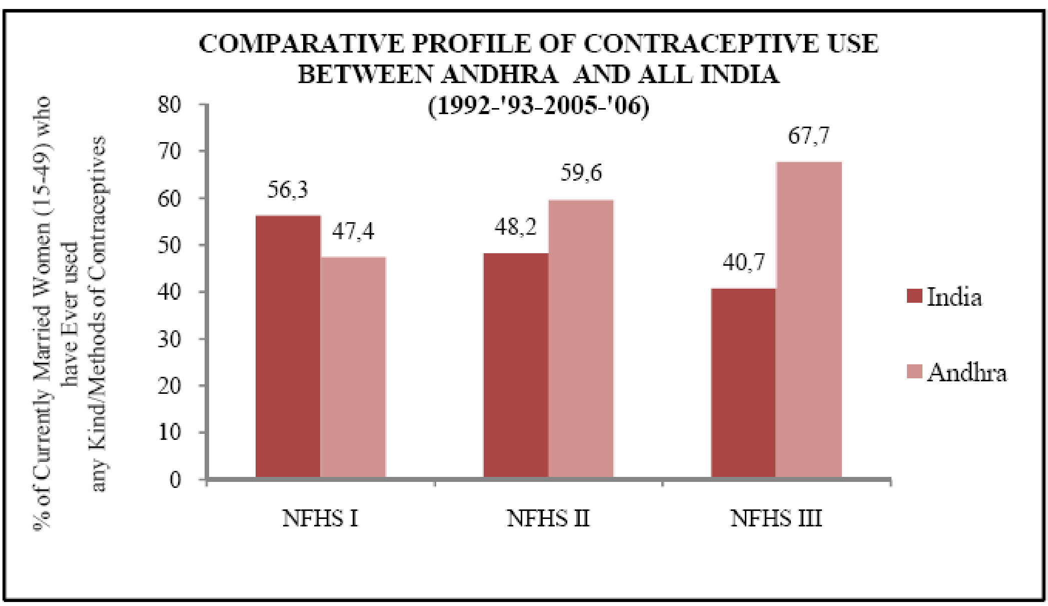

Figure 3.

Unlike India, Andhra has shown a progressive increase in usage of any kinds of contraceptives across the three NFHS Rounds accompanied by a decline in total unmet need from 10.4% in 1992-’93 to 5.0% in 2005-’06. (Source: NFHS III Report). The use of contraceptives among the currently married women within the reproductive age group at a more disaggregated level according to their educational levels and place of residence strikes some of the hidden facts more clearly.

Table 2 clearly depicts dissolution of the gaps in the levels of contraceptive use between rural and urban Andhra over the years (1992-’93 to 2005-’06) indicating a strong rural-urban convergence. Not only the gap has lessened in terms of rural-urban differences, even in terms of differential levels of educational attainment among the currently married women (15-49 years), the gap in contraceptive use has narrowed down and women with no education who were the most vulnerable group in terms of contraceptive use in 1992-93 has in fact recorded the maximum usage of contraceptives in 2005-06 outnumbering those who have completed 10 or more years of education. Even though in this case a qualitative judgement based on the actual type/method of contraceptive use becomes important, but the alarming use of contraceptive among the rural and uneducated women clearly signify an equitable distribution for which the community level determinants and effective diffusion of the measures for controlling unmet needs become important.

Table 2. Percentage of currently married women (aged 15-49) who have ever used any kind/method of contraceptives according to Place of residence and Educational Levels

Periods	Place of Residence		Education Levels				Overall
	Rural	Urban	No Education	<8 years complete	8-9 years complete	10 years complete and above	
NFHS I	45.7	61	44.9	59.8	57.6	61.1	47.4
NFHS II	59.2	66.2	59.7	64	57.6	61.8	59.6
NFHS III	67.7	67.7	70.5	67.3	66.2	59.7	67.7

Source: NFHS I, II and III Rounds, Unit Level Records.

Role of modernization factors: Nuclearisation of families

Studies on the influence of modernity and industrialization on family structure has been a long-standing topic of discussion among sociologist, social anthropologists, etc. their view been expressed that the joint family or extended family system typical of an agrarian, pre-industrial economy must inevitably give way to more smaller and adaptive nuclear families once the traits of modernization enters the society like urbanization, take-off for industrialization, etc. With average household size amounting to 5.91 in 2005-06, Andhra clearly marks itself as one of the leading representative of small family size as far as the national scenario is concerned taking itself the third place. However, there appears a rural-urban variation in household size with the rural households once again performing much better in mean household size compared to the urban counterparts as the numbers which have been exemplified in Figure. 4. The actual mechanisms operating behind this deviation from the theoretical norm has been dealt in the later analysis. The nuclear family which can be taken as a proxy of small families shows a contrasting picture between India and Andhra Pradesh (Figure 5), the latter recording more of nuclear households than the all-India picture essentially signifying the fact that the joint family system which often acts as an impediment to modernization is actually disintegrating among a small vocal class who have set the traits of modernization such that as the case of Andhra Pradesh reporting non-nuclear families less than the national average.

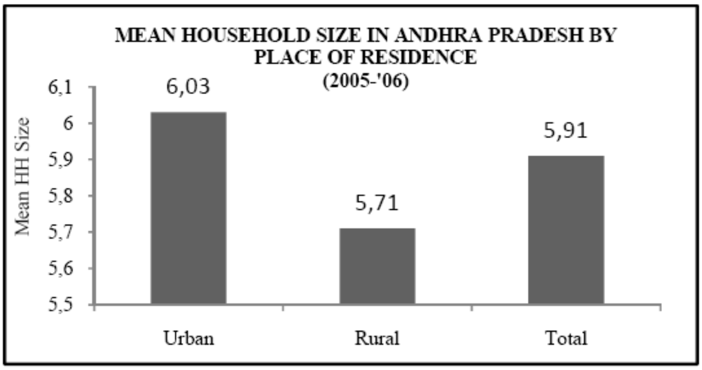

Figure 4.

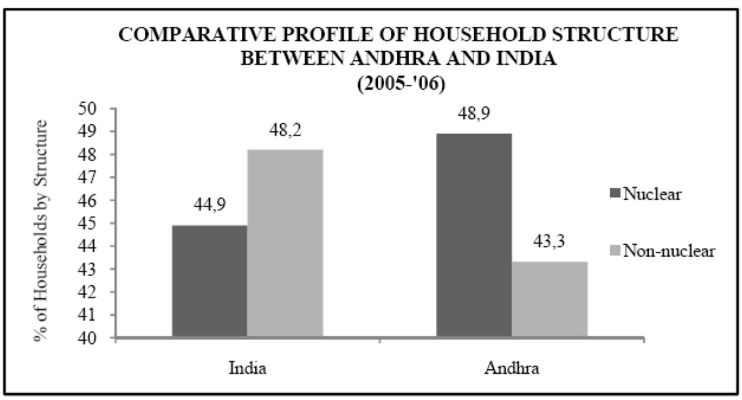

Figure 5.

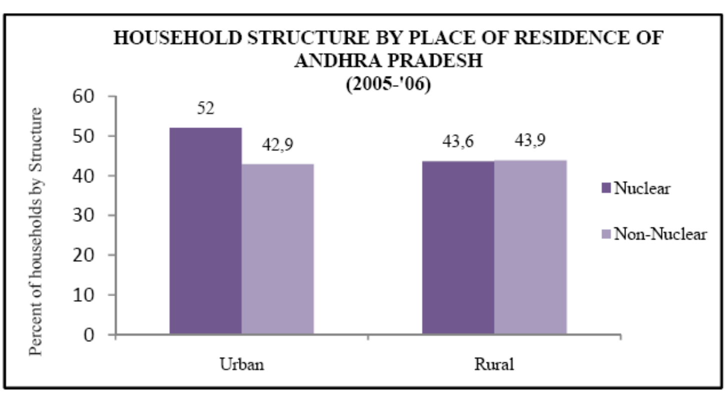

Figure 6.

This process of nuclearisation of families is essentially an urban phenomenon in Andhra as depicted in Figure 6 with the rural households exhibiting almost an equitable distribution in terms of family structure.

Size of the family according to socio-economic characteristics of the population

The size of family when cross-classified by wealth index (Table 3) shows an increasing trend of richest households to have higher family size rather than the poorer counterparts. Among all the household sizes the poorest households records the maximum proportion in the ideal family size, i.e., 3-4 household members followed by 4-6 household size. This is essentially an interesting picture especially in the second and the third classes of the household sizes with the poorest recording the maximum proportion and richest the lowest.

Table 3. Percentage of households of different sizes by wealth index and place of residence (2005-'06)

Wealth Index	Rural				Urban			
	Less than or equal to 3	3-4	4-6	More than 6	Less than or equal to 3	3-4	4-6	More than 6
Poorest	6.56	39.34	40.98	13.11	9.4	34	28.3	28.3
Poorer	9.86	23.47	37.56	29.11	19.2	32.7	28.8	19.2
Middle	9.03	24.41	34.11	32.44	15.1	30.2	30.7	24.1
Richer	8.13	25.00	40.63	26.25	10.7	30.6	29.8	29
Richest	6.52	34.78	32.61	26.09	10.8	21.6	26.8	40.8

Source: NFHS III Round, Unit Level Records.

Even in terms of rural-urban variation (Table 3), the poorest have shown the maximum concentration in small family clusters and the difference between the top 20 and bottom 20% is more pronounced in urban areas especially in the ideal family size, i.e., households constituting 3-4 members. However, in rural areas the larger family size (More than 6) has more of the middle classes (32.44%) as compared to the urban counterparts wherein the richest take the leading position in the largest family size (40.8%). One thing becomes quite clear from the above analyses is that the richer have a more tendency in making up larger families, which is more pronounced in the urban areas and the poorer, the most vulnerable group have gone towards smaller families irrespective of the place of residence.

Generally across all the social groups (Figure 7), the nuclear families show a higher proportion than the non-nuclear families but the highest concentration of such households could be observed across the marginalized groups i.e., the STs (Scheduled Tribes) and SCs (Scheduled Castes). The others castes comprising of the general community have only a marginal difference between nuclear and non-nuclear households.

Other Backward Class (OBC) constituting the half of the share of population in Andhra Pradesh (Table 4) has 49% of the households living in nuclear families. The other half constitutes of one-fourth marginalized social groups (SC and ST) and about one-fourth General households. The marginalized groups have more than half of the households classified as nuclear families. The analysis again highlights the importance of nuclear families in the emerging household structure of Andhra Pradesh.

Table 4. Share of socio-economic groups according to place of residence in Andhra Pradesh (2005-'06)

Place of Residence	Scheduled caste	Scheduled tribe	Other Backward Class	None of above
Urban	15.12	4.01	49.22	31.65
Rural	19.89	10.71	52.45	16.95
Total	17.50	7.36	50.84	24.30

Source: NFHS III, Unit Level Records.

Table 5. Percentage of households of different Sizes by caste groups

Type of Caste/ Class	Household Size			
	Less than or equal to 3	3-4	4-6	More than 6
SC	5.90	33.49	36.08	24.53
ST	8.08	25.25	39.90	26.77
OBC	10.57	29.36	34.40	25.67
Others	12.65	26.88	31.03	29.45

Source: NFHS III, Unit Level Records.

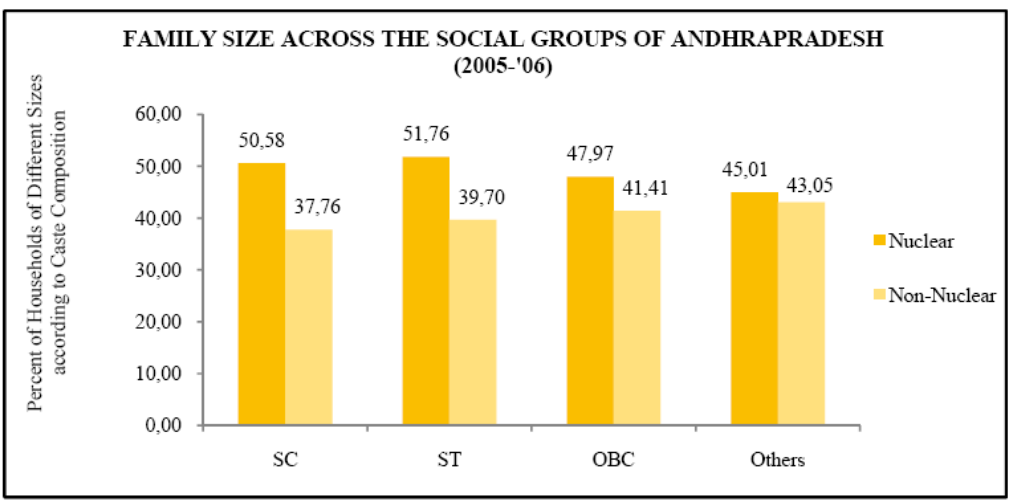

Figure 7.

In terms of disaggregated household size, the difference between the social groups is not so prominent in the highest household size, however the gap becomes clearer towards the smaller household size such that of households with total number of members ranging from 3-4 and 4-6. For, the lowest class of household size (Table 5), here in fact the other castes have fared better than the SCs and STs in households less than or equal to 3 members. At a glance the maximum share of all the socio-economic groups could be recorded in households having 3-4 members.

THE CASE OF FERTILITY DECLINE IN ANDHRA PRADESH: A PARADOX OF SOCIO-ECONOMIC DEVELOPMENT

Rationale behind fertility decline

Among the factors other than private income that have a strong influence on fertility, basic education, especially *female education* is considered as one of the most powerful. According to Dreze and Sen (2) female education influences- 1) desired family size, 2) the relationship between desired family size and planned number of births, and 3) ability to achieve the planned number of births.

Educated women are most likely to voice resentment at the burden of repeated pregnancies and to take action to lighten that burden. According to Dyson and Moore (3), this may occur because educated women have other sources of prestige and fulfillment besides reproductive performance, more control over household resources and personal behavior, and greater involvement in reproductive decisions. Further, opportunity cost of time tends to be comparatively high for educated women, and this creates an incentive to minimize such time-intensive activities such as child bearing and child rearing. Most importantly maternal education helps in achieving planned number of births by facilitating knowledge and command over contraceptives.

Female labour force participation have a negative impact on fertility since the double burden of household work and gainful employment enhances the effectiveness of women's agency in society and repeated pregnancy quite stressful. The context of *urbanisation* becomes relevant and acts independently to control fertility on account of greater access to relevant information in urban areas and the breakdown of the socio-cultural hindrances to economic development such as joint family structure.

The effect of *poverty* has significant impact upon fertility after controlling the other explanatory variables such as female work participation rate which is generally found to be higher in poor families.

Exemplification for the case of Andhra Pradesh

The discourse of fertility decline in India is mainly confined to the three southern states namely, Kerala, Tamil Nadu and Andhra Pradesh all having achieved fertility rates below the replacement level. James (4) held that the experience of Kerala led to the understanding that even without considerable improvement in the levels of industrialization, urbanization and material improvement in the standard of living of the population, fertility decline took place with social development. In case of Tamil Nadu, fertility decline almost paced as that of Kerala even though with a somewhat lower level of social development. Of them female literacy assumes to be a very important determinant of social development governing the fertility decline. The massive decline in fertility in Kerala could be attributed to this indicator in spite of lower levels of urbanization and industrialization as already mentioned. Tamil Nadu's story is not the magic female literacy as so much as that of Kerala, but more of the modernization factors like urbanization, etc. So the present analysis tends to draw an exploratory note on the socio-economic development versus fertility decline in Andhra Pradesh keeping in mind the contexts of Kerala and Tamil Nadu where the fertility decline has been achieved at a much early period.

With Total Fertility Rate much lower than the National Average and female literacy and urbanization slightly below the All India level, not mentioning the Head-Count Ratio which is 10% less compared to India (1999-00 and 2004-05), the fertility transition in Andhra Pradesh draws several questions to the mind of the researcher. The fast decline in fertility rate without any significant improvement in the conventional indicators of socio-economic development is mysterious and the nature and extent of this transition leading to the small family size calls for serious investigation.

Table 6 clearly suggests that there is a poor correspondence between female literacy rate and total fertility rate in Andhra Pradesh. Hence, from the experience of Andhra Pradesh it is difficult to prescribe any threshold level of female literacy for fertility transition. Even though female work force participation is higher than the national average, but it often do not signify gainful employment as being a predominantly agricultural economy the majority of women work as agricultural labourers associated with low cultural rigidities of women work. Urbanization which is a proxy for economic development has been at a lower level even though the percent population below poverty line is much low than the national average. With the concentration of larger sized households (as well as non-nuclear) among the richer classes which have been empirically established in the previous section calls for a dichotomous situation between the levels of economic development and its implications on family size.

Table 6. Socio-economic indicators of development of Andhra Pradesh and India for different periods

Indicators	Years	Andhra Pradesh	India
Female Literacy (%)	1991	27.32	32.17
	2001	43.76	45.13
	2011	53.8	56.99
Female Work Participation Rate (%)	1991	30.05	15.93
	2001	35.11	25.6
Urbanisation (%)	1991	26.89	25.73
	2001	27.3	27.81
	2011	33.49	31.16
Head Count Ratio (%)	1999-00	15.77	26.1
	2004-05	15.8	27.5
Total Fertility Rate	1992-'93	2.6	3.4
	2005-'06	1.8	2.7

Source: Primary Census Abstract, Census of India, 1991, 2001 and 2011; Planning Commission, Poverty Estimates, 1999-00 and 2004-05; NFHS I, II and III Reports.

The economically most vulnerable sections have in fact performed much better in relation to controlled family size and planned number of births which has been often supported from the Government interventions in the form of active interventions for the spread of the use of contraceptives among the rural poor.

IMPLICATIONS OF SMALL FAMILIES ON CHILD HEALTH CARE

Child's medical care (Post natal)

As mentioned earlier, medical care of the child is broadly categorized under two heads, namely, Preventive and Curative Cares. The following subsections tries to establish causal links between the two types of medical care and its relationship with family size, here used as the explanatory variable.

The present subset attempts to analyze the effects of some selected demographic and socio-economic variables on the levels of immunization of a child for six vaccine preventable diseases such as tuberculosis, diphtheria, peruses, tetanus, poliomyelitis, and measles. According to the guidelines developed by WHO children (1-2 years) who received BCG, measles, and three doses each of DPT and polio, excluding polio0 (Polio 0 is administered at birth along with BCG) are considered to be fully vaccinated. The analysis tries to explore the status of immunization coverage from the demand-side with a simplifying assumption of ceteris paribus supply side constraint on account of a long history of Government negligence in health spending.

Post natal medical preventive care

Children are the unit of the present analysis which uses the children's recoded file (1-2 years) with an overall sample size of 1214. The analysis of immunization coverage uses a number of demographic and socio-economic variables. The dependent variable is full immunization that says whether a particular child is fully immunized or not. The selected predictor variables are household structure, disaggregated household size, place of residence (rural, urban), wealth index, type of caste or tribe of household head, mother's employment status and sex specific birth order.

Children belonging from smaller household size find themselves to be better fully immunized than the largest household size. However, not much variation could be observed among the last three classes, in fact the ideal family size (3-4 members) tend to have a marginally less value than households with more than 6 members with respect to the immunization coverage. The nuclear and urban households which have less of non-nuclear families have in fact reported a better situation in immunization coverage. The rural-urban disparity in immunization is not due to demographic factors but due to socio-economic correlates. The likelihood of immunization increases with mother's employment status and wealth index. There appears a mixed situation of immunization coverage and the birth order of children. As in many cases boys of 4^{th} order and girls of 5^{th} order or higher seemed to have higher values than the 1^{st} or 2^{nd} birth order. A plausible explanation could be that of very few children existing in 4th or above birth order in Andhra Pradesh, its values thereby being inflated by getting a higher weightage. But boys are likely to be more immunized than girls in the 1st, 2nd even in the 3rd birth order. There appears a considerable gap between the girl and boy in 3rd birth order, with 13.4% girls receiving full immunization as compared to 32.4% boys (Table 7). The result depicts a greater apathy on part of the parents to immunize a higher order female child.

Table 7. Percent of children (1-2 years) who have received universal immunization according to Background Characteristics

Background Variables	Percentage of children of 1-2 years of age who have received universal immunisation
Household structure	
Nuclear	32
Non-nuclear	27.4
Family Size	
Less than or equal to 3	34.1
3-4	21.9
4-6	23.1
More than 6	23.1
Type of place of residence	
Urban	33.3
Rural	23.4
Wealth Index	
Poorest	14.6
Poorer	21.7
Middle	26.5
Richer	28.1
Richest	42.8
Mother's Employment	
Not Worked	25.2
Worked Last Year	14.3
Currently Working	31.1
Type of caste or tribe of the household head	
Scheduled caste	16.9
Scheduled tribe	16.3
Other backward class	28.9
None of above	33.6
Sex-Specific Birth Order	
Birth Order	**Percentage of boys of 1-2 years of age who have received universal immunisation**
1	36.7
2	25.1
3	32.2
4	44.1
5+	15
Birth Order	**Percentage of girls of 1-2 years of age who have received universal immunisation**
1	26.2
2	20.4
3	13.4
4	33.3
5+	35

Source: Computed from NFHS III, Unit Level Records.

Post natal medical curative care

The exercise for curative medical care for children aged 0-2 years who have been medically treated had they been suffering from diarrhea, fever, cold or cough within two weeks of occurrence, the analysis show a clear daughter disadvantage in treatment (Table. 8).

Table 8. Percent of Children (0-2 years) who have received any kind of medical treatment in last two weeks (diarrhoea, fever, cold or cough) according to background characteristics

Background Variables	Percentage of children (0-2 years) who received any kind of medical treatment in last 2 weeks while suffering in diarrhoea, fever, cold or cough
Household Structure	
Nuclear	81.5
Non-Nuclear	88.9
Household Size	
Less than or equal to 3	85.7
3-4	83.3
4-6	78.6
More than 6	100
Place of Residence	
Rural	85.7
Urban	83.3
Type of Caste or Tribe of the Household Head	
SC	84.6
ST	100
OBC	82.4
Others	86.7
Sex Specific Birth Order	
Boys	
1	92.3
2	100
3	83.3
4	80
5+	72.1
Girls	
1	60
2	52
3	50

Table 8. (Continued)

Background Variables	Percentage of children (0-2 years) who received any kind of medical treatment in last 2 weeks while suffering in diarrhoea, fever, cold or cough
4	48
5+	43
Wealth Index	
Poorest	85.7
Poorer	100
Middle	77.8
Richer	88.9
Richest	88.9
Employment Status of Mothers	
Not Employed	88.9
Employed in last year	100
Currently working	81.2

Source: Computed from NFHS III, Unit level Records.

Children of higher birth order are less likely to be medically treated which shows that the negligence effect more than offsets the learning effect. Unlike universal immunization, curative medical treatment functions well in non-nuclear households (a proxy for large families) with 100% coverage in households more than 6 members. Accordingly, the rural families which have a higher share of non-nuclear families report marginally higher value than the urban counterparts. This could be partially related to the employment status of the mother. Child preventive care is higher for unemployed and those who have been employed in the previous year signifying that the exclusive care of the child varies with the levels of preoccupation of mother's work. The tribal households generally involved in community living tends to impart some time for taking care of the diseases of their children, even if they believe in the more traditional forms of medication unlike the other castes. The analysis clearly indicates that the level of awareness captured by universal immunization of the child may not signify a comprehensive child care when the day to day child illness like diarrhea, cold, cough, etc. enter as an obstacle to the healthy growth of the child which is highly dependent on the potential time devoted by the parents in taking care of their children. In joint families, the child is not left alone when its mother is working outside and here in comes the importance of traditional extended families in imparting care to the child which in most cases performed by the native kin relatives.

Post natal non-medical care

Breastfeeding constitutes an important component of the intensive care of the child. Table 9 provides a bivariate association between breastfeeding cross classified by the socio-economic and demographic predictive indicators for child care.

Table 9. Percent children less than 1 year who are currently breastfed according to background characteristics

Background Variables	Percentage of children below 1 years of age who are currently breastfed
Household Structure	
Nuclear	81.6
Non-Nuclear	84.9
Household Size	
Less than or equal to 3	75.9
3-4	83.3
4-6	84.5
More than 6	87.3
Place of Residence	
Rural	76.4
Urban	88.2
Type of Caste or Tribe of the Household Head	
SC	91.7
ST	91.9
OBC	88.4
Others	65.5
Sex Specific Birth Order	
Boys	
1	82.5
2	86.4
3	90
4	100
5+	88.9
Girls	
1	80.1

Table 9. (Continued)

Background Variables	Percentage of children below 1 years of age who are currently breastfed
2	79.8
3	88.9
4	90.5
5+	90
Wealth Index	
Poorest	91.1
Poorer	93.5
Middle	89.1
Richer	82.4
Richest	59.5
Employment Status of Mothers	
Not Employed	81.4
Employed in last year	100
Currently working	90.7

Source: Computed from NFHS III, Unit level Record.

It becomes clear that breastfeeding is more a common phenomena among the non-nuclear households and families of larger size.

In support of this argument it could be said that parents alone do not have to bear the entire domestic burden in joint families, henceforth the double burden faced by working women is often offset by the helping hands provided by the members of an extended family.

Contrary to the nuclear households, even if the woman is not employed, the entire burden of domestic chores rests upon her which tends to happen at the cost of sometimes feeding the child. However, there is not much discrimination in breastfeeding between a boy and girl infant so also across the birth orders as could be observed in other dimensions of child care.

However, significant discrepancy exist among the socio-economic groups, especially among communities at the lower end of the social ladder the practice of breastfeeding is widespread which have gone to the extent of around 91% of the households in which children are breastfed irrespective of the sex of the child as well as birth order.

THE MULTIVARIATE MODEL

In order to trace out the differentials in child care in terms of the desired family size and a number of socio-demographic factors, a binary logistic regression analysis has been attempted. Two separate models have been worked out to show differentials in child care in terms of medical and non-medical terms. The dependent variable in the case of medical care is the percentage of children below 2 years who have received universal immunization, whereas in the other case, it is the percentage of children below 1 year who are currently breastfed. The main objective of this exercise to show the differences in probable outcomes in terms of child care according to different family sizes and household structure as well as to identify the other proximate determinants that in turn affect the quality of child care other than family size. It is notable that a number of these factors also have significant relation with changes in family size itself; therefore, the differential probabilities that may occur in response to these factors can be interpreted as the indirect effects of family size, or more specifically, the modernization factor itself.

Results of the two separate models has shown different outcomes in terms of medical and non-medical care that needs to be explained in terms of different effects of socio-demographic factors. It can be observed that for the preventive medical care like immunization, where the proportion of households, whether belonging to any category, shows significantly slower progress, have shown better responses from the nuclear or urban households and vice versa. However, the story is different in case of non-medical care like breastfeeding, where the conventional factors of modernization have not seen to have any significant effects.

Table 10 summarize the result, where it can be seen that the chances to universally immunize the child is lower in non-nuclear families, which is statistically significant. Opposite outcome can be observed for the same factor in the case of breastfeeding, where the odds ratio in favor of being breastfed declines in the case of nuclear families, although it’s not statistically significant. Almost same kind of result can be found when we enquire the effects in terms of family size, where the smaller families that have less than or equal to four members have more chances to the child to be immunized rather than the families having more members than four.

The result is statistically significant for smaller families, although found to be insignificant in the case of breastfeeding, where the families having 4-6 members have the highest chances to the child below 1 year to be breastfed by his or her mother. It is notable that in this case, the odds ratios are significant in the case of larger families (4-6 members), which is just opposite to the case of immunization, where the smaller families have a significant result, thereby making the differentiation more concrete.

Apart from family size, the other proximate determinants of child care have shown significant observations. Households inhabiting in the rural areas are reported to have lower chances to universally immunize or breastfed their children than the urban counterparts, although the difference is quite marginal in the case of breastfeeding, whereas it is much higher in the case of immunization (both the results are statistically significant). In other words, the difference in chances of being breastfed between the rural and urban areas is only 2% in favor of urban, whereas it is about 25.4% in the case of universal immunization.

Table 10. Summary of Binary Logistic Regression

Independent variable	Percentage of children 1-2 years of age who have received universal immunization	Percentage of children below 1 year of age who are currently breastfed
	Odds Ratio	Odds Ratio
Household Structure (Ref. Nuclear)		
Non-Nuclear	0.939***	1.616
Household Size (Ref. More than 6)		
Less than or equal to 3	1.416**	0.966
3-4	0.926	1.169
4-6	1.139	1.723***
Place of Residence (Ref. Urban)		
Rural	0.746**	0.980
Caste of the Household Head (Ref. General)		
SC	0.497*	4.744*
ST	0.376*	3.668**
OBC	0.969	2.524*
Sex of the Child (Ref. Male)		
Female	0.582*	0.647***
Birth Order (Ref. 5+)		
1	1.669***	0.053**
2	1.004	0.082***
3	1.038	0.189
4	0.503*	0.230
Desire for more children (Ref. Don't Want)		
Want Child	0.902***	2.425*
Undecided	1.586***	1.263
Wealth Index (Ref. Richest)		
Poorest	0.284*	1.868

Independent variable	Percentage of children 1-2 years of age who have received universal immunization	Percentage of children below 1 year of age who are currently breastfed
	Odds Ratio	Odds Ratio
Poorer	0.419*	5.392*
Middle	0.613**	2.466*
Richer	0.493*	1.807***
Mother's Employment (Ref. Currently Working)		
Not Working	0.626***	0.557
Worked in Last Year	0.397***	6.298
Nature of Mother's Employment (Ref. No Work)		
Agriculture Self-Employed	2.717**	2.071***
Agriculture employee	1.194	1.679***
Skilled Worker	0.308**	0.678***
Unpaid HH worker	1.112	1.009
Mother's Educational Attainment (Ref. Higher than Secondary Education)		
No Education	0.235*	1.827
Incomplete Primary	0.431*	1.487
Complete Primary	0.504**	4.255*
Incomplete Secondary	0.644***	1.303***
Complete Secondary	0.380*	0.545***
Constant	1.325	9.555
-2 Log Likelihood	1523.174	462.774

Significance Levels: *1%, **5%, ***10%.

Such a factor again confirms the inverse effect of modernization factor over quality child care, especially in terms of non-medical purposes, where the factors like efficient management of children by providing enough time in care matters much than the factors like awareness about diseases or economic worth of the family. This hypothesis is clearly supported by the outcomes traced out by the factors like wealth index where the chances of immunizing the child is more or less uniform among the poorer, middle and richer classes in comparison to the richest class (all the results are statistically significant); whereas in the case of breastfeeding, the odds ratio of the poorer class seems to be much higher in favor of being breastfed in comparison to the richest class, which is statistically significant. Same kind of results can be found if the mother's level of education and occupational structure is taken into account. It can be seen that in the case of universal immunization, the chance of those mothers' who have no education is significantly lower to immunize her child than the mothers' who have higher education but in the case of breastfeeding the opposite result can be seen. The odds ratio in favour of breastfeeding in the case of mothers having no education is reported to be 1.827, which is 0.545 in the case of those mothers who have completed their secondary education, which is statistically significant. In other words, in comparison to the mothers who have higher than secondary level of education, the odds in favour of breastfeeding the child is reported to be 82.7% higher in the case of to the mothers who have no education, but 45.5% lower to the mothers who have completed their secondary education. Mothers worked in the last year are reported to have higher chances to breastfed their babies than the mothers who are currently working, although the result is statistically insignificant. However, further disaggregation according to the occupational structure of the mothers reveals the fact that in comparison to the women who do not work, women engaged in the agricultural workforce, whether self-employed or as labourers, are reported to have higher odds in favour of breastfeeding than the skilled workers engaged in tertiary sectors. The nuclear families or the smaller households, which are the most proximate outcomes of modernization and are reported to be centred in urban areas; mainly constituted by highly educated working couples and mostly by two or single child; are therefore, inevitably manifested their indirect effect over the levels of child care through these determinants.

The caste of the household, that have shown significantly higher concentration of nuclear and small size families among the scheduled caste and scheduled tribe households, also reported to have higher odds ratio in favour of breastfeeding in comparison to general households, which is statistically significant. In the case of universal immunization, the chances to immunize the children are seen to be lower in all castes in comparison to generals. The result is statistically significant and perhaps ascribed to the lower socio-economic status and social opportunities granted to these marginalized groups in comparison to non-scheduled castes. Another episode of discrimination, which deals with the gender differential in child care, clearly portrays the lower status granted to the girl child in case of both medical and non-medical care. However, a detailed analysis with respect to sex specific birth order in the previous sections has shown that boys in the first or second birth orders are subjected to immunized more than their female counterparts and vice versa. The same is in the case of breastfeeding, where the proportion of breastfed girls is much higher in high birth order than the boys. The odds ratios with respect to birth order have not shown any significant observations in the case of breastfeeding, although in the case of universal immunization, children in the first birth order are reported to have higher chances to be immunized than the children in the lower counterparts, which is statistically significant. Desire for more children in this respect plays an important role which more specifies the tendency of a family to provide quality care to its existing child and also to the future child. It is interesting to observe that in comparison to the families who do not want child, families that want child used to have lower chances to immunize their existing child, which is statistically significant. This factor, however, have no effect on breastfeeding, as existing children are reported to have fairly high odds in favour of breastfeeding in the families that want more child, which is also statistically insignificant. This factor partially explains the children in the upper birth order to be more immunized in the context of those families that want no more children.

In summary, it can be opined that the factors of modernization are reported to have significant effects over the levels and quality of child care in different terms. The curative and medical care that needs appropriate knowledge, sense and ability about hygiene and disease prevention is reportedly found in nuclear or small size families who have overcome unmet needs in medical care. On the other hand, the factors of non-medical care that demands efficient involvement of mothers with the child are found to be lower in smaller families, thereby resulting discrepancies in child care across different family size.

DISCUSSION

The family size transition in Andhra Pradesh evokes out of the desire for small families operating jointly through the mechanism of fertility decline and increasing trend of nuclearisation of families which could be taken as a proxy for small families. The process of nuclearisation is more an urban phenomenon. The richest set of households in terms of access to resources has higher non-nuclear families than the poorest. The process of fertility decline in Andhra Pradesh is unaccompanied by appreciable social development. Female Literacy which is one of the most important explanatory variables impacting fertility decline is well below the national average.

The higher use of contraceptives is responsible for this. The integrative care of the child captured through post natal care shows differentiation according to family size when care is disaggregated into protective efforts including curative and preventive care and non-medical care which signifies the intensive care of the child. The factors of modernization have different effects in terms of levels and quality of child care. Small or nuclear households are reported to have performed better in terms of medical care like immunization whereas non medical care like breastfeeding are reported to have higher among non-nuclear households.

The other proximate determinants of child care like mothers' occupational structure or their educational attainment are also seen to have similar effects where mothers' having lower level of education or those who are employed in agriculture are reported to be perform better in terms of non-medical care like breastfeeding. However, in the nuclear families, lack of baby care owing to rising opportunity costs of the working women is responsible for it. A strong evidence of rural-urban dilution is observed in the levels of child care, where the rural families are seen to be attempting small family norms and also showing the tendency of quality child care like their urban counterparts.

The summary results of the analysis points out the key fact that the small family norms, that has been incepted in Andhra as an exception to the usual discourse of socio-economic development, have not seen to intensify the discrimination in child care to a greater level like its north Indian counterparts, rather than portrays significant differential in quality and levels of child care.

Dissections across the characteristics of the family size, namely the place of residence or mothers' occupational structure or mothers' level of education has pointed out that the levels of child care differs not only according to the levels of education or income profile of the households but also the quality time or involvement of the parents to the child irrespective of income and educational level of the households. It is the differential effect of the modernization factors that is needed to be handled judiciously.

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Chapter 7

MATERNAL AND CHILD HEALTH

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ABSTRACT

Maternal and child health is of paramount importance for healthy development of human beings. 68 developing countries account for 97% of maternal and child deaths worldwide. This paper aims to examine the child health issues in developing countries including India and the ways for strengthening health systems to improve the quality and utilisation of health services for new born and child health. WHO build block of health systems include the following as constituting health systems: Leadership and governance consist of management of health systems by political, economic and administrative authority at national, district and sub-district level. Financing arrangements include funding and incentive system at the national and district level. Service delivery includes conception and development of programmes and interventions at national level, district level programmes in line with national health agenda and services delivered effectively at sub-district and community level. Health workforce includes sufficient number of trained, productive and responsive workers aiming to achieve the best health outcomes. Medical products and technologies "equitable access, assured quality, safety, efficacy and cost-effectiveness". Information and evidence in a functional health system ensures the "production, analysis and use of reliable and timely information on health determinants, health systems performance and health status". A comprehensive and integrated approach to strengthening health systems can certainly contribute in reduction of maternal and child deaths thereby achieving millennium development goals 4 and 5.

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INTRODUCTION

Maternal and child health is of paramount importance for healthy development of human beings. Nevertheless, child health is at peril in many developing countries. WHO data and many other data are a testament to this statement. Lack of access to functional, effective and affordable health services is one of the many factors responsible for affecting child health status adversely in developing countries. It is increasingly understood that almost all the issues related to child health can be addressed by strengthening health systems which is wide and comprehensive subject. The health systems encompass various topics such as the national leadership and health policies; financing; drugs, vaccines and medical technologies; health data; district level, sub-district level and community level health workforce; and delivery of quality, safe and efficient services to the mothers and children who need them and where they need them.

India is one of the 68 countries which account for 97% of maternal and child deaths worldwide (1). This paper aims to examine the child health issues in developing countries including India and the ways for strengthening health systems to improve the quality and utilisation of health services for new born and child health.

CHILD HEALTH IN DEVELOPING COUNTRIES

Good health in the foundation years is crucial to the full potential development of a human being be that in a developing nation or a developed country (2). Therefore, every child in the world has a right to get care and services for the promotion of his/ her healthy development. However, in contrast to the rights of children, the reality is that many children die during or soon after their birth or before reaching the age of five. These high numbers of deaths of infants and children mostly occur in developing nations especially in African and Asian countries (3). According to World Health Organization (WHO), the world's average child mortality rate in the year 2000 was 67 deaths per 1000 live births which had improved from 85 per 1000 in 1990(4).

Despite significant achievement in reduction of child mortality in the last two decades (2), ten million plus children still die annually nearly all in low-income countries from the diseases and causes that can be averted (3). Child health is closely related to the health of mothers. Therefore, knowledge of maternal health can not be ignored while understanding causes of child deaths. The figure of 10 million deaths of children includes 4 million neonatal deaths and 6 million deaths of children under 5 in addition to half a million maternal deaths (5). It was assessed that among 90% of deaths of children under 5 years in 42 countries in year 2000, the leading causes of deaths were neonatal causes (33%), diarrhoea (22%) and pneumonia (21%) (3,6). A small percentage of deaths of children under 5 could be attributed to malaria (9%), AIDS (3%), measles (1%) and less than 1% to unknown causes (3, 6). These figures haven't changed much since then.

The causes of maternal and child deaths are identified to be distal determinants such as poverty, lack of education, physical environment, social status, early marriage, low age at first child birth and proximal determinants such as under-nutrition, infectious diseases, neonatal causes and injury (3,7). The leading causes of neonatal, infant, child death that are recognized worldwide especially in developing countries are diarrhoea, pneumonia, malaria, neonatal causes such as sepsis, asphyxia and others (3,6).

In India, high infant mortality, high maternal mortality, persistent malnutrition, high levels of anaemia in women and children, early marriage and low age at child birth are amongst many challenges that Indian public health system faces (8).

Reduction in neonatal, infant and child mortality is one of the Millennium Development Goals (MDGs) and an international priority (7). There are various kinds of interventions and ample funding to reduce child death, but still insufficient efforts and lack of political commitment to reduce child death exist (1). The interventions that are available and have been proven to be feasible to implement in poor countries at high coverage can help reduce these child deaths (3, 7). Many of these interventions remain under-serviced (1).

It is believed that many people in developing countries die, many a times soon after birth, without being recorded officially anywhere thereby remaining uncountable (9). The main reason for this invisibility is poor record maintenance at the government level of the birth, deaths and the causes of deaths (9).

Maternal health and child health cannot be seen in isolation. Amongst various factors affecting child health, health of mothers in one of them. Countdown to 2015 for maternal, newborn and child survival revealed that 56 countries had high to very high maternal mortality (1). The study findings show that “routinely scheduled interventions such as immunisation and antenatal care had much higher coverage than those that rely on functional health systems and 24-hour availability of clinical services such as skilled or emergency care at birth and care of ill newborn babies” (1). Data for postnatal care that were available showed very low utilisation in almost all 68 countries identified for 97% of maternal and new born deaths (1).

It is understood that to improve maternal, newborn and child health, there has to be continuum of care (5). The aim of this approach is to integrate maternal and child health issues, place of service delivery and the number of health issues (5). Incorporating essential newborn care can also help in preventing HIV transmission in infants (10). It is recognized that the health of mothers, neonates and children are a continuum of life cycle (5). This includes planning and spacing pregnancies for women, prevention and treatment of sexually transmitted infections for both men and women, ante-natal care during pregnancy for safe childbirth and post-natal care to both mother and neonate (5). The needs of adolescents include education on nutrition, sexual and reproductive health (5).

The continuum of care approach applies not only in life cycle but also in place of service such as if women and children need medical care, there should be continuum of care from home to hospital in case of emergencies (5). However, due to various factors such as “logistical convenience, donor directives, organizational expertise and specific lines of scientific inquiry”, there is often a lack of integration of services which results in “fragmented service delivery and affects quality of care” (5).

In the wake of above mentioned issues, it is considered imperative to strengthen the health systems to address the child health issues effectively for achieving MDG 4 and maternal health related to MDG 5.

WHAT CONSTITUTES HEALTH SYSTEM AND HOW TO STRENGTHEN HEALTH SYSTEMS?

There is no consensus regarding the composition of health systems (11). However, WHO's building blocks of health systems include the following as constituting health systems (11, 12):

- Leadership and governance consisting of management of health systems by political, economic and administrative authority at national, district and sub-district level
- Financing arrangements include funding and incentive system at the national and district level
- Service delivery includes conception and development of programmes and interventions at national level, district level programmes in line with national health agenda and services delivered effectively at sub-district and community level.
- Health workforce includes sufficient number of trained, productive and responsive workers aiming to achieve the best health outcomes.
- Medical products and technologies entails "equitable access, assured quality, safety, efficacy and cost-effectiveness" (12)
- Information and evidence in a functional health system ensures the "production, analysis and use of reliable and timely information on health determinants, health systems performance and health status" (12).

Leadership and governance

Leadership and governance is one of the crucial building blocks requiring the governments at national level to take lead in managing their respective national health issues including partnerships and collaborations with other government sectors, health organizations and civil societies (2, 12, 13); providing policy guidance; generation, analysis and effective utilization of health data; regulation, "system design ensuring appropriate strategy and structure and reducing duplication" and accountability (12, 13). There is evidence that effective governance strategies with private health care such as "regulation, franchising and accreditation" could contribute in improving the quality of health services (11). India recognizes the public health challenges especially child health issues and has taken steps in the form of National Rural Health Mission (NRHM) to reach the maximum number of people with accountable, accessible and affordable health care services (8) to reach the millennium development goals. Data collection methods and definition of health systems needs further strengthening.

For the achievement of MDGs scaling up of service delivery is recognized as a priority (14). Scaling up at the sub-national levels largely depends upon the managerial capacity, lack of which causes hindrance in scaling up (14). At the district level, it is important to have sufficient number of managers adequately trained and appropriately positioned (14). The "knowledge, skills and behaviours (collectively called competencies)" of managers with effective support systems helps in managing the resources and delivery of services effectively (14). The written responsibilities of respective positions, organizational rules and regulations, decentralization of authority, supervision, transparency and incentives help managers perform better (14). Often clinical staff with little management training are given management roles which sometimes they may not succeed in (14). Some basic concepts such as "communication, negotiation, conflict management, problem-solving, information analysis and work planning" should be incorporated in the curriculum of the clinical staff (14).

There are international aid initiatives to support improvement in child health such as Global Fund to fight AIDS, Tuberculosis and Malaria (GFATM), Global Alliance for Vaccines and Immunization (GAVI) etc. (15). However, the countries receiving funds need to take a lead on developing common understanding of the health systems and its functions and the operational guidelines and roadmaps for the respective country and the donor (15). There is a "need for coordinated and implementation-oriented approach to dealing with health systems" (15). The centralized planning process related to global fund has led to lack of ownership at sub-national levels (15). Some of the other problems of the health systems identified by a world bank study included shortage of human resources, lack of guidance for retention of "key staff", procurement delays, inconsistent pricing of drugs and commodities (15). It is the role of leadership and governance of a country to sort out these issues for strengthening health systems and thus use international aid effectively.

Financing

Sufficient funds should be arranged for health systems to function effectively, be the funds raised through public or private sector (12). The changes in health financing must be appropriate to the needs, cultural and traditional values of a country and should include transparency and accountability (12). Financial risk pooling such as health insurance to support poor people should be strengthened (12, 13).

"The Indian public spending on health is amongst the lowest in the world whereas its proportion of private spending on health is one of the highest" (8). The household expenditure is more than three times the public expenditure on health (8). The unregulated private health care sector increases the cost of health care thereby making the health care services unreachable for poor people in rural areas (8).

Health workforce

"In any country, a well-performing health workforce is one which is available, competent, responsive and productive" (12).

Most of the South Asian and African countries have huge gap between the requirement and supply of qualified medical practitioners. India too has shortage of trained clinical staff. A country's health workforce consists broadly of paid or unpaid clinical and paramedical staff, management and support workers including lay health workers in public and private health care sector (12). Investment in training and supervision of lay health workers such as traditional birth attendant and village health workers has been found to be promising especially for reducing neonatal and child death at the community level in the absence of clinical staff (16). World Health Organization acknowledges the dearth of professional human resources in the field of health and therefore, calls for the need to strengthen the skills of community health workers to fulfil the gap in health services at the community level (16).

Studies have found that management of pneumonia and diarrhoea is achievable at the community level by community health workers (17).

At the district level, training needs of existing health staff especially related to dealing with neonatal and child health issues should be identified and on-the-job or class-room training programmes should be organized to enhance the capacity of the staff (14,18). The upgradation of knowledge, skills and positive behaviours of health workforce is crucial to efficient and effective service delivery and for integration of health programmes (12). Attrition of health staff affects delivery of service adversely so "ways of retention of health workforce" should be identified and pronounced (12).

Service delivery

"In any health system, good health services are those which deliver effective, safe, good quality personal and non-personal care to those that need it, when needed, with minimum waste. Services – be they prevention, treatment or rehabilitation – may be delivered in the home, the community, the workplace or in health facilities" (12)

'Countdown to MDGs' conducted a study and identified India as one of the 68 countries which account for 97% of maternal and child deaths worldwide (1). The main gaps identified were low coverage especially in contraceptive services, care in childbirth, postnatal care and clinical management of illnesses in newborn babies and children (1). The study noted that in identified 68 countries "skilled attendance, oral rehydration therapy and care-seeking for pneumonia increased by 2% or less compared with increase of 4-7% for tetanus immunization in pregnancy, ante-natal care (at least one visit) and insecticide-treated bed-nets" (1).

Reasons identified for low coverage include: cultural and social factors are considered as hindrances, but changes in global funding have decreased number of family planning programmes. It is suggested to invest more in family planning programmes to reduce maternal and child deaths (1).

The coverage of continuum of care varied (1). "Services that can be routinely scheduled such as ANC and immunisation – had high coverage whereas services that needed clinical care such as clinical case management of newborn and childhood illnesses had low coverage"(1).

About 50% of mothers and babies in the identified 68 countries for low coverage received skilled attendance at birth (1). Geographically distant location of health facility, transport costs and poor quality of services were the main deterrents (1). Unavailability or poor quality of service also led to decreased (one third of sick children served) clinical case management of child illnesses (1). Less than 1% IMCI services were provided to mother, neonate or children (1).

It is suggested to increase coverage by integrating the services such as prevention of mother to child transmission of HIV and malaria treatment services should be given during antenatal visit (1). Similarly, programmatic links should be promoted between various elements of continuum of care such as counselling mothers on feeding practices for infants and children or birth control measures and to provide vitamin A supplementation and insecticide-treated nets during immunisation visits(1).

Information and evidence

Effective measurement of achievement of MDGs greatly depends on the reliable, quality and timely data to guide the required decisions in countries (1, 9). National Family Welfare programme in India shows the effective use of birth monitoring data for population planning and infant and child mortality related policies and targets (9). Countdown to MDGs found that almost one third of all data were either inadequate, did not use comparable definitions, were not nationally representative or were old (1, 9). It is suggested that the data on maternal care and postnatal care should be given preference in order to monitor maternal and neonatal health (1, 9, 18). There should be compulsory registration of all births, deaths including still births and causes of death (9, 18, 19). Financial monitoring needs to be strengthened to make health systems more transparent and accountable (1). A framework for assessment of maternal, newborn and child survival that is relevant to countries especially for results-based strengthening of health systems is needed (1, 18).

CONCLUSION

Improving child health is one of the Millennium Development Goals to be achieved substantially by 2015. It is noted that child health is largely dependent on the health of mothers, the primary care-givers to children. Therefore, child health needs to be considered in continuum of life-cycle i.e., pregnancy of mother, delivery, neonatal phase, infancy and childhood. While there are various socio-cultural, economic, logistical, educational and other factors responsible for affecting the health of children, the studies indicate towards weak health systems as significant cause affecting child health adversely. “An adequately functioning health system is crucial to progress towards the MDGs” (1). “Priority attention in the health system strengthening should be given to establishment of a functional continuum of care that encompasses women before pregnancy, childbirth, the postnatal period and the first 24 months of a child’s life” (1).

Political commitment and leadership can guide the strategic planning for achieving MDGs through health systems strengthening. Countries need scientific and reliable data to assess progress related to health status of its population as well as data related to health systems and make results-based decisions. At the community level, till there is adequate clinical staff, there is strong evidence for strengthening the skills of community health workers to reduce maternal and neonatal mortality. A comprehensive and integrated approach to strengthening health systems can certainly contribute in reduction of maternal and child deaths thereby achieving millennium development goals 4 and 5.

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Chapter 8

STATE-WISE PATTERN OF GENDER BIAS IN CHILD HEALTH IN INDIA

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ABSTRACT

Health being one of the most basic capabilities, the removal of gender bias in child health can go a long way in achieving gender parity in many other dimensions of human development. This chapter examines the state-wise pattern of gender bias in child health in India. It uses 21 selected indicators of health outcome (e.g., post-neonatal death, child death and prevalence of malnutrition) and health-seeking behaviour (e.g., full immunisation, oral rehydration therapy, fever/ cough treatment and breast-feeding). Three rounds of unit level National Family Health Survey data are analysed using Borda Rule and Principal Component Analysis techniques. Children under age three years are the unit of the analysis. The study found that any consistently robust state-wise pattern of gender bias against girl children in child health is not present among all the 29 Indian states over the three rounds of NFHSs. Among the major 19 states, there is high gender bias in three Empowered Action Group of states (namely, Uttar Pradesh, Madhya Pradesh, and Bihar) and in Andhra Pradesh, Punjab, and Gujarat as well. However, there is a consistent state-wise pattern in girl children's health achievement. With Rawlsian theory of justice, to reduce gender bias in child health we need to focus on the states with low health achievement by girls.

INTRODUCTION

Advancement of health care services is of utmost importance for its intrinsic value. The provision of public health is a basic human right and a crucial merit good. With the inception

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of the Human Development Index (HDI), the Human Poverty Index (HPI), and the Gender-related Development Index (GDI) by the United Nations Development Programme (UNDP), governments are required to redefine development. Universal access to health together with safe drinking water, sanitation, nutrition, basic education, information and employment are essential to balanced development. If India, like China, is to glean the gains of a demographic dividend and become an economic superpower by 2030, it will have to guarantee that her people are healthy, live long, generate wealth and dodge the tag of a 'high risk country'.

Since the Bhore Committee Report (1) and the Constitution of India, the Government of India (GoI) has corroborated many times its aim of advancing the average health of its citizens, reducing inequalities in health, and fostering financial access to health care, particularly for the most destitute. In the Directive Principles of State Policy of the Constitution of India, Articles 38-2 and 41, stress the need for equitable access and assistance to the sick and the underserved, and right to employment, education, while Article 47 stresses on improving nutrition, the standard of living and public health. Article 39 and Article 45 directs for gender equality and protection of children rights including education (2:84-91). A World Bank report on gender and development begins with the statement: 'Large gender disparities in basic human rights, in resources and economic opportunity…are pervasive around the world… these disparities are inextricably linked to poverty' (3).

The dual causality between health and wealth is well documented. Health and mortality status of infants and gender bias in health are 'synoptic indicators' of a society's present condition. A study of gender bias in child health is relevant as an area of research in its own right since children are helpless and solely subject to the social setting in which they born. Health being one of the most basic capabilities, removal of gender bias in child health can go a long way in achieving gender parity in many other dimensions of human development. Gender-specific health policies would make women more independent and empowered and thus achieve some of the goals laid by Millennium Development Declaration (declared in Sep, 2000 by 189 countries).

BACKGROUND

Let us start with a theoretical background of gender bias. On a biological basis, women tend to have a lower mortality rate than men at nearly all age groups, ceteris paribus (4:11). But, owing to the gender bias against women in many parts of the world, women receive less attention and care than men do, and particularly girls often receive far lesser support than boys. As a consequence, mortality rates of females often exceed those of males (4-11). Gender discrimination prevails regardless of the realisation that prejudice in morbidity, nutritional status, or use of health care will probably contribute to greater gender bias in mortality (12-22).

Gender bias, even when it is not disastrous, may still generate greater debility among surviving girls and its effect may be perpetuated over generations (4, 11, 23-25). If the 'Barker thesis' (i.e., fetal origin of adult diseases hypothesis) (26, 27) is true, there is a possibility of a causal connection 'that goes from nutritional neglect of women to maternal undernourishment, and from there to fetal growth retardation and underweight babies, thence to greater child undernourishment' and to a higher incidence of permanent disadvantages in health much later in adult life (28:248,29). ‘What begins as a neglect of the interests of women ends up causing adversities in the health and survival of all—even at advanced ages’ (28:248). Thus, gender bias not only hurts women, but inflicts a heavy economic cost on the society by harming the health of all, including that of men (29). Gender bias can be a blend of ‘active’ bias (e.g., ‘intentional choice to provide health care to a sick boy but not to a sick girl’), ‘passive’ neglect (e.g., ‘discovering that a girl is sick later than that would be the case for a boy, simply because girls may be more neglected in day-to-day interactions than are boys’), and ‘selective favouritism’ (‘choices made by resource-constrained families that favour those children that the family can ill afford to lose’) (11).

Women in India face discrimination in terms of social, economic and political opportunities because of their inferior status. Gender bias prevails in terms of allocation of food, preventive and curative health care, education, work and wages, and fertility choice (30-33). A large body of literature suggests son preference and low status of women are the two important factors contributing to the gender bias against women. The patriarchal intra-familial economic structure coupled with the perceived cultural, religious and economic utility of boys over girls, based on cultural norms, have been suggested as the original determining factors behind the degree of son preference and the inferior status of women across the regions of India (11, 30). Daughters are considered as a net drain on parental resources in patrilineal and patrilocal communities (34). Intra-household gender discrimination has primary origins not in parental preference for boys but in higher returns to parents from investment in sons (35).

On an empirical note, son preference in India has endured for centuries. The 1901 census noted ‘there is no doubt that, as a rule, she (a girl) receives less attention than would be bestowed upon a son. She is less warmly clad, … she is probably not so well fed as a boy would be, and when ill, her parents are not likely to make the same strenuous efforts to ensure her recovery’ (20:67). Population sex ratios from censuses almost steadily stepped up, from 1030 males per 1,000 females in 1901 to 1072 males per 1,000 females in 2001 (36-41). Due to unequal treatment of women, India now has the largest share of ‘missing women’ in the world (42). ‘A strong preference for sons has been found to be pervasive in Indian society, affecting both attitudes and behaviour with respect to children and the choice regarding number and sex composition of children’ (12, 43-50). Son preference is an obstructing factor for maternal and child health care utilisation (51, 52).

Existing empirical literature on inter-state (or regional) pattern of gender bias suggests that boys are much more likely than girls to be taken to a health facility when sick in both north and south India (6, 17, 53-59). Girls are more likely to be malnourished than boys in both northern and southern states (6, 12, 29, 54, 60-63). ‘The states with strong anti-female bias include rich ones (Punjab and Haryana) as well as poor (Madhya Pradesh and Uttar Pradesh), and fast-growing states (Gujarat and Maharashtra) as well as growth-failures (Bihar and Uttar Pradesh)’ (28:230).

Gender bias in child health prevails even today when India is shining or Bharat Nirman is going on. ‘For India the infant mortality rate is marginally higher for females [58 per 1,000] than for males [56 per 1,000]. However, in the neonatal period, like elsewhere, mortality in India is lower for females [37 per 1000] than for males [41 per 1,000]. As children get older, females are exposed to higher mortality than males. Females have a 36 percent higher mortality than males in the post-neonatal period, and a 61 percent higher mortality than males at age 1-4 years’. (50:183). Boys are (seven percent) more likely than girls to be fully vaccinated. Boys are also somewhat more likely than girls to receive each of the individual vaccinations. (50:230). Among the children under age 5 years with symptoms of acute respiratory infection (ARI), treatment was sought from a health facility or provider for 72 percent of the boys but 66 percent of the girls (50:235). Among the children under age 5 years with fever, treatment was sought from a health facility or provider for 73 percent of the boys but 68 percent of the girls (50:237). Boys are also (seven percent) more likely than girls to be taken to a health facility for treatment in case of diarrhoea (50:242). Among children under five years, girls are three percent more likely to be underweight than boys (50:270). Among the last-born children, boys are 11 percent more exclusively breastfed than girls (50:281). For the children age 6-59 months, girls are more anaemic than boys (50:289).

The above discussion provides ample evidence of gender bias in child health indicators that ultimately transforms to gender imbalance in many other dimensions of human development. Thus, this paper attempts to answer the following questions. First, is there evidence of gender bias in the selected indicators of health outcome and health seeking behaviour of children? Second, if gender bias is there, what is the state-wise pattern of gender bias in child health in India? Third, does this state-wise pattern of gender bias remain unchanged over the study period of almost one-and-a-half decades? If we can identify the pattern of gender bias, it is possible to focus on those particular states to reduce and remove gender bias.

OUR STUDY

The present study uses data from National Family Health Survey (NFHS)-III (2005-06), NFHS-II (1998-99), and NFHS-I (1992-93). ‘NFHS-III collected information from a nationally representative sample of 109,041 households, 124,385 women age 15-49, and 74,369 men age 15-54. The NFHS-III sample covers 99 percent of India’s population living in all 29 states’ (50:xxix). ‘The NFHS-II survey covered a representative sample of more than 90,000 eligible women age 15-49 from 26 states that comprise more than 99 percent of India’s population’ (64:xiii). The NFHS-I survey covered a representative sample of 89,777 ever-married women age 13-49 from 24 states and the National Capital Territory of Delhi, which comprise 99 percent of the total population of India (10:xix). It is worth to noting that NFHS-II (1998-99), the second round of the series, is regarded as ‘storehouse of demographic and health data in India’ (65).

Children under age three years are the unit of the present analysis, which uses the children’s recoded data-files. The selected 21 indicators of health-seeking behaviour and health outcome are: for childhood immunisation—A: childhood full vaccination; for diarrhoea—B: childhood diarrhoea with 'no treatment', C: childhood diarrhoea with 'medical treatment', D: childhood diarrhoea with 'given ORS'; for breastfeeding—E: childhood breastfeeding with 'never breastfed', F: childhood breastfeeding with 'less than six months breastfed', G: childhood breastfeeding with 'at least six months breastfed', H: childhood breastfeeding with 'currently breastfeeding', I: childhood breastfeeding with 'exclusively breastfed for first six months'; for malnutrition—J: severely stunted (height-for-age, -3 SD), K: stunted (height-for-age, -2 SD), L: severely underweight (weight-for-age, -3 SD), M: underweight (weight-for-age, -2 SD), N: severely wasted (weight-for-height, -3 SD), O: wasted (weight-for-height, -2 SD); for fever/ cough—P: childhood fever/ cough with 'received no treatment', Q: childhood fever/ cough with 'received medical treatment', R: childhood fever/ cough with 'received medical treatment in public health facility', S: childhood fever/ cough with 'received medical treatment in private health facility'; and for mortality—T: post-neonatal death, U: child death. Total number of observations for all India for all the indicators is presented in table 1.

Table 1. Indicator-wise Total Number of Observations in India

Indicator		NFHS-I (1992-93)			NFHS-II (1998-99)			NFHS-III (2005-06)		
		Total	**Boy**	**Girl**	**Total**	**Boy**	**Girl**	**Total**	**Boy**	**Girl**
Immunisation	**A**	11853	6053	5800	10076	5163	4913	10419	5546	4873
Diarrhoea	**B**	3975	2068	1907	5721	3015	2706	3778	2051	1727
	C	3975	2068	1907	5721	3015	2706	3778	2051	1727
	D	3975	2068	1907	5721	3015	2706	3778	2051	1727
Breastfeeding	**E**	34626	17576	17050	30317	15741	14576	31205	16314	14891
	F	34626	17576	17050	30317	15741	14576	31205	16314	14891
	G	34626	17576	17050	30317	15741	14576	31205	16314	14891
	H	34626	17576	17050	30317	15741	14576	31205	16314	14891
	I	7404	3712	3692	6494	3400	3094	6062	3029	3033
Malnutrition	**J**	19380	9818	9562	24831	12941	11890	26580	13925	12655
	K	19380	9818	9562	24831	12941	11890	26580	13925	12655
	L	27683	13944	13739	24831	12941	11890	26580	13925	12655
	M	27683	13944	13739	24831	12941	11890	26580	13925	12655
	N	19460	9853	9607	24989	13008	11981	26582	13926	12656
	O	19460	9853	9607	24989	13008	11981	26582	13926	12656
Fever/ Cough	*****	9299	4959	4340	10544	5748	4796	7856	4258	3598
	P	3149	1496	1653	4198	2137	2061	2589	1334	1255
	Q	6150	3463	2687	6346	3611	2735	5267	2924	2343
	R	1659	931	728	1454	840	614	965	514	451
	S	4906	2732	2174	5726	3210	2516	4722	2620	2102
Death	**T**	12336	6298	6038	10572	5578	4994	10494	5321	5173
	U	24581	12486	12095	21348	10987	10361	22193	11780	10413

Note: Definitions of A-U are in the text. *: number of children who had fever/ cough; P-S are expressed as a percentage of *.

State-wise gender gap for all the indicators are calculated using the following formula. This measure of gender gap is the relative gap between boy and girl minus one and then taken in per cent (used in 11:403,30:844,57:757,66:8,67,68:22-31,69,70:272). Some studies measure gender gap as the absolute gap (71, 72—difference and absolute difference) or as the relative gap (73—simple arithmetic average of relative gaps) or both (74, 75). These studies use a particular gap (or more than one gap) without giving any or much rationale behind it.

A relative gap measure captures both the levels of coverage and gender equality. The value of gender gap decreases as coverage rates increase for both boys and girls with same absolute gap between them and it decreases as coverage rates increases for both boys and girls with lower absolute gap between them. A gender-equity-sensitive indicator (GESI) would have been a better measure though the choice of degree of inequality aversion equal to two is questionable.

This relative gap formula satisfies all the four principles of an inequality index, namely, principle of population symmetry, principle of transfer, principle of scale invariance and principle of constant addition[1]. An absolute gap formula, however, does not satisfy principle of scale invariance and principle of constant addition. Moreover, the absolute gap formula is not unit-free but a relative gap formula is free of any units.

In a multivariate analysis, a problem arises with considerable number of correlated variables even though each variable may constitute a different dimension in a multidimensional hyperspace. As the multidimensional hyperspace is quite difficult to think about, social scientists often use some tool to reduce dimensions.

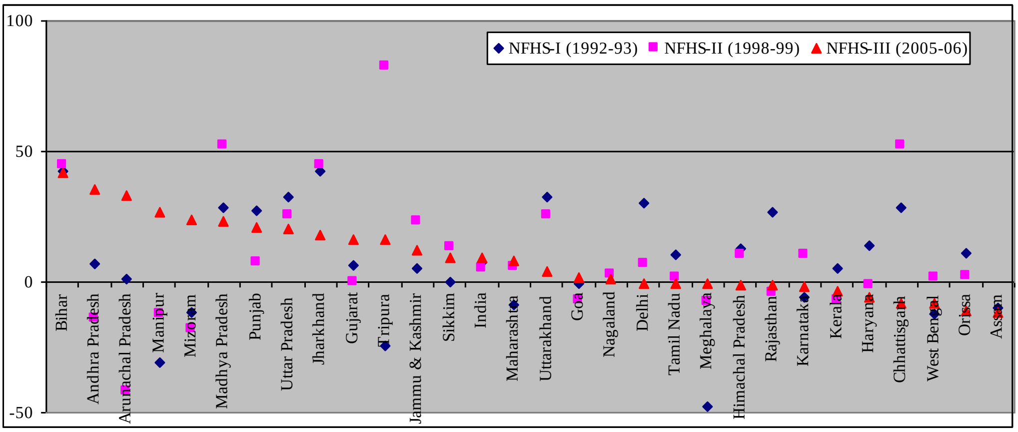
The 21 dimensions will be reduced by some ordinal measure. As an ordinal aggregator, the study will use the well-known Borda rule (named after Jean-Charles de Borda who devised it in 1770). The rule gives a method of rank-order scoring, the method being to award each state a point equal to its rank in each indicator (A-U) of ranking, adding each state's scores to obtain its aggregate score, and then ranking states on the basis of their aggregate scores (76:109-16), separately for each round of NFHS.

To check robustness of the results, the study also uses Principal Component Analysis (PCA) technique as a second tool to reduce dimensions. PCA reduces a large set of variables to a much smaller set that still contains most of the information about the large set. It abridges the variation in a correlated multi-dimension to a set of uncorrelated components. Principal components are estimated from the Eigen vectors of the covariance or correlation matrix of the original variables. Eigen vectors provide the weights to compute the principal components, while Eigen values measure the amount of variation explained by each principal component. Thus, the objective of PCA is to achieve parsimony and reduce dimensionality by extracting the smallest number of principal components that account for most of the variation in the original data without much loss of information (77:40). Principal components (defined as a normalised linear combination of the original variables) are constructed from the 21 indicators. Then a composite index is constructed as a weighted average of the principal components or factors, where the weights are (Eigen value of the corresponding principal component)/ (sum of all Eigen values) (78:107-9). On the basis of the values of the composite index, all the states are ranked in ascending order, separately for each round of NFHS.

FINDINGS

Childhood full vaccination rate is calculated as the percentage among the living children age 12-23 months who received all six specific vaccinations (BCG, measles, and three doses each of DPT and Polio (excluding Polio 0[2])) at any time before the interview (from 'either source'[3]) for boy and girl children separately for each state. Then gender gap is calculated using the above-mentioned formula. State-wise gender gap in full immunisation is shown in figure 1.

Childhood diarrhoea rates are calculated as percentage among the living children age 1-35 months who had diarrhoea in the last two weeks before the interview for boy and girl children separately for each state. For all three indicators of diarrhoea (B, C, and D), state-wise gender gap is presented in figures 2-4.



Note: Figure excludes two outliers for Nagaland in NFHS-I (555) and Assam for NFHS-II (139)

Figure 1. State-wise Gender Gap in Childhood Full Vaccination.

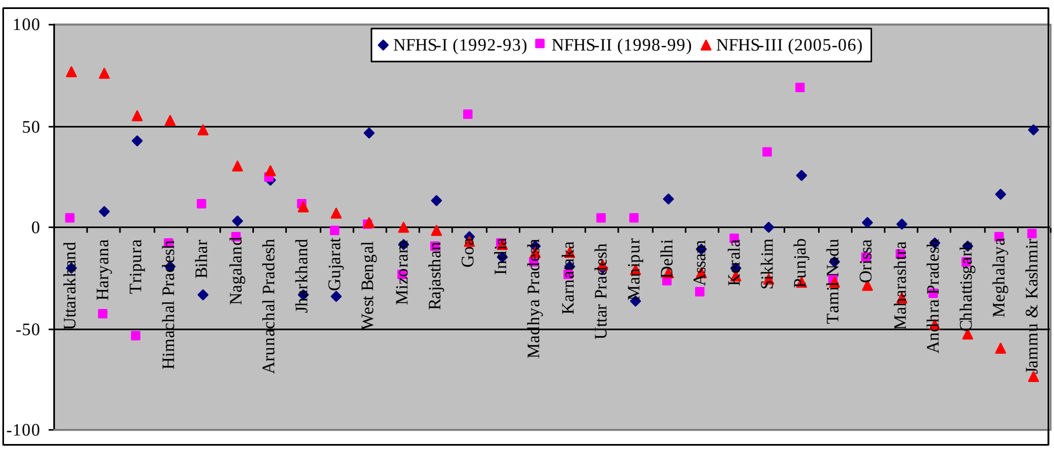


Figure 2. State-wise Gender Gap in Childhood Diarrhoea with 'No Treatment'.

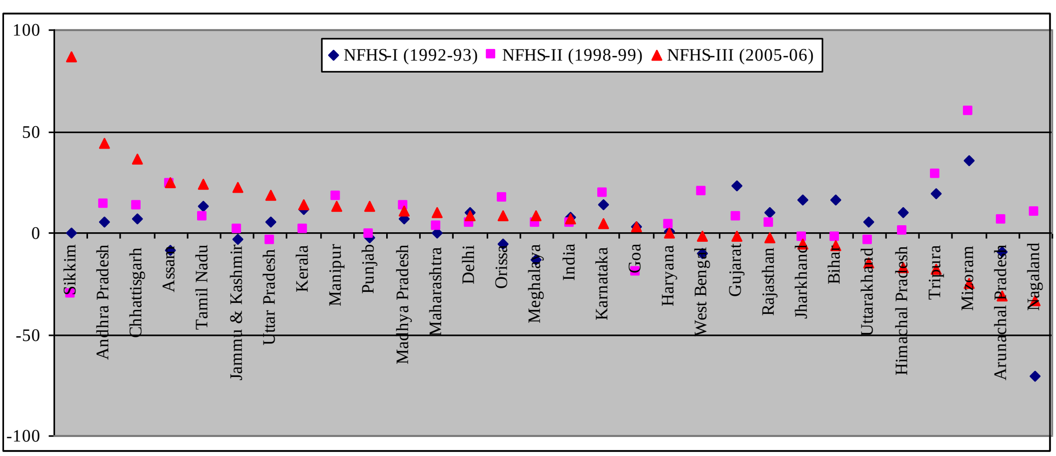
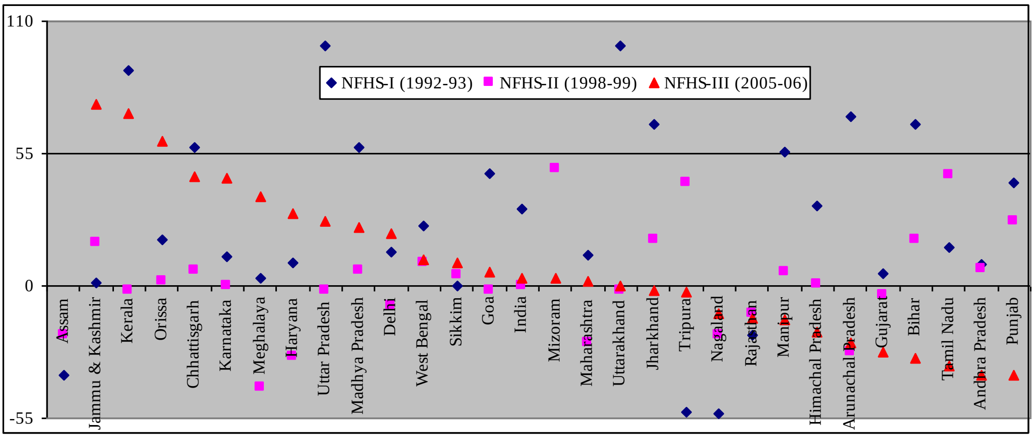


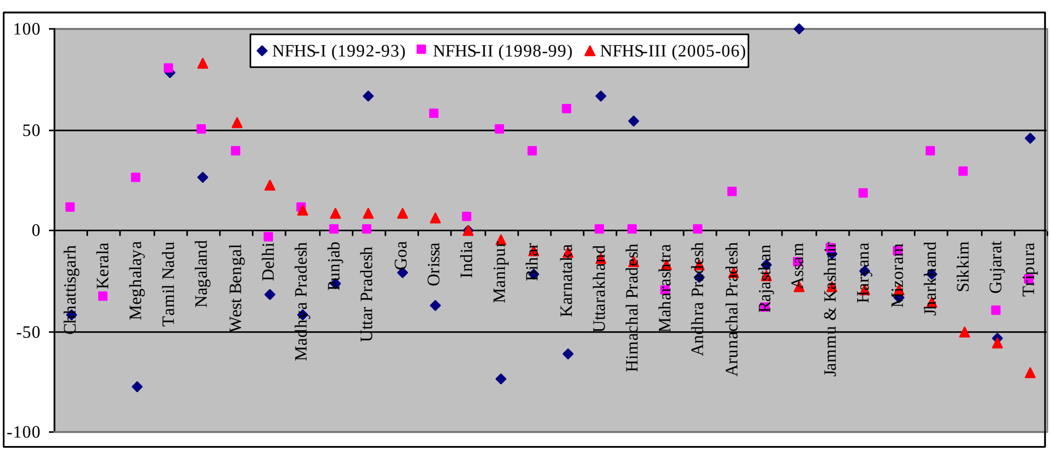
Figure 3. State-wise Gender Gap in Childhood Diarrhoea with 'Medical Treatment'.



Note: Figure excludes two outliers for Mizoram (139) in NFHS-I and Assam (382) for NFHS-III.

Figure 4. State-wise Gender Gap in Childhood Diarrhoea with ‘Given ORS’.

Childhood breastfeeding rates (E, F, G, H, and I) are calculated as percentage among the living children age less than three years for boy and girl children separately for each state. State-wise gender gaps in childhood breastfeeding for all these five indicators are shown in figures 5-9. In the exclusively breastfed for first six months category (I), only the living children below six months who are currently breastfed and not having any of the following: plain water, powder/ tinned milk, fresh milk, other liquid, green leafy vegetables, fruits, solid & semi-solid foods are considered.



Note: Figure excludes the outliers for Kerala (233), West Bengal (129) and Arunachal Pradesh (178) in NFHS-I and Meghalaya (173), Tamil Nadu (160) for NFHS-III.

Figure 5. Sate-wise Gender Gap in Childhood Breastfeeding (Never Breastfed).

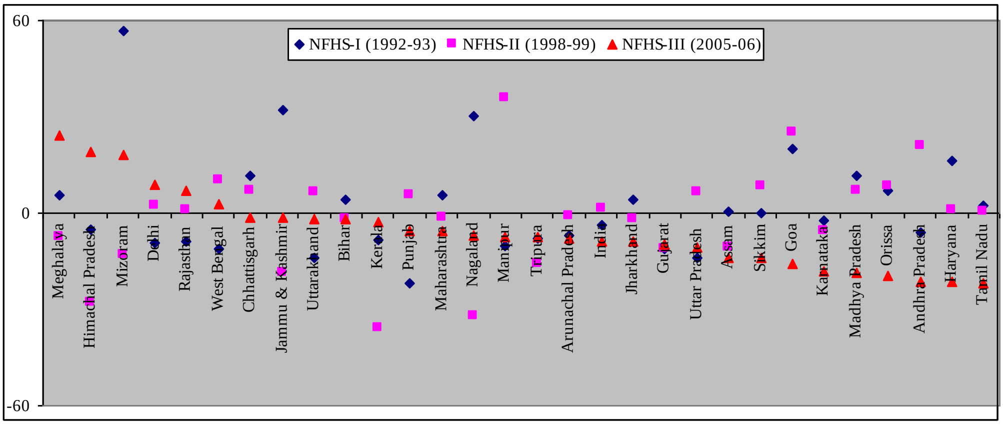


Figure 6. State-wise Gender Gap in Childhood Breastfeeding (less than Six months Breastfed).

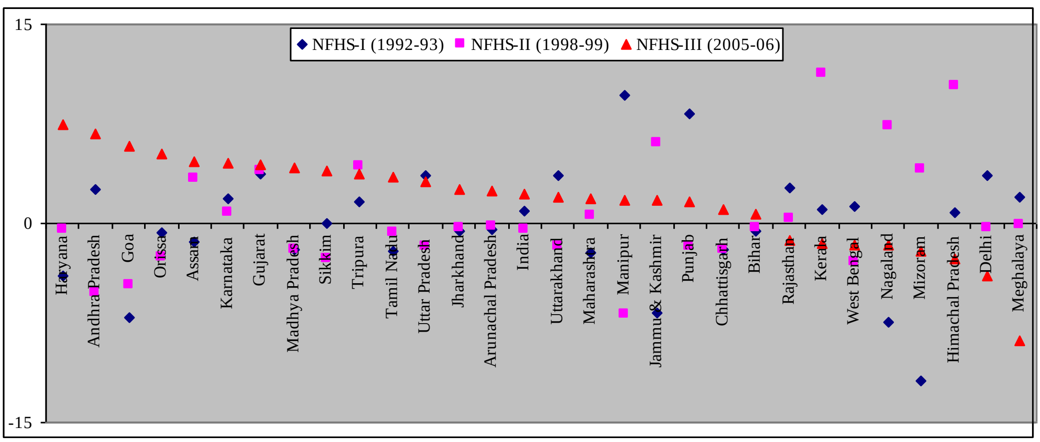


Figure 7. State-wise Gender Gap in Childhood Breastfeeding (at least 6 months Breastfed).

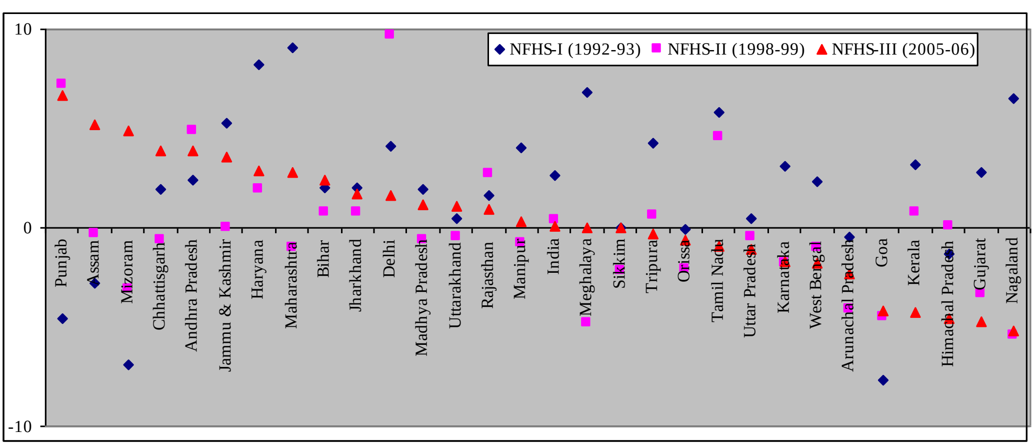


Figure 8. State-wise Gender Gap in Childhood Breastfeeding (Currently Breastfeeding).

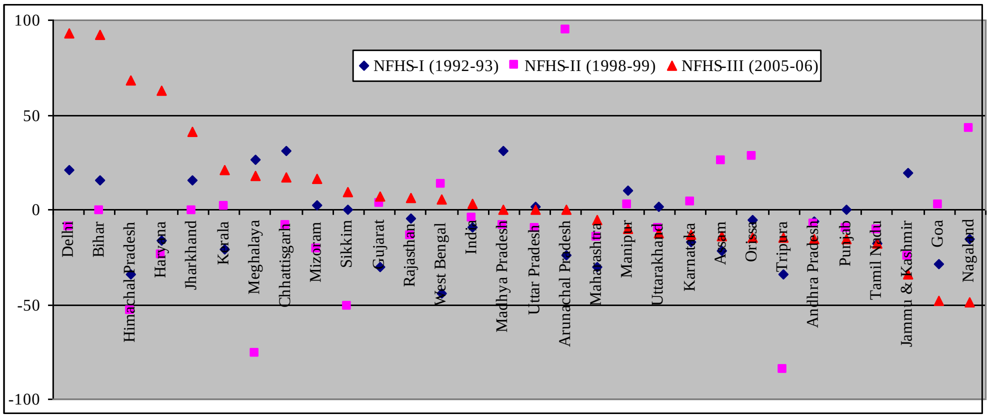
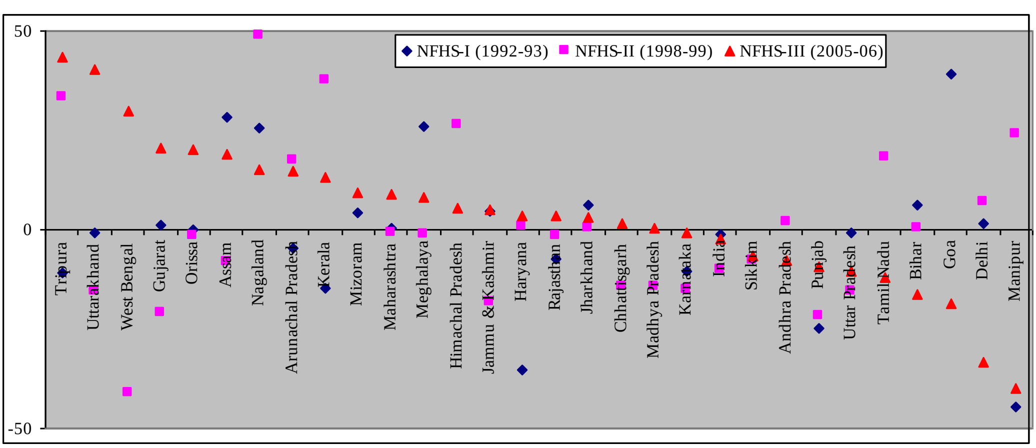


Figure 9. State-wise Gender Gap in Childhood Breastfeeding (Exclusively Breastfed for first Six months).

Childhood malnutrition rates (J, K, L, M, N, and O) are calculated as percentage among the living children age less than three years who are below -3 or -2 standard deviation from the international reference population median for boy and girl children separately for each state. Gender gap in childhood malnutrition is shown in figures 10-15.

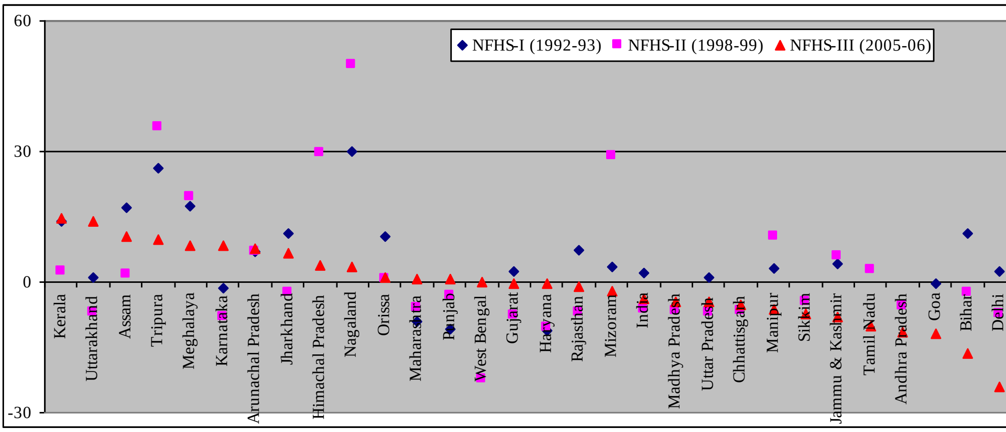
Childhood fever/ cough rates (P and Q) are calculated as percentage among the living children age 1-35 months who had fever/ cough in the last two weeks before the interview for boy and girl children separately for each state. R (or S) are calculated as percentage among the living children age 1-35 months who had fever/ cough in the last two weeks before the interview and taken to any public (or private) health facility to seek treatment for boy and girl children separately for each state[4]. Gender gap in childhood fever/ cough treatment is presented in figures 16-19.

Post-neonatal death rate is calculated as percentage of children age 1-11 months who died among the children ever born for boy and girl children separately for each state.



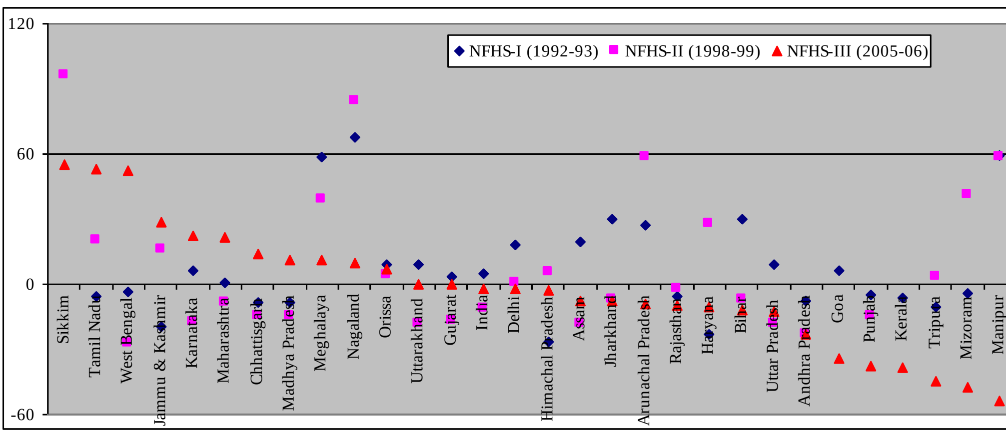
Note: Figure excludes the outliers for Mizoram (116) and Goa (344) in NFHS-II.

Figure 10. State-wise Gender Gap in Childhood Severe Stunting (Height-for-Age; below -3 SD).



Note: Figure excludes the outlier Goa (118) in NFHS-II.

Figure 11. State-wise Gender Gap in Childhood Stunting (Height-for-Age; below -2 SD).



Note: Figure excludes the outliers Goa (183) and Kerala (311) in NFHS-II.

Figure 12. State-wise Gender Gap in Childhood Severe Underweight (Weight-for-Age; below -3 SD).

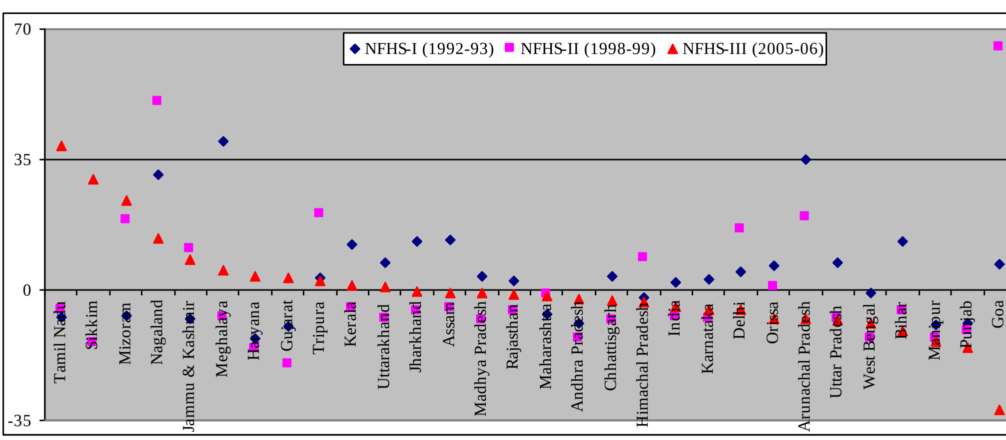
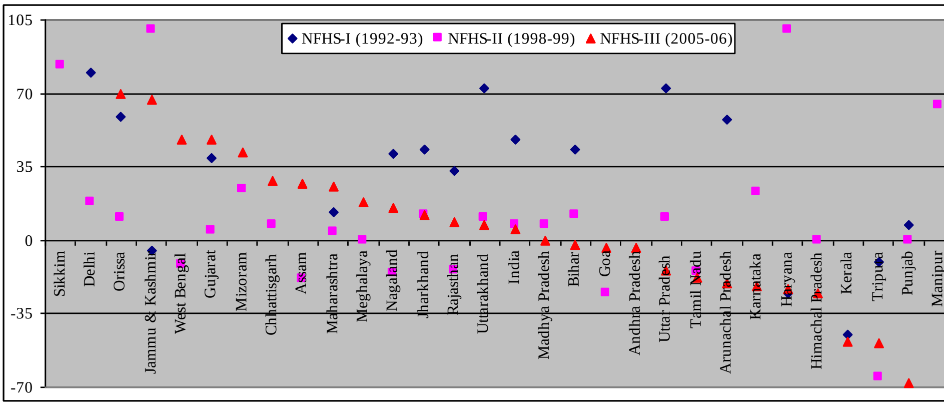
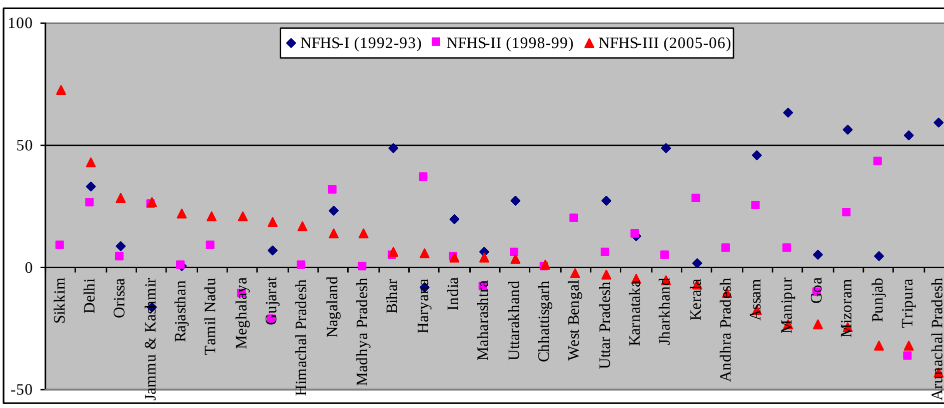


Figure 13. State-wise Gender Gap in Childhood Underweight (Weight-for-Age; below -2 SD).



Note: Figure exclude the outliers Assam (136), Meghalaya (179), Goa (119), Karnataka (269) and Manipur (217) in NFHS-I, Andhra Pradesh (156), Arunachal Pradesh (433) and Kerala (150) in NFHS-II and Sikkim (125), Delhi (119) in NFHS-III.

Figure 14. State-wise Gender Gap in Childhood Severe Wasting (Weight-for-Height; below -3 SD).



Note: Figure exclude the outliers Meghalaya (137) in NFHS-I and Arunachal Pradesh (126) in NFHS-II.

Figure 15. State-wise Gender Gap in Childhood Wasting (Weight-for-Height; below -2 SD).

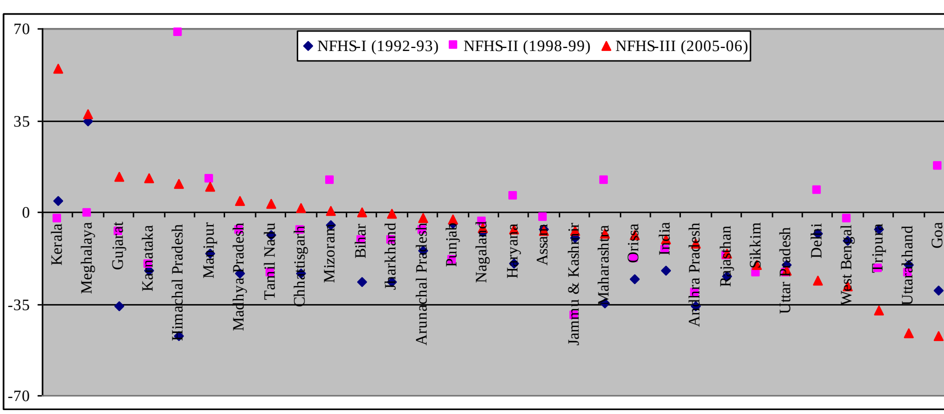


Figure 16. State-wise Gender Gap in Childhood Fever/ Cough (Received No Treatment).

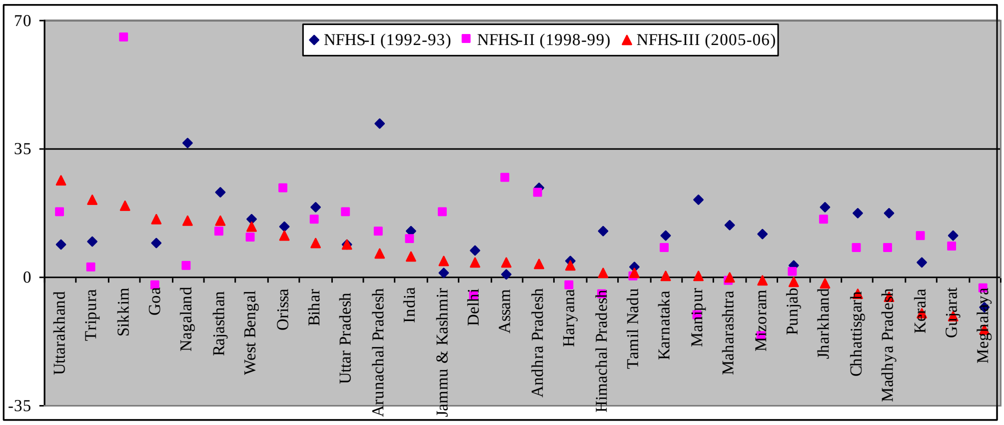
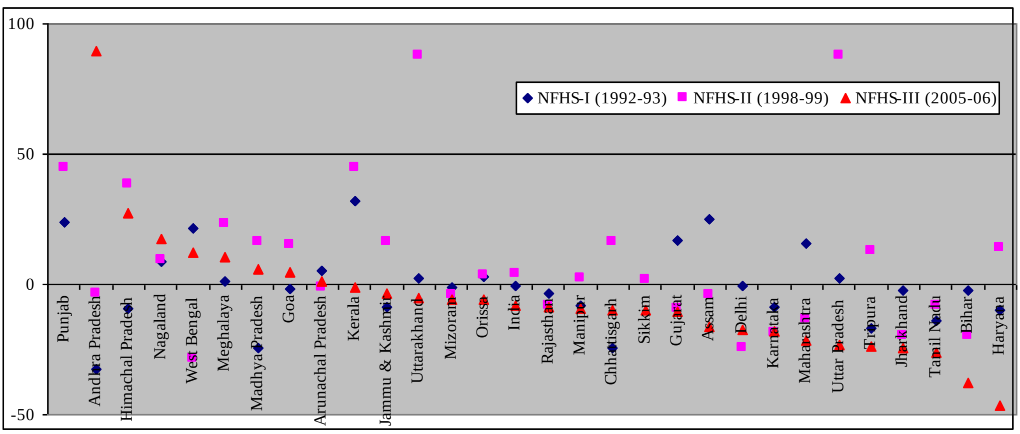


Figure 17. State-wise Gender Gap in Childhood Fever/ Cough (Received Medical Treatment).



Note: Figure excludes the outlier Punjab (189) in NFHS-III.

Figure 18. State-wise Gender Gap in Childhood Fever/ Cough (Received Medical Treatment in Public Health Facility).

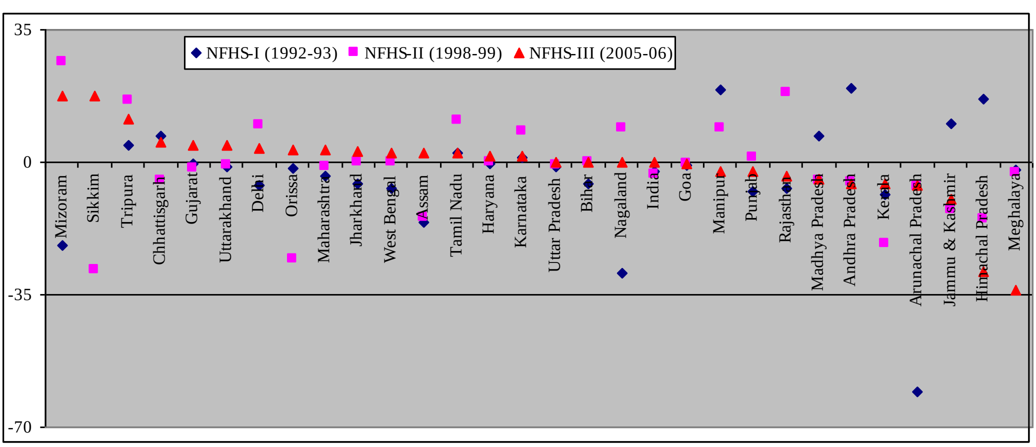
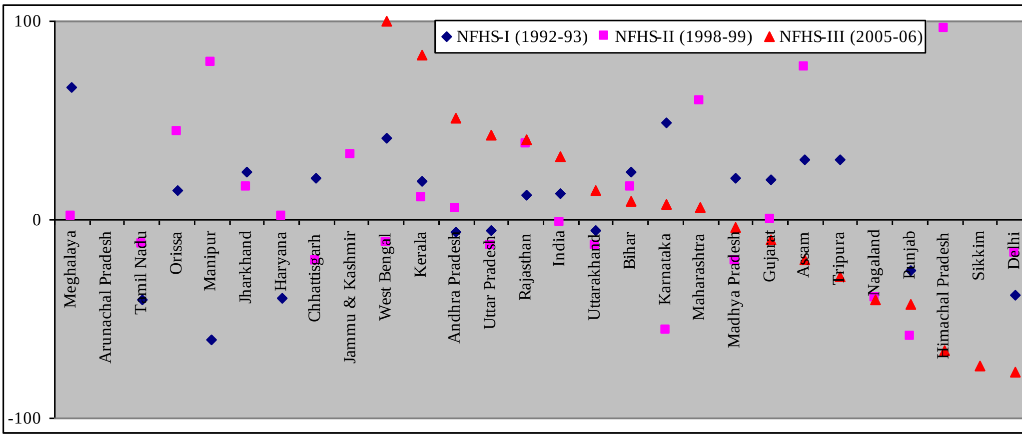
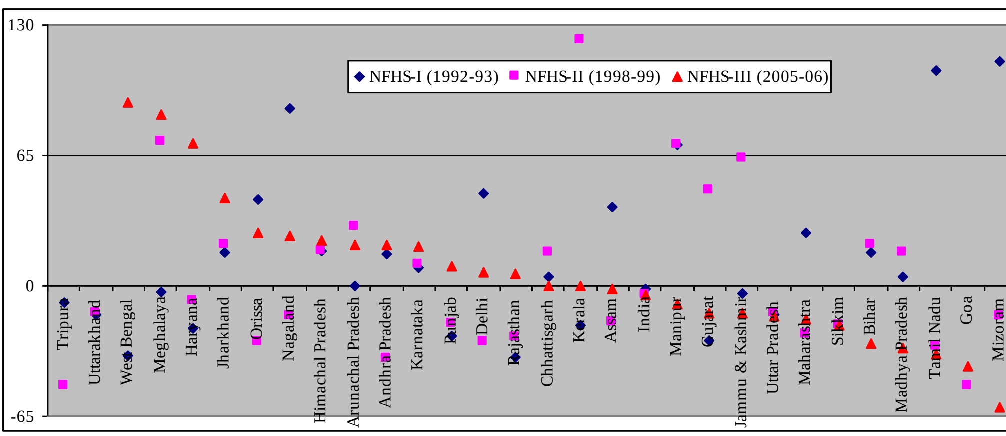


Figure 19. State-wise Gender Gap in Childhood Fever/ Cough (Received Medical Treatment in Private Health Facility).



Note: Figure exclude the outliers J & K (115), Maharashtra (129) and HP (227) in NFHS-I, Arunachal Pradesh (181) in NFHS-II and Meghalaya (644), Arunachal Pradesh (238), TN (182), Orissa (155), Manipur (125), Jharkhand (122), HR (122), Chhattisgarh (113) and J & K (111) in NFHS-III.

Figure 20. State-wise Gender Gap in Post-Neonatal Death.



Note: Figure exclude the outliers Goa (457) and Mizoram (112) in NFHS-I, WB (139) and Kerala (122) in NFHS-II and Tripura (347) and Uttarakhand (217) in NFHS-III.

Figure 21. State-wise Gender Gap in Child Death.

Child death rate is calculated as percentage of children age 12-35 months who died among the children ever born for boy and girl children separately for each state. Gender gap in childhood deaths is shown in figures 20 and 21.

We are now with an estimate of the magnitudes of gender bias for each of the 21 selected indicators over all the 29 states of India for all three rounds of NFHSs. We use Borda rule and PCA to reduce dimensions.

Borda rule

Each state is ranked for each of the chosen indicators to capture the relative position of the Indian states in gender bias against girl children. A higher rank (number) indicates higher gender bias against girl children. Ranking is done in ascending order (a higher value indicates higher gender bias against girls) for the following indicators—A, C, D, G, H, I, Q, R, and S. For the rest of the indicators, ranking is done in descending order (a lower value indicates higher gender bias against girls). Borda rank is calculated for each state on the basis of their aggregate scores for each round of NFHS. State-wise Borda rank in gender bias against girl children in child health is presented in table 2. Again, a higher rank (number) signifies higher gender bias against girls. For any NFHS round, a Borda rank of one signifies lowest gender bias against girls in that state for that period.

Table 2. State-wise Borda Rank in Gender Bias against Girl Children, Various NFHS Rounds

	NFHS-I (1992-93)	**NFHS-II (1998-99)**	**NFHS-III (2005-06)**
Nagaland	**2**	**10**	**1**
Meghalaya	**5**	**4**	**2**
H.P.	**17**	**8**	**3**
Gujarat	**28**	**26**	**4**
W.B.	**8**	**17**	**5**
Uttarakhand	**24**	**18**	**6**
Rajasthan	**21**	**25**	**7**
Kerala	**14**	**5**	**8**
Jharkhand	**19**	**13**	**9**
Karnataka	**18**	**27**	**10**
Arunach. P.	**4**	**1**	**11**
Tamil Nadu	**10**	**23**	**12**
Tripura	**8**	**29**	**13**
J.& K.	**7**	**16**	**14**
Orissa	**10**	**15**	**14**
Maharashtra	**12**	**11**	**16**
Haryana	**13**	**9**	**17**
Mizoram	**6**	**7**	**18**
Delhi	**15**	**11**	**19**
Chhattisgarh	**22**	**20**	**20**
Assam	**1**	**28**	**21**
M.P.	**22**	**20**	**22**
Bihar	**19**	**13**	**23**
Sikkim	**NA**	**6**	**24**
Punjab	**16**	**22**	**25**
Manipur	**27**	**3**	**26**
U.P.	**24**	**18**	**27**
Andhra P.	**26**	**24**	**28**
Goa	**3**	**2**	**29**

Note: Total excludes the ranks obtained in the indicators—for NFHS-I: J, K, N, O, and T due to non-availability of data for some of the states other than Sikkim; for NFHS-II and III: E, and T due to non-availability of data for some of the states. States are ordered according to NFHS-III rankings.

Table 3. Rank-Correlation (Spearman) Matrix of Borda Rankings in Three Rounds of NFHSs

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.3**	—	
NFHS-III	**0.2**	**-0.01**	—

Note: none significant even at 10% level (two tail).

From table 2, one can see that there are lot of ups and down in the state-wise rankings as we move from NFHS-I to NFHS-III. Over almost the one and a half decade of the study period, Gujarat, Himachal Pradesh, Uttarakhand, Jharkhand, Chhattisgarh and Meghalaya consistently improved their ranks, i.e., gender bias against girl children is consistently reduced relative to the other states. But the picture is just the reverse for Punjab and Mizoram where gender bias against girl children in child health has consistently increased over time. Table 3 provides the (Spearman) correlation coefficient for each pair of Borda rankings from the three rounds of NFHSs (given in table 2). The correlation coefficients are not significant even at 10 percent level, suggesting that the state-wise pattern of gender bias against girl children in child health is not consistent.

To check the robustness of the absence of a consistent state-wise pattern in gender bias in child health, the analysis needs further calibration. First, instead of all the 21 indicators we took only six indicators[5] (A, C, G, L, Q and U) for all the 29 states. Doing the same exercise as above, the (Spearman) correlation coefficients for each pair of Borda rankings from the three rounds of NFHSs (not reported) are not significant even at 10 percent level as before (table 4). Second, we do the same exercise for the major 19 states with the same six indicators (A, C, G, L, Q and U).

Table 4. Rank-Correlation (Spearman) Matrix of Borda Rankings in Three Rounds of NFHS

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.26**	—	
NFHS-III	**0.10**	**0.04**	—

Note: None significant even at 10% level (two tail).

Again the correlation coefficients are not significant as before (see table 5 and 6). For some more observations, we have to look at table 5 again. Among the major 19 states, Himachal Pradesh, Rajasthan, Jharkhand, Chhattisgarh, and West Bengal consistently improved their ranks over the study period, i.e., gender bias against girl children is consistently reduced relative to the other states. But the scenario is just the reverse for Jammu and Kashmir, Uttar Pradesh, Maharashtra, Andhra Pradesh and Tamil Nadu where gender bias against girl children in child health is consistently increased over time. More strikingly, in NFHS-III, West Bengal has the least gender bias against girl children in child health and hence West Bengal succeeded to place itself even ahead of Kerala as far as gender bias in child health is concerned (see 69 on worsening women's status in Kerala).

Table 5. Borda Rank in Gender Bias against Girl Children for Major Nineteen States

	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
W.B.	**8**	**7**	**1**
H.P.	**15**	**4**	**2**
Chhattisgarh	**16**	**11**	**3**
Kerala	**5**	**3**	**4**
Karnataka	**5**	**19**	**4**
Uttarakhand	**9**	**16**	**6**
Jharkhand	**11**	**9**	**7**
Rajasthan	**19**	**14**	**8**
Maharashtra	**1**	**6**	**9**
Orissa	**1**	**18**	**10**
Gujarat	**18**	**8**	**11**
Haryana	**5**	**1**	**12**
M.P.	**16**	**11**	**13**
Tamil Nadu	**4**	**4**	**14**
Punjab	**13**	**2**	**15**
J.& K.	**1**	**11**	**16**
Bihar	**11**	**9**	**17**
U.P.	**9**	**16**	**18**
Andhra P.	**14**	**15**	**18**

Note: States are ordered according to NFHS-III rankings.

Table 6. Rank-Correlation (Spearman) Matrix of Borda Rankings in Three Rounds of NFHS

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.045**	—	
NFHS-III	**-0.059**	**0.084**	—

Note: none significant even at 10% level (two tail).

Overall, there is high gender bias in the four Empowered Action Group[6] of states (namely, Rajasthan, Uttar Pradesh, Madhya Pradesh, and Bihar) and in Punjab, Andhra Pradesh, and Gujarat as well. The 'offshoots', namely, Uttarakhand, Chhattisgarh and Jharkhand performed better in NFHS-III than their mother states namely, Uttar Pradesh, Madhya Pradesh and Bihar respectively after the division of the latter set of states (84:385).

Principal Component Analysis (PCA)

For calculation of PCA, all the 21 indicators are made unidirectional[7]. Say, for b, we use the B: childhood diarrhea with 'no treatment'. We deducted the percentages of boy and girl received 'no treatment' from 100 to get percentages of boy and girl received 'any treatment'. Then gender gap is calculated using the previously mentioned formula. The same method is applied for b, e, f, j, k, l, m, n, o, p, t, and u also. Principal components are constructed using PCA with all the selected 21 indicators. The principal components with Eigen value greater than one are considered. With those selected principal components, we calculate a composite index as a weighted average of these principal components, where the weights are (Eigen value of the corresponding principal component)/ (sum of all Eigen values), separately for three rounds of NFHSs. With the values of composite index, states are ranked in ascending order, separately for each round of NFHS. A higher rank (number) indicates higher gender bias against girls.

Here we consider six principal factors with Eigen values greater than one in both NFHS-I and -II; and in NFHS-III, seven principal factors with Eigen values greater than one are considered. The cumulative variance explained by these principal factors is 83 percent for NFHS-I, 78 percent for NFHS-II and 82 percent for NFHS-III. With these principal factors, we construct a composite index and rank the states accordingly. Table 7 presents the state-wise composite index and their rank. From table 7 one can see that there are lot of ups and down in the state-wise rankings as we move from NFHS-I to NFHS-III. Over the study period of thirteen years, Gujarat, Himachal Pradesh, Rajasthan, Karnataka and to some extent Orissa consistently improved their ranks, i.e., gender bias against girl children is consistently reduced relative to the other states. But the picture is just reverse for Punjab, Bihar and Mizoram where gender bias against girl children in child health is consistently increased over time. For the entire picture of state-wise pattern of gender bias over the three rounds of NFHSs, we need table 8. Table 8 provides the (Spearman) correlation coefficient for each pair of rankings from the three rounds of NFHSs (given in table 7). The correlation coefficients are not significant even at 10 percent level suggesting that there is no consistent state-wise pattern of gender bias against girl children in child health.

To check the robustness of the absence of a consistent state-wise pattern in gender bias in child health, the analysis is calibrated further. First, we consider only one principal component that explains the largest proportion of total variation in all the 21 indicators. The total variance explained by the first principal component is only 24 percent for NFHS-I, 23 percent for NFHS-II, and 20 percent for NFHS-III. The states are ranked on the basis of the values of these principal factors. But, the (Spearman) correlation coefficients are not significant except for the correlation coefficient between the ranks in NFHS-I and NFHS-II (significant at five percent level) (results are not presented). As the total explained variance is quite low, we should not place much value on this solitary exception. Second, we consider only the 19 major states. Now, we are considering only two principal factors with Eigen values greater than one in NFHS-I and three principal factors with Eigen values greater than one for both NFHS-II and -III. The cumulative variance explained by these principal factors is 57 percent for NFHS-I, 79 percent for NFHS-II and 76 percent for NFHS-III. With these principal factors, we construct a composite index and rank the states accordingly. Again, the correlation coefficients of the ranks are not significant as before (results are not presented).

Table 7. State-wise Composite Index and Rank in Gender Bias against Girl Children, Various NFHS Rounds[8,9]

	Composite Index			Rank		
	NFHS-I	NFHS-II	NFHS-III	NFHS-I	NFHS-II	NFHS-III
Meghalaya	-0.54	-0.4	-1.18	**3**	**5**	**1**
H.P.	0.3	-0.06	-0.49	**24**	**12**	**2**
Nagaland	-0.48	-0.34	-0.41	**4**	**6**	**3**
Kerala	-0.39	-0.08	-0.33	**7**	**10**	**4**
Gujarat	0.37	0.33	-0.33	**26**	**22**	**5**
W.B.	-0.11	0.39	-0.33	**11**	**23**	**6**
Assam	-0.59	0.97	-0.16	**1**	**29**	**7**
Uttarakhand	-0.03	0.5	-0.16	**16**	**27**	**8**
Rajasthan	0.34	0.06	-0.15	**25**	**15**	**9**
J.& K.	-0.13	0.15	-0.14	**8**	**21**	**10**
Maharashtra	0.05	-0.13	-0.14	**19**	**9**	**11**
Orissa	-0.05	0.03	-0.14	**14**	**14**	**12**
Karnataka	0.16	0.11	-0.12	**20**	**17**	**13**
Tamil Nadu	-0.04	-0.08	-0.1	**15**	**10**	**14**
Jharkhand	-0.12	0.12	-0.08	**9**	**18**	**15**
Chhattisgarh	0.26	0.48	-0.08	**22**	**25**	**16**
Mizoram	-0.58	-0.44	-0.07	**2**	**4**	**17**
Haryana	0.03	-0.25	-0.01	**16**	**8**	**18**
M.P.	0.26	0.48	0.04	**22**	**25**	**19**
Delhi	-0.08	-0.34	0.06	**12**	**6**	**20**
Arunach. P.	-0.41	-0.99	0.08	**6**	**1**	**21**
Sikkim	NA	0.13	0.28	**NA**	**20**	**22**
Tripura	0.21	0.39	0.31	**21**	**23**	**23**
Manipur	1.51	-0.78	0.4	**28**	**3**	**24**
U.P.	-0.03	0.5	0.48	**16**	**27**	**25**
Goa	-0.45	-0.95	0.59	**5**	**2**	**26**
Punjab	-0.07	0.06	0.65	**13**	**15**	**27**
Bihar	-0.12	0.12	0.73	**9**	**18**	**28**
Andhra P.	0.77	0.02	0.77	**27**	**13**	**29**

Note: States are ordered according to NFHS-III rankings.

Table 8. Rank-Correlation (Spearman) Matrix of Rankings in Three Rounds of NFHS

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.25**	—	
NFHS-III	**0.18**	**-0.07**	—

Note: none significant even at 10% level (two tail).

Among the major 19 states, Rajasthan and Jharkhand consistently improved their ranks over the study period, i.e., gender bias against girls is consistently reduced relative to the other states. But the scenario is just reverse for Jammu and Kashmir, Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh and Tamil Nadu where gender bias against girl children in child health is consistently increased over time. More strikingly, in NFHS-III, West Bengal has least gender bias against girl children in child health. Overall, there is high gender bias in three Empowered Action Group of states (namely, Uttar Pradesh, Madhya Pradesh, and Bihar) and in Punjab, Andhra Pradesh, and Gujarat as well.

DISCUSSION

The study uses 21 selected indicators of health outcome and health-seeking behaviour from three rounds of National Family Health Survey data. Borda rule and PCA tools are applied for the analyses of the data. Children under three years are the unit of the analysis. The study found that any consistently robust state-wise pattern of gender bias against girl children in child health is not present among all the 29 Indian states over the three rounds of NFHSs. However, the absence of any consistent state-wise pattern in gender bias does not mean that there is no gender bias in child health in the Indian states. Among the 19 major states, overall, there is high gender bias in three Empowered Action Group of states (namely, Uttar Pradesh, Madhya Pradesh, and Bihar) and in Andhra Pradesh, Punjab, and Gujarat as well. The states succeeded in reducing gender bias against girl children in child health over the years relative to the other states are Gujarat, Himachal Pradesh, Rajasthan, West Bengal, Uttarakhand, Chhattisgarh, and Jharkhand. But for the states of Jammu and Kashmir, Punjab, Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu gender bias against girl children is consistently increased over time relative to the other states.

Along with the gender gap one should also look at the absolute level of health achievement for both boys and girls. There may be untoward cases of low gender gap with low absolute achievement level for both sexes. By the Rawlsian (85) theory of justice, which gives complete priority to the worst-off group's gain (86:70), one should focus on the health achievement by the girl children only, as the reduction in gender bias in child health being the ultimate motto.

An attempt has been also made to see if there is any state-wise pattern in health status for girl children only over the three rounds of NFHSs. For this we select only six indicators (A, C, G, L, Q and U) of health-seeking behaviour and health outcome for girl children only. Based on these six indicators, the Borda ranks of the states are presented in table 9 for three rounds of NFHSs. Table 10 shows that the (Spearman) rank correlations of the ranks of states for various NFHS rounds are strongly significant now. Thus there is a consistent state-wise pattern of girl children's health status. This finding may be interpreted as, overall, girl children's health achievement in different states moved more or less in the same direction, but girl children's relative achievement compared to boys in health has not moved in the same direction for all the states over the study period.

Concentrating on the consistent state-wise pattern of girl children's health achievement is fairly justified on the Rawlsian premise as in the social valuation function it assumes the degree of inequality aversion tending to infinity. As a policy measure, to reduce gender bias in child health we need to focus on the states with low health achievement by girls (i.e., lower

Borda ranks in table 9), viz., Rajasthan, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, Orissa, Assam, and Andhra Pradesh.

The scope of the present study is rather limited. It does not address the questions like why there are a specific state-wise pattern in gender bias exists in a particular time period or is such pattern is related to the state-wise public health expenditure or why such pattern changes inconsistently over time. The study can be extended further in these lines.

Table 9. Borda Rank of Health Status for Girl Children, Various NFHS Rounds

	NFHS-I	NFHS-II	NFHS-III
Kerala	**27**	**28**	**29**
W.B.	**17**	**14**	**28**
Goa	**26**	**29**	**27**
Haryana	**23**	**25**	**26**
H.P.	**25**	**26**	**25**
Maharashtra	**21**	**27**	**24**
Tamil Nadu	**19**	**24**	**23**
Delhi	**22**	**22**	**22**
Karnataka	**18**	**20**	**21**
Punjab	**23**	**23**	**20**
J.& K.	**28**	**20**	**19**
Sikkim	**NA**	**12**	**18**
Meghalaya	**16**	**4**	**17**
Tripura	**7**	**18**	**16**
Uttarakhand	**2**	**9**	**15**
Mizoram	**20**	**13**	**14**
Manipur	**9**	**18**	**13**
Gujarat	**14**	**15**	**12**
Orissa	**8**	**6**	**11**
Chhattisgarh	**10**	**6**	**9**
Nagaland	**13**	**11**	**9**
Andhra P.	**12**	**17**	**8**
M.P.	**10**	**6**	**7**
Bihar	**2**	**1**	**6**
Jharkhand	**2**	**1**	**5**
Rajasthan	**1**	**5**	**4**
Arunach. P.	**15**	**16**	**3**
U.P.	**2**	**9**	**2**
Assam	**6**	**3**	**1**

Note: The chosen indicators are A, C, G, L, Q and U. Ranking is done in ascending order (a higher value indicates better status of girls) for the following indicators— A, C, G, and Q. For L and U, ranking is done in descending order (a lower value indicates better status of girls). A higher rank (number) indicates better status of girl children. States are ordered according to NFHS-III rankings.

Table 10. Rank-Correlation (Spearman) Matrix of Borda Rankings in Three Rounds of NFHS

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.81***	—	
NFHS-III	**0.79***	**0.78***	—

Note: Level of significance (two tailed) — *: 1%.

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End notes

[1] Principle of population symmetry—cloning the entire population should not alter inequality. Principle of transfer—the Pigou-Dalton principle of transfers states that inequality is diminished if units are transferred from a larger one to a smaller one. Principle of scale invariance—it insists that an index will remain unchanged when the raw values are multiplied by a positive constant. Principle of constant addition—equal additions to the raw values should diminish the score of an inequality index ant that equal subtractions should increase it (79:17-19,80:174-78). Sopher's index (DIS) does not satisfy principle of scale invariance.

[2] Polio 0 is administered at birth along with BCG.

[3] Vaccination coverage rates are calculated from information on immunisation cards where these are available, and mother's report where there are no cards. This is the practice usually followed by the Demographic Health Survey (DHS) (81,82) and validated by other research (83) (mentioned in 32:2078).

[4] Percentage of the children (also for boy and girl children separately) who were sick and taken to any public health facility steadily declined over time from 27 percent in 1992-93 to 18 percent in 2005-06. But percentage of the children who were sick and taken to any private health facility steadily increased over the same time from 80 percent to 90 percent. This raises serious concern about the quality and acceptability of the public health facilities in India.

[5] We choose only one indicator for each of the health dimension, i.e., immunisation, diarrhoea, breastfeeding, malnutrition, fever/ cough treatment, and mortality. The choice of a particular indicator within a dimension is not only due to the data unavailability but also due to the other available guidelines. For example, World Health Organisation (WHO) prescribes for at least six months breastfeeding. Similarly, weight-for-age (underweight) is a composite index of height-for-age (stunting) and weight-for-height

(wasting). It takes into account both acute and chronic malnutrition. Weight-for-age, prescribed by the WHO, is most commonly used for child welfare work in India.

[6] A group of eight backward states with miserable socio-demographic indicators was formed as Empowered Action Group (EAG). This consists of Bihar, Jharkhand, Madhya Pradesh, Chattisgarh, Orissa, Rajasthan, Uttar Pradesh, and Uttarakhand. The group was formed on 20th March, 2001 under the Ministry of Health and Family Welfare to design and implement area specific programmes to strengthen the primary health care infrastructure.

[7] The chosen indicators are: Immunisation—a: childhood full vaccination; Diarrhoea—b: childhood diarrhoea with 'any treatment', c: childhood diarrhoea with 'medical treatment', d: childhood diarrhoea with 'given ORS'; Breastfeeding—e: childhood breastfeeding with 'ever breastfed', f: childhood breastfeeding with 'not less than six months breastfed', g: childhood breastfeeding with 'at least six months breastfed', h: childhood breastfeeding with 'currently breastfeeding', i: childhood breastfeeding with 'exclusively breastfed for first six months'; Malnutrition—j: childhood nutrition (height-for-age, above -3 SD), k: childhood nutrition (height-for-age, above -2 SD), l: childhood nutrition (weight-for-age, above -3 SD), m: childhood nutrition (weight-for-age, above -2 SD), n: childhood nutrition (weight-for-height, above -3 SD), o: childhood nutrition (weight-for-height, above -2 SD); Fever/ Cough—p: childhood fever/ cough (received any treatment), q: childhood fever/ cough (received medical treatment), r: childhood fever/ cough (received medical treatment in public health facility), s: childhood fever/ cough (received medical treatment in private health facility); Mortality—t: post-neonatal survival, u: child survival.

[8] Total composition excludes the following indicators—NFHS-I: j, k, n, o, and t; NFHS-II & -III: e, and t — due to non-availability of data for some of the states.

[9] NFHS-I: Here six principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—3.911, 2.465, 2.204, 1.883, 1.665, and 1.088. The cumulative total variance explained is 83%. Composite Index is constructed as a weighted average of the six principal factors. The corresponding weights are Eigen value/ Sum of six Eigen-values.

NFHS-II: Here six principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—4.447, 2.963, 2.579, 2.053, 1.618 and 1.155. The cumulative total variance explained is 78%. Composite Index is constructed as a weighted average of the six principal factors. The corresponding weights are Eigen value/ Sum of six Eigen-values.

NFHS-III: Here seven principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—3.715, 3.230, 2.842, 2.003, 1.357, 1.305 and 1.049. The cumulative total variance explained is 82%. Composite Index is constructed as a weighted average of the seven principal factors. The corresponding weights are Eigen value/ Sum of seven Eigen-values.

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Chapter 9

HOW TO STIMULATE CHILDHOOD IMMUNISATION IN INDIA

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ABSTRACT

This chapter analyses the effects of some selected demographic and socioeconomic predictor variables on the likelihood of immunisation of a child for six vaccine-preventable diseases covered under the universal immunisation program. It focuses on immunisation coverage a) in all India, b) in rural and urban areas, c) for three states, namely, Andhra Pradesh, Tamil Nadu, and Uttar Pradesh, and d) for three groups of states, namely, EAG, North-Eastern and Other states. The study applies a logistic regression model to National Family Health Survey-III (2005-06) data. Excepting only one variable, the results are robust across different models. The likelihood of immunisation increases with urban residence, mother's education level, mother's age, mother's exposure to mass media, mother's awareness about immunisation, antenatal care during pregnancy, wealth index, household electrification, mother's empowerment index, and caste/ tribe hierarchy. It is also higher for boys than girls but it decreases for higher birth-order irrespective of the sex of the child.

INTRODUCTION

Immunisation programme is one of the essential interventions for protection of children from life threatening circumstances, which are avertable. Immunisation programme in India was kicked up in 1978 as Expanded Programme on Immunisation (EPI). It gained impetus in 1985

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as Universal Immunisation Programme (UIP) and carried out in phased manner to cover all districts in the country by 1989-90 (1:58). In India, under the UIP, vaccines for six vaccine-preventable diseases (tuberculosis, diphtheria, pertussis (whooping cough), tetanus, poliomyelitis, and measles) are available free of cost to all. Lots of energy and money have been spent on the UIP but various survey results show a glaring gap between the targets and achievements even after several years. Given the tight budgetary allocations, one should take care of the effectiveness of the Programme. This paper, in continuation of another paper (2), tries to find the causes of poor immunisation coverage rate in India.

There are some bottlenecks from both supply and demand sides. In a developing country like India, any programme like UIP could be affected by supply-side financial constraints when the overall Central and State budgetary allocations on health care are meagre. Moreover, the availability of supply-side data at the disaggregated level is rare. Thus supply-side analysis is beyond the scope of the present study. It focuses purely on the demand-side, assuming the ceteris paribus supply-side constraints.

The report of the sub-committee on national health prepared for the consideration of National Planning Committee of the Indian National Congress had advocated state intervention to preserve and maintain health of the people by organising and controlling health care to achieve proper integration of curative and preventive services (3:224-5). The UIP, a carefully planned strategy launched in 1985-86, aimed for systematic district-wise expansion to cover all the districts by 1989-90 (4,5). More than 90 million pregnant women and 83 million infants were to be immunised over a five-year period under the UIP (6). The programme was given the status of a National Technology Mission in 1986 (7) to provide a sense of urgency and commitment to achieve the goals within the specified period. UIP became a part of the Child Survival and Safe Motherhood (CSSM) Programme in 1992 (8:176). Since 1997, immunisation activities have been essential part of the National Reproductive and Child Health (RCH) Programme (9:54). The GoI constituted a National Technical Committee on Child Health on 11th June, 2000 and launched Immunisation Strengthening Project on the recommendation of the Committee (8:173). The Department of Family Welfare established a National Technical Advisory Group on Immunisation on 28th August, 2001 to assist GoI in developing a nationwide policy framework for vaccines and immunisation (8:174).

Vaccine-preventable diseases have many socio-economic costs: sick children miss school and cause parents to lose time from work. These diseases also result in doctor’s visits, hospitalisations, poor health and even premature deaths. Vaccinations are one of the best ways to put an end to the serious effects of certain diseases. Vaccination not only protects children of today, but it also helps protect future generations. Immunizing individual children helps to protect the health of our community. In a community with higher immunization coverage, chances of unvaccinated children being exposed to disease germs passed around by other unvaccinated children are less.

Since vaccination of one child confers health benefits for others, in free market vaccinations will be under-supplied, as the true marginal costs will not be recouped by providers (private marginal benefit will be less than social marginal benefit). Preventive interventions by the Government can offset both the pure infection externality and the pure prevention externality (10) and ensure optimal level of service delivery. Expenditures for health care are imperative, because they contribute to human welfare both directly and indirectly. Health expenditure can improve the health status of the population directly by reducing fertility, morbidity and mortality. It improves social welfare indirectly via the effects of increase in labour productivity, decrease in population growth, superior human capital to raise per capita GNP. A healthy health sector will build a healthy economy and vice-versa. Health of population is a product of society and has an indispensable contribution to economic growth and political stability. UIP is often cited as 'the most cost-effective route to child's better health' (11). 'Universal immunization of children … is crucial to reducing infant and child mortality' (12:227).

'Despite large resource allocation and mass immunisation campaigns, efforts to increase the number of fully immunised children in India have met with limited success, raising concerns about the effectiveness of public health delivery systems' (13:998). Several survey results support the testimony of a glaring gap between the goals aspired for and the targets touched. To quote, '…achievement of the target of protecting … 85 percent of infants with vaccines …remains a distant dream' (14:160).

This National Review mentioned some supply side bottlenecks that may hinder the UIP to achieve its goals, which even in its annual report (9), mentions some supply constraints as major causes for poor immunisation. To strengthen routine immunization, GoI has planned some strategies, again to address some supply side issues, as a part of the State Program Implementation Plan (9:54). The annual reports (year 2000 onwards), still discuss the same supply-side constraints as major causes for poor immunization (9). But the mere focus on supply-side issues alone has evidently failed to achieve the desired goals of UIP. This paper hence tries to explore if it is possible to raise immunization coverage rate from the demand-side with a simplifying assumption of ceteris paribus supply-side constraint as we have a long history of Government negligence in health spending. This assumption is more realistic in the present scenario of global economic meltdown causing crunching foreign aid. Some researchers also argue that '…the Program suffers not so much from lack of funds as from functional isolation' (15). Public health should not be treated as the sole responsibility of the health sector. Policies and programmes in other sectors such as environment, education, welfare, industry, labour, information, etc., have also be informed and influenced by public health considerations (16).

No matter how noble the idea of UIP, a 'non-controversial' programme of GoI, it faces severe criticism from many scholars. As (17, 18) pointed out, it is a part of 'ill conceived and unimaginative global venture' and '… revealed many serious flaws in the programme itself. The most outstanding among them was that a massive, expensive and a very complicated programme had been recommended for launching without even finding out what the problem was, leave alone the other important epidemiological considerations, such as incidence rates under different ecological conditions and time trends of the chosen diseases'. It is also (18) mentioned that the programme is an 'onslaught' of the totalitarian approach of the developed North to 'sell' their 'social' products in the vast 'market' of developing South deviating from the Alma Ata Declaration (19).

Some researchers dub UIP as 'an unholy alliance of national and international power brokers (who) could impose their will on hundreds of millions of human beings living in the poor countries of the world …' (20). It is also noted strongly that the immunisation policy in India, instead of being determined by disease burden and demand, is increasingly driven by the supply push, generated by industry and mediated by international organisations (21).

OUR STUDY

The present study uses data from National Family Health Survey (NFHS)-III (2005-06). NFHS-III collected information from a nationally representative sample of 109,041 households, 124,385 women age 15-49, and 74,369 men age 15-54. The NFHS-III sample covers 99 percent of India's population living in all 29 states' (12:xxix). It is worth to note that NFHS-II (1998-99), the second round of the series, is regarded as 'storehouse of demographic and health data in India (22).

NFHS-III data on immunisation is based on vaccination card for each living child born since January 2000 in states where fieldwork started in 2005 (or since January 2001 in states where fieldwork started in 2006) or on mother's report in case of non availability of the card (12:227). The 12-23 month age group is taken for the present analyses because both international and GoI guidelines specify that children should be fully immunised by the time they complete their first year of life.

In NFHS-III, according to the guidelines developed by World Health Organisation, children who received BCG, measles, and three doses each of DPT and Polio (excluding Polio 0[1]) are considered to be fully vaccinated. Based on information obtained from 'either source', 43.5 percent of children are fully vaccinated whereas 5.1 percent have not received any dose of the six vaccines (12:229). The analysis of vaccine specific data indicates much higher coverage rate for each vaccines in urban areas than in rural areas (12:232). Dropout rates for each dose of both DPT and Polio are lower in urban areas than in rural areas (12). Immunisation coverage rate in India has been improving very tardily since the time of NFHS-I (1992-93) when the proportion of fully vaccinated children was 35.4 percent to 42 percent in NFHS-II (1998-99) to 43.5 percent in NFHS-III (2005-06) (an increase by only eight percentage points in thirteen years!) (23,24). These marginal improvements indicate that the target of UIP remains 'distant dream' even after two decades. State-wise coverage rate of immunisation for all three rounds of NFHS are shown in Table 1 and Figure 1. The states where coverage rate of full immunisation was lower than the national average in NFHS-II, experienced an increase in the rate in NFHS-III, but they were still below the national average. On the other hand, the states where coverage rate of full immunisation was higher than national average in NFHS-II witnessed a fall in the rate in NFHS-III (and they are mostly big states!) excepting Manipur, Chhattisgarh, Tripura, Orissa, Uttarakhand, West Bengal, Haryana, Sikkim, Jammu and Kashmir. This declining trend is also revealed by MoHFW which mentions '… recent household survey conducted in the year 2002-03 (RCH-II) has indicated that the coverage levels in most of the districts have been declining with respect to district level coverage reported in the year 1998-99 (NFHS-II)' (1:60,25). From Figure 2, it is evident that even in 2005-06 there is a large patch with low coverage that includes the large states of Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar, Jharkhand and the north-eastern states excluding Tripura, Mizoram and Manipur. State weight (v005s/1000000) is used for analysis of single state and national weight (v005/1000000) is used in all other cases to restore the correct population proportion.

An immunisation coverage model is used in this study to estimate the effects of the selected background variables on immunisation coverage. The measure of a child's immunisation is a binary variable that indicates whether a child has had been administered all the six vaccinations or not.

Table 1. Childhood Vaccinations by State, Various NFHS Rounds

Percentage among the living children age 12-23 months who received specific vaccinations at any time before the interview (from 'either source') by States						
	Full Vaccination			**No Vaccination**		
	NFHS-I (1992-93)	**NFHS-II (1998-99)**	**NFHS-III (2005-06)**	**NFHS-I (1992-93)**	**NFHS-II (1998-99)**	**NFHS-III (2005-06)**
India	**35.4**	**42.0**	**43.5**	**30.0**	**14.4**	**5.3**
North						
Delhi	57.8	69.8	63.2	6.7	5.1	9.8
Haryana	53.5	62.7	65.3	17.5	9.9	7.8
H.P.	62.9	83.4	74.2	8.7	2.8	1.9
J.& K.	65.7	56.7	66.7	16.2	10.4	4.5
Punjab	61.9	72.1	60.1	17.5	8.7	6.6
Rajasthan	21.1	17.3	26.5	48.5	22.5	6.2
Uttarakhand	19.8	21.2	60.0	43.3	29.4	9.1
Central						
Chhattisgarh	29.2	22.4	48.7	34.3	13.9	2.5
M.P.	29.2	22.4	40.3	34.3	13.9	5.0
U.P.	19.8	21.2	23.0	43.3	29.4	3.5
East						
Bihar	10.7	**11.0**	32.8	**53.4**	16.9	7.1
Jharkhand	10.7	**11.0**	34.2	**53.4**	16.9	4.4
Orissa	36.1	43.7	51.8	28.0	9.4	11.6
W.B.	34.2	43.8	64.3	22.4	13.6	5.9
Northeast						
Arunach. P.	22.5	20.5	28.4	47.5	28.7	**23.6**
Assam	19.4	17.0	31.4	43.6	33.2	15.6
Manipur	29.1	42.3	46.8	32.3	17.2	6.5
Meghalaya	9.7	14.3	32.9	54.9	**42.3**	17.0
Mizoram	56.4	59.6	46.5	14.5	10.5	7.0
Nagaland	**3.8**	14.1	**21.0**	75.0	32.7	19.7
Sikkim	NA	47.4	69.6	NA	17.6	3.2
Tripura	19.0	40.7	49.7	42.1	23.5	15.3
West						
Goa	**74.9**	82.6	78.6	5.4	**0.0**	**0.0**
Gujarat	49.8	53.0	45.2	18.9	6.6	4.5
Maharashtra	64.1	78.4	58.8	7.5	2.0	2.8
South						
Andhra P.	45.0	58.7	46.0	17.5	4.5	3.8
Karnataka	52.2	60.0	55.0	15.2	7.7	6.9
Kerala	54.4	79.7	75.3	11.4	2.2	1.8
Tamil Nadu	64.9	**88.8**	**80.9**	**3.3**	0.3	**0.0**

Number of observation: 11,853 for NFHS-I; 10,076 for NFHS-II; 10,419 for NFHS-III.

Note: In HFHS-I, survey was not done in Sikkim and J & K represents Jammu region only. In NFHS-I and –II, the three states of Uttarakhand, Chhttisgarh and Jharkhand were part of undivided Uttar Pradesh, Madhya Pradesh and Bihar respectively. Data for former three states are same as the latter three for NFHS-I and -II.

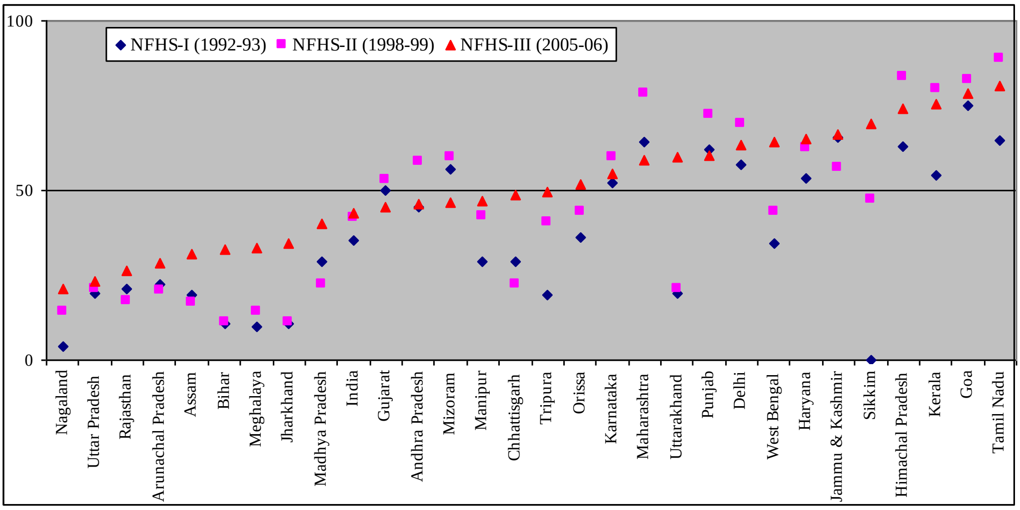

Figure 1. State-wise Coverage Rate of Full Vaccination, Various NFHS Rounds.

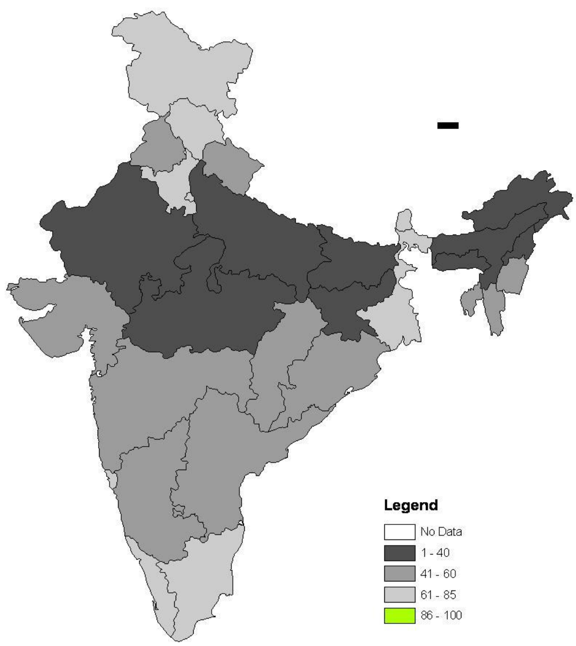

Figure 2. State-wise Full Vaccination Coverage in NFHS-III (2005-06).

The analyses use bivariate (unadjusted) and multivariate (adjusted) binary logit regression tools. Logistic regression results are presented in multiple classification analysis (MCA) form. Probability of immunisation (P) is presented in percentage form (multiplying by 100).

Unadjusted values are calculated from logit regressions incorporating only one predictor variable. Adjusted values are calculated from logit regressions incorporating all the selected predictor variables simultaneously. When calculating the adjusted values for a particular predictor variable, all other predictor variables are controlled by setting them to their mean values in the underlying regression (2, 26, 27).

FINDINGS

Children are the units of the present analysis, which uses the children's recoded file. The child data file contains selected characteristics of children aged less than five years, selected characteristics of their mothers and selected characteristics of the households in which the mother and child reside for 56,438 children. The analysis focuses on the 10,419 children aged 12-23 months during the Survey.

The analysis of immunisation coverage uses a number of demographic and socioeconomic variables. The dependent variable is full immunisation that says whether a particular child is fully immunised or not. The selected predictor variables are sex of the child (female, male), birth order of the child (1, 2, 3, 4 and above), residence (rural, urban), mother's education (Illiterate, Primary, Secondary, Higher), mother's age (15-19, 20-24, 25-29, 30-49 years), antenatal care (no, yes), religion (Hindu, Muslim, Christian and other minorities), caste/ tribe (general, other backward castes, scheduled caste, scheduled tribe), standard of living index[2] (low, medium, high, not de jure resident), wealth index (poorest, poorer, middle, richer, richest), media exposure (no, yes), mother's awareness (no, yes), sex of household head (female, male), mother's empowerment index (MEI) (low, medium, high), zone of states (Central, North, East, Northeast, West, South) and household electrification (no, yes). Mean values (in percentage) of the variables are presented in Table 2.

Wealth index is an index of the economic status of the households and is based on 33 household assets and housing characteristics. 'At the national level, 20 percent of the household population is in each wealth quintile although this is not necessarily true at the state level' (12:43). Media exposure of children's mother includes whether a child's mother reads newspaper at least once in a week or listens to radio at least once in a week or watches TV at least once in a week or goes to cinema hall or theatre once in a month. Mother's awareness includes whether child's mother visited a health facility/ camp or discussed immunisation or discussed nutrition/ health education in the past three months. For the variable zone of states, Central includes Chhattisgarh, Madhya Pradesh and Uttar Pradesh; North includes Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan and Uttarakhand; East includes Bihar, Jharkhand, Orissa and West Bengal; North-East includes Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura; West includes Goa, Gujarat and Maharashtra; South includes Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

An attempt has been made to construct an indicator (MEI) to see how the mother's decision-making power in the household affects the chance of immunisation. Such an index could vary widely with changes in its components or their weights. Percentage distribution of MEI[3] by states is shown in Figure 3. From Figure 3, it is evident that only four of the Empowerment Action Group (EAG) of states (namely, Rajasthan, Madhya Pradesh, Orissa, and Bihar) are among the bottom nine states, but the seven North-Eastern (NE) states (excluding Tripura) are among the top nine states in terms of MEI.

Table 2. Mean Values* of the Selected Variables

Variable	Mean (in Percentage)								
	India	**Rural**	**Urban**	**AP**	**TN**	**UP**	**EAG**	**NE**	**Other**
Full Immunisation (Yes)	**43.5**	**38.6**	**57.6**	**46.0**	**80.9**	**23.0**	**31.6**	**34.1**	**59.4**
Sex of child (Male)	**53.2**	**52.8**	**54.4**	**51.2**	**61.5**	**55.2**	**53.0**	**53.2**	**53.5**
Birth order									
1#	**31.4**	**29.0**	**38.3**	**32.5**	**47.3**	**22.0**	**25.8**	**33.8**	**38.2**
2	**27.9**	**25.9**	**33.3**	**41.0**	**33.7**	**22.8**	**23.2**	**25.6**	**33.9**
3	**16.6**	**17.6**	**13.8**	**15.9**	**15.2**	**17.4**	**17.3**	**17.8**	**15.7**
4+	**24.1**	**27.5**	**14.6**	**10.6**	**3.8**	**37.8**	**33.7**	**22.9**	**12.2**
Residence (Urban)	**26.1**	—	—	**37.2**	**47.4**	**20.1**	**18.5**	**15.2**	**36.7**
Mother's education									
Illiterate#	**47.8**	**55.8**	**25.0**	**36.9**	**12.8**	**65.2**	**63.1**	**29.6**	**30.0**
Primary	**13.6**	**14.3**	**11.7**	**18.5**	**16.6**	**10.4**	**12.9**	**23.3**	**13.7**
Secondary	**32.9**	**27.5**	**48.2**	**38.3**	**55.3**	**19.7**	**20.2**	**43.2**	**48.1**
Higher	**5.7**	**2.3**	**15.1**	**6.3**	**15.2**	**4.8**	**3.8**	**4.0**	**8.2**
Mother's age									
15-19#	**9.1**	**10.3**	**5.7**	**9.6**	**2.5**	**7.4**	**8.9**	**8.2**	**9.5**
20-24	**41.5**	**41.3**	**42.0**	**52.3**	**40.8**	**37.4**	**38.3**	**37.4**	**45.9**
25-29	**30.3**	**28.9**	**34.3**	**28.3**	**41.8**	**29.9**	**30.8**	**29.0**	**29.9**
30-49	**19.0**	**19.4**	**17.9**	**9.8**	**14.8**	**25.3**	**22.1**	**25.4**	**14.7**
Antenatal care (Yes)	**72.5**	**68.2**	**84.5**	**89.4**	**88.3**	**62.0**	**60.7**	**70.3**	**87.5**
Religion									
Hindu#	**77.7**	**79.7**	**71.8**	**82.1**	**84.1**	**77.7**	**82.7**	**51.5**	**73.5**
Muslim	**17.4**	**15.6**	**22.5**	**12.8**	**5.2**	**21.7**	**15.4**	**22.5**	**19.5**
Christ and minorities	**4.9**	**4.7**	**5.7**	**5.1**	**10.7**	**0.7**	**1.9**	**26.0**	**7.0**
Caste/ Tribe									
General#	**27.6**	**23.2**	**39.9**	**25.9**	**1.9**	**22.8**	**19.8**	**30.3**	**37.8**
OBC	**41.2**	**42.4**	**37.7**	**47.9**	**65.1**	**50.2**	**48.6**	**18.7**	**32.9**
SC	**21.8**	**22.8**	**18.9**	**19.1**	**31.4**	**25.5**	**22.1**	**14.4**	**21.9**
ST	**9.4**	**11.6**	**3.5**	**7.1**	**1.7**	**1.5**	**9.4**	**36.5**	**7.4**
SLI									
Low #	**30.1**	**36.4**	**12.0**	**22.5**	**25.5**	**30.2**	**36.2**	**39.0**	**21.5**
Medium	**30.8**	**32.6**	**25.6**	**35.5**	**35.5**	**35.2**	**31.3**	**37.8**	**29.6**
High	**30.3**	**21.6**	**54.9**	**31.2**	**33.8**	**24.4**	**22.4**	**19.8**	**41.1**
Not dejure resident	**8.9**	**9.4**	**7.5**	**10.8**	**5.2**	**10.2**	**10.1**	**3.3**	**7.8**
Wealth Index									
Poorest#	**24.8**	**31.8**	**5.0**	**13.0**	**8.4**	**29.7**	**34.4**	**21.1**	**13.0**
Poorer	**22.3**	**27.4**	**8.0**	**15.7**	**15.5**	**26.7**	**25.8**	**33.1**	**17.0**
Middle	**19.5**	**21.0**	**15.3**	**30.9**	**30.9**	**19.4**	**17.2**	**25.6**	**21.8**
Richer	**17.7**	**13.7**	**29.0**	**24.3**	**25.3**	**13.1**	**12.4**	**13.2**	**24.7**
Richest	**15.8**	**6.3**	**42.7**	**16.1**	**20.0**	**11.2**	**10.2**	**7.0**	**23.6**
Media Exposure (Yes)	**55.1**	**45.5**	**82.1**	**78.0**	**90.6**	**44.5**	**42.4**	**50.8**	**71.3**
Mother's awareness(Yes)	**59.3**	**57.7**	**63.8**	**52.3**	**84.6**	**64.9**	**56.4**	**35.2**	**64.9**
Sex of HH-Head (Male)	**88.8**	**88.2**	**90.6**	**92.1**	**89.1**	**89.8**	**87.7**	**89.7**	**90.2**
MEI									
Low #	**38.1**	**41.7**	**28.0**	**40.3**	**14.6**	**37.7**	**40.9**	**20.9**	**36.1**
Medium	**24.7**	**24.7**	**24.7**	**22.9**	**19.7**	**25.1**	**25.0**	**21.6**	**24.7**
High	**37.1**	**33.6**	**47.3**	**36.8**	**65.7**	**37.2**	**34.1**	**57.5**	**39.2**

Variable	Mean (in Percentage)								
	India	**Rural**	**Urban**	**AP**	**TN**	**UP**	**EAG**	**NE**	**Other**
Zone									
Central#	**28.8**	**30.9**	**22.9**	—	—	—	—	—	—
North	**12.8**	**12.6**	**13.2**	—	—	—	—	—	—
East	**25.3**	**28.9**	**15.2**	—	—	—	—	—	—
Northeast	**3.6**	**4.2**	**2.1**	—	—	—	—	—	—
West	**13.6**	**10.3**	**23.0**	—	—	—	—	—	—
South	**15.9**	**13.2**	**23.7**	—	—	—	—	—	—
Electricity$									
No#	**36.4**	**46.2**	**8.9**	**11.5**	**8.9**	**54.5**	**50.5**	**56.6**	**17.0**
Yes	**54.8**	**44.6**	**83.7**	**78.0**	**85.9**	**35.4**	**39.4**	**40.2**	**75.4**
Number of children	**10419**	**7696**	**2723**	**432**	**290**	**1364**	**5592**	**377**	**4450**

#: Reference category; *: Mean value of a variable represents the set of proportions of children falling in each category of that variable. Standard deviations of the variables are not reported. $: For electricity, the proportions do not add up to 100 because of the category of 'Not *de jure* resident' that is not taken into the analysis.

Table 3. Hypothesised Relationship of Variables with Full Immunisation

Variable	Hypothesised Sign
Sex of child	+
Birth order	-
Residence	+
Mother's education	+
Mother's age	+
Antenatal care	+
Religion	+/-
Caste/ Tribe	+/-
Std. of Living Index	+
Wealth Index	+
Media Exposure	+
Mother's awareness	+
Sex of HH-Head	-
Mother's Empowerment Index	+
Zone	+/-
Electricity	+

The hypothesised direction of relationship between dependent variable and each of the predictor variables are presented in Table 3.

Before going to the regression results, it is important to look at the possible collinearities among the predictor variables to avoid the problems of multicollinearity. In most real life observational research (as opposed to experimental research, where treatments can be randomised), a certain amount of multicollinearity is inevitable, because most of the predictor variables (e.g., standard of living index and wealth index) are correlated to some extent.

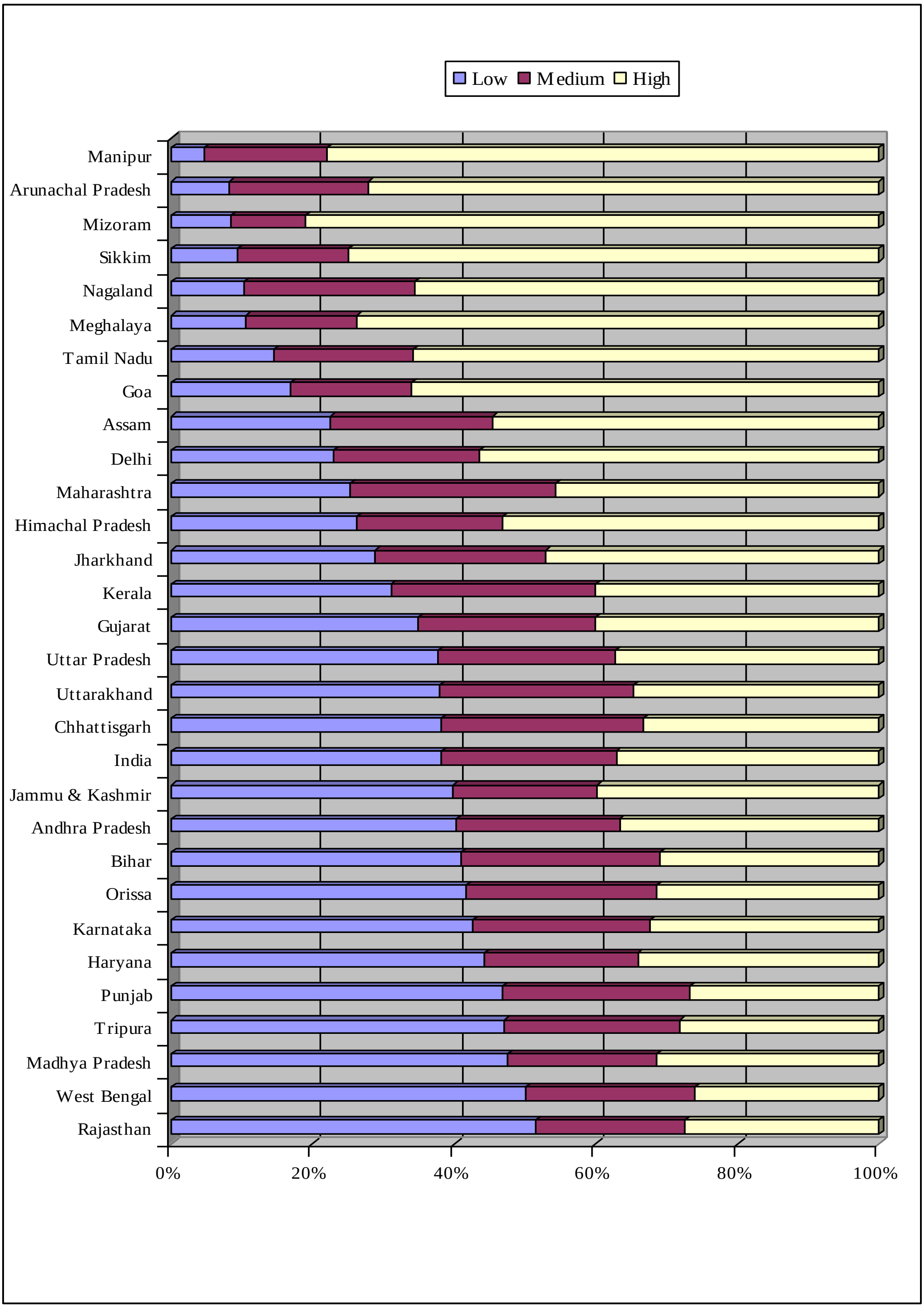

Figure 3. Percentage Distribution of Mother's Empowerment Index by States.

As a thumb rule, when two predictor variables are correlated and both are relevant for explanation from a theoretical point of view, one should not eliminate one of the variables to reduce multicollinearity, unless the correlation coefficients are higher than about 0.8 (27:39-40;28:264 (threshold to be 0.9)). But the Pearson Correlation Matrix (Table 4) shows the maximum correlation coefficient is 0.7 which is much less than the threshold magnitude. Also given the huge observations in the data, the present analysis enjoys the luxury of keeping all the predictor variables.

Effect on full immunisation coverage in India

There is evidence of gender discrimination in childhood immunisation in India (see India column of Table 5) though the vaccines are freely available. In India, boys are significantly more (10 percent for unadjusted, five percent for adjusted) likely to be fully immunised than girl children. Some researchers also noted such behaviour of families to neglect and discriminate against girl children (29-34). Gender bias is an important obstacle against improving immunisation coverage. However, it has been noted that although there are substantial mixed variations in immunisation coverage by sex, the median difference across all countries is very close to zero (35).

There is a consistently inverse relationship between immunisation coverage and birth order of a child. The different likelihoods of immunisation for different birth orders are also strongly significant. One can think of two countervailing effects of higher-order births on likelihood of vaccination.

The positive one could be some kind of learning effect about immunisation which almost does not vary or may increase marginally with higher birth-order. The negative one could be some kind of negligence effect and this effect perhaps increasingly increases with higher birth-order. Thus for higher order births, it seems that the negligence effect more than offsets the learning effect.

Another variable namely, sex-wise birth-order (an interaction variable of sex of the child and his/ her birth-order) is constructed to see whether the likelihood of vaccination decreases with increase in birth-order for girls only or not. Likelihood (unadjusted) of vaccination decreases with increase in birth-order irrespective of the sex of a child, but the rate of decrease is higher for girls except fourth or higher birth-order (see Table 6). Such inverse relationship is also supported by (31, 36). However, a positive relationship between immunisation coverage and birth order has been found by some researchers (37).

Urban children are much more (49 percent for unadjusted) likely to be fully vaccinated than rural ones. Higher immunisation coverage in urban areas is also supported by many researchers (38, 39). But, after controlling for other variables, the rural-urban disparity is not statistically significant. It suggests that the unadjusted effect of rural-urban residence is actually due to the other predictor variables correlated with residence.

There is a strong positive relationship between mother's education and children's immunisation coverage. The probability of being fully immunised is almost three times higher for the children of mothers with high school or above education than the children of illiterate mothers. The adjusted effects are lower than unadjusted ones (almost double) but still strongly significant. Such a positive effect of maternal education is also hypothesised by many researchers (13, 31, 32, 38, 39, 40-46) though (47) finds a spurious effect.

Table 4. Correlation (Pearson) Matrix

	Full Vaccination	Sex of Child	Birth Order	Residence	Mother's Education	Mother's Age	Antenatal Care	Religion	Cast/ Tribe	Std. of Living Index	Sex of HH-Head	Electricity	Media Exposure	Mother's Awareness	MEI	Zone of States
Sex of Child	-0.04*	—														
Birth Order	-0.22*	0.0	—													
Residence	0.17*	-0.0	-0.2*	—												
Mother's Education	0.37*	-0.0*	-0.4*	0.3*	—											
Mother's Age	-0.02	0.0	0.6*	0.0*	-0.1*	—										
Antenatal Care	0.25*	-0.0*	-0.2*	0.2*	0.3*	-0.1*	—									
Religion	-0.003	0.0	0.0*	0.1*	0.0*	0.1*	0.0	—								
Cast/ Tribe	-0.14*	0.0**	0.1*	-0.2*	-0.3*	-0.0	-0.1*	-0.1*	—							
Std. of Living Index	0.2*	-0.0	-0.3*	0.3*	0.4*	-0.1*	0.2*	0.0	-0.2*	—						
Sex of HH-Head	-0.02	-0.0	0.0*	-0.0*	-0.0*	0.0**	-0.1*	0.1*	-0.0**	-0.0*	—					
Electricity	0.18*	-0.0	-0.3*	0.3*	0.3*	-0.1*	0.2*	0.0	-0.2*	**0.7***	-0.0*	—				
Media Exposure	0.26*	-0.0*	-0.3*	0.3*	0.5*	-0.1*	0.2*	-0.0	-0.2*	0.4*	-0.0*	0.3*	—			
Mother's Awareness	0.15*	-0.0*	-0.1*	0.1*	0.1*	-0.0	0.1*	0.0*	-0.1*	0.1*	0.0	0.0*	0.1*	—		
MEI	0.07*	-0.0*	0.1*	0.1*	0.1*	0.2*	0.0*	0.1*	0.0	-0.1*	0.1*	-0.0	0.1*	0.0*	—	
Zone of States	0.21*	-0.0	-0.2*	0.2*	0.3*	-0.1*	0.2*	0.1*	-0.0*	0.1*	0.0**	0.2*	0.2*	0.0*	0.1*	—
Wealth Index	0.32*	-0.1*	-0.3*	0.5*	0.6*	-0.0	0.3*	0.1*	-0.3*	0.6*	-0.0*	0.5*	0.5*	0.1*	0.0*	0.2*

Significance level (two tailed) — **: 5%, *: 1%. Note: Numbers less than 0.05 are written as 0.0.

Table 5. Summary of Effects (P in percent) on Full Immunisation Coverage

Background Variables		India		Rural		Urban	
		Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**	**Unadjusted**	**Adjusted**
Sex of child	Female#	**41***	**41**	**37***	**34**	**56***	**59**
	Male	**45***	**43*****	**40***	**37****	**59*****	**59**
Birth order	1#	**55***	**50**	**49**	**44**	**66***	**64**
	2	**49***	**42***	**44***	**37***	**61****	**58****
	3	**39***	**39***	**37***	**35***	**47***	**53***
	4 & +	**26***	**33***	**24***	**27***	**36***	**51***
Residence	Rural#	**39***	**42**	—	—	—	—
	Urban	**58***	**41**	—	—	—	—
Mother's Education	Illiterate#	**26***	**33**	**25***	**29**	**33***	**46**
	Primary	**46***	**44***	**44***	**39***	**52***	**58***
	Secondary	**62***	**51***	**60***	**47***	**65***	**62***
	Higher	**80***	**59***	**80***	**60***	**80***	**69***
Mother's age	15-19#	**39***	**35**	**37***	**28**	**52**	**56**
	20-24	**45***	**38*****	**41****	**32*****	**56**	**57**
	25-29	**46***	**45***	**39**	**38***	**63***	**63**
	30-49	**38**	**47***	**33**	**44***	**54**	**57**
Antenatal care	No#	**23***	**30**	**21***	**25**	**36***	**49**
	Yes	**51***	**46***	**47***	**41***	**62***	**60***
Religion	Hindu#	**44***	**44**	**39***	**38**	**60***	**61**
	Muslim	**36***	**33***	**32***	**26***	**45***	**49***
	Christ &	**56***	**46**	**48***	**38**	**73***	**67**
Caste/ Tribe	General#	**55***	**46**	**50**	**40**	**64***	**62**
	OBC	**40***	**40***	**36***	**34***	**54***	**57****
	SC	**39***	**41****	**35***	**36*****	**52***	**56*****
	ST	**32***	**39***	**30***	**34****	**53****	**55**
Standard of Living Index	Low#	**28***	**41**	**27***	**34**	**34***	**61**
	Medium	**42***	**43**	**40***	**37**	**52***	**61**
	High	**62***	**43**	**58***	**38**	**67***	**57**
	NDR	**39***	**37**	**35***	**30**	**52***	**62**

Table 5. (Continued)

Background Variables		India		Rural		Urban	
		Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**	**Unadjusted**	**Adjusted**
Wealth Index	Poorest#	**24***	**36**	**24***	**32**	**27***	**53**
	Poorer	**33***	**38**	**33***	**34**	**33**	**48**
	Middle	**47***	**44***	**48***	**41***	**44***	**51**
	Richer	**55***	**43***	**55***	**37**	**56***	**56**
	Richest	**71***	**51***	**69***	**43***	**72***	**66*****
Media Exposure	No#	**29***	**40**	**29***	**35**	**36***	**55**
	Yes	**55***	**43****	**50***	**37*****	**62***	**59**
Mother's Awareness	No#	**35***	**35**	**30***	**29**	**49**	**51**
	Yes	**50***	**47***	**45***	**41***	**63***	**63***
Sex of HH-Head	Female#	**41***	**41**	**36***	**34**	**60***	**62**
	Male	**44**	**42**	**39**	**36**	**57**	**58**
Mother's Empowerment Index	Low#	**40***	**39**	**37***	**33**	**52**	**56**
	Medium	**43***	**42****	**40****	**37****	**53**	**55**
	High	**47***	**45***	**40****	**39***	**63***	**62****
Zone	Central#	**29***	**32**	**25***	**25**	**45***	**52**
	North	**46***	**40***	**41***	**34***	**60***	**58**
	East	**45***	**55***	**42***	**50***	**56***	**64***
	Northeast	**34****	**31**	**33***	**27**	**39**	**40**
	West	**54***	**39***	**46***	**31****	**64***	**60***
	South	**60***	**46***	**57***	**40***	**65***	**63***
Electricity	No#	**28***	**37**	**27***	**32**	**28***	**48**
	Yes	**55***	**45***	**51***	**40***	**61***	**61***

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Another variable, father's education has also tried to examine how the likelihood of vaccination is affected by it as around 48 percent of Indian mothers are illiterate. The effect of father's education (unadjusted) is significantly positive but its extent is less than that of mother's education (see Table 6).

Chance of immunisation of children increases with their mother's age. A positive relationship is also noted by (48). In the context of rural Bangladesh, some researchers show that likelihood of vaccination decreases for the mothers older than 28 years (32).

Antenatal care during pregnancy is positively associated with child vaccination. The chance of immunisation is almost two times (unadjusted) or about one-and-a-half times (adjusted) higher for the children of mothers' with some antenatal care than the children of mothers' with no antenatal care. Such a positive relationship is also noted by many researchers (29 (in rural areas only), 31, 32). This shows the possibility of positive information spill-over or learning-by-doing (49) from antenatal care during pregnancy on childhood immunisation. Mothers' who receives antenatal care may also receive counselling about the need of child immunisation.

Chance of immunisation seems to vary with religion also. The likelihood of being fully immunised is 44 percent for children from Hindu household, 36 percent for children from Muslim household and 56 percent for children from Christian and other minority community household. The adjusted chances are 44, 33 and 46 percent respectively. Muslim children are least likely to be fully vaccinated.

Caste/ tribe also seem to affect immunisation coverage. The chance of being fully vaccinated is 55 percent for children from general category household, 40 percent for children from OBC household, 39 percent for children from SC household and 32 percent for children from ST household. The result is, surprisingly, consistent with the relative hierarchy of castes/ tribes. The adjusted chances are 46, 40, 41 and 39 percent respectively.

Chance of immunisation increases with the standard of living index or wealth index of child's household. Incorporation of wealth index in the model wipes away the adjusted effect of SLI. The wealth index has significantly strong positive effect on immunisation. It has been argued that household income is a proximate determinant of immunisation coverage (45), which others have also found (32, 37). Though vaccines are freely available under UIP, household income (as measured by SLI or wealth index) does have a positive effect on childhood immunisation.

Media exposure has significantly positive effect on immunisation. Chance of full immunisation is higher (90 percent for unadjusted, eight percent for adjusted) for children of mothers' who have some media exposure compared to children whose mothers' are not exposed to mass media. But (47) does not find any significant effect of media.

Mother's awareness about immunisation also has significantly strong positive effect on vaccination. Chance of full immunisation is higher (43 percent for unadjusted, 34 percent for adjusted) for children of mothers' with some awareness than for children of unaware mothers'.

Sex of household head does not have any statistically significant effect on immunisation. However, in the context of rural Orissa, children from male headed households are more likely to be immunised than those from female headed households (50). Moreover, he shows that the gender inequality (boys are more likely than girls) in preventive health care persists regardless of the gender of the household head (50).

Mother's empowerment index has a positively significant effect on immunisation coverage. The unadjusted chances of being fully immunised are 40 percent for children of mothers with low MEI, 43 percent for children of mothers with medium MEI and 47 percent for children of mothers with high MEI and the adjusted chances are 39, 42, and 45 percent respectively.

The immunisation rate varies widely across different zones as well as within the same zone. For example, in South zone coverage varies from 81 percent (Tamil Nadu) to 46 percent (Andhra Pradesh). The unadjusted chances of being fully immunised are 29 percent for Central, 46 percent for North, 45 percent for East, 34 percent for Northeast, 54 percent for West, 60 percent for South and the adjusted chances are 32, 40, 55, 31, 39, 46 percent respectively.

Household electrification has also a significantly strong positive role (raises by 96 percent for unadjusted and 22 percent for adjusted) on full immunisation in India (32). Such a positive effect possibly works through availability of electronic mass media, establishment of an institutional health facility in the vicinity, higher SLI or wealth index, etc.

Effect on full immunisation coverage in rural and urban India

Separate regressions for rural and urban areas have tried to show clearly how the effects vary due to change in place of residence in lieu of a residence dummy. These regression results are compared with the all-India 'reference' regressions. Unadjusted and adjusted effects on full immunisation coverage for rural (sample size 7696) and urban India (sample size 2723) are presented in Table 5.

Gender discrimination of being fully immunised is favourable to boys (nine percent more than girls even after adjustment) in rural India but in urban India it disappears after adjustment. In urban India, after controls, mother's age and mother's exposure to mass media do not have any statistically significant effect. Effects of the other variables remain the same as the baseline (all India) regression.

Adjusted effect of demographic factors on full immunisation in India

Here a separate regression is tried, incorporating only the demographic factors to see their independent effect. The adjusted effects of demographic factors on full immunisation coverage in India are shown in Table 7.

Urban children are significantly more (26 percent than rural children) likely to be vaccinated even if the rural-urban gap vanished after controls in all-India regression. It implies that the unadjusted likelihoods for residence in all-India regression capture mainly the effects of the selected socioeconomic variables. Hence it can be assumed that the rural-urban disparity is not due to demographic factors but socioeconomic factors. The effect of castes/ tribes becomes consistent with their relative hierarchy. Effects of the other variables remain the same as the baseline (all India) regression.

Table 6. Unadjusted Effects on Full Immunisation Coverage in India

Background Variables		**P (in %)**
Sex-wise Birth-order	Female, Birth-1#	**54***
	Female, Birth-2	**48***
	Female, Birth-3	**32***
	Female, Birth-4 & +	**24***
	Male, Birth-1	**55**
	Male, Birth-2	**50****
	Male, Birth-3	**44***
	Male, Birth-4 & +	**27***
Father's Education	Illiterate#	**27***
	Primary	**40***
	Secondary	**50***
	Higher	**66***

#: Reference category; Significance level (two tailed): **5%, *1%.

Table 7. Adjusted Effects of Demographic Factors in India

Background Variables		**P (in %)**
Sex of child	Female#	**40**
	Male	**43***
Birth order	1#	**55**
	2	**45***
	3	**37***
	4 & +	**26***
Residence	Rural#	**39**
	Urban	**49***
Mother's age	15-19#	**28**
	20-24	**37***
	25-29	**48***
	30-49	**50***
Antenatal care	No#	**27**
	Yes	**48***
Religion	Hindu#	**44**
	Muslim	**30***
	Christ &	**52***
Caste/ Tribe	General#	**51**
	OBC	**40***
	SC	**39***
	ST	**32***
Sex of HH-Head	Female#	**42**
	Male	**42**
Zone	Central#	**31**
	North	**40***
	East	**49***
	Northeast	**33**
	West	**45***
	South	**52***

#: Reference category; Significance level (two tailed): *1%.

Adjusted effect of socioeconomic factors on full immunisation in India

Here another regression is tried, incorporating only the socioeconomic factors to see their independent effect. The adjusted effects of socioeconomic factors on full immunisation coverage in India are shown in Table 8. Effects of all the variables remain the same as the baseline (all India) regression.

Table 8. Adjusted Effects of Socioeconomic Factors in India

Background Variables		**P (in %)**
Mother's Education	Illiterate#	**31**
	Primary	**46***
	Secondary	**55***
	Higher	**68***
Standard of Living Index	Low#	**43**
	Medium	**43**
	High	**42**
	NDR	**40**
Wealth Index	Poorest#	**36**
	Poorer	**39*****
	Middle	**46***
	Richer	**45***
	Richest	**53***
Media Exposure	No#	**39**
	Yes	**45***
Mother's Awareness	No#	**36**
	Yes	**48***
Mother's Empowerment Index	Low#	**40**
	Medium	**43*****
	High	**45***
Electricity	No#	**38**
	Yes	**47***

#: Reference category; Significance level (two tailed): ***10%, *1%.

Extension: Region-specific pattern

Adjusted effect on full immunisation in three states of India

Three states of India, namely Uttar Pradesh, Tamil Nadu and Andhra Pradesh are selected for state-level analysis. These states are selected because UP (23 percent) and TN (81 percent) are the two extreme cases and AP (46 percent) is one with just above the national average (43.5 percent) in terms of coverage of full vaccination[4].

Adjusted effect on full immunisation in Andhra Pradesh

The adjusted effects on full immunisation coverage in Andhra Pradesh are presented in Table 9 for 432 children. Residence, antenatal care, religion, wealth index, media, and electricity do not have any significant effect. Effect of SLI becomes significantly negative. Relationship between MEI and immunisation becomes inverted-U shaped.

Table 9. Adjusted Effects (P in %) on Full Immunisation Coverage

Background Variables		AP	TN	UP	India	EAG States	N-E States	Other States
Sex of child	Female#	36	90	18	41	27	30	60
	Male	53*	87	19	43***	30***	27	61
Birth order	1#	54	90	33	50	40	33	65
	2	39**	79**	21*	42*	31*	30	59*
	3	36**	75**	17*	39*	28*	24	55*
	4 & +	50	100	12*	33*	21*	24	56*
Residence	Rural#	45	92	19	42	29	30	61
	Urban	43	81*	18	41	29	20	59
Mother's Education	Illiterate#	24	85	14	33	24	17	49
	Primary	52*	94***	23*	44*	32*	25	62*
	Secondary	58*	83	30*	51*	42*	39*	64*
	Higher	77*	94	37*	59*	48*	49**	73*
Mother's age	15-19#	64	75	6	35	18	32	60
	20-24	42**	85	15*	38***	25*	27	57
	25-29	41**	90	22*	45*	34*	28	62
	30-49	49	91	26*	47*	33*	30	67***
Antenatal care	No#	33	85	13	30	24	16	47
	Yes	46	88	23*	46*	32*	35*	62*
Religion	Hindu#	44	87	21	44	31	36	62
	Muslim	43	90	11*	33*	19*	17***	53*
	Christ &	56	95	48***	46	38	26	62
Caste/ Tribe	General#	53	96	20	46	30	32	64
	OBC	47	91	20	40*	29	28	57*
	SC	34**	78	15***	41**	26**	22	62
	ST	31***	82	20	39*	28	28	55**
Standard of Living Index	Low#	65	90	16	41	27	28	65
	Medium	46**	92	20	43	30***	30	62
	High	37*	83	17	43	29	28	60
	NDR	21*	60***	26*	37	29	16	41*

Table 9. (Continued)

Background Variables		AP	TN	UP	India	EAG States	N-E States	Other States
Wealth Index	Poorest#	**47**	**81**	**17**	**36**	**25**	**18**	**49**
	Poorer	**33**	**79**	**16**	**38**	**28**	**31**	**49**
	Middle	**40**	**88**	**22**	**44***	**31****	**33**	**62***
	Richer	**48**	**92**	**19**	**43***	**31*****	**27**	**62***
	Richest	**59**	**89**	**25**	**51***	**35****	**42**	**71***
Media Exposure	No#	**51**	**74**	**18**	**40**	**27**	**29**	**60**
	Yes	**43**	**89*****	**19**	**43****	**32***	**28**	**61**
Mother's Awareness	No#	**37**	**85**	**14**	**35**	**25**	**25**	**52**
	Yes	**51***	**88**	**21***	**47***	**32***	**35**	**65***
Sex of HH-Head	Female#	**37**	**75**	**16**	**41**	**30**	**29**	**64**
	Male	**45**	**89****	**19**	**42**	**29**	**28**	**60**
Mother's Empowerment Index	Low#	**34**	**81**	**18**	**39**	**26**	**29**	**59**
	Medium	**53***	**92**	**16**	**42****	**30****	**29**	**59**
	High	**51***	**88**	**20**	**45***	**32***	**28**	**63****
Electricity	No#	**49**	**92**	**19**	**32**	**27**	**26**	**62**
	Yes	**43**	**87**	**18**	**40***	**31*****	**33**	**60**

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Adjusted effect on full immunisation in Tamil Nadu

The likelihood of immunisation is not significantly affected by almost all the predictor variables. Chance of vaccination is almost certain for the children of Tamil Nadu. Though TN had achieved herd immunity (above 85 percent coverage rate) in NFHS-II (1998-99), it experienced a fall (by 10 percentage points!) in coverage rate in NFHS-III (2005-06).

The adjusted effects on full immunisation coverage in Tamil Nadu are presented in Table 9 for 290 children. Gender discrimination in immunisation is not significant. But urban children are significantly less likely to be immunised. Effect of male household headship has significantly positive effect.

Adjusted effect on full immunisation in Uttar Pradesh

The adjusted effects on full immunisation coverage in Uttar Pradesh are presented in Table 9 for 1364 children. Sex of the child, residence, wealth index, media exposure, MEI and electricity do not have any significant effects. Effects of the other variables remain same as the baseline (all India) regression.

Adjusted effect on full immunisation in three state-wise areas

A group of eight backward states with poor socio-demographic indicators was formed as Empowered Action Group (EAG). This consists of Bihar, Jharkhand, Madhya Pradesh, Chattisgarh, Orissa, Rajasthan, Uttar Pradesh, and Uttarakhand. The group was formed on 20th March, 2001 under the Ministry of Health and Family Welfare (MoHFW) to design and implement area specific programmes to strengthen the primary health care infrastructure. The group of North-Eastern states consists of eight states namely, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. The remaining thirteen states (AP, Goa, Gujarat, Haryana, HP, J&K, Karnataka, Kerala, Maharashtra, Punjab, TN, WB, and Delhi) are clubbed as Other states. Immunisation coverage rates are 31.6, 34.1 and 59.4 percent and the sample sizes are 5592, 377 and 4450 for EAG, NE, and Other group of states respectively.

Effects on full immunisation for EAG, NE and Other group of states are given in Table 9 and these are compared with the national level effects. Male children are significantly more likely to be vaccinated in EAG states only. Children of higher birth-order are less likely to be vaccinated except the North-Eastern children. Residence does not have any significant effect in each case. Children of more educated mothers are more likely to be immunised. The effect of mother’s age has almost positive effect except for the children of North-Eastern states. Children of mothers’ with some antenatal care are more likely to be vaccinated. Muslim children are least likely to be immunised in each case. Children from backward caste/ tribe households are also deprived in terms of vaccination except the North-Eastern states. The effect of household SLI is almost positive in EAG states only. Wealth index has no effect for North-Eastern states only. Effect of media exposure do not have any significant effect in North-Eastern and Other states and mother’s awareness do not have any significant effect in North-Eastern states only. Household headship does not have any significant effect in any case. Likelihood increases with MEI except North-Eastern states. Household electrification does not have any significant effect in North-Eastern and Other states.

CONCLUSION

Six vaccine-preventable diseases are covered under UIP, and vaccination is given free of cost to every child in India. Though vaccines are available for free, the goals of UIP are far from being achieved after two decades since its inception.

The present study attempts to investigate the demographic and socio-economic determinants of immunisation in India. It is possible to give a big push to the immunisation uptake, only when one understands the demand-side factors well, to achieve the chartered goals of UIP.

The study analyses the effects of some selected demographic and socioeconomic predictor variables on the chance of immunisation of a child. It focuses on immunisation coverage for children (a) in all India, (b) in rural and urban areas in India, (c) for three states namely, Uttar Pradesh, Tamil Nadu (two extremes in terms of immunisation coverage performance) and Andhra Pradesh (just above national average) (d) for three groups of states, namely, Empowered Action Group, North-Eastern and Other states.

The study applies binary bivariate and multivariate logit model to National Family Health Survey-III (2005-06) data. Excepting a few cases, the results are very much consistent across the different statistical models.

Robust results:

- Boys are more likely to be immunised than girl children.
- Children of higher-order births are less likely to be vaccinated. This is true irrespective of the sex of a child, but the rate of decrease is higher for girl children, except fourth or higher birth-order. It seems that the negligence effect more than offsets the learning effect. The result perhaps shows the greater apathy on part of the parents to immunise subsequent children.
- The likelihood of immunisation is higher for children from urban areas. The rural-urban disparity in vaccination is not due to demographic factors but due to socioeconomic factors.
- Likelihood of vaccination increases with mother's education level, mother's age, mother's exposure to mass media and mother's awareness about immunisation.
- Some antenatal care during pregnancy raises immunisation chances significantly. This increases possibility to meet health personnel who help mothers' to raise awareness by disseminating information regarding immunisation.
- Among the religious groups, Muslim children are least likely to be immunised whereas children from Christian and other religious minority communities are most likely to be immunised.
- Household income measured by SLI or wealth index has a positive effect on immunisation.
- Children from households with electricity are more likely to be immunised.
- Compared to general caste children, OBCs are less likely to be immunised, followed by the SCs and STs.
- Household headship has no effect on childhood immunisation. Likelihood of immunisation strictly increases with mother's empowerment index.

Tentative result

- Children from the East zone are most likely to be immunised, followed by South, North, West, North-East and Central respectively.

The need of the hour is an equitable, participatory and inter-sectoral approach to health and health care (51). Provision of vaccination should not be treated as the sole responsibility of the health sector. Policies and programmes in other sectors such as education, welfare, industry, labour, information, environment, etc. have also to be informed and influenced by public health considerations (16). To stimulate immunisation coverage, policy makers' should also try to improve mothers' education, media exposure, mothers' awareness, mothers' empowerment, wealth index of the household, electrification and to promote small family norm. There are also need of targeting of girl children, children from backward castes and Muslim religious community and children from EAG and NE states.

The provision of basic survival needs should be complemented with universal immunisation. For instance, measles in a healthy child is a negligible disease but mortality due to measles is 400 times greater in an undernourished population and the spread and severity of the epidemic is directly linked to overcrowding. Similarly, if an adequate amount of safe drinking water is made available, poliomyelitis will cease to be a problem (52:27). Thus provision of basic survival needs should be complemented to universal immunisation. The editorial comment (53) also emphasised that 'health improvements brought about by immunisation, … can only be sustained by availability of food, water and shelter and the political and economic power of the people to obtain them'. It also asserts that the imposition of these techno-centric approaches to deal with the problems of child health in the third world was destined to divert attention from the lack of basic survival needs.

As UIP is a 'massive, expensive and very complicated programme', the government should focus on a long-term vision of providing basic survival needs universally instead of only filling up our children's intestines with the 'myopic', 'techno-centric' doses of vaccines. Preventive health care, therefore, requires immunisation as well as good sanitation, proper nutrition, availability of safe drinking water and shelter as the common minimum social needs that must be met before we embark on an ambitious plan of government outlay for development (54).

End notes

[1] Polio 0 is administered at birth along with BCG.

[2] Details of its calculations are given in 23:39-41.

[3] The following recoded variables are chosen for its construction: permission to get medical help for self (v467b= 1 if no problem or not a big problem, 0 if big problem), who decides how to spend money (v739= 1 if decided by mothers alone or jointly with husband or other persons, 0 otherwise), mother's type of earnings for work (v741= 1 if earns cash or kind, 0 otherwise), final say on health care (v743a=1 if decided by mothers alone or jointly with husband or other persons, 0 otherwise), final say on making large household purchases (v743b=1 if decided by mothers alone or jointly with husband or other persons, 0 otherwise), final say on making household purchases for daily needs (v743c=1 if decided by mothers alone or jointly with husband or other persons, 0 otherwise), final say on visits to family or relatives (v743d=1 if decided by mothers alone or jointly with husband or other persons, 0 otherwise),

final say on deciding what to do with money husband earns (v743f=1 if decided by mothers alone or jointly with husband or other persons or husband has no earning, 0 otherwise), allowed to go to market (s824a=1 if allowed to go alone, 0 otherwise), allowed to go to health facility (s824b=1 if allowed to go alone, 0 otherwise), allowed to go to places outside this village/ community (s824c=1 if allowed to go alone, 0 otherwise), have bank or saving account (s825=1 if yes, 0 otherwise), has money for her own use (w124= 1 if yes, 0 otherwise). The method of unweighted aggregation is followed by which the scores of the above-mentioned thirteen recoded variables are simply added to get the scores of MEI. The MEI is then categorised as: low (0) if score≤4, medium (1) if 4<score<7, and high (2) if score≥7.

[4] Though the least coverage rate is for Nagaland with 21 percent, UP is chosen for the analysis due to higher sample size. For the same reason, AP is chosen over Gujarat (45 percent).

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Chapter 10

REGIONAL PATTERN OF GENDER BIAS IN CHILD HEALTH IN INDIA

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ABSTRACT

Health being one of the most basic capabilities, the removal of gender bias in child health can go a long way in achieving gender parity in various dimensions of human development. The present study examines the region-wise pattern of gender bias in child health in India. It uses six selected indicators of health outcome (childhood nutrition and childhood survival) and health-seeking behaviour (e.g., full immunisation, diarrhoea treatment, fever/ cough treatment and breast-feeding). Three rounds of unit level National Family Health Survey data are analysed using Borda Rule and Principal Component Analysis techniques. Children under age three years are the unit of the analysis. The study found that any consistently robust region-wise pattern of gender bias against girl children in child health is *not* present among all the six Indian regions of states over the three rounds of NFHS. The north region succeeded in reducing gender bias over the years but there is almost consistently high gender bias in the central region. There is, however, a consistent regional pattern in the absolute health achievement by girl children. To reduce gender bias in child health, the policy makers should try to raise health achievement of girl children more attentively in the central, east and northeast regions.

INTRODUCTION

Advancement of health care services is of utmost importance for its *intrinsic* value. The provision of public health is a basic human right and a crucial *merit* good. With the inception of the *Human Development Index* (HDI), the *Human Poverty Index* (HPI), and the *Gender-*

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related Development Index (GDI) by the *United Nations Development Programme* (UNDP), governments are required to redefine development. Universal access to health together with safe drinking water, sanitation, nutrition, basic education, information and employment are essential to balanced development. If India, like China, is to glean the gains of a demographic dividend and become an economic superpower by 2030, it will have to guarantee that her people are healthy, live long, generate wealth and dodge the tag of a 'high risk country'.

Since the *Bhore Committee Report* (1) and the *Constitution of India*, the Government of India (GoI) has corroborated many times its aim of advancing the average health of its citizens, reducing inequalities in health and, fostering financial access to health care, particularly for the most destitute. In the *Directive Principles of State Policy* of the Constitution of India, Articles 38-2 and 41 stress the need for equitable access and assistance to the sick and the underserved, right to employment and education, while Article 47 stresses on improving nutrition, the standard of living and, public health. Article 39 and Article 45 directs for gender equality and protection of children rights including education (2: 84-91). A World Bank report on gender and development begins with the statement: 'Large gender disparities in basic human rights, in resources and economic opportunity…are pervasive around the world… these disparities are inextricably linked to poverty' (3).

The dual causality between health and wealth is well documented. Health and mortality status of infants and gender bias in health are 'synoptic indicators' of a society's present condition. A study of gender bias with reference to child health is relevant as an area of research in its own right since children are helpless and solely depend on the social setting in which they are born. Health being one of the most basic capabilities, removal of gender bias in child health can go a long way in achieving gender parity in many other dimensions of human development. Gender-specific health policies would make women more independent and empowered and, thus achieve some of the goals laid by *Millennium Development Declaration* (declared in September 2000 by 189 countries).

BACKGROUND

Let us start with a theoretical background of gender bias. Biologically women tend to have a lower mortality rate than men at nearly all age groups, *ceteris paribus* (4:11). But, owing to the gender bias against women in many parts of the world, women receive less attention and care than men do, and particularly girls often receive far lesser support as compared to boys. As a consequence, mortality rates of females often exceed those of males (4-11). Gender discrimination prevails regardless of the realisation that prejudice in morbidity, nutritional status, or use of health care will probably contribute to greater gender bias in mortality (12-22).

Gender bias, even when it is not disastrous, may still generate greater debility among surviving girls and its effect may be perpetuated over generations (4, 11, 23-25). If the 'Barker thesis' (i.e., fetal origin of adult diseases hypothesis) (26, 27) is true, there is a possibility of a causal connection 'that goes from nutritional neglect of women to maternal undernourishment, and from there to fetal growth retardation and underweight babies, thence to greater child undernourishment' and to a higher incidence of permanent disadvantages in health much later in adult life (28, 29). 'What begins as a neglect of the interests of women ends up causing adversities in the health and survival of all—even at advanced ages' (28). Thus, gender bias not only hurts women, but inflicts a heavy economic cost on the society by harming the health of all, including that of men (29). Gender bias can be a blend of 'active' bias (e.g., 'intentional choice to provide health care to a sick boy but not to a sick girl'), 'passive' neglect (e.g., 'discovering that a girl is sick later than that would be the case for a boy, simply because girls may be more neglected in day-to-day interactions than are boys'), and 'selective favouritism' ('choices made by resource-constrained families that favour those children that the family can ill afford to lose') (11).

Women in India face discrimination in terms of social, economic and political opportunities because of their inferior status. Gender bias prevails in terms of allocation of food, preventive and curative health care, education, work and wages and, fertility choice (30-33). A large body of literature suggests preference to son and low status of women are the two important factors contributing to the gender bias against women. The patriarchal intra-familial economic structure coupled with the traditionally perceived cultural, religious and economic utility of boys over girls based on cultural norms have been suggested as the original determining factors behind the degree of son preference and the inferior status of women across the regions of India (11, 30). Daughters are considered as a net drain on parental resources in patrilineal and patrilocal communities (34). Intra-household gender discrimination has primary origins not in parental preference for boys but in higher returns to parents from investment in sons (35).

On an empirical note, preference to son in India has endured for centuries. The 1901 census noted 'there is no doubt that, as a rule, she (a girl) receives less attention than would be bestowed upon a son. She is less warmly clad, … she is probably not so well fed as a boy would be, and when ill, her parents are not likely to make the same strenuous efforts to ensure her recovery' (20). Population sex ratios from censuses almost steadily stepped up, from 1,030 males per 1,000 females in 1901 to 1,072 males per 1,000 females in 2001 (36-41). Due to unequal treatment of women, India now has the largest share of 'missing women' in the world (42). 'A strong preference for sons has been found to be pervasive in Indian society, affecting both attitudes and behaviour with respect to children and the choice regarding number and sex composition of children (12, 43-50). Son preference is an obstructing factor for maternal and child health care utilisation (51, 52).

Existing empirical literature on inter-state (or regional) pattern of gender bias suggests that boys are much more likely than girls to be taken to a health facility when sick in both north and south India (6, 17, 53-59). Girls are more likely to be malnourished than boys in both northern and southern states (6, 12, 29, 54, 60-63). 'The states with strong anti-female bias include rich ones (Punjab and Haryana) as well as poor (Madhya Pradesh and Uttar Pradesh), and fast-growing states (Gujarat and Maharashtra) as well as growth-failures (Bihar and Uttar Pradesh)' (28).

Gender bias in child health prevails even today when India is *shining* or *Bharat Nirman* is going on. 'For India the infant mortality rate is marginally higher for females (58) than for males (56). However, in the neonatal period, like elsewhere, mortality in India is lower for females (37) than for males (41). As children get older, females are exposed to higher mortality than males. Females have a 36 percent higher mortality than males in the post-neonatal period, and a 61 percent higher mortality than males at age 1-4 years (50). Boys (45 percent) are slightly more likely than girls (42 percent) to be fully vaccinated. Boys are also somewhat more likely than girls to receive each of the individual vaccinations (50). Among the children under age five years with symptoms of acute respiratory infection (ARI), treatment was sought from a health facility or provider for 72 percent of the boys but 66 percent of the girls (50). Among the children under age five years with fever, treatment was sought from a health facility or provider for 73 percent of the boys but 68 percent of the girls (50). Boys are also (seven percent) more likely than girls to be taken to a health facility for treatment in case of diarrhoea (50). Among children under five years, girls are three percent more likely to be underweight than boys (50). Among the last-born children, boys are 11 percent more exclusively breastfed than girls (50). For the children age 6-59 months, girls are more anaemic than boys (50).

The above discussion provides ample evidence of gender bias in child health indicators that ultimately transforms to gender imbalance in many other dimensions of human development. Thus, this paper attempts to answer the following questions. First, is there evidence of gender bias in the selected indicators of health outcome and health seeking behaviour of children? Second, if gender bias is there, what is the regional pattern of gender bias in child health in India? Third, has this regional pattern of gender bias remained unchanged over the study period of almost one-and-a-half decades? If we can identify a robust pattern of gender bias, it is possible to focus on the particular region(s) to reduce and remove gender bias.

OUR STUDY

The present study uses data from National Family Health Survey (NFHS)-III (2005-06), NFHS-II (1998-99), and NFHS-I (1992-93). 'NFHS-III collected information from a nationally representative sample of 109,041 households, 124,385 women age 15-49 years and 74,369 men aged 15-54 years. The NFHS-III sample covered 99 percent of India's population living in all 29 states' (50). The NFHS-II survey covered a representative sample of more than 90,000 eligible women age 15-49 years from 26 states that comprise more than 99 percent of India's population (64). The NFHS-I survey covered a representative sample of 89,777 ever-married women aged 13-49 years from 24 states and the National Capital Territory of Delhi, which comprise 99 percent of the total population of India (10). NFHS-II (1998-99), the second round of the series, is regarded as 'storehouse of demographic and health data in India (65).

Children under age three years are the unit of the present analysis, which uses the children's recoded data-files. The selected six indicators of health-seeking behaviour and health outcome are: health-seeking behaviour— childhood full vaccination (A), childhood diarrhoea with 'medical treatment' (B), childhood breastfeeding with 'at least six months breastfed' (C), childhood fever/ cough with 'received medical treatment' (E); health outcome— childhood nutrition (weight-for-age, above -2 SD) (D), childhood survival (F) (see tables 1-6 for details). For the variable region of states, *North* includes Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab and Rajasthan; *Central* includes Madhya Pradesh, Chhattisgarh, Uttar Pradesh, and Uttarakhand; *East* includes Bihar, Jharkhand, Orissa and West Bengal; *Northeast* includes Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura; *West* includes Goa, Gujarat and Maharashtra; *South* includes Andhra Pradesh, Karnataka, Kerala and Tamilnadu.

In tables 1-6, X_b and X_g represents achievements for boy and girl children in any health indicator X. Number of observations for boy and girl children are represented by n_b and n_g respectively. For any achievement pair (X_b, X_g) for boys and girls respectively, we construct an 'equally distributed equivalent' X_{ede}. This is defined to be the level of achievement that, if attained equally by boys and girls, as (X_{ede}, X_{ede}), would be socially judged to be exactly as valuable as the actually observed achievements (X_b, X_g). For simplicity, we assume that the parameter of equity preference (or the degree of inequality aversion) equal to two in the social valuation function (for achievement) that is additively separable, symmetric and of constant elasticity marginal valuation form. The equally distributed equivalent achievement X_{ede}, yields a measure that is, in fact, a gender-equity-sensitive indicator (GESI). A GESI is an index of overall achievement taking note of inequality, rather than a measure of gender equality. With degree of inequality aversion equal to two, X_{ede} is weighted harmonic mean of X_b and X_g where the weights are proportion of boys and girls [$X_{ede}=(p_b.X_b^{-1} + p_g.X_g^{-1})^{-1}$ where $p_b=n_b/(n_b+n_g)$ and $p_g=n_g/(n_b+n_g)$]. When degree of inequality aversion equal to zero, there is no concern for equality and X_{ede} becomes weighted arithmetic mean of X_b and X_g, where the weights are proportion of boys and girls [$\overline{X} = (p_b.X_b + p_g.X_g)$]. The corresponding measure of gender inequality (or gap) is simply the Atkinson index: I = 1- ($X_{ede}/\overline{X}$). Lesser the value of I, lesser will be the gender inequality, i.e., a lower value implies better status (for details, see the technical note-1 in (66)). The region with the lowest value of I will have a rank of one.

For robustness of the results, in addition to this, gender gap is also calculated using the following formula: Gender Gap=$(X_b/X_g)*100$. The region with the least value will have a rank of one. This measure of gender gap is the relative gap between boy and girl minus one and then taken in per cent (11, 30, 57, 67-72). Some studies measure gender gap as the absolute gap ((72, 73)—difference and absolute difference) or as the relative gap ((74)—simple arithmetic average of relative gaps) or both (75, 76). These studies use a particular gap (or more than one gap) without giving any or much rationale behind it.

A relative gap measure captures both the levels of coverage and gender equality. The value of gender gap decreases as coverage rates increase for both boys and girls with same absolute gap between them and it decreases as coverage rates increases for both boys and girls with lower absolute gap between them. This relative gap formula satisfies all the four principles of an inequality index, namely, *principle of population symmetry*, *principle of transfer*, *principle of scale invariance* and *principle of constant addition*[1]. An absolute gap formula, however, does not satisfy *principle of scale invariance* and *principle of constant addition*. Moreover, the absolute gap formula is not unit-free but a relative gap formula is free of any units.

In a multivariate analysis, problem arises with considerable number of correlated variables even though each variable may constitute a different dimension in a multidimensional hyperspace. As the multidimensional hyperspace is quite difficult to think about, social scientists often use some tool to reduce dimensions.

The six dimensions will be reduced by some ordinal measure. As an ordinal aggregator, the study will use the well-known Borda rule (named after Jean-Charles de Borda who devised it in 1770). The rule gives a method of rank-order scoring, the method being to award each region a point equal to its rank in each indicator of ranking, adding each region's scores to obtain its aggregate score, and then ranking regions on the basis of their aggregate scores

(79), separately for each round of NFHS. The region with lowest aggregate score will have a Borda rank of one (i.e., least gender inequality). In case of a tie (i.e., more than one region with equal aggregate score), we allot the average rank to each of the regions in a tie.

To check robustness of the results, the study also uses Principal Component Analysis (PCA) technique as a second tool to reduce dimensions. PCA reduces a large set of variables to a much smaller set that still contains most of the information about the large set. It reduces the variation in a correlated multi-dimension to a set of uncorrelated components. Principal components are estimated from the Eigen vectors of the covariance or correlation matrix of the original variables. Eigen vectors provide the weights to compute the principal components, while Eigen values measure the amount of variation explained by each principal component. Thus, the objective of PCA is to achieve parsimony and reduce dimensionality by extracting the smallest number of principal components that account for most of the variation in the original data without much loss of information (80). Principal components (defined as a normalised linear combination of the original variables) are constructed from the six indicators. Then a composite index is constructed as a weighted average of the principal components or factors, where the weights are (Eigen value of the corresponding principal component)/ (sum of all Eigen values) (81). On the basis of the values of the composite index, all the regions are ranked in ascending order (i.e., the region with lowest value will have a rank one), separately for each round of NFHS.

FINDINGS

Childhood full vaccination rate (A) is calculated as the percentage among the living children age 12-23 months who received all six specific vaccinations (BCG, measles, and three doses each of DPT and Polio (excluding Polio 0[2])) at any time before the interview (from ‘either source’[3]) for boy and girl children separately for each region. Then gender gap is calculated using the above-mentioned formulae. Region-wise gender gap in full immunisation is shown in table 1.

Childhood diarrhoea with medical treatment rate (B) is calculated as percentage of children seeking any medical treatment among the living children age 1-35 months who had diarrhoea in the last two weeks before the interview for boy and girl children separately for each region. Region-wise gender gap is presented in table 2.

Childhood breastfeeding with 'at least six months breastfed' rate (C) is calculated as percentage among the living children age less than three years who had at least six months breastfeeding for boy and girl children separately for each region. Region-wise gender gap in childhood breastfeeding is shown in table 3.

Childhood nutrition (weight-for-age, above -2 SD) rate (D) is calculated as percentage among the living children age less than three years who are above minus two standard deviation from the international reference population median for boy and girl children separately. Gender gap in childhood nutrition is presented in table 4.

Childhood fever/ cough with ‘received medical treatment’ rate (E) is calculated as percentage of children seek any medical treatment among the living children age 1-35 months who had fever/ cough in the last two weeks before the interview for boy and girl children separately for each region. Gender gap in childhood fever/ cough treatment is presented in table 5.

Childhood survival rate (F) is calculated as percentage of children aged 12-35 months who are surviving among the children ever born for boy and girl children separately for each region. Gender gap in childhood survival is shown in table 6.

We are now with two separate estimates of the magnitudes of gender bias for each of the six selected indicators over all the six regions of India for all three rounds of NFHSs. We use Borda rule and PCA to reduce dimensions.

Borda rule

Each region is ranked for each of the chosen indicators to capture the relative position of the Indian regions in gender bias against girl children. Ranking is done in ascending order (a higher value indicates higher gender bias against girls) for all the six indicators. Borda rank is calculated for each region on the basis of their aggregate scores for each round of NFHS. Region-wise Borda rank in gender bias against girl children in child health is presented in tables 7 and 9 (based on two separate measures of gender bias for robustness of the results). Again, a higher rank (number) signifies higher gender bias against girls. For any NFHS round, a Borda rank of one signifies lowest gender bias against girls in that region for that period.

From tables 7 and 9, one can see that there are lot of ups and down in the region-wise rankings as we move from NFHS-I to NFHS-III. Over almost the one-and-a-half decades of the study period, only the north region consistently improved their ranks, i.e., gender bias against girl children has consistently reduced relative to the other regions. On an average, there is consistently relatively high gender bias in both central and south regions and relatively low gender bias in north and west regions. For the third question of consistency of the regional pattern, we calculate the Spearman rank correlations. Spearman's *rho* is a rank-order correlation coefficient which measures association at the ordinal level. This is a nonparametric version of the Pearson correlation based on the ranks of the data rather than the actual values. Tables 8 and 10 provide the (Spearman) correlation coefficient for each pair of Borda rankings from the three rounds of NFHSs (given in tables 7 and 9 respectively). The correlation coefficients are not significant even at 10 percent level, suggesting that the regional pattern of gender bias against girl children in child health is not consistent over the years.

Principal Component Analysis (PCA)

Principal components are constructed using PCA with all the selected six indicators. The principal components with Eigen value greater than one are considered. With those selected principal components, we calculate a composite index as a weighted average of these principal components, where the weights are (Eigen value of the corresponding principal component)/ (sum of all Eigen values), separately for three rounds of NFHSs. With the values of composite index, regions are ranked in ascending order, i.e., a lower value indicates lower gender bias against girls, separately for each round of NFHS. The region with lowest value of composite index will have the rank of one (i.e., the best region). Region-wise composite index and their rank in gender bias against girl children in child health is presented in tables 11 and 13 (based on two separate measures of gender bias for robustness of the results).

From tables 11 and 13, one can see that there are lot of ups and down in the region-wise rankings as we move from NFHS-I to NFHS-III. Over the study period of thirteen years, on an average, only north and east regions consistently improved their ranks, i.e., gender bias against girl children is consistently reduced relative to the other regions. On an average, there is relatively high gender bias in central region. For the entire picture of region-wise pattern of gender bias over the three rounds of NFHSs, we need tables 12 and 14. Tables 12 and 14 provide the (Spearman) correlation coefficient for each pair of rankings from the three rounds of NFHSs (given in tables 11 and 13 respectively). The correlation coefficients are not significant even at 10 percent level suggesting that there is no consistent region-wise pattern of gender bias against girl children in child health.

DISCUSSION

The study uses six selected indicators of health outcome and health-seeking behaviour from three rounds of National Family Health Survey data. Borda rule and PCA tools are applied for the analyses of the data. Children under three years were the unit of the analysis. The study found that any consistently robust region-wise pattern of gender bias against girl children in child health is not present among the six Indian regions of states over the three rounds of NFHSs. However, the absence of any consistent region-wise pattern in gender bias does not mean that there is no gender bias in child health in the Indian regions. The north region succeeded in reducing gender bias over the years. There is almost consistently high gender bias in the central region. However, in the erstwhile better performing region of south, where multidimensional gender bias in child health is increasing over the years, there is a need for urgent intervention (see (70) on worsening women's status in Kerala).

Along with the gender gap one should also look at the absolute level of health achievement for both boys and girls. There may be untoward cases of low gender gap with low absolute achievement level for both sexes. By the Rawlsian theory of justice (85), which gives complete priority to the worst-off group's gain (86:70), one should focus on the health achievement by the girl children only, with the reduction in gender bias in child health being the ultimate motto.

An attempt has been also made to see if there is any regional pattern in the absolute health achievement for girl children only over the three rounds of NFHSs. For this we use achievements in the six indicators of health-seeking behaviour and health outcome for girl children only. For any indicator, the region with highest achievement for girl children will have a rank of one. A Borda rank of one (i.e., best performing region) will be assigned to the region with lowest total score. Based on these six indicators, the Borda ranks of the regions are presented in table 15 for three rounds of NFHSs. Table 16 shows that the (Spearman) rank correlations of the ranks of regions for various NFHS rounds are strongly significant now. Thus there is a consistent regional pattern of girl children's health status. This finding may be interpreted as, overall, girl children's health achievement in different regions moved more or less in the same direction, but girl children's relative achievement compared to boys in health has not moved in the same direction for all the regions over the study period.

Concentrating on the consistent region-wise pattern of girl children's health achievement is fairly justified on the Rawlsian premise as in the social valuation function it assumes the degree of inequality aversion tending to infinity. As a policy measure, to reduce gender bias in child health we need to focus on the regions with low health achievement of girls (i.e., higher Borda ranks (number) in table 15). Thus, to reduce gender bias, the policy makers should try to raise health achievement of girl children more attentively in the central, east and northeast regions.

The scope of the present study is rather limited. It does not address the questions like why a specific region-wise pattern in gender bias exists in a particular time period or if such pattern is related to the region-wise public health expenditure or why such pattern changes inconsistently over time. The study can be extended further on these lines.

APPENDIX

Table 1. Childhood Full Vaccinations by Region and Gender

Percentage among the living children age 12-23 months who received all six specific vaccinations at any time before the interview (from 'either source')								
	X_b	X_g	n_b	n_g	X_{ede}	$\overline{X}$	Gender Gap	
							I	$(X_b/X_g)*100$
NFHS-I								
India	**36.7**	**34.1**	6053	5800	35.4	35.4	**0.001348**	**107.6**
North	46.6	38.1	725	661	42.1	42.5	0.010050	122.3
Central	25.4	19.3	1865	1735	22.0	22.5	0.018599	131.6
East	22.5	21.8	1315	1264	22.2	22.2	0.000250	103.2
Northeast	18.1	20.7	237	241	19.3	19.4	0.004490	87.4
West	57.9	60.8	801	803	59.3	59.4	0.000597	95.2
South	54.8	52.8	1110	1096	53.8	53.8	0.000345	103.8
NFHS-II								
India	**43.1**	**40.9**	5163	4913	42.0	42.0	**0.000686**	**105.4**
North	43.9	41.3	685	560	42.7	42.7	0.000922	106.3
Central	24.6	18.5	1425	1409	21.1	21.6	0.020030	133.0
East	28.4	26.0	1151	1063	27.2	27.2	0.001943	109.2
Northeast	23.4	16.0	188	144	19.5	20.2	0.034677	146.3
West	71.6	69.6	669	720	70.5	70.6	0.000200	102.9
South	69.3	70.6	1045	1017	69.9	69.9	0.000086	98.2
NFHS-III								
India	**45.3**	**41.5**	5545	4872	43.4	43.5	**0.001909**	**109.2**
North	46.7	43.4	655	601	45.1	45.1	0.001339	107.6
Central	31.2	27.4	1666	1413	29.3	29.5	0.004177	113.9
East	45.8	43.4	1346	1289	44.6	44.6	0.000724	105.5
Northeast	34.0	34.1	200	176	34.0	34.0	0.000002	99.7
West	56.8	50.7	782	631	53.9	54.1	0.003183	112.0
South	62.6	56.8	896	762	59.8	59.9	0.002344	110.2

Note: In NFHS-I, survey was not done in Sikkim and J & K represents Jammu region only. In NFHS-II, 'northeast' excludes Tripura.

Table 2. Childhood Diarrhoea with 'Medical Treatment' by Region and Gender

Percentage of children seek any medical treatment among the living children age 1-35 months who had diarrhoea in the last two weeks before the interview								
	X_b	X_g	n_b	n_g	X_{ede}	$\bar{X}$	Gender Gap	
							I	$(X_b/X_g)*100$
NFHS-I								
India	**64.4**	**59.7**	2057	1901	62.1	62.1	**0.001432**	**107.9**
North	69.2	66.2	253	204	67.8	67.9	0.000485	104.5
Central	67.2	63.4	515	495	65.3	65.3	0.000846	106.0
East	60.6	56.2	507	452	58.4	58.5	0.001414	107.8
Northeast	38.2	37.9	55	58	38.0	38.0	0.000016	100.8
West	63.9	58.8	310	267	61.4	61.5	0.001718	108.7
South	66.2	59.5	417	425	62.6	62.8	0.002841	111.3
NFHS-II								
India	**65.1**	**62.0**	3001	2702	63.6	63.6	**0.000593**	**105.0**
North	72.9	71.3	421	331	72.2	72.2	0.000121	102.2
Central	62.0	61.5	1038	940	61.8	61.8	0.000016	100.8
East	51.7	48.5	536	524	50.1	50.1	0.001020	106.6
Northeast	45.9	40.4	61	57	43.1	43.2	0.004057	113.6
West	74.5	71.6	499	475	73.1	73.1	0.000394	104.1
South	73.2	64.8	447	375	69.1	69.4	0.003677	113.0
NFHS-III								
India	**66.1**	**61.6**	2049	1726	64.0	64.0	**0.001233**	**107.3**
North	68.3	66.2	281	216	67.4	67.4	0.000240	103.2
Central	68.3	59.2	621	507	63.9	64.2	0.005042	115.4
East	58.8	61.2	520	492	59.9	60.0	0.000400	96.1
Northeast	40.6	36.2	64	58	38.4	38.5	0.003274	112.2
West	74.4	71.5	308	256	73.1	73.1	0.000392	104.1
South	70.2	58.9	255	197	64.8	65.3	0.007536	119.2

Table 3. Childhood Breastfeeding (at least six months Breastfed) by Region and Gender

Percentage among the living children age less than three years who had at least 6 months breastfeeding								
	X_b	X_g	n_b	n_g	X_{ede}	$\bar{X}$	Gender Gap	
							I	$(X_b/X_g)*100$
NFHS-I								
India	**78.5**	**77.8**	17438	16920	78.2	78.2	**0.00002005**	**100.90**
North	78.5	77.0	2209	1958	77.8	77.8	0.00009271	101.95
Central	77.8	76.3	5142	4996	77.1	77.1	0.00009473	101.97
East	80.4	80.5	3810	3621	80.4	80.4	0.00000039	99.88
Northeast	76.8	77.4	715	743	77.1	77.1	0.00001513	99.22
West	78.3	78.4	2342	2321	78.3	78.3	0.00000041	99.87
South	78.0	77.2	3220	3281	77.6	77.6	0.00002657	101.04
NFHS-II								
India	**77.5**	**77.9**	15740	14576	77.7	77.7	**0.00000662**	**99.5**
North	76.4	75.9	2080	1808	76.2	76.2	0.00001073	100.7
Central	76.3	77.7	4490	4201	77.0	77.0	0.00008255	98.2
East	77.6	78.6	3458	3187	78.1	78.1	0.00004092	98.7

Percentage among the living children age less than three years who had at least 6 months breastfeeding								
	X_b	X_g	n_b	n_g	X_{ede}	$\overline{X}$	**Gender Gap**	
							I	**(X_b/X_g)*100**
Northeast	78.9	77.2	517	457	78.1	78.1	0.00011815	102.2
West	80.5	79.1	2193	2030	79.8	79.8	0.00007683	101.8
South	77.5	77.8	3002	2893	77.6	77.6	0.00000373	99.6
NFHS-III								
India	**79.5**	**77.8**	16313	14892	78.7	78.7	**0.00011656**	**102.2**
North	76.0	76.0	2069	1763	76.0	76.0	0.00000000	100.0
Central	79.6	77.2	4871	4483	78.4	78.4	0.00023387	103.1
East	80.4	79.7	4010	3821	80.1	80.1	0.00001911	100.9
Northeast	78.9	76.9	603	592	77.9	77.9	0.00016477	102.6
West	79.8	77.7	2131	1878	78.8	78.8	0.00017707	102.7
South	80.5	77.4	2629	2355	79.0	79.0	0.00038428	104.0

Table 4. Childhood nutrition (Weight-for-Age) by Region and Gender

Percentage among the living children age less than three years who are above -2 SD from the International Reference Population median								
	X_b	X_g	n_b	n_g	X_{ede}		**Gender Gap**	
							I	**(X_b/X_g)*100**
NFHS-I								
India	**47.1**	**48.1**	13945	13739	47.6	47.6	**0.000110**	**97.9**
North	58.5	57.0	1689	1496	57.8	57.8	0.000168	102.6
Central	40.3	43.8	4180	4152	42.0	42.0	0.001732	92.0
East	38.9	43.0	3006	2954	40.8	40.9	0.002506	90.5
Northeast	51.2	57.0	531	546	54.0	54.1	0.002873	89.8
West	51.8	47.9	1829	1827	49.8	49.9	0.001530	108.1
South	55.5	53.7	2710	2764	54.6	54.6	0.000272	103.4
NFHS-II								
India	**54.7**	**51.2**	12941	11891	53.0	53.0	**0.001090**	**106.8**
North	59.0	56.6	1736	1504	57.9	57.9	0.000429	104.2
Central	49.4	45.0	3590	3324	47.2	47.3	0.002169	109.8
East	49.5	45.6	2814	2571	47.6	47.6	0.001678	108.6
Northeast	65.8	66.0	386	344	65.9	65.9	0.000002	99.7
West	53.6	50.2	1870	1718	51.9	52.0	0.001071	106.8
South	64.2	60.8	2545	2430	62.5	62.5	0.000739	105.6
NFHS-III								
India	**55.1**	**53.0**	13923	12655	54.1	54.1	**0.000377**	**104.0**
North	61.5	60.3	1826	1566	60.9	60.9	0.000096	102.0
Central	50.9	47.9	4153	3748	49.4	49.5	0.000920	106.3
East	49.9	45.5	3647	3501	47.6	47.7	0.002126	109.7
Northeast	61.6	61.6	510	492	61.6	61.6	0.000000	100.0
West	57.3	57.4	1692	1506	57.3	57.3	0.000001	99.8
South	63.3	65.2	2095	1842	64.2	64.2	0.000218	97.1

Table 5. Childhood Fever/ Cough (Received Medical Treatment) by Region and Gender

Percentage of children seek any medical treatment among the living children age 1-35 months who had fever/ cough in the last two weeks before the interview								
	X_b	X_g	n_b	n_g	X_{ede}		Gender Gap	
							I	$(X_b/X_g)*100$
NFHS-I								
India	**69.8**	**61.9**	4959	4338	65.9	66.1	**0.003582**	**112.8**
North	79.7	72.4	482	362	76.4	76.6	0.002257	110.1
Central	71.0	63.9	1227	1052	67.5	67.7	0.002754	111.1
East	63.8	54.7	1358	1194	59.2	59.5	0.005873	116.6
Northeast	36.3	34.2	273	260	35.2	35.3	0.000887	106.1
West	78.6	69.4	733	643	74.0	74.3	0.003848	113.3
South	75.3	68.2	886	827	71.7	71.9	0.002445	110.4
NFHS-II								
India	**62.8**	**57.0**	5747	4797	60.0	60.2	**0.002325**	**110.2**
North	72.8	68.4	687	531	70.8	70.9	0.000955	106.4
Central	59.1	51.9	1770	1473	55.6	55.8	0.004172	113.9
East	51.5	45.0	1345	1141	48.3	48.5	0.004507	114.4
Northeast	38.7	34.4	194	157	36.7	36.8	0.003422	112.5
West	75.4	74.9	790	688	75.2	75.2	0.000011	100.7
South	72.9	65.1	961	807	69.1	69.3	0.003171	112.0
NFHS-III								
India	**68.7**	**65.1**	4257	3597	67.0	67.1	**0.000719**	**105.53**
North	76.3	70.4	486	345	73.7	73.9	0.001571	108.38
Central	67.2	63.7	1303	1074	65.6	65.6	0.000708	105.49
East	66.7	60.7	1295	1161	63.7	63.9	0.002211	109.88
Northeast	43.4	38.8	143	152	40.9	41.0	0.003129	111.86
West	71.3	75.6	506	431	73.2	73.3	0.000851	94.31
South	74.4	75.1	524	434	74.7	74.7	0.000022	99.07

Table 6. Childhood Survival by Region and Gender

Percentage of children age 12-35 months who are living among the children ever born								
	X_b	X_g	n_b	n_g	X_{ede}		Gender Gap	
							I	$(X_b/X_g)*100$
NFHS-I								
India	**91.6**	**91.5**	12486	12095	91.6	91.6	**0.0000003**	**100.1**
North	93.3	91.1	1558	1401	92.2	92.3	0.0001419	102.4
Central	90.0	88.9	3716	3608	89.5	89.5	0.0000378	101.2
East	90.8	91.1	2736	2629	90.9	90.9	0.0000027	99.7
Northeast	90.2	92.7	549	535	91.4	91.4	0.0001868	97.3
West	94.2	94.1	1623	1643	94.1	94.1	0.0000003	100.1
South	92.2	94.1	2306	2280	93.1	93.1	0.0001040	98.0
NFHS-II								
India	**93.3**	**93.0**	10984	10361	93.2	93.2	**0.0000026**	**100.32**
North	93.6	91.9	1496	1278	92.8	92.8	0.0000835	101.85
Central	91.0	90.6	3181	3059	90.8	90.8	0.0000048	100.44
East	92.5	94.0	2410	2266	93.2	93.2	0.0000646	98.40

Percentage of children age 12-35 months who are living among the children ever born								
	X_b	X_g	n_b	n_g	X_{ede}		**Gender Gap**	
							I	**I**
Northeast	93.8	93.4	368	318	93.6	93.6	0.0000045	100.43
West	95.5	95.4	1499	1389	95.5	95.5	0.0000003	100.10
South	96.0	94.7	2030	2051	95.3	95.3	0.0000465	101.37
NFHS-III								
India	**93.9**	**93.6**	11780	10413	93.8	93.8	**0.0000026**	**100.32**
North	94.0	94.6	1470	1214	94.3	94.3	0.0000100	99.37
Central	93.0	91.6	3575	3180	92.3	92.3	0.0000573	101.53
East	93.2	93.7	2869	2678	93.4	93.4	0.0000071	99.47
Northeast	92.6	93.1	432	405	92.8	92.8	0.0000072	99.46
West	95.6	94.9	1533	1297	95.3	95.3	0.0000134	100.74
South	95.2	95.6	1901	1639	95.4	95.4	0.0000044	99.58

Table 7. Indicator-wise Ranking of Various Regions in Gender Bias against Girl Children and Borda Rank

	A	B	C	D	E	F	Total	Borda Rank
NFHS-I								
North	5	2	5	4	2	6	24	**4**
Central	6	3	6	3	4	5	27	**6**
East	3	4	3	2	6	3	21	**2**
Northeast	1	1	1	1	1	1	6	**1**
West	2	5	2	6	5	4	24	**4**
South	4	6	4	5	3	2	24	**4**
NFHS-II								
North	3	2	4	2	2	6	19	**2**
Central	5	1	1	6	5	4	22	**4.5**
East	4	4	2	5	6	1	22	**4.5**
Northeast	6	6	6	1	4	3	26	**6**
West	2	3	5	4	1	2	17	**1**
South	1	5	3	3	3	5	20	**3**
NFHS-III								
North	3	2	1	4	4	1	15	**1**
Central	6	5	5	5	3	6	30	**6**
East	2	1	2	6	5	3	19	**2.5**
Northeast	1	4	3	3	6	2	19	**2.5**
West	5	3	4	2	1	5	20	**4**
South	4	6	6	1	2	4	23	**5**

Note: Gender Gap=(X_b/X_g)*100. See text for the meaning of the indicators A-F.

Table 8. Rank-Correlation (Spearman) Matrix of Borda Rankings in Three Rounds of NFHSs

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**-0.46**	—	
NFHS-III	**0.62**	**0.04**	—

Note: none significant even at 10% level (two tail).

Table 9. Indicator-wise Ranking of Various Regions in Gender Bias against Girl Children and Borda Rank

	A	B	C	D	E	F	Total	Borda Rank
NFHS-I								
North	5	2	5	1	2	5	20	**3**
Central	6	3	6	4	4	3	26	**6**
East	1	4	1	5	6	2	19	**1.5**
Northeast	4	1	3	6	1	6	21	**4.5**
West	3	5	2	3	5	1	19	**1.5**
South	2	6	4	2	3	4	21	**4.5**
NFHS-II								
North	3	2	2	2	2	6	17	**2.5**
Central	5	1	5	6	5	3	25	**4.5**
East	4	4	3	5	6	5	27	**6**
Northeast	6	6	6	1	4	2	25	**4.5**
West	2	3	4	4	1	1	15	**1**
South	1	5	1	3	3	4	17	**2.5**
NFHS-III								
North	3	1	1	3	4	4	16	**1**
Central	6	5	5	5	2	6	29	**6**
East	2	3	2	6	5	2	20	**3**
Northeast	1	4	3	1	6	3	18	**2**
West	5	2	4	2	3	5	21	**4**
South	4	6	6	4	1	1	22	**5**

Note: Gender Gap=I. See text for the meaning of the indicators A-F.

Table 10. Rank-Correlation (Spearman) Matrix of Borda Rankings in Three Rounds of NFHSs

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.18**	—	
NFHS-III	**0.44**	**-0.03**	—

Note: none significant even at 10% level (two tail).

Table 11. Region-wise Composite Index[4] and Rank in Gender Bias against Girl Children, Various NFHS Rounds

	Composite Index			Rank		
	NFHS-I	NFHS-II	NFHS-III	NFHS-I	NFHS-II	NFHS-III
North	0.661	0.244	-0.606	**6**	**5**	**2**
Central	0.575	-0.814	0.341	**5**	**1**	**4**
East	-0.053	-0.793	-1.063	**2**	**2**	**1**
Northeast	-1.358	1.081	-0.078	**1**	**6**	**3**
West	0.086	0.164	0.458	**3**	**4**	**5**
South	0.089	0.118	0.948	**4**	**3**	**6**

Note: Gender Gap=(Xb/Xg)*100.

Table 12. Rank-Correlation (Spearman) Matrix of Rankings in Three Rounds of NFHSs

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**-0.26**	—	
NFHS-III	**0.14**	**-0.09**	—

Note: none significant even at 10% level (two tail).

Table 13. Region-wise Composite Index[5] and Rank in Gender Bias against Girl Children, Various NFHS Rounds

	Composite Index			Rank		
	NFHS-I	**NFHS-II**	**NFHS-III**	**NFHS-I**	**NFHS-II**	**NFHS-III**
North	0.153	-0.674	-0.479	**4**	**1**	**3**
Central	0.995	0.198	1.184	**6**	**5**	**6**
East	0.181	-0.283	-0.569	**5**	**2**	**2**
Northeast	-0.335	1.102	-0.791	**2**	**6**	**1**
West	-0.162	-0.223	0.158	**3**	**3**	**4**
South	-0.831	-0.120	0.496	**1**	**4**	**5**

Note: Gender Gap=I.

Table 14. Rank-Correlation (Spearman) Matrix of Rankings in Three Rounds of NFHSs

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**-0.26**	—	
NFHS-III	**0.20**	**0.09**	—

Note: none significant even at 10% level (two tail).

Table 15. Borda Rank of Health Achievement for Girl Children, Various NFHS Rounds

	A	B	C	D	E	F	Total	Borda Rank
NFHS-I								
North	3	1	5	1.5	1	4.5	16	**2**
Central	6	2	6	5	4	6	29	**6**
East	4	5	1	6	5	4.5	25.5	**5**
Northeast	5	6	3	1.5	6	3	24.5	**4**
West	1	4	2	4	2	1.5	14.5	**1**
South	2	3	4	3	3	1.5	16.5	**3**
NFHS-II								
North	3	2	6	3	2	5	21	**3**
Central	5	4	4	6	4	6	29	**6**

Table 15. (Continued)

	A	B	C	D	E	F	Total	Borda Rank
East	4	5	2	5	5	3	24	**4**
Northeast	6	6	5	1	6	4	28	**5**
West	2	1	1	4	1	1	10	**1**
South	1	3	3	2	3	2	14	**2**
NFHS-III								
North	3.5	2	6	3	3	3	20.5	**3**
Central	6	4	4	5	4	6	29	**5.5**
East	3.5	3	1	6	5	4	22.5	**4**
Northeast	5	6	5	2	6	5	29	**5.5**
West	2	1	2	4	1	2	12	**1**
South	1	5	3	1	2	1	13	**2**

Note: See text for the meaning of the indicators A-F.

Table 16. Rank-Correlation (Spearman) Matrix of Borda Rankings in Three Rounds of NFHS

	NFHS-I	NFHS-II	NFHS-III
NFHS-I	—		
NFHS-II	**0.89****	—	
NFHS-III	**0.84****	**0.99***	—

Note: Level of significance (two tailed) — *: 1%, **: 5%.

End notes

[1] Principle of population symmetry—cloning the entire population should not alter inequality. Principle of transfer—the Pigou-Dalton principle of transfers states that inequality is diminished if units are transferred from a larger one to a smaller one. Principle of scale invariance—it insists that an index will remain unchanged when the raw values are multiplied by a positive constant. Principle of constant addition—equal additions to the raw values should diminish the score of an inequality index ant that equal subtractions should increase it (77:17-19,78:174-78). Sopher's disparity index (DIS) does not satisfy principle of scale invariance.

[2] Polio 0 is administered at birth along with BCG.

[3] Vaccination coverage rates are calculated from information on immunisation cards where these are available, and mother's report where there are no cards. This is the practice usually followed by the Demographic Health Survey (DHS) (82,83) and validated by other research (84) (mentioned in 32:2078).

[4] NFHS-I: Here two principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—2.779, and 1.745. The cumulative total variance explained is 75%. Composite Index is constructed as a weighted average of the two principal factors. The corresponding weights are Eigen value/ Sum of two Eigen-values.

NFHS-II: Here two principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—2.471, and 1.812. The cumulative total variance explained is 71%.

NFHS-III: Here two principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—3.073, and 1.644. The cumulative total variance explained is 79%.

[5] NFHS-I: Here three principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—2.835, 1.522 and 1.322. The cumulative total variance explained is

95%. Composite Index is constructed as a weighted average of the three principal factors. The corresponding weights are Eigen value/ Sum of three Eigen-values.

NFHS-II: Here three principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—2.694, 1.615 and 1.241. The cumulative total variance explained is 93%.

NFHS-III: Here two principal components/ factors are constructed with Eigen-values greater than one. The corresponding Eigen-values are—3.121, and 1.420. The cumulative total variance explained is 76%.

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Chapter 11

THE INDIAN EXPERIENCE OF THE UNIVERSAL IMMUNISATION PROGRAMME

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ABSTRACT

This chapter attempts to analyse the effects of some selected demographic and socioeconomic predictor variables on the likelihood of immunisation of a child for six vaccine-preventable diseases covered under the Universal Immunisation Programme (UIP). It focuses on immunisation coverage across India with special emphasis on three groups of states, viz., Empowered Action Group, North-Eastern and Other states. The study applies a logistic regression model to the three rounds of National Family Health Survey unit-level data. The results are robust across different models. The likelihood of immunisation increases with urban residence, mother's education level, mother's age, mother's exposure to mass media, mother's awareness about immunisation, antenatal care during pregnancy, SLI or wealth index, household electrification, mother's empowerment index, and caste/ tribe hierarchy. It is also higher for boys than girls but it decreases for higher birth-order children irrespective of the sex of the child. Interestingly, sex of household headship has no effect. Religion and zone of states also have some effects. Emphasis on these demand enhancing factors is necessary to make the immunisation programme universal.

INTRODUCTION

Immunisation programme is one of the essential interventions for protection of children from life threatening diseases, which are avertable. The immunisation programme in India was flagged off in 1978 as Expanded Programme on Immunisation (EPI). It gained impetus in

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1985 as the Universal Immunisation Programme (UIP) and was carried out in a phased manner to cover all districts in the country by 1989-90 (1). In India, under the UIP, vaccines for six vaccine-preventable diseases (tuberculosis, diphtheria, pertussis (whooping cough), tetanus, poliomyelitis, and measles) are available free of cost to all. Lots of effort and funds have been exhausted, but several survey results have testified to a gap between the goals aspired and the targets reached. This paper will try to examine the determinants of the immunisation coverage rate in India in order to stimulate the rate from the demand-side as well. It will use the same method to analyse three different cross-sections of the National Family Health Survey (NFHS) data that covers 13 years period to check the consistency of robustness of the determinants over time.

There are some bottlenecks from both supply and demand sides. In a developing country like India, any programme like UIP could be affected by supply-side financial constraints, when the overall Central and State budgetary allocations on health care are meagre. Moreover, the availability of supply-side data at the disaggregated level is rare. Thus supply-side analysis is beyond the scope of the present study. It focuses purely on the demand-side, assuming the ceteris paribus supply-side constraints.

A National Planning Committee of the Indian National Congress advocated state intervention to preserve and maintain health of the people by organising curative and preventive services (2). The UIP, a carefully planned strategy launched in 1985-86, aimed at systematic district-wise expansion to cover all the districts by 1989-90 (3, 4). More than 90 million pregnant women and 83 million infants were to be immunised over a five year period under the UIP (5). The programme was given the status of a National Technology Mission in 1986 (6) to provide a sense of urgency and commitment to achieve the goals within the specified period. UIP became a part of the Child Survival and Safe Motherhood (CSSM) Programme in 1992-93 (7). Since 1997, the immunisation activities have been an essential part of the National Reproductive and Child Health (RCH) Programme (8). The Government of India (GoI) constituted a National Technical Committee on Child Health in 2000 and launched the Immunisation Strengthening Project (7).

Vaccine-preventable diseases have many socio-economic costs: sick children miss school and may cause parents to lose time from work. These diseases also result in doctor's visits, hospitalisations, poor health and even premature deaths. Vaccinations are one of the best ways to put an end to the serious effects of certain diseases. Vaccination not only protects children of today, but it also helps protect future generations. Immunising individual children helps to protect the health of our community. In a community with higher immunisation coverage, chances of unvaccinated children getting exposed to disease germs passed around by other unvaccinated children are less. Since vaccination of one child confers health benefits for others, in free market vaccinations will be under-supplied, as the true marginal costs will not be recouped by providers (private marginal benefit will be less than social marginal benefit). Preventive interventions by the Government can offset both the pure infection externality and the pure prevention externality (9) and ensure optimal level of service delivery. Expenditures for health care are imperative, because they contribute to human welfare both directly and indirectly. Health expenditure can improve the health status of the population directly by reducing fertility, morbidity, and mortality. It improves social welfare indirectly via the effects of increase in labour productivity, decrease in population growth, superior human capital to raise per capita GNP. A healthy health sector will build a healthy economy and vice-versa. Health of population is a product of society and has an indispensable contribution to economic growth and political stability. UIP is often cited as 'the most cost-effective route to child's better health' (10). 'Universal immunisation of children … is crucial to reducing infant and child mortality' (11).

'Despite large resource allocation and mass immunisation campaigns, efforts to increase the number of fully immunised children in India have met with limited success, raising concerns about the effectiveness of public health delivery systems' (12). To quote, '…achievement of the target of protecting … 85 percent of infants with vaccines …remains a distant dream' (13). This National Review mentioned some supply side bottlenecks that may hinder the UIP to achieve its goals, which even in its annual report (8), mentions some supply constraints as major causes for poor immunisation. To strengthen routine immunisation, GoI has planned some strategies, again to address some supply side issues, as a part of the State Programme Implementation Plan (8). The annual reports (year 2000 onwards), still discuss the same supply-side constraints as major causes for poor immunisation (8). But the mere focus on supply-side issues alone has evidently failed to achieve the desired goals of UIP. This paper hence tries to explore if it is possible to raise immunisation coverage rate from the demand-side with a simplifying assumption of ceteris paribus supply-side constraint as we have a long history of Government negligence in health spending. This assumption is more realistic in the present scenario of global economic meltdown causing crunching foreign aid. Some researchers also argue that '…the Programme suffers not so much from lack of funds as from functional isolation' (14). Public health should not be treated as the sole responsibility of the health sector. Policies and programmes in other sectors such as environment, education, welfare, industry, labour and information have to be informed and influenced by public health considerations (15).

No matter how noble the idea of UIP, a seemingly 'non-controversial' programme of GoI, it faces severe criticism from many scholars. As (16, 17) pointed out, it is a part of 'ill conceived and unimaginative global venture' and '… revealed many serious flaws in the programme itself'. 'The most outstanding among them was that a massive, expensive and a very complicated programme had been recommended for launching without even finding out what the problem was, leave alone the other important epidemiological considerations, such as incidence rates under different ecological conditions and time trends of the chosen diseases' (16, 17). It is also mentioned (16) that the programme is an 'onslaught' of the totalitarian approach of the developed north to 'sell' their 'social' products in the vast 'market' of developing south, deviating from the Alma Ata Declaration (18). Some researchers dub UIP as 'an unholy alliance of national and international power brokers (who) could impose their will on hundreds of millions of human beings living in the poor countries of the world …' (19). It is also noted strongly that the immunisation policy in India, instead of being determined by disease burden and demand, is increasingly driven by the supply push, generated by industry and mediated by international organisations (20).

OUR STUDY

The present study use data from National Family Health Survey (NFHS)-I (1992-93), NFHS-II (1998-99), and NFHS-III (2005-06). 'NFHS-III collected information from a nationally representative sample of 109,041 households, 124,385 females age 15-49 years and 74,369 males age 15-54 years. The NFHS-III sample covers 99 percent of India’s population living in all 29 states’ (11). ‘The NFHS-II survey covered a representative sample of more than 90,000 eligible women age 15-49 years from 26 states that comprise more than 99 percent of India’s population’ (21). The NFHS-I survey covered a representative sample of 89,777 ever-married women age 14-49 from 24 states and the NCT of Delhi, which comprise 99 percent of the total population of India (22). It is worth to noting that NFHS-II (1998-99), the second round of the series, is regarded as ‘storehouse of demographic and health data in India’ (23).

Data on immunisation is based on a vaccination card for each living child or on the mother’s report in case of non availability of the card (11, 21, 22). Vaccination coverage rates are calculated from information on immunisation cards, where these are available and mother’s report where there are no cards. This is the practice usually followed by the Demographic Health Survey (DHS) (24, 25) and validated by other research (26, 27). The 12-23 month age group is taken for the present analysis because both international and GoI guidelines specify that children should be fully immunised by the time they complete their first year of life.

According to the guidelines developed by World Health Organisation, children who received BCG, measles, and three doses each of DPT, and Polio (excluding Polio 0 which is administered at birth along with BCG) are considered to be fully vaccinated. Immunisation coverage rate in India has been improving very tardily since the time of NFHS-I (1992-93) when the proportion of fully vaccinated children was 35.4 percent to 42 percent in NFHS-II (1998-99) to 43.5 percent in NFHS-III (2005-06) (an increase by only eight percentage points in thirteen years!). These marginal improvements indicate that achievement is lagging way behind the goal of UIP in India.

However, state-wise coverage rate of immunisation has shown considerable convergence over time. As shown in table 1 and figure 1, standard deviation in state-wise coverage rate changes from 21 in NFHS-I to 25 in NFHS-II to 17 in NFHS-III. The states where coverage rate of full immunisation was lower than the national average in NFHS-II, experienced an increase in the rate in NFHS-III, but they are still below the national average. On the other hand, the states where coverage rate of full immunisation was higher than national average in NFHS-II witnessed a fall in the rate in NFHS-III (and they are mostly big states!) excepting Manipur, Chhattisgarh, Tripura, Orissa, Uttarakhand, West Bengal, Haryana, Sikkim, Jammu and Kashmir. This declining trend is also revealed by MoHFW which mentions ‘… recent household survey conducted in the year 2002-03 (RCH-II) has indicated that the coverage levels in most of the districts have been declining with respect to district level coverage reported in the year 1998-99 (NFHS-II)’ (1, 28). The same state-wise coverage rates are also shown in figure-2-4 for the three rounds of NFHS. These maps clearly show that the immunisation coverage improved for most of the states over time. The contiguous regions of states (with low coverage rate) of the so called BIMARU states and the north-eastern states have been declining over the years. Still in 2005-06 the large patch with low coverage includes the large states of Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar, Jharkhand and the north-eastern states excluding Tripura, Mizoram and Manipur. Tamil Nadu is the only state in India that achieved herd immunity (> 85 percent) once in 1998-99 but lost that subsequently too. An immunisation coverage model is used in this study to estimate the effects of the selected background variables on immunisation coverage. The measure of a child’s immunisation is a binary variable that indicates whether a child has been administered all the six vaccinations or not.

Table 1. Childhood Vaccinations by State, Various NFHS Rounds

Percentage among the living children age 12-23 months who received specific vaccinations at any time before the interview (from 'either source') by States	Full Vaccination			No Vaccination		
	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
India	**35.4**	**42.0**	**43.5**	**30.0**	**14.4**	**5.3**
North						
Delhi	57.8	69.8	63.2	6.7	5.1	9.8
Haryana	53.5	62.7	65.3	17.5	9.9	7.8
H.P.	62.9	83.4	74.2	8.7	2.8	1.9
J.& K.	65.7	56.7	66.7	16.2	10.4	4.5
Punjab	61.9	72.1	60.1	17.5	8.7	6.6
Rajasthan	21.1	17.3	26.5	48.5	22.5	6.2
Uttarakhand	19.8	21.2	60.0	43.3	29.4	9.1
Central						
Chhattisgarh	29.2	22.4	48.7	34.3	13.9	2.5
M.P.	29.2	22.4	40.3	34.3	13.9	5.0
U.P.	19.8	21.2	23.0	43.3	29.4	3.5
East						
Bihar	10.7	**11.0**	32.8	**53.4**	16.9	7.1
Jharkhand	10.7	**11.0**	34.2	**53.4**	16.9	4.4
Orissa	36.1	43.7	51.8	28.0	9.4	11.6
W.B.	34.2	43.8	64.3	22.4	13.6	5.9
Northeast						
Arunach. P.	22.5	20.5	28.4	47.5	28.7	**23.6**
Assam	19.4	17.0	31.4	43.6	33.2	15.6
Manipur	29.1	42.3	46.8	32.3	17.2	6.5
Meghalaya	9.7	14.3	32.9	54.9	**42.3**	17.0
Mizoram	56.4	59.6	46.5	14.5	10.5	7.0
Nagaland	**3.8**	14.1	**21.0**	75.0	32.7	19.7
Sikkim	NA	47.4	69.6	NA	17.6	3.2
Tripura	19.0	40.7	49.7	42.1	23.5	15.3
West						
Goa	**74.9**	82.6	78.6	5.4	**0.0**	**0.0**
Gujarat	49.8	53.0	45.2	18.9	6.6	4.5
Maharashtra	64.1	78.4	58.8	7.5	2.0	2.8
South						
Andhra P.	45.0	58.7	46.0	17.5	4.5	3.8
Karnataka	52.2	60.0	55.0	15.2	7.7	6.9
Kerala	54.4	79.7	75.3	11.4	2.2	1.8
Tamil Nadu	64.9	**88.8**	**80.9**	**3.3**	0.3	**0.0**

Number of observation: 11,853 for NFHS-I; 10,076 for NFHS-II; 10,419 for NFHS-III.

Note: In HFHS-I, survey was not done in Sikkim and J & K represents Jammu region only. In NFHS-I and –II, the three states of Uttarakhand, Chhattisgarh and Jharkhand were part of undivided Uttar Pradesh, Madhya Pradesh and Bihar respectively. Data for former three states are same as the latter three for NFHS-I and -II.

The analyses use bivariate (unadjusted) and multivariate (adjusted) binary logit regression tools. Logit regression results are presented in multiple classification analysis (MCA) form. Probability of immunisation (P) is presented in percentage form (multiplying by 100).

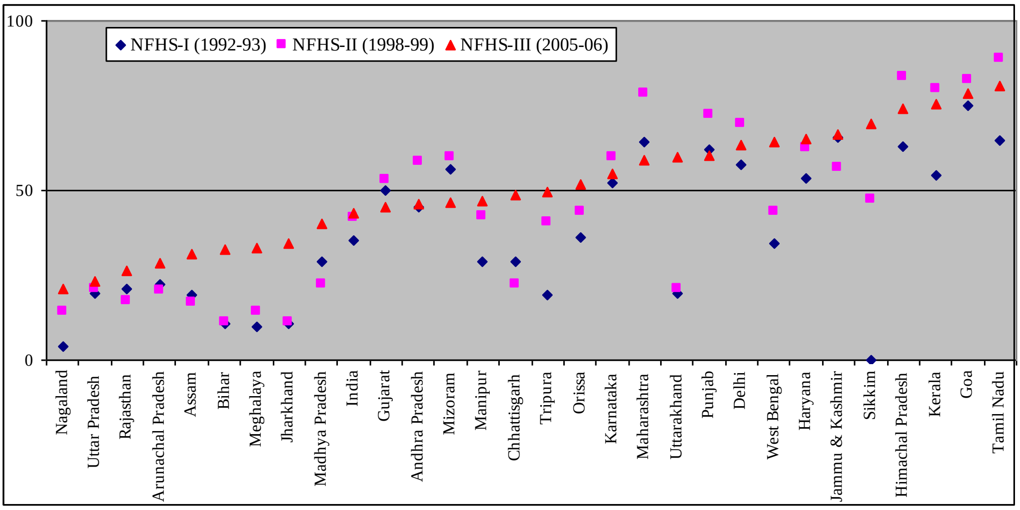
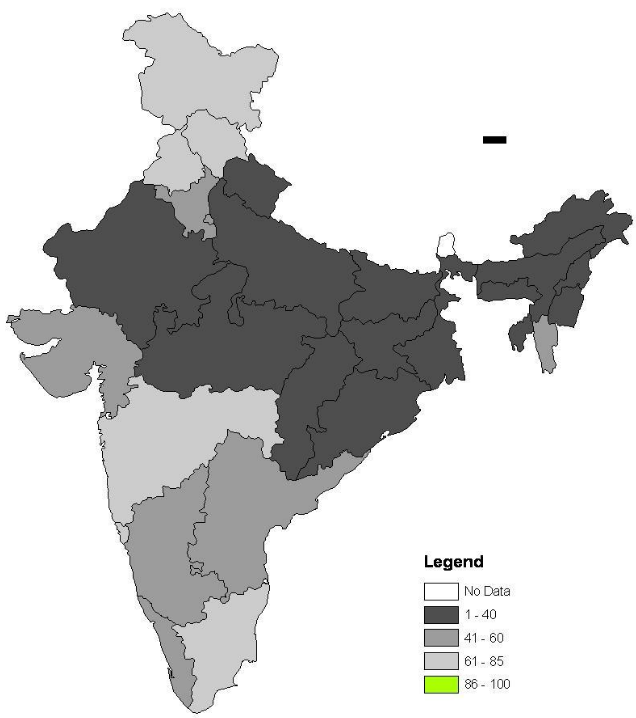


Figure 1. State-wise Coverage Rate of Full Vaccination, Various NFHS Rounds.



Note: In HFHS-I, survey was not done in Sikkim and J & K represents Jammu region only.

Figure 2. State-wise Full Immunisation Coverage Rate in NFHS-I (1992-93).

Unadjusted values are calculated from logit regressions incorporating only one predictor variable. Adjusted values are calculated from logit regressions incorporating all the selected predictor variables simultaneously. While calculating the adjusted values for a particular predictor variable, all other predictor variables are controlled by setting them to their mean values in the underlying regression (29, 30).

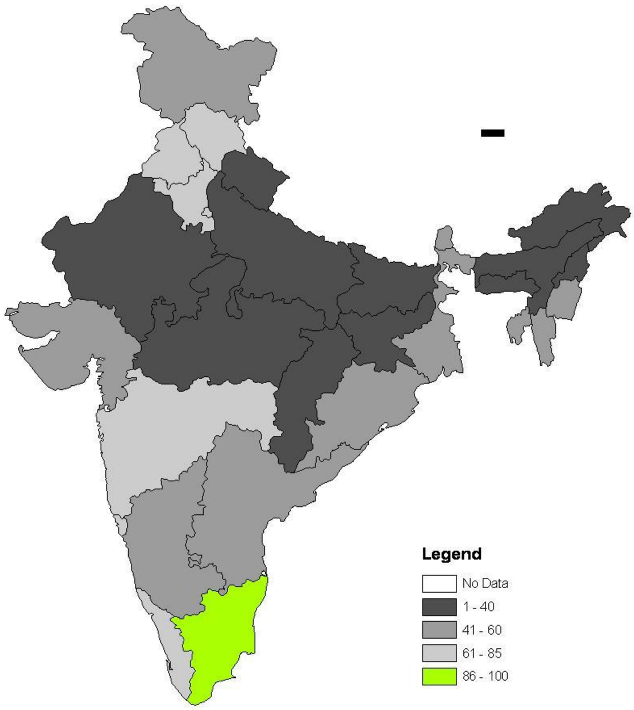


Figure 3. State-wise Full Immunisation Coverage Rate in NFHS-II (1998-99).

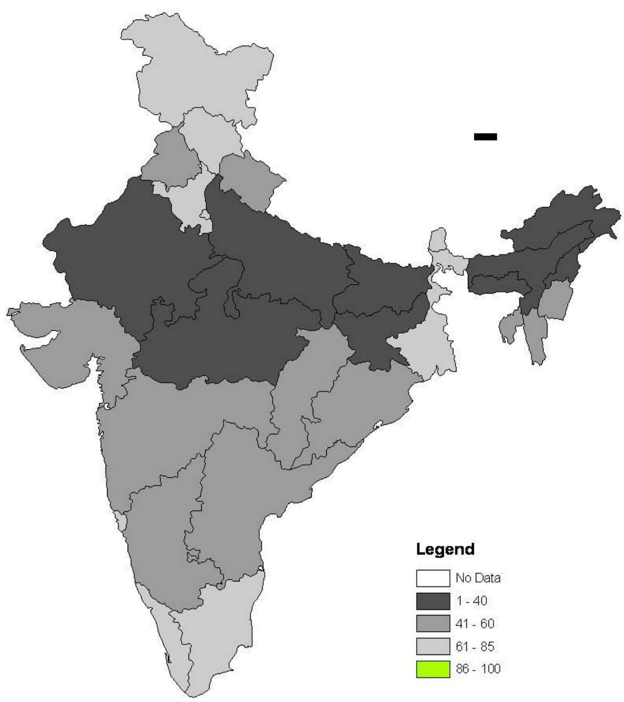


Figure 4. State-wise Full Immunisation Coverage Rate in NFHS-III (2005-06).

DETERMINANTS OF FULL IMMUNISATION IN INDIA

Children are the units of the present analysis using the children's recoded file. The analysis focuses on 10,419 children for NFHS-III, 10,076 children for NFHS-II, and 11,853 children for NFHS-I aged 12-23 months during the respective Survey.

The analysis of immunisation coverage uses a number of demographic and socioeconomic variables. The dependent variable is full immunisation that says whether a particular child is fully immunised or not. The selected predictor variables are sex of the child (female, male), birth order of the child [1, 2, 3, 4 and above], residence (rural, urban), mother's education (Illiterate, Primary, Secondary, Higher), mother's age [19 or less, 20-24, 25-29, 30-49 years], antenatal care (no, yes), religion (Hindu, Muslim, Christian and other religious minorities), caste/ tribe (general, other backward castes, scheduled caste, scheduled tribe), standard of living index (low, medium, high, not de jure resident) (SLI is calculated for NFHS-I) (21), but it excludes the following variables—agricultural land ownership and household ownership), wealth index (poorest, poorer, middle, richer, richest), media exposure (no, yes), mother's awareness (no, yes), sex of household head (female, male), mother's empowerment index (MEI) (low, medium, high), zone of states (Central, North, East, Northeast, West, South) and household electrification (no, yes). Mean values (in percentage) of the variables are presented in table 2.

Table 2. Mean Values* (in Percentage) of the Selected Variables

Variables	India			Rural			Urban		
	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
Full Immunisation (Yes)	**35.4**	**42.0**	**43.5**	**30.9**	**36.6**	**38.6**	**50.7**	**60.4**	**57.6**
Sex of child (Male)	**51.1**	**51.2**	**53.2**	**50.7**	**51.4**	**52.8**	**52.2**	**50.7**	**54.4**
Birth order									
1#	**27.9**	**29.3**	**31.4**	**26.8**	**27.4**	**29.0**	**32.0**	**36.1**	**38.3**
2	**24.1**	**26.4**	**27.9**	**22.9**	**25.6**	**25.9**	**27.9**	**29.3**	**33.3**
3	**17.5**	**17.9**	**16.6**	**18.0**	**18.3**	**17.6**	**15.6**	**16.6**	**13.8**
4+	**30.5**	**26.3**	**24.1**	**32.3**	**28.7**	**27.5**	**24.5**	**18.0**	**14.6**
Residence (Urban)	**22.9**	**22.6**	**26.1**	—	—	—	—	—	—
Mother's education									
Illiterate#	**63.6**	**58.2**	**47.8**	**71.2**	**65.3**	**55.8**	**38.1**	**34.2**	**25.0**
Primary	**14.6**	**17.7**	**13.6**	**13.9**	**17.2**	**14.3**	**16.7**	**19.2**	**11.7**
Secondary	**18.8**	**9.1**	**32.9**	**14.0**	**8.1**	**27.5**	**35.1**	**12.5**	**48.2**
Higher	**3.0**	**14.9**	**5.7**	**0.9**	**9.3**	**2.3**	**10.1**	**34.1**	**15.1**
Mother's age									
15-19#	**11.7**	**12.2**	**9.1**	**12.7**	**13.3**	**10.3**	**8.3**	**8.3**	**5.7**
20-24	**38.8**	**39.6**	**41.5**	**38.8**	**39.6**	**41.3**	**38.7**	**39.5**	**42.0**
25-29	**28.6**	**29.8**	**30.3**	**27.5**	**28.7**	**28.9**	**32.4**	**33.4**	**34.3**
30-49	**21.0**	**18.4**	**19.0**	**21.0**	**18.3**	**19.4**	**20.7**	**18.7**	**17.9**
Antenatal care (Yes)	**65.8**	**62.3**	**72.5**	**60.3**	**55.5**	**68.2**	**84.3**	**85.5**	**84.5**

Variables	India			Rural			Urban		
	NFHS-I (1992-93)	**NFHS-II (1998-99)**	**NFHS-III (2005-06)**	**NFHS-I (1992-93)**	**NFHS-II (1998-99)**	**NFHS-III (2005-06)**	**NFHS-I (1992-93)**	**NFHS-II (1998-99)**	**NFHS-III (2005-06)**
Religion									
Hindu#	**79.9**	**78.8**	**77.7**	**82.7**	**81.0**	**79.7**	**70.5**	**71.4**	**71.8**
Muslim	**14.9**	**15.9**	**17.4**	**12.7**	**14.1**	**15.6**	**22.4**	**22.1**	**22.5**
Christ and minorities	**5.2**	**5.3**	**4.9**	**4.6**	**4.9**	**4.7**	**7.2**	**6.4**	**5.7**
Caste/ Tribe									
General#	**77.6**	**37.9**	**27.6**	**74.6**	**34.3**	**23.2**	**87.4**	**49.8**	**39.9**
OBC	—	**20.4**	**41.2**	—	**21.6**	**42.4**	—	**16.2**	**37.7**
SC	**13.1**	**9.4**	**21.8**	**14.3**	**10.8**	**22.8**	**9.3**	**4.6**	**18.9**
ST	**9.3**	**32.3**	**9.4**	**11.1**	**33.2**	**11.6**	**3.3**	**29.4**	**3.5**
SLI									
Low #	**44.1**	**36.5**	**30.1**	**51.1**	**42.6**	**36.4**	**20.7**	**15.7**	**12.0**
Medium	**34.4**	**47.0**	**30.8**	**35.8**	**46.7**	**32.6**	**29.6**	**48.0**	**25.6**
High	**21.5**	**16.5**	**30.3**	**13.1**	**10.7**	**21.6**	**49.7**	**36.3**	**54.9**
NDR	—	—	**8.9**	—	—	**9.4**	—	—	**7.5**
Wealth Index									
Poorest#	—	—	**24.8**	—	—	**31.8**	—	—	**5.0**
Poorer	—	—	**22.3**	—	—	**27.4**	—	—	**8.0**
Middle	—	—	**19.5**	—	—	**21.0**	—	—	**15.3**
Richer	—	—	**17.7**	—	—	**13.7**	—	—	**29.0**
Richest	—	—	**15.8**	—	—	**6.3**	—	—	**42.7**
Media Exposure (Yes)	**47.3**	**54.9**	**55.1**	**38.8**	**46.2**	**45.5**	**76.0**	**84.7**	**82.1**
Mother's awareness(Yes)	**72.7**	**35.7**	**59.3**	**67.3**	**33.6**	**57.7**	**90.8**	**42.8**	**63.8**
Sex of HH-Head (Male)	**94.5**	**93.5**	**88.8**	**94.8**	**94.0**	**88.2**	**93.5**	**91.6**	**90.6**
MEI									
Low #	—	**77.4**	**38.1**	—	**80.3**	**41.7**	—	**67.6**	**28.0**
Medium	—	**12.4**	**24.7**	—	**11.3**	**24.7**	—	**16.2**	**24.7**
High	—	**10.2**	**37.1**	—	**8.4**	**33.6**	—	**16.2**	**47.3**
Zone									
Central#	**30.4**	**28.1**	**28.8**	**32.6**	**29.9**	**30.9**	**22.8**	**22.1**	**22.9**
North	**11.7**	**12.4**	**12.8**	**11.2**	**11.3**	**12.6**	**13.4**	**16.0**	**13.2**
East	**21.8**	**22.0**	**25.3**	**23.6**	**24.9**	**28.9**	**15.6**	**11.9**	**15.2**
Northeast	**4.0**	**3.3**	**3.6**	**4.6**	**3.8**	**4.2**	**2.1**	**1.5**	**2.1**
West	**13.5**	**13.8**	**13.6**	**11.2**	**11.1**	**10.3**	**21.3**	**23.0**	**23.0**
South	**18.6**	**20.5**	**15.9**	**16.8**	**19.0**	**13.2**	**24.7**	**25.6**	**23.7**
Electricity$									
No#	—	—	**36.4**	—	—	**46.2**	—	—	**8.9**
Yes	**46.9**	**55.4**	**54.8**	**37.2**	**45**	**44.6**	**79.7**	**90.8**	**83.7**
Number of children	**11853**	**10076**	**10419**	**9138**	**7795**	**7696**	**2715**	**2281**	**2723**

#: Reference category; *: Mean value of a variable represents the set of proportions of children falling in each category of that variable. Standard deviations of the variables are not reported. $: For electricity, the proportions do not add up to 100 because of the category of 'Not *de jure* resident' (NDR) that is not taken into the analysis (for NFHS-III).

The definitions of variables for NFHS-I are as follows: Antenatal care includes if mothers' had at least one antenatal visit for pregnancy. Media exposure of children's mother includes whether a child's mother listens to radio every week or watches TV every week or goes to cinema hall at least once in a month. Mother's awareness includes whether child's mother heard family planning messages on radio or TV or had antenatal check ups at home by health workers or had antenatal visits for pregnancy. Definition of variables for NFHS-II and NFHS-III will be available at (31) and (32) respectively. The hypothesised direction of relationship between the dependent variable and each of the predictor variables is presented in table 3.

Table 3. Hypothesised Relationship of Variables with Full Immunisation

Variable	Hypothesised Sign
Sex of Child	+
Birth Order	+
Residence	+
Mother's Education	+
Mother's Age	+
Antenatal Care	+
Religion	+/-
Caste/ Tribe	+/-
SLI	+
Wealth Index	+
Media Exposure	+
Mother's Awareness	+
Sex of HH-Head	-
MEI	+
Zone	+/-
Electricity	+

Note: See text for description of the variables.

Before going to the regression results, it is important to look at the possible collinearities among the predictor variables to avoid the problems of multicollinearity. As a thumb rule, when two predictor variables are correlated and both are relevant for explanation from a theoretical point of view, one should not eliminate one of the variables to reduce multicollinearity, unless the correlation coefficients are higher than about 0.8 (threshold to be 0.9) (30,33). But the Pearson Correlation Matrix (not reported) shows that none of the correlation coefficients is higher than the threshold magnitude. Also given the large sample-size in the data, the present analysis enjoys the luxury of keeping all the predictor variables.

Effect on full immunisation coverage in India

There is evidence of gender discrimination in childhood immunisation in India (see table 4) though the vaccines are freely available. In India, boys are still significantly more likely to be fully immunised than girl children though the gender gap fell to five percent in NFHS-III from 10 percent in the previous two rounds. Other researchers have also noted such behaviour of families in neglecting and discriminating against girl children (in rural areas only) (34-39). Gender bias is an important obstacle against improving immunisation coverage.

Table 4. Summary of Effects (P in %) on Full Immunisation Coverage in India

Background Variables		NFHS-I (1992-93)		NFHS-II (1998-99)		NFHS-III (2005-06)	
		Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Sex of Child	Female#	34*	29	41*	39	41*	41
	Male	37*	32*	43**	43**	45*	43***
Birth Order	1#	46*	37	54*	49	55*	50
	2	42*	33*	49*	43*	49*	42*
	3	34*	29*	39*	35*	39*	39*
	4 & +	22*	24*	24*	35*	26*	33*
Residence	Rural#	31*	31	37*	41	39*	42
	Urban	51*	29***	60*	42	58*	41
Mother's Education	Illiterate#	23*	26	28*	36	26*	33
	Primary	45*	35*	52*	45*	46*	44*
	Secondary	63*	42*	63*	52*	62*	51*
	Higher	76*	50*	73*	52*	80*	59*
Mother's Age	15-19#	34*	25	37*	28	39*	35
	20-24	39*	29**	45*	38*	45*	38***
	25-29	38**	34*	46**	47*	46*	45*
	30-49	27*	33*	33*	47*	38	47*
Antenatal Care	No#	11*	17	18*	30	23*	30
	Yes	48*	40*	57*	48*	51*	46*
Religion	Hindu#	36*	32	42*	42	44*	44
	Muslim	26*	23*	33*	32*	36*	33*
	Christ &	53*	34	64*	56*	56*	46
Caste/ Tribe	General#	38*	32	47*	42	55*	46
	OBC	—	—	43*	41	40*	40*
	SC	26*	27*	40*	44	39*	41**
	ST	25*	29	26*	31*	32*	39*
Standard of Living Index	Low#	23*	28	30*	39	28*	41
	Medium	36*	31***	43*	40	42*	43
	High	60*	36*	65*	46*	62*	43
	NDR	—	—	—	—	39*	37
Wealth Index	Poorest#	—	—	—	—	24*	36
	Poorer	—	—	—	—	33*	38
	Middle	—	—	—	—	47*	44*
	Richer	—	—	—	—	55*	43*
	Richest	—	—	—	—	71*	51*
Media Exposure	No#	22*	29	25*	38	29*	40
	Yes	50*	33*	56*	43*	55*	43**
Mother's Awareness	No#	10*	29	33*	36	35*	35
	Yes	45*	31	58*	51*	50*	47*
Sex of HH-Head	Female#	42*	29	48	40	41*	41
	Male	35*	31	42*	41	44	42

Table 4. (Continued)

Background Variables		NFHS-I (1992-93) Unadjusted	NFHS-I (1992-93) Adjusted	NFHS-II (1998-99) Unadjusted	NFHS-II (1998-99) Adjusted	NFHS-III (2005-06) Unadjusted	NFHS-III (2005-06) Adjusted
MEI	Low#	—	—	**39***	**41**	**40***	**39**
	Medium	—	—	**51***	**40**	**43***	**42****
	High	—	—	**58***	**43**	**47***	**45***
Zone	Central#	**22***	**24**	**22***	**28**	**29***	**32**
	North	**43***	**36***	**43***	**39***	**46***	**40***
	East	**22**	**23**	**27***	**31*****	**45***	**55***
	Northeast	**20**	**19****	**20**	**21****	**34****	**31**
	West	**59***	**48***	**71***	**66***	**54***	**39***
	South	**54***	**41***	**70***	**60***	**60***	**46***
Electricity	No#	**21***	**27**	**24***	**37**	**28***	**37**
	Yes	**51***	**35***	**57***	**44***	**55***	**45***

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

However, it has been noted that although there are substantial varied variations in immunisation coverage by sex, the median difference across all countries is very close to zero (40). There is a consistent inverse relationship between immunisation coverage and birth order of a child. The different likelihoods of immunisation for different birth orders are also strongly significant. One can think of two countervailing effects of higher-order births on the likelihood of vaccination. The positive one could be some kind of learning effect about immunisation which almost does not vary or may increase marginally with higher birth-order. The negative one could be some kind of negligence effect and this effect perhaps increasingly increases with higher birth-order. Thus for higher order births, it seems that the negligence effect more than offsets the learning effect.

Another variable namely, sex-wise birth-order, is constructed to see whether the likelihood of vaccination decreases with the increase in birth-order for girls only or not. The likelihood (unadjusted) of vaccination decreases with increase in birth-order irrespective of the sex of a child (see table 5). Such an inverse relationship is also supported by (36, 41). However, a positive relationship between immunisation coverage and birth order has been found (42).

Higher immunisation coverage in urban areas is affirmed by many researchers (43, 44). But, after controlling for other variables, the rural-urban disparity is not statistically significant (except NFHS-I in table 4). This suggests that the unadjusted effect of rural-urban residence is actually due to the other predictor variables correlated with residence.

There is a strong positive relationship between mother's education and children's immunisation coverage. Such a positive effect of maternal education is also hypothesised by many researchers (12, 36, 37, 43-52).

Another variable, father's education, was also considered to examine its effect on the likelihood of vaccination as around half of Indian mothers are illiterate. This effect of father's education (unadjusted) is significantly positive but its impact is less than that of mother's education (see table 5). The chance of immunisation of children increases with their mother's age. A positive relationship is also noted by (53). In the context of rural Bangladesh, (37) shows that the likelihood of vaccination decreases for the mothers older than 28 years.

Table 5. Unadjusted Effects (P in %) On Full Immunisation Coverage in India

Background Variables		NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
Sex-wise Birth-order	Female, Birth-1[#]	**45***	**53****	**54***
	Female, Birth-2	**39***	**49****	**48***
	Female, Birth-3	**33***	**36***	**32***
	Female, Birth-4 & +	**20***	**23***	**24***
	Male, Birth-1	**46**	**55**	**55**
	Male, Birth-2	**44**	**49*****	**50****
	Male, Birth-3	**34***	**42***	**44***
	Male, Birth-4 & +	**24***	**25***	**27***
Father's Education	Illiterate[#]	**20***	**27***	**27***
	Primary	**35***	**40***	**40***
	Secondary	**45***	**47***	**50***
	Higher	**65***	**56***	**66***

#: Reference category; Significance level (two tailed): *** 10%, ** 5%, * 1%.

Antenatal care during pregnancy is positively associated with childhood immunisation (34, 36, 37). This shows the possibility of positive information spillover or learning-by-doing (54) from antenatal care during pregnancy on childhood immunisation. Mothers who receive antenatal care may also receive counselling about the need for child immunisation.

The chance of immunisation also seems to vary with religion. The likelihood of being fully immunised is higher for children from Christian and other religious minority communities and lower for children from the Muslim community compared to their counterparts from Hindu households. Caste/ tribe also affects immunisation coverage. The chance of being fully vaccinated is consistent with the relative traditional social hierarchy of castes/ tribes.

The chance of immunisation increases with the standard of living index of the child's household. But for NFHS-III, incorporation of wealth index in the model wipes away the adjusted effect of SLI. The wealth index also has a significantly strong positive effect on immunisation. It has been argued that household income as a proximate determinant of immunisation coverage (50), which others have also found (37, 42). Though vaccines are freely available under UIP, household income (as measured by SLI or wealth index) does have a positive effect on childhood immunisation.

Media exposure has a significantly positive effect on immunisation. The chance of full immunisation is higher for children of mothers' who have some media exposure compared to children whose mothers are not exposed to mass media, while others have not found that connection (52). Mothers' awareness about immunisation has significantly strong positive effect on vaccination. Mother's empowerment index also has a positively significant effect on immunisation coverage in NFHS-III but not in NFHS-II.

The sex of household head does not have any statistically significant effect on immunisation. However, in the context of rural Orissa, children from male headed households were more likely to be immunised than those from female headed households (55). The immunisation rate varies widely across different zones too. The chance is highest for West, followed by South, North, East, Central, and North-east. Household electrification has also a significantly strong positive role on full immunisation in India (37).

Effect on full immunisation coverage in rural and urban India

Separate regressions for rural and urban areas have tried to show clearly how the effects vary due to change in place of residence in lieu of a residence dummy. These regression results are compared with the all-India ‘baseline’ regressions. Unadjusted and adjusted effects on full immunisation coverage for rural and urban India are presented in table 6 and 7.

Gender discrimination in immunisation against girl child prevails in rural India but in urban India it disappears after controlling for other variables. Media exposure does not have any significant effect on immunisation in urban India after controlling for other variables. The effects of the other variables remain the same as the baseline regression.

Table 6. Summary of Effects (P in %) on Full Immunisation Coverage in Rural India

Background Variables		NFHS-I (1992-93)		NFHS-II (1998-99)		NFHS-III (2005-06)	
		Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Sex of Child	Female#	29*	24	35*	31	37*	34
	Male	33*	27*	38*	34*	40*	37**
Birth Order	1#	41*	31	48***	42	49	44
	2	36*	27**	44*	36*	44*	37*
	3	30*	25*	34*	29*	37*	35*
	4 & +	20*	21*	22*	24*	24*	27*
Mother's Education	Illiterate#	22*	23	26*	29	25*	29
	Primary	43*	31*	48*	36*	44*	39*
	Secondary	59*	37*	59*	43*	60*	47*
	Higher	80*	55*	69*	44*	80*	60*
Mother's Age	15-19#	34*	23	35*	22	37*	28
	20-24	35	24	40*	30*	41**	32***
	25-29	31	28*	40*	39*	39	38*
	30-49	22*	27**	25*	36*	33	44*
Antenatal Care	No#	11*	15	17*	23	21*	25
	Yes	44*	35*	53*	41*	47*	41*
Religion	Hindu#	32*	27	37*	33	39*	38
	Muslim	20*	18*	25*	25*	32*	26*
	Christ &	47*	30	59*	49*	48*	38
Caste/Tribe	General#	33*	27	40*	34	50	40
	OBC	—	—	38	32	36*	34*

Background Variables		NFHS-I (1992-93) Unadjusted	NFHS-I (1992-93) Adjusted	NFHS-II (1998-99) Unadjusted	NFHS-II (1998-99) Adjusted	NFHS-III (2005-06) Unadjusted	NFHS-III (2005-06) Adjusted
	SC	**24***	**22***	**37*****	**37*****	**35***	**36*****
	ST	**24***	**24**	**24***	**23***	**30***	**34****
Standard of Living Index	Low#	**23***	**25**	**29***	**31**	**27***	**34**
	Medium	**34***	**26**	**39***	**33**	**40***	**37**
	High	**56***	**30***	**58***	**37****	**58***	**38**
	NDR	—	—	—	—	**35***	**30**
Wealth Index	Poorest#	—	—	—	—	**24***	**32**
	Poorer	—	—	—	—	**33***	**34**
	Middle	—	—	—	—	**48***	**41***
	Richer	—	—	—	—	**55***	**37**
	Richest	—	—	—	—	**69***	**43***
Media Exposure	No#	**21***	**24**	**24***	**30**	**29***	**35**
	Yes	**46***	**29***	**52***	**35***	**50***	**37*****
Mother's Awareness	No#	**10***	**23**	**28***	**28**	**30***	**29**
	Yes	**41***	**27**	**53***	**42***	**45***	**41***
Sex of HH-Head	Female#	**40***	**26**	**40***	**32**	**36***	**34**
	Male	**30***	**26**	**36*****	**33**	**39**	**36**
MEI	Low#	—	—	**34***	**32**	**37***	**33**
	Medium	—	—	**44***	**32**	**40****	**37****
	High	—	—	**50***	**34**	**40****	**39***
Zone	Central#	**20***	**21**	**19***	**23**	**25***	**25**
	North	**37***	**30***	**36***	**31***	**41***	**34***
	East	**20**	**19**	**25***	**25**	**42***	**50***
	Northeast	**17**	**16****	**17**	**15***	**33***	**27**
	West	**59***	**47***	**68***	**61***	**46***	**31****
	South	**50***	**35***	**66***	**52***	**57***	**40***
Electricity	No#	**21***	**23**	**24***	**30**	**27***	**32**
	Yes	**48***	**30***	**52***	**36***	**51***	**40***

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Table 7. Summary of Effects (P in %) on Full Immunisation Coverage in Urban India

Background Variables		NFHS-I (1992-93) Unadjusted	NFHS-I (1992-93) Adjusted	NFHS-II (1998-99) Unadjusted	NFHS-II (1998-99) Adjusted	NFHS-III (2005-06) Unadjusted	NFHS-III (2005-06) Adjusted
Sex of Child	Female#	**52**	**50**	**61***	**64**	**56***	**59**
	Male	**50**	**50**	**60**	**63**	**59*****	**59**
Birth Order	1#	**60***	**58**	**69***	**71**	**66***	**64**
	2	**58**	**53*****	**65****	**64****	**61****	**58****
	3	**49***	**47***	**58***	**59***	**47***	**53***
	4 & +	**31***	**37***	**38***	**49***	**36***	**51***

Table 7. (Continued)

Background Variables		NFHS-I (1992-93) Unadjusted	NFHS-I (1992-93) Adjusted	NFHS-II (1998-99) Unadjusted	NFHS-II (1998-99) Adjusted	NFHS-III (2005-06) Unadjusted	NFHS-III (2005-06) Adjusted
Mother's Education	Illiterate#	**29***	**40**	**39***	**51**	**33***	**46**
	Primary	**50***	**49***	**65***	**67***	**52***	**58***
	Secondary	**67***	**57***	**71***	**71***	**65***	**62***
	Higher	**75***	**60***	**76***	**69***	**80***	**69***
Mother's Age	15-19#	**36***	**34**	**47**	**45**	**52**	**56**
	20-24	**52***	**47***	**61***	**58***	**56**	**57**
	25-29	**56***	**54***	**64***	**66***	**63***	**63**
	30-49	**46****	**55***	**60***	**74***	**54**	**57**
Antenatal Care	No#	**15***	**24**	**28***	**52**	**36***	**49**
	Yes	**57***	**55***	**66***	**65***	**62***	**60***
Religion	Hindu#	**53***	**51**	**63***	**65**	**60***	**61**
	Muslim	**38***	**43***	**49***	**55***	**45***	**49***
	Christ &	**66***	**54**	**77***	**69**	**73***	**67**
Caste/ Tribe	General#	**52***	**50**	**63***	**64**	**64***	**62**
	OBC	—	—	**63**	**65**	**54***	**57****
	SC	**42***	**45**	**53***	**62**	**52***	**56*****
	ST	**36***	**47**	**46***	**51*****	**53****	**55**
Standard of Living Index	Low#	**27***	**37**	**43***	**65**	**34***	**61**
	Medium	**45***	**48***	**57***	**60**	**52***	**61**
	High	**64***	**56***	**72***	**66**	**67***	**57**
	NDR	—	—	—	—	**52***	**62**
Wealth Index	Poorest#	—	—	—	—	**27***	**53**
	Poorer	—	—	—	—	**33**	**48**
	Middle	—	—	—	—	**44***	**51**
	Richer	—	—	—	—	**56***	**56**
	Richest	—	—	—	—	**72***	**66*****
Media Exposure	No#	**31***	**50**	**38***	**61**	**36***	**55**
	Yes	**57***	**49**	**65***	**64**	**62***	**59**
Mother's Awareness	No#	**13***	**55**	**52**	**56**	**49**	**51**
	Yes	**55***	**49**	**72***	**71***	**63***	**63***
Sex of HH-Head	Female#	**45**	**43**	**65***	**64**	**60***	**62**
	Male	**51**	**50**	**60**	**63**	**57**	**58**
MEI	Low#	—	—	**56***	**63**	**52**	**56**
	Medium	—	—	**68***	**62**	**53**	**55**
	High	—	—	**72***	**65**	**63***	**62****
Zone	Central#	**36***	**37**	**36***	**42**	**45***	**52**
	North	**58***	**56***	**58***	**58***	**60***	**58**
	East	**35**	**37**	**44****	**46**	**56***	**64***
	Northeast	**40**	**37**	**46**	**45**	**39**	**40**
	West	**60***	**58***	**75***	**76***	**64***	**60***
	South	**63***	**60***	**79***	**77***	**65***	**63***
Electricity	No#	**29***	**49**	**32***	**46**	**28***	**48**
	Yes	**56***	**50**	**63***	**65***	**61***	**61***

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Adjusted effects of demographic factors on full immunisation in India

Here a separate model is tried, incorporating only the demographic factors to see their independent effect. The adjusted effects of demographic factors on full immunisation coverage in India are shown in table 8.

Urban children are significantly more likely to be vaccinated even if the rural-urban gap vanished after controls in the baseline regression. This implies that the unadjusted likelihoods for residence in baseline regression capture mainly the effects of the selected socioeconomic variables. Hence it can be concluded that the rural-urban disparity is not due to demographic factors but to socioeconomic factors. The effects of the other variables remain the same as in the baseline regression.

Table 8. Adjusted Effects (P in %) of Demographic Factors in India

Background Variables		**NFHS-I (1992-93)**	**NFHS-II (1998-99)**	**NFHS-III (2005-06)**
Sex of Child	Female#	**29**	**38**	**40**
	Male	**32***	**41****	**43***
Birth Order	1#	**42**	**53**	**55**
	2	**35***	**44***	**45***
	3	**29***	**34***	**37***
	4 & +	**21***	**25***	**26***
Residence	Rural#	**29**	**38**	**39**
	Urban	**37***	**46***	**49***
Mother's Age	15-19#	**22**	**23**	**28**
	20-24	**28***	**36***	**37***
	25-29	**35***	**47***	**48***
	30-49	**36***	**47***	**50***
Antenatal Care	No#	**14**	**25**	**27**
	Yes	**43***	**49***	**48***
Religion	Hindu#	**32**	**40**	**44**
	Muslim	**22***	**29***	**30***
	Christ &	**37****	**58***	**52***
Caste/ Tribe	General#	**33**	**43**	**51**
	OBC	**—**	**39***	**40***
	SC	**24***	**40****	**39***
	ST	**25***	**27***	**32***
Sex of HH-Head	Female#	**31**	**40**	**42**
	Male	**31**	**39**	**42**
Zone	Central#	**24**	**25**	**31**
	North	**40***	**39***	**40***
	East	**21****	**28**	**49***
	Northeast	**20*****	**19****	**33**
	West	**51***	**67***	**45***
	South	**41***	**61***	**52***

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Adjusted effects of socioeconomic factors on full immunisation in India

Here a different model is tried, incorporating only socioeconomic factors to see their independent effect. The adjusted effects of socioeconomic factors on full immunisation coverage in India are shown in table 9. MEI has a strictly positive effect on immunisation for both in NFHS-II and -III. Hence, we can argue that mother's empowerment occurs through the demographic factors (e.g., caste, religion, etc.) along with the socioeconomic factors. The effects of all the variables remain the same as in the baseline regression.

Table 9. Adjusted Effects (P in %) of Socioeconomic Factors in India

Background Variables		NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
Mother's Education	Illiterate#	25	31	31
	Primary	37*	47*	46*
	Secondary	48*	55*	55*
	Higher	58*	61*	68*
Standard of Living Index	Low#	32	43	43
	Medium	30***	38*	43
	High	33	39**	42
	NDR	—	—	40
Wealth Index	Poorest#	—	—	36
	Poorer	—	—	39***
	Middle	—	—	46*
	Richer	—	—	45*
	Richest	—	—	53*
Media Exposure	No#	30	34	39
	Yes	34*	46*	45*
Mother's Awareness	No#	15	33	36
	Yes	40*	54*	48*
MEI	Low#	—	39	40
	Medium	—	45*	43***
	High	—	49*	45*
Electricity	No#	25	29	38
	Yes	40*	50*	47*

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Adjusted effects on full immunisation in three state-wise groups

A group of eight backward states with poor socio-demographic indicators was formed as the Empowered Action Group (EAG). This consists of Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan, Uttar Pradesh, and Uttarakhand. The group was formed in 2001 under the Ministry of Health and Family Welfare (MoHFW) to design and implement area-specific programmes to strengthen the primary health care infrastructure. The group of North-Eastern (NE) states consists of eight states namely, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. The remaining thirteen states (AP, Goa, Gujarat, Haryana, HP, J&K, Karnataka, Kerala, Maharashtra, Punjab, TN, WB, and Delhi) are clubbed as Other states. Mean values (in percentage) of the variables are presented in table 10. Immunisation coverage rates for EAG and NE states are almost half of the rate for Other states.

Table 10. Mean Values (in Percentage) of the Selected Variables

Variables	EAG States			North-eastern States			Other States		
	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)	NFHS-I (1992-93)	NFHS-II (1998-99)	NFHS-III (2005-06)
Full Immunisation (Yes)	**20.5**	**20.1**	**31.6**	**19.5**	**20.2**	**34.1**	**53.2**	**65.7**	**59.4**
Sex of child (Male)	**51.9**	**51.5**	**53.0**	**49.6**	**56.8**	**53.2**	**50.3**	**50.6**	**53.5**
Birth order									
1#	**24.5**	**23.4**	**25.8**	**23.3**	**27.5**	**33.8**	**32.1**	**35.4**	**38.2**
2	**20.7**	**22.6**	**23.2**	**20.5**	**25.4**	**25.6**	**28.1**	**30.4**	**33.9**
3	**17.1**	**18.5**	**17.3**	**18.5**	**15.7**	**17.8**	**17.7**	**17.4**	**15.7**
4+	**37.7**	**35.5**	**33.7**	**37.7**	**31.4**	**22.9**	**22.0**	**16.8**	**12.2**
Residence (Urban)	**16.1**	**15.8**	**18.5**	**12.1**	**10.2**	**15.2**	**31.3**	**30.4**	**36.7**
Mother's education									
Illiterate#	**76.9**	**72.4**	**63.1**	**57.5**	**51.2**	**29.6**	**49.5**	**44.4**	**30.0**
Primary	**9.3**	**11.6**	**12.9**	**19.6**	**25.0**	**23.3**	**19.9**	**23.3**	**13.7**
Secondary	**11.3**	**6.4**	**20.2**	**21.2**	**13.6**	**43.2**	**26.9**	**11.6**	**48.1**
Higher	**2.5**	**9.6**	**3.8**	**1.7**	**10.2**	**4.0**	**3.6**	**20.7**	**8.2**
Mother's age									
15-19#	**9.7**	**11.7**	**8.9**	**14.0**	**11.7**	**8.2**	**13.6**	**12.7**	**9.5**
20-24	**35.8**	**36.8**	**38.3**	**31.4**	**32.4**	**37.4**	**42.7**	**42.9**	**45.9**
25-29	**28.3**	**28.5**	**30.8**	**28.2**	**30.0**	**29.0**	**29.0**	**31.1**	**29.9**
30-49	**26.2**	**23.0**	**22.1**	**26.4**	**25.8**	**25.4**	**14.7**	**13.3**	**14.7**
Antenatal care (Yes)	**47.8**	**39.4**	**60.7**	**56.4**	**60.2**	**70.3**	**86.3**	**85.7**	**87.5**
Religion									
Hindu#	**85.1**	**84.3**	**82.7**	**51.2**	**44.4**	**51.5**	**76.7**	**75.6**	**73.5**
Muslim	**13.5**	**14.4**	**15.4**	**29.2**	**31.2**	**22.5**	**15.2**	**16.4**	**19.5**
Christ and minorities	**1.4**	**1.30**	**1.9**	**19.6**	**24.3**	**26.0**	**8.2**	**8.0**	**7.0**
Caste/ Tribe									
General#	**74.4**	**32.4**	**19.8**	**69.2**	**47.7**	**30.3**	**81.8**	**42.7**	**37.8**
OBC	**—**	**21.5**	**48.6**	**—**	**8.9**	**18.7**	**—**	**20.1**	**32.9**
SC	**15.0**	**9.9**	**22.1**	**3.1**	**37.3**	**14.4**	**11.9**	**7.0**	**21.9**
ST	**10.6**	**36.2**	**9.4**	**27.7**	**6.1**	**36.5**	**6.3**	**30.2**	**7.4**
SLI									
Low #	**47.0**	**84.3**	**36.2**	**64.4**	**46.4**	**39.0**	**39.2**	**32.4**	**21.5**
Medium	**36.2**	**14.4**	**31.3**	**26.3**	**45.5**	**37.8**	**33.0**	**47.6**	**29.6**
High	**16.8**	**1.30**	**22.4**	**9.2**	**8.0**	**19.8**	**27.8**	**20.0**	**41.1**
Not dejure resident	**—**	**—**	**10.1**	**—**	**—**	**3.3**	**—**	**—**	**7.8**
Wealth Index									
Poorest#	**—**	**—**	**34.4**	**—**	**—**	**21.1**	**—**	**—**	**13.0**
Poorer	**—**	**—**	**25.8**	**—**	**—**	**33.1**	**—**	**—**	**17.0**
Middle	**—**	**—**	**17.2**	**—**	**—**	**25.6**	**—**	**—**	**21.8**
Richer	**—**	**—**	**12.4**	**—**	**—**	**13.2**	**—**	**—**	**24.7**
Richest	**—**	**—**	**10.2**	**—**	**—**	**7.0**	**—**	**—**	**23.6**

Table 10. (Continued)

Variables	EAG States NFHS-I (1992-93)	EAG States NFHS-II (1998-99)	EAG States NFHS-III (2005-06)	North-eastern States NFHS-I (1992-93)	North-eastern States NFHS-II (1998-99)	North-eastern States NFHS-III (2005-06)	Other States NFHS-I (1992-93)	Other States NFHS-II (1998-99)	Other States NFHS-III (2005-06)
Media Exposure (Yes)	32.5	39.0	42.4	36.4	51.5	50.8	64.6	71.2	71.3
Mother's awareness (Yes)	57.6	21.4	56.4	62.9	27.4	35.2	90.0	50.6	64.9
Sex of HH-Head (Male)	96.2	94.4	87.7	94.1	93.4	89.7	92.8	92.6	90.2
MEI									
Low #	—	84.6	40.9	—	82.9	20.9	—	69.8	36.1
Medium	—	9.2	25.0	—	9.8	21.6	—	15.9	24.7
High	—	6.2	34.1	—	7.3	57.5	—	14.3	39.2
Electricity									
No#	—	—	50.5	—	—	56.6	—	—	17.0
Yes	33.2	39.0	39.4	27.3	33.1	40.2	63.7	73.5	75.4
Number of children	5948	4901	5592	478	332	377	5427	4844	4450

Table 11. Adjusted Effects (P in %) on Full Immunisation Coverage

Background Variables		EAG States NFHS-I (1992-93)	EAG States NFHS-II (1998-99)	EAG States NFHS-III (2005-06)	North-eastern States NFHS-I (1992-93)	North-eastern States NFHS-II (1998-99)	North-eastern States NFHS-III (2005-06)	Other States NFHS-I (1992-93)	Other States NFHS-II (1998-99)	Other States NFHS-III (2005-06)
Sex of Child	Female#	14	15	27	12	11	30	53	68	60
	Male	19*	18*	30***	13	19***	27	54	69	61
Birth Order	1#	20	21	40	17	18	33	60	76	65
	2	17**	20	31*	17	15	30	56**	69*	59*
	3	16**	17**	28*	14	8	24	50*	63*	55*
	4 & +	14*	12*	21*	8	17	24	43*	57*	56*
Residence	Rural#	16	16	29	12	14	30	55	68	61
	Urban	17	19	29	14	22	20	51**	69	59
Mother's Education	Illiterate#	14	15	24	10	11	17	47	62	49
	Primary	23*	19**	32*	12	16	25	53*	71*	62*
	Secondary	25*	28*	42*	20***	19	39*	63*	74*	64*
	Higher	35*	25*	48*	33	39*	49**	69*	76*	73*
Mother's Age	15-19#	12	11	18	10	23	32	47	56	60
	20-24	17*	14***	25*	12	15	27	51***	67*	57
	25-29	18*	20*	34*	16	16	28	58*	73*	62
	30-49	17**	21*	33*	12	11	30	59*	71*	67***
Antenatal Care	No#	12	14	24	11	9	16	26	56	47
	Yes	23*	23*	32*	14	20**	35*	58*	70*	62*
Religion	Hindu#	17	18	31	18	16	36	55	70	62
	Muslim	12*	11*	19*	8**	10	17***	42*	59*	53*
	Christ &	24	39*	38	8***	21	26	56	75***	62
Caste/ Tribe	General#	18	18	30	13	19	32	54	67	64
	OBC	—	16	29	—	10	28	—	73*	57*
	SC	12*	19	26**	15	15	22	51	69	62
	ST	17	12**	28	11	12	28	57	60**	55**

Background Variables		EAG States NFHS-I (1992-93)	EAG States NFHS-II (1998-99)	EAG States NFHS-III (2005-06)	North-eastern States NFHS-I (1992-93)	North-eastern States NFHS-II (1998-99)	North-eastern States NFHS-III (2005-06)	Other States NFHS-I (1992-93)	Other States NFHS-II (1998-99)	Other States NFHS-III (2005-06)
Standard of Living Index	Low#	**15**	**14**	**27**	**10**	**17**	**28**	**49**	**69**	**65**
	Medium	**17*****	**18***	**30*****	**19*****	**14**	**30**	**52**	**66**	**62**
	High	**18**	**19****	**29**	**18**	**13**	**28**	**61***	**74*****	**60**
	NDR	—	—	**29**	—	—	**16**	—	—	**41***
Wealth Index	Poorest#	—	—	**25**	—	—	**18**	—	—	**49**
	Poorer	—	—	**28**	—	—	**31**	—	—	**49**
	Middle	—	—	**31****	—	—	**33**	—	—	**62***
	Richer	—	—	**31*****	—	—	**27**	—	—	**62***
	Richest	—	—	**35****	—	—	**42**	—	—	**71***
Media Exposure	No#	**16**	**16**	**27**	**13**	**12**	**29**	**52**	**67**	**60**
	Yes	**18*****	**18**	**32***	**12**	**19**	**28**	**54**	**69**	**61**
Mother's Awareness	No#	**15**	**15**	**25**	**9**	**14**	**25**	**57**	**62**	**52**
	Yes	**18**	**22***	**32***	**16**	**20**	**35**	**53**	**74***	**65***
Sex of HH-Head	Female#	**13**	**19**	**30**	**12**	**19**	**29**	**53**	**65**	**64**
	Male	**17**	**17**	**29**	**13**	**15**	**28**	**53**	**69**	**60**
MEI	Low#	—	**17**	**26**	—	**14**	**29**	—	**67**	**59**
	Medium	—	**13****	**30****	—	**16**	**29**	—	**72****	**59**
	High	—	**15**	**32***	—	**28**	**28**	—	**73***	**63****
Electricity	No#	**14**	**15**	**27**	**11**	**14**	**26**	**46**	**59**	**62**
	Yes	**22***	**20***	**31*****	**16**	**16**	**33**	**57***	**72***	**60**

#: Reference category; Significance level (two tailed): ***10%, **5%, *1%.

Effects on full immunisation for EAG, NE and Other group of states are given in table 11 and these are compared with the baseline model. Male children are significantly more likely to be vaccinated in EAG states only. Children of higher birth-order are less likely to be vaccinated, except for the children from NE states. Residence does not have any significant effect in each case.

Children of more educated mothers are more likely to be immunised. The effect of mother's age has a positive effect except for the children of NE states. Children of mothers with some antenatal care are more likely to be vaccinated. Muslim children are the least likely to be immunised in each case. Children from backward caste/ tribal households are also deprived in terms of vaccination except in the NE states.

The effects of household SLI or wealth index are significantly positive in EAG and other group of states. The effect of media exposure does not have any significant effect in NE and Other states and mother's awareness does not have any significant effect in NE states only. The gender of the household head does not have any significant effect in any case. The likelihood of immunisation increases with MEI except for the NE states. Household electrification has a positive effect except in the NE states.

DISCUSSION

Six vaccine-preventable diseases are covered under UIP, and vaccination is given free of cost to every child in India. Though vaccines are available for free, the goals of UIP are far from being achieved even in two decades after its inception. The present study attempts to investigate the demographic and socio-economic determinants of immunisation in India. It is possible to give a big push to the immunisation uptake, only when one understands the demand-side factors well, to achieve the chartered goals of UIP. Though the supply-side factors play a crucial role, the present study provides a justification for concentrating on the demand-side as well since the supply-side factors alone has evidently failed to achieve the goals.

This study analyses the effects of some selected demographic and socioeconomic predictor variables on the chance of immunisation of a child. It focuses on immunisation coverage for children (a) in all India, (b) in rural and urban areas in India, (c) for three groups of states, namely, Empowered Action Group, North-Eastern and Other states. The study applies binary bivariate and multivariate logit model to the three rounds of National Family Health Survey data. Except for a few cases, the results are consistently robust across the different models:

Robust results

- Boys were more likely to be immunised than girl children.
- Children of higher-order births were less likely to be vaccinated. This is true irrespective of the sex of a child. It seems that the negligence effect more than offsets the learning effect. The result perhaps shows the greater apathy on part of the parents to immunise subsequent children.
- The likelihood of immunisation was higher for children from urban areas. The rural-urban disparity in vaccination is not due to demographic factors but due to socioeconomic factors.
- The likelihood of vaccination increased with mother’s education level, mother’s age, mother’s exposure to mass media and mother’s awareness about immunisation.
- Some antenatal care during pregnancy raises immunisation chances significantly. This increases the possibility of meeting health personnel who help mothers to raise their awareness by disseminating information regarding immunisation.
- Among the religious groups, Muslim children were least likely to be immunised whereas children from Christian and other religious minority communities are most likely to be immunised in comparison of the Hindu children.
- The standard of living index or wealth index has a positive effect on immunisation.
- Children from households with electricity are more likely to be immunised. Such a positive effect possibly works through availability of electronic mass media, establishment of an institutional health facility in the vicinity and higher wealth index.
- Compared to general caste children, OBCs are less likely to be immunised, followed by the SCs and STs.
- The gender of the household head had no effect on childhood immunisation.
- The likelihood of immunisation increased with the mother’s empowerment index.

Tentative result

- Children from the West zone are most likely to be immunised, followed by South, North, East, Central, and North-east.

These results suggest that a synergistic effort incorporating a number of other sectors is needed to achieve universal immunisation. Policies and programmes in other sectors such as education, welfare, industry, labour, information, environment, etc. have also to be informed and influenced by public health considerations (15, 56). To stimulate immunisation coverage, policy makers should also try to improve mothers' education, media exposure, mothers' awareness, mothers' empowerment, wealth index of the household, electrification and promote a small family norm. It is also necessary to target girl children, children from backward castes and Muslim religious community and children from EAG and NE states.

The provision of basic survival needs should be complemented with universal immunisation. For instance, measles in a healthy child is a negligible disease but mortality due to measles is 400 times greater in an undernourished population and the spread and severity of the epidemic is directly linked to overcrowding. Similarly, if an adequate amount of safe drinking water is made available, poliomyelitis will cease to be a problem (57). It has been noted (58) that 'health improvements brought about by immunisation … can only be sustained by availability of food, water and shelter and the political and economic power of the people to obtain them'. This is why it has been argued that the imposition of these techno-centric approaches to deal with the problems of child health in the third world operated to divert attention from the lack of basic survival needs.

As UIP is a 'massive, expensive and very complicated programme', the Government should focus on a long-term vision of providing basic survival needs universally instead of only filling up our children's intestines with the 'myopic' 'techno-centric' doses of vaccines. Preventive health care, therefore, requires immunisation as well as good sanitation, proper nutrition, availability of safe drinking water and shelter as the common minimum social needs that must be met before we embark on an ambitious plan of government outlay for development (59). Let us hope that the Government learns from its experience in the past two-and-a-half decades and, soon embarks on such a long term vision.

The sustainability of the Indian growth experience is undeniably dependent on the quality of its human resources. In order to garner the optimum gain from its growth process as well as the well-documented 'demographic dividend', India needs manpower that is healthy and educated. Achieving universal immunisation is one of the early hurdles that the country needs to overcome in order to reap the benefits of rapid economic growth.

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SECTION TWO: EDUCATIONAL ISSUES

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Chapter 12

EDUCATIONAL BACKWARDNESS AMONG THE MUSLIMS AND THE CAPABILITY THESIS

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ABSTRACT

Muslims are among the most educationally backward communities in West Bengal. The present study argues that educational backwardness of Muslims is a very complex phenomena and cannot be contextualized through any unilinear process. Muslim educational backwardness has to be portrayed in multilayered nuanced ways. The capability approach offers this. These studies contextualize educational deprivation of Muslims in West Bengal in multilayered and nuanced perspectives i.e., educational backwardness of an individual/community as an outcome demand side, supply side and institutional constraints. In short, educational backwardness of Muslims in West Bengal is capability deprivation.

INTRODUCTION

West Bengal is one of the poorest performing states in terms of universalisation of elementary education and rank along with educationally backward states like Madhya Pradesh, Chattishgarh and Uttar Pradesh. Studies dealing with West Bengal's failure on universal elementary education have cited the inequalities in participation and achievements among various sub-groups of the population as one of major constraints. Particularly the low participation of the lower caste and the rural segment of the population are noted (1), but studies often overlook the lower participation and achievements of the Muslims.Until recently, backwardness of Muslims in participation and achievements at elementary level in

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West Bengal was one of the least explored. The educational backwardness of the Muslim community in West Bengal has come to public awareness very recently. For instance the literacy rate according to the 2001 census was much lower among Muslims (57.5 percent) compared to Hindus (72.4 percent).The Muslim population accounted for 25.3 percent of the total population, but they constituted only 13.7 percent of the total literate population. This clearly indicates that their share in the population does not reflect educational participation and achievements, in fact they are the most deprived community in terms of educational achievements (2). Muslim constitutes 32.3 percent of the school going population, which translated to 4.74 million out of 14.68 million school going children, while Hindus constitutes 66.5 percent or 9.67 million. Muslim have a substantial share in school going children and also a higher share in out-of-school children, which clearly indicates backwardness of Muslims in educational participation.

Educational backwardness of Muslims in West Bengal cannot be seen in isolation; it is not as simple as lower achievements due to low socio economic development of the community, but has to be contextualized within the wider framework of analysis of deprivation in well-being. This study deals with the deprivation of well-being in order to contextualise deprivation in educational development of an individual or a community in multilayered and nuanced perspective. The demand side constraints emanates from the non affordability, which in turn is influenced by the all over low socio-economic conditions of the individual and the community. Supply side constraints come from low or non availability of educational institutions, which takes place due to selective discrimination in the provision of educational institutions to a community and barriers set by the prevailing institutions, which consider education not important and relevant and hence no tradition of availing education among the community.

Three popular explanations are available behind the educational backwardness of Muslim communities: Particularised hypothesis (3), characteristic hypothesis (3), and selectivity of supply-side hypothesis (4). Particularised hypothesis in brief assumes that educational deprivation among Muslims is entrenched in their religious location and therefore intrinsic to the community (5-7).The characteristic hypotheses proposed the educational deprivation of Muslims as a result of the overall lower socio-economic status of the Muslim community (8, 9). Selectivity of the supply side hypotheses highlighted that educational backwardness of Muslims is primarily due to selective discrimination in the provision of educational infrastructure in Muslim clusters(4). The present study argue that these explanations are rather simplistic and the educational deprivation of Muslims in West Bengal has to be explained through a complex multilayered framework of analysis considering *household level low standard of living* and, *overall community level deprivation.*

Some studies (5-7) have looked at the traditional way of that community and others (8, 9) at the socio-economic aspects, but they suffer from empirical legitimacy. Very few have acknowledged the non-availability of educational institutions and poor educational infrastructure as one of the contributory reasons for educational backwardness of Muslims (4, 10).

The present study argues that the educational backwardness of Muslim is a very complex phenomena and cannot be contextualized through any unilinear process. Muslim educational backwardness has to be portrayed in a multilayered nuanced ways. The capability approach offers this. However, this requires a radical shift away from the traditional welfare way of explanation. Some of these differences will be individual, while others will be structural differences in society, related to gender, class, race, caste, and so on. To take on Muslim educational deprivation is partially captured by the socio-economic condition of the household as the same household determinants brings differential level of deprivation for Hindus and Muslim in the same socio-economic strata. The present study tries to contextualise the educational backwardness of Muslims within the framework of capability deprivation.

OUR STUDY

The present study is based on secondary data obtained from various sources like School Report Cards (2008-2009) and Census of India (2001). To look into the variation of out-of-school children across various income groups the entire populations are divided into five income quintiles, namely poorest (bottom 20 percent), poor, middle, rich and richest income categories. The formula is as follows.

$$Q = \frac{N}{5}$$

Where, N=Total Population

To examine the disparities in availabilities in the educational infrastructure in various Muslim concentrated areas blocks are categorised into six Muslim concentrated areas considering the percentage of Muslim population (see table 1).

To assess the disparities in the availability of educational infrastructure the Educational Infrastructure Index (EII) with its 20 indicators was used. The indicators are broadly representing four dimensions of the Educational Infrastructure Index (EII), namely availability, physical Infrastructure, teacher related factor and the functioning of schools (see table2).

Table 1. Categorisation blocks into various levels of Muslim concentration

Percentage of Muslim population	Concentration categories	Abbv. form	No. of Blocks	Percentage of Blocks
Less than 5	Extremely Low	Ext low	51	15.0
6-15	Low	Low	93	27.3
16-25	Moderately Low	Mod Low	59	17.3
26-45	Moderately High	Mod High	67	19.6
46-75	High	High	59	17.3
More than 75	Extremely High	Ext High	12	3.5
Total	**Overall**	**Overall**	**341**	**100.0**

Source: Census of India, 2001.

Table 2. Educational Infrastructure Index (EII) its Dimension and components

Dimensions	Indicator	Dimension Index	Educational Infrastructure Index (EII)
Availability	school per 100000 population, Primary-upper primary ratio	**Availability Index (AVI)**	
Physical infrastructure	Student-Classroom Ratio (SCR), Percentage of schools having SCR>60, Percentage of schools having common toilet, Percentage of schools having separate girls toilets, Percentage of schools having drinking water available, Percentage of schools having electricity, Percentage of schools having boundary wall, Percentage of schools having playground, Percentage of schools having book bank, Percentage of schools having zero or less than one black board per classroom	**Physical Infrastructure Index (PINFI)**	
Teacher related factor	Pupil-Teacher Ratio (PTR), Percentage of schools with PTR more than 60, Percentage of schools having female teacher, Percentage of teachers with professional qualification	**Teaching-resource Index(TRI)**	
School functioning	receive school development grant, receive TLM grant, with working days less than 200, CRC coordinator not even visited once in a year	**School functioning Index (SFI)**	

Source: School Report Cards, 2008-09.

Among all the 20 indicators some are positive indicators and some are negative indicators. The following procedure was adopted in converting the indicators into unidirectional normalized form. First the best and the worst values in an indicator were identified. The best and the worst values were depending on the nature of the indicators. In case of a positive indicator, the highest value would be treated as the best value and the lowest, would be considered as the worst value. Similarly, if the indicator was negative in nature, then the lowest value would be considered as the best value and the highest, the worst value. Once the best and worst values were identified, the following formula was used to obtain normalize values:

The variable is transformed as:

$$NVij = \left\{1 - \left[\frac{BestXi - ObservedXij}{BestXi - WorstXi}\right]\right\} \tag{1}$$

NV_{ij} – normalised index of ‘i’th indicator of ‘j’th blocks; X_i - orginal value of ‘i’th indicator;

i = 1,2 ….n.

The best X_{ij} is decided subject to the concerned indicator's lower or higher value corresponding to the best situation.

Normalized Values always lies between 0 and 1. As the value of a particular indicator inclined towards 1 indicates better performance and vice-versa.

Four Dimensions Index(accessibility, physical infrastructure, teacher-related and functioning index)were compute dusing the following formula:

$$Di = \frac{\sum NV_{ij}}{n} \tag{2}$$

$\sum NV_{ij}$= Sum of all normalized indicator
i= 1…n denotes specific indicators
For example in accessibility Index,
X_1=Schools per 1000 enrolled students,
X_2 =Primary-Upper Primary Ratio
j=1…n blocks
n= Total number of indicator used in calculating the indicator
D_i= Dimension index

Simple-unweighted index was chosen to develop the final Educational Infrastructure Index (EII).

$$EII = \frac{\sum D_i}{N}$$

Where,
$\sum D_i$=sum of all dimension Index
i= 1…4 denotes specific dimension index
N= number of Dimension Index

The EII value ranges between 0 and 1. The value inclined towards 1 indicates high educational infrastructure, while inclined towards 0 indicates low educational infrastructure.

To portray the low standards of living, lack of community amenities and the educational infrastructure it used cross-tabs to establish the causality of linkages between the concentration and capability deprivation**.**

FINDINGS

Incidence of out-of-school children is one of the most widely used indicators to represent educational deprivation. Overall, 2,041,657 children in the age-group of 6-14 years are out-of-school in West Bengal. This means that 13.9 percent of the school going children are out-of-school across rural and urban areas. In order to represent the incidence of out-of-schools among the various religious groups Hindu, Muslim and others religious group they are further subdivided into three sub-groups. By definition Muslims and the other religious communities can not have any scheduled component of the population (as wrongly done by NSSO). The marked scheduled section of the population among Muslims and others are defined as OBC-II, which holds the lowest socio-economic. Withholding the out-of-school children among religious group reveals that the incidence is higher among the Muslims and girls' belonging to OBC-II among Muslims registered the highest incidence of out-of-school children. The incidence of out-of-school children was 11.6 percent for Hindus and others, but 18.6 percent for Muslims. OBC-II among Muslims is the most deprived as the incidence of out-of-school children is highest among them compared to other socio-religious group. The incidence of out of schools is higher across all the sub-groups of population among Muslims compared to their major counter parts (Hindus). For instance although non-scheduled non-OBC are privileged group among all religious groups, but 18.6 percent of the children of Muslims non-scheduled son-OBC are out-of-school children, while it is only 6.7 percent for non-scheduled non-OBC of Hindus. The incidence of out-of-school children among Muslims scheduled (41.4 percent) population was almost three times more than that of scheduled Hindus (15.6 percent). Even males and females of all socio-economic of population have registered more out-of-school children for Muslims than Hindus. Although the females were deprived for Hindus across all the sub-groups but not as prominent as for Muslim OBC and scheduled casts (50 percent of the school going girls' and 100 percent of the school going girls' of the OBC and scheduled Muslims were out-of-school children, while it was 0.0 percent and 28.1 percent for boys'). Incidentally, among Muslim non-scheduled non-OBC had higher incidence of out-of-school male children (see table 3 and figure 1).

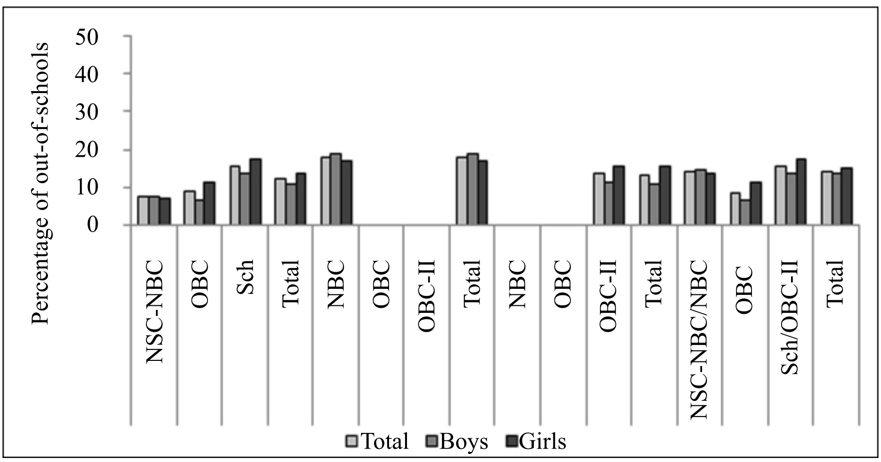


Figure 1. Incidence of out-of-schools across various Socio-Religious Groups (Rural).

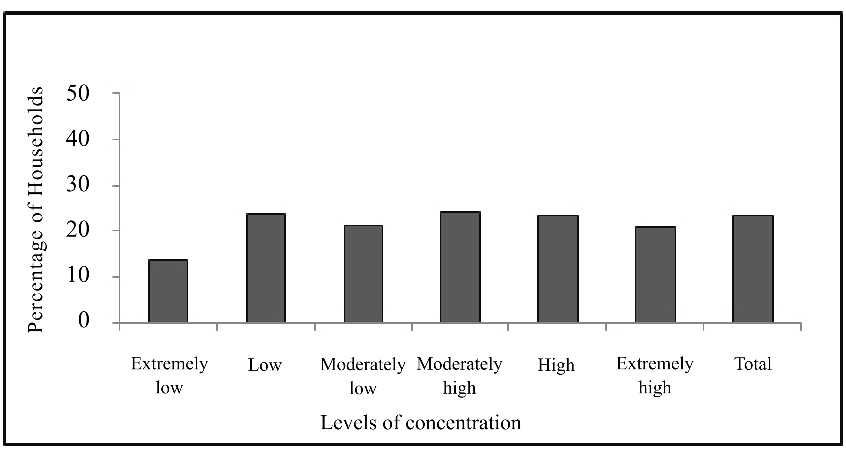


Figure 2. Household having drinking water sources with in premises in various Muslim concentrated blocks.

Table 3. Incidence of Out-of-school children across various Socio-Religious Groups (Overall), 2007-08

Religion	Caste	No. of out-of-school children			Percentage of out-of-school children		
		Total	Boys	Girls	Total	Boys	Girls
Hindu	Non-OBC& Non-Scheduled	247499	130364	117135	6.7	6.7	6.8
	OBC	88076	36946	51130	9.2	6.9	12.3
	Scheduled	800433	368662	431771	15.6	13.9	17.5
Hindu Total		**1136008**	**535972**	**600036**	**11.6**	**10.4**	**13.0**
Muslim	Non-OBC	878604	484639	393965	18.6	19.6	17.5
	OBC	1397	0	1397	13.2	0.0	50.0
	OBC-II	4850	2684	2166	41.4	28.1	100.0
Muslim Total		**884851**	**487323**	**397528**	**18.6**	**19.6**	**17.6**
Others	Non-OBC	0	0	0	0.0	0.0	0.0
	OBC	N.A	N.A	N.A	N.A	N.A	N.A
	OBC-II	20798	7532	13266	12.5	9.3	15.5
Other Total		**20798**	**7532**	**13266**	**11.6**	**8.6**	**14.5**
Overall	Non-OBC& Non-Scheduled/Non- OBC	1126103	615003	511100	13.4	13.9	12.8
	OBC	89473	36946	52527	9.3	6.8	12.5
	Scheduled/ OBC-II	826081	378878	447203	15.6	13.8	17.5
Overall Total		**2041657**	**1030827**	**1010830**	**13.9**	**13.4**	**14.5**

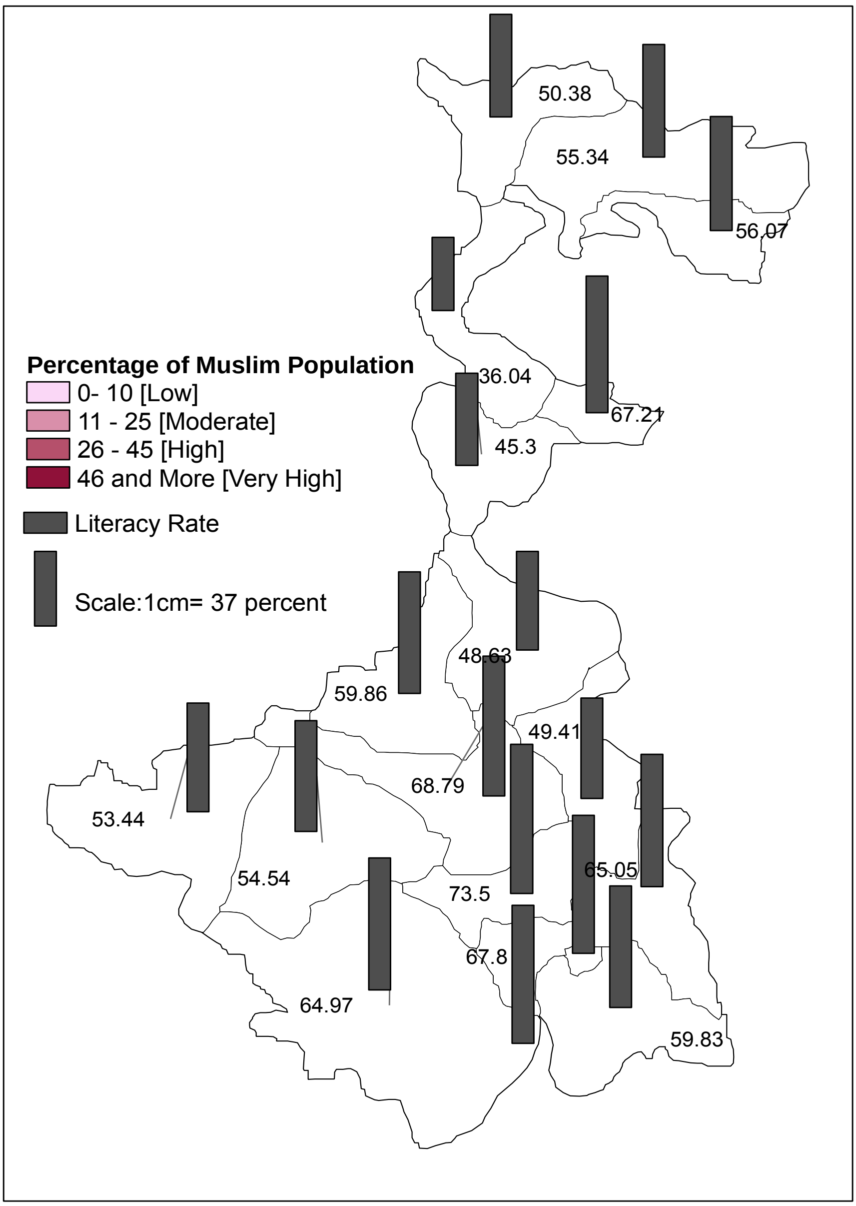
Source: NSS-64th Round, Education in India: Participation and Expenditure, 2007-0

Is educational backwardness among muslim intrinsic to their religion?

The district level analysis of the overall literacy rate clearly shows that there is a substantial spatial variation in literacy rate reflecting the persistence of regional disparity. It can also be noted that districts which are lagging behind in terms of literacy rate with respect to overall and urban literacy rate such as Murshidabad, Malda, and Uttar Dinajpur have sizeable Muslim population. Many studies have considered socio-economic development and well-being which includes educational achievements among Muslims as intrinsic to their community and is determined by religion. Accordingly to this school of thought Muslim is a homogenous monolithic society. If it is so then literacy rate among Muslim should exhibit very little or ideally no spatial variations.

The locational specificities have profound impact on behaviour of all groups and sub-group of population residing there. The prevailing environment in a particular location has much to do with the entitlement of a section of population; in a developed environment, the access to education is enhanced for all to take the advantage of. Conversely, in a restrictive environment, only small segments of the population belong to dominant caste and enjoys the access to resources and instructional mechanism frames in such a manner that the socio-culturally marginilised section is systematically excluded from participating in development processes. Hence, it will be interesting to look at the variation in literacy rate among Muslim and overall literacy rate across the districts boundary. There is a considerable variation in literacy rate within the Muslims also; it varied from as low as 36.0 percent in Uttar Dinajpur to as high as 73.5 percent in Hoogly. The variation in literacy within Muslims is also supported by higher value of C.V for Muslim literacy which is 17.0 comparisons to 14.6 for overall literacy (see Map-1).

One interesting thing to look at is the inter districts variation in literary rate among Muslims, which is very high; in fact it is higher than the overall. Therefore it is clear that Muslims are not homogenous categories and religion has not that significant impact, because otherwise the magnitude spatial variation in literacy rate must not be that much.



Map 1. Literacy Rate among various Muslim concentrated districts.

Is educational backwardness among muslims totally captured by the low socio-economic conditions of the community?

Income is an important determinant of schooling as the incidence of overall out-of-school children is inversely related with the income status of the household. The proportion of out-of-school children is decreased from the poorest quintile to the richest quintile. In other words, the average numbers of children out-of-school children is highest in the poorest income household and lowest in the richest income household. Overall out-of-school children in West Bengal is 13.9 percent, but the incidence is as high as 23.6 percent in the poorest income household and as low as 5.4 percent in the richest income households. Hence, it emerge that the income is a prime determinant of the out of schools and exhibit a reverse kind of relationship. The effect of income on out-of-school children is not consistent with religious affiliation of individual.

The incidence of out of schools across the entire religious group indicates income as a prominent effect. For instance the overall incidence of out of schools for Hindus is 11.6 percent, but it is only 2.6 percent for the richest household and keep a consistent increasing proportion as with lowering income of the household and is 20.7 percent among the poorest household. Muslims household maintained the same trend with the only exception of the lowest incidence of out-of-school children among the richer household (7 percent) instead of richest one (16.7 percent) and the highest incidence among the poorest household (27.5 percent). One interesting thing is that although income effects on out-of-school children for both Hindus and Muslims, but the magnitude of effect is not same. For instance, the incidence of out-of-school children in the poorest quintile is 20.7 percent for Hindus, whereas it is 27.5 percent for Muslims, and in richest household of Hindus it is only 2.6 percent, whereas it is 16.7 percent for them.

Is there any evidence of selective discrimination in availability of educational infrastructure in muslim dominated blocks in west bengal?

While by and large certain socio-economic characteristics exert profound influence on educational backwardness of Muslim it also has limitations. Some of the aspects of that limitation are striking, such as same income strata brings differential incidence of out-of-school children for Hindus and Muslims in West Bengal. It is also highly possible that the educational backwardness of Muslims is an articulation of the overall depressed milieu i.e., underserved in all aspects of basic amenities along with educational infrastructure in particular at the community level.

To assess the selective discrimination in availability of educational infrastructure all the four dimensions of it i.e., availability, physical infrastructure, teaching resource and school functioning comprises of 14 indicators (see table 2) are brought in a single frame by constructing the Educational Infrastructure Index at community block level in West Bengal. In the educational infrastructure index overall 19.1 percent which translated to be out of 341 blocks 65 blocks in very educational infrastructure index category, 19.4 percent which translated to be 66 blocks in low educational infrastructure index category. Contrary to that 5.3 percent of the blocks lies on very high educational infrastructure index category which translated to be 18 blocks and 25.8 percent of the blocks equivalent to 88 blocks high educational infrastructure index categories. When the distribution of various categories of educational infrastructure index portrayed in terms various levels of concentration of Muslim population it is very clear that the majority of the blocks in the areas having higher concentration of Muslim population were clustered in the very low and low educational infrastructure index category. For instance, in extremely high Muslim concentrated areas 33.3 percent of the blocks (4 out of 12) and 25.0 percent (3 out of 12) belonged to very low and low educational infrastructure index categories while none in the high and very high educational infrastructure index categories. In the blocks having high concentration of Muslim population, 42.4 percent of the blocks (25 out of 59) lies in the very low educational infrastructure index categories followed by 23.7 percent (14 out of 59) in low educational infrastructure index categories on the other hand only 10.2 percent blocks (6 out of 59) have high educational infrastructure index and none in high educational infrastructure index categories. Contrary, in extremely low Muslim concentrated areas only 23.5 percent of the blocks (12 out of 51) were in the very low accessibility categories followed by 21.6 percent of the blocks (11 out of 51) is in low educational infrastructure index categories on the other hand 2.0 percent blocks (1 out of 59) have very high educational infrastructure index and 31.4 percent (16 out of 51) high educational infrastructure index categories. In low Muslim concentrated areas only 9.7 percent of the blocks (9 out of 93) is in very low educational infrastructure index categories followed by 14.0 percent of the blocks (13 out of 93) is in low educational infrastructure index categories on the other hand 11.8 percent blocks (11out of 93) have very high educational infrastructure index and 28.0 percent (26 out of 93) high educational infrastructure index categories (see table 4).

From the above discussions it is very clear that in availability of educational infrastructure areas, which have higher concentration (more specifically in very high and high concentration of Muslim population) are clearly deprived compared to areas, which are having lower concentration of Muslim population. The majority of the schools in higher Muslim concentrated areas are deprived in availability of educational infrastructure, which can be one of the major reasons for the educational backwardness for Muslim.

Table 4. Distribution of various levels of Educational Infrastructure Index in different Muslim concentrated blocks

Percentage of Muslim population	Very Low		Low		Moderate		High		Very High		Total	
	No	Per (%)	No	Per (%)	No	Per (%)	No	Per (%)	No	Per (%)	No	Per (%)
0-5 (Ext. low)	12	23.5	11	21.6	11	21.6	16	31.4	1	2.0	51	100.0
6-15 (Low)	9	9.7	13	14.0	34	36.6	26	28.0	11	11.8	93	100.0
16-25 (Mod. Low)	5	8.5	9	15.3	14	23.7	27	45.8	4	6.8	59	100.0
26-45 (Mod. High)	10	14.9	16	23.9	26	38.8	13	19.4	2	3.0	67	100.0
46-75 (High)	25	42.4	14	23.7	14	23.7	6	10.2	0	0.0	59	100.0
76-100 (Ext. High)	4	33.3	3	25.0	5	41.7	0	0.0	0	0.0	12	100.0
Total	**65**	**19.1**	**66**	**19.4**	**104**	**30.5**	**88**	**25.8**	**18**	**5.3**	**341**	**100.0**

Source: Own calculation from School Report Card, 2008-09.

Muslim educational deprivation: A capability nexus

The capability approach is a broad normative framework for the evaluation of individual well-being and social arrangements, the design of policies and proposals about social change in society. The capability approach is used in a wide range of fields, most prominently in development thinking, welfare economics, social policy and political philosophy. In development policy circles, it has provided the foundations of the human development paradigm.

The core characteristic of the capability approach is its focus on what people are effectively able to do and to be, that is, on their capabilities. This contrasts with philosophical approaches that concentrate on people's happiness or desire-fulfillment, or on theoretical and practical approaches that concentrate on income, expenditures, consumption or basic needs fulfillment.

Sen (11) argued that in social evaluations and policy design, the focus should be on what people are able to do and be, on the quality of their life, and on removing obstacles in their lives so that they have more freedom to live the kind of life which, upon reflection, they find valuable:

> "The capability approach to a person's advantage is concerned with evaluating it in terms of his or her actual ability to achieve various valuable functionings as a part of living. The corresponding approach to social advantage –for aggregative appraisal as well as for the choice of institutions and policy – takes the set of individual capabilities as constituting an indispensable and central part of the relevant informational base of such evaluation"(11).

A key analytical distinction in the capability approach is that between the means and the ends of well-being and development. Only the ends have intrinsic importance, whereas means are only instrumental to reach the goal of increased well-being and development. What are then, according to the capability approach, the ends of well-being and development? Well-being and development should be discussed in terms of people's capabilities to function, that is, on their effective opportunities to undertake the actions and activities that they want to engage in, and be whom they want to be. These beings and doings, which Sen calls achieved functionings, together constitute what makes a life valuable. Functionings include working, resting, being literate, being healthy, being part of a community, being respected, and so forth. The distinction between achieved functionings and capabilities is between achievements and freedoms. What is ultimately important is that people have the freedoms (capabilities) to lead the kind of lives they want to lead, to do what they want to do and be the person they want to be.

The capability approach involves "concentration on freedoms to achieve in general and the capabilities to function in particular" (12). The major constituents of the capability approach are *functionings* and *capabilities*. Functionings are the "beings and doings" of a person, whereas a person's capability is "the various combinations of functionings that a person can achieve. Capability is thus a set of vectors of functionings, reflecting the person's freedom to lead one type of life or another" (12). A person's functionings and capability are closely related, but distinct.

Another crucial distinction in the capability approach is the distinction between commodities (that is, goods and services) on the one hand and functioning on the other hand.

The different constituents of the capability approach and the role that commodities have to play are perhaps best represented schematically:

The capability approach can be meaningfully used to understand the educational deprivation of Muslims because it accounts human diversity a major agencies for 'achieved functioning'. The capability approach accounts for diversity in two ways: by its focus on functionings and functioning as dependent on personal and socio-environmental conversion factors. As already stated Muslim educational backwardness cannot be portrayed in a simple frame because all the three approaches i.e., particularized approach, characteristic approach and even selectivity in supply side approach failed to capture the educational backwardness of Muslim in totality. Hence the educational deprivation of Muslim has been contextualizing in a multilayered and nuanced ways. The capability approach also emphasizes that achievement or inequality of individual/community needs to be included in the framework based on a *multidimensional distribuendum* that can account for non-financial and non-material elements. The capability approach offers this. However, this requires a radical shift away from the traditional welfare way of explanation. The conversion of the characteristics of the commodities into functionings can also differ across individuals. Some of these differences can be individual, while others may be structural differences in society, related to gender, class, race, caste, and so on. To take on Muslim educational deprivation is partially captured by the socio-economic condition of the household, as the same household determinants brings differential levels of deprivations for Hindus and Muslim in the same socio-economic strata (the religious affiliation as put forwarded by many scholar is rather insignificant). That clearly indicates Muslims educational backwardness in West Bengal can be an articulation of the overall depressed milieu-withholding their particular deprivation at household level.

Capability approach viewed commodities are goods and services. They should not necessarily be thought of as exchangeable for income or money. The educational achievement cannot be seen in isolation. It has to be considered as goods and functioning to achieve it depends on multilevel factors However, the relation between the good and the functionings to achieve certain beings and doings is influenced by three *conversion factors*. Firstly, *personal characteristics* (e.g., metabolism, physical condition, sex, reading skills, intelligence) influence how a person can convert the characteristics of the commodity into a functioning. Secondly, *social characteristics* (e.g., public policies, social norms, discriminating practises, gender roles, societal hierarchies, power relations) and *environmental characteristics* (e.g., climate, infrastructure, institutions, and public goods) play a role in the conversion from characteristics of the good to the individual functioning. (*As per capability approach individual capability is another important reason but here individual categories is seen much of a function of household conditions and standard of living. It is assuming that the child capabilities are same but differential achievement is influenced and articulated by household factors. Although it is highly possible two individual got the same opportunity of schooling but brings differential educational achievement but the provision of universal elementary education is free and no retention policy is adopted at elementary level so one children remain non enrolled or dropping out before completing the schooling cycle or even remain non enrolled is more of household failure than individual*). The functioning to achieve education is dependent on *household factors* such on the desire of the family to acquire education, expenditure on education and the provision of educational facility at the *community level*. However, the conversion factor for educational achievement can be modified as *household characteristics* (income, landholding, occupation, wildlings and perceived returns of education). *Social characteristics* (e.g., public policies, social norms, discriminating practices, gender roles, societal hierarchies, power relations etc.).*Community characteristics* (e.g., infrastructure, institutions, and public goods). While an attempt has contextualizing educational backwardness of Muslims as per the capability approach (multilayered and nuanced ways) the individual characteristics and social characteristics remained non-captured, but the household level and the community level factors discussed in detail in order to bring a satisfactory explanation behind educational backwardness of the Muslim community in West Bengal (see table 5). The community level factors are further subdivided into physical infrastructure and educational infrastructure. These two subsets are very closely related and independent as well. Suppose a village has primary schools and teachers are appointed from outside the village and there is no paved way in the village then the teachers are more likely to absent (particularly during the rainy season) and have a negative impact on the school functioning and quality of schooling and children will drop out. On the other hand a village that is prosperous in all physical aspects, but have no institutions of schooling and hence no school on the village has a negative impact on schooling of children.

The present study first looked at the standard of living of the households with the help of availability of drinking water, availability of electricity availability of latrine availing banking service, having radio, having bicycle. Community level availability of basic amenities has been looked through the villages having electric power for domestic use, villages having electric power for agricultural use, cultivable area under irrigation, village having approached by paved road, villages having post office with in villages, villages having commercial bank with in the villages. The availability of educational institutions has been looked through the availability index, physical infrastructure index, teaching-resource index and school functioning index (see table 6).

Table 5. Capability Nexus of Educational deprivation of Muslims

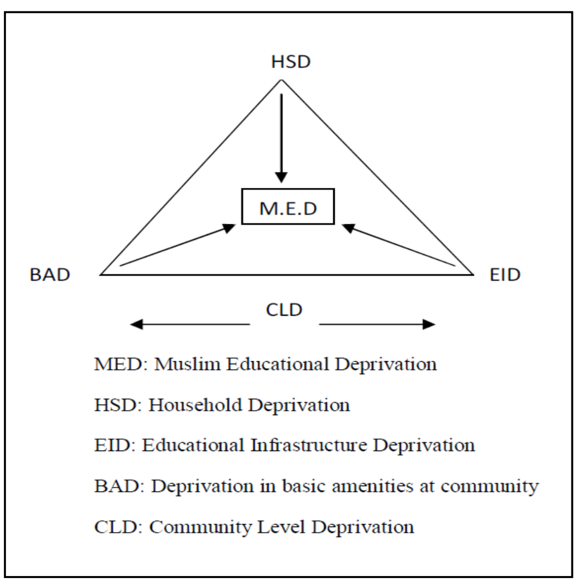
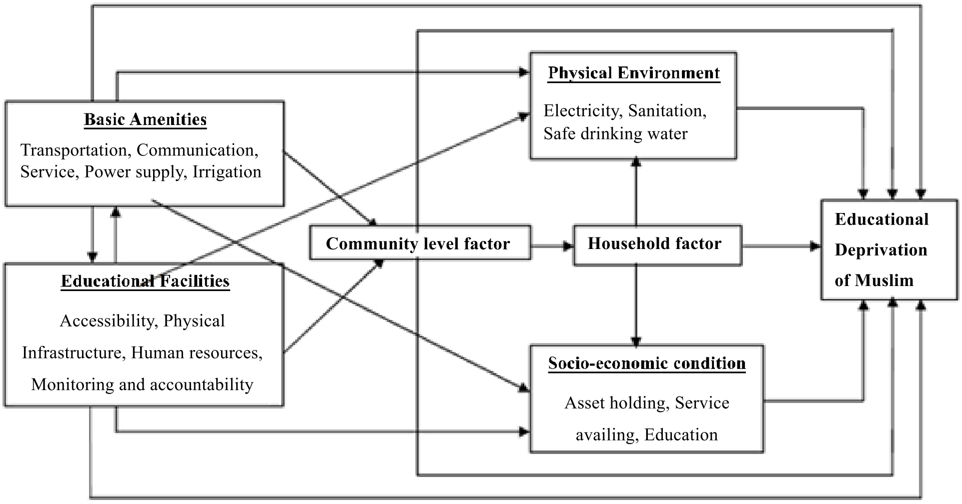


Table 6. Illustrations of various conversion factors of capability nexus of educational deprivation among Muslims in West Bengal



Low household standard of living

The standard of living of a household always has significant impact on the achievement of individual belonging to that particular household. In case of educational achievement, it is not always true that a higher standard of living of the household necessarily brings higher achievements, but a household with high standard of living is capable of providing the logistic and mental support to their children compared to a household having low standards of living and hence the incidence of out of schools in West Bengal is highest in the poorest income quintile, while lowest in the highest income quintile irrespective of religion and caste and gender affiliation. There are various parameters of standard of living of households, which includes the economic condition (asset holding), physical environment (sanitation, drinking water availability and electricity etc.), the educational status etc. Here an attempt has been made to understand the household standards of living in various categories of Muslim concentration areas (see table 7). It mainly covers two dimension of household standard of living mainly economic condition (as supplemented by household asset holding and availing banking service), and physical environment of the household as supplemented by drinking water availability, electricity availability and latrine availability. It has been found all the indicators representing asset holding is inversely related with the higher concentration of Muslim population. In all the parameters of asset holing the extremely high and high Muslim concentrated areas registered lower asset holding than the overall average and was much lower compared to low and moderately low Muslim dominated areas. But the extremely low Muslim concentrated areas had equal or more disadvantage in asset holding compared to low and very high Muslim concentrated areas. For instance, in West Bengal overall 36.7 percent of the household had radios, but in extremely high Muslim dominated areas only 23.7 percent and in low concentrated areas 29.9 percent of the household had radios, while it was 40.3 percent and 41.9 percent of the household in low and moderately low Muslim concentrated areas. Although 13.4 percent of the household in West Bengal had television, it was as low as

6.9 percent in extremely low Muslim concentrated areas, while 14.8 percent of the household in low Muslim concentrated areas had television. Bicycle is one of the common vehicles of movement in rural areas and is considered as one of the important assets. In West Bengal 54.3 percent of the household have bicycles, but again in extremely high Muslim concentrated areas 50.9 percent of the household have bicycles, which is lower than the West Bengal average and even lower than the low Muslim concentrated areas (58.7 percent).

When the physical environment of the household is a concern, then again areas having higher concentration of Muslim population were deprived in the physical environment. For example, all over West Bengal 23.4 percent of the household had a drinking water facility, but it was 20.8 percent in extremely high Muslim concentration areas, while 24.0 percent in low Muslim concentration areas. Overall 20.3 percent of the households in West Bengal had electricity facilities, but it was only 11.1 percent in extremely high Muslim concentrated areas followed by 15.1 percent in high Muslim concentrated areas, while 23.0 percent of the household having electricity facilities in low Muslim concentrated areas followed by 25.4 percent in moderately low Muslim concentrated areas. The availability of a latrine was overall in West Bengal 26.9 percent, but it varied from 17.2 percent in extremely low Muslim concentrated areas to 31.3 percent of the low Muslim concentrated areas (see figure 4).

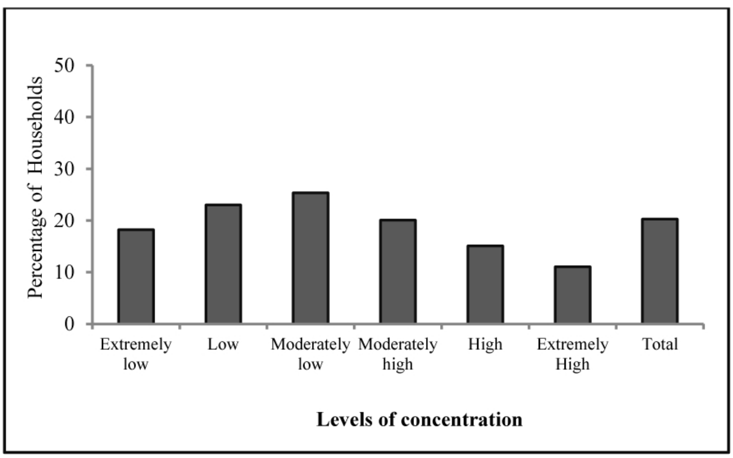


Figure 3. Household having electricity in various Muslim concentrated blocks.

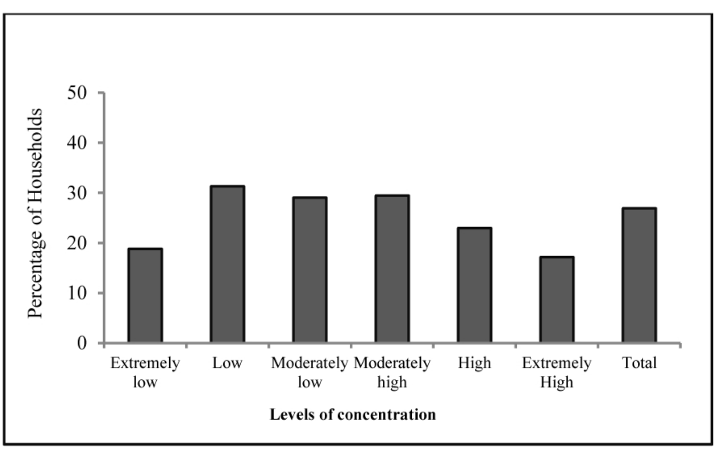


Figure 4. Household having latrine within household premises in various Muslim concentrated blocks.

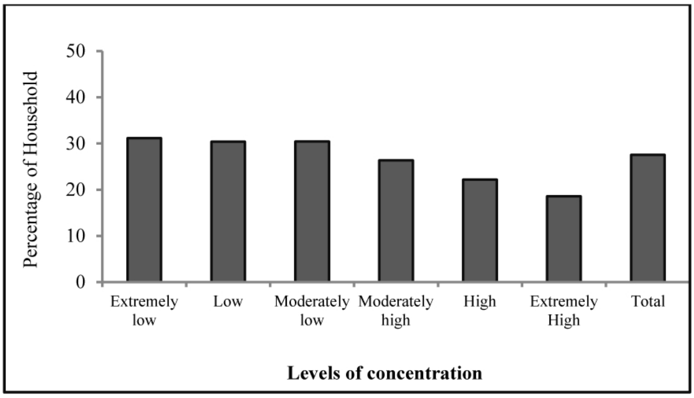


Figure 5. Household availing banking service in various Muslim concentrated blocks.

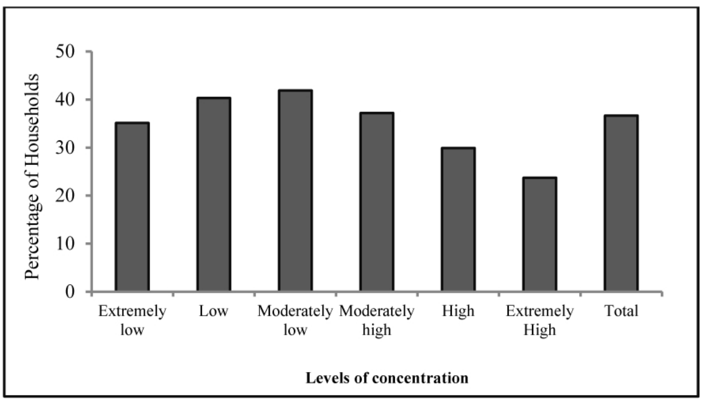


Figure 6. Household having radio in various Muslim concentrated blocks.

The asset holding and the physical environment of the household clearly showed that households in the higher Muslim concentrated areas were disadvantaged then in the lower Muslim concentrated areas. The Muslim child belonging to the higher concentration areas of Muslims had a higher chance of being deprived compared to Muslim household located in lower concentration of Muslim area, where the household deprivation was relatively lower.

Table 7. Disparities in availability of educational infrastructure in various Muslim concentrated blocks

Categories of Muslim concentration	Avail-ability	Physical Infrastructure	Teacher Related Factor	School Functioning	Educational infrastructure Index
0-5 (Ext low)	0.53	0.56	0.67	0.77	0.62
6-15Low	0.54	0.59	0.66	0.78	0.64
16-25(Mod low)	0.53	0.59	0.67	0.78	0.66
26-45(Mod high)	0.52	0.57	0.66	0.72	0.63
46-75(High)	0.46	0.53	0.78	0.7	0.57
>75 (Ext High)	0.44	0.52	0.37	0.78	0.59
Total	**0.53**	**0.56**	**0.67**	**0.77**	**0.62**

Source: School Report Card, 2008-09.

Community deprivation

The household deprivation is aggravated by the existing deprivation at the community level. The community level factors were a physical, social and economic condition that prevails at the community level. It is very difficult to measure the institutional factor that exists in a particular region. It is often argued that in areas where there is no institution of schooling it is educationally deprived, but it often miss out the invisible role played by the government policies. The areas with no available schooling may be due to the fact these areas were historically devoid of basic amenities like roads, irrigation facilities or communication facilities, which restrict the overall development of that particular region. An effort was made to measure the community development by considering various dimensions of rural development (see table 8).

Table 8. Disparities in household standard of living in various Muslim concentrated blocks

Categories of Muslim concentration	Percentage of household						
	drinking Water	electricity	latrine	availing banking service	having radio	having television	having bicycle
0-5 (Ext low)	13.9	18.2	18.8	31.2	35.1	11.9	57.4
6-15Low	24.0	23.0	31.3	30.4	40.3	14.8	58.7
16-25(Mod low)	21.3	25.4	29.1	30.4	41.9	16.3	58.2
26-45(Mod high)	24.1	20.1	29.4	26.4	37.2	14.2	47.8
46-75(High)	23.6	15.1	23.0	22.2	29.9	10.0	50.8
>75 (Ext High)	20.8	11.1	17.2	18.6	23.7	6.9	50.9
Total	**23.4**	**20.3**	**26.9**	**27.6**	**36.7**	**13.4**	**54.3**

Source: Census of India, 2001.

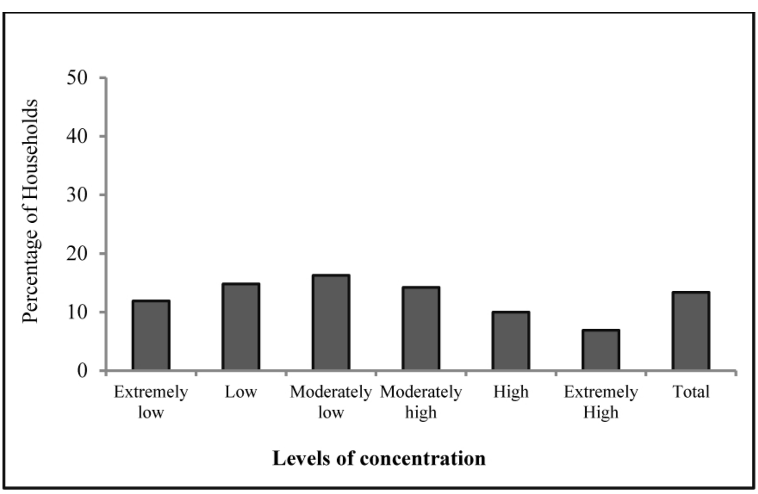


Figure 7. Household having television in various Muslim concentrated blocks.

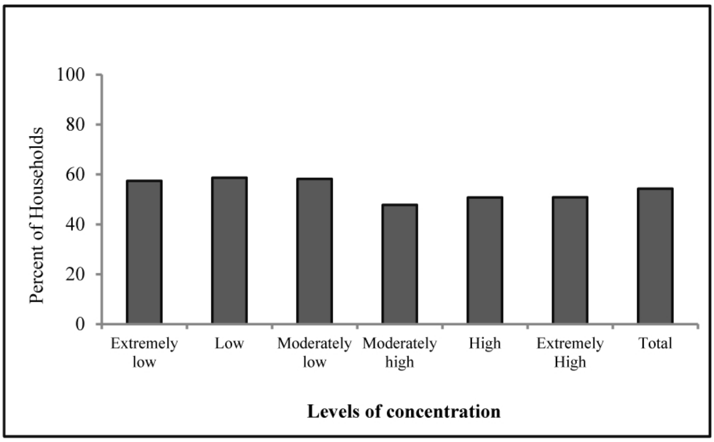


Figure 8. Household having by cycle in various Muslim concentrated blocks.

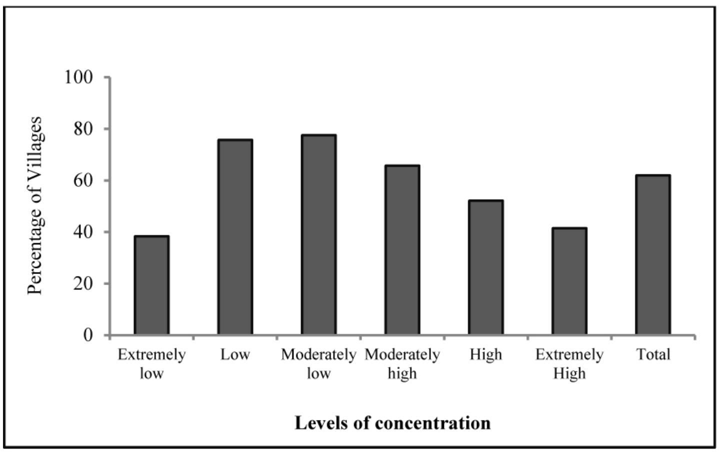


Figure 9. Villages having electricity available for domestic use in various Muslim concentrated blocks.

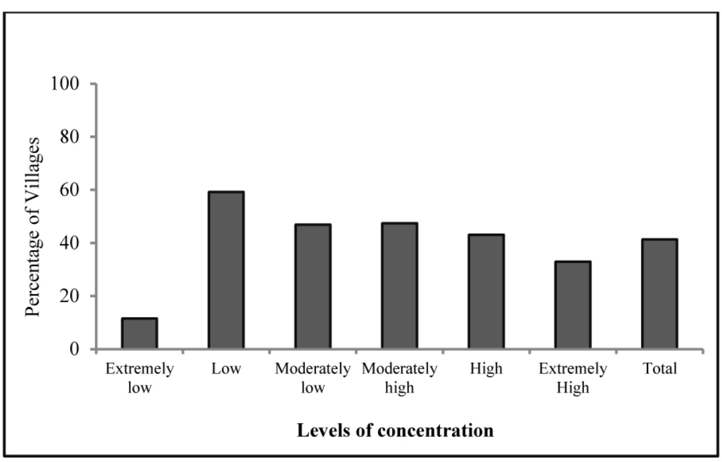


Figure 10. Villages having electricity available for agricultural use in various Muslim concentrated blocks.

The availability of electricity has direct impact on household standard of living. Overall in West Bengal, 61.9 percent of the villages had electricity facilities, but is was much lower in the higher Muslim concentrated areas. For instance only 41.9 of the villages had electricity facilities in the extremely high Muslim concentrated areas, followed by 52.1 percent in the high Muslim concentrated areas. It was 75.7 percent in the villages in low Muslim concentrated areas and the 77.5 percent in the moderately low Muslim concentrated areas.

The electricity available for agricultural use is an important indicator of agricultural development. Agriculture is the prime economic activity in the rural areas and the major source of livelihood. Overall in West Bengal 41.4 percent of the villages had electric power availability for agricultural use, but again the higher Muslim concentrated areas had lower availability compared to overall average and much lower than areas having lower concentration of Muslim population.

The percentage of area under irrigation is considered as the direct measure of agricultural development. Overall in West Bengal 45.4 percent of the cultivable area is under irrigation, but in higher Muslim concentrated areas the irrigation had lower coverage than overall and much lower than the lower Muslim concentrated areas.

The village having paved road provides much better transport facilities and is an important indicator village prosperity. While overall West Bengal 45.3 percent of the villages had paved road it was only 37.6 percent of the villages in extremely high Muslim concentrated areas and 49.9 percent in the villages with low Muslim concentrated areas.

Availability of a post office is relevant for communication and information distribution in rural areas. The high Muslim concentrated areas had availability of a post office comparable or rather higher than the low Muslim concentrated areas of West Bengal. For instance, 23.3 percent of the villages in extremely high Muslim concentrated areas had a post office available within the village.

Villages having a commercial bank reflects the economic prospect of the villages and a positive impact on the economic condition of the village. The areas having higher concentration of Muslim population were again deprived of this facility. While overall in West Bengal 5.3 percent of the villages had a banking facility available, only 3.3 percent in high Muslim villages (see figure 14)

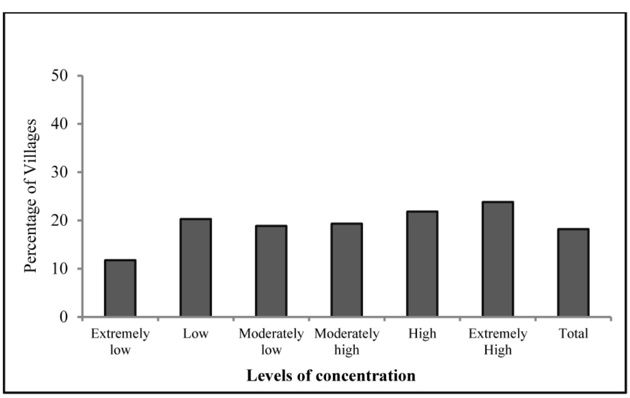


Figure 11. Villages having post office with in villages in various Muslim concentrated blocks.

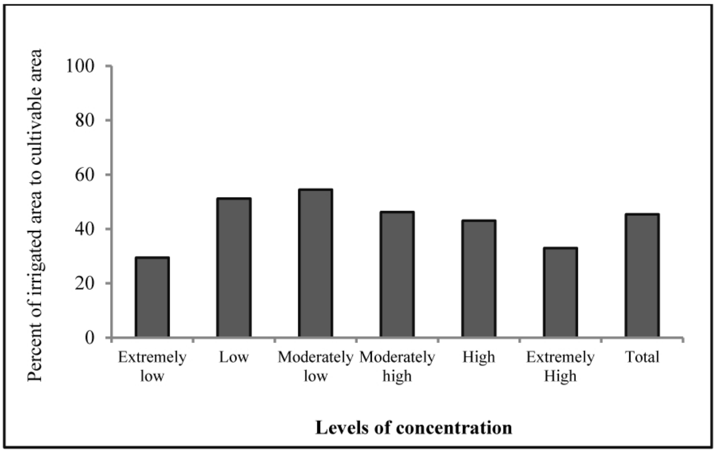


Figure 12. Cultivable area under irrigation in in various Muslim concentrated blocks.

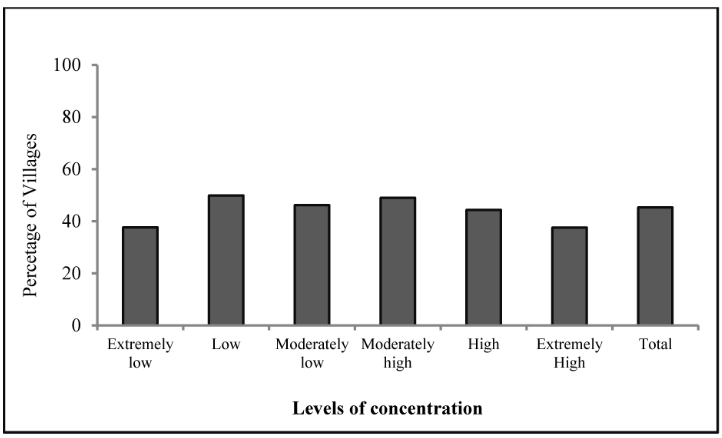


Figure 13. Village having paved road in various Muslim concentrated blocks.

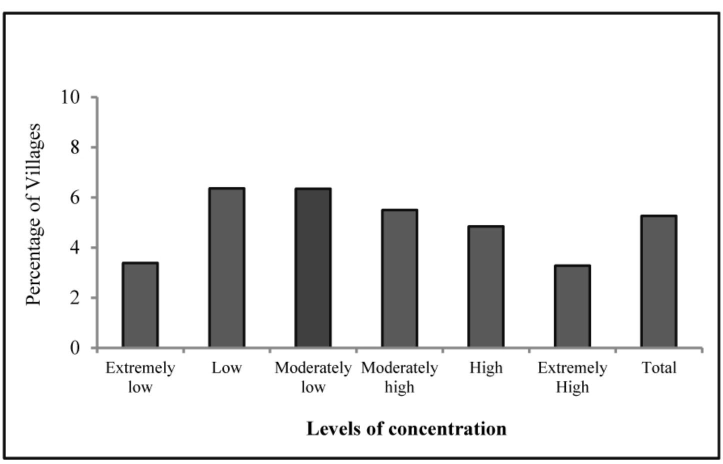


Figure 14. Villages having commercial bank with in the village in various Muslim concentrated blocks.

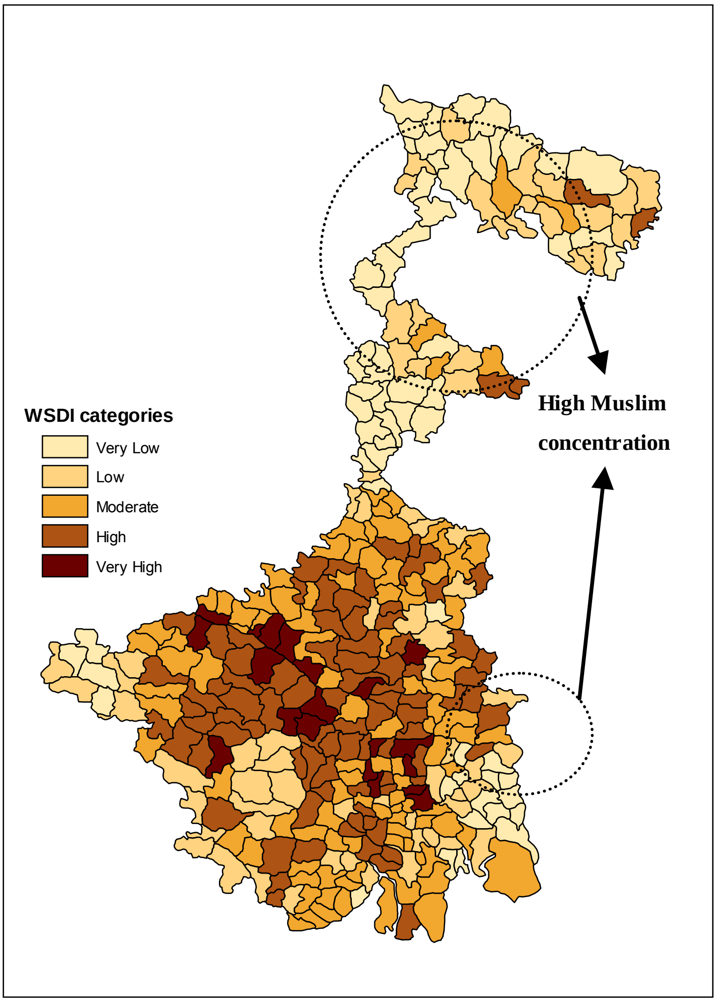
Table 9. Disparities in availability of community level amenities in different Muslim concentrated blocks

Categories of Muslim concentration	Percentage of					
	villages having electric power for domestic use	villages having electric power for agricultural use	cultivable area under irrigation	village having approached by paved road	villages having post office with in villages	villages having commercial bank with in the villages
0-5 (Ext low)	38.3	11.5	29.5	37.7	11.8	3.4
6-15Low	75.7	59.2	51.2	49.9	20.3	6.4
16-25(Mod low)	77.5	46.9	54.5	46.2	18.9	6.3
26-45(Mod high)	65.7	47.4	46.2	49.0	19.3	5.5
46-75(High)	52.1	43.1	43.1	44.4	21.8	4.8
>75 (Ext High)	41.5	33.0	33.0	37.6	23.8	3.3
Total	61.9	41.4	45.4	45.3	18.2	5.3

Source: Census of India, 2001.

Deprivation in availability of educational infrastructure

The prime objective of the school development is creation of an overall learning environment for a comprehensive development of children. The creation of a learning environment in schools is comprehensive in nature and is essential, because young and developing minds not only use it, they will grow there in one of the most important periods of their life. The educational achievement of children is directly influenced by the educational infrastructure. The educational infrastructure has several components and are broadly combined into four sub-sets, namely, availability, physical infrastructure, teacher related factor and school functioning (see table 9). A student dropping out from school is in fact directly and indirectly influenced by the existing infrastructure of the schools. For example, the lack of a separate toilet for girls will make girls drop out. The children coming from the deprived households in many instances depend on schools for their educational achievement. While a student from a well off household can compensate for the lack of some aspects of the school development, such as schools without a library (so a free text book is not available), lack of available teacher (can be compensated by private tutor at home), but a child from a deprived household lack these opportunities. Since most of the Muslim children are coming from deprived households it is important to have higher level of educational infrastructure in these areas. The higher Muslim concentrated areas (particularly extremely high Muslim concentrated areas and the high Muslim concentrated areas) are always performing worse than the overall averages and more specifically than lower Muslim concentrated areas (see figures 15-19 and map 2).



Source: School Report Card, 2008-09
Note: Map not to scale

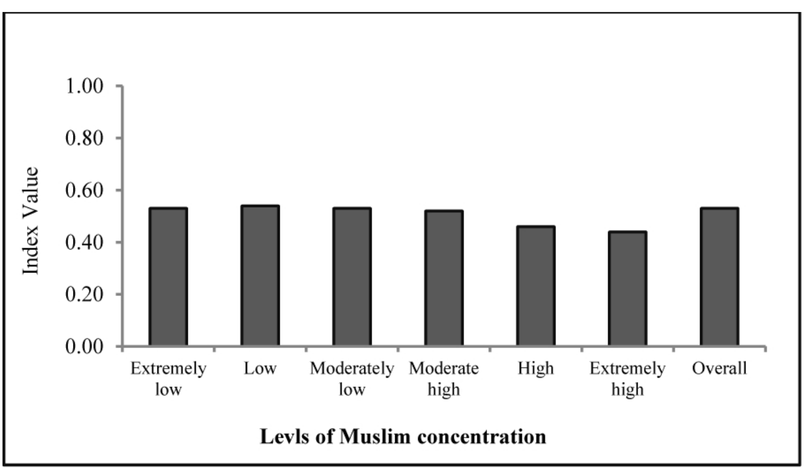


Figure 15. Availability Index in various Muslim concentrated blocks.

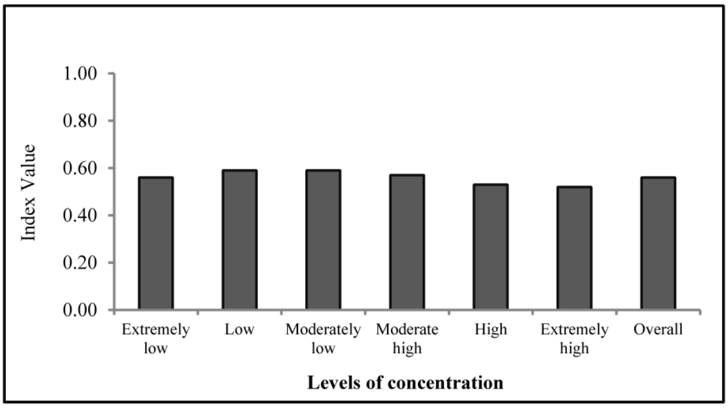


Figure 16. Physical Infrastructure Index in various Muslim concentrated blocks.

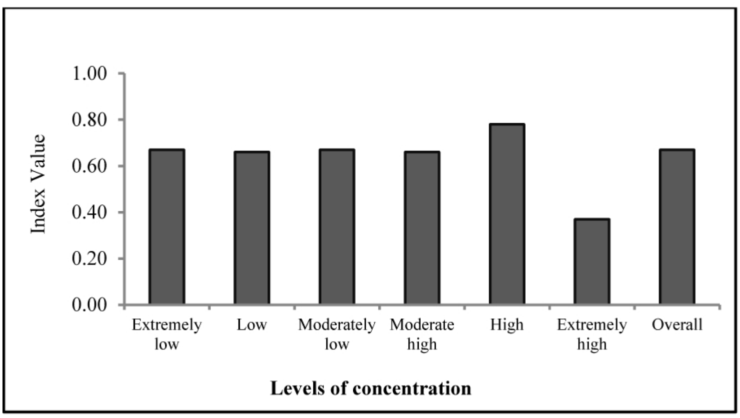


Figure 17. Teacher Resource Index in various Muslim concentrated blocks.

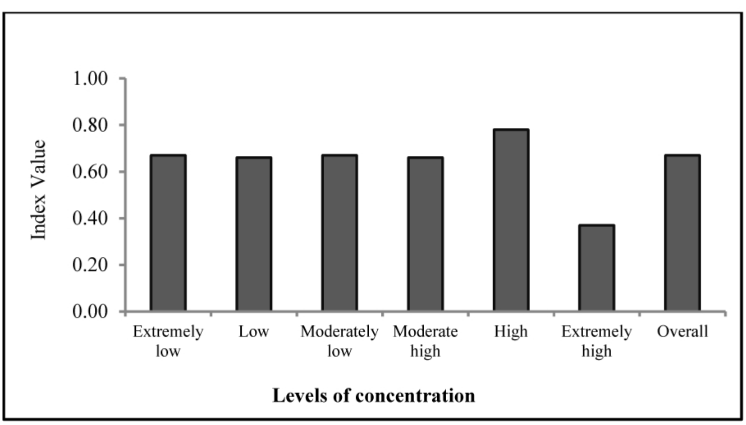


Figure 18. School Functioning Index in various Muslim concentrated blocks.

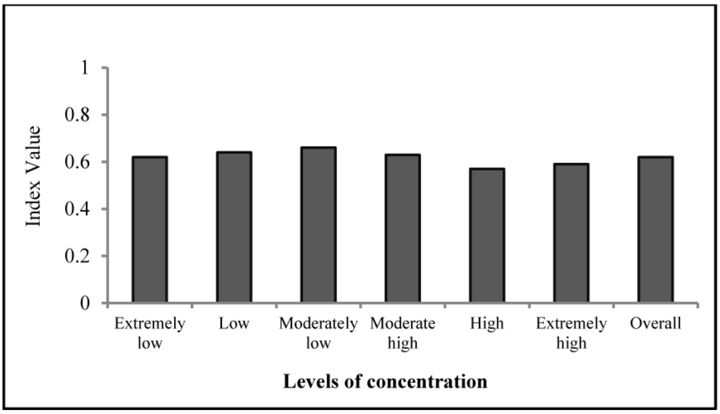


Figure 19. Whole School Development Index in various Muslim concentrated blocks.

DISCUSSION

The discussion of the educational backwardness of Muslims in West Bengal must be considered in a multilevel and nuanced way. The Muslim educational deprivation is very complex and an outcome of a multifactorial deprivation. Children from the Muslim communities are facing a threefold deprivation: deprivation at the household level, lack of community physical infrastructure and low educational infrastructure and Muslim educational backwardness can therefore be more meaningfully explained by this capability deprivation.

It was found that the households located in high Muslim concentrated areas were more deprived concerning standard of living, availability of basic amenities and overall educational infrastructure in West Bengal compared to areas with lower concentration of Muslims.

Based on available data this chapter has made an attempt to contextualize the multifactoral derivation of Muslims in West Bengal.

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I would like to express my gratitude to my supervisor Prof. Sachidanand Sinha and my friends Nilanjan Patra, Samik Choudhary, Saikat Banerjee, Sambuddha Goswami, Safayat Karim, for their insightful comment, which contributed much to this paper.

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Chapter 13

RIGHT TO EDUCATION ACT (2009): A CRITICAL EVALUATION

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ABSTRACT

Education of children at the age group of 6-14 years is facilitated in India through the Right to Education Bill 2009. While the bill is a major step towards universal elementary education in India, it has some serious loopholes, which may violate the noble objective of the bill. In India there is a vast regional variation in terms of availability of educational infrastructure and therefore essential to estimate the shortfalls in the educational infrastructure and the cost of mitigating the shortfall to mobilize the required resources. An exercise has been performed in West Bengal considering the blocks and delineating it into various categories of Muslim concentrated areas. It has been found that the areas having a higher concentration of a Muslim population were clearly lagging in availability of educational infrastructure and should be given priority in resource allocation in order to make education a true right in West Bengal.

INTRODUCTION

Universal good quality of basic education is a requisite for all modern societies, for the sake of social equity, cultural values and economic functionality (1). Attainment of education and primarily elementary education is important, both due to its impact on the living standards of people as well as enhancing individuals capability. Thus universal elementary education has become an accepted concept and a national project in India, which has remained the central objective of all educational policy and planning in this country. The present school education

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structure, evolved over ages, comprises five year of Primary Education (I-V), three years of Upper Primary (VI-VIII) and two years of Secondary Education (XI-XII), and two years of Senior Secondary Education (XI-XII); Primary and Upper Primary taken together comprise Elementary Education. A number of committees have been established and based on their recommendations several schemes and incentives have been implemented in order to universalize the access and retention of elementary education in India. Several legislations, commissions, schemes and programs have been formed after the independence of India to achieve universal elementary education in India. The constitutions of India stated that….

> “[t]he state shall endeavour to provide, with a period of ten years from the commencement of this constitution, for free and compulsory education for all until they complete the age of fourteen years (Article 45)”

Elementary education was implemented in India through the Right to Education Bill in 2009, but there is still a wide gap in achievements between various states. West Bengal is one of the few states that performs below average towards universal elementary education (UEE). West Bengal has a 25% Muslim population, which has been found as one of the most educationally backward communities in India. The Muslim dominated areas must therefore have priority in resource allocation.

OUR STUDY

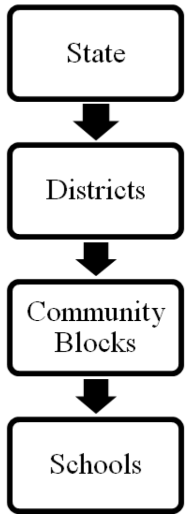
The information on various parameters of school infrastructure and functioning has been collected from the *School Report Card, NUEPA, 2008-09*. The data on unit cost in various school infrastructures has been sourced from *The Project Approval Board Minutes and Approved Annual Work Plan (AWP), 2008-09*.

West Bengal has been categorized into six categories of Muslim concentration considering the community blocks as the unit of study (see table 1).

Table 1. Categorisation districts into various levels of Muslim concentration

Percentage of Muslim population	Concentration categories	No. of Blocks	Percentage of Blocks
Less than 5	Extremely Low	51	15.0
6-15	Low	93	27.3
16-25	Moderately Low	59	17.3
26-45	Moderately High	67	19.6
46-75	High	59	17.3
More than 75	Extremely High	12	3.5
Total	**Overall**	**341**	**100.0**

Source: Census of India, 2001.



Hierarchies of implementation units of Central funds.

Shortfall and the associated cost of mitigating the shortfall in various parameters of school infrastructure and functioning has been worked out by considering the norms and standards set against each indicator. The exercise has been done by considering all schools located in various Muslim concentrated areas. To calculate the shortfall in various parameters of comprehensive school development the prescribed norms and standards of the various parameters has been considered (see table 2).

Then based on whether a school has satisfied a particular norm or standards the individual component of the various parameters has been recorded in the following manner as shown in table 3. The shortfall Index at the block level is calculated by using the following formula:

$$SF\ Index = \frac{No\ of\ school\ failed\ to\ satisfy\ i^{th}\ indicator}{Total\ no\ of\ schools}$$

The calculation of the cost of shortfall was performed by considering the unit cost of each item. Note that the cost of shortfall calculation in the present study is done without considering kitchen shed (see table 4).

The cost of mitigating shortfall in a particular component has been calculated by the following formula:

$$Total\ Cost\ of\ Shortfall\ in\ a\ Block\ (TCS_b) = \sum_{j=1}^{n} \left(S_j\ C_j\right)$$

S_j= No of Schools which have shortfall in a particular indicator
C_j =cost of particular indicator
Where, j denotes the Particular indicator and j=1, 2, 3… 13

Table 2. Scheduled as per RTE outlining Norms and Standard for schools

Sl. No.	Item	Norms and standards	
1	Number of Teacher		
	a. For first class to fifth Class (I-V)	Admitted children	Number of teachers
		Up to 60	2
		61-90	3
		91-120	4
		121-150	5
		151-200	PTR less than 40 (excluding headmaster)
	b. for sixth to eight classes (V-VIII)	PTR= 35:1	
		at least three subject teachers	
2	Building	All weather Building consisting of	
		1 class room for every teachers and additional one office-cum-store room for headmaster	
		barrier free access	
		separate toilets for boys and girls	
		safe and adequate drinking water facility to all children	
		a kitchen where mid-day meal is cooked in the school	
		playground	
		arrangement for securing the school building by boundary wall or fencing	
3	Minimum number of working days/ instructional hours in an academic year	220 days for I-V	
		220 days for VI-VIII	
		800 instructional hours per academic years for I-V	
		1000 instructional hours per academic years for VI-VIII	
4	Minimum number of working hours per week for the teachers	45 teaching including preparation hours	
5	Teaching/learning equipment	provided to each class	
6	Library	provided to each school	
7	Play material, games and sports equipments	Provide to each class	

Source: RTE act 2009, pp 12-13.

Table 3. Methods of recoding of individual indicator

	indicator	Satisfy	not satisfy
I	PTR	1	0
II	Storeroom/ Headmaster room	1	0
III	Common Toilet	1	0
IV	Separate Girls Toilet	1	0
V	Boundary wall	1	0
VI	Playground	1	0
VII	Library	1	0
VIII	TLM grant less than 500 per teacher	1	0
IX	Working Days	1	0

Table 4. Unit cost of various items in West Bengal

	Component	Unit cost (Rs)
I	Toilet/Urinal	32500
II	Separate Girls' Toilet	32500
III	Drinking Water Facility	39500
IV	Boundary wall	60000
V	HM room	400000
VI	Kitchen Shed	60000
VII	Teacher Pay (1-V)	5200
VIII	Teacher Pay (VI-VIII)	7150
IX	Library	6500

Source: Minutes of the Project Approval Board (PAB) Meetings, 2008-09.

Cost of shortfall has been commuted in all six categories separately. Total cost of shortfall in each Muslim concentrated Regions,

$$S = TCS_{bm_i} = \sum_{j=1}^{n} TCS_{bm_{ij}}$$

Where, indicates each Muslim concentrated region i=1,…..,6.

m_1=extremely low Muslim Concentrated Blocks.
m_2= low Muslim Concentrated Blocks.
m_3=moderately low Muslim Concentrated Blocks.
m_4= moderately high Muslim Concentrated Blocks.
m_5=high Muslim Concentrated Blocks.
m_6=extremely high Muslim Concentrated Blocks.

FINDINGS

Education in India has been notorious for not being socially inclusive during ancient and medieval periods. Up to the 19th century, it was largely considered a privilege restricted to persons at the higher end of the caste or class system. Education was the sole privilege of the priestly castes (Brahmins) primarily because of the religious basis for the content of education, coupled with the elitist medium of instruction that was chosen to impart the knowledge. Admission to Gurukulas or Ashramas was not open to all. The Muslim rulers of the Indian sub-continent also did not consider education as a function of the state. It was perceived as a branch of religion. Therefore, in ancient and medieval India, education was intertwined with religion.

However, education of the 'Indian masses' was largely neglected at the beginning of the colonial era, although they introduced the modern education in India. The neglect of education by the British was also acknowledged by the Wood's Despatch of 1854 (Charles Wood, 1st Viscount Halifax (1800-1885)). In this context, the demand for education in India can be traced back to the early stages of the freedom struggle in British India. It subsequently became an integral part of the freedom struggle. The Indian National Congress fought valiantly for the expansion of elementary education and literacy, in general, and in rural India, in particular. In the evidence placed before the Education Commission (Hunter Commission) appointed in 1882, Dadabhai Naoroji and Jyothiba Phule from Bombay demanded state-sponsored free education for at least four years. This demand was indirectly acknowledged in the Commission's recommendations on primary education. The Commission also recommended that schools should be open to all castes and classes. The first law on compulsory education was introduced by the State of Baroda in 1906. This law provided for compulsory education for boys and girls in the age groups of 7–12 years and 7–10 years respectively. The first documented use of the word right in the context of elementary education appears in a letter written by Rabindranath Tagore (1861-1941) to the International League for the Rational Education of Children in 1908. In 1911, Gopal Krishna Gokhale (1866-1915) proposed a bill for compulsory education in the Imperial Legislative Council, albeit unsuccessfully. The Legislative Council of Bombay was the first amongst the provinces to adopt a law on compulsory education. Gradually, other provinces followed suit as control over the elementary education was transferred to Indian Ministers under the Government of India Act in 1919. However, even though provincial legislatures had greater control and autonomy in enacting laws, progress in universal education was poor due to the lack of control over resources. In 1937, at the All India National Conference on Education held at Wardha, Mahatma Gandhi (1869-1948) mooted the idea of self-supporting 'basic education' for a period of seven years through vocational and manual training. This concept of self-support was floated in order to counter the Government's constant excuse of lack of resources. The plan was to not only educate children through vocational training/manual training by choosing a particular handicraft, but also to simultaneously use the income generated from the sale of such handicrafts to partly finance basic education. Furthermore, education was supposed to be in the mother tongue of the pupils with Hindustani as a compulsory subject. Two other interesting features of the Wardha Scheme were: First, within the 'basic education course', there were two divisions; the 'lower basic' or 'primary' corresponded to class's I–V. The 'upper basic' or 'post-primary' corresponded to classes VI–VII. The division between primary and post primary was created with a view to giving pupils the option of shifting to another form of education if they so desired after the first five years of 'basic education'. Second, a minimum wage for teachers was stipulated under the Wardha Scheme. Based on these ideas, the Wardha Scheme of Education was formulated for rural areas. The next landmark development in the history of education in India was the Post War Plan of Education Development of 1944, also called the Sargent Plan, which recommended elementary education for eight years (6–14 years' age group).

DEMAND FOR A FUNDAMENTAL RIGHT TO EDUCATION IN THE POST INDEPENDENCE ERA

The period spanning between 1950 to the judgement in the Unnikrishnan's Case in 1993 saw several legal developments to make the elementary education compulsory. The Indian Education Commission (Kothari Commission, 1964–1968), reviewed the status of education in India and made their recommendations. Most important amongst these is the recommendation of a common school system with a view to eliminating inequality in access to education. Immediately thereafter, the National Policy on Education, was formed in 1968. The 1968 Policy was the first official document as evidence of the Indian Government's commitment towards elementary education. The policy dealt with issues of equalisation of educational opportunity and required the common school system to be adopted in order to promote social cohesion. However, it was not supported by legal tools that could enforce such policy mandates. Interestingly, it even required that special schools should provide a proportion of free-studentships to prevent social segregation in schools.

A second round of studies was conducted by the Ministry of Education in conjunction with the National Institute of Educational Planning and Administration, and this process contributed to the formation of the National Policy on Education, 1986. This policy, while re-affirming the goal of universalisation of elementary education, did not recognise the 'right to education'. The 1986 Policy is also severely criticised for having introduced non-formal education in India. The 1986 Policy was reviewed by the Acharya Ramamurti Committee in 1990, and this review process contributed to the revised National Policy on Education of 1992. The Acharya Ramamurti Committee recommended that the right to education should be included as a fundamental right in Part III of the Constitution. However, this recommendation was not implemented immediately. A great legal breakthrough was achieved in 1992 when the Supreme Court of India held in Mohini Jain v State of Karnataka, that the 'right to education' is concomitant to fundamental rights enshrined under Part III of the Constitution and that 'every citizen has a right to education under the Constitution. The Supreme Court subsequently reconsidered the above mentioned judgement in the case of Unnikrishnan, J P v State of Andhra Pradesh. The Court (majority judgement) held that 'though right to education is not stated expressly as a fundamental right, it is implicit in and flows from the right to life guaranteed under Article 21… (and) must be construed in the light of the Directive Principles of the Constitution. Thus, 'right to education, understood in the context of Article 45 and 41 means: (a) every child/citizen of this country has a right to free education until he completes the age of fourteen years and (b) after a child/citizen completes 14 years, his right to education is circumscribed by the limits of the economic capacity of the State and its development'.

In the meanwhile, major policy level changes were made under the dictates of the IMF-World Bank Structural Adjustment Programme and the World Bank-funded District Primary Education Programme (DPEP) introduced in 1994. Under DPEP, the national commitment towards elementary education up to 14 years was reduced and primary education for the first five years was introduced. Further, the concept of multi-grade teaching and para-teachers was also introduced. While policy level changes had diluted the quality of elementary education, the Unnikrishnan Judgement empowered people with a legal claim. Several public interest litigation petitions were filed in different High Courts to enforce the Unnikrishnan Judgement and acquire admission into schools. This created tremendous pressure on the Parliament and thereafter a proposal for a Constitutional amendment to include the right to education as a fundamental right was made in 1996. Accordingly, the Constitution (Eighty-Third) Amendment Bill was introduced in the Rajya Sabha in July 1997. The 83rd Amendment proposed that Article 21-A be introduced (fundamental right to education for 6–14 years), former Article 45 be deleted (the then existing directive principle on EFA) and Article 51-A(k) (fundamental duty on parents) be introduced. Between 1997 and 2001, due to change in governments, the political will required to bring about the amendment was absent. In

November 2001 however, the Bill was re-numbered as the 93rd Bill and the 83rd Bill was withdrawn. The 93rd Bill proposed that former Article 45 be amended to provide for early childhood care and education instead of being deleted altogether. This bill was passed in 2002 as the 86th Constitutional Amendment Act. Currently, under Article 21-A of the Constitution, every child between the ages of 6–14 has a fundamental right to education, which the State shall provide ‘in such manner as the State may, by law, determine’. Early childhood care and education (for children in the age group of 0–6 years) is provided for as a directive principle of State Policy under Article 45 of the Constitution.

BASIC FEATURES OF RIGHT TO EDUCATION ACT 2009

The enactment of Right of Children to Free and Compulsory Education (RTE) Act 2009 is a step in right direction to ensure the universal elementary education in India.

> “*Every child of the age of six to 14 years shall have a right to free and compulsory education in a neighbourhood school till completion of elementary education*.”

The salient features of the right of children for free and compulsory education are:

- Free and compulsory education to all children of India in the six to 14 age group
- No child shall be held back, expelled, or required to pass a board examination until completion of elementary education
- Children, who have either dropped out from schools or have been to any educational institution, will be enrolled in the schools with no school refusing admission to any child.
- Private institutions have to reserve 25 percent of seats for children from weaker sections of society
- Neighbourhood schools will be identified by a system o school mapping, and children of six and above who not in schools will be identified by local authorities or school management committees
- A child who completes elementary education shall be awarded a certificate
- All such schools are required to be recognized falling which they shall be penalized for up to Rs. 1 lakhs
- It also provides for adequate number of teachers to maintain a ratio of one teacher for every 30 students
- School teachers will need adequate professional degree within five years or else will lose job
- School must have proper infrastructure, which includes a playground, library, adequate number of classroom, toilets, barrier free access for physically challenged students and drinking water facilities and those schools which do not have any of the infrastructure must ensure it within three years
- 75 percent member of the school management committees will comprise parents of the students who will monitor the functioning of the schools and utilisation of grants

- The national council for the protection Child Rights shall monitor the implementation of the act, together with commissions
- Financial burdens will be shared between the Centre and States in the ratio of 55:45 and 90:10 for the North-Eastern states

Critical evaluation of RTE

RTE is the most vital steps that have taken so far to make the education as right for every child. India has never demanded that kind of inclusive education ever before. Yet a close look at the bill shows some glaring shortcomings. This section will try to analyze critically the various loopholes of the bill through taking instances from the bill and substantiate the rationality of the ambitious objective by putting the ground reality from taking evidence from West Bengal.

The Bill needs to bring into its ambit all children in the age group of 3-16 years. It ignores children below 6 years of age (2). As one of the signatory to the UN Child Right Convention India has accepted the international definition of child, which is up to age 18 years. The bill proposes to cover the children in the age band of 6-14 years thus overlooking the right to education of below six years and above 14 years of age.

Is it possible to make education really free?

The key barrier of access to schools for children from poor and deprived section is the issue of cost. The schooling cost generally perceived as the direct cost in the form of schools fees, but the schools fees constitutes only one component of educational expenditure. The hidden cost is varied, such as cost of stationary, text books and the most important issue is the of child labour and loss of family income. Children from poor and deprived households contribute to family income through participation in wage labour. Hence, a child from poor and deprived households must be getting incentives trough provision of free textbook, stationary, mid day meal and scholarship. But in practical terms in West Bengal a high percentage of children are not getting financial support and school attendance therefore low.

Does everybody have equal opportunity of education?

The education system in India is multi-structured and hence students have differential access to quality education. The right to education talks about every child having equal right to quality education, but the private school are now accounting for almost 25 percent of the student enrollment in India as well as in West Bengal. Beside this the government system has a variety of alternative schools (3), which creates a non-homogenous structure of education and access is determined by social and class background. As result children in India will continue to receive education through a multi-layered school system with each social segment in a separate layer, the much acclaimed norms and standards in the bill’s scheduled notwithstanding (4). The Right to Education has lost the opportunity of a unified elementary education system in India.

Is quality of education guaranteed in RTE?

The bill guaranteed that every child in the country of aged 6-14 years has to pass through the education system and will surely get a certificate of completion, but the bill does not guarantee that a child has acquired competencies from the education process. Although it defined the norm and standards or the schools infrastructure to provide quality education, it has not set any standards for the learning outcomes. A case of guaranteeing graduation without education.

25 percent reservation in private schools

Is it really a help to the children from underprivileged groups to avail better quality of education from private institutions? It talks about waiving the tuition fees, but in practical terms the private school child has to purchase a range of items like uniforms, shows, extracurricular charges, computer fees etc. and now the question is who will bear that cost?

State of elementary education in West Bengal

At present West Bengal is one of the few states lagging behind the universal elementary education. According to MHRD Report (2009-10) West Bengal is ranked 19 at the elementary level in the Educational Development Index (The EDI score of West Bengal is 0.503 whereas 0.772 in Kerala which is at rank 1). West Bengal's performance is more alarming at upper-primary level as indicated by ranked 17 among the 28 major states at primary level and raked 22 at upper-primary level (see table 5).

Educational backwardness among muslims in India and West Bengal

West Bengal has the second largest Muslim population, but their numerical preponderance does not reflect the sphere of socio-economic development. Muslims are the most socio-economically backward compared to other religious groups in West Bengal. According to the 2001 census Muslim constitutes the second largest (Hindu are the dominant community with a population of 58 million which constitutes 72.47 percent of the total population) religious group (20 million) in West Bengal.

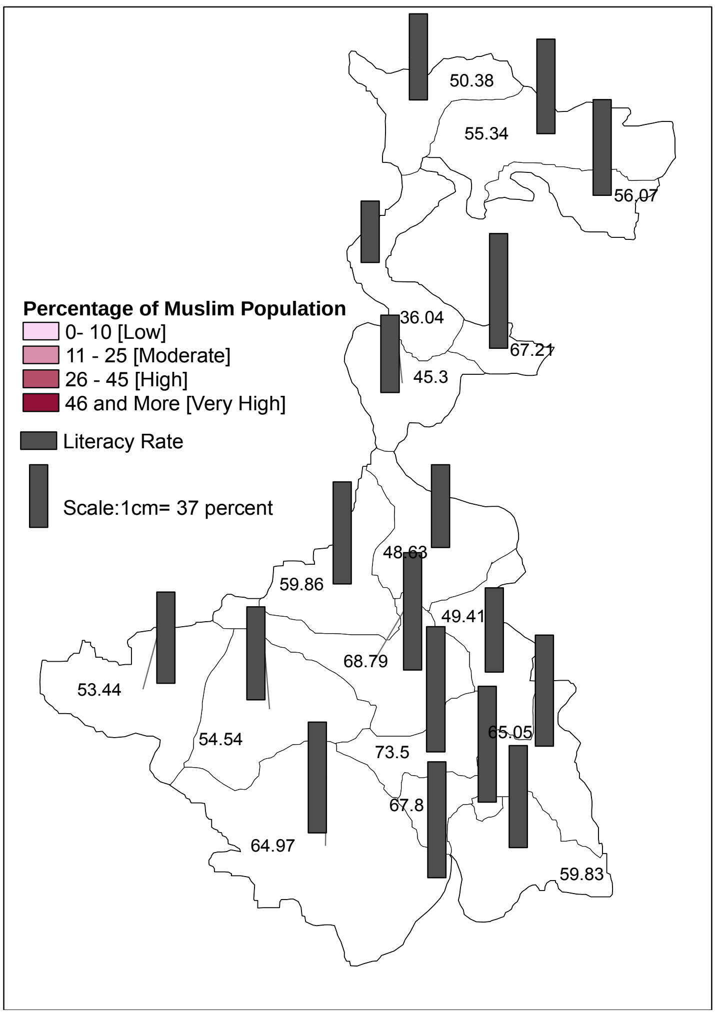
Table 5. Educational Development Index of West Bengal and other states, 2009-10

State	Primary	Rank	Upper Primary	Rank	Elementary Level	Rank
West Bengal	0.460	17	0.540	22	0.503	19
Kerela	0.700	1	0.844	1	0.772	1
Tamil Nadu	0.677	2	0.811	2	0.744	2
Punjab	0.656	3	0.803	3	0.730	3
Uttar Pradesh	0.534	14	0.511	24	0.523	16

Source: DISE, 2008-09.

In West Bengal, Muslims had the lowest literacy rate among all religious communities. Literacy rate of Muslims (57.5 percent) was low by 14.9 percent than their major counterpart Hindus (72.4 percent for Hindus compared to 57.5 percent among Muslims) in West Bengal.

The district level variation in literacy rate portrays an important regional profile lagging behind in terms of literacy rate (see map 1). Therefore, it is clear that the majority s of illiterate populations are located in certain pockets in West Bengal and Muslims have the higher share. The incidence of out-of-school children, which is a major burden for the success of universal elementary education, is more prevalent among the Muslim than the other religious communities. For instance the incidence of out-of –school children among Muslims was 18 percent, while 11.6 percent for Hindus and other religious communities. Availability of adequate infrastructure is another major component, but it has been noticed that areas having higher Muslim concentration of Muslim population are also lagging in availability of educational infrastructure (see table 6).

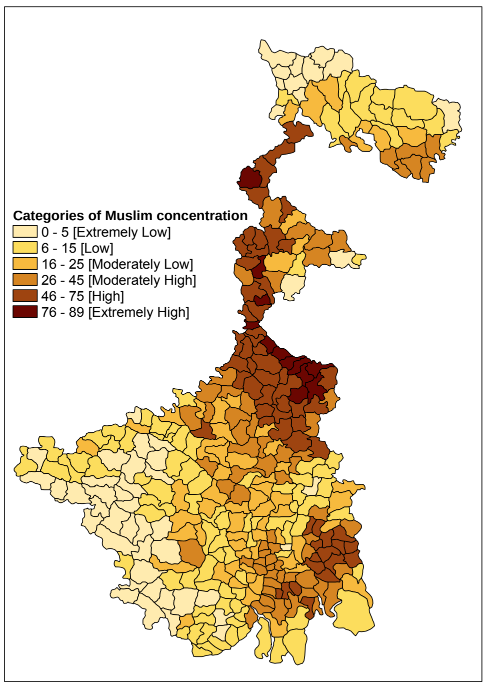


Map 1. Literacy Rate among various Muslim concentrated districts.

Table 6. Variation in Educational infrastructure development index in Muslim concentrated blocks at primary and upper primary level in West Bengal

Classification of Muslim concentration	Primary Level			Upper Primary Level		
	Median	**Best**	**Worst**	**Median**	**Best**	**Worst**
Less than 5 (Ext. Low)	0.56	0.66	0.41	0.62	0.74	0.47
6-15 (Low)	0.61	0.72	0.43	0.62	0.77	0.43
16-25 (Mod. Low)	0.61	0.71	0.45	0.64	0.75	0.42
26-45 (Mod. High)	0.57	0.68	0.41	0.6	0.75	0.42
46-75 (High)	0.49	0.69	0.35	0.56	0.71	0.32
More than 75 (Ext. High)	0.58	0.62	0.37	0.47	0.6	0.33
Total	**0.59**	**0.73**	**0.37**	**0.6**	**0.77**	**0.32**

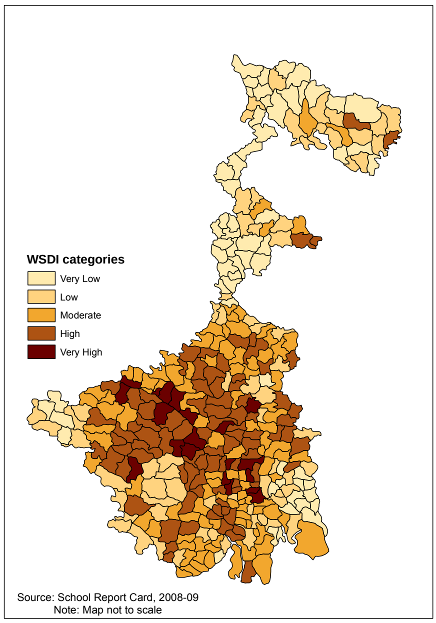
Source: School Report Cards, 2008-09.



Map 2. Block level concentration of Muslim population.

Variation in incidence of shortfall in various level of muslim concentrated blocks

In this context the the illiteracy and incidence of out-of-school children are highest among the Muslims in West Bengal and the area lag educational infrastructure. Now education is a right and all children have the right to quality education and in order to ensure quality education The Right to Education Act have prescribed some norms and standard in physical and human resource infrastructure and functioning of schools. Every school must maintain the standard norms and those who do not have to fulfill the requirements within three years from the commencement of the Act. An attempt has been made to construct a Shortfall Index taking all schools of West Bengal into consideration. This not only helps to distinguish the overall deprivation of availability of educational infrastructure higher Muslim concentrated areas, but also very much relevant to formulate policy and mobilize resources in an area-based approach to develop comprehensive school development. The school which is unable to satisfy the norms and standard set against the individual parameters are marked as Shortfall for that particular indicator and then the Shortfall index for each individual indicator is constructed for block level and various categories of Muslim concentration (see table 7).



Map 3. Block level variation in Educational Infrastructure.

Table 7. Shortfall in various parameters of Comprehensive School Development in different Muslim concentrated blocks

Categories of Concentration of Muslim population	PTR		Storeroom/ Headmaster room	Common Toilet	Separate Girls Toilet	Boundary wall	Playground	Library	TLM grant less than 500 per teacher	Working Days	
	Primary	Upper Primary								Primary	Upper Primary
0-5 (Ext low)	70.5	64.7	34.4	31.3	63.7	72.2	63.0	37.5	27.2	17.0	40.8
6-15Low	72.9	73.9	30.2	19.1	55.8	67.2	57.7	43.0	39.0	12.1	35.4
16-25(Mod low)	67.6	75.7	30.3	17.9	48.1	62.7	60.3	46.4	52.9	15.5	31.7
26-45(Mod high)	73.0	70.2	36.6	23.4	49.0	61.2	64.5	40.2	52.9	20.2	40.6
46-75(High)	82.2	83.6	37.1	27.5	51.1	64.5	69.5	34.5	67.7	20.9	47.3
>75 (Ext High)	83.8	78.6	33.1	28.1	62.1	66.0	74.1	22.6	94.6	21.3	47.9
Total	**73.3**	**73.7**	**33.4**	**23.2**	**53.8**	**65.4**	**62.8**	**40.2**	**49.0**	**16.9**	**38.8**

Source: School Report Card, 2008-09.

Table 8. Number and Percentage of schools having shortfall in various parameters of Comprehensive School Development

Categories of Concentration of Muslim population	PTR				Common toilet		Girls toilet		Boundary wall		Library		Drinking water		Separate store room/headmaster room	
	Primary		Upper Primary													
	No of teacher short	Percentage of school having shortfall	No of teacher short	Percentage of school having shortfall	no of school	Percentage of school	no of school	Percentage of school	no of school	Percentage of school	no of school	Percentage of school	no of school	Percentage of school	no of school	Percentage of school
0-5 (Ext. low)	9749	70.5	2982	64.7	2421	30.4	5074	63.7	5934	74.5	2663	33.5	1000	12.6	2995	34.4
6-15 (Low)	17340	72.9	8635	73.9	2101	15.6	7533	55.8	9735	72.1	5088	37.7	798	5.9	4625	30.2
16-25 (Mod. Low)	11724	67.6	6096	75.7	911	10.0	4394	48.1	6461	70.7	3585	39.2	403	4.4	3260	30.3
26-45(Mod. High)	14484	73.0	6096	70.2	747	7.7	4734	49.0	7192	74.5	2637	27.3	295	3.1	4408	36.6
46-75 (High)	13879	82.2	7852	83.6	907	11.9	3905	51.1	5888	77.1	1485	19.4	256	3.4	3531	37.1
75 &more (Ext. High)	2365	83.8	2691	78.6	162	11.6	870	62.1	1082	77.2	62	4.4	11	0.8	573	33.1
Total	**69541**	**73.3**	**34352**	**73.7**	**7249**	**14.7**	**26510**	**53.8**	**36292**	**73.6**	**15520**	**31.5**	**2763**	**5.6**	**19392**	**33.4**

Source: School Report Cards, 2008-09.

The shortfall index in various parameters of educational infrastructure reveals an interesting picture (see table 8). Overall 73.3 percent of the primary schools and 73.7 percent of the upper primary schools in West Bengal failed to meet the prescribed norms. The schools located in areas of higher concentration of Muslim population registered higher magnitude of shortfall (83.8 percent for primary level as against 70.5 percent in low Muslim concentrated areas). The same was found for upper primary level (64.7 percent in extremely low Muslim concentrated areas and increased to 78.6 percent in extremely high Muslim concentrated areas) (see figure 1).

One of the important aspects of school infrastructure is that every school should have one store room or headmaster room. In West Bengal 33.4 percent of the schools are without headmaster room or store room.

As far as the availability of toilet is concerned, in West Bengal 23.2 percent were shortfalled concerning common toilets (see figure 2). The shortfall in separate girls' toilet was much higher as the shortfall in West Bengal was 53.8 percent and again the higher Muslim concentrated areas registered much higher shortfall (see figure 3).

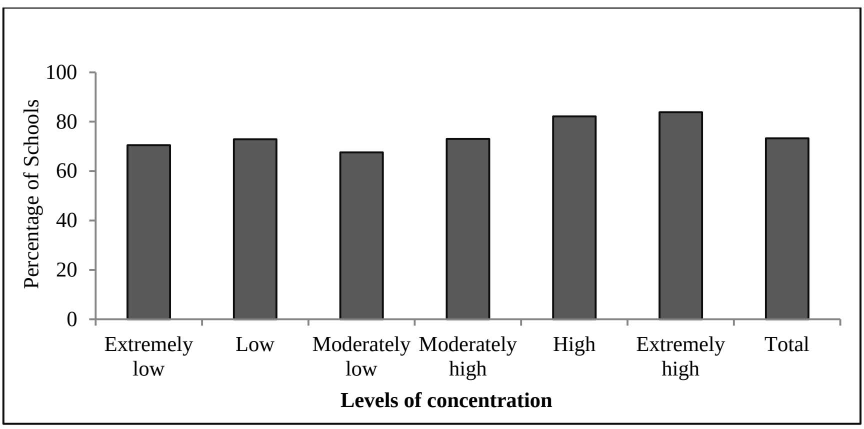


Figure 1. Shortfall in Pupil-Teacher Ratio (PTR) at Primary level in various Muslim concentrated blocks.

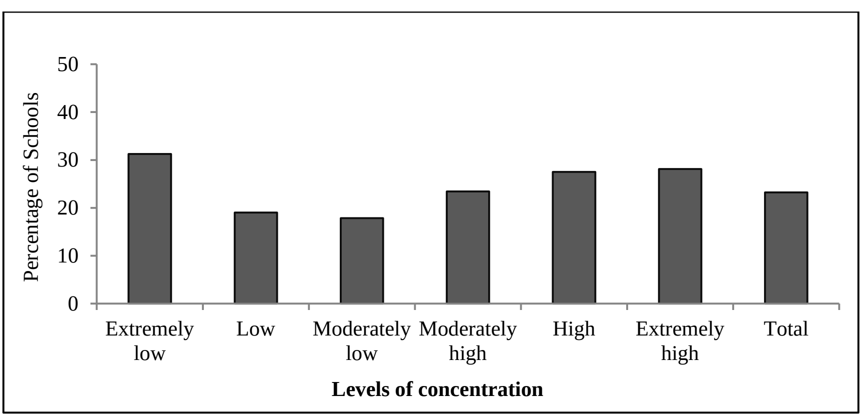


Figure 2. Shortfall in availability of Common Toilet in various Muslim concentrated blocks

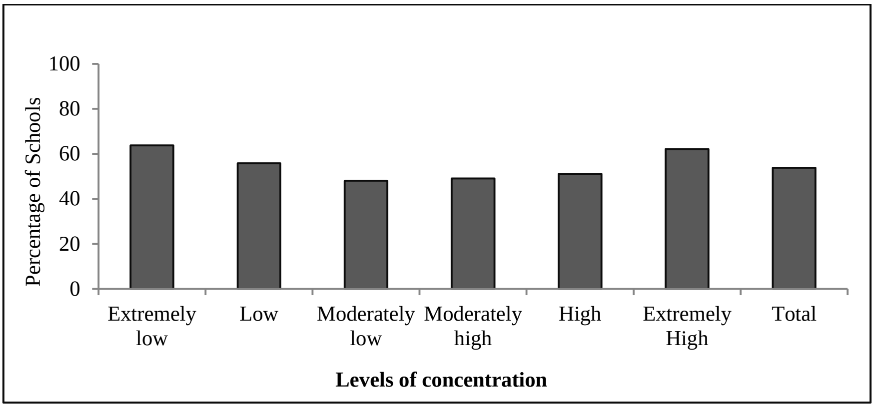


Figure 3. Shortfall in availability of Girls toilet in various Muslim concentrated blocks.

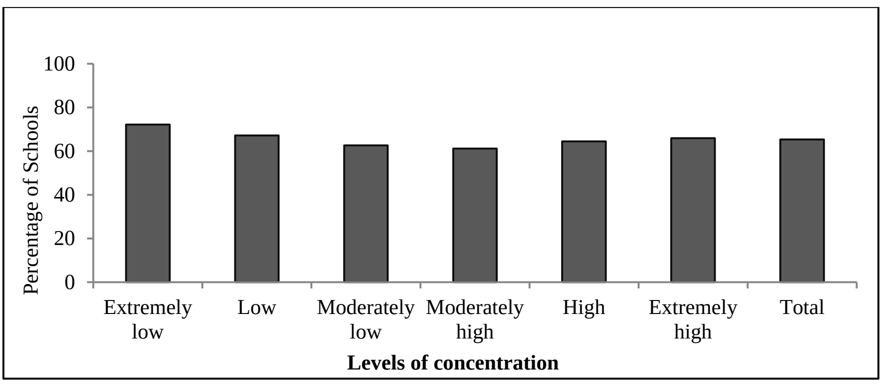


Figure 4. Shortfall in availability of Boundary Wall in various Muslim concentrated blocks.

The shortfall in availability of boundary wall in West Bengal was 65.4 percent and in this case no special deprivation was found in higher concentration of Muslim population as the shortfall was almost homogenous across all the categories of Muslim concentration (see figure 4).

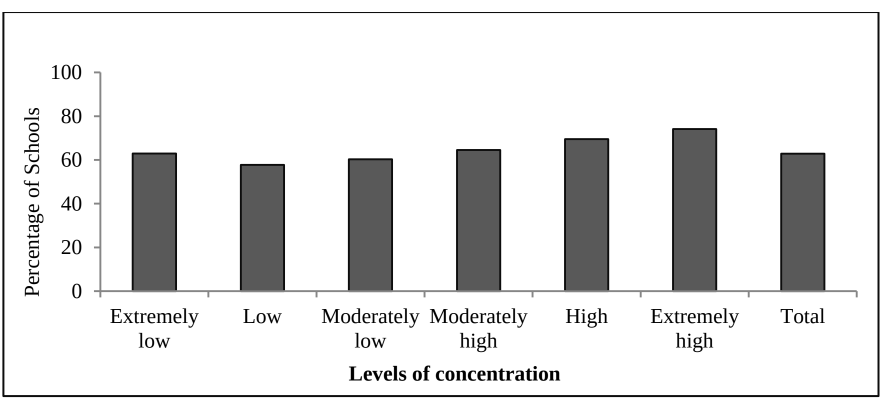


Figure 5. Shortfall in availability in Playground in various Muslim concentrated blocks.

The incidence of shortfall in playground was significantly higher as 62.8 percent of the schools registered shortfall in playground availability. In this case the shortfall was higher in the higher concentration of Muslim population (74.1%) (see figure 5)

The overall shortfall in libraries in West Bengal was 40.2 percent, but is comparatively lower in areas with higher concentration of Muslim population. (see figure 6)

Every school must receive a Teaching Learning Material (TLM) grant and it maintained the previous SSS norms of 500 Rs per teacher. Overall 49.0 percent schools in West Bengal received TLM grant and less than 500R per teacher, but this varied from as high as 94.6 percent shortfall in extremely high Muslim concentrated areas to 27.2 percent shortfall in extremely low Muslim dominated areas. In general areas with higher concentration of Muslim population have much higher shortfall in prescribed TLM grants (see figure 7)

The shortfall in working days figure 16.9 percent at primary level and 38.8 percent at upper primary level, but again areas having higher concentration of Muslim population had registered more shortfalls in working days. The shortfall in working days at primary level varies from 21.3 percent in extremely high Muslim concentrated areas to as low as 12.1 percent in low Muslim concentrated areas. At upper primary level also extremely high Muslim concentrated areas have much shortfall of 47.9 percent where as it is as low as 31.7 percent in moderately low Muslim concentrated areas (see figure 9).

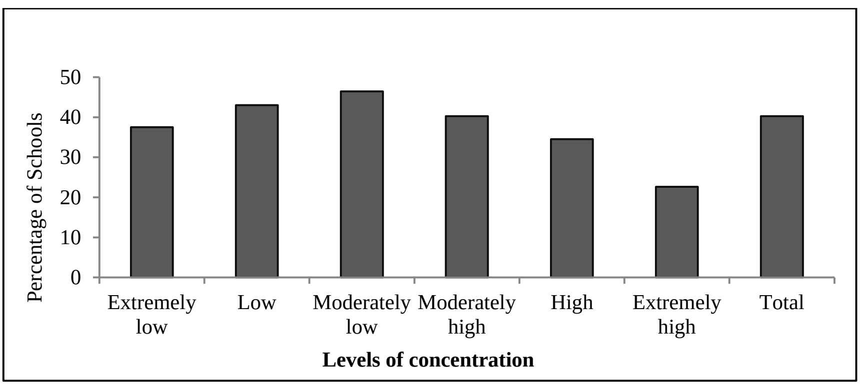


Figure 6. Shortfall in availability of Library in various Muslim concentrated blocks.

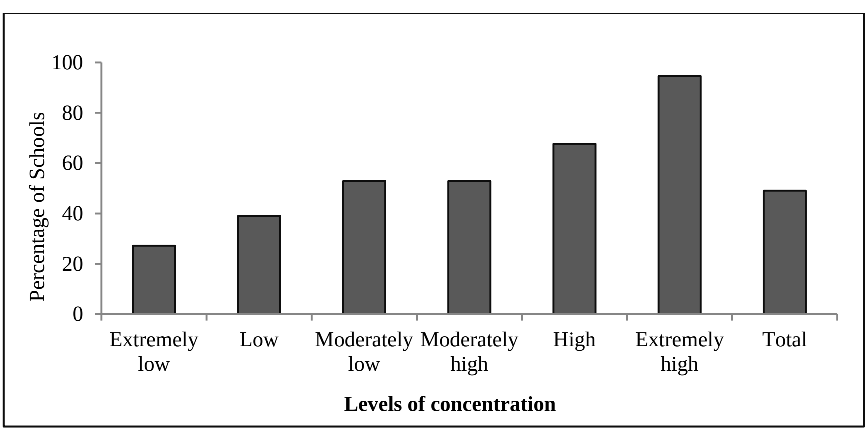


Figure 7. Shortfall in TLM grant in various Muslim concentrated blocks.

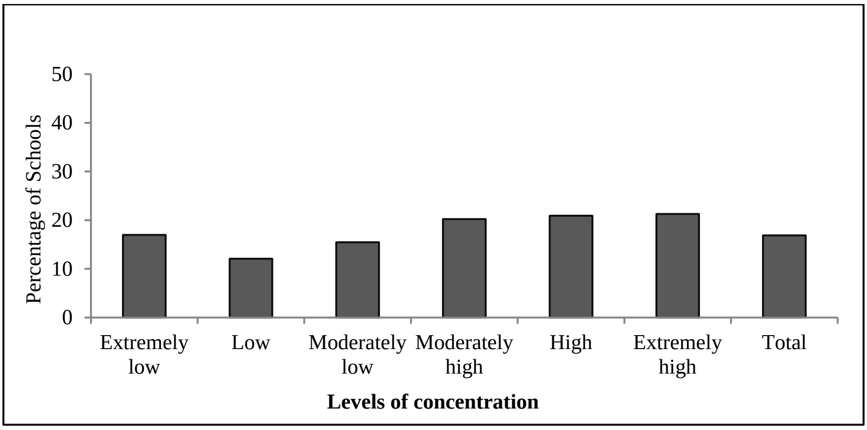


Figure 8. Shortfall in working days at primary level in various Muslim concentrated blocks.

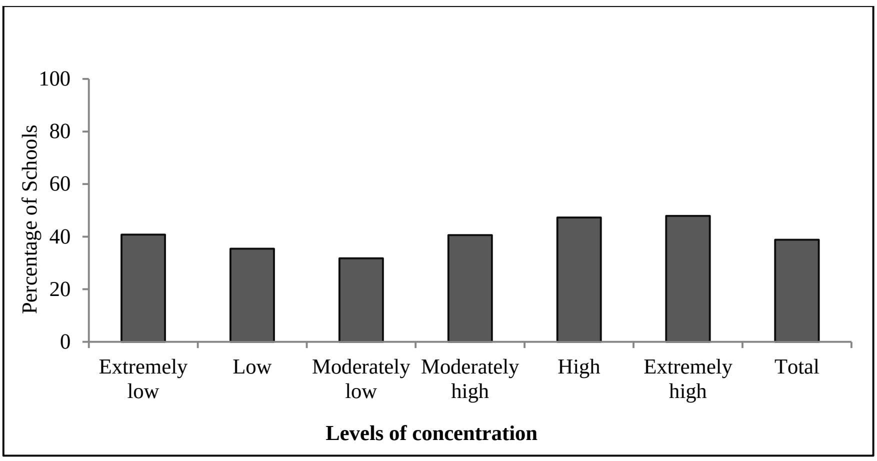


Figure 9. Shortfall in working days at upper primary in various Muslim concentrated blocks.

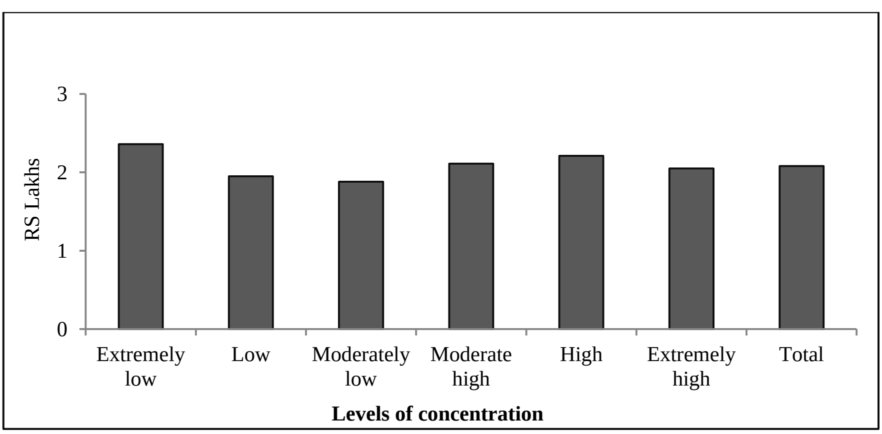


Figure 10. Average cost Per School (in RS Lakhs) to mitigate the shortfall in various Muslim concentrated blocks.

Table 9. Cost estimation of achieving UEE in India

Authority/Source	Amount Required (Rs Amount Required (Rs crores)	Average Annual Requirement (Rs crores)
Saikia Committee (1997)	40,000 for 5 years	8000
Tapas Majumdar Committee (1999)	1,36,922 for 10 years	13, 692.2
93rd Amendment Bill (2001)	98,000 for 10 years	9800
CABE Committee Report* (2005)	3,21,196 to 4,36,459 for 6 years	53,533 to 72,743
NUEPA* (2009)	1,71,780 for 5 years	34,356

Source: Authors compilations from various documents.

Estimation of cost of implementation of right to education in India by various organizations

There are various individual and system efforts to estimate the cost of achieving education to all children in the age group of 6-14 years in India (see table 9). The table shows the various estimates have been made, over the years, for achieving education through a fundamental Right to Education. The Saikia Committee, a committee of state education ministers, made only a rough estimate, taking a per-child expenditure of Rs 948 and multiplying it with the number of children in the age group 6-14 years. When the task was handed over to the Tapas Majumdar Committee, it was done in a much more thorough manner, resulting in a much higher estimate. A similar discrepancy can be observed between the 2001 and the 2005 estimates. It is clear that making estimates for a legislation as vast in scope as this involves a meticulous exercise. A team from the National University for Educational Planning and Administration has prepared a report titled ‘Financial implications of the right of children to free and Compulsory Education Act, 2009’, dated December 2009. The figure they arrived at was Rs 171,780 crores for over five years from 2010-11 to 2014-15, or about Rs 34,356 crore per year. This is the estimated additional cost for implementing RTE, which is to form the basis of the government’s budget allocation. It is over twice what has been allocated in the 2010-2011 Union Budget.

Cost implications of RTE in different muslim concentrated blocks of West Bengal

It has been seen that the incidence of shortfall in various parameters of school development set in RTE was comparatively higher in the areas having higher concentration of Muslim population. Once the shortfall has been calculated it is necessary to estimate the cost of mitigating the shortfall within the time frame of 3 years as prescribed by in RTE (see table 10).

Table 10. Cost (in Rs lakhs) of mitigating the shortfall in various Muslim concentrated blocks

Categories of Concentration	PTR		Common Toilet	Girls toilet	boundary wall	Library	drinking water	separate store room/headmaster room	Total (in Lakhs)	Average cost Per School (in in Lakhs)
	Primary	Upper Primary								
0-5 (Ext. low)	512.1	213.2	786.8	1649.1	3560.4	213.0	3950.0	7936.8	18821.4	2.36
6-15 (Low)	911.5	617.4	682.8	2448.2	5841.0	407.0	3152.1	12256.3	26316.3	1.95
16-25 (Mod. Low)	616.6	435.9	296.1	1428.1	3876.6	286.8	1591.9	8639.0	17170.8	1.88
26-45(Mod. High)	761.1	435.9	242.8	1538.6	4315.2	211.0	1165.3	11681.2	20350.9	2.11
46-75 (High)	729.1	561.4	294.8	1269.1	3532.8	118.8	1011.2	9357.2	16874.3	2.21
75 &more (Ext. High)	124.4	192.4	52.7	282.8	649.2	5.0	43.5	1518.5	2868.3	2.05
Total	**3654.7**	**2456.2**	**2355.9**	**8615.8**	**21775.2**	**1241.6**	**10913.9**	**51388.8**	**102402.0**	**2.08**

Source: School Report Cards, 2008-09.

Discussion

The right to education is fundamental and in India the bill to ensure that right has not been fully implemented. It overlooks some basic aspects it lost the great opportunity of making historically non-homogenous structure education into a homogenous one. The right to education (RTE) lacked norms and standards related to infrastructure and school functioning due to financial restrains.

West Bengal as a whole portrayed a very perishing picture of availability of various component of the comprehensive school development as per the norms and the standards set in RTE 2009:

- The incidence of shortfall is maximum in availability of teachers and in various physical infrastructure like availability separate girls toilet, play ground, electricity etc. the incidence of shortfall in much prominent in higher Muslim concentrated areas for almost all of the parameters.
- The average cost per schools to mitigate the shortfall is also more in higher Muslim concentrated areas compared to lower Muslim concentrated areas.

The above discussion clearly reveals that higher Muslim concentrated areas are more lagging against the prescribed norms of each indicator and hence priority has to be given to mitigating the shortfall in higher Muslim concentrated areas. Required resource moblisation also has to be done to ensure the right to education.

ACKNOWLEDGMENTS

I would like to express my gratitude to my supervisor Prof. Sachidanand Sinha and my friends Nilanjan Patra, Samik Choudhary, Saikat Banerjee, Sambuddha Goswami, Safayat Karim, for their insightful comment, which contributed much to this paper.

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Chapter 14

THE MYTH BEHIND AND THE REALITY OF UNIVERSAL ACCESS TO ELEMENTARY EDUCATION

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ABSTRACT

The unequal access to elementary education is an important dimension of the failure of human entitlement in India. In spite of strong government initiatives, a large number of school children remain out of schools, which reflects the failure of universalization of access. Most of the studies conducted so far overlook the role of institutional failure responsible behind the unequal access and aspect of spatiality. This study goes further beyond the traditional way of looking into the out of school issue and gives more emphasis to the institutional factors behind children not attending schools. An educational development index is formed at the district level by employing the principal component analysis method and correlating it with the drop out rate and uses advanced buffering techniques to look into the existence of spatiality in out-of-school children in Bihar and West Bengal districts. This study had several interesting findings, such as the lack of educational infrastructure and the importance of spatiality in the formulation of policy in order to universalize the access and bring the out of school children back into the educational sphere.

INTRODUCTION

The human development approach recognized elementary education as an important part of development in itself (1). Deprivation in elementary education itself became an integral part of human poverty. The human development approach viewed elementary education as a human right, as an opportunity and as an entitlement. The inequality in access across various

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sections of the population at the elementary level itself became a failure of human entitlement. Thus the universalization of elementary education has become an accepted concept and a national project in India. Elementary education in India refers to the first eight years of schooling i.e., primary (I-V) and upper primary (VI-VIII) school education. Sarva Siksha Abhiyan (SSA) was launched in 2001 by the Government of India as its commitment to universalize the access and completion of elementary schooling by 2010.

In spite of strong government initiatives, a substantial number of children remain out of school, which makes the goal of universal elementary education a distant dream. The children out of school is one of the major reasons behind the failure of universal access to elementary education in India, which is largely attributed to range of inter-related barriers both from demand side and supply side. Low income households are often cited as the most important constraint for the lack of child education, with families unable to cover the direct costs (uniform, books, transport costs etc.) (2-4). The opportunity cost of schooling is also higher for poorer families (2, 5-8). Another important barrier behind children not attending schools comes from the supply side i.e., the institutional failure, such as, limited availability of educational infrastructure in a region (5, 9-12). The inequality in access can be the result of the institutional failure in a particular region, but often the role of institutional failure has been overlooked in most of the study dealing with the problem of universal access.

The present study makes an attempt to understand the levels of out-of-school children and its various dimensions at the national level and then an in depth analysis of the district level pattern of incidence of out-of-school children in West Bengal and Bihar. The rationale behind choosing West Bengal and Bihar as the study area is firstly that these two states constitute more than one fourth (more than 25 percent) of the out-of-school population in India; and secondly, these two states are at the bottom of the ladder in terms of implementation of SSA, which largely aimed at the development of educational infrastructure. Thirdly, the nature of out-of-school children is different in these respective states and hence important to look into the processes from the policy making perspective.

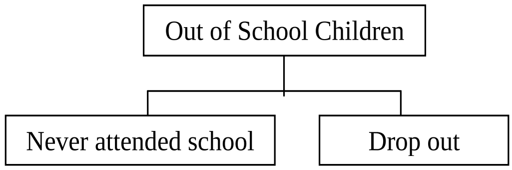
OUR STUDY

The present study is based on secondary data and relevant information collected from the district level information for education (DISE, 2007-08) and Social and Rural Research Institutes (2004-05).

Almost all the institutional factors associated with dropouts were brought into a single frame by constructing the Educational Infrastructure Development Index through considering the following variables, *Percentage of school having more than one school, percentage of school having more than one teacher, percentage of school with Student-Class Room Ratio(SCR) <60, Percentage of school having toilets, Percentage of school having drinking water facility, percentage of school with Pupil-Teacher Ratio (PTR)<100, Number of schools per 1,000 students*. The Principal Component Analysis Method was used to construct the Educational Infrastructure Development Index. The Educational Infrastructure Development Index has been overlaid on drop-out rates to assess the degree of correspondence between the two.

FINDINGS

Before going into the details it is necessary to have a clear-cut understanding of the concept of out of school children. Out of school children are those who are either never enrolled to a school or are dropping out from the school before completing the schooling cycle.



Overall, 6.94% of all the children in the age group of 6-14 years were out-of-school (see table1) in rural and urban areas together in India. The rural areas were more deprived as the percentage of children who were out-of-school was higher in rural areas (7.8%) as compared to urban areas (4.3%) (see figure 1 and map 1).

Table 1. Percent of Out of school children

	Rural	Urban	Total
All Children (6-13 years)	7.8	4.34	6.94
Male	6.78	4.33	6.18
Female	9.14	4.36	7.92
SC	8.55	6.25	8.17
ST	10.11	4.21	9.54
OBC	7.73	3.83	6.9
Muslim	12.03	7.17	9.97
Other	4.39	2.44	3.73

Source: Social and Rural Research Institutes, 2004-05

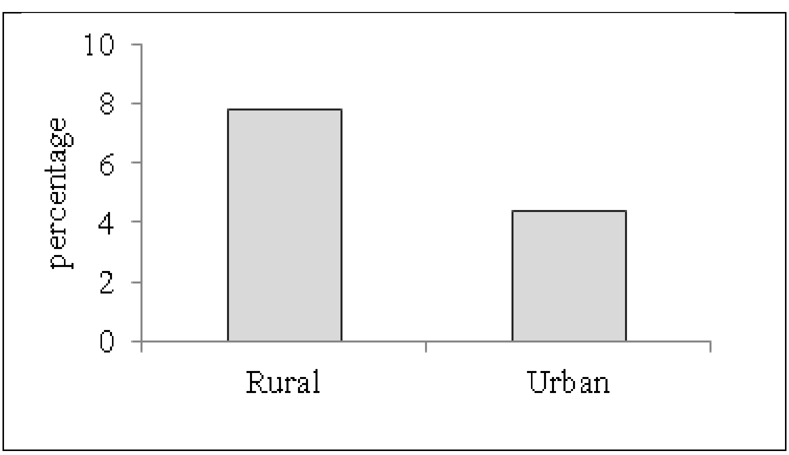
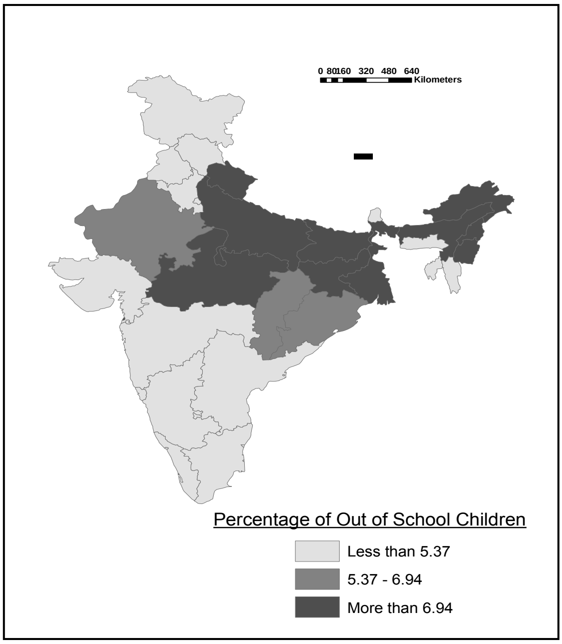


Figure 1. Out- of –school children in India: location wise.



Map 1. Percentage of Out-of-school children in different states of India.

The percentage of children who were out-of-school was lower among males (6.2) compared to those out-of-school among females (7.9%). Further data suggests that in the rural areas the percentage of girls who were out-of-school was 9.1% and 6.8% of boys. It is interesting to note that the proportion of out-of-school children among males and females was very similar in the urban areas, with 4.3 of boys being out-of-school and 4.4% of girls (see figure 2).

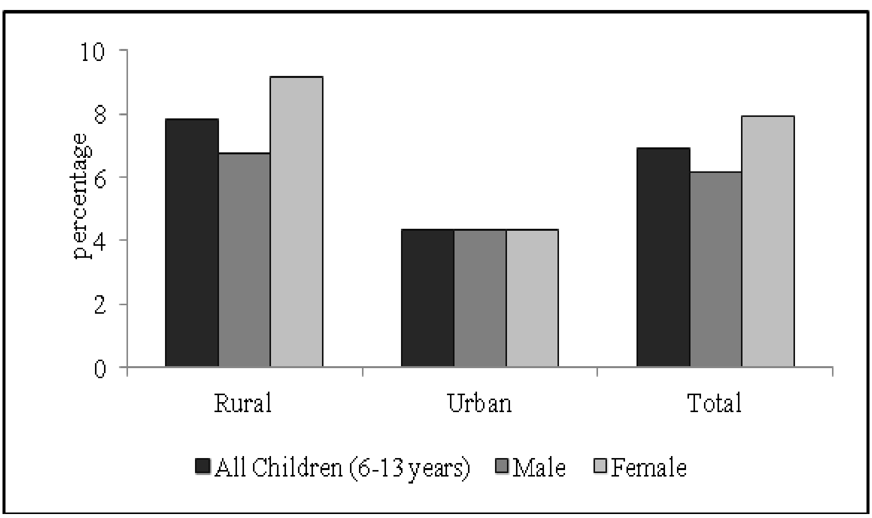


Figure 2. Out-of-school children in India: Gender wise.

It may be noted that in terms of accessibility, Muslim and ST are lagging behind all other social groups as the proportion of out-of-school children was relatively higher in Muslim and

ST households. Among Muslims, the proportion of children who were out-of-school was 9.97% which translated to 2,253,252 children, whereas the proportion of out-of-school children in the ST category was 9.54% accounting for 1,656,978 children. The next highest proportion was for the SC category with 8.17% of the children (numbering 3,104,866) who were out-of-school. Among OBCs, 6.90% of the children accounting for 4,602,260 children were out-of-school. Among those who belonged to 'other' social groups (higher social class), only 3.73% of the children (numbering 1,848,378) were out-of-school (see figure 3).

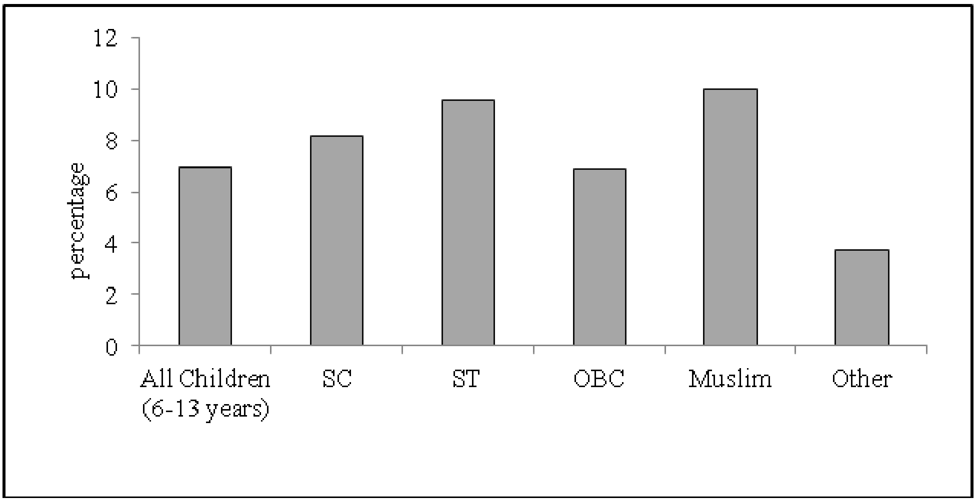


Figure 3. Social Group wise distribution of out-of-school children in India.

Out-of-schools in Bihar and West Bengal: A snapshot

Bihar and West Bengal have registered a substantial number of children out-of-school. In fact Bihar registered the highest number of children out-of-school (17%) while West Bengal (8.67%) ranked fourth (see table 2 and figure 4).

Table 2. Percentage of out-of-school children

India	6.94
Bihar	17.00
West Bengal	8.67

Source: Social and Rural Research Institute, 2004-05.

In Bihar, out of a hundred, almost 82.58% have never attended school and 17.42% are dropping out from the schools. While in West Bengal almost half of out-of-schools (50.54%) have never attended schools and half are dropping out before completing the schooling cycle (see table 3 and figure 5). Therefore the policy intervention should be directed differently in those two states.

From the above discussion it is clear that Bihar and West Bengal showing a substantial wastage at the elementary level. It is therefore necessary to identify the problem zones to bring the out-of-school children back into the schools.

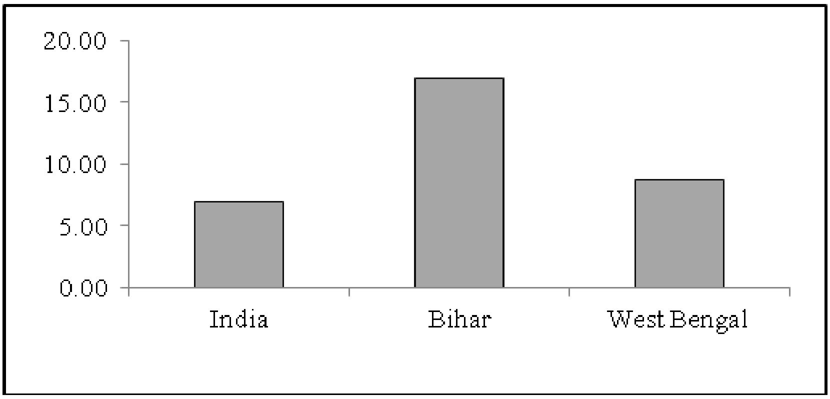


Figure 4. Out-of-school children in West Bengal and Bihar with respect to India.

Table 3. Distribution of out-of-school children into never attended and dropout category

	Percentage of never attended school	Drop Out
India	68.26	31.74
Bihar	82.58	17.42
West Bengal	50.54	49.46

Source: Social and Rural Research Institute, 2004-05.

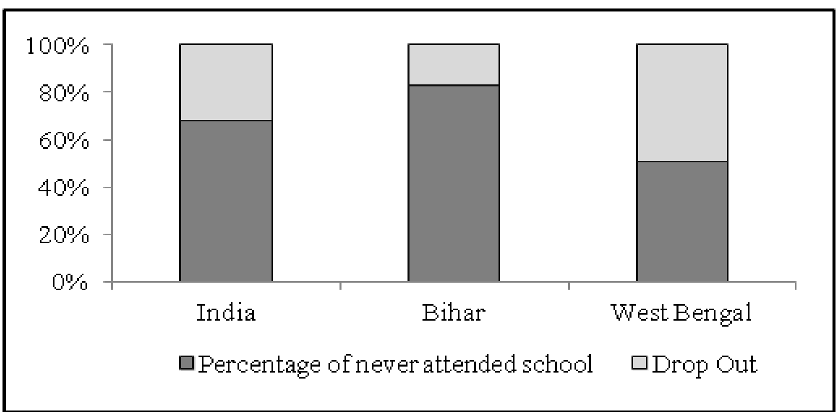


Figure 5. Distribution of out-of-school children into never attended and dropout categories.

Bihar inter-districts variation in dropout

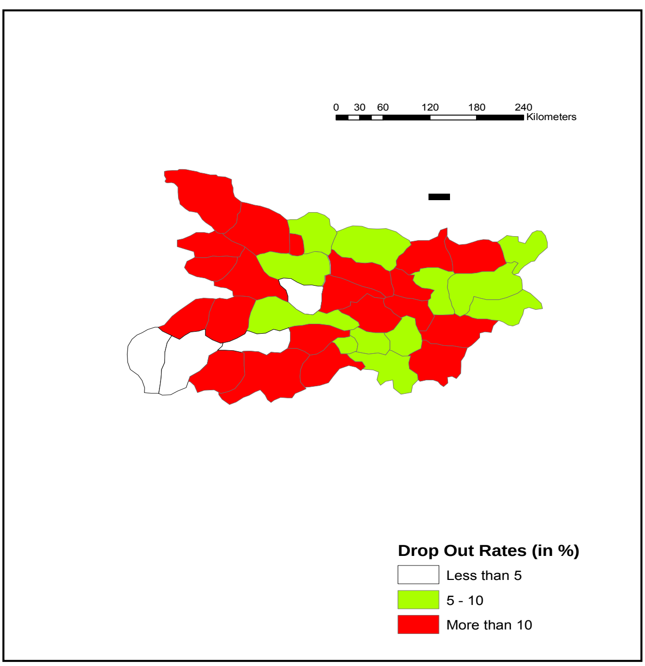
To have a clear-cut regional variation that exists within Bihar, the districts are classified into three groups on the basis of dropout, High incidence (more than 10%), Medium incidence (5-10%) and Low incidence (Less than 5%). The incidence of dropout varies from as high as 25.4% in Purba Champaran to as low as 2% in Jhenabad.

Out of 37districts, 21 districts had registered a high incidence (56.8%) of dropout, 11 have Medium incidence (29.7%) and only five districts had shown a low incidence (13.5%) of dropout (see table 4 and map 2). A generalized regional pattern can be identified in Bihar where the districts showing high incidence of dropout were located mostly on the Western and in the central part having a north-south extension.

Table 4. Incidence of dropout in Bihar, 2007-08

District name	Dropout rate	District name	Dropout rate
Paschim Champaran	24.2	Aurangabad	13.1
Purba Champaran	25.4	Jehnabad	2.0
Gopalgang	13.1	Gaya	11.5
Siwan	11.7	Seikhpura	7.8
Saran	16.2	Nawada	22.2
Sheohar	14.1	Lakhisawrai	7.3
Sitamarahi	7.8	Jamui	4.8
Muzzaffpur	9.9	Munger	6.7
Madhubani	5.4	Saharsa	13.7
Dharbanga	12.6	Sapul	17.7
Vaishali	4.1	Araria	12.1
Samastipur	11.0	Madhepura	7.8
Bhojpur	14.4	Purnia	9.5
Patna	9.8	Kishangang	7.8
Begusarai	16.2	Katihar	7.7
Khagaria	22.4	Bhagalpur	11.2
Bauxer	12.0	Banka	22.5
Kaimur(Bhabua)	4.4	Nalanda	13.3
Rohtas	4.0	-	-

Source: DISE, 2007-08.



Map 2. Dropout Rate in Primary level in Bihar, 2007-08.

Determinants of dropouts

Most of the literature dealing with the determinants of dropouts identified both demand side and supply side constraints behind children dropping out from the schools before completing the schooling cycle. The present study focuses on only the supply side determinants of dropouts. It was found that the unavailability of an adequate number of teachers was a major reason behind children dropping out of school, as indicated by the correlation coefficient value of -0.47 and the 1 percent level of significance followed by shortages of classrooms (as indicated by the correlation coefficient of -0.46 between the dropout and percentage of school having more than one classroom and the correlation was significant at 5 percent level of significance), schools driven by a single teacher (correlation coefficient of -0.39 between the Dropout and percentage schools having more than one teacher and the correlation was significant at 5 percent level of significance), shortages of schools (as indicated by correlation coefficient is -0.36 between dropout rates and the number of schools per 1000 students enrolled and was significant at 5 percent level of significance), unavailability of toilets in the schools (the correlation coefficient between the dropout and percentage of schools having toilets was -035 and significant at 5 percent level of significance), and the least affected were schools without access to drinking water facilities (the correlation coefficient between dropout and percentage of schools having drinking water facility was -0.28) (see table 5).

Table 5. Correlation between Dropout rate and various supply side determinants in Bihar

	% of school having more than one class room	% school having more than one teacher	% of school with SCR<60	% of school having toilets	% of school having drinking Water Facility	% of school having PTR<100	no of schools/1000
Drop out	-0.46**	-0.39*	-0.41*	-0.35*	-0.28	-0.47**	-0.36*

**Correlation significant at 1 percent level of significance.
*correlation significant at 5 percent level of significance.

To have a visual representation of the relationship between dropout and supply side determinants, the dropout rate was overlaid on the Educational Infrastructure Development Index (see table 6). Some striking results were found, such as eight districts had very high level of accessibility and infrastructure development, but at the same time a very high incidence of dropout. Therefore, it is clear that the demand side factors also play a major role in the completion of the schooling cycle. While the role of supply side in drop-out rates was sometimes clearly visible, such as the six (16.3%) districts that had a very low level of accessibility and infrastructure development and a very high incidence of dropout. But, the low occurrence of medium-medium combination and absence of low-low combination again stressed the fact that the demand side factors were significant determinants of completing the schooling cycle (see table 7and map 3).

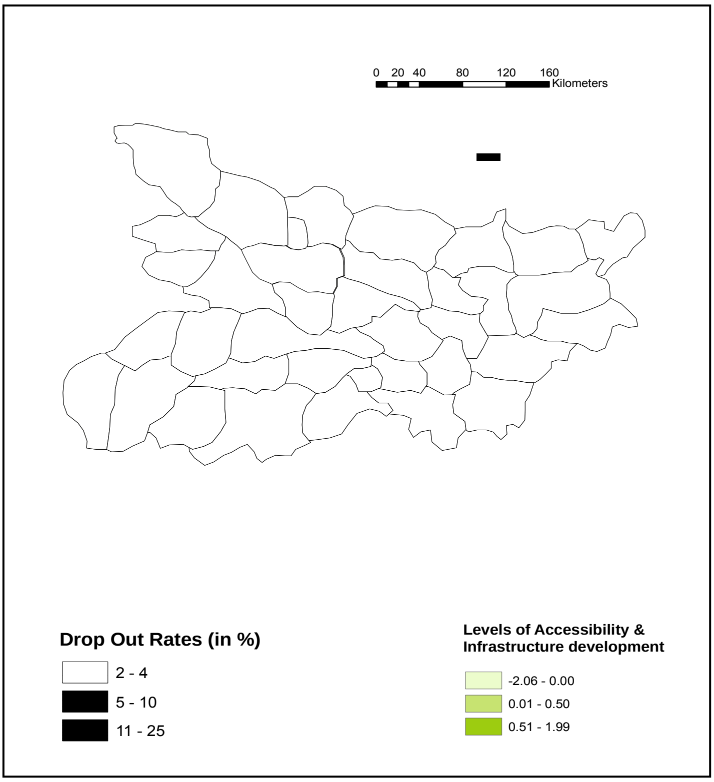
Table 6. Educational development index in Bihar

Distname	% sch with >1 class room	% sch >1 teacher	% of sch with SCR<60	% of school having toilets	% sch. drinking Water Facility	% of school having PTR<100	no of schools/1000	C.I	Rank
Araria	90.8	94.2	91.9	13.6	81.2	82.5	4.31	-0.93	31
Aurangabad	75.4	95.1	29.5	23.3	95.2	93.4	5.36	-0.79	28
Banka	85.2	83.3	56.1	20.8	65.4	85.7	7.28	-1.97	36
Bauxer	85.7	69.9	37.6	14.3	94.1	53.9	4.66	0.3	20
Begusarai	95.4	86.9	26.4	45.4	90.5	61.5	3.06	1.99	1
Bhagalpur	88.8	84.4	39.6	26.1	79	77.4	4.42	0.12	22
Bhojpur	87.5	43.1	36.4	13	96.7	40.9	4.9	0.44	18
Dharbanga	85	88.9	35.9	18.2	8.7	81.4	4.39	-1.15	32
Gaya	94.4	81.9	26.3	26	81.5	79.6	4.9	0.45	16
Gopalgang	88.7	95.4	20.1	33.3	96	90.7	3.77	0.92	5
Jamui	84	82.4	44.1	22.4	75.5	83.5	5.38	-0.82	29
Jehnabad	86.8	90.8	32.2	19.6	90.5	98.3	4.84	-0.27	25
Kaimur(Bhabua)	93.7	97.7	32.7	23	92.8	95	4.05	0.56	13
Katihar	82.4	95.7	24.1	40.4	93	80.9	4.18	0.58	12
Khagaria	91.1	97.2	32.8	16.9	87.7	93.2	4.65	0.06	23
Kishangang	94.5	96.8	13.7	19	97.6	88.5	4.24	1.02	4
Lakhisawrai	79.7	84.1	29.5	10.3	81.6	77.7	4.46	-0.35	26
Madhepura	90.4	99	25.6	22.9	85.8	93.8	4.53	0.26	21
Madhubani	88	93.6	24	12.9	93.9	89.3	4.3	0.3	19
Munger	83.4	80.8	57.5	15	69.6	86	6.53	-1.82	35
Muzzaffpur	92.6	96.1	28.9	41.5	82.7	92.8	4.41	0.58	11
Nalanda	76.9	90	45.2	45.1	90	88.5	5.79	-0.9	30
Nawada	80.3	6	47	9.5	67.4	83.8	6.24	-2.06	37
Paschim Champaran	94.2	92.1	27.2	26.6	90.9	80.7	4.44	0.78	9
Patna	82.3	84.5	60.4	19	74.4	88.4	6.34	-1.75	34
Purba Champaran	89.1	95.2	31.7	48.5	84.6	89.7	4.37	0.54	14
Purnia	89.8	98.4	13.6	13.3	89	75.8	3.48	1.12	2
Rohtas	79.2	94.5	39.1	16.1	96.1	93.9	5.02	-0.74	27
Saharsa	94.5	95.3	26.3	22.2	87.8	88.5	4.17	0.7	10
Samastipur	80.6	96.2	25	37.4	90.2	84.7	3.91	0.44	17
Sapul	95.2	96.4	23.2	35	85.7	83.8	4.47	0.91	6
Saran	93.1	83.1	42.5	16.9	92.9	56.6	4.18	0.81	7
Seikhpura	84.6	81.4	61.2	15.4	88.8	85.5	6.81	-1.65	33
Sheohar	99	98.5	44	46.5	84	91.5	4.26	0.79	8
Sitamarahi	94.4	75	33.2	50.5	85.3	70.6	4.46	1.02	3
Siwan	88.3	95.7	23.1	22.7	95	91.9	4.12	0.52	15
Vaishali	82.6	92	34.5	29.3	76.7	84.8	4.02	-0.02	24

Table 7. Combination of Dropout rate and levels of accessibility and infrastructure development in Bihar

	Accessibility and infrastructure development			
	No. of districts (%)	High	Medium	Low
Dropout	High	8 (21.6)	6 (16.3)	6 (16.3)
	Medium	5 (13.5)	2 (5.4)	5 (13.5)
	Low	1 (2.7)	4 (10.8)	0 (0.0)

Source: Author's own calculation.



Map 3. Dropout rate and Levels of Educational Infrastructure Development in Bihar.

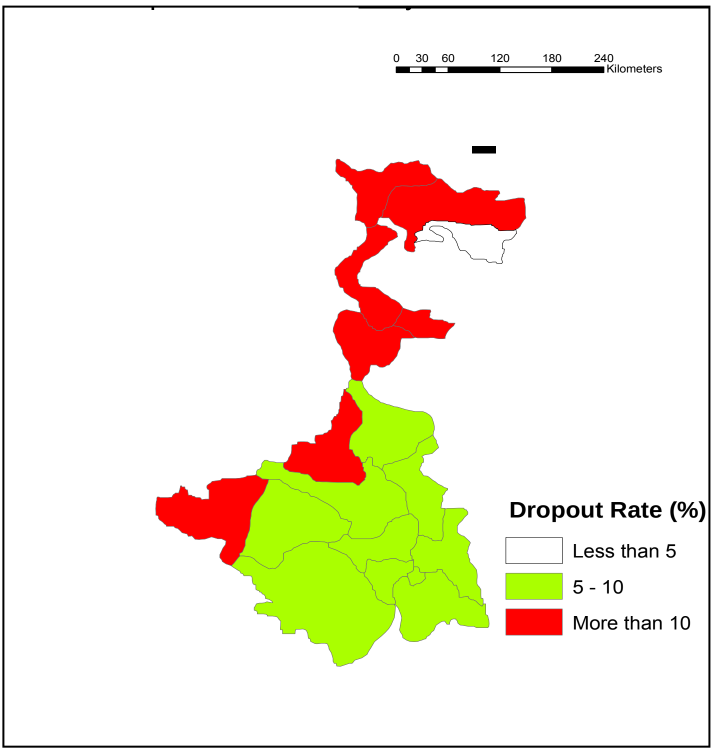
West Bengal inter-districts variation in dropout

The dropout rate in Bihar showed a characteristic inter-district variation from as high as 53.6% in Darjeeling to as low as 4.2% in Koch Bihar. The picture of inter-district variation can be captured in much detail and patterns become visible when the districts are clubbed into three categories', namely, high dropout, medium dropout and low dropout. There are seven districts that have a very high incidence of dropout, 10 districts with a medium incidence of dropout and only one district with a low incidence of dropout (see table 8 and map 4). The dropout rate in West Bengal also showed a clear cut regional dimension with districts having high levels dropout confined to the Northern and Western parts of the states, furthest from Kolkata.

Table 8. Incidence of dropout in West Benal, 2007-08

District name	Dropout rate	District name	Dropout rate
Darjeeling	53.6	Nadia	10
Jalpaiguri	13.1	North 24 Pargana	9.1
Kooch Bihar	4.2	Hugli	9.9
Uttar Dinajpur	21.3	Bankura	8
Dakshin Dinajpur	12.4	Purulia	13
Maldah	12.3	Mednipur	9.8
Murshidabad	11.1	Haora	7.5
Birbhum	10.9	Ko;kata	9.8
Bardhaman	9.3	South 24 Pargana	10.4

Source: DISE, 2007-08.



Map 4. Dropout Rate in Primary level in Wes Bengal, 2007-08.

Determinants of dropouts

In West Bengal the unavailability of an adequate number of teachers emerged as the major supply side determinants behind children dropping out from school, as indicated by the correlation coefficient value of -0.51 at 1 percent level of significance followed by shortages of classrooms (as indicated by the correlation coefficient of -0.42 between the dropout and percentage of school having more than one classroom and the correlation was significant at 5 percent level of significance), schools driven by a single teacher (correlation coefficient of -

0.36 between the dropout and percentage schools having more than one teacher and the correlation was significant at 5 percent level of significance), unavailability of toilets in the schools (the correlation coefficient between the dropout and percentage of schools having toilets was -035 and significant at 5 percent level of significance), shortages of schools (as indicated by correlation coefficient was -0.31 between dropout and number of school per 1000 student enrolled and significant at 5 percent level of significance). The least schools effected were those without access to drinking water facilities (the correlation coefficient between dropout and percentage of schools having drinking water facility was -0.24) (see table 9)

Table 9. Correlation between dropout and various supply side determinants

	% of school having more than one class room	% school having more than one teacher	% of school with SCR<60	% of school having toilets	% of school having drinking Water Facility	% of school having PTR<100	no of schools/1000
Drop out	-0.42*	-0.36*	-0.44*	-0.38	-0.24	-0.51**	-0.31*

**Correlation significant at 1 percent level of significance.

*Correlation is significant at 5 percent level of significance.

Table 10. Educational development index in West Bengal

Dist. name	%-age of school having more than one class room	%-age school having more than one teacher	%-age of school with SCR<60	%-age of school having toilets	%-age of school having drinking Water Facility	%-age of school having PTR<100	No. of schools/ 1000	C.I	Rank
Darjeeling	86.10	80.50	87.20	33.20	31.40	93.40	10.16	-2.69	18
Jalpaiguri	78.00	96.70	47.00	66.50	80.00	95.40	5.72	0.27	11
Kooch Bihar	82.30	99.40	58.90	87.70	95.10	98.30	6.53	1.13	1
Uttar Dinajpur	77.30	97.60	24.30	65.90	91.20	80.60	4.67	0.75	3
Dakshin Dinajpur	77.00	95.60	57.20	65.00	83.80	98.50	7.31	0.18	12
Maldah	79.20	99.20	36.90	59.10	78.30	78.60	4.47	0.32	10
Murshidabad	88.50	99.60	41.10	72.80	81.90	95.30	4.90	0.78	2
Birbhum	82.10	96.20	64.80	79.60	77.90	97.90	7.61	0.33	8
Bardhaman	90.80	98.60	80.40	74.90	90.20	99.20	7.27	0.67	5
Nadia	92.80	98.70	85.70	91.00	80.80	94.20	9.60	0.69	4
North 24 Pargana	75.10	95.20	55.50	71.10	79.10	95.00	6.43	0.14	13
Hugli	86.50	95.80	75.50	75.50	86.00	98.70	72.42	0.32	9
Bankura	65.90	90.90	73.40	44.40	84.30	99.00	11.06	-0.72	15
Purulia	74.10	80.20	74.50	19.90	73.80	96.60	10.50	-1.93	17
Mednipur	84.70	95.10	84.00	88.50	88.10	96.60	9.60	0.54	6
Haora	82.40	98.20	61.80	76.20	79.10	99.20	6.54	0.44	7
Ko;kata	91.40	92.20	91.30	75.40	76.00	98.60	8.27	-0.13	14
South 24 Pargana	70.30	81.20	45.10	52.80	75.20	72.30	5.57	-1.10	16

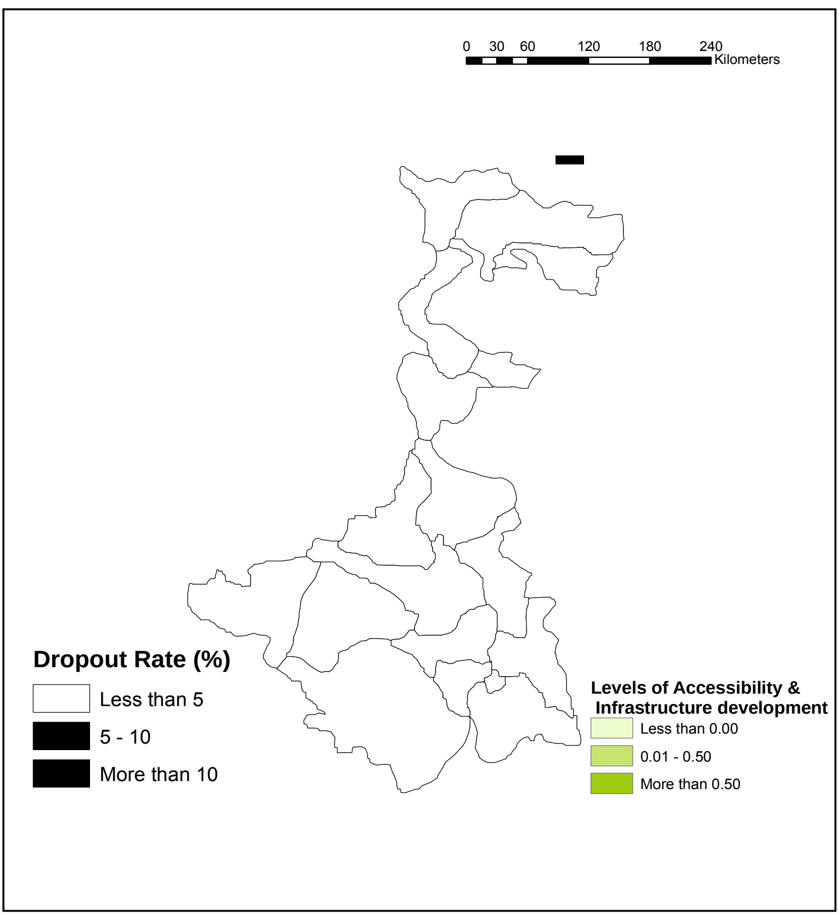
Source: DISE, 2007-08.

Again, the incidence of dropout was overlaid on the Educational Infrastructure Development Index (see table 10). It is clear that there were only two districts (11.1%) with a very high incidence of dropout and very low levels of educational infrastructure development. At the same time there was only one district (5.6%) having a low incidence of dropout as well as high levels of accessibility and infrastructure development and four districts (22.4%) with a medium-medium combination. Most of the districts had s high dropout-medium level of accessibility and infrastructure development and medium dropout-high level of accessibility and infrastructure development (see table 11 and map 5).

Table 11. Combination of dropout rate and levels of accessibility and infrastructure development in Bihar

	Accessibility and infrastructure development			
		High	Medium	Low
Dropout	High	1 (5.6)	4(22.2)	2(11.1)
	Medium	4(22.2)	4(22.2)	2(11.1)
	Low	1(5.6)	0(0.0)	0(0.0)

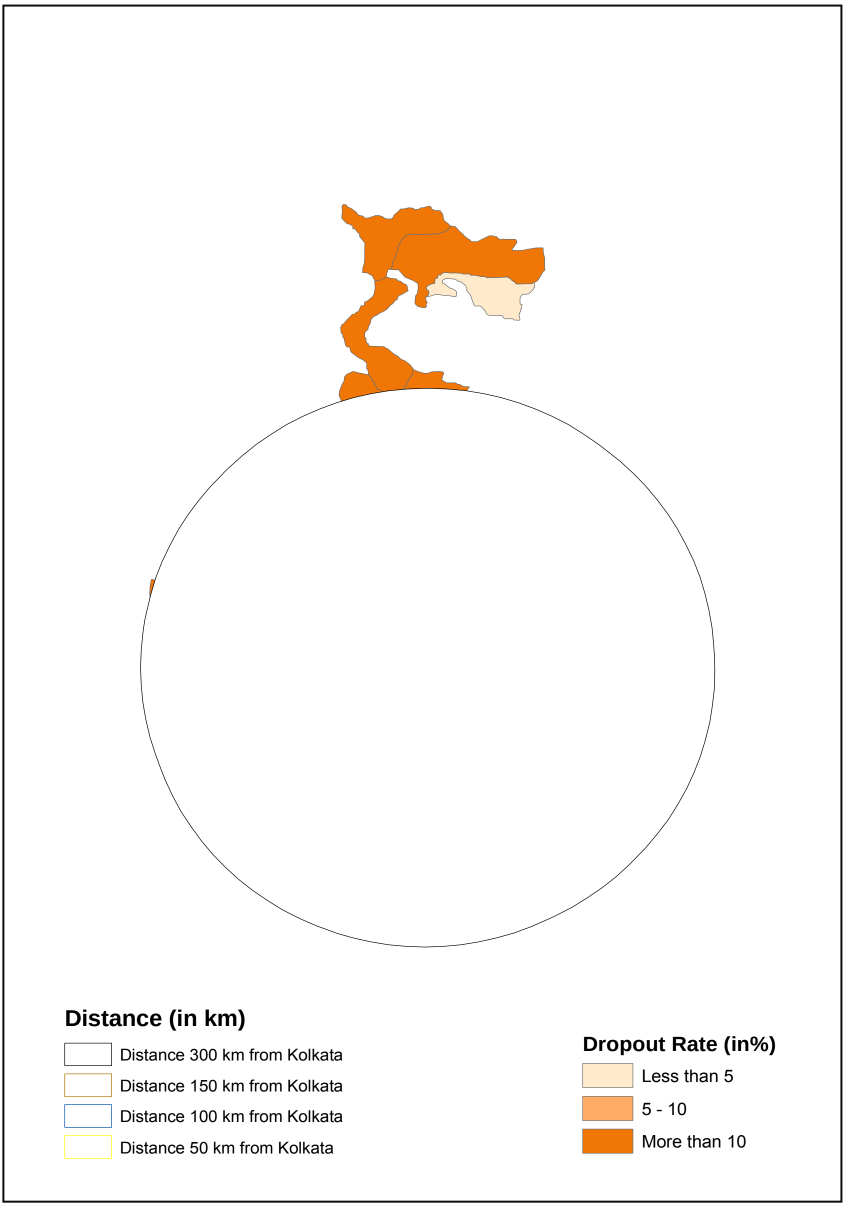
Source: Authors own calculation.



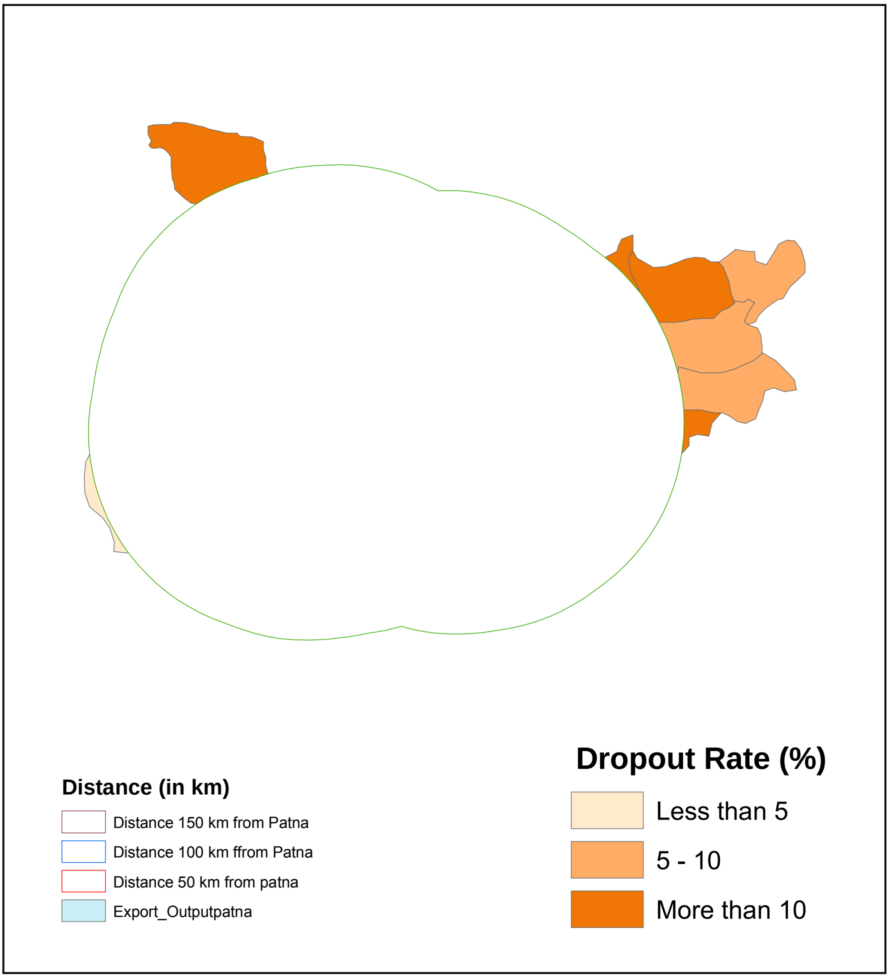
Map 5. Dropout rate and Levels of Educational Infrastructure Development in West Bengal.

Spatiality in out-of-schools in Bihar and West Bengal

The first and foremost step to target out-of-school children was to identify where a large portion of them were located. Hence, the present study employs an innovative approach by using Buffering Techniques to apply the concept of spatiality. The underlying hypothesis is that the probability of drop-outs increases as the location of children away from the most central or focal point increases (not in term of geographical position but in terms of institutional functioning). Kolkata and Patna were considered the focal points of institutional functioning.



Map 6. Incidence of dropout increasing outward from Kolkata.



Map 7. Incidence of dropout increasing outward from Patna.

Using 50 km, 100km, 150 km, 300 km Buffering Zones from Kolkata and Patna, a very clear cut regional pattern emerged. In West Bengal, the districts which were located more to the North and Western parts away from Kolkata (see map 6) contained the major chunk of out-of-school children and the proportion of them increased as the distance from Kolkata increased. In Bihar, the districts which were immediately near and furthest away from Patna (see map 7) contained the major chunk of out-of-school children, whereas the districts located between these two high incidence zones had moderate levels of uneducated children. This observation clearly reveals the spatiality in the incidence of out-of-school children and it needs to be handled very carefully, while targeting these groups to bring the children back into school (see map 5 and 6)

Discussion

Children who remain out of school are a major reason behind India's failure to universalize elementary education. Bihar and West Bengal are the two states where not only a huge number of children have never been enrolled in school, but also a substantial number of children are dropping out from the school before completing the schooling cycle, creating huge wastages. The children who remain out of school or drop out have wider socio-economic implications. At a glance, there were various pin pointing similarities and dissimilarities which emerged from the comparison of drop-outs between Bihar and West Bengal. These can be listed as follows.

Firstly, the majority of out-of-school children in Bihar never enrolled into school, whereas most of the children who were out-of-school in West Bengal were dropping out from school. Secondly, both West Bengal and Bihar had a substantial number of children who were dropping out from school before completing the schooling cycle, and thirdly, Bihar had 56.8 percent of the districts which registered high incidences of dropout, while it was 38.9 percent for West Bengal. Fourthly, when the dropout was overlaid on accessibility and infrastructure development, it was found that 24.4 percent of the districts in Bihar had the ideal situation i.e., high incidence of dropout-low accessibility and infrastructure development, medium incidence of dropout-medium levels of accessibility and infrastructure development and low incidence of dropout-high levels of accessibility and infrastructure development, whereas 38.8 percent of the district in West Bengal showed that ideal station.

Therefore, it can be concluded that supply side factors have more influence on dropout rates in West Bengal than in Bihar, and the inadequacy of teachers and shortage of classrooms were major forcing factors behind the dropout rates both in Bihar and West Bengal. In spite of the fact that there was a huge improvement in the infrastructure and accessibility, the supply side constraints remained one of the major reasons behind children dropping out of school. The districts which displayed the combination of high dropout rates and low levels of accessibility and infrastructure development must make establishing schools, expanding classrooms and recruiting teachers a priority.

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Chapter 15

THE ISSUE OF CHILDREN OUT-OF-SCHOOLS AT THE ELEMENTARY LEVEL IN INDIA

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In spite of strong government initiatives many school going children are out of school in India. This chapter explores the regional pattern of out of school children among various social groups in India in order to address some specific questions: What is the magnitude and regional variation of out of school children among various social groups and what are demand and supply side determinants for the children who are out of schools? The phenomena of out of school children cannot be seen in isolation, since it has to be linked with the overall socio-economic status of the households and provision of schooling facilities in each nation/state/region. The study attempts to explore the pattern and determinants of out-of-school children through a comprehensive approach by associating the percentage of out-of-schools household economic conditions and availability of infrastructure and accessibility in Indian states. It uses the data from MHRD (2004-05) and District Information System for Education (2005-06). The study applies a multivariate regression model considering out of schools as dependent variable and percentage of household head regular wage earner, percentage of household heads literate above primary level, percentage of female teacher availability, percentage of schools with common toilets, standardised PTR and standardised SCR as the explanatory variables. The states, which are having out of school children more than the national average were showing a typical location pattern mostly confined around the North and Central belt, together forming a contiguous belt. Three mechanisms are proposed through which child schooling may be improved: Provision, enforcement and enabling conditions.

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INTRODUCTION

The normative school of thought ascribes social order in a society as based on freedom, equity and justice. One of the most influential scholars of the normative school was John Rawls (1921-2002) and his theory of social justice put forward the idea that the state should ensure universal access to 'social primary goods' (like liberties, opportunities, self-respect etc.). Education is perhaps the most important of 'social primary goods' since it assumes primary significance in perspectives of human capital and human development. Human rights and educational deprivation can have severe negative implications. Since the independence of India, several policy measures have been taken towards educational development in general and in child schooling in particular. Universal Elementary Education (UEE) where all children of the age group 6-14 years irrespective of their caste, class, gender affiliation must complete eight years of schooling, has become a national project in India. Several schemes have been launched with a time specific target to reach the goal of UEE. Sarva Siksha Abhayan (SSA) is the umbrella launched to remove all existing facets of inequity in elementary education and achieve UEE by 2010. But the achievements to date suggest that the goal of UEE in India still remains elusive. The progress in this direction cannot be disclaimed. The pace has been tardy and halting making the achievement of UEE a distant dream. In spite of strong government initiatives a large section of children of the relevant age group are either never enrolled or not able to complete the cycle of elementary schooling in India. According to the MHRD report (2004-05) more than 13 million children comprising 6.94% of the child population in the age group of 5-14 years, remained out-of-schools. Moreover, this phenomenon is disparate in terms of region, location, caste, gender, poverty status and occupation in India. The present study considers out of school children as the central theme and a systematic effort has been given to understand and explore the pattern and determinants of out-of-school children in India. The present paper tries to address two specific questions, first, what proportion of out-of-schools is there at the national level and the pattern of regional variation in its incidence and second, what are the factors responsible for keeping children out-of-school.

Literature dealing with the educational deprivation of children considers child labour and out-of-school children as a single entity (1), but this proposition is very difficult to accept, since there are some inherent differences in terms of characteristics between the two (2, 3). Here, out of school children are defined as those who have never been enrolled in schools or are enrolled but not able to complete the schooling cycle.

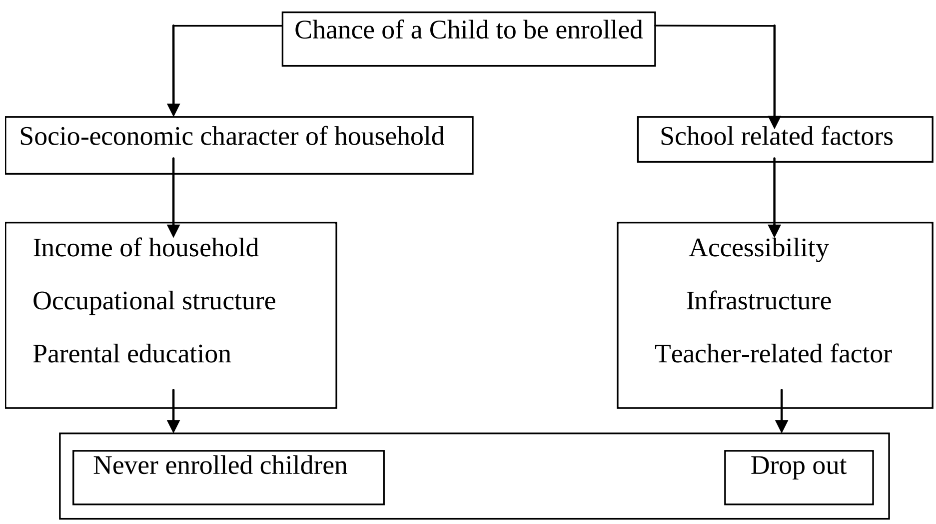
Most of the available literature highlights the income of the household, parental motivations, educational level of the parents especially, mothers education (4-7), as a major demand side and availability of school, availability of adequate classroom, presence of female teacher, toilet facilities within the school etc., as a prime supply side determinants of schooling of children in India (5, 6, 8, 9).

The present study has followed the supply-demand framework to examine the phenomena of out-of-schools. It implies that the chance for children to be out-of-school in a nation/state/region depends on the supply and demand factors with respect to schooling. The phenomena of out-of-schools may be said to arise out of the inadequate demand for and/or inadequate supply of schooling. Demand in general, arises out of the willingness and affordability and these in turn depend on the perceived values of education and the costs of schooling (both direct and indirect costs). All these, ultimately depend on the socio-economic conditions at the household levels. The supply of schooling infrastructure, albeit a necessary factor is not a sufficient condition for increase in the levels of schooling.

OUR STUDY

The present study is entirely based on secondary data collected from two different sources. Data regarding out-of-schools has been taken from the MHRD reports on out-of-school children in India for 2004-05. Information on household heads occupations and levels of education has been taken from the same sources. Information on physical and human resource availability in schools was taken from the District Information System for Education (DISE) for 2004-05.

Table 1. Schematic representation of conceptual framework of the Study



Out-of-schools

The aim of the present study was to find the pattern of out-of-schools and its determinants in India. To reach the objective various methodologies have been used. The states are divided into low (out-of-school= <6.00%), moderate (out-of-school=6.00-7.00%) and high (out-of-school= >7.00%) incidence categories. *Ratio method* has been used to find the gender disparities in out-of-schools:

$$G.D = \frac{Tf}{Tm}$$

Tm = Total male out-of-school
Tf =Total female out-of-school

G.D values will be either equal to 1 which represents perfect gender equity or will be less than 1, which represents male deprived or more than 1 means female deprived. To have a better understanding of the interstate variation in gender disparity in out-of-schools, the states are divided into three category, namely, no gender disparity (G.D= >1.10), Female deprived (G.D= 0.90-1.10), male deprived (G.D= <0.90)

To understand the causality of the relationship between the out-of-school and its various determinants the *Correlation Method* was used. To assess the individual impact of various determinants the *Ordinary Least Square Regression* model was performed considering the percentage of out-of-school as the dependent variable and percentage of household head are regular wage earner, percentage of household heads literate above primary level, percentage of female teacher availability, percentage of schools with common toilets, standardised PTR and standardised SCR as the explanatory variables.

FINDINGS

After more than 60 years of constitutional promise of universalisation of elementary education, a large part of the children in the age group 6-13 years remain out-of-schools. As per the MHRD Report (2004-05) more than 13 million, comprising 6.94 percent of the total estimated child populations, were out-of-school. India is not a homogenous country especially in terms of its socio-economic development across sub population groups differing by their spatial and socio-economic characteristics. Hence, a national snapshot of the out of school children in the age group 6-14 years is presented by (see table 2) their distribution by location (rural & urban), gender and social group.

Table 2. Percentage of Out of school Children- a National Snapshot

	Percentage of Out of School Children (6-13)
Overall	6.94
Rural	7.8
Urban	4.34
S.C	8.17
S.T	9.54
O.B.C	6.90
Muslim	9.97
Others	3.73
Overall	6.94

Source: MHRD Report, 2004-05.

The percentage of children who were out of-school was higher in rural areas (7.8%) as compared to urban areas (4.34%). When the same is viewed in terms of gender, female were deprived, the percentage of children who were out of-school was lower among males (6.18%) compared to those out-of-school among females (7.92%). At the national level the female-male ratio was almost 1.28 that means per one male almost one 1.28 female were out-of-school. Children belong to historically deprived sections such as SC and ST and educational deprived community are more vulnerable to be out-of-school. Among Muslims, the proportion of children who were out-of-schools was 9.97%; whereas the proportion of out-of-school children in the ST category was 9.54%. The next highest proportion was for the SC category with 8.17% of the children. Among OBCs, 6.90% of the children were out-of-school. Among those who belonged to 'other' social groups (higher social class) only 3.73% of the children are out-of-school.

India is not a homogenous country, hence wide variation was observed in the incidence of out-of-schools across various states and across sub population groups (gender, social groups) among various states.

The incidence of out-of-schools exhibits marked regional variations in India. While among the major states, Jammu and Kashmir (0.29%) having the lowest proportion of out-of-schools, Bihar (17%) was at the other extreme (followed by fellow BIMARU states like Jharkhand, Madhya Pradesh, and Uttar Pradesh etc.). Interestingly, even in West Bengal, Assam and Uttaranchal the levels of out-of-schools was much higher than the national level and much closer to the BIMARU states figures. Whereas all the rest of the states had the proportion of out-of-schools lower than the national average. Like the other social parameters again the South Indian states exhibited a much better picture and the proportion of out-of-school children was very low. To have a better picture of regional pattern of out-of-schools in India, the states were classified into three categories, namely, high, moderate and low levels of out-of-school. The majority of the states (see table 3) had low levels of out-of-schools, numbered 21 out of 35 accounting for about 60% of the total states. While, 12 states (34.29%) had higher levels of out-of-schools and only two states (5.71%) had moderate or near national average levels of out-of-schools. The distribution of the states exhibited a striking regional picture; most of the states which were having higher levels of out-of-schools were located around the North-West and Central part of India and together forming a contiguous belt.

Table 3. Distribution of states into various levels of out-of-schools

Class	Proportion of out-of-schools	No. of States	Percentage of States
High	More than 7.00	12	34.29
Moderate	6.00-7.00	2	5.71
Low	Less than 6.00	21	60.00

Source: Authors own calculation from MHRD Report, 2004-05.

In India location also has profound impact on the achievement of the individual. At aggregate level out-of-schools in rural areas were higher than the urban areas; the same trend was also found at the state level (see tables 4 and 5). In rural areas 14 states (40%) belonged to high levels of out-of-school category, whereas in urban areas it was only four states (11.43%), two states (5.71%) both in rural and urban areas belonged to moderate levels of out-of-school category and 19 states (54.29%) belonged to low out-of-school category in rural areas, whereas it was 29 states (82.86%) in urban areas.

Overall females are more deprived than males in all parameter of development in India, but the occurrence of gender disparity also showed striking regional variation (see table 6). It was been found that 20 (57.14) states belonged to female deprived and incidentally almost all the Bimaru states belong to that category along with educationally developed states like Kerala, Maharashtra, Gujarat etc. Nine states (25.71%) belonged to no gender disparity category, which included states like Tail Nadu, Andhra Pradesh, West Bengal, Meghalaya, Sikkim, Mizoram etc. In the male deprived category there were six (17.14%) states.

Table 4. Distribution of states into various levels of out-of-schools (Rural)

Class	Proportion of out-of-schools	No. of States	% of States
High	More than 7.00	14	40.00
Moderate	6.00-7.00	2	5.71
Low	Less than 6.00	19	54.29

Source: Authors own calculation from MHRD Report, 2004-05.

Table 5. Distribution of states into various levels of out-of-schools (Urban)

Class	Proportion of out-of-schools	No. of States	% of States
High	More than 7.00	4	11.43
Moderate	6.00-7.00	2	5.71
Low	Less than 6.00	29	82.86

Source: Authors own calculation from MHRD Report, 2004-05.

Table 6. Distribution of states into various levels of Gender Disparity in out-of-schools

	class width	No. of States	Percentage (%)
Female deprived	>1.10	20	57.14
No gender deprivation	0.90-1.10	9	25.71
Male deprived	<0.90	6	17.14

Source: Authors own calculation from MHRD Report, 2004-05.

Table 7. Distribution of states into various levels out-of-schools according to various social categories

	High		Moderate		Low		N.A	
	No. of States	%-age of States	No. of States	%-age of States	No. of States	%-age of States	No. of States	%-age of States
S.C	7	20.00	2	5.71	17	48.57	9	25.71
S.T	14	40.00	0	0.00	16	45.71	5	14.29
O.B.C	7	20.00	3	8.57	19	54.29	6	17.14
Muslim	12	34.29	0	0.00	16	45.71	7	20.00
Others	4	11.43	1	2.86	26	74.29	4	11.43

Source: Authors own calculation from MHRD Report, 2004-05.

When the out-of-schools were disaggregated into sub population groups at state level it again retained the same trend as at the aggregate level (see table 7). At state level ST are the most deprived, since almost 40% of the states registered high incidence of out-of-schools for ST children followed by Muslims where 34% of the states belonged to high incidence of out-of-schools for Muslim, then by OBC and SC where 20 % of the states belonged to high incidence of out-of-schools and only 11.43 states for others had high incidence of out-of-schools. Contrary to this 74.29% of the states belonged to low incidence of out-of-schools for others followed by 54.29% for OBC, 48.57% for the SC and 45.71% each for Muslim and ST in the low incidence of out-of-schools category. That clearly indicates that so called higher groups children are more likely to be enrolled and complete their schooling cycle, whereas Muslim and ST children are more likely to remain out-of-schools (see figure 1).

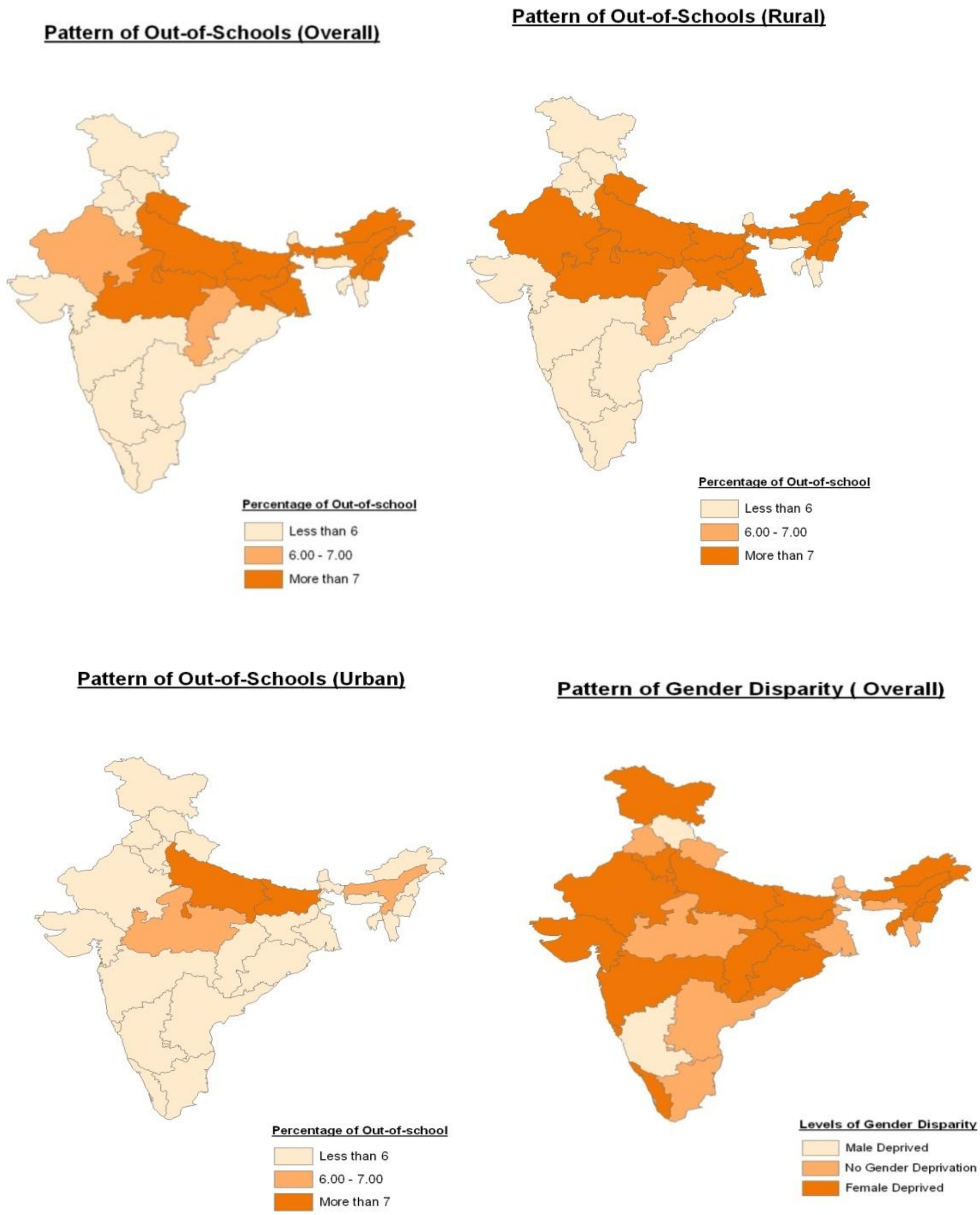


Figure 1. Distribution of states into various levels out-of-schools according to various social categories.

The dynamics of out-of-schools in various states of India has shown characteristic differences. The proportion of never enrolled was 68.26%, whereas 31.74% were drop outs. But there is a wide spread variation at state level in terms of proportion of these two facets. In some states it is associated with the never enrolled children, whereas in some states it is linked with the drop outs (see figure 2). In states like Uttar Pradesh, Madhya Pradesh, Bihar, Rajasthan the proportion of never enrolled children is much higher than the all India proportion, whereas in states like West Bengal, Gujarat and Chhattisgarh the proportion of drop out is the major contributing factor behind the out-of-schools. So, policy must be directed to tackle two different problems separately.

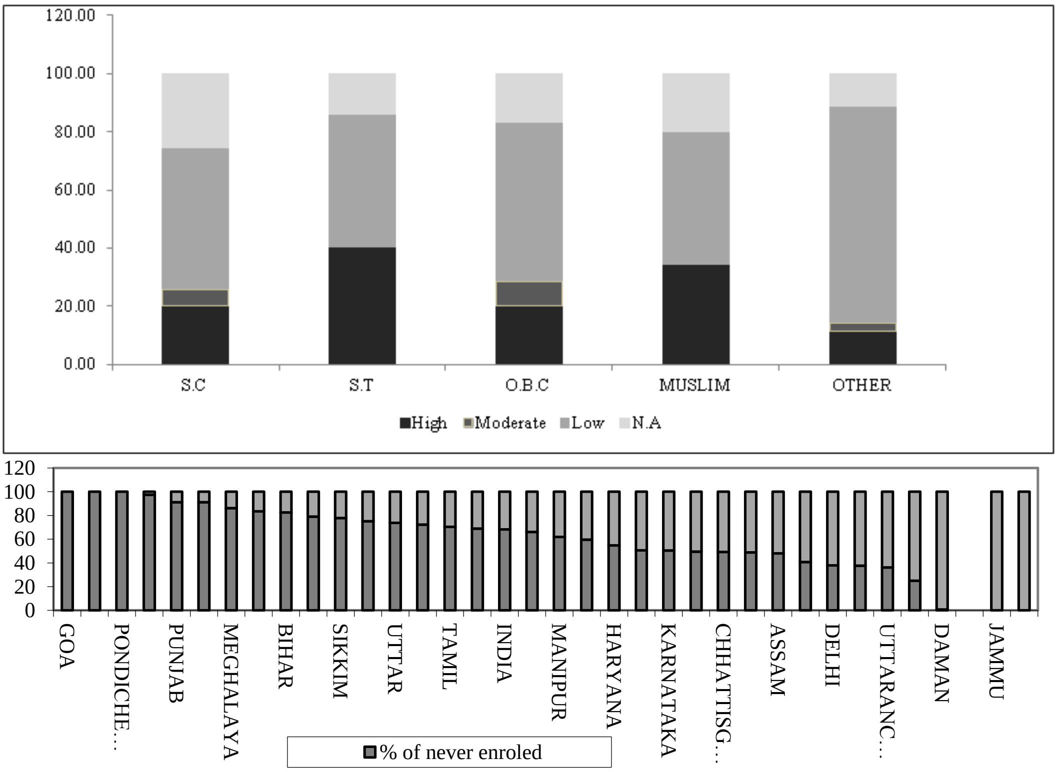


Figure 2. Distribution of out-of-schools into Never enrolled and drop outs in different states.

Table 8. Correlation between out-of-school and various determinants

	HH RWE	HHLAPL	PFTCH	PST	PTR	SCR
out of school children	-0.53*	-0.64**	-0.61**	-0.48*	0.54*	0.56*

**Correlation is significant at the 1 percent level (2 tailed).

* Correlation is significant at the 5 percent level (2 tailed).

(HHRWE- Percentage of Households Head Regular Wage Earner, HHLAPL- percentage of Household Head literate Above Primary Level ,PFTCH- Percentage of Female Teachers, PST- percentage of schools having toilets, SPTR- Standardized Pupil Teacher Ratio, SSCR- Standardized Student Class Room Ratio).

Now the question is what are the factors associated behind the creation of such characteristic regional variation in the incidence of out-of-schools across various sub-population groups? Research into the factors which are responsible for keeping out children from school considered both demand and supply factors, which acts as the barrier of schooling. In this study both demand and supply side factors were considered and individual impact of these determinants on out-of-schools were examined by correlation (see table 8) and Ordinary Least Square Regression (see table 9).

Table 9. Multivariate Regression Model

Independent Variable	**Dependent Variable**
	out-of-school children
Constant	0.22 (0.04)
HH RWE	0.70 (0.01)
HHLAPL	0.15 (0.12)
PFTCH	0.75 (0.38)
PST	0.43 (0.18)
SPTR	0.36 (0.23)
SSCR	0.42 (0.25)
R2	0.86
N	35

Value in parentheses indicating Standard Error (SE).

(HHRWE- Percentage of Households Head Regular Wage Earner, HHLAPL- percentage of Household Head literate Above Primary Level ,PFTCH- Percentage of Female Teachers, PST- percentage of schools having toilets, SPTR- Standardized Pupil Teacher Ratio, SSCR- Standardized Student Class Room Ratio).

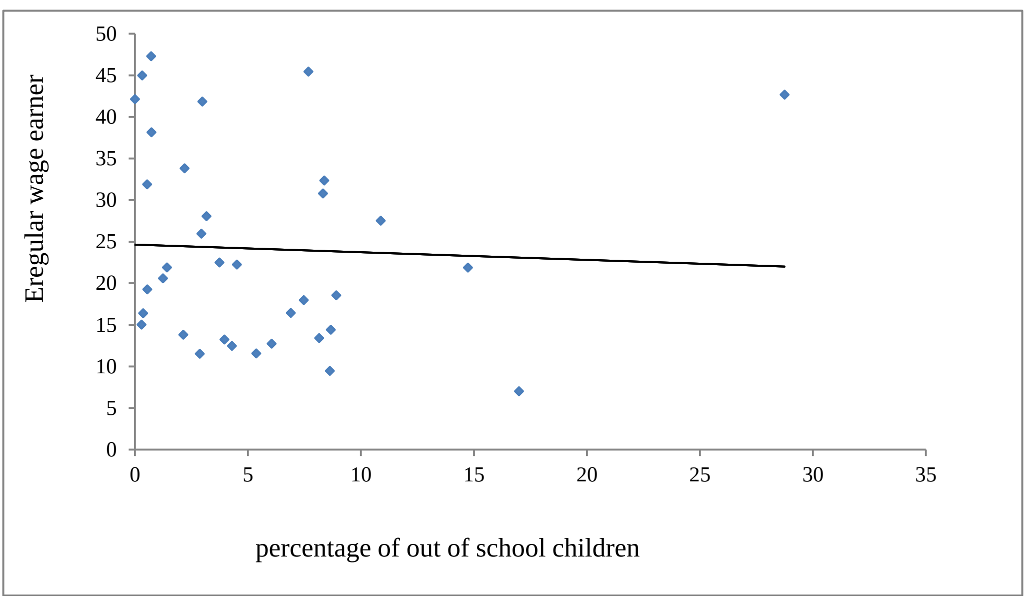


Figure 3. Relationship between the out-of-schools and percentage of household head regular wage earner.

In the present study low income of the household and low education of the head of the household was considered as the influential household level factors behind children out-of-schools. Household income was found to be an important factor in determining access to education as schooling potentially incurs a range of costs, both upfront and hidden. Upfront costs include schools fees, while more hidden costs include costs of uniforms, travelling, equipments and opportunity costs of sending a child into schools. Hence, low income acts as a burden to send the child into the school. A number of studies highlighted the direct links between the poverty and children out-of-schools (4, 5). Porteus et al. (6) while discussing exclusions pointed poverty as the “most common primary and contributory reason for student to be out-of-schools.” The present study used percentage of household heads who were regular wage earner as a proxy to levels of income of the household. It was been found that directionality of association between these two variables was negative (see figure 3). The correlation coefficient between two variables was -0.53 and was significant at 1 percent levels of significance. That indicates, as income of the household increases the chance of a children to be out-of-schools decreased and vice-versa.

Schooling of children largely depend on how parents perceive education and hence, research indicates that educational level of the household member is particularly influential in determining whether and how long children access to schooling. Higher parental education is associated with the increased access to schooling and lower dropout rates (10). In the present study the impact of parental education was tested on the basis of associating out-of-schools with the percentage of household heads literate above primary level. It was found that both the variables (see figure 4) were negatively associated (R= -0.64) and statistically significant at 1 percent level of significance. That implies the chance of getting enrolled in school was higher in the household, where the members were.

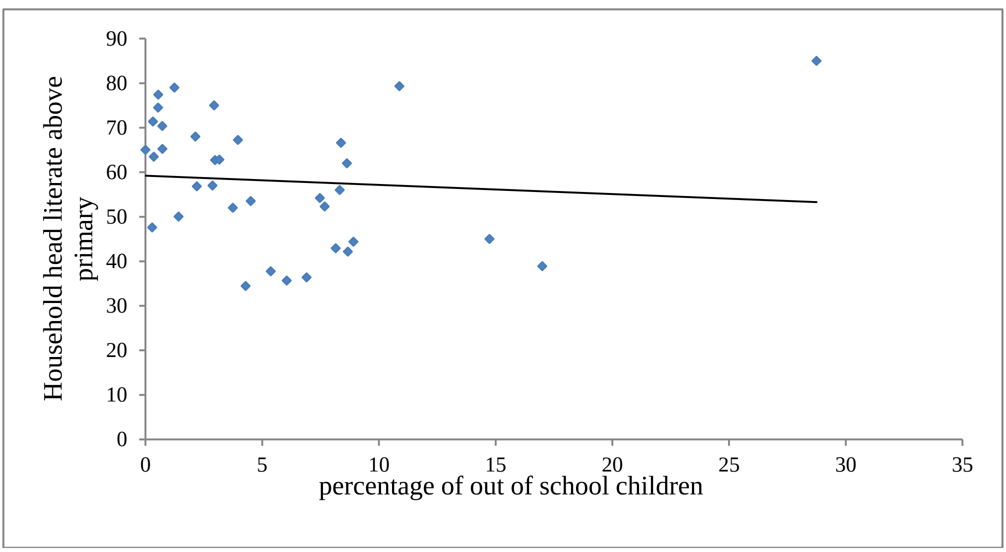


Figure 4. Relationship between the out-of-schools and educational level of the head of the household.

Accessibility of schools, physical resources and the human resource availability of schools were also important determining factors behind child schooling. Educational access can be restricted by inadequate supply of schools (8). The lacks of schools availability not only affect the initial access, but also the retention of child in the schools. Distance to schools being an important determining factors for educational access, particularly for girl children in India (8, 11). Availability of adequate teacher, sufficient class rooms and toilets, particularly separate toilet for girls, are other important determinants of child’s retention.

Here, the impact of the supply side aspects has been tested by associating percentage of female teacher's availability, percentage of schools having toilet, pupil-teacher ratio and student-class room ratio with the percentage of out-of-schools children. It has been found that the percentage of female teachers and the percentage of schools with common toilets were negatively associated (see figure 5) with out-of-schools, while pupil-teacher ratio and student-class room ratio were positively associated (see figures 6 and 7) with out-of-schools. That means the higher the proportion of female teachers and percentage of schools having toilet, the lower the proportion of out-of-schools and on the other side the higher the pupil-teacher ratio and student-class room ratio, the higher the of out-of-schools.

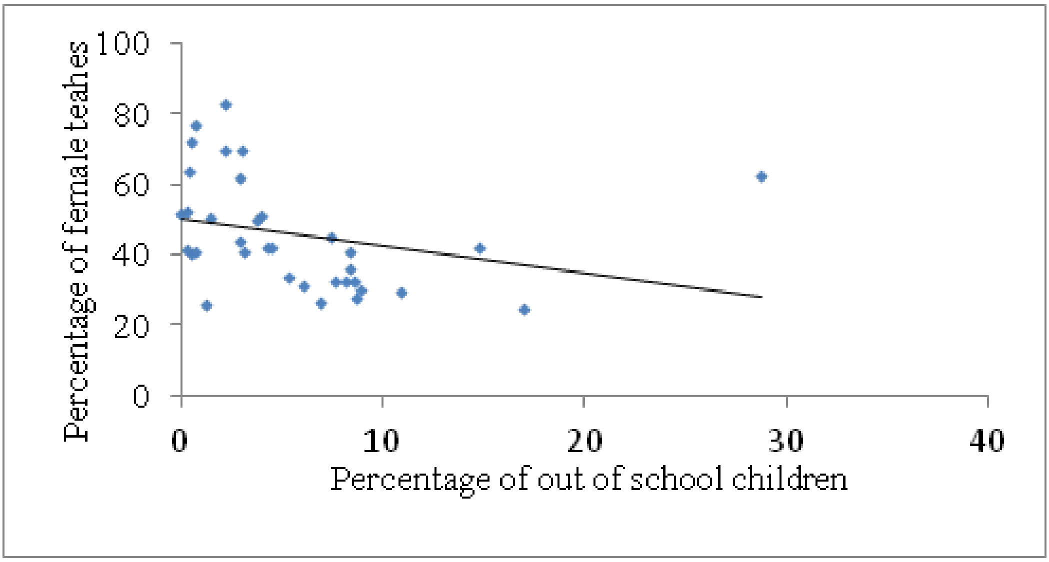


Figure 5. Relationship between the out-of-schools and availability of female teachers.

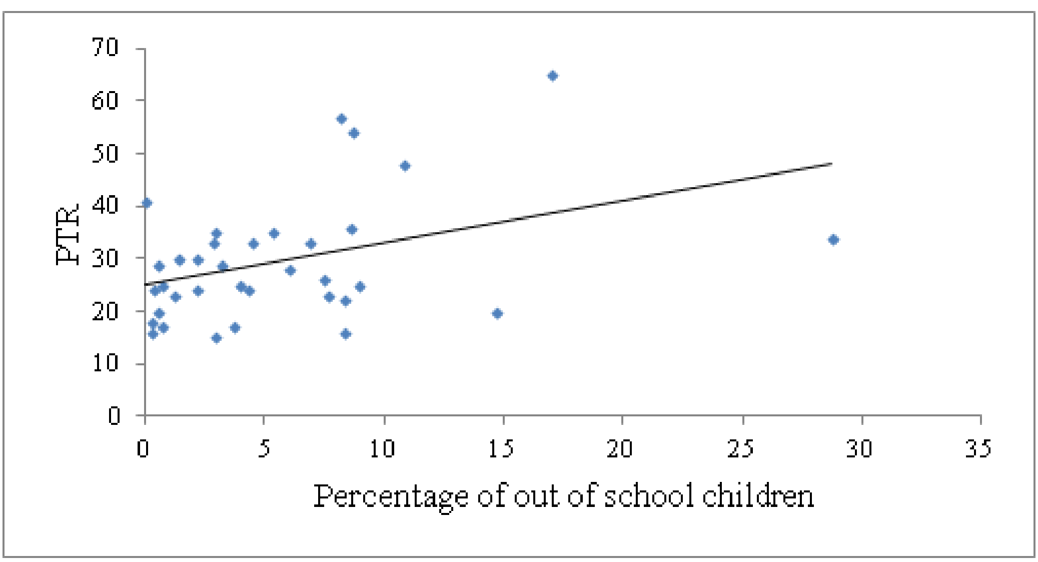


Figure 6. Relationship between the out-of-schools and availability of teacher.

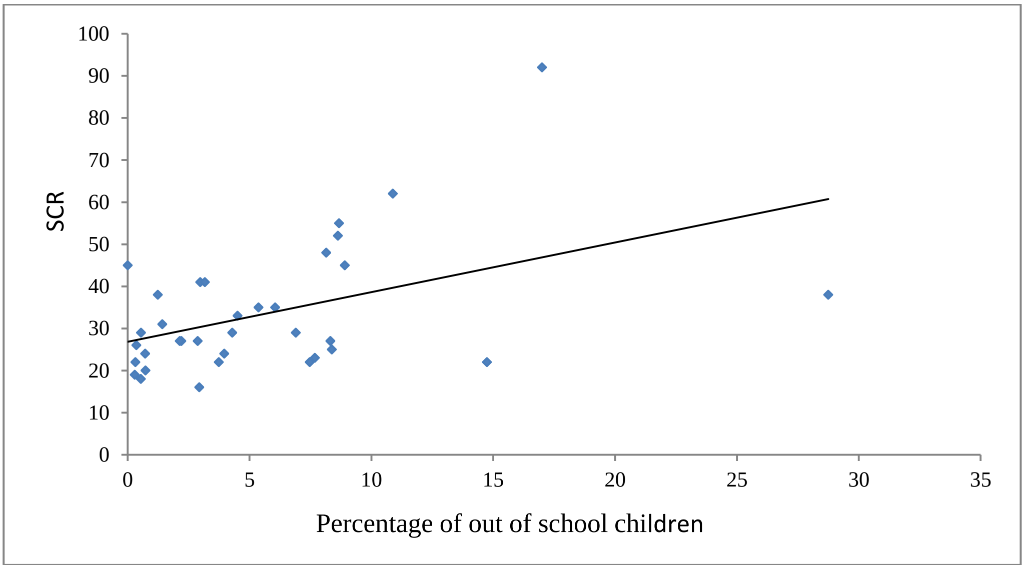


Figure 7. Relationship between the out-of-schools and availability of class room.

To assess the individual impact of all determinants, the analysis used simple Linear Multivariate Regression model (see table 9) considering percentage of out-of-school children as the dependent variable and the percentage of household head were regular wage earner, percentage of household heads literate above primary level, percentage of female teacher availability, percentage of schools with common toilets, standardised PTR and standardised SCR as the explanatory variables.

From the above it is clear that the explanatory power of the model is very high, indicated by the $R^2=0.86$. Hence, it can be said that out of school children was largely dependent on the above mentioned five explanatory variables.

The multivariate model indicates that all the five variables were negatively associated with percentage of-out-of-schools. Among them household heads literate above the primary level has the most profound impact on reducing the out-of-schools as indicated by the β coefficient, followed by teacher-pupil ratio, student-class room ratio, percentage of household heads with regular wage earner and percentage of female teacher availability, if other explanatory variables were constant.

Discussion

Based on the above discussions, the present study had several key findings. First, the pattern of out-of-schools children in India showed marked regional variation. It was interesting to note that most of the states which were having out-of-school children higher than the national level were clustering around the central and the north-west part of India and together formed a 'contiguous belt'. Secondly, children from the rural areas were more likely to be out-of-schools compared to their urban counterparts. Thirdly, the incidence varied across social groups with highest incidence found for children of historically underprivileged social groups (SC and ST) and religious minorities (e.g., Muslim). Fourthly, there were characteristics of individual determinants (location, caste and gender), differences according to each of the attributes, while keeping the other attributes fixed, was significant and the difference in each attribute (for instance gender) varied with the other two attributes (location and caste). Fifthly, children from the low income households where the household members were illiterate were more likely to be out-of-schools.

One may conclude that children being out-of schools is a consequence of multiple deprivations, which could be summed up as the problem of insecurity. In the present study in a given socio-cultural setting, economic factors like low levels of income and parental education emerge as major deciding factors behind child schooling. Children out-of-schools were either engaged in household duties or working as a valued member in the family.

Apart from the problem of cost of schooling, more specifically indirect cost of schooling, physical access and in some cases social access act in unison as reason for out-of-schools. As a consequence, the constitutional provision of 'free' elementary education becomes a rhetoric rather than reality for many poor children in India. In the policy perspectives, it is assumed that the state has the obligation to deliver the educational services. The supply (provision) of schooling is necessary, but not a sufficient condition for ensuring universal child schooling. Rather the present study proposed three mechanisms through which child schooling may be improved: provision, enforcement and enabling conditions.

The provision meets both the manifested demand and the latent demand by converting the latent into manifested through demonstration effect, persuasion and role modeling. The enforcement keeps the obligation on parents to send their children to schools. Finally, policy directed towards out-of-school children not only emphasizes the provision of schooling, but should ensure the availability of required means for all parents for attainment of the goal of *universalisation of elementary education*.

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SECTION THREE: BLOOD DISORDERS

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Chapter 16

SPECTRUM OF HEMOGLOBINOPATHIES AND EVALUATION OF BETA-THALASSEMIA TRAIT IN THE TRIBAL LAND OF MIDDLE INDIA

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ABSTRACT

It is fascinating that about half of the world's indigenous communities live in India. They constituted 8.2% of the total population as per 2001 census. Tribal communities are highly vulnerable to many hereditary hemolytic disorders that cause high degree of morbidity and mortality. Pattern of hemoglobin disorders in Central India is still unknown. Based on 1251 referral cases studied during March 2010 to March 2012 from a tertiary hospital, has shown the highest incidence of sickle cell trait (24.6%) and β-thalassemia trait (12.1%) in the general population of Central India. From the tribal land of Odisha, the highest frequency of β-thalassemia trait (12.7%) was noticed among Paraja Bhuyan tribe of Sundargarh district, followed by Paraja tribe (8.5%) of Koraput district, Dudh Kharia (8.1%) of Sundargarh district, Santhal (8.0%) of Mayurbhanj district, Paik Bhuyan (7.8%) of Sundargarh district. High frequency of β-thalassemia trait (10.4%) was recorded among Hill Korwa of Chhattisgarh. A very low frequency of β-thalassemia trait (range: 0.4-3.8%) was observed among other major scheduled tribes of Chhattisgarh. The prevalence of β-thalassemia trait (range being 0.2-3.6%) was found very low in Madhya Pradesh. However, the highest frequency of β-thalassemia trait (10.0%) was recorded among Gond tribe of Damoh district in Madhya Pradesh. The frequency of β-thalassemia trait was equally high among scheduled castes such as Jharia caste (10.0%) of Jabalpur district, and followed by Chaudhury (9.0%) of Damoh district, and other backward castes (8.6%) of the state. The frequency of β-thalassemia trait was recorded to be around 3% among Bagata tribe of Andhra Pradesh. The frequency of β-thalassemia trait in primitive

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tribes of Gujarat (3.1-4.6%), Maharashtra (1.6-3.2%) and Tamil Nadu (0.9-2.3%) was also found very low. In view of the high prevalence of β-thalassemia trait among some tribal communities, emphasis was laid on intervention and prevention through antenatal carrier screening, genetic/marriage counseling and establishment of prenatal diagnostic facilities in localities of at risk tribes in India.

INTRODUCTION

It is fascinating that about half of the indigenous people of the world, i. e. 84,326,240 as per 2001 census live in India and they constitute 8.2% of the total population of the country. The common terminology used for these people is aboriginese, indigenous people, tribal communities, and tribals; the primitive tribes/communities being the most backward of all people. There are about 635 tribes and subtribes including 75 primitive communities registered in 2001 census. These communities are highly vulnerable to hereditary hemolytic disorders that cause high degree of morbidity, infant and maternal mortality in India.

The malady of hemoglobinopathies in India is an important public health problem. Of the erythrocytic disorders of hemoglobin (Hb), beta (β)-thalassemia is the most common among the general castes/communities of India. In the North/North-western part of India, α- and β-thalassemia, and sickle cell and hemoglobin D significantly represents a public health problem. The β-thalassemia is an inherited disorder in which the body is unable to synthesize adequate amount of hemoglobin due to a genetic defect that leads to absence or reduced synthesis of one or more polypeptide globin chains of hemoglobin molecule. This causes a spectrum of anomalies among the vulnerable individuals/communities leading to ineffective erythropoiesis. It has a wide geographical spread throughout the country, the highest prevalence being in the North-western, followed by North-eastern, and the lowest being in Southern parts of India (1, 2). With a wide range of variation of its prevalence in different communities of India, it would be interesting to explore the prevalence of β-thalassemia among the under privileged indigenous people of India.

This research paper would considerably be of interest to the international scientific community to know that the indigenous communities that are endogamous in India were originally more or less completely free from hereditary β-thalassemia. However, with the advent of penetration of invaders and/or migration of local/nonlocal nontribal communities and/or invaders from other parts of the world, especially from Mediterranean/gulf and/or South East Asian regions, the β-thalassemia was introduced in them. In addition to knowing the pattern of hemoglobinopathies in a tertiary hospital in Central India, it would be fascinating to see geographical/regional or ethnic variations with respect to distribution of β-thalassemia trait in tribal land belt of India.

OUR STUDY

This study is a part of a major ongoing research project undertaken on ‘Reproductive Outcome in Carrier Couples of Hemoglobinopathies in a Tertiary Hospital in Central India.’ Ethical approval was obtained from the Human Ethical Committee, Regional Medical Research Centre for Tribals (ICMR), Jabalpur, Madhya Pradesh, Central India. A total of

1251 subjects suspected to be suffering from anemia/hemoglobinopathies referred from a tertiary hospital, Netaji Subhash Chandra Bose Medical College & Hospital, Jabalpur in Central India were screened for β-thalassemia and other hemoglobinopathies during the period from March 2010 to March 2012.

About 2ml. of blood was taken intravenously under aseptical conditions using disposable syringes and needles with disodium salt of ethylene diamine tetra acetic acid (EDTA) as anticoagulant from each individual after taking informed/written consent and was free of blood transfusion for at least one month for screening of hemoglobinopathies and β-thalassemia syndrome. Blood so collected was transported to laboratory at RMRCT, Jabalpur under wet-cold conditions for analysis. All the adopted procedures and techniques standardized in the laboratory were followed for diagnosis as described elsewhere (3, 4). Hematological indices were measured using MS_59 Hematological Analyzer (Melet and Schloesing Laboratories, Cergy-Pontoise Cedex, France). Laboratory investigations were carried out following standard procedures. All the blood samples were further subjected to confirmation by hemoglobin variant analysis (made for Bio-Rad Diagnostics Group, Hercules, California, USA). For quality control, results were cross-checked periodically. Family studies were carried out to confirm the diagnosis, wherever it was necessary.

FINDINGS

Table 1 shows the pattern of hemoglobinopathies in a tertiary hospital in Central India. It is interesting to note that the sickle cell trait is the most common hemoglobinopathy (24.6%), followed by β-thalassemia trait (12.1%), sickle cell disease (7.7%), β-thalassemia major (2.4%), sickle cell-β-thalassemia (2.4%), sickle cell-E disease (0.2%), hemoglobin E trait (0.3%), and hemoglobin E-β-thalassemia (0.1%) in the decreasing order. Out 1251 blood samples screened, 50.2% were found normal, i.e., without any hemoglobinopathies.

Table 1. Spectrum of hemoglobinopathies in a Tertiary Hospital in Central India

Types of Hemoglobinopathies	Number	Percentage
Normal	628	50.2
Sickle cell trait	308	24.6
Sickle cell disease	96	7.7
Sickle cell-β-thalassemia	30	2.4
Sickle cell-E disease	2	0.2
Hemoglobin E trait	4	0.3
Hemoglobin E-β-thalassemia	1	0.1
β-thalassemia trait	152	12.1
Thalassemia Major	30	2.4
Total	1251	100.0

During this study, three typical families of β–thalassemia were encountered and their illustrated details are presented in tables 2-4, which are self explanatory. In the state of Madhya Pradesh, we have encountered not only the β^0, β^+-thalassemia but also the β^{++}-

thalassemia in some tribal as well as nontribal communities with mild clinical manifestations, thus indicating that β^{++}-thalassemia is not a rare disease entity in India (Table 2 to 4).

Table 2. A Gond family with Sickle cell-β^0-thalassemia belonging to scheduled tribe community from Jabalpur district of Madhya Pradesh, India

Parameters of study/ Hematological indices	Parents		Offsprings
	Sadaram Haveli (Father)	Saroj Bai (Mother)	Two stillbirths (Daughters) and one miscarriage of 5 months
Age in years	28	26	
Sex	Male	Female	
Hb (g/dl)	11.0	9.0	
RBC($x10^3/\mu l$)	4.8	4.2	
HCT (%)	35.9	30.3	
MCV (fl)	74.7	72.8	
MCH (pg)	22.8	21.6	
MCHC (g/dl)	30.6	29.7	
RDW (%)	11.6	11.6	
WBC ($x10^3/\mu l$)	8.8	8.1	
Sickling test	-ve	+ve	
Electrophoresis:			
Major bands	AA_2	SFA_2	
Hb A_2 (%)	6.2	5.3	
Hb F (%)	1.6	6.7	
Hb S (%)	-	88.0	
Hb A (%)	92.2	-	
Red Cell Morphology	Microcytosis, Hypochromia	Microcytosis, Hypochromia	
Clinical Symptoms	-	Pallor Back Ache Mild Jaundice Splenomegaly (4 cm), H/o Hospitalization	

* Name of patient changed.

DISCUSSION

The thalassemias and related hemoglobinopathies are responsible for a large number of genetic disorders and hence are of great public health importance especially in Central India. A large number of hemoglobin variants prevalent among the populations of Central India (Table 1) indicate that hemoglobinopathies and also their related clinical complications are not uncommon at birth. The inherited disorders of hemoglobin synthesis are one of the important public health challenges in the region. The present scenario of hemoglobinopathies reflects the genetic heterogeneity of the population of the region. Historical accounts (5) reveal that several ethnic elements with varied genetic heritages have been absorbed into the mainstream, resulting in population diversity with the passage of time (6). The findings of high incidence of different hemoglobinopathies in the region are in agreement with the population admixture in Central India.

Table 3. A Yadav family with β^+-thalassemia belonging to Other Backward Community from Narsinghpur district of Madhya Pradesh, India

Parameters of study /Hematological indices	Parents		Offsprings	
	Komal Singh (Father)	Saroj Bai (Mother)	Vipin (Son)	Vineet (Son)
Age in years	35	30	8	5
Sex	Male	Female	Male	Male
Hb (g/dl)	13.8	9.6	11.3	8.4
RBC($x10^3/\mu l$)	5.4	3.3	4.7	3.9
HCT (%)	45.9	28.0	34.3	27.3
MCV (fl)	85.1	86.1	72.8	70.6
MCH (pg)	25.6	27.6	24.1	21.6
MCHC (g/dl)	30.1	32.1	33.0	30.6
RDW (%)	11.7	12.4	12.8	15.4
WBC ($x10^3/\mu l$)	9.1	7.2	13.1	16.2
Sickling test	-ve	+ve	+ve	+ve
Major bands	AA_2	SF	AS	$ASFA_2$
Hb A_2 (%)	5.3	3.0	2.2	7.2
Hb F (%)	1.3	20.0	1.6	30.5
Hb S (%)	-	77.0	32.2	32.6 -
Hb A (%)	93.4	-	64.0	29.7
Red cell Morphology	Microcytemia Hypochromia	Microcytemia Hypochromia	Leucocytosis Microcytemia, Hypochromia	Leucocytosis, Microcytemia Hypochromia
Clinical symptoms	-	Splenomegaly		Occasional joint and abdominal pains, Hepato-splenomegaly (3 cm)

*Name of patient changed.

All the β-thalassemia major patients were transfusion dependent, whereas only 10% of the sickle cell disease cases needed blood transfusion. High levels of fetal hemoglobin ranging from 2 to 30% were observed among the sickle cell disease patients. It is interesting to note that splenomegaly was consistently observed in β-thalassemia trait, β-thalassemia major and in sickle cell disease cases in this population. *Plasmodium falciparum* malaria is rampant in this region, which may also be responsible for splenomegaly in subjects with either a normal hemoglobin profile or with sickle cell or β-thalassemia trait.

Table 4. A Jharia family with β^{++}-thalassemia belonging to scheduled caste community from Jabalpur Town of Madhya Pradesh, India

Parameters of study/ Hematological indices	Parents		Offsprings		
	Pradeep (Father)	Sadhna (Mother)	Sunita (Daughter)	Shivani (Daughter)	Chaman (Son)
Age in years	35	31	13	11	10
Sex	Male	Female	Female	Female	Male
Hb (g/dl)	15.3	12.6	11.3	10.3	11.2
RBC (x10^3/μl)	4.6	5.2	4.4	3.6	4.4
HCT (%)	47.8	42.3	37.4	33.6	37.9
MCV (fl)	103.1	80.7	84.2	93.3	86.2
MCH (pg)	33.1	24.1	25.5	28.5	25.5
MCHC (g/dl)	32.1	29.8	30.3	30.5	29.5
RDW (%)	10.2	11.9	12.9	12.9	11.8
WBC (x10^3/μl)	10.2	6.6	14.2	6.9	5.4
Sickling test	+ve	+ve	+ve	-ve	+ve
Electrophoresis:					
Major bands	ASA_2	AS	AS	AA	ASA_2
Hb A_2 (%)	6.6	3.0	2.2	2.2	6.7
Hb F (%)	11.8	1.0	1.2	1.0	10.6
Hb S (%)	42.0	34.7	32.6	-	37.2
Hb A (%)	39.6	61.3	64.0	96.8	45.5
Red cell Morphology	Macro-cytemia	-	Leuco-cytosis, Normo-chromic anemia	Normo-chromic anemia	Normo-chromic anemia
Clinical symptoms	-	-	-	-	Occasional joint and abdominal pains

* Name of patient changed.

Due to the intriguing nature of the people, historical accounts (5) regarding the gene flow or migrations of different waves of people from different corners of Central India are still obscure.

Epidemiology and clinical profile of β-thalassemia in tribal land Belt of India

Reporting of thalassemia major in the tribal communities in the rural India is either almost absent or very rare due to non-availability of reliable diagnostic and medical facilities or due to missed diagnosis because of untrained medical manpower. Thus, in the absence of a true picture of clinical manifestations, prognosis and management strategies for the prevention and control of β-thalassemia in the country, there is a demand for special attention to be given in vulnerable communities in rural areas especially to the indigenous people in India.

Inherited disorders of hemoglobin are the commonest monogenic disorders in the Indian subcontinent. They are frequently encountered in scheduled castes (SC) and scheduled (indigenous) tribes (ST), and in other backward castes (OBC) than in other endogamous communities residing in adjacent geographical regions of Central India. The tribal land belt in India constitutes the states of West Bengal, Jharkhand, Odisha, Northern Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, Uttar Pradesh, and some pockets of Kerala and Tamil Nadu in South India. The β-thalassemia syndrome and sickle cell (Hb S) disorders are the most predominant genetic and clinical disease burden in Central India (3, 7). These disorders present heterogeneity in their geographical distribution, scatter or spread in the vulnerable people. The undivided state of Madhya Pradesh (i.e., Madhya Pradesh and Chhattisgarh) harbors about one-fourth of the total tribal (aborigional or indigenous people) population of India.

The sporadic surveys carried out by different medical/research institutes/centers either independently or in collaboration with medical colleges (hospital based data), research institutes/centers or nongovernmental organizations (NGOs) indicate the occurrence of β-thalassemia in the tribal land of India. Therefore, the reports of published data pertaining to incidence/prevalence of β-thalassemia trait in some primitive tribe/scheduled tribal/nontribal communities in tribal land are available for a few states of India. However, the data pertaining to prevalence of β-thalassemia trait are still scanty. A summary of the prevalence data available from the published sources is presented here in table 5.

Out of a total of 12 primitive tribes in the state of Odisha, 9 were studied for β-thalassemia syndrome. The highest prevalence (β-thalassemia trait) of 10.8% among the Kutia Kondh primitive tribe of Kandhamal district in Odisha was reported (Table 5). Out of 62 major scheduled tribes in Odisha, 13 tribes were investigated for hemoglobin disorders and β-thalassemia. The highest frequency of β-thalassemia trait: 12.7% among the Paraja Bhuyan tribe of Sundargarh district, followed by Paraja tribe (8.5%) of Koraput district, Dudh Kharia (8.1%) of Sundargarh district, Santhal (8.0%) of Mayurbhanj district, Paik Bhuyan (7.8%) of Sundargarh district, and so on in the decreasing order was noticed in the state of Odisha (Table 5).

In a recently carved state of Chhattisgarh, out of four primitive tribes, all were studied for hemoglobinopathies and β-thalassemia. The highest frequency of β-thalassemia trait, i.e., 10.4% was recorded among the Hill Korwa of Korba district of Chhattisgarh. A very low frequency of β-thalassemia trait (ranging between 0.4-3.8 percent) was observed among other major scheduled tribes of the state (Table 5).

Of the three primitive tribes in the state of Madhya Pradesh, two tribes, namely, Baiga and Bharia were studied for hemoglobinopathies and β-thalassemia, but the prevalence of β-thalassemia trait (range being 0.2-3.6%) was found very low (Table 5). Out of 46 major scheduled tribes of Madhya Pradesh, 9 were studied for hemoglobinopathies and β-thalassemia. The highest frequency of β-thalassemia trait (10.0%) was observed among Gond tribe of Damoh district of Madhya Pradesh. However, in other tribes, the prevalence of β-thalassemia trait was found to be low (Table 5). Among the scheduled caste communities of Madhya Pradesh, the frequency of β-thalassemia trait was equally high among Jharia caste

(10.0%) of Jabalpur district, and followed by Chaudhury (9.0%) of Damoh district, and other backward castes (8.6%) of the state.

Table 5. Prevalence of β-thalassemia trait in major primitive tribes, scheduled castes/tribes/other backward castes of Chhattisgarh, Gujarat, Madhya Pradesh, Maharashtra, Odisha, and Tamil Nadu of India

State	Caste/Tribe	Group	N	β-Thalassemia Trait	
				n	%
Odisha[1]	Primitive Tribes	Bondo	165	4	2.4[2]
		Paudi Bhuyan	379	8	2.1
		Didayi	227	9	4.0[2]
		Juang	457	22	4.8[2]
		Kutia Kondh	65	7	10.8
		Kondh	375	16	4.3[2]
		Lodha	78	6	6.7
		Saora	177	11	6.2
		Lanjia Saora	74	2	2.7
		Sabar	102	6	5.9
	Scheduled Tribes	Bathudi	95	0	0.0
		Bhatra	166	11	6.6
		Bhumiz	116	2	1.7
		Bhuyan	92	0	0.0
		Bhuyan	836	53	6.2
		Paik Bhuyan	244	19	7.8
		Paraja Bhuyan	213	27	12.7
		Gond	219	1	0.5
		Kharia	54	1	1.9
		Kharia	767	48	6.2
		Dudh Kharia	422	34	8.1
		Dhelki Kharia	345	14	4.1
		Kissan	130	2	1.5
		Kolha	102	2	2.0
		Kondh	254	16	6.3
		Munda	96	5	5.2
		Oraon	104	2	1.9
		Paraja	176	15	8.5
		Santhal	100	8	8.0
Chhattisgarh[3]	Primitive Tribes	Birhor	270	6	2.2
		Hill Korwa	744	62	8.4
		Hill Korwa	402	42	10.4
		Kamar	320	21	6.6
		Kawar	114	0	0.0
		Kawar	72	0	0.0
		Hill Maria	93	0	0.0
		Maria	94	0	0.0

State	Caste/Tribe	Group	N	β-Thalassemia Trait n	%
		Maria	101	0	0.0
		Muria	101	0	0.0
	Scheduled Tribes	Bhatra	102	0	0.0
		Bhatra	99	0	0.0
		Dhurwa	81	0	0.0
		Gond	127	0	0.0
		Gond	157	0	0.0
		Halba	122	0	0.0
		Halba	99	0	0.0
		Halba	365	9	2.4
		Halba	95	0	0.0
		Kodaku	400	15	3.8
		Oraon	422	0	0.0
		Oraon	215	4	1.9
		Pando	458	2	0.4
		Patelia	166	0	0.0
Madhya Pradesh[3]	Primitive Tribes	Baiga	175	6	3.5
		Baiga	1566	3	0.2
		Baiga	990	28	3.6
		Baiga	219	4	1.6
		Bharia	183	0	0.0
		Bharia	102	0	0.0
	Scheduled Tribes	Barela	345	0	0.0
		Barela	316	4	1.3
		Bhil	904	0	0.0
		Bhil	433	0	0.0
		Bhil	316	3	1.0
		Bhilala	403	0	0.0
		Bhilala	370	5	1.3
		Gond	299	3	1.0
		Gond	321	32	10.0
		Gond	3224	281	8.7
		Gond	280	0	0.0
		Gond	158	0	0.0
		Gond	75	0	0.0
		Gond	83	0	0.0
		Gond	286	0	0.0
		Gond	252	12	4.6
		Gond	311	7	2.2
		Kol	290	17	5.9
		Korku	250	12	4.8
		Korku	301	7	2.3
		Korku	296	12	3.9
		Panika	210	3	1.4

Table 5. (Continued)

State	Caste/Tribe	Group	N	β -Thalassemia Trait n	%
		Pradhan	226	0	0.0
		Pradhan	990	28	3.6
		Raj Gond	321	10	3.1
	Scheduled Castes	Balai	276	7	2.5
		Basod	150	6	4.0
		Basod	123	0	0.0
		Chaudhary	339	31	9.0
		Chaudhary	195	7	3.6
		Jharia	637	15	2.3
		Jharia	409	41	10.0
		Katiya	181	2	1.1
		Mehra	352	1	0.3
		Mehra	114	6	5.2
		Mehra	216	3	1.4
		Mehra	219	0	0.0
	Other Backward Castes	Backward Castes	58	5	8.6
Gujarat[2]	Primitive Tribes	Kotvaida	285	13	4.6
		Kolcha	653	20	3.1
		Kathodi	124	4	3.2
		Total	1062	37	3.5
Maharashtra[2]		Madia	602	18	3.0
		Kolam	595	19	3.2
		Katkari	879	14	1.6
		Total	2076	51	2.5
Tamil Naidu[2]		Irula	687	15	2.2
		Kurumba	384	6	1.6
		Moolu Kurumba	322	3	0.9
		Paniya	301	7	2.3
		Total	1694	31	1.8

[1] Data from reference 7.
[2] Data from reference 8.
[3] Data from reference 3.

The frequency of β-thalassemia trait in primitive tribes of Gujarat (3.1-4.6%), Maharashtra (1.6-3.2%) and Tamil Nadu (0.9-2.3%) was found very low (Table 5) by Mukherjee et al. (8). The frequency of β-thalassemia trait was recorded to be around 3% (6/202) among Bagata tribe of Andhra Pradesh (9).

These findings are thought provoking. In order to explain, interpret and synthesize the above prevalent scenario of β-thalassemia trait among the tribal communities of India, the following etiquettes, factual evidence, and vicissitudes must be kept in mind. Historical evidence shows the existence of at least three well established open corridors (passages) to penetrate India, i.e., Northwestern, Northeastern, and Southwestern (sea routes) part of the country (10-12). These corridors in the distant past had facilitated the invasions/migrations of the people for several reasons, i.e., looting, plundering, conquering/grabbing the wealth accumulated in India. A majority of them came to India as dacoits/soldiers without wives and some had taken away Indian people with them as slaves. Biological contact was not a hindrance for these people under the circumstances. Being subdued by the mighty invaders, the people of India might have assimilated the inherited genetic characters of the incomers and some of these invaders (e.g., Mughuls) did not go back to their home land and settled permanently in India. With the passage of times, the offspring of these people mingled with the main stream of the people of India (13, 14).

Apart from this, India has witnessed the inter-state, inter-community or inter-religion battles/feuds/wars for rivalry/capture of power, dominancy, etc. which has forcefully amalgamated the population of India (13, 14). Natural disasters such as earthquakes, draughts, floods, and epidemics in several parts of India from time to time have also contributed for the emigration (exodus) of the people from one place to another in search of food, better safety and security, and economic viability. In some cases due to poverty and indebtedness, daughters were sold (bride price) to rich landlords/wealthy people to pay the debt or sustain livelihood, etc. These people carried good as well as bad gene pools with them wherever they migrated to other places and some of them were seduced and had also mixed and merged with the local people. Under this population scenario, the occurrence of different frequencies of β-thalassemia is not unexpected and the tribal people of India are not exception to this vulnerable seductive situation. In fact, β-thalassemia trait frequency in the tribals represents the degree (multiplication) of penetration of foreign elements (β-thalassemia) and the inbreeding.

As regard the clinical manifestations, the sickle cell-β^+thalassemia is found to have milder course than the sickle cell-β^0 thalassemia (15). Sickle cell-β^+thalassemia produces Hb S, Hb F and Hb A_2 with variable amount of Hb A. The severe forms have low, i.e., <10% (16) and (3-15%) (17) Hb A level. Mild forms have higher, i.e., >10% (18) and (18-30%) (17, 19) levels of Hb A. On the contrary, clinically there was no significant difference between these genotypes (β^+ and β^{++}) indicating that the low levels of Hb A (3-5%) were insufficient to modify the clinical features (18, 20). However, in the latter study (18), the figures for total hemoglobin (Hb S, Hb F, Hb A_2) level were found exaggerated in some reported cases.

Since it (β^{++}thalassemia) has encountered in a few communities with low prevalence/frequency so far investigated, therefore, it is said to be of rare occurrence, but actually it is not of rare occurrence in India (21). Several communities have not yet been investigated due to mild clinical manifestations of β^{++}-thalassemia gene and it is likely to present in high frequency in India. It is equally important that in some studies only the variants of hemoglobin have been investigated depending upon the laboratory infrastructural facilities available and not the whole abnormal hemoglobin spectrum, with the result either the actual diagnosis is missed or misdiagnosed, accordingly the results were reported.

Several β–thalassemia mutations, namely, IVS 1-5 (G-C), IVS 1-1(G-T), CD 41-42, CD 30 (G-C), CD 15 (G-A), CD 8-9, 619bp deletion, nonsense codon 15, frame shift at codon 16, etc. are commonly known to occur in Asian Indians (16-18, 20, 22, 23). According to Nishank et al. (24), the tribal population possessed only the IVS 1-5 (G-C) mutation, whereas, nontribals had the IVS 1-1 (G-T), IVS 1-5 (G-C), FS 41/42 (-CTTT), FS 8/9 (+G), and CD 30

(G-C) β-thalassemia mutations in Odisha state. Similarly, Mukherjee et al. (18) encountered only CD 15 (G-A) mutation in tribals, and IVS 1-5 (G-C), CD 15 (G-A), CD 8/9 (+G), and CD 30 (G-C) mutations of β-thalassemia in nontribal populations of Western India.

Geographical distribution

The thalassemias are wide-spread with about 5% of the world population affected by it. It is most prevalent around the Mediterranean Sea i.e., countries like Greece, Italy, Turkey and Northern Africa. It is also seen in Saudi Arabia, Iran, Afghanistan, Pakistan, India and South East Asian countries like Thailand and Indonesia (25). The prevalence is the highest in Italy, Greece and Cyprus. Population migration and intermarriage between different ethnic groups have introduced thalassemia in almost every country of the world. In India, the prevalence of β-thalassemia is very high among certain linguistic communities like Punjabi, Sindhi, Gujarati, Bengali, Parsee, Lohana and certain scheduled tribes belonging to northern, western and eastern parts of India, while it is much less in the southern parts of India (2).

β-thalassemias are a group of hereditary blood disorders characterized by genetic anomaly in the synthesis of β-globin chain of hemoglobin resulting in variable phenotypes ranging from severe anemia to clinically asymptomatic individuals (15). In the homozygous state, β-thalassemia (i.e., thalassemia major) causes severe transfusion-dependent anemia. In the heterozygous state, the β-thalassemia trait (i.e., thalassemia minor) causes mild clinical manifestations with mild to moderate microcytic anemia. Beta-thalassemias are caused by point (genetic) mutations or, more rarely, deletions in the β-globin gene on chromosome 11, leading to reduced (β^+) or absence of synthesis (β^o) of the β-chains of hemoglobin, however, several additional (epigenetic) factors influence the clinical manifestations of the disease (15). That is, the same particular mutation may have different clinical manifestations in different patients. The following factors are known to influence the clinical phenotype in hemoglobin disorders: (i) Intra-cellular fetal hemoglobin (Hb F) concentrations: (a) Level of expression of Hb F (i.e., the expression of the β-globin gene) determines, in part, the severity of disease. (b) Patients with high Hb have milder disease. (ii) Co-inheritance of α-thalassemia: (a) Patients with co-inheritance of α-thalassemia have a milder clinical course because they have a less severe α–β chain imbalance. (b) The coexistence of sickle cell trait and β-thalassemia is a major symptomatic hemoglobin disorder with most of the symptoms and complications of the sickle cell disease.

Persons heterozygous for sickle Hb and β-thalassemia (Hb S/β-thal) also may experience sickle cell disease, although their symptoms tend to be less severe than those persons homozygous for sickle cell disease. The sickle cell-β–thalassemia varies in severity, depending on the inherited β-thalassemia mutation. There are two main varieties of β-thalassemia in different populations, β^0-thalassemia, in which no β-globin is produced, and β^+-thalassemia, in which some β-globin is produced, but less than normal. The diagnostic feature of β-thalassemia is an elevated level of Hb A_2 in heterozygotes, which is found in most forms of β^0 and β^+-thalassemia (15). The β^{++}-thalassemia, with more than 10% of adult hemoglobin (Hb A), also occurs having milder symptoms and less severe clinical manifestations.

Clinical severity of β-thalassemia major

Individuals with thalassemia major usually present symptoms within first two years of life with severe anemia, requiring regular red blood cell (RBC) transfusions. Findings in untreated or poorly transfused individuals with thalassemia major, as seen in some developing countries, are growth retardation, pallor, jaundice, poor musculature, hepatosplenomegaly, and development of masses from extramedullary hematopoiesis, and skeletal changes that result from expansion of the bone marrow **(2, 26)**. Regular transfusion therapy leads to iron overload-related complications including endocrine complication (growth retardation, failure of sexual maturation, diabetes mellitus, and insufficiency of the parathyroid, thyroid, pituitary, and less commonly, adrenal glands), dilated myocardiopathy, liver fibrosis and cirrhosis. Patients with thalassemia intermedia present later in life with moderate anemia and do not require regular transfusions. Main clinical features in these patients are hypertrophy of erythroid marrow with medullary and extramedullary hematopoiesis and its complications (osteoporosis, masses of erythropoietic tissue that primarily affect the spleen, liver, lymph nodes, chest and spine, and bone deformities and typical facial changes), gallstones, painful leg ulcers and increased predisposition to thrombosis **(2, 26)**.

Thalassemia minor (trait) is clinically asymptomatic but some subjects may have moderate anemia. These patients are either asymptomatic or have mild anemia and rarely moderate degree of anemia. Symptoms of β-thalassemia trait include: fatigue, irritability, jaundice, trouble in breathing, slow growth in child (2). Clinical examination is normal except for mild anemia. Usually subjects are given iron and vitamin supplements to which they do not respond. The peripheral blood smear shows microcytosis, hypochromia, anisocytosis, poikilocytosis and target cells. Serum iron studies are normal, except in those who have coexisting iron deficiency - a condition not uncommon in India (2). Diagnosis is made by hemoglobin electrophoresis which shows increase in Hb A_2 to more than 3.5%. Hb F is usually normal but may be elevated in some cases. When both parents are carriers, there is a 25% risk at each pregnancy of having children with homozygous thalassemia (27, 28).

Management and treatment therapy

The condition of β-thalassemia trait usually requires no treatment. Folic acid supplements may help to prevent relative folate deficiency which may occur as a result of increased cell turnover. Though red cells are hypochromic and microcytic, they do not need iron. Unfortunately, this fact is ignored by many doctors and results in injudicious prescription of hematinics containing iron to all those patients who look pale or have anemia. Not only this therapy is of no use but it could lead to iron overload and its complications **(4, 26)**. Thus use of iron supplements is contraindicated unless there is coexisting iron deficiency. Iron supplements are required in pregnant women with β-thalassemia minor, but serum iron should be carefully monitored. These patients should be educated about thalassemia major if they do not have a child suffering from the disease in their family. They should be told about means of preventing the birth of a thalassemia major baby, i.e., by screening the spouse of the carrier parent and by prenatal diagnosis. Regular transfusion of red blood cells at the interval of a fortnight/month with timely chelation therapy is the optimal solution/treatment under Indian setting (2, 4).

Intervention and prevention

To tackle such a huge population suffering from β-thalassemia and other hemoglobinopathies, the following practical options are available in the Indian context:

1. Genetic counseling and prenatal diagnosis

Prevention of β-thalassemia is based on carrier identification, genetic counseling and prenatal diagnosis (29). Carrier detection and genetic counseling provide information for individuals or couples at high risk (i.e., both carriers) regarding the mode of inheritance, the genetic risk of having affected children and the natural history of the disease including the available treatment and therapies under investigation. Prenatal diagnosis for pregnancies at increased risk is possible by analysis of DNA extracted from fetal cells obtained by amniocentesis, usually performed at approximately 15-18 weeks' gestation or chorionic villi sampling at 11 weeks' gestation. Both disease-causing alleles must be identified before prenatal testing can be performed. Analysis of fetal cells in maternal blood (non-invasive technique) and analysis of fetal DNA in maternal plasma for the presence of the father's mutation are currently under investigations (30, 31). Pre-implantation genetic diagnosis may be available for families in which the disease-causing mutations have been identified (32).

2. Bone marrow and cord blood transplantation

Bone marrow transplantation (BMT) remains the only definitive cure currently available for patients with β-thalassemia. The outcome of BMT is related to the pretransplantation clinical conditions, specifically the presence of hepatomegaly, extent of liver fibrosis, history of regular chelation and hence severity of iron accumulation. In patients without the above risk factors, stem cell transplantation from an HLA identical sibling has a disease-free survival rate over 90% (33). The major limitation of allogenic BMT is the lack of an HLA-identical sibling donor for the majority of affected patients. In fact, approximately 25-30% of thalassemic patients could have a matched sibling donor. BMT from unrelated donors has been carried out on a limited number of individuals with β-thalassemia. Provided that selection of the donor is based on stringent criteria of HLA compatibility and that individuals have limited iron overload, results are comparable to those obtained when the donor is a compatible sib (34). However, because of the limited number of individuals enrolled, further studies are needed to confirm these preliminary findings. If BMT is successful, iron overload may be reduced by repeated phlebotomy, thus eliminating the need for iron chelation. Chronic graft-versus-host disease (GVHD) of variable severity may occur in 5-8% of individuals.

Cord blood transplantation from a related donor offers a good probability of a successful cure and is associated with a low risk of GVHD (35, 36). For couples who have already had a child with thalassemia and who undertake prenatal diagnosis in a subsequent pregnancy, prenatal identification of HLA compatibility between the affected child and an unaffected fetus allows collection of placental blood at delivery and the option of cord blood transplantation to cure the affected child (37). On the other hand, in cases with an affected fetus and a previous normal child, the couple may decide to continue the pregnancy and pursue BMT later, using the normal child as the donor.

Considering the Indian social and cultural pattern, highlighting the awareness programs and genetic counseling in high risk communities is the only powerful and economic tool to control thalassemia (2). This strategy imparts the information to the target population without creating undue fear and concern, and takes into consideration the social structure and taboos, religion and economic aspects. Major constrains are poverty and illiteracy in India. In conclusion, apart from the above mentioned available options, genetic/marriage counseling in the high risk communities is a useful strategy to control β-thalassemia disorder in India.

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Chapter 17

A RARE FAMILY AFFLICTED WITH MULTIPLE HEMOGLOBIN DISORDERS

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ABSTRACT

Hemoglobin disorders are genetically inherited hematological anomalies commonly encountered in the Central region of India. They cause a public health concern due to the high degree of morbidity, mortality, and fetal wastage in the vulnerable and underprivileged people. A rare family afflicted with multiple hemoglobinopathies from Rewa district of Madhya Pradesh in India was encountered during screening for cause of anemia. About 2-3ml intravenous blood samples were collected from all members of this referred family after obtaining the informed consent. Background data were recorded like age, sex, caste, place of origin, reproductive history, consanguinity, etc. Detailed hematological, biochemical, and genetical investigations were carried out following the standard procedures and technology for this family. This study highlights the rare and compound occurrence of abnormal hemoglobins, i.e., Hb E and Hb S interacting with β-thalassemia that is reported for the first time from the state of Madhya Pradesh. It was noticed that the cases with Hb E-β-thalassemia and sickle cell-β-thalassemia manifest variable clinical and hematological profile. High levels of fetal hemoglobin reduce the severity of clinical symptoms in patients. Apart from occurrence of SE disease in one parent, asymptomatic hemoglobin AS and AE carrier siblings were also detected in the family. This family provides for the first time a comprehensive database on the occurrence of double heterozygosity, testifying either ethnic admixture and/or genetic diversity in the state of Madhya Pradesh, India.

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INTRODUCTION

Of the several hemoglobin variants so far identified and found predominantly prevalent, only three variants – sickle cell (Hb S), hemoglobin E (Hb E) and hemoglobin D (Hb D) are very common in the Indian population (1). The average allele frequency of sickle cell gene has been estimated to be 4.3% in India and that of hemoglobin E being 10.9% in North Eastern region of India (2). With a wide prevalence range of 3-17% and an average being 4.2%, the β-thalassemia commonly encounters throughout India with a wide range of geographical variations (1). The sickle cell disease is wide spread in tribal as well as nontribal communities especially belonging to Central-Eastern part of India (3).

No genetic disease could be as simple as the sickle cell disease. It is a simple disease but there is no cure. In the absence of any cure, the majority of the sickle cell patients have a miserable and short life span (4). Instances of sudden death in such cases have also been reported. This genetic disease is responsible for considerable morbidity and mortality (5). The majority of cases need first blood transfusion between one to three years of age reflecting a high morbidity especially in the preschool age. At this age, cross infection is more common, which could precipitate a sickle cell crisis (4, 6, 7). The anemia in sickle cell trait (AS) is mild and infrequent and one must look for other causes of anemia in them like iron deficiency, parasitic infestations, malaria, etc. The sickle cell disease affects the ability of red blood corpuscles (RBCs) to carry oxygen to various parts of the body by acquiring the shape of a sickle. In the absence of oxygen, the distortion in shape and size of cells leads to increased blood viscosity and blocking of the small vessels, resulting in devastating pain. The pain originates virtually at any time in any organ of the body in joints or bones. The disease carries the risk of debilitating fatigue, blindness, organ damage, and cardiac stroke within a life span of just about 20-30 years (4, 7). The symptoms of the disease include anemia, hand-foot syndrome and infection. The clinical course of these patients is punctuated by episodes of "crisis" and increased susceptibility to serious infections because of functional asplenia. The usual complications are vaso-occlusive crises (severe pain in almost all parts of the body), hemolytic crises (yellow eyes, jaundice or hepatic infection), aplastic crises (diminished production of RBCs) and the deadliest of complications, the sequestration crises (blood suddenly goes to spleen) (4, 7).

Double heterozygosis for hemoglobin disorders is a rare entity. Due to the paucity of adequate literature available on the occurrence of heterosis for hemoglobinopathies in India and the hemoglobinopathies being a major genetic and public health problem in the state of Madhya Pradesh, the present family was investigated in details for double heterozygosity of sickle cell and hemoglobin E interacting with β-thalassemia. This study will not only add to prognostic understanding of the heterosis phenomenon for hemoglobinopathies in the state but also be useful for genetic counseling, prenatal diagnosis and future molecular studies on the subject in India.

OUR STUDY

The index case was referred to us as a suspected case of hemolytic anemia and hemoglobinopathy from Pediatric Out-patient Department, Netaji Subhash Chander Bose

Medical College and Hospital, Jabalpur for detailed investigations. Subsequently, the other members of the family were also investigated after taking informed/written consent and a family pedigree was drawn.

About 2-3 ml. intravenous blood samples were collected using ethylene diamine tetra acetic acid (EDTA) as anticoagulant by disposable syringes and needles from each individual after obtaining the informed consent. All the signs and symptoms related to hemoglobinopathy after clinical examination were recorded. Laboratory investigations were carried out following the standard procedures after cross checking for quality control from time to time. Hematological parameters were studied by using an automated Blood Cell Counter (Model-$MS_5$9, Melet Schloesing Laboratories, Cergy-Pontoise Cedex, France).

The sickling test was performed by using freshly prepared sodium metabisulphite solution as reducing agent for the presence or absence of sickle cell hemoglobin (8). The routine hemoglobin lysate electrophoresis was carried out on cellulose acetate membrane (CAM) in Tris-EDTA-Borate buffer at pH 8.9 and quantification of A_2 fraction of adult hemoglobin was done by elution method (9). The value more than 3.5% of A_2 fraction of adult hemoglobin was taken as cut off point for determining the β-thalassemia trait. Those individuals having the very high hemoglobin A_2 value, i.e., more than 10% were suspected to have Hb A_2 plus Hb E, which was confirmed by the investigation of other family members. Estimation of fetal hemoglobin was done as described by Weatherall (9).

The diagnosis of sickle cell-β-thalassemia was based on the findings of hemoglobin (Hb) A, F, S and A_2 on electrophoresis under alkaline pH, elevated HbA_2 levels (>3.5%). All the blood samples were further subjected to hemoglobin variant analysis for detecting any discrepancy (made for Bio-Rad Diagnostics, Hercules California, USA).

FINDINGS

The clinical, hematological and genetical findings of cases of sickle cell-β-thalassemia and cases of hemoglobin E-β-thalassemia and their family members have been summarized in table 1.

A 13 year old female child (index case; Daughter-2) with severe anemia, recurrent fever, icterus and retarded growth and development who has become transfusion dependent was referred to us for complete hematological investigations. She had enlarged spleen (4-5cm) with palpable hepatomegaly. Her sickling test was found negative. Almost all the red cell indices were below normal range, i.e., hemoglobin level (2.7g/dl), RBC counts ($0.9.10^6$/µl), HCT (8.8%), MCV (65.2fl), MCH (17.5pg), MCHC (15.6g/dl), RDW (27.7%), and normal WBC and Platelet counts (Table 1). Red cell morphology showed hypochromatosis, microcytosis, and target cells. After alkaline (pH 8.9) electrophoresis, it was known that she had raised A_2/E hemoglobin (54.6%), fetal hemoglobin 14.5%, and only 30.9% normal adult hemoglobin (AA band).

The 45 year old thin and lean father of this child had complaints of irritability, dysponea, chest pains, upper respiratory tract infection (URTI), splenomegaly (5-6cm) with palpable liver. His sickling test was found positive. His red cell indices picture was like this: hemoglobin level (9.9g/dl), RBC counts ($3.8.10^3$/µl), HCT (31.7%), MCV (84.6fl), MCH (26.4pg), MCHC (31.2g/dl), RDW (14.6%), WBC ($5.9.10^3$/µl) and Thrombocytopenia

(88.10^3/µl). Red cell morphology showed hypochromia and microcytemia. The alkaline electrophoresis showed only two major bands at the position of A_2/E (26.5%) and a thick band (65.9%) at sickle position with a minor band at fetal hemoglobin band level. No normal adult hemoglobin (AA) band was observed.

The 39 year old healthy mother of the index case had no clinical complaints. However, her periphery red cell smear showed hypochromia and microcytosis. The sickling test was found negative. Her hemogram showed: hemoglobin level (10.0g/dl), RBC counts ($3.1.10^3$/µl), HCT (32.0%), MCV (102.8fl), MCH (32.0pg), MCHC (31.2g/dl), RDW (14.5%), and normal WBC and platelet counts (Table 1). The alkaline electrophoresis showed only two major bands at the position of A_2/E (5.2%) and a thick band (93.6%) at adult hemoglobin (AA) position level.

Table 1. A Typical Family belonging to Oilman Caste (Teli) with Multiple Hemoglobinopathies from Rewa District of Madhya Pradesh, India

Parameters of Study/Hemato-logical Indices	Parents		Offsprings			
	Father	Mother	Daughter-1	Daughter-2	Daughter-3	Son
Sex	Male	Female	Female	Female	Female	Male
Age in years	45	39	15	13	10	8
Hb (g/dl)	9.9	10.0	6.2	2.7	9.9	11.1
RBC (x10^3/□l)	3.8	3.1	2.8	0.9	4.5	5.2
HCT (%)	31.7	32.0	18.6	8.8	29.0	34.5
MCV (fl)	84.6	102.8	70.6	65.2	71.3	70.3
MCH (pg)	26.4	32.0	21.3	17.5	21.8	21.3
MCHC (g/dl)	31.2	31.2	27.6	15.6	27.6	29.1
RDW (%)	14.6	14.5	13.2	27.7	11.5	12.7
WBC (x10^3/□l)	5.9	6.8	5.4	9.7	8.1	7.6
PLT (x10^3/□l)	88	250	102	280	310	268
Sickling Test	+ve	-ve	-ve	-ve	+ve	+ve
Electrophoresis:						
Major bands	SE	AA_2	AE	AEF	ASA_2	AS
Hb A_2 (%)	26.5	5.2	26.3	54.6	7.7	2.1
Hb F (%)	7.6	1.2	1.0	14.5	15.0	1.2
Hb S (%)	65.9	-	-	-	43.2	30.5
Hb A (%)	-	93.6	72.7	30.9	34.1	66.2
Red cell Morphology	Hypochromia Microcytemia Thrombocyto-penia	Micro-cytosis, Hypo-chromia	Hypo-chromatosis Thrombo-cytopenia	Hypo-chromatosis Microcytosis, Target cells	Hypo-chromatosis	Normo-chromia
Clinical symptoms	Irritability Dysponea, Chest pains, URTI, Palpable liver Splenomegaly	No complaints	No compalints	Pallor, Severe anemia, Recurrent fever,Jaundice Splenomegaly, Retarded growth & development	Joint & abdominal pains, Pallor Dysponea Spleno-megaly	No compla-ints

Thus the index case (Daughter-2) was diagnosed as hemoglobin E-β^{++}thalassemia. Patient was given whole blood transfusion and showed the signs of improvement. The siblings of this index case were also studied and their findings are presented in table 1.

The 15 year old sibling sister (Daughter-1) of this index case with severe anemia had no clinical complaints, but the red cell morphology showed hypochromia and microcytosis. The sickling test was found negative. The red cell indices were like this: hemoglobin level (6.2g/dl), RBC counts (2.8.10^3/µl), HCT (18.6%), MCV (70.6fl), MCH (21.3pg), MCHC (27.6g/dl), RDW (13.2%), and normal WBC and Thrombocytopenia (Table 1). The alkaline electrophoresis showed only two major bands at the position of A_2/E (26.3%) and a thick band at AA (72.7%) hemoglobin position, with normal fetal hemoglobin (Table 1). Thus, this sibling was diagnosed as hemoglobin E trait (AE).

Another 10 year old female sibling (Daughter-3) of the index case had pallor, dysponea, joint and abdominal pains, and splenomegaly (3-4cm) with hypochromatosis. Her sickling test was found positive. The hemogram of this case showed: hemoglobin level (9.9g/dl), RBC counts (4.5.10^3/µl), HCT (29.0%), MCV (71.3fl), MCH (21.8pg), MCHC (27.6g/dl), RDW (11.5%), and normal WBC and platelet counts (Table 1). The alkaline electrophoresis showed four prominent bands, i.e., one at the position of A_2/E (7.7%), the other three at sickle (43.2%), fetal (15.0%) and AA (34.1%) positions, respectively. This sibling was diagnosed as sickle cell-β^{++} thalassemia case.

An eight year old brother of the index case had no clinical complaints. His red cell smear showed only normochromic cells. However, the sickling test was positive. His red cell indices presented the following picture: hemoglobin level (11.1g/dl), RBC counts (5.2.10^3/µl), HCT (34.50%), MCV (70.3fl), MCH (21.3pg), MCHC (29.1g/dl), RDW (12.7%), and normal WBC and platelet counts (Table 1). Electrophoresis showed only two thick bands at the position of sickle (30.5%) and AA hemoglobin (66.2%) level. Both hemoglobin A_2 and fetal were in the normal range (Table 1). This case was diagnosed as sickle cell trait (AS).

DISCUSSION

The genetic heterogeneity, double heterozygosity, or compound cases of hemoglobin disorders are not uncommon in the backward and under-privileged communities of India, especially in the Central region of India. Heterosis, also called hybrid vigor or boost in performance, is the increase in growth, size, fecundity, function, yield, or other characters in hybrids over those of the parents. In other words, heterosis is increased strength of different characteristics in hybrids, the possibility to obtain a "better" individual by combining the virtues of its parents. Aberrant heterosis is antagonistic to heterosis, i.e., combination of ill effects or abnormal qualities in an individual. Therefore, it is not always true that the heterosis increases the strength of different characteristics in hybrid. Aberrant heterosis may occur with severer ill effects, abnormal qualities, or even lethal for the survival of an individual.

All the cases in the family under study had a large range of variation in hemoglobin levels (2.7-11.1%), but the majority had moderate to severe anemia. Patients of hemoglobin E-β-thalassemia and sickle cell-β-thalassemia disease manifest heterogeneity in clinical manifestations, prognosis, hematological picture, and management profile in India (10). The patients with early onset and severe anemia have the disease course similar to homozygous β-thalassemia in the former and that of sickle cell disease in the latter case, while those patients with late onset and mild anemia manage with occasional blood transfusions or remain completely asymptomatic without any hemolytic crisis in life. Similar observations were made for Hb E-β-thalassemia in Sri Lanka (11), Thailand (4), and for sickle cell-β-thalassemia in India (10, 12-14).

The phenotypic severity is dependent on the type of β-thalassemia mutation, levels of HbE and HbF, and the number of β-globin genes, which tend to reduce the severity of the disease (12, 13). The interaction of hemoglobin E with β-thalassemia results in a wide spectrum of clinical conditions, in some cases indistinguishable from β-thalassemia major, whereas, in others it has a milder course without dependent on transfusion. These findings get further support from the earlier studies (15-18). The Hb E is a mild structural variant of β-globin chain, being asymptomatic in homozygous state (19). The clinical and hematological profile of the index case of Hb E-β-thalassemia in the present study was identical with those of β-thalassemia major patient. This clinical picture is compatible with the studies reported from other parts especially from the North-Eastern region of India where its frequency is reported to be very high (6, 20, 21, 22). The index case had marked anemia, jaundice, bossy maxillary bones and prominent hepatosplenomegaly. The peripheral blood smear examination revealed a hypochromic and microcytic picture with predominance of target cells. Patients with hemoglobin E-β-thalassemia in Central-Eastern Indian belt, generally, are transfusion dependent from the age of one year onward and need multiple blood transfusions, varying from 1 to 25 units (10). This family is the 1st in series for Hb E-β-thalassemia from Madhya Pradesh. In the present study, apart from hemoglobinopathies, some other factors like iron/folic acid deficiency, nutritional deficiency disorders, parasitic infestations, malarial or viral infections, etc. which are very common in the state of Madhya Pradesh, may be responsible for mild or severe course of the disease.

It is apparent from table 1 that the sickle cell-β-thalassemia case before blood transfusion showed reduced values of red cell indices like HCT, MCV, MCH and MCHC manifesting hematological aberrations. The red cell morphology also showed hypochromia and microcytosis in this family. The CBC values were either reduced or normal in carriers of Hb AS, Hb AE or β-thalassemia trait in the family.

The present study highlights the co-inheritance of β-thalassemia and hemoglobin E or sickle cell gene, which is wide spread in Eastern, Northern, Southern and Western Madhya Pradesh (7, 23). To conclude, it may be summarized that this family provides for the first time a comprehensive database on the occurrence of double heterozygosity, testifying either ethnic admixture and/or genetic diversity in the state of Madhya Pradesh, India. Further, it is a pity that a large number of such double heterozygosity cases remain mostly undiagnosed or misdiagnosed, wrongly interpreted and mismanaged leading to premature death without proper treatment in the state of Madhya Pradesh (24). For bringing awareness, motivation for carrier detection to reduce the genetic burden, and intervention in affected families and communities need to be launched vigorously in Central India.

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Chapter 18

REPRODUCTIVE WASTAGE IN CARRIER COUPLES OF HEMOGLOBINOPATHIES

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ABSTRACT

The β-thalassemia syndrome and sickle cell disorders are the major genetic and public health challenges in Central India. In view of credit for the 2nd highest infant mortality rate (IMR) in Madhya Pradesh (70 per thousand live-births in 2011), it was presumed that carriers of hemoglobinopathies might be one of the contributing factors for the high IMR. Couples including their offspring with at least one affected/suspected case of hemoglobinopathies, referred to us from NSCB Medical College and Hospital, Jabalpur were consecutively studied as matched case controls. A total of 333 couples were referred during the period from March 2010 to March 2012. Out of 333 couples, 138 were found normal and 195 couples had different hemoglobin disorders. It was observed that the number of conceptions (2.456 vs 1.522), live-births (2.246 vs 1.319), surviving offspring (2.005 vs 1.406), stillbirths (0.082 vs 0.051), and deaths under 10 year (0.236 vs 0.145) were higher and neonatal deaths (0.103 vs 0.116), and deaths under one year (0.118 vs 0.123) per couple at the time of investigations were lower in couples with hemoglobinopathies in comparison to normal controls.

It was observed that the frequency of couples with combinations: HbAS x HbAS, HbAS x HbSS, and β-Thalassemia Trait x β-Thalassemia Trait, was considerably higher in the under-privileged communities such as scheduled castes (SC) and scheduled tribes (ST), and in Other Backward Castes (OBC) of the state of Madhya Pradesh. Affected families were imparted genetic/marriage counseling. This study indicated that afflicted couples with these hereditary disorders were increasing the affected/carrier offspring. This increased production of defective offspring leads to increased morbidity and mortality and may be contributing towards increased neonatal/infant mortality or fetal wastage in the state of Madhya Pradesh, India.

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INTRODUCTION

The hemoglobinopathies are a group of heterogeneous single gene disorders that includes the structural hemoglobin variants and the thalassemias. More than 270 million people worldwide are heterozygous carriers of hereditary disorders of hemoglobin, and at least 300,000 affected homozygotes or compound heterozygotes are born each year (1). It has also been estimated that about 45 million are carriers and about 15,000 infants born each year with hemoglobinopathies in India (2). Of the several abnormal hemoglobins so far identified in India, there are three variants – sickle cell (Hb S), hemoglobin E (Hb E) and hemoglobin D (Hb D), which are predominantly prevalent (3). There are regional variations for the distribution of these structural variants of hemoglobin. The cumulative allele frequency in different parts of India for these variants has been found to be 5.35% (3). The average allele frequency of sickle cell and hemoglobin D has been observed to be 4.3% and 0.86%, respectively with hemoglobin E constituting 10.9% in North Eastern region of India (3). The sickle cell disease is wide spread in tribal as well as in nontribal communities especially in the Central-Eastern region of India. With a prevalence range of 3-17% (average 4.2%), the β-thalassemia syndrome is prevalent throughout India (2). Thus, hemoglobinopathies are a huge genetic burden and pose a major clinical health care challenge in India.

The sickle cell hemoglobinopathy and β-thalassemia syndrome are a major genetic and community health care challenge in Central India. The victims include the infants, growing children, adolescent girls, pregnant women and a large number of ignorant and vulnerable people. Inherited disorders of hemoglobin cause high degree of hemolytic anemia, clinical jaundice, frequent infections, painful crises, splenomegaly, development and growth retardation (4-6) and are responsible for high infant morbidity, mortality and fetal wastage in India (7-10). In sickle cell disease, the distorted red cells lead to increased viscosity, hemolysis, and anemia and a further decrease in oxygenation. When sickling occurs within small blood vessels, it can cause logjams (clogging) that can interrupt blood supply to vital organs (vasoocclusive crisis). Repeated vasoocclusive crises result in widespread microvascular obstruction with interruption of normal perfusion and function of several organs, including the spleen, lungs, kidneys, heart, and brain. Adults with sickle cell disease are functionally asplenic, having undergone autosplenectomy and contribute to the increased incidence of severity of infection. A great deal of literature is available in India regarding the clinical and hematological aspects of these disorders, but the details regarding the reproductive outcome in affected couples are scanty (8,11).

The neonatal (NMR) and infant mortality rate (IMR) are the most important indicators of socio-economic status of a community/country. After the failure of achieving the target goal of "Health for All by the year 2000" the emphasis and thrust of Indian government has shifted to qualitative improvement in the health services through strengthening of physical facilities like provision of essential equipment, supply of essential drugs and consumables, construction of buildings and staff quarters, filling up of vacant posts of medical and paramedical staff and ongoing in-service training of staff to enhance their knowledge in the latest medical development and technology. The stress, however, remained on the provision of preventive, promotive and rehabilitative health services to the people, thus, representing a shift from medical care to health care and from urban to rural population of India. For developing vast human resources of the country, accelerating the socio-economic development and attaining improved quality of life, Primary Health Care has been accepted as one of the main instruments of action.

Early detection and effective clinical management of anemia in pregnancy may contribute substantially to the reduction in under-nutrition in childhood, adolescence and improvement in maternal health and reduction in maternal mortality. Maternal anemia is associated with poor intrauterine growth and increased risk of preterm births and low birth weight babies. This in turn results in higher perinatal morbidity and mortality, and higher infant mortality rate (8, 9). A doubling of low birth weight rate and 2 to 3 fold increase in the perinatal mortality rates is seen when the hemoglobin is less than 8g/dl (12). Intrauterine growth retardation and low birth weight inevitably lead to poor growth trajectory in infancy, childhood and adolescence and contribute to low adult height (12). Parental height and maternal weight are determinants of intrauterine growth and birth weight (13). Thus maternal anemia contributes to intergenerational cycle of poor growth in the offspring (12).

In view of credit of the 2nd highest infant mortality rate (IMR) in the state of Madhya Pradesh (70 per thousand live-births in 2011) in comparison to other states and in India (53) and the high prevalence of hemoglobin disorders, it was presumed that β-thalassemia syndrome and hemoglobinopathies might be one of the significantly contributing factors for the infant/neonatal mortality or fetal wastage in carrier couples of hemoglobinopathies in the state of Madhya Pradesh, India.

OUR STUDY

In the present study, a total of 333 native couples (families) were screened for β-thalassemia and other hemoglobinopathies during the period between March 2010 to March 2012, irrespective of age, sex, religion, caste, and community. Detailed reproductive history of each couple was recorded like total number of conceptions, abortions, miscarriages or stillbirths, live-births, surviving children, infant or neonatal deaths, cause of death, etc. A couple was asked the detailed reproductive history only once to avoid duplication. Matched couples who were free from any kind of β-thalassemia syndrome and hemoglobinopathies served as case controls for the present study.

The couples (parents) including their offspring with at least one suspected/confirmed case of homozygous β-thalassemia/HbE/Sickle cell anemia or compound heterozygosity routinely referred to us from Netaji Subhash Chandra Bose Medical College & Hospital, Jabalpur were included in the study. Those cases with only iron deficiency anemia, induced abortion or accidental deaths were excluded from the study.

For the present study, the neonatal mortality rate (NMR) is defined as the number of deaths within 28 days of life per thousand live-births in a particular area, whereas, the infant mortality rate (IMR) is defined as the number of deaths within one year per thousand live-births in a particular area.

There are several relevant co-confounding and concomitant non-genetic variables that are known to affect reproductive outcome in terms of neonatal and infant mortality and enhance reproductive wastage in both normal controls and carrier cases of hemoglobinopathies (8). For inclusion criteria, the factors like lack of tetanus toxoid immunization, malnutrition (nutritional deficiencies), neonatal infection, prematurity (low birth weight), acute respiratory infection, abnormal condition of placenta and cord, anemia and jaundice, hand and foot syndrome, retarded growth and development, diarrhea, malaria, lack of basic health care, prevalent unhygienic conditions, poverty, illogical socio-cultural traditions and taboos, single parenthood, were covered.

The neonatal period constitutes almost two-third of the deaths of IMR. The causes of death during neonatal period are: sepsis, birth asphyxia (when a baby does not breathe or cry immediately after birth), prematurity (born before 37 weeks of gestation) and low birth weight (less than 2.5 Kg), birth injury and congenital anomaly (cleft lip and cleft palate, heart disease) including genetic defects (hemolytic anemia or jaundice). The post neonatal period (29 to 365 days) accounts for deaths due to acute respiratory tract infection, diarrhea, hemolytic anemia, malnutrition, measles, malaria or genetic abnormalities. Among the chief causes of neonatal mortality, neonatal infections (pneumonia, septicemia, meningitis and diarrhea) are the most common accounting for almost 50% of all deaths. Exclusion criteria for this study include birth asphyxia, birth injury, HIV infection, sexually transmitted diseases (syphilis, etc.), aplastic anemia and other hematological disorders, congenital anomalies, measles, accidental death, etc.

Intravenous 2ml. of blood was taken under aseptical conditions from each individual after taking informed/written consent for screening of hemoglobinopathies and β-thalassemia syndrome. Blood so collected was transported to our laboratory under wet-cold conditions for investigations. All the adopted techniques and procedures standardized in the laboratory were followed as described elsewhere (8, 10). For quality control, results were cross-checked periodically.

Out of 333 couples, 138 were found normal and 195 couples had different hemoglobin disorders. Results of investigations were given to parents for treatment and further clinical management by the concerned referring doctor. It was envisaged to bring awareness among these couples through genetic counseling about the genetic disorders and their causal effects on health. Their eradication is necessary because they are not curable but preventable through carrier detection, education and genetic counseling, prenatal diagnosis.

FINDINGS

It is emphasized that both normal controls and abnormal subgroups (combined hemoglobinopathies) had similar characteristics with respect to the concomitant factors and the present observations of reproductive outcome are attributable to different genotypes of hemoglobinopathies in the state of Madhya Pradesh from Central India.

The reproductive history of normal controls as well as different combinations of genotypes of hemoglobinopathies in carrier couples is presented in Table 1. It is interesting to note that the number of conceptions (2.456 vs 1.522), live-births (2.246 vs 1.319), surviving offspring (2.005 vs 1.406), stillbirths (0.082 vs 0.051), and deaths under 10 year (0.236 vs 0.145) were higher and neonatal deaths (0.103 vs 0.116), and deaths under one year (0.118 vs 0.123) per couple at the time of investigations were lower in couples with hemoglobinopathies as compared to normal controls.

Table 1. A comparative study of reproductive wastage in couples with different hemoglobinopathies and normal controls

Diagnosis (Genotypes of Couples)	No. of Couples		Conceptions	Abortions	Stillbirths	Neonatal Deaths●	< 1 year Deaths■	< 10 years Deaths
Hb AA X Hb AS	44		89	6	6	4	4	4
		Per Couple	2.023*	0.136	0.136*	0.091	0.091	0.091
Hb AA X Hb SS	13		24	2	4	1	1	1
		Per Couple	1.846*	0.154*	0.308*	0.077	0.077	0.077
Hb AS X Hb AS	57		176	11	2	7	8	24
		Per Couple	3.087*	0.193*	0.035	0.123*	0.140*	0.421*
Hb AS X Hb SS	8		14	0	0	3	3	6
		Per Couple	1.750*	0.000	0.000	0.375*	0.375*	0.750*
Hb AS X Hb AE	1		3	1	0	0	0	0
Hb SE X β-Thal.T.	1		4	0	0	0	0	0
Hb AE X β-Thal.T.	1		7	0	0	0	0	0
Hb AS X β-Thal.T.	13		45	1	0	0	1	3
		Per Couple	3.461*	0.077	0.000	0.000	0.077	0.231*
Hb AA X S-β-Thal.	2		2	0	0	0	0	0
		Per Couple	1.000	0.000	0.000	0.000	0.000	0.000
Hb AS X S-β-Thal.	5		11	0	1	1	1	1
		Per Couple	2.200*	0.000	0.200*	0.200*	0.200*	0.200*
β -Thal.T.X S-β-Thal.	2		3	0	0	0	0	0
		Per Couple	1.500	0.000	0.000	0.000	0.000	0.000
Hb AA X β-Thal.T.	17		27	0	3	3	3	3
		Per Couple	1.588*	0.000	0.176*	0.176*	0.176*	0.176*
β-Thal.T.X β-Thal.T.	31		74	4	0	1	2	4
		Per Couple	2.387*	0.129	0.000	0.032	0.064	0.129
Hemoglobinopathies (Combined)	**195**		**479**	**25**	**16**	**20**	**23**	**46**
		Per Couple	**2.456***	**0.128**	**0.082***	**0.103**	**0.118**	**0.236***
Hb AA X Hb AA (Normal)	**138**		**210**	**21**	**7**	**16**	**17**	**20**
		Per Couple	**1.522**	**0.152**	**0.051**	**0.116**	**0.123**	**0.145**

●Birth to 28 days. ■Birth to 365 days or within 1 year. *Higher values than the controls.

Table 2. Surviving children (offspring) with hemoglobinopathies

Diagnosis (Genotypes of Couples)	No. of Couples	Concep-tions	Total Surviving	Hb AA		Hb AS		Hb SS		S-□-Thal.		□-Thal. T		□ Thal. Major		Hb SE		Hb E-Thal		Hb AE	
				M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Hb AA X Hb AS	44	89	73	33	21	8	11														
Hb AA X Hb SS	13	24	17			10	7														
Hb AS X Hb AS	57	176	140	30	26	10	16	35	23												
Hb AS X Hb SS	8	14	8			2	4	0	2												
Hb AS X Hb AE	1	3	2	0	1											1	0				
Hb SE X β -Thal.T.	1	4	3			0	2													0	1
Hb AS X β -Thal. T.	13	45	41	2	3	4	5			11	2	6	8								
Hb AS X S- β -Thal.	5	11	9			1	1	1	1	2	1	0	2								
Hb AA X S- β -Thal.	2	2	2	0	1							0	1								
Hb AA X β -Thal. T.	17	27	20	6	11							0	3								
β -Thal. T. X β -Thal. T.	31	74	66	8	17							6	9	10	16						
β -Thal. T. X S- β -Thal.	2	3	3			2	0			1	0										
Hb AE X β -Thal. T.	1	7	7	1	4							1	0					0	1		
Hemoglobinopathies (Combined)	**195**	**479**	**391**	**80**	**84**	**37**	**46**	**36**	**26**	**14**	**3**	**13**	**23**	**10**	**16**	**1**	**0**	**0**	**1**	**0**	**1**
Per Couple*		**2.456**	**2.005**	**0.841**		**0.426**		**0.318**		**0.087**		**0.185**		**0.133**		**0.0005**		**0.0005**		**0.0005**	
Per 1000 Live-births*			**893**	**375**		**190**		**142**		**39**		**82**		**59**		**2**		**2**		**2**	
Hb AA X Hb AA (Normal)	**138**	**210**	**194**	**82**	**112**																
Per Couple*		**1.522**	**1.405**	**1.405**																	
Per 1000 Live-births*			**924**	**867**																	

* Sexes combined.

It was also observed that the frequency of couples with combinations: HbAS x HbAS, HbAS x HbSS, and β-Thalassemia Trait x β-Thalassemia Trait, was considerably higher in the scheduled castes (SC), scheduled tribes (ST), and in Other Backward Castes (OBC) in the state of Madhya Pradesh.

Further, it is noteworthy that the fertility or the number of conceptions per defective (combined hemoglobinopathies) couple is higher than in the normal controls (Table 1). This implies that the carrier couples produce more children than the normal couples to ensure the survival of at least some of them.

Table 2 presents the surviving offspring with hemoglobinopathies per couple as well as per 1000 live-births in different diagnostic categories.

DISCUSSION

This study strongly supports the contention that hereditary hemoglobin disorders including β-thalassemia syndrome and sickle cell disease contribute significantly to the reproductive wastage and high neonatal, infant and childhood morbidity and mortality in the state of Madhya Pradesh in Central India. There are several high risk vulnerable communities that practice territorial endogamy and marriage among blood relatives because of economic/property benefits leading to inbreeding due to small effective community size. There have emerged several independent breeding isolates of a community with the passage of time which had a common stock in the distant past. Historically, the written records are not available and only the verbal instructions are followed generation after generation but these genetic characteristics indicate their common origin. Moreover, the increased frequency of homozygous hemoglobinopathies (in surviving offspring) of autosomal recessive disorders (Table 2) either testifies the occurrence of inbreeding or high prevalence of hereditary hemolytic disorders (β-thalassemia syndrome and hemoglobinopathies) in the vulnerable communities leading to high morbidity, neonatal and infant/childhood mortality and fetal wastage in Madhya Pradesh. These findings are in agreement with our previous similar studies carried out in the state of Orissa (8).

This study has revealed that hereditary causes, apart from other concomitant non-genetic factors, could also be responsible for the high neonatal/infant mortality in Madhya Pradesh. It is apparent that the reproductive wastage (stillbirths, neonatal deaths, and childhood deaths) per couple with hemoglobinopathies is higher, compared to normal couples (Table 1 and 2). These results are consistent with our previous findings (8, 9). Moreover, the number of deaths of offspring below 1 year of age (infant mortality) and below 10 years of age (childhood mortality) in such couples is also higher than in normal couples. These findings show that the progeny of sickle-cell trait, β-thalassemia, and sickle cell/β-thalassemia, etc. couples contribute disproportionately to the high neonatal/infant mortality in the state of Madhya Pradesh. Similar findings are also expected from the adjacent state of Chhattisgarh, being earlier the part of undivided state of Madhya Pradesh.

Further, it is intriguing in the state of Madhya Pradesh, the number of conceptions (fertility) per defective poor couple is higher (combined hemoglobinopathies) than in the normal controls (Table 1). This implies that the carrier and poverty-stricken couples produce more children than the normal couples to overcome the non-survival of some of them. These results are consistent with our previous similar findings reported from the state of Orissa (8, 14).

Fetal wastage from abortions, stillbirths, and neonatal deaths is increased in mothers with homozygous sickle-cell disease (15). Spontaneous abortions occurred in 19.2% of pregnancies of sickle-cell disease mothers (16). An increased rate of stillbirths (11.5%) in pregnant women with sickle cell disease (16) and 5% was observed in pregnant women in Baltimore (17). Overall perinatal mortality (stillbirths and neonatal deaths) was 8.1%, four-fifths attributable to stillbirths and one-fifth to neonatal deaths (16). In the present study comparatively lower number of abortions, stillbirths, neonatal mortality, infant mortality, and mortality below 10 years per 100 live-births have been observed to be 5.7%, 3.7%, 4.6%, 5.3%, and 10.5%, respectively in couples with carrier of hemoglobinopathies (combined) in the state of Madhya Pradesh. These findings show comparatively improvement in medical health care in India with the passage of time.

It is emphasized that there is an urgent need to take up intervention and prevention program at least in affected couples at grass root level in the state of Madhya Pradesh to mitigate the sufferings of poverty stricken underprivileged, innocent, and vulnerable people.

The quality of health care in Madhya Pradesh (India) is hampered by various factors for child health care and some of these factors are listed here:

1. Pregnant women have unequal access to health care, before, during and after birth and newborns suffer as a consequent of it. Almost two-third of pregnant women deliver at home and only half of them receive care from skilled birth attendants. Similarly, less than 50% have 3 or more antenatal check ups during gestational period and one-third do not get two doses of tetanus toxoid vaccine indicating poor antenatal care. This leads to complicated deliveries resulting in maternal and neonatal morbidity and mortality.
2. Families in rural areas generally consult a primary health care provider close to their home for their sick baby and only visit a hospital or a specialist in a situation where irreversible damage has already been done.
3. Poverty stricken people from the villages and urban slums do not avail the referral system out of fear for loss of daily wages.
4. Recognition of illness by parents in a newborn is always delayed due to the subtle signs and symptoms. In addition, disease often progresses rapidly in newborns and allow little time for parents to take a decision.
5. Care seeking is influenced by traditional customs more in neonatal period than afterwards. In many areas/communities the newborns are not taken out of the house during the first 12 days or so even though the baby falls sick. In some communities, the belief is to give a complete bath on certain day only. These harmful practices contribute to higher number of deaths.
6. Female babies (daughters) are neglected more often than the sons when they fall sick.
7. Poor communication and transport facilities are other hurdles.
8. Over 80% of qualified doctors work in urban areas and private sectors. Poor people living in villages have no other option but to go to local practitioners, out of whom many are unqualified or herbal/witchcraft/magic healers.

9. There is a scarcity of trained nursing personnel who form the backbone of perinatal-neonatal and child care at all levels of care. The system itself lacks resources for training and capacity building to fulfill the gap thus arisen.
10. Discrimination being practiced against a particular community/individual further mars the health seeking attitude/behavior. Misbehavior by the greedy staff of the health facility. No incentive is given to any good health performing individual doctor/paramedical staff by the concerned authority or the government.

CONCLUSION

The sickle cell disease and β-thalassemia syndrome are the major genetic and public health challenges in Central India. In view of credit of the 2nd highest infant mortality rate (IMR) in Madhya Pradesh (70 per thousand live-births in 2011) it was presumed that the hemoglobinopathies might be one of the contributing factors in the carrier couples of hemoglobinopathies for IMR. Couples (parents) including their offspring with at least one affected/suspected case of hemoglobinopathies referred to us from NSCB Medical College & Hospital, Jabalpur were consecutively studied as matched case controls.

A total of 333 couples were referred during the period from March 2010 to March 2012. Out 333 couples, 138 were found normal and 195 couples had different hemoglobin disorders. It was observed that the number of conceptions (2.456 vs 1.522), live-births (2.246 vs 1.319), surviving offspring (2.005 vs 1.406), stillbirths (0.082 vs 0.051), and deaths under 10 year (0.236 vs 0.145) were higher and neonatal deaths (0.103 vs 0.116), and deaths under one year (0.118 vs 0.123), per couple at the time of investigations were lower in couples with hemoglobinopathies as compared to normal controls.

The frequency of couples with HbAS x HbAS, HbAS x HbSS and β-Thal.T x β-Thal.T combinations was considerably higher in the scheduled castes, scheduled tribes, and in Other Backward Castes. Affected families were imparted genetic/marriage counseling. This study indicated that afflicted couples of these hereditary disorders were increasing the defective offspring (surviving: 58%). This increased production of defective offspring (surviving: 58.06%) leads to increased morbidity and mortality and may be contributing towards increased neonatal/infant mortality or fetal wastage in Madhya Pradesh, India.

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Chapter 19

HEMATOLOGICAL PROFILE OF PREGNANT WOMEN WITH CARRIER STATUS OF HEMOGLOBIN DISORDERS

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ABSTRACT

Hemoglobin disorders are commonly encountered maladies throughout the Indian subcontinent. Pregnant women constitute an important segment of the society. Genetic screening in pregnant women is mandatory for the detection of hemoglobin disorder in the absence of any response to diet therapy. This chapter was undertaken to assess the hemato-physiological stress during different trimesters and to identify hemoglobinopathies following the standard methodology and techniques in 178 pregnant women of Coastal Odisha in Central Eastern region of India. An incidence of 13.5% hemoglobinopathies was recorded in pregnant women which was alarmingly high in the coastal state of Odisha. Statistically significant reduced profile of mean hematological indices was observed in pregnant women with carrier hemoglobin disorders against the matched normal controls. A consistent significant decrease in the mean red cell indices was noted in 1st and 2nd trimesters of pregnant women with sickle cell trait and β-thalassemia carrier as against the matched normal pregnant women. However, significant improvement with the nutritional supplementations and prophylactic measures in the 3rd trimester have shown almost similar hematological indices of pregnant women with β-thalassemia trait, hemoglobin AE, and sickle cell trait, to those of matched normal pregnant women. It is concluded that genetic screening for the detection of hemoglobin disorders in pregnant woman is highly essential for the regular check up, antenatal care, and clinical management right from the conception to delivery in India.

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INTRODUCTION

The people of Indian subcontinent ancestry are at a higher risk for being carriers of hemoglobinopathies and should be offered carrier screening (1). Genetic screening can identify couples at risk for offspring with hemoglobinopathies and allow them to make informed decisions regarding reproduction and prenatal diagnosis (2, 3). Couples at risk for having a child with a hemoglobinopathy may benefit from genetic counseling to review the natural history of these disorders, prospects for treatment and cure, their risk, availability of prenatal genetic testing, and reproductive options (4). A combination of laboratory tests may be required to provide the information necessary to counsel couples who are carriers of one of the thalassemias or sickle cell disease. To ensure accurate hemoglobin identification, which is essential for genetic counseling, a complete blood count (CBC) is the appropriate initial laboratory test for people of non-African descent. Although the advances in prenatal diagnosis of hemoglobinopathies have been impressive, the use of technology has somewhat been limited in India because of ethical, social, and cultural concerns (5, 6).

Pregnancy in women with sickle cell disease is associated with an increased risk of morbidity and mortality because of the combination of underlying hemolytic anemia and multiple organ dysfunctions associated with this disorder (7, 8). Pregnancies in women with sickle cell disease are at increased risk for spontaneous abortion, preterm labor, intrauterine growth retardation, and stillbirth (7, 9). The magnitude of the risk varies with genotype and severity of anemia. However, morbidity and mortality have decreased markedly over the past three decades in India because of improvements in general medical care for patients with sickle cell disease, improvements in transfusion medicine, and advancements in neonatal care. Early symptoms are usually nonexistent or nonspecific (e.g., fatigue, weakness, light-headedness, mild dyspnea with exertion). Anemia increases risk of preterm delivery and postpartum maternal infections (10). Other symptoms and signs may include pallor and, if anemia is severe, tachycardia or hypotension. Anemia almost always becomes more severe as pregnancy progresses (10). Sickle cell trait increases the risk of urinary tract infections (UTIs) but is not associated with severe pregnancy-related complications. In spite of the decline in maternal and perinatal mortality rates, however, pregnancy is still a significant clinical risk for many patients with sickle cell disease.

Several predominant hemoglobin (Hb) variants, namely, Hb C, Hb D, Hb E, Hb S and homozygous/heterozygous β-thalassemia are encountered in India. In view of the high prevalence of β-thalassemia syndrome and abnormal hemoglobin variants in India (1, 6), it would be worthwhile to study the hemato-physiological stress in a cross-section of pregnant women in a hyper malaria endemic state of Odisha in Central Eastern region of India. This study also presents a comparative hematological picture of pregnant women with carrier status of abnormal hemoglobin variants against normal controls reflecting the status of reproductive health care in India.

OUR STUDY

This study was carried out at the Division of Human Genetics, Regional Medical Research Centre (Indian Council of Medical Research), Bhubaneswar, Odisha during the period from

June 2004 to May 2005. For the present study, 2-3 ml intravenous blood samples were consecutively collected using disposable syringes and needles in disodium salt of Ethylene Diamine Tetraacetic Acid (EDTA) coated vials after taking informed consent from each pregnant woman visiting for antenatal check up at the Out Patient Department (OPD), Department of Obstetrics and Gynaecology, Capital Hospital, Bhubaneswar (116 samples) and from the Out Patient Department (OPD), Department of Obstetrics and Gynaecology, M.K.C.G Medical College & Hospital, Berhampur (62 samples) in coastal Odisha. Blood samples so collected were transported under wet ice-cold conditions to laboratory at Bhubaneswar within 24 h of collection for laboratory investigations and were analyzed following the standardized laboratory procedures and techniques. Hematological parameters were studied using an automated Blood Cell Counter (Model MS4, Melet Schloesing Laboratories, Cergy-Pontoise Cedex, France).

The sickling test was performed, using freshly prepared sodium metabisulphite solution as a reducing agent for the presence or absence of sickle hemoglobin (11). Routine hemoglobin lysate electrophoresis was carried out on cellulose acetate membrane (CAM) in Tris-EDTA-borate buffer at pH 8.9 and quantification of hemoglobin A_2 fraction was done by elution method (12). The value of more than 3.5% of hemoglobin A_2 fraction of adult hemoglobin was taken as the cut off point for determining the β-thalassemia trait and more than 10% for hemoglobin E. Estimation of fetal hemoglobin was carried out as described by Weatherall (12). For the confirmation of Hb-H disease, blood film prepared with brilliant cresyl blue stain was examined for large Heinz body like inclusions (12).

The diagnosis of sickle cell/β-thalassemia was based on findings of hemoglobin A, F, S and A_2 on electrophoresis under acidic and alkaline media, elevated Hb A_2 levels (>3.5%), and family study. In view of the inverse relationship between Hb A_2 and Hb F levels, high levels of Hb F were very common in Indian sickle cell patients (13). All the blood samples were further subjected to confirmation by hemoglobin variant analysis (made for Bio-Rad Diagnostics Group, Hercules, California, USA).

Each subject was requested to provide the background information such as name, age, residential address, reproductive history (abortion, miscarriage, stillbirth, etc.) if any, month of gestation, history of hospitalization if any, blood transfusion or pregnancy related complications if any, etc. Out of a total of 178 pregnant women studied, one hundred fifty four (154) matched women who were free from any kind of hemoglobinopathies based on laboratory test findings were labeled as normal controls. Of the 24 pregnant women identified with hemoglobin disorders, 10 each were carriers of sickle cell disease and β-thalassemia syndrome, 2 carriers of hemoglobin E disease, and one each were sickle cell-E disease and hemoglobin H disease referred as diseased group.

Results obtained were statistically tested by performing student's t-test to compare the normal with each diagnostic category for the difference between the two independent variables and significance, if any, also indicated.

FINDINGS

Out of 178 pregnant women screened for hemoglobinopathies, 24 showed hemoglobin abnormalities (see table 1). Thus, the incidence of hemoglobin disorders in this cross-section of pregnant women who attended the urban hospitals accounted for 13.5%, which is alarmingly high in the coastal state of Odisha. The women with β-thalassemia trait and sickle cell trait constituted 5.6% each of the pregnant women, 1.1 % hemoglobin E trait and 0.6% each sickle cell-E-disease and Hb H-disease consisted of the whole lot of pregnant women studied from urban hospitals of coastal Odisha.

There was statistically significant increase in mean hematological indices such as hemoglobin level ($p<0.02$), RBC count ($p<0.05$), and HCT ($p<0.001$), and decrease of MCH ($p<0.001$), MCHC ($p<0.001$), and Hb A ($p<0.001$) in heterozygous hemoglobin E pregnant women in comparison to normal pregnant women. Considering the mean hematological indices in pregnant women with β-thalassemia trait in comparison to controls, it was observed that there was statistically significant decrease in MCV ($p< 0.05$), HCT ($p<0.01$), and Hb A ($p<0.001$) and an increased level of Hb A_2 ($p<0.001$) in pregnant women with carrier status of β-thalassemia syndrome. Statistically highly significant decrease in mean hematological indices in pregnant women with heterozygous sickle cell disease in comparison to controls was observed in MCV ($p<0.001$), MCH ($p<0.01$), Hb A_2 level ($p<0.001$), and Hb A ($p<0.001$).

While comparing the mean red cell indices of pregnant women in 1^{st} trimester between the normal controls and heterozygotes of sickle cell disease, it was observed that there was a consistent decrease in hemoglobin level, RBC, MCV ($p<0.01$), HCT, MCH ($p<0.01$), MCHC ($p<0.05$), Hb A_2 ($p<0.001$), and Hb A ($p<0.001$) in sickle cell heterozygotes in comparison to normal pregnant women. The comparison of mean red cell indices in 1^{st} trimester of pregnant women having β-thalassemia trait with normal controls showed statistically highly significant increased level of Hb A_2 ($p<0.001$) and decreased levels of Hb F ($p<0.001$), and Hb A ($p<0.001$) in pregnant women with β-thalassemia trait.

In 2^{nd} trimester of pregnant women, there was a statistically highly significant decrease in the mean hematological indices such as RBC ($p<0.001$), MCV, HCT, and Hb A ($p<0.001$) and increase in Hb level, MCH, WBC, Hb A_2 ($p<0.001$), and Hb F in heterozygotes of β-thalassemia syndrome as compared to normal pregnant women. In sickle cell carrier pregnant women during 2^{nd} trimester, there was noted an increase in mean hemoglobin level, RBC count, HCT, MCHC and decrease in mean MCV, MCH, WBC ($p<0.001$), and Hb A ($p<0.001$) in comparison to normal pregnant women.

Table 1. Prevalence of different hemoglobin disorders in pregnant women of coastal Odisha

Diagnosis	No.	%
Normal (Hb AA)	154	86.5
β-Thalassemia Trait	10	5.6
Sickle Cell Trait	10	5.6
Hemoglobin E Trait	2	1.1
Sickle Cell-Hemoglobin E Disease	1	0.6
Hemoglobin H Disease	1	0.6
Total	178	100.0

Table 2. Mean values of hematological indices for different hemoglobinopathies in pregnant women of Odisha state, India

Diagnosis	N		Age in years	Hb (g/dl)	RBC ($10^6/\mu l$)	MCV (fl)	HCT (%)	MCH (pg)	MCHC (g/dl)	RDW (%)	WBC ($10^3 \mu l$)	Sick-ling	Electro-Phoresis	HbA_2/E (%)	HbF (%)	HbS (%)	Hb A (%)
Normal Control	154	Mean S.D.	23.7 4.4	9.9 2.2	4.0 1.0	80.7 10.5	32.0 8.6	26.8 4.3	32.5 3.0	9.5 2.0	8.1 3.6	-ve	AA	2.3 0.7	0.8 0.2	- -	96.6 0.8
Hemoglobin E trait	2	Mean S.D.	23.0 0.0	10.8b 0.3	5.3a 0.6	82.2 0.9	34.8d 0.4	25.5d 0.1	30.8d 0.1	8.6 0.4	9.1 1.6	-ve	AE	27.0 4.0	0.4 0.0	- -	72.2d 3.3
β-Thalassemia trait	10	Mean S.D.	24.4 4.1	10.1 2.0	4.0 1.0	74.2a 9.2	29.8c 8.5	27.3 6.4	33.3 2.2	9.6 1.1	8.4 2.7	-ve	AA	4.1d 0.3	1.1 0.5	- -	94.7d 0.6
Sickle cell trait	10	Mean S.D.	22.6 5.5	9.5 2.2	4.0 0.8	74.1d 5.0	29.5 6.5	23.9c 2.9	32.7 3.3	9.7 2.2	6.4 3.4	+ve	AS	1.9d 0.3	0.9 0.5	25.3 6.2	72.7d 6.6
Sickle cell-hemoglobin E disease	1	-	23	12.6	2.4	61.9	34.7	31.0	19.3	13.4	12.9	+ve	SE	26.2	5.8	68.0	0.0
Hemoglobin H disease	1	-	26	11.2	5.9	66.1	38.9	21.8	32.1	12.3	10.5	-ve	AFH*	2.7	10.5	-	65.6

Comparisons: a: $p<0.05$; b: $p<0.02$; c: $p<0.01$; d: $p<0.001$.
Normal Control vs. β-Thal. Trait.
Normal control vs Hb AE.
Normal control vs Sickle cell Trait.

Table 3. Mean values of hematological indices according to trimester in different hemoglobinopathies for pregnant women of Odisha

Diagnosis	N		Age in years	Gestation Period	Hb (g/dl)	RBC ($10^6/\mu l$)	MCV (fl)	HCT (%)	MCH (pg)	MCHC (g/dl)	RDW (%)	WBC ($10^3\mu l$)	Sick-ling	Electro-Phoresis	HbA_2/E (%)	HbF (%)	HbS (%)	Hb A (%)
Normal Control	59	Mean S.D.	22.6 4.0	1st Trimester	10.2 2.1	3.9 0.8	84.1 9.5	33.7 8.3	27.9 4.2	32.6 2.8	9.4 2.1	7.0 3.2	-ve	AA	2.5 0.7	0.9 0.2	-	96.3 0.8
β-Thalassemia trait	3	Mean S.D.	23.7 6.4	1st Trimester	9.8 2.9	3.8 0.3	74.4 12.5	29.8 7.5	25.4 6.4	32.6 1.6	10.0 1.3	6.0 3.5	-ve	AA	4.1d 0.4	0.8d 0.2	-	95.1d 0.3
Sickle cell trait	5	Mean S.D.	18.4 2.3	1st Trimester	8.7 2.8	3.7 1.0	75.5c 6.3	28.2 8.9	23.2c 2.8	30.8a 1.6	10.0 3.2	7.1 4.3	+ve	AS	1.7d 0.3	0.9 0.3	27.1 7.7	71.5d 8.8
Hemoglobin H disease	1	-	26	1st Trimester	11.2	5.9	66.1	38.9	21.8	32.1	12.3	10.5	-ve	AFH*	2.7	10.5	-	65.6
Normal Control	53	Mean S.D.	24.7 4.6	2nd Trimester	9.5 2.4	4.0 1.0	78.3 9.8	31.1 8.8	26.1 4.5	32.5 2.9	9.4 1.5	8.3 3.6	-ve	AA	2.3 0.7	0.8 0.3	-	96.8 0.8
β-Thalassemia trait	4	Mean S.D.	23.8 1.7	2nd Trimester	9.7 2.0	3.3d 0.2	75.5 8.7	24.3 8.8	30.4 7.6	32.9 1.7	9.2 0.4	9.0 1.6	-ve	AA	4.1d 0.3	1.2 0.5	--	94.7d 0.4
Sickle cell trait	2	Mean S.D.	29.5 3.5	2nd Trimester	10.9 0.8	4.5 0.5	74.9 3.6	33.1 1.8	24.6 0.6	32.9 0.8	9.0 0.3	5.3d 0.6	+ve	AS	2.0 0.3	0.5 0.1	25.1 1.5	73.1d 0.7
Sickle cell-hemoglobin E disease	1	-	23	2nd Trimester	12.6	2.4	61.9	34.7	31.0	19.3	13.4	12.9	+ve	SE	26.2	5.8	68.0	0.0
Normal Control	42	Mean S.D.	24.0 4.4	3rd Trimester	9.8 2.0	4.0 1.2	78.7 11.5	30.6 8.5	26.2 4.1	32.2 3.3	9.9 2.4	9.6 3.5	-ve	AA	2.5 0.8	0.8 0.2	-	96.4 0.8
β-Thalassemia trait	3	Mean S.D.	24.3 6.1	3rd Trimester	10.8 1.3	5.2 1.1	72.3 10.1	37.1c 3.1	25.1 4.9	34.6 3.3	9.9 1.6	10.1 1.9	-ve	AA	4.3d 0.4	1.4 0.6	-	94.2d 0.8
Sickle cell trait	3	Mean S.D.	26.0 5.2	3rd Trimester	9.9 1.0	4.1 0.5	71.4b 3.5	29.2 2.9	24.6 4.5	35.7 4.6	9.7 0.9	6.2 3.3	+ve	AS	2.1 0.3	1.2 0.7	22.6 6.0	74.4d 5.8
Hemoglobin E trait	2	Mean S.D.	23 0.0	3rd Trimester	10.8c 0.3	5.3c 0.6	82.2 0.9	34.8c 0.4	25.5 0.1	30.8c 0.1	8.6 0.4	9.1 1.6	-ve	AE	27.0 4.0	0.4 0.0	--	72.2d 3.3
Normal Control	154	Mean S.D.	23.7 4.4	Trimesters Combined	9.9 2.2	4.0 1.0	80.7 10.5	32.0 8.6	26.8 4.3	32.5 3.0	9.5 2.0	8.1 3.6	-ve	AA	2.3 0.7	0.8 0.2	-	96.6 0.8

*=Hemoglobin H Disease; a: $p<0.05$; b: $p<0.02$; c: $p<0.01$; d: $p<0.001$.

1st Trimester: Normal control vs Sickle cell Trait.
Normal control vs β-Thal. Trait.

2nd Trimester: Normal control vs Sickle cell Trait.
Normal control vs β-Thal. Trait.

3rd Trimester: Normal control vs Sickle cell Trait.
Normal control vs Hb AE.
Normal control vs β-Thal. Trait.

In the 3rd trimester of pregnant β-thalassemia carrier women, an increase in mean hemoglobin level, RBC, HCT ($p<0.01$), MCHC, WBC, Hb A_2 ($p<0.001$), and Hb F and decrease of mean MCV, MCH, and Hb A ($p<0.001$) was recorded as compared to normal pregnant women. In sickle cell carrier pregnant women during 3rd trimester, there was an increase in the mean hematological indices such as hemoglobin level, RBC, MCHC, and Hb F and decrease of MCV ($p<0.02$), HCT, MCH, WBC, and Hb A ($p<0.001$) in comparison to normal pregnant women. The carrier pregnant women of hemoglobin E disease during 3rd trimester showed an increase of mean hemoglobin level ($p<0.01$), RBC ($p<0.01$), MCV, and HCT ($p<0.01$) and decrease of MCH, MCHC ($p<0.01$), and Hb A ($p<0.001$) as compared with the hematological indices of normal pregnant women.

DISCUSSION

The Indian subcontinent is a vast reservoir of several hemoglobin variants; to name a few of them like Hb C, Hb D, Hb E, and Hb S and β-thalassemia syndrome that are frequently encountered in India too. In view of the high prevalence of β-thalassemia syndrome and abnormal hemoglobin variants in India (1, 6, 8), it was interesting to study the hemato-physiological stress in a matched cross-section of pregnant women in a hyper-malaria endemic state of Odisha in Central Eastern region of India. The study presented a comparative hematological picture of pregnant women with carrier status of hemoglobin variants against the matched normal controls. A hospital based cross section of pregnant women has shown an incidence of 13.5% hemoglobinopathies, which is alarmingly high in the coastal state of Odisha (see table 1).

In general, pregnancies in women with hemoglobinopathies are at increased risk for spontaneous abortion, preterm labor, intrauterine growth retardation, and stillbirth (4, 9, 14). The magnitude of the risk varies with genotype, health and nutritional status of mother, severity of anemia, and availability of health care facilities. However, despite improvements in neonatal and maternal health care, in some places/states, the pregnancy in women is still associated with an increased risk of morbidity and mortality (9). This study has shown reduced mean hematological indices profile in pregnant women with carrier hemoglobin disorders against the normal pregnant women (see table 2) indicating the increased consequential risk in their pregnancy outcome. However, adequate and acceptable hematological profile in normal pregnant women is still lacking in India.

Normally during pregnancy, erythroid hyperplasia of the bone marrow occurs, and RBC mass increases. Plasma volume increases early in pregnancy with a 50% increase and delayed increase in RBC mass and volume but less than the plasma volume. Changes in blood volume, plasma volume, red cell volume and cardiac output begin in the first trimester. However, a disproportionate increase in plasma volume results in hemodilution (hydremia of pregnancy): Hematocrit decreases between 38 and 45% in healthy women. Despite hemodilution, oxygen-carrying capacity remains normal throughout pregnancy. Hematocrit normally increases immediately after birth. A consistent statistically significant decrease in the mean red cell indices (in some diagnostic groups such as hemoglobin level, RBC count, MCV, HCT, MCH, MCHC, and Hb A) in 1st trimester of pregnant women with hemoglobinopathies (sickle cell and β-thalassemia carriers) as against normal pregnant women was observed in the present study (see table 3) indicating the adverse status of nutrition, calcium, iron, zinc, folic acid, and vitamins (C, E, B_6, $B_{12,}$ etc.) stores in pregnant women with hemoglobinopathies. There is an urgent need of intervention with nutritional supplementations and prophylactic measures to be taken immediately to ameliorate pregnancy outcome in these pregnant women. The situation in 2nd trimester of pregnant women with hemoglobinopathies (sickle cell trait and β-thalassemia trait) was equally worse than the normal pregnant women (see table 3).

Anemia occurs in one-third of the women during the 3rd trimester. Anemia increases risk of preterm delivery and postpartum maternal infections (3, 10, 15, 16). The most common causes are iron and folate deficiencies. Normal pregnancy is associated with demand of 1,000 mg of additional iron, i.e., 500 mg to increase maternal RBC volume, 300 mg transported to fetus, and 200 mg for normal iron loss. However, in the 3rd trimester, improvement with the nutritional supplementations and prophylactic measures was observed even in pregnant women with hemoglobinopathies (e.g., β-thalassemia trait, hemoglobin AE, and sickle cell trait) almost similar to normal pregnant women (see table 3) in this cross sectional hospital based study. This shows a positive impact on pregnant women regarding the antenatal care, regular check up, and clinical management at a medical facility in India.

Straight transfusion in pregnant women with major hemoglobinopathies is usually performed to raise the patient's hematocrit to a value between 25 and 30%. Over-transfusion may, sometime, increase blood viscosity and worsen sickling. Packed red blood cells are the blood product of choice since they reduce the risk of antigen sensitization. It is common for pregnant women with major hemoglobinopathies to develop positive antibody, screened from repetitive blood transfusions. Therefore, transfusion is only advisable when there is an utmost urgency.

During pregnancy, hemoglobinopathies, particularly the sickle cell disease, sickle cell-β-thalassemia, β-thalassemia trait, and α-thalassemia, can worsen maternal and perinatal outcomes. Patients with hemoglobinopathy should not be given iron supplementation. The increased rate of hemolysis in patients with hemoglobinopathy provides a rapid turnover of the patient's iron stores. Iron supplementation for patients with hemoglobinopathies places them at risk for hemachromotosis and excess iron deposition. Preexisting sickle cell disease**,** particularly if severe, increases risk of maternal infection (most often, pneumonia, urinary tract infections, and endometritis), pregnancy-induced hypertension, heart failure, and pulmonary infarction. Fetal growth restriction, preterm delivery, and low birth weight are also common (15, 16).

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Chapter 20

CLINICAL AND HEMATOLOGICAL PROFILE OF HEMOGLOBIN D DISEASE IN SEVEN SINDHI FAMILIES

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ABSTRACT

Among the common hereditary hemolytic disorders, the β-globin chain disorders of hemoglobin are prevalent in many parts of the world. Hemoglobin D is one of the abnormal hemoglobins sporadically encountered in some communities of India. The Sindhi community is one of the emigrant communities which came to India during partition in 1947 from Pakistan and settled in different cities and towns. Their main occupation is business or trade. Sporadic hospital based reports indicate that Sindhi community in India is highly vulnerable to hemoglobinopathies especially to hemoglobin D disease. To the best of our knowledge, no community based study available on Sindhi community in India. This study has screened 508 individuals at random belonging to different localities in Jabalpur town of Madhya Pradesh. We have encountered seven families with 12 cases (5 males and 7 females) of hemoglobin D in Sindhi community after doing hematological, biochemical, and electrophoretic investigations. One case of double heterozygosity of Hb D and β-thalassemia (0.2%) was detected. Although the incidence of 2.16% for heterozygous Hb D was high in the Sindhi community, but both heterozygous and double heterozygosity cases were not suffering either from hypochromic or microcytic hemolytic anemia, but were asymptomatic healthy individuals. This shows mild clinical manifestations of hemoglobin D disease in India.

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INTRODUCTION

There are several hereditary diseases, caused by abnormal hemoglobins that affect millions of people around the world. Among them, the most important are those related with alterations in β-globin chain of the hemoglobin. In 1952 hemoglobin D (Hb D) was reported as new hemoglobin variant which migrated electrophoretically in the same position as sickle cell (Hb S) hemoglobin, see review (1). This new hemoglobin was found to be much more soluble than Hb S, and the erythrocytes which contained it could not be induced to sickle. It was assigned the letter D. Hemoglobin D structurally differs from normal hemoglobin A at 121 β-chain position, where glutamine replaces glutamic acid (1,2). Clinical manifestations of hemoglobin D disease are mild with variable hematological picture.

The homozygous hemoglobin D disease is a rare entity and usually presents with mild hemolytic anemia and mild to moderate splenomegaly. Hemoglobin D usually occurs in six forms: heterozygous Hb D trait, Hb D-thalassemia, Hb SD disease, Hb DE disease (3), Hb CD disease (4), and the rare homozygous Hb D disease, and usually associated with mild hemolytic anemia and mild to moderate splenomegaly in India (1,3-5). Heterozygous form of Hb D is clinically silent, but coinheritance of Hb D with Hb S, Hb E or thalassemia produces clinically severe conditions like sickle cell anemia and chronic hemolytic anemia of moderate intensity.

Hb D is a hemoglobin variant that is found in many parts of the world. It is often found in people with ancestors from India and Pakistan and also occurs in people from England, Holland, Australia, China and the Middle East. Hemoglobin D is not very uncommon in India. Hb D is found amongst Sindhi, Punjabi and Gujarati population groups with origin in North West India, Pakistan and Iran (1). There are D hemoglobins that interact with Hb S. Hb $D^{\text{Los Angeles}}$ (also called D^{Punjab}) has a substitution of glycine for the glutamic acid at β-globin 121 position. Individuals with compound heterozygotes for Hb S and Hb $D^{\text{Los Angeles}}$ have moderately severe hemolytic anemia and occasional pain episodes.

Except for the sporadic individual case reports, no community profile is available on hemoglobin D disease in India (1, 2, 5). Keeping the above scenario in mind, the present study has been conducted in Jabalpur Town among the vulnerable Sindhi Community which migrated during the partition in 1947 from Sindh region of Pakistan.

OUR STUDY

The Sindhi community migrated during partition in 1947 from Sindh region of Pakistan to India has settled down in different parts of India mainly in the major cities for doing business. They are an inbred population in India. For the present study, out of five different settlements of Sindhi community, namely, Madaar Tekri [132], Shanti Nagar [83], Laal maati, Dwarika Nagar [139], Bhantalaya [47] and Omti, Bhartipur [107] in Jabalpur Town of Madhya Pradesh, 508 blood samples were randomly collected for screening of hemoglobin disorders, G-6-PD deficiency and ABO and Rhesus (D) blood groups in Central India. Majority of these individuals had migrated from Khairpur, Sakhar, and Ladkana districts of Sindh state in Pakistan to Jabalpur and are living here since over 60 years. Both the sexes irrespective of their age were representatives. Of the seven families studied here belonged to six clans or titles, namely, Tharyani, Punjwani, Varyani, Makhija, Rabuwani, and Dusia. Because of the practice of consanguinity and inbreeding, the homozygosity of recessively inherited characters is apparent in the community.

About 2-3 ml. intravenous blood samples were collected using ethylene diamine tetra acetic acid (EDTA) as anticoagulant by disposable syringes and needles from each individual after obtaining the informed/written consent in the presence of community leaders. A doctor recorded all the signs and symptoms related to hemoglobinopathies after clinical examination on the pre-designed proforma. Any other ailment present was treated/referred to local health facilities. Blood samples so collected were transported to laboratory at RMRCT, Jabalpur under ice-cold conditions within 24 hours of collection. Laboratory investigations were carried out following the standard procedures after cross checking for quality control from time to time. Hematological parameters were studied by using an automated Blood Cell Counter (Model: MS4, Melet Schloesing Laboratories, Cergy-Pontoise Cedex, France).

The sickling test was performed on red cells by using freshly prepared 2% sodium metabisulphite solution as reducing agent (6). The routine hemoglobin electrophoresis was carried out on cellulose acetate membrane (CAM) in Tris-EDTA-Borate buffer at pH 8.6 and quantification of A_2 fraction of hemoglobin by elution method (7). The value more than 3.5% of A_2 fraction of hemoglobin was taken as cut off point for determining the β-thalassemia trait. Estimation of fetal hemoglobin was done as described by Weatherall (7). Confirmation for the presence of hemoglobin D was done as described elsewhere (2). Family studies were carried out to confirm the diagnosis, wherever it was felt necessary. However, the data presented here refer to the probands only.

The glucose-6-phosphate dehydrogenase (G-6-PD) enzyme deficiency was primarily detected by using Dichlorophenol Indophenol (DCIP) dye as described by Bernstein (8). Females heterozygous for G-6-PD deficiency have two populations of cells, one with normal G-6-PD activity and the other deficient. This is the result of inactivation of one of the two X chromosomes (Lyon's hypothesis) in individual cells early in the development of the embryo. All progeny (somatic) cells in females will have the characteristics of only the active X chromosome. The total G-6-PD activity of blood in female will depend on the proportion of normal to deficient cells. In most cases, the activity will be between 20 and 80% of the normal. However, a few heterozygotes (about 1%) may have almost only normal or almost only G-6-PD deficient cells. The present study has not at all encountered any such ambiguity; therefore, there were either 60-80% of the cells normal or deficient in all cases. Subsequent confirmation was done by following the Beutler et al. (9) and WHO procedures (10) in case any doubt arose for the detection of G-6-PD deficiency.

Out of 508 persons screened, 12 cases with hemoglobin D were detected after doing hematological, biochemical, and electrophoretic investigations for the available family members.

Table 1. Hematological indices, G-6-PD deficiency and ABO and Rhesus blood group profile of hemoglobin D cases of Jabalpur Town (Lalmati-Dwarika Nagar) in Central India

Subject/ Clan	Age in years	Sex	Hb (g/dl)	RBC ($x10^6/\mu l$)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (g/dl)	Electro-phoresis	HbF (%)	HbA_2 (%)	G6PD Deficiency	Blood Group
Father	52	Male	12.6	3.16	36.7	116.1	39.9	34.3	AD	0.44	2.80	N	O+
Mother	45	Female	11.3	4.16	36.1	86.8	27.2	31.3	AA	0.39	3.22	N	AB+
Daughter	22	Female	11.4	4.45	33.5	75.3	25.5	33.9	AD	0.34	2.95	N	A+
Daughter	20	Female	9.6	4.56	30.8	67.6	21.1	31.2	AD	0.24	2.22	N	B+
Tharyani													
Father	38	Male	13.1	5.31	49.6	92.4	30.3	32.5	AA	0.49	3.48	N	B+
Mother	36	Female	9.1	4.22	24.9	59.0	22.5	24.5	AD	0.61	2.23	N	B+
Daughter	12	Female	11.9	4.45	34.7	78.1	26.8	34.4	AA	0.70	2.84	N	B+
Daughter	10	Female	12.3	4.83	36.2	75.0	25.6	34.1	AD	0.30	3.36	N	B+
Punjwani													
Father	40	Male	13.9	5.62	33.9	95.9	31.9	39.0	AD	0.46	3.00	N	B+
Mother	35	Female	12.3	3.91	36.6	93.6	31.3	36.8	AA	0.47	4.38	N	B+
Son	18	Male	11.5	5.18	41.6	80.4	26.1	32.5	AD	0.83	4.21	N	B+
Son	16	Male	11.9	4.21	35.6	84.4	28.2	33.3	AD	0.78	2.12	N	B+
Son	14	Male	12.4	4.76	36.9	77.6	26.1	33.6	AA	0.55	2.46	N	B+
Varyani													
Mother	45	Female	11.0	4.54	33.2	72.4	24.0	33.2	AA	0.67	2.06	N	B+
Daughter	21	Female	12.6	4.55	36.9	81.2	27.7	34.1	AD	0.87	2.53	N	B+
Makhija													
Mother	40	Female	12.0	5.43	37.1	68.4	22.2	32.4	AD	0.91	2.91	N	B+
Son	14	Male	13.4	5.20	40.0	76.9	25.7	33.5	AA	0.84	2.72	N	B+
Rabuwani													
Father	27	Male	13.2	5.37	40.1	74.8	24.6	32.9	AD	0.85	3.20	N	B+
Mother	24	Female	9.5	4.14	29.8	72.0	22.8	31.7	AA	0.76	2.13	N	B+
Tharyani													
Daughter	20	Female	9.0	4.38	23.8	54.3	20.5	37.8	AD	0.74	2.80	N	O+
Dusia													

Table 2. Mean values of hematological indices in cases of hemoglobin D and normal controls of Jabalpur Town in Central India

Diagnostic Categories	Sex	Age in years	Hb (g/dl)	RBC ($x10^6/\mu l$)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (g/dl)	Hb F (%)	Hb A_2 (%)	Electrophoresis
Normal Control (N=3)											
Mean	Male	22.0	13.0	5.09	42.2	82.3	27.4	33.2	0.63	2.89	
SD±		13.9	0.5	0.29	6.6	8.7	2.5	0.6	0.19	0.53	AA
Hb D Trait (N=4)											
Mean	Male	33.8	12.9	4.59	36.6	92.8	31.1	34.9	0.63	2.78	AD
SD±		15.6	0.8	1.13	2.6	17.8	6.5	2.8	0.21	0.47	
Hb D/ β-Thalassemia (N=1)	Male	18	11.5	5.18	41.6	80.4	26.1	32.5	0.83	4.21	AD
Normal Control (N=5)											
Mean	Female	32.2	11.2	4.24	34.1	80.6	26.4	33.5	0.60	2.93	AA
SD±		14.2	1.1	0.25	2.7	9.4	3.3	2.2	0.16	0.95	
Hb D Trait (N=7)											
Mean	Female	24.1	10.9	4.63	31.9	68.7	23.6	32.6	0.57	2.71	AD
SD±		10.3	1.6	0.40	5.6	9.5	2.7	4.1	0.28	0.41	

FINDINGS

Table 1 shows the hemoglobin D individuals with other family members of Sindhi community among whom this abnormal hemoglobin was detected along with other genetic traits like G-6-PD deficiency and ABO and Rhesus (D) blood groups in Jabalpur town of Madhya Pradesh, India.

Out of the seven families of Hb D studied, three families were complete, two had one parent and one child, and one was unmarried daughter. Hematological details of three complete families and other families along with their pedigree are shown in Table 1. Out of a total of 20 members screened, none was found with G-6-PD deficiency. The ABO blood group distribution in 20 individuals was as follows: O (2), AB (1), A (1), and B (16); and none had Rhesus negative.

Out of 12 cases (5 males and 7 females) detected with heterozygous hemoglobin D, one had compound heterozygosity of hemoglobin D with β-thalassemia (Tables 1 and 2). This case (18 years boy) was neither having hemolytic anemia (Hb= 11.5 g/dl) nor any other heath problem. Similarly, all other heterozygous hemoglobin D cases were not suffering from hemolytic anemia and were generally healthy. None of these 12 cases showed any association with G-6-PD deficiency or any particular blood group (s).

Laboratory findings of hemoglobin D variant

There are a number of hemoglobins termed Hb D based on mobility on hemoglobin electrophoresis. In general, they are of significance because they migrate identically in the same position as Hb S on cellulose acetate in alkaline (pH 8.6) electrophoresis. They move with Hb A in acid electrophoresis at pH 6.2 on citrate agar gel. Hb D can be distinguished from Hb S by its normal solubility as well as different mobility from Hb S on citrate agar electrophoresis. The mobility on isoelectric focusing is variable. Heterozygotes for Hb D and Hb A are normal, i.e., without any clinical manifestations. Homozygosity for Hb D is associated with normal hemoglobin levels, decreased osmotic fragility, and some target cells. Double heterozygotes for Hb D and β-thalassemia have hypochromic mild anemia and microcytosis.

DISCUSSION

It is seen that the Sindhi community of Jabalpur town in Central India shows a comparatively higher incidence of heterozygous hemoglobin D (2.16%) and hemoglobin D thalassemia (0.2%) in their population. Kate et al. (11) have shown the overall incidence of 4.62% for Hb D (three persons from two families had homozygous Hb D) in a study carried out on Sindhi population (238 screened) in and around Pune, Maharashtra state. Out of 508 individuals screened, 11 were heterozygous for Hb D. One case of double heterozygosity of hemoglobin D with β-thalassemia was also encountered in the present study of Sindhi community. None of these individuals had any evidence of hemolytic anemia and were generally asymptomatic and healthy.

In India, the allele frequency of hemoglobin D ($\beta^{121Glu \rightarrow Gln}$) is relatively low (1%) with a tendency to cluster in the Northwestern part of the country (12). Although, geographic spread shows regional variations of hemoglobin D distribution with about 3% prevalence in Northwestern India especially in undivided greater Punjab, 2% in Uttar Pradesh and about 1% in Gujarat and Maharashtra states of India (13) The prevalence of Hb D in India has been documented with variable allele frequency from Punjab, Gujarat, Jammu & Kashmiir, Uttar Pradesh, Maharashtra, Karnataka, Orissa, West Bengal, Assam, and Goa, either in the homozygous or heterozygous state (1).

Hemoglobin D^{Punjab} occurs with the high prevalence (2%) in Sikhs in Punjab, India, whereas in Gujarat state it has a prevalence rate of 1% (13). It is also found sporadically in Blacks and Europeans, the latter usually coming from countries that have had close associations with India in the past (14). Heterozygous state of Hb D does not produce any clinical or hematological symptoms, but its association with Hb S produces clinically significant, but less severe condition mimicking sickle cell anemia (15,16). Even the different Hb D variants seem to produce different severity of disease with Hb S. Hb D^{Punjab} produces clinically significant condition like sickle cell disease, whereas Hb D^{Iran} and Hb D^{Ibadan} are non-interacting and produce benign conditions like sickle cell trait (17). Hb D^{Ibadan} has a β-globin substitution of lysine for the normal threonine. Compound heterozygotes for Hb S and Hb D^{Ibadan} have mild anemia and usually do not have other complications.

In today's ever changing population demography with racial inter mixing, hemoglobin D disease should no longer be considered as an entity confined to the south Asian region. Hemoglobin D is a genetically transmitted blood disorder which originated on the Indian sub-continent, and spread to England, Scotland and Ireland during the colonial period when many soldiers – Englishmen, Scots and Irishmen – took Indian wives back to their homelands (1). It is worthwhile to review the hemoglobin D case study because it proves two things:

- Firstly, that genetically inherited conditions, such as sickle cell and hemoglobin D, are transmitted directly by racial mixing; and
- Secondly, to show that it is not just southern Europe that has been affected by racial mixing during the course of history, but that northern European lands have also fallen prey to this phenomenon, albeit in smaller overall numbers.

Hemoglobin D is uncommon in North America, occurring in less than 1 of 5000 persons. In the Punjab region of India and Pakistan, approximately 3 percent of the populations have the hemoglobin D Trait. This trait is more common in people of English, Irish, or Scotch ancestry than in those of other ethnic groups (14). The high frequency of hemoglobin D Trait in this population is believed to reflect the large number of Indian wives brought home to England by British troops during Britain's long occupation of India.

Inheritance of hemoglobin D disease and genetic counseling

One role of the blood is to take the oxygen from the air in the lungs and bring it to all parts of the body. The part of the blood that does this job is the red blood cell. Hemoglobin is the part of the red blood cell that carries the oxygen. The way hemoglobin is made in the body depends on the genes a child inherits from both parents. A gene carries instructions, like what color the child's skin or eyes will be. Different genes carry different instructions. We can inherit genes which cause unusual types of hemoglobin to be made, or genes which interfere with the amount of hemoglobin made. The usual adult hemoglobin is called hemoglobin A. The less common types of hemoglobin are named by letters such as hemoglobin D, hemoglobin S, etc.

Each child inherits one gene from the mother and one from the father that instructs the body how to make hemoglobin. If an individual inherits one gene for the usual hemoglobin A and one gene for hemoglobin D, they are said to have hemoglobin D trait. People with hemoglobin D trait may pass the hemoglobin D gene to their children. If only one parent has hemoglobin D trait, there is a 50/50 chance that the children might inherit the trait. The chances are the same with each pregnancy. If a person inherits the hemoglobin D gene from both parents, only hemoglobin D is made in the body. When only hemoglobin D is present, the red blood cells are broken down in the body a little faster than usual. This can cause mild anemia. Most people with homozygous hemoglobin D usually have no health problems.

When one parent has sickle cell trait and the other parent has hemoglobin D trait, there is a one-in-four (25%) chance that their child will have sickle-hemoglobin D disease. They may also have a child with sickle cell trait (1-in-4, or 25% chance), hemoglobin D trait (1-in-4, or 25% chance), or a child with the usual hemoglobin (1-in-4, or 25% chance). The chances are the same with each pregnancy (18). Symptoms of sickle-hemoglobin D disease include a higher risk for certain infections to occur and can also include painful episodes and an enlarged spleen. Sickle-hemoglobin D disease does not affect intelligence. There is no cure for sickle hemoglobin D disease, but there are treatments for the problems caused by the disease. It is very important that people with sickle-hemoglobin D disease receive regular medical care.

It can be helpful for people to know about their hemoglobin type so they can make informed decisions regarding family planning (19). Testing and counseling can be arranged, and questions answered about hemoglobin D or any other kind of inherited hemoglobin condition by contacting "Newborn Screening Program". A woman can have testing as early as the second month of pregnancy (11-12th week) to see if the baby has sickle-hemoglobin D disease. When the disease is found early in pregnancy, parents can choose whether or not to continue the pregnancy.

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Chapter 21

DETECTION OF A RARE HEREDITARY PERSISTENCE OF FETAL HEMOGLOBIN IN A TRIBAL FAMILY

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In the normal newborn infants, human fetal hemoglobin (Hb F) is readily replaced by the adult hemoglobins A and A_2 and at the age of about six months only a small percentage of fetal hemoglobin is detectable. The failure of normal process of switching off the production of γ-chains during neonatal period leads to a high level of fetal hemoglobin in adult life without causing any anemia. This is called as a hereditary persistence of fetal hemoglobin (HPFH). The Hb F in general delivers less oxygen to tissues, shortens the life span of red cells, and makes red cells unsuitable to cope with physiological stress of life. The HPFH is an autosomal co-dominantly inherited condition of rare occurrence. The present study reports for the first time a Paraja-Bhuyan (tribal) family having HPFH in four members, i.e., a mother with her three children from Sundargarh district of Orissa. These four cases showed no apparent clinical or hematological abnormality except mild pallor observed in two younger children. The acid elution test revealed pancellular distribution of fetal hemoglobin in all cases of HPFH in the erythrocytes. The findings of the present study have been discussed in the light of a few case reports available in the literature. The prevalence of HPFH among the autochthonous people of India although of rare occurrence, but the sporadic cases do occur in rural India that remain undetected most of the times.

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INTRODUCTION

The fetal hemoglobin (Hb F) in human erythrocytes, which forms a bulk of hemoglobin during the later two trimesters of intrauterine life, is sometimes, found to be persistently high even in adult life. It is believed that the normal process of switching off the γ-chain production and turning on the β- and δ-chains fails to occur and a high level of fetal hemoglobin continues in adult life unassociated with anemia. The term hereditary persistence of fetal hemoglobin (HPFH) is used to describe a group of conditions in which there is a persistent fetal hemoglobin synthesis into adult life in the absence of any major hematological abnormality. These conditions are divided into pancellular HPFH, in which the Hb F is more or less uniformly distributed, and heterocellular HPFH in which the Hb F is heterogeneously distributed among the red cells (1). The fetal hemoglobin, in general, functionally delivers less oxygen to tissues because of high affinity for oxygen, shortens the life span of red cells, and unsuitable to bear the physiological stress of life (2).

It has been shown that the γ-chain of the fetal hemoglobin exists in two forms, i.e., with a glycine residue in the 136th position, and with an alanine residue in the same position of the polypeptide chain. Depending upon the nature of γ-chain of fetal hemoglobin, the carriers of HPFH may be classified as Hb $^{G}\gamma$, Hb $^{A}\gamma$ and Hb $^{G}\gamma$ Hb $^{A}\gamma$ by Schroeder and Coworkers (3). The most common type of pancellular HPFH, the Black form, is due to deletion of a part or all of the δ and β regions of the β-globin gene complex, and in most cases resembles δβ–thalassemia. In the homozygous state, it shows a mild thalassemia like blood picture, and the hemoglobin consists entirely of hemoglobin F. Heterozygotes have a fetal hemoglobin level of 6-25%, and the only hematological abnormality is a slight reduction in mean cell hemoglobin (MCH). It is an autosomal co-dominantly inherited condition of rare occurrence.

The persistence of fetal hemoglobin in adult life was first described in West Africa and the term Hereditary Persistence of Fetal Hemoglobin (HPFH) was used when a case of persistent Hb F in adult life was seen along with sickle cell hemoglobin (Hb S) in a Jamaican family (4, 5). Suspected case of HPFH was reported from Bombay area along with β-thalassemia in an East Indian Christian family (6). The first reported case showed Hb E and HPFH in three sibs of a Thai family (7). To the best of our knowledge, there is no study so far available which has reported the HPFH gene in the tribal population of Orissa (2). This is the first study reporting the occurrence of HPFH in a scheduled tribe, Paraja-Bhuyan family from Sundargarh district of Western Orissa.

THE BHUYAN TRIBE

The Bhuyan tribe is an endogamous community, which is mostly confined to Sundargarh district of Orissa. This district is bordering district, surrounded by Jharkhand state in the North, Chhattisgarh state in the West, Keonjhar district in the East and Jharsuguda, Sambalpur, and Deogarh districts in the Southern part of the district (see figure 1). However, the sporadic families of Bhuyan tribe are also seen in Anugul, Deogarh, Jharsuguda and Keonjhar districts. Some of their families have also migrated to Assam working in the tea plantation as labour force (8). In the state of Orissa, the total population of Bhuyan tribe was

207,792 persons according to Census of 1981, which increased to 256,930 persons in the year 2001. The sex ratio of Bhuyan tribe was 1,016 females per 1,000 males. The literacy rate was 22.5% in the year 1981, which increased to 38.1% by the year 2001.

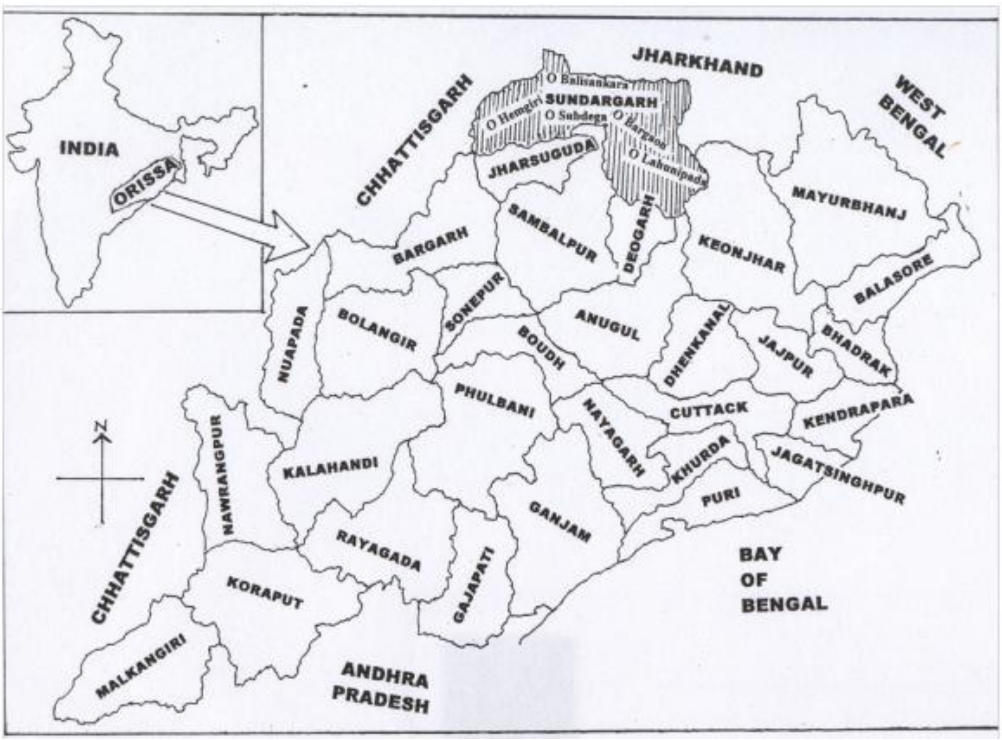

Figure 1. Map of Orissa showing thirty districs and study area (shaded).

The Bhuyan tribe although originally belonged to one ethnic stock, but now divided into three social groups namely, the Hill Bhuyan (Pahari or Paudi Bhuyan), Paraja Bhuyan (Common People) and the Paik or Khandayat Bhuyan (Warrior Bhuyan), which are distinguished from each other on the basis of three grades of primitive culture in the state of Orissa. The Hill Bhuyan, the primitive and backward section, represents the hunting and food gathering stage of economic life along with the practice of rudimentary shifting cultivation and primitive culture. The Paraja Bhuyan section represents the more advanced culture with habit of plough-cultivation and food production. The Khandayat Bhuyans have the most advanced culture, which equates them with other nontribal population of the region. The inter-group marriages are not taking place at all. Reproductively and genetically, they are completely isolated from each other.

OUR STUDY

Out of a total 212 Paraja-Bhuyan screened from Gad Dwar village in Hemgiri block of Sundargarh district of Orissa, incidently one family of hereditary persistence of fetal hemoglobin was detected (see figure 1). About 2-3 ml. of blood was intravenously collected after obtaining the informed/written consent in the presence of a doctor and community leaders. A medical doctor recorded signs and symptoms related to hemoglobinopathies after clinical examination on the pre-designed proforma. Any other ailment present was treated/referred to local health facility. Blood samples so collected were transported to the laboratory at Bhubaneswar under ice-cold conditions within 24 hours of collection. Laboratory investigations were carried out following the standard procedures. Hematological parameters were studied by using an automated Blood Cell Counter (Model-MS4, Melet Schloesing Laboratories, Cergy-Pontoise Cedex, France).

The routine horizontal hemoglobin electrophoresis was carried out on cellulose acetate membrane (CAM) in Tris-EDTA-Borate buffer at pH 8.6 to identify abnormal hemoglobins by their differential mobility and quantitation of A_2 fraction of hemoglobin was performed by elution method at pH 8.6 (1, 9). Estimation of fetal hemoglobin (Hb F) was done as per the method of Betke and Coworkers (10) described in Weatherall (1). This method is the most reliable for the quantitation of low percentages of Hb F (below 10-15%). The subjects with HPFH have fetal Hb values ranging from 5% to as high as 35% without any other apparent hematological abnormalities. The acid elution-staining test of Kleihauer and Coworkers (11), which is based on the differential elution of fetal and adult hemoglobins, was used to demonstrate intra-cellular distribution of fetal hemoglobin containing erythrocytes.

The G-6-PD enzyme deficiency was detected by using Dichlorophenol Indophenol (DCIP) dye as described by Bernstein (12) and, subsequently, confirmed by WHO procedures (13) and Beutler and Coworkers (14). ABO and Rhesus blood groups typing were done by slide method, following the instructions of the manufacturer (Tulip Diagnostics Pvt. Ltd, Goa, India).

FINDINGS

Table 1. Salient features of Paraja Bhuyan (Tribal) family in Sundargarh district of Western Orissa, India

Code No.	6047	6048	6049	6050	6051	6052	6053
Name	SC	SK	HC	NC	NC	AC	DC
Age (Years)	59	55	36	30	09	08	06
Sex	M	F	M	F	F	M	M
Hb (g/dl)	10.9	11.3	13.5	12.5	12.1	11.9	10.6
RBC (10^6/ul)	5.3	5.3	5.7	4.9	5.1	5.1	4.6
MCV (fl)	78.2	78.1	73.9	83.7	76.0	76.0	79.6
HCT (%)	41.2	41.7	42.3	41.2	38.4	38.9	37.0
MCH (pg)	20.7	21.1	23.6	25.4	23.9	23.2	22.8
MCHC (g/dl)	26.4	27.0	31.9	30.3	31.5	30.6	28.6
WBC (10^3/ul)	8.9	4.6	6.7	8.1	10.7	8.4	8.7
Electro-phoresis	$A+A_2$	$A+A_2$	$A+A_2$	$A+A_2$	$A+A_2$	$A+A_2$	$A+A_2$
Hb A (%)	97.6	97.1	97.2	89.4	84.4	90.6	87.9
Hb A_2 (%)	2.2	2.6	2.2	2.2	1.9	2.9	1.3
Hb F (%)	0.2	0.3	0.6	8.4	13.7	6.5	10.8
G-6-PD Enzyme	N	N	N	N	N	N	N
ABO Blood Group	B	B	O	O	O	O	O
Rhesus Blood Group	+ve	+ve	+ve	+ve	+ve	+ve	+ve

G-6-PD Enzyme, N= Normal.

Laboratory investigations of all family members are summarized in Table-1. It is apparent from table and figure–2 that the father (HC) and both grand parents (SC and SK) were found to have normal level of fetal hemoglobin (range 0.2-0.6%) and A_2 (range 2.2-2.6%). However, the mother (NC, 6050) showed raised fetal hemoglobin (8.4%), normal hemoglobin level (12.5%), normal A_2 (2.2%) and normal electrophoresis ($A+A_2$). Parents of this mother could not be tested. All of her three children had raised fetal hemoglobin (range 6.5-13.7%), transmitted from their mother as codominant. It is an autosomal codominantly inherited condition. Neither other clinical nor hematological abnormality could be detected in all the four cases, except mild pallor was observed in two younger (AC and DC) children (see table1 and figure 2). However, the low values of MCV and MCH noted in this family may suggest interaction with alpha-thalassemia. All had normal G-6-PD enzyme activity with O blood group and Rhesus positivity.

Acid elution staining test revealed pancellular distribution of fetal hemoglobin in all the cases with HPFH in their red cells.

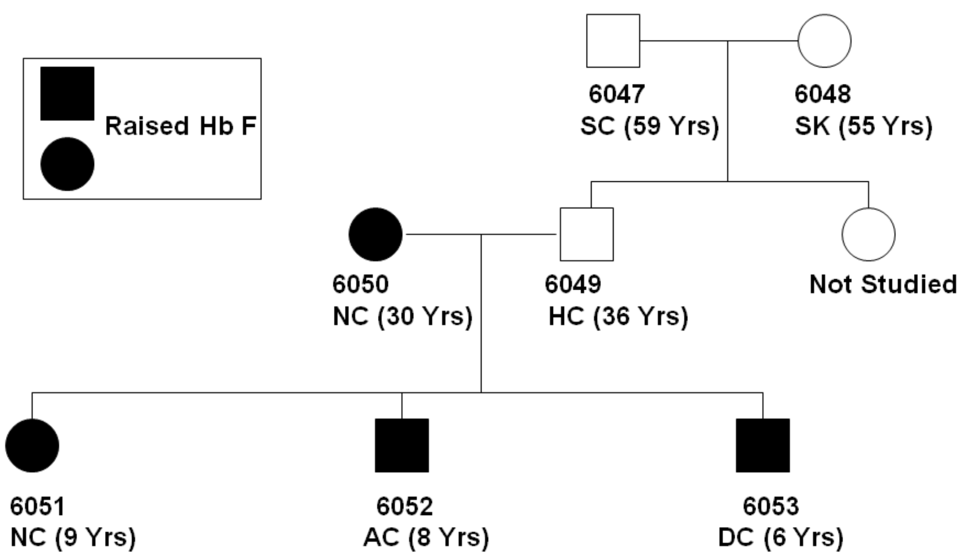

Figure 2. Family pedigree of Paraja-Bhuyan tribe with hereditary persistence of fetal hemoglobin in Sundargarh distric of Orissa, India.

DISCUSSION

The evidence for HPFH gene in this Paraja-Bhuyan tribe is established by the presence of high level of fetal hemoglobin in four family members without any apparent abnormal red cell morphology, except mild pallor in two of the three children and pancellular distribution of fetal hemoglobin in erythrocytes as demonstrated by acid elution staining test in all cases. These findings appear to exclude other known conditions causing elevation of Hb F such as beta-thalassemia and acquired hematological disorders. However, the present study is the first report of HPFH in a Paraja-Bhuyan (tribal) family from Sundargarh district of Orissa.

The mother (NC, 6050) seems to have inherited a gene for HPFH from either of her parents, which she, subsequently, has passed on codominantly to her three children. It is now known from the structural analysis that normal γ-chain is duplicated. One is having glycine at 136th position and the other having alanine instead. Thus, broadly, there can be at least three different types of HPFH, i.e., $^{G}\gamma$, $^{A}\gamma$ or $^{G}\gamma^{A}\gamma$ types (15). Pancellular HPFH is an extremely heterogeneous condition, which is due to a deletion of the δ and β-globin genes, resulting in persistent $^{G}\gamma$ and $^{A}\gamma$ synthesis but not entirely well compensated

form of δβ–thalassemia. Homozygotes have 100% fetal hemoglobin and red cell changes almost identical to those of heterozygous β-thalassemia (1). Heterozygotes have normal hematological findings and fetal hemoglobin homogeneously distributed among their red cells. The hemoglobin F is a mixture of $^{G}\gamma$ and $^{A}\gamma$ varieties in this condition. Further, molecular level investigations in the present family need to be done.

Both deletion and nondeletion forms of HPFH have been characterized (16). In the deletion variants, both $^{G}\gamma$ and $^{A}\gamma$-globin synthesis is increased, whereas only one or the other γ-globin gene is over-expressed in the nondeletion syndromes. Consequently, the nondeletion variants may be classified as $^{G}\gamma$ HPFH and $^{A}\gamma$ HPFH. The most prevalent deletion variants are those encountered in black Americans (HPFH-1) and black Ghanians (HPFH-2). Deletions in both variants are approximately 105 kb in length, with endpoints staggered by approximately 5 kb. The Indian and two Italian HPFH variants are characterized by smaller deletions. All of the 3' breakpoints of HPFH deletions fall adjacent to or within the 3' β-globin gene enhancer. Increased Hb F synthesis in the deletion forms of HPFH is thought to be a result of the transposition of enhancer sequences into proximity with the γ-globin genes (16).

Although less prevalent than deletion variants, nondeletion types of HPFH have been observed in many populations including the Italians, Greeks, Swiss, British, Chinese, Japanese and black Americans. Most of these types of HPFH result from base substitutions in the promoter regions 5' to the $^{G}\gamma$ and $^{A}\gamma$ genes. These substitutions are within DNA sequence motifs that bind regulatory proteins. Mutations at these sites are likely to alter the binding affinity for regulatory proteins, thereby influencing expression of the juxtaposed to γ-globin gene. Single base substitutions in the promoter region of the $^{A}\gamma$-globin gene include T → C at position -198 in the British $^{A}\gamma$ HPFH, C → T at -196 in Chinese, Greek, and Italian $^{A}\gamma$ HPFH, T→ C at -175 in black American $^{A}\gamma$ HPFH, and G→A at-1 17 in Greek $^{A}\gamma$ HPFH. The $^{G}\gamma$ HPFH phenotype results from base substitutions at positions -202, -175, and -161 5' to the $^{G}\gamma$-globin gene. The genetic basis for Seattle HPFH remains to be elucidated. Although base substitutions in the enhancer region 3' to the $^{A}\gamma$-globin gene initially were implicated in increased Hb F synthesis, these mutations were later found to be prevalent polymorphisms not associated with the HPFH phenotype (16).

Relatively the studies pertaining to HPFH are very limited in India. Only a few cases have been reported from Western India and Kolkata (2). Cases of HPFH hemoglobin along with β-thalassemia have been reported from Bombay (17). One of them was first investigated with high fetal trait in 1953 in a Christian family and was reported as having interaction with thalassemia (6). Similar conditions were noticed in two Bengalee families (18), and a later study in Bombay revealed this type of double heterozygous condition in two cases (19). Barkhan and Adinolfi (20) in a family of mixed Indian and Portuguese ancestry in London and Bird and Coworkers (21) in an Indian boy at Pune have recorded similar cases of HPFH with beta-thalassemia. One Maratha family showing hemoglobin E with this gene (HPFH) has been described from Bombay (22, 23).

In view of the evidence of multiple structural genes for the γ-chain of human fetal hemoglobin, some of the HPFH already reported from Bombay were subjected to biochemical analysis. In one case in a 9-year-old boy, HPFH in homozygous state was found to have Hb F entirely of $^{G}\gamma$ type. In addition the case of Hb E with HPFH was also found to be $^{G}\gamma$ type (24, 25). A similar study of six individuals in four families showing HPFH were found to have two types of γ-chains (the $^{G}\gamma$–chain with glycine in 136th position and the $^{A}\gamma$ chain with alanine in the same position), which were present in the ratio of 70:30. It was suggested that these heterozygotes form a distinct sub-group of hemoglobin $^{G}\gamma^{A}\gamma$ class (15). Some members of this family carried β-thalassemia gene along with the above abnormality (24, 25).

CONCLUSION

This paper is a small part of our major research project on "Intervention for hereditary common hemolytic disorders among the major tribals of Sundargarh district in Orissa". While screening a village of Bhuyan tribe for hemoglobinopathies and G-6-PD deficiency in order to intervene and provide genetic counseling to affected persons, this family with hereditary persistence of fetal hemoglobin (HPFH) was incidentally detected and studied in details. Unless molecular analysis is carried out, the interaction of α-thalassemia with HPFH cannot be ruled out by clinical studies only. However, the normal hemoglobin concentration, the slightly reduced MCV and MCH values, presence of target cells, low level of A_2 (1.3-2.9%), raised fetal hemoglobin (6.5-13.7%) and evenly distribution of Hb F in erythrocytes in the present family, all these aspects suggest not the cases of α-thalassemia, but the possibility of HPFH in Paraja-Bhuyan tribal family. The prevalence of HPFH among the autochthonous people of India although of rare occurrence, but the sporadic cases do occur in the country side, which remain undetected or unnoticed most of the times.

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Chapter 22

HIGH OCCURRENCE OF G6PD DEFICIENCY AND DIVERSITY OF HEMOGLOBIN VARIANTS IN BHUYAN TRIBE

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Aboriginal communities constituting 8.2% of the total population in India present a neglected health scenario. Hereditary hemolytic disorders cause high morbidity and mortality. Genetic diversity in relation to hemoglobin (Hb) variants, G6PD deficiency and ABO and Rhesus blood groups was investigated in three subgroups of the Bhuyan tribe (Paik, Paraja and Paudi) in Sundargarh district of Orissa, India. ß-thalassemia trait was the only hemoglobinopathy seen in the Paudi Bhuyan with a low prevalence of 1.8% compared with that detected in the Paik Bhuyan (7.8%) and Paraja Bhuyan (12.7%). Sickle cell trait (7.4%, 0.9%), and HbD trait (1.6%, 0%), were also detected in the Paik and Paraja Bhuyan, respectively. The hereditary persistence of fetal hemoglobin (1.9%) was detected only in the Paraja Bhuyan. High G6PD deficiency of 13.7%, 16.4%, and 21.1% was detected in Paudi, Paik and Paraja Bhuyan, respectively with an overall average of 16.4% in the Bhuyan tribe. Rhesus (D) negative blood group was absent in Paraja Bhuyan and had an overall frequency of 0.2% in the Bhuyan tribe. The high overall occurrence of G6PD deficiency and the diversity of Hb variants in the three subgroups suggest that inherited hemolytic disorders pose a major public health challenge having multifaceted biomedical and public health implications in the Bhuyan tribe. Administration of antimalarial drugs needs to be done with caution. Further, genetic isolation was observed in three sects of Bhuyan tribe.

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INTRODUCTION

Inherited hemoglobin (Hb) disorders are the global genetic and public health challenges. The highest frequency of sickle cell disease is encountered in tropical and subtropical regions, particularly in the sub-Saharan Africa, India and the Middle East (1). Sporadic cases of hemoglobin D also occur in many parts of the Indian subcontinent (2). With a prevalence rate of 3-5% of thalassemia carriers, the estimated carrier population in India would be 30-50 million (3).

The inherited erythrocytic deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD) is an important metabolic, genetic and public health challenge in malaria-endemic areas of India (4). It is a predisposing factor in the causation of drug-induced hemolytic anemia and congenital non-spherocytic hemolytic disease. The deficient fibroblasts in humans suffer growth retardation and premature cellular senescence. In the absence of reduced glutathione (GSH), oxidative stress can lead to hemolysis of erythrocytes resulting in hemolytic anemia.

A great deal of variations in G6PD deficiency exists among different populations of the world. The variations can be explained in terms of evolutionary history and the mating practices (endogamous or non-endogamous nature) in a community. High prevalence can be explained in terms of the geographical spread of malaria. G6PD deficiency varies from 0% to 30.7% in different castes, tribes, and ethnic, religious and linguistic groups in India. The deficiency varies from 0.4% to 30.7% in the tribal communities of Orissa (4). Most of the individuals remain undiagnosed due to lack of awareness and nonavailability of testing facilities in India (4). In view of the huge clinical burden of hemoglobinopathies on physicians, dismal health scenario, and limited genetic studies carried out on the tribal communities in India, this study presents the prevalence of hereditary hemolytic disorders, implications of endemic malaria in the light of biomedical and public health genetics, and genetic diversity in relation to Hb variants and G6PD deficiency in the Bhuyan primitive tribe, in Sundargarh district of Northwestern Orissa, India.

OUR STUDY

This study was a part of a major project undertaken on the ‘Intervention for hereditary common hemolytic disorders among the major tribals of Sundargarh district of Orissa’ carried out during the period from January 2000 to December 2004 with the financial support from the Ministry of Health and Family Welfare, Government of India through the Indian Council of Medical Research (ICMR), New Delhi. Ethical approval was obtained from the Human Ethical Committee, Regional Medical Research Centre (ICMR), Bhubaneswar (Orissa), India before initiation of the investigations.

Geographical location

The district lies in the North-western portion of the Orissa State in Central-Eastern region of India. It is bounded on the North by Jharkhand State, on the South by Jharsuguda, Sambalpur and Deogarh districts, on East and North-east by Keonjhar and Western Singhbhum districts of Orissa and Jharkhand, on the West and North-west Raigarh district of Chhatisgarh. The district lies between 21 degrees 35' N and 22 degrees 32' N latitudes and between 83 degrees 32' E and 85 degrees 22' E longitudes. Area of the district is 9712 sq. kms. The district headquarters is located at Sundargarh. This study was carried out in Sundargarh district of Orissa.

Background of the Bhuyan tribe

The Bhuyan tribe although originally belonged to one ethnic stock, but is now divided into three social and biological groups namely, the Hill Bhuyan (Pahari or Paudi Bhuyan), the Paik or Khandayat Bhuyan (Warrior Bhuyan), and Paraja Bhuyan (Common People), which are distinguished from each other on the basis of three grades of primitive culture in the state of Orissa. The Hill Bhuyan, the primitive and backward section, represents the hunting and food gathering stage of economic life along with the practice of rudimentary shifting cultivation and primitive culture. The Paraja Bhuyan section represents the more advanced culture with a habit of plough-cultivation and food production. The Khandayat Bhuyans have the most advanced culture, which equates them with other nontribal population of the region. Reproductively and genetically, they are completely isolated from each other as the inter-group marriages are not taking place. The scatter and distribution of these tribes in particular locality is shown in the Adivasi Atlas of Orissa (5).

Sampling procedure

A randomized sampling procedure was adopted for each subgroup living in entirely different eco-niches by selecting exclusive villages in Hemgiri (Ratansara village for Paik Bhuyan), (Gad Dwar village for Paraja Bhuyan), and Lahunipara (Badjal, Budhabhuin and Kuliposh colony for Paudi Bhuyan) blocks for screening the hemoglobinopathies, β-thalassemia syndrome, G6PD deficiency and ABO and Rhesus (D) blood groups irrespective of the age, sex and individual morbidity (susceptibility) pattern. Out of a total 836 Bhuyans, there were 213 Paraja (106 males and 107 females), 244 Paik or Khandayat (117 males and 127 females), and 379 Pahari or Paudi (184 males and 195 females) belonging to all age groups screened from Sundargarh district of Orissa.

Blood collection

About 2-3 ml intravenous blood samples were collected using ethylene diamine tetra acetic acid (EDTA) as anticoagulant by disposable syringes and needles from each individual after obtaining the informed/written consent in the presence of a doctor and community leaders. On request, the local doctor recorded all the signs and symptoms related to hemoglobinopathies after clinical examination on the pre-designed proforma. Other ailments were treated/referred to local health facilities. Blood samples so collected were transported to the laboratory at

Bhubaneswar under ice-cold conditions within 24 h of collection. Laboratory investigations were carried out following the standard procedures after cross-checking for quality control from time to time. Hematological parameters were studied by using an automated Blood Cell Counter (Model: MS4 Melet Schloesing Laboratories, Cergy-Pontoise Cedex, France).

Laboratory investigations

The sickling test was performed on red cells by using freshly prepared 2% sodium metabisulphite solution as reducing agent (6). The routine hemoglobin electrophoresis was carried out on cellulose acetate membrane (CAM) in Tris-EDTA-Borate buffer at pH 8.6 and quantification of A_2 fraction of hemoglobin by elution method (7). A value of more than 3.5% of A_2 hemoglobin was taken as the cut-off point for determining the β-thalassemia trait. Estimation of fetal hemoglobin was done as described by Weatherall (7). Confirmation for the presence of hemoglobin D, and hereditary persistence of fetal hemoglobin (HPFH) was done as described elsewhere (8,9). Family studies were carried out to confirm the diagnosis, wherever it was felt necessary.

G6PD enzyme deficiency was primarily detected by using Dichlorophenol Indophenol (DCIP) dye as described by Bernstein (10). G6PD activity in females will depend on the proportion of normal to deficient cells. In most of the cases, the normal activity will vary from 20% to 80%. However, a few heterozygotes (about 1%) may have almost only normal or almost only G6PD deficient cells. The present study has not at all encountered any such ambiguity; therefore, there were either 60-80% normal cells or deficient cells in all cases. Subsequent confirmation was done by following the Beutler et al. (11) and WHO procedures (12) in case any doubt arose for the detection of G6PD deficiency.

The typing of ABO and Rhesus (D) blood groups was done as per the instructions of the manufacturer (Tulip Diagnostics Private Limited, Panaji, Goa) in India.

FINDINGS

A Paraja Bhuyan family with four members (a mother with two sons and a daughter) with HPFH was detected in Gad Dwar village (see table1). In Ratansara village, a Khandayat Bhuyan family carrying Hb D trait in four members (father, daughter and two sons) was identified. ß-thalassemia trait was the only hemoglobinopathy detected in the Paudi Bhuyan tribe and it predominated in males (see table 1). High G6PD deficiency was detected in the Bhuyan tribe and was more common in males than in females (see table 1).

The hematological profile of carrier or trait cases of sickle cell disease, Hb D, HPFH and β -thalassemia was almost identical with respect to mean values with those of normal (control) cases (Hb AA) in the Bhuyan tribe. The mean percentage value of HbA_2 for β-thalassemia trait was higher in Bhuyan tribe in comparison to normal mean value (see table 2). Further, it was seen that the mean percentage value of sickle Hb in sickle cell trait cases in Bhuyan tribe was low.

Table 1. Distribution of hemoglobinopathies and glucose-6-phosphate dehydrogenase (G6PD) deficiency among the subgroups of the Bhuyan tribe of Sundargarh district in Orissa, India

Diagnosis	Sex	Paraja Bhuyan	Paik Bhuyan	Paudi Bhuyan			All Bhuyan
		Gad Dwar	Ratansara	Badjal	Budhabhuin	Kuliposh Colony	
		(N = 213)	(N = 244)	(N = 152)	(N = 132)	(N = 95)	(N = 836)
		n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
β-thalassemia trait	Male Female Total	13 (6.1) 14 (6.6) 27 (12.7)	9 (3.7) 10 (4.1) 19 (7.8)	4 (2.6) 1 (0.7) 5 (3.3)	0 0 0	2 (2.1) 0 2 (2.1)	28 (3.3) 25 (3.0) 53 (6.3)
Sickle cell trait	Male Female Total	0 2 (0.9) 2 (0.9)	5 (2.0) 13 (5.3) 18 (7.4)	0 0 0	0 0 0	0 0 0	5 (0.6) 15 (1.8) 20 (2.4)
Hemoglobin D trait	Male Female Total	0 0 0	3 (1.2) 1 (0.4) 4 (1.6)	0 0 0	0 0 0	0 0 0	3 (0.4) 1 (0.1) 4 (0.5)
Hereditary persistence of fetal hemoglobin	Male Female Total	2 (0.9) 2 (0.9) 4 (1.9)	0 0 0	0 0 0	0 0 0	0 0 0	2 (0.2) 2 (0.2) 4 (0.5)
G6PD deficiency	Male Female Total	29 (13.6) 16 (7.5) 45 (21.1)	25 (10.2) 15 (6.1) 40 (16.4)	10 (6.6) 8 (5.3) 18 (11.8)	11 (8.3) 9 (6.8) 20 (15.2)	9 (9.5) 5 (5.3) 14 (14.7)	84 (10.0) 53 (6.3) 137 (16.4)

Table 2. Hematological indices and estimation of HbA_2, HbF and HbS/D in different diagnostic categories of Bhuyan tribe (sexes combined) cases in Sundargarh district of Orissa, India

Diagnosis	Hb g/dl Mean/SD	RBC $X10^6$/ml Mean/SD	HCT % Mean/SD	MCV Fl Mean/SD	MCH Pg Mean/SD	MCHC g/dl Mean/SD	WBC $X10^3$/ml Mean/SD	HbA_2 % Mean/SD	HbF % Mean/SD	HbS/D % Mean/SD
SCT N=20	11.4±2.3	5.0±0.8	36.4±5.9	73.1±4.6	22.2±4.6	30.5±4.6	7.4±2.0	2.5±0.5	0.9+0.4	16.5±2.4
HbAD N=4	11.5±1.0	5.3±0.8	42.7±5.5	81.2+4.2	20.9±2.9	25.6±2.7	5.6±1.1	1.6±0.7	0.5±0.3	28.4±1.7
β-Thal. T N=53	10.6±1.7	5.0±0.8	37.9±6.9	77.0±6.6	21.5±2.2	28.0±1.8	7.4±3.0	5.0±0.8	0.6±0.2	-
HPFH N=4	11.8±0.8	4.9±0.2	38.9±1.7	78.8±3.7	23.8±1.1	30.3±1.2	8.9±1.2	2.1±0.6	8.4±3.2	-
HbAA Normal Control N=1419	11.0±1.6	5.1±0.7	39.3±5.4	77.1±7.8	21.6±2.9	28.0±2.2	6.2±2.4	2.3±0.5	1.4±0.6	-

SCT = Sickle Cell Trait

HbAD = Hemoglobin D Trait

β-Thal.T = Beta-Thalassemia Trait

HPFH = Hereditary Persistence of Fetal Hemoglobin

HbAA = Adult Hemoglobin

SD = Standard Deviation

The clinical symptoms as recorded by the local Primary Health Centre (PHC) doctor in the field and, subsequently, confirmation of the diagnosis by the laboratory tests, revealed the following clinical picture of different diagnostic categories (see tables 1 and 2). The most common clinical features emerged out from the analysis were: pallor, fatigue, recurrent fever, joint pains, abdominal pains, chest pains, splenomegaly, epistaxis, etc. The sickle cell trait cases showed typical drepanocytes without hypochromia, and fatigue, dysponoea, pallor, recurrent fever, joint pains, jaundice, and splenomegaly in homozygous sickle cell patients. The β -thalassemia trait cases manifested fatigue, pallor, recurrent fever, frequent infections, joint pains, etc. Heterozygotes of Hb D did not show any specific clinical symptoms of microcytosis, target cells or decreased osmotic fragility except hypochromic mild anemia.

Table 3. Distribution of ABO and Rhesus blood groups in subgroups of the Bhuyan tribe of Sundargarh district in Orissa, India

Tribe	Village	ABO				Rh (D)
		A	B	AB	O	
		n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Paraja Bhuyan	Gad Dwar (N = 213)	55 (25.8)	77 (36.2)	15 (7.0)	66 (31.0)	0
Paik Bhuyan	Ratansara (N = 244)	81 (33.2)	69 (28.3)	23 (9.4)	71 (29.1)	1 (0.4)
Paudi Bhuyan	Badjal (N = 152)	46 (30.3)	55 (36.2)	17 (11.2)	34 (22.4)	1 (0.7)
	Budhabhuin (N = 132)	45 (34.1)	36 (27.3)	23 (17.4)	28 (21.2)	0
	Kuliposh Colony (N =95)	26 (27.4)	33 (34.7)	9 (9.5)	27 (28.4)	0
	Subtotal (N = 379)	118 (31.2)	124 (32.7)	49 (12.9)	88 (23.2)	1 (0.3)
All Bhuyan (N = 836)		253 (30.3)	271 (32.4)	87 (10.4)	225 (26.9)	2 (0.2)

There are slight variations in the distribution of ABO and Rhesus (D) blood groups in all the villages and subgroups of Bhuyan tribe (see table 3). The average frequency of Rhesus (D) negative blood group was observed to be very low (0.2%). In ABO blood group system, the frequency of blood group B preponders over A in Paraja Bhuyan of Gad Dwar village, Paudi Bhuyan of Badjal village, and Paudi Bhuyan of Kuliposh Colony and is in agreement with the general trend or pattern prevalent among the tribal communities of the region.

DISCUSSION

This study presents interesting findings with respect to abnormal structural Hb variants as well as ß-thalassemia in the different subgroups of the Bhuyan tribe. No other community in the region of Central Eastern India has shown such a wide range of genetic diversity in Hb disorders as that of the Bhuyan tribe, in particular the Paraja and Paik Bhuyan (see tables 1 and 2). Sickle cell disease, HbD and HPFH were found completely absent in the Paudi Bhuyan. A family with HPFH in the Paraja Bhuyan and a family with HbD trait in the Paik Bhuyan were detected for the first time in a tribal population of Orissa. None of the family members with HPFH had any clinical abnormality, except mild pallor in two children. Functionally, fetal Hb delivers less oxygen to the tissues because of a high affinity for oxygen, shortens the lifespan of red cells and is unsuitable to bear the physiological stress of life. The most common Hb E variant found in Northeastern region (13) was not detected in the present study. The frequency of ß-thalassemia trait was highest in Paraja Bhuyan (12.7%), followed by Paik Bhuyan (7.8%) and Paudi Bhuyan (1.8%) pointing to the genetic disintegration or isolation as well as genetic diversity in the Bhuyan tribe.

The subgroups of the Bhuyan tribe have revealed the variations in the distribution of Hb variants as well as in the frequency of G6PD deficiency, living in the same district or geographical area. Surprisingly, there seems to be no overlapping of the studied genetic markers (Hb S, Hb D and HPFH) in the subgroups of the Bhuyan tribe. This further certifies that their reproductive interaction or genetic exchange is not taking place with each other even in the same geographical location or district as a result of which they are probably emerging independent isolates in western Orissa. From population genetic or public health perspective, this also indicates the strict adherence to subtribal endogamy practice in the community. The small size of effective breeding population leads to increased homozygosity (in other words due to consanguinity) in the community particularly for recessively inherited characteristics such as in the present study.

The Bhuyan tribe and its subgroups have genetic and public health challenges of Hb variants including ß-thalassemia syndrome and G6PD deficiency. The high occurrence of G6PD deficiency has multifaceted implications in biomedical sciences and public health genetics. G6PD deficiency decreases bactericidal activity of neutrophils as a result of which the subject becomes prone to repeated infections leading to high morbidity and mortality. Administration of drugs/treatment in some susceptible cases in vulnerable communities such as the Bhuyan tribe might be exaggerating the outcome. The use of antimalarials needs a caution in these tribal people, which may cause hemolytic anemia associated with G6PD deficiency for the following oxidative stresses:

- Anti-malarial drugs like primaquine and many other drugs (list is big)
- Fava beans (components like divicine and isouramil have been found responsible)
- Chemicals like naphthalene, antifungal sprays
- Herbs like Coptis sinesis and Calculus bovis
- Infectious diseases
- Neonatal jaundice

There are clinical manifestations of G6PD deficiency that are related to other tissues. A number of polymorphisms identified with erythrocyte surface oligoproteins (blood groups), globin genes (Hb S, Hb C, Hb E, thalassemias, oxidative stress (G6PD deficiency), cytoadherence and immune system have been associated with protection against malaria. Some evidences supporting the protection against malaria in G6PD deficient phenotypes are: (i) G6PD deficiency is strongly associated with the distribution of malarial endemicity (14), (ii) Studies in vitro comparing the growth of parasites in G6PD deficient red blood cells with growth in normal cells showed that growth is protracted in deficient cells (15-17), (iii) Ruwende et al. (18) based on two large case–control studies of over 2000 African children showed that A Type G6PD deficiency can reduce the risk of malarial infection by 46–58% in heterozygous females and hemizygous males (18), and (iv) RFLPs at the G6PD locus and microsatellite variation in close proximity to the G6PD locus have shown consistence with the estimated time of spread of malaria and the emergence of agriculture (19). Luzzatto et al. (20) studied differential parasitization of deficient and non-deficient red blood cells of the same individual in 20 heterozygous females and found that parasitization was 2–80 times greater in non-deficient than in deficient cells. These studies showed that G6PD deficient cells are protective against malaria.

Malarial parasites break down hemoglobin after invasion. They do so to make room to grow and may also derive nutrition from it. The byproduct of this process, particularly the oxidized iron is potentially toxic to the parasite. Reduced glutathione (GSH) supplies reduce energy to cells under natural mechanisms to overcome the oxidative stress. Any deficiency in the production of GSH in the cell can provide resistance against the malarial parasite. Thus, the deficiency of G6PD which is an important enzyme in the pentose phosphate pathway, a metabolic pathway that produces ribose and NADPH, the reduced energy for glutathione can confer resistance to malaria. Malaria-protective polymorphisms are likely to be at high frequencies in affected populations and may show strong linkage disequilibrium with neighboring genetic markers (18, 20). The Sundargarh district of Northwestern Orissa is a highly malaria endemic region, and variants of Hb and high occurrence of G6PD deficiency is reflected as the natural selection mechanism for protection against malaria. The indirect evidence has supported the impact of oxidative stress on G6PD deficient individuals with relatively lower susceptibility to malaria (14). Roth et al. (16) in vitro studies demonstrated that G6PD deficiency in hemizygous males and heterozygous females equally protected against malaria. Selection can maintain deleterious alleles in the population as in the case of sickle cell trait, if there is a heterozygote advantage.

Table 3 shows slight variations in the distribution of ABO and Rhesus (D) blood groups in subgroups of Bhuyan tribe. The overall pattern of distribution in the Bhuyan community is consistent with the general trend. The average frequency of Rhesus (D) negative blood group was very low and incompatible blood group does not seem to be a health problem in the community.

To conclude, it is observed that in order to counter the lethal effects of endemic malaria especially Plasmodium falciparum, the subgroups of Bhuyan tribe have emerged with polymorphic variants of hemoglobin and high G6PD deficiency. However, the huge burden of hemoglobinopathies and dismal health scenario place heavy emotional, social and financial burden on individual, family and community contributing significantly to high morbidity and mortality. In all diagnostic categories, the low mean value of hemoglobin level may also indicate iron deficiency, parasitic infection or parasitic infestations in highly malaria endemic areas of Sundargarh district in Orissa. Molecular medicine or genotype/phenotype interaction studies may yield further information on evolutionary biology.

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Chapter 23

PUBLIC HEALTH CHALLENGES OF SICKLE CELL DISORDERS, β-THALASSEMIA SYNDROME AND G6PD DEFICIENCY

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The undivided state of Madhya Pradesh is inhabited by 46 tribal communities in Central India that constitute about 23% tribal population of India. This randomly conducted study presents the public health challenges of sickle cell disorders, β-thalassemia syndrome and G6PD deficiency in relation to malaria endemicity in scheduled caste and tribal communities of Chhattisgarh and Madhya Pradesh in Central India. High prevalence of the sickle cell disorders was recorded in tribes of Baiga (22.3%) and Bharia (13.2%) with a range of β-thalassemia trait being 0-3.6% in Madhya Pradesh, followed by Hill Maria (22.5%), Maria (20.2%) and Muria (14.9%) tribes with β-thalassemia trait range of 0-10.4% in Chhattisgarh. The G6PD deficiency was varying from 0% to 21.5% in Chhattisgarh and from 1.8% to 12.1% in Madhya Pradesh. The frequency of sickle cell disorders fluctuated between 4.1% to 34.0% among the scheduled tribes of Madhya Pradesh and between 0.9% to 22.5% in scheduled tribes of Chhattisgarh. The range of β-thalassemia trait was variable from 0% to 10.4% in Chhattisgarh and from 0% to 10.0 percent among the scheduled tribes of Madhya Pradesh. The G6PD deficiency range was 1.3% to 9.3% among the scheduled tribes and 0% to 6.9% in scheduled castes of Madhya Pradesh. Among the scheduled castes, the frequency of sickle cell disorders varied from 4.4% to 37.9%, the sickle cell-β-thalassemia being 3.9%. The frequency of β-thalassemia trait was variable between 0 to 10.0 percent among the scheduled castes of Madhya Pradesh.

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INTRODUCTION

Indigenous communities in India constitute about half of the aboriginal people of the world and about 8.2% of the Indian population with 635 scheduled tribes and subtribes including 75 primitive tribal groups as per 2001 census. Tribal people in India are socially and economically backward communities mostly dwelling in the forests and hilly terrains completely isolated from the elite society. They have their own way of living and life-styles under different socio-cultural settings. Their life style is peculiar because of their social and cultural habits, which make them distinct. The ecological conditions are also different from the general population. Their primitive economy and dependence on natural resources also make them vulnerable to the on-slaughter of the Nature. Tribal situation in India presents a mosaic picture. The Central part of India comprising the states of Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Orissa and Rajasthan harbor the majority of these indigenous or aboriginal people.

The undivided state of Madhya Pradesh has the largest proportion (23%) of tribal communities in India. The tribal communities are shifting cultivators, forest dwellers, artisans, land-owner and landless communities of depleted resources and other communities mainly dependent on forest for their sustenance facing multiple existing problems in Madhya Pradesh. These tribes differ from one another in population size, literacy and socio-cultural aspects. Their geographical scatter also vastly differs from plains to dense forests and hilly terrains. Therefore, each tribe has different health challenges owing to variability, i.e., geographical, socio-economic development, cultural characteristics, etc.

Lack of proper educational facilities and health care, faulty feeding habits, certain irrational belief systems and special tribal chores are likely to aggravate their health and nutritional status. Their health challenges need special attention in the context of primarily for two reasons; firstly, many of the tribal communities are backward and, thus, deserve special attention because they have special provisions for up-liftment as per the constitution of India, and secondly, the growth of tribal communities is very uneven. In few communities, there is a definite decline, threatening their very existence. This decline might not be due to low level of fertility but rather due to the high level of mortality and illogical health practices.

It is believed that developmental programs had little effect on tribal people because they were not geared towards their specific needs/requirements. The usual concept about diseases in the tribal society is that they are caused by a breach of some taboo or by hostile spirits or the ghosts of the dead. Accordingly, the tribes have more faith in magico-religious type of treatment of the diseases than to utilize modern medical and health care facilities available at Primary Health Centre (PHC). Therefore, they have continued to depend on their traditional health care practices without any tangible impact on them from the conventional health care services.

Of the human hereditary hemolytic disorders, hemoglobinopathies, β-thalassemia syndrome and glucose-6-phosphate dehydrogenase (G6PD) enzyme deficiency are the most important genetic and public health challenges confronting the tribal population in Central India (1-4). This study was designed (i) to evaluate exclusively the scenario of sickle cell disorders, β-thalassemia syndrome and G6PD deficiency in scheduled caste and tribe communities, and (ii) to understand the interaction and impact of malaria endemicity and the prevalence of G6PD deficiency, β-thalassemia and sickle cell disorders on a cross-section of scheduled caste and tribal communities scattered in various malaria endemic parts of Chhattisgarh and Madhya Pradesh in Central India.

OUR STUDY

There are 46 scheduled tribes in the undivided state of Madhya Pradesh which constitute about 23% of the total population of India. There are three numerically predominant groups of tribes, namely Gonds (more than 37 lakh), Bhils (more than 17 lakh) and Kamars (more than 5 lakh), constituting more than sixty lakh population in the state. There are some tribal communities which are still at the pre-agricultural level of technology, having low literacy, with stagnant or diminishing population and some of them even facing the danger of slow extinction. These are seven primitive tribes, namely, Abujhmarias, Baigas, Birhors, Bharias, Hill Korwas, Kamars (Kawars), and Saharias categorized based on the use of their level of technology, education level, low level of growth, high morbidity and mortality, poor health and hygiene conditions, and inhuman standard of living in the underprivileged states of Chhattisgarh and Madhya Pradesh. Except the Baigas, Bharia and Saharias (resident of Madhya Pradesh), rest of the four primitive tribes are inhabitants of newly (2000 AD) carved state of Chhattisgarh.

As per 2001 census, 47 communities composed of scheduled castes (SC) in Madhya Pradesh that constituted 15.2% of the total population of the state and attained 8th rank for SC population in India. They inhabit mostly side by side scheduled tribe communities forming a buffer population between general castes and scheduled tribes in Madhya Pradesh.

Subjects

This investigation pertains to the tribes listed in table-1. Both primitive and scheduled tribes were studied belonging to different districts of the states of Chhattisgarh and Madhya Pradesh in the Central part of India. High concentration villages were identified in each district for particular tribe and a few villages at random were selected for the collection of blood samples after taking informed consent, irrespective of the age and sex from each individual. Ethical clearance was obtained prior to conducting the study from the Ethical Committee of Regional Medical Research Centre for Tribals (ICMR), Jabalpur and informed consent was taken before taking the blood sample.

Blood collection

Intravenous blood samples were collected from each individual (2-3 ml) under aseptic conditions in disodium salt of ethylene diamine tetra acetic acid (EDTA) coated vials and transported under ice-cold conditions within 24 h of collection to the laboratory at Jabalpur, where the analysis was carried out following the standard methodology, procedures and techniques after cross checking for quality control from time to time.

Table 1. Locations of scheduled caste and tribal communities studied in the states of Chhattisgarh and Madhya Pradesh, India

Sl . No.	Name of Tribe/Caste	District	Sample Size
Chhattisgarh State:			
1.	Birhor	Raigarh	270
2.	Bhatra	Bastar	99
3.	Halba	Durg (Rajnandgaon)	365
4.	Hill Korwa	Jashpur	744
5.	Hill Korwa	Surguja	402
6.	Kamar	Raipur	320
7.	Hill Maria	Bastar	93
8.	Maria	Bastar	101
9	Oraon	Raigarh, Surguja	215
Madhya Pradesh State:			
10.	Baiga	Shahdol	219
11.	Bharia	Chhindwara (Inside valley)	183
12.	Bharia	Chhindwara (Outside valley)	102
13.	Gond	Chhindwara (Inside valley)	75
14.	Gond	Chhindwara (Outside valley)	158
15.	Gond	Chhindwara	83
16.	Gond	Jabalpur	3224
17.	Gond	Mandla	280
18.	Gond	Seoni	286
19.	Gond	Shahdol	252
20.	Gond	Balaghat	311
21.	Raj Gond	Damoh	321
22.	Kol	Satna	290
23.	Pradhan	Dindori	226
24.	Pradhan	Dindori	990
25.	Basod (SC)	Chhindwara	150
26.	Jharia (SC)	Jabalpur	637
27.	Jharia (SC)	Jabalpur	409
28.	Mehra (SC)	Chhindwara	114
29.	Mehra (SC)	Seoni	216
30.	Mehra (SC)	Balaghat	219
Total			11354

SC=Scheduled Caste.

Laboratory investigations

The sickling test was performed by the wet sealed method, using 2% freshly prepared sodium metabisulphitc solution. Hemoglobin (Hb) electrophoresis was performed using cellulose acetate membrane (CAM) in alkaline buffer at pH 8.6 following the method of Dacie and

Lewis (5). Fraction of hemoglobin A_2 was estimated by the elution method using cellulose acetate membrane (CAM) in Tris-EDTA-Borate (TEB) buffer at pH 8.6 (5, 6) and that of fetal hemoglobin as per Weatherall (6). The hemoglobin A_2 value of more than 3.5% was taken as the cut-off point for the β-thalassemia trait. Hemoglobin variant (made for Bio-Rad Diagnostics Group, Hercules California, USA) analysis was carried out to confirm the doubtful cases. Hematological parameters were studied by using an automated Blood Cell Counter (Model-$MS_5$9, Melet Schloesing Laboratories, Cergy-Pontoise Cedex, France).

The G6PD enzyme deficiency was primarily detected by using Dichlorophenol Indophenol (DCIP) dye as described by Bernstein (7). Females heterozygous for G6PD deficiency have two populations of cells, one with normal G6PD activity and the other deficient. This is the result of inactivation (Lyon's hypothesis) of one of the two X chromosomes in individual cells early in the development of the embryo. All progeny (somatic) cells in females will have the characteristics of only the active X chromosome. The total G6PD activity of blood in female will depend on the proportion of normal to deficient cells. In most cases, the activity will be between 20 and 80% of the normal. However, a few heterozygotes (about 1%) may have almost only normal or almost only G6PD deficient cells. The present study has not at all encountered any such ambiguity; therefore, there were either 60-80% of the cells normal or deficient in all cases. Subsequent confirmation was done by following the Beutler et al. (8) and WHO procedures (9), in case, any doubt arose for the detection of G6PD deficiency.

FINDINGS

Of the primitive tribes of the state of Chhattisgarh, the frequency of sickle cell disorders ranged from 0.9% in Kamars to the highest of 22.5% in Hill Maria and β-thalassemia trait varied from 0% to 10.4% with the highest frequency in the Hill Korwas (Table-2). No case of compound condition (sickle cell and β-thalassemia) was recorded in the primitive tribes. The frequency of sickle cell disorders was equally high in the scheduled tribes of Chhattisgarh. However, the frequency of sickle cell trait (heterozygotes) was higher than the homozygous sickle cell disease in the scheduled tribes (Table-2). The β-thalassemia trait was found in a very low frequency, i.e.1.9% and 2.4% in Oraon and Halba tribes, respectively. Compound cases of these two conditions were not detected.

Out of three primitive tribes of Madhya Pradesh, only two tribes, namely, Baiga and Bharia were studied for the present milieu (Table-2). The frequency of sickle cell disorders was high in Baiga (22.3%) and Bharia (13.2%) primitive tribes, with a preponderance of sickle cell carriers in both populations. The frequency of β-thalassemia trait varied from 0% to 3.6% with the highest frequency in the Baiga tribe (3.6%). However, the picture of hemoglobinopathies was quite different in scheduled tribes of Madhya Pradesh (Table-2). The frequency of sickle cell hemoglobinopathy fluctuated from 4.1% to 34.0% among the scheduled tribes of Madhya Pradesh. Both the sickle cell heterozygotes and homozygotes were encountered during the study (Table-2) along with a few cases of sickle cell-β-thalassemia (0.1-0.8%). The frequency of β-thalassemia trait was variable between 0-10.0 percent among the scheduled tribes of Madhya Pradesh.

Table 2. Distribution of sickle cell disorders and β–thalassemia trait in scheduled caste and tribal communities of Chhattisgarh and Madhya Pradesh, India

		No. Tested	Hb AS		Hb SS		β-Thal. Trait		Hb S/β-Thal.		Reference
Tribe/Caste	Place/Dist.		n	%	n	%	n	%	n	%	
Chhattisgarh State											
Primitive Tribes:											
Birhor	Raigarh Dist.	270	0	0.0	0	0.0	6	2.2	-	-	PS
Hill Korwa	Jashpur Dist.	744	13	1.7	0	0.0	62	8.4	-	-	PS
Hill Korwa	Surguja Dist.	402	0	0.0	0	0.0	42	10.4	-	-	PS
Kamar	Raipur Dist.	320	3	0.9	0	0.0	21	6.6	-	-	PS
Kawar	Ambikapur	114	1	0.9	0	0.0	-	-	-	-	20
Kawar	Raipur Dist.	72	4	5.5	0	0.0	-	-	-	-	20
Hill Maria	Bastar Dist.	93	21	22.5	0	0.0	0	0.0	-	-	PS
Maria	Bastar Dist.	94	19	20.2	2	2.1	0	0.0	-	-	21
Maria	Bastar Dist.	101	14	13.9	0	0.0	0	0.0	-	-	PS
Muria	Bastar Dist.	101	15	14.9	1	1.0	0	0.0	-	-	21
Scheduled Tribes:											
Bhatra	Bastar Dist.	102	10	9.8	2	2.0	0	0.0	-	-	21
Bhatra	Bastar Dist.	99	13	13.1	0	0.0	0	0.0	-	-	PS
Dhurwa	Bastar Dist.	81	5	6.2	2	2.5	0	0.0	-	-	21
Gond	Ambikapur	127	26	20.5	1	0.8	-	-	-	-	20
Gond	Raipur Dist.	157	25	15.9	1	0.6	-	-	-	-	20
Halba	Raipur Dist.	122	17	13.9	0	0.0	-	-	-	-	20
Halba	Bastar Dist.	99	12	12.1	2	2.0	0	0.0	-	-	21
Halba	Rajnandgaon Durg Dist	365	54	15.6	1	0.3	9	2.4	-	-	PS
Halba	Bastar Dist.	95	18	19.0	1	1.0	0	0.0	-	-	PS
Kodaku	Sarguja Dist.	400	12	3.0	1	0.3	15	3.8	-	-	22
Oraon	Ambikapur	422	9	2.1	2	0.5	-	-	-	-	20
Oraon	Raigarh & Surguja Dist	215	0	0.0	0	0.0	4	1.9	-	-	PS
Pando*	Sarguja Dist.	458	5	1.1	1	0.2	2	0.4	-	-	22
Madhya Pradesh State											
Primitive Tribes:											
Baiga	Mandla Dist.	1566	244	15.6	7	0.5	3	0.2	-	-	25
Baiga	Dindori Dist.	990	182	18.4	11	1.1	28	3.6	-	-	22
Baiga	Shahdol Dist.	219	23	10.5	0	0.0	4	1.6	-	-	PS
Bharia	Chhindwara Dist. (Inside)	183	24	13.2	0	0.0	0	0.0	-	-	PS
Bharia	Chhindwara Dist. (Outside)	102	3	2.9	0	0.0	0	0.0	-	-	PS
Scheduled Tribes:											
Barela	Khargone	345	88	25.5	3	0.9	-	-	-	-	20
Barela	Nimar Dist.	316	86	27.2	1	0.3	4	1.3	-	-	23
Bhil	Jhabua Dist.	904	183	20.0	8	0.9	-	-	-	-	20
Bhil	Ratlam Dist.	433	51	11.8	1	0.2	-	-	-	-	20
Bhil	Nimar Dist.	316	45	14.2	0	0.0	3	1.0	-	-	23
Bhilala	Jhabua Dist	403	123	30.5	7	1.7	-	-	-	-	20

Table 2. (Continued)

		No. Tested	Hb AS		Hb SS		β-Thal. Trait		Hb S/β-Thal.		Reference
Tribe/Caste	Place/Dist.		n	%	n	%	n	%	n	%	
Bhilala	Nimar Dist.	370	68	18.4	1	0.3	5	1.3	-	-	23
Gond	Betul Dist.	299	34	11.4	2	0.7	3	1.0	-	-	24
Gond	Damoh Dist.	321	106	33.0	3	1.0	32	10.0	-	-	24
Gond	Kundam Dist.	3224	612	19.0	22	0.7	281	8.7	26	0.8	PS
Gond	Mandla Dist	280	52	18.6	0	0.0	0	0.0	-	-	PS
Gond	Chhindwara Dist. (Outside)	158	25	15.8	4	2.5	0	0.0	-	-	PS
Gond	Chhindwara Dist. (Inside)	75	15	4.3	\0	0.0	0	0.0	-	-	PS
Gond	Chhindwara	83	10	12.0	4	4.8	0	0.0	-	-	PS
Gond	Seoni Dist.	286	54	18.9	4	1.5	0	0.0	-	-	PS
Gond	Shahdol Dist.	252	33	13.1	3	1.2	12	4.6	-	-	PS
Gond	Balaghat Dist.	311	48	15.4	2	0.6	7	2.2	-	-	PS
Kol	Satna Dist.	290	12	4.1	0	0.0	17	5.9	-	-	PS
Korku	Chindwara Dist	250	43	17.2	3	1.2	12	4.8	-	-	24
Korku	Khandwa Dist	301	51	16.9	2	0.7	7	2.3	-	-	23
Korku	Betul Dist.	296	41	13.8	2	0.7	12	3.9	-	-	24
Patelia	Jhabua Dist.	166	34	20.5	3	1.8	-	-	-	-	20
Panika	Shahdol Dist.	210	60	28.6	7	3.3	3	1.4	-	-	23
Pradhan	Dindori Dist.	226	64	28.3	4	1.8	0	0.0	-	-	PS
Pradhan	Dindori Dist.	990	182	18.4	11	1.1	28	3.6	1	0.1	PS
Raj Gond	Damoh Dist.	321	33	10.3	1	0.3	10	3.1	-	-	PS
Scheduled Castes:											
Balai	Khandwa	276	39	14.1	1	0.4	7	2.5	-	-	23
Basod .	Betul Dist	123	24	19.5	1	0.8	0	0.0	-	-	24
Basod	Chhindwara	150	33	22.0	0	0.0	6	4.0	-	-	PS
Choudhary (Chamar)	Damoh Dist.	339	6	18.0	3	1.0	31	9.0	-	-	24
Choudhary (Chamar)	Shahdol	195	10	5.1	0	0.0	7	3.6	-	-	23
Jharia	Jabalpur Dist	637	28	4.4	0	0.0	15	2.3	-	-	PS
Jharia	Jabalpur Dist	409	155	37.9	5	1.2	41	10.0	16	3.9	PS
Katiya	Chhindwara	181	45	24.9	4	2.2		1.1	-	-	24
Mehra	Betul Dist.	352	114	32.4	7	2.0	1	0.3	-	-	24
Mehra	Chhindwara	114	23	19.8	4	3.4	6	5.2	-	-	PS
Mehra	Seoni Dist.	216	4.6	21.3	1	.5	3	1.4	-	-	PS
Mehra	Balaghat	219	40	18.3	0	0.0	0	0.0	-	-	PS
Other Backward Class	Chhindwara	58	7	12.1	1	1.7	5	8.6	-	-	24

Thal.= Thalassemia; Dist.= District; * a case hemoglobin AE was detected; PS= Present Study.

Almost similar picture of hemoglobinopathies emerged out for the scheduled caste communities of Madhya Pradesh (Table-2). The frequency of sickle cell hemoglobinopathy fluctuated from 4.4% to 37.9% among the scheduled castes. Both sickle cell heterozygotes as well as sickle cell homozygotes along with the sickle cell-β-thalassemia (3.9%) were encountered during the study (Table-2). The frequency of β-thalassemia trait was variable between 0-10.0 percent among the scheduled castes of Madhya Pradesh (Table-2).

Table 3. Distribution of G6PD deficiency in scheduled caste and tribal communities of Chhattisgarh and Madhya Pradesh, India

Tribe/Caste	Place/Dist.	No. Tested	M+F		M		
			n	%	n	%	Reference
Chhattisgarh State							
Primitive Tribes:							
Birhor	Raigarh	270	0	0.0	-	-	PS
Hill Korwa	Jashpur	383	-	-	32	84	PS
Hill Korwa	Surguja	402	6	1.6	-	-	PS
Kamar	Raipur	320	5	1.6	-	-	PS
Kawar	Ambikapur	137	-	-	22	16.0	20
Kawar	Raipur	116	-	-	25	21.5	20
Hill Maria	Bastar	93	3	3.6	-	-	PS
Maria	Bastar	101	14	14.0	-	-	PS
Maria	Bastar	47	0	0.0	-	-	21
Muria	Bastar	75	2	2.7	-	-	21
Scheduled Tribes:							
Bhatra	Bastar	105	3	2.9	-	-	21
Bhatra	Bastar	99	0	0.0	-	-	PS
Dhurwa	Bastar	23	0	0.0	-	-	21
Gond	Ambikapur	169	-	-	22	13.0	20
Gond	Raipur	284	-	-	46	16.2	20
Halba	Raipur	108	-	-	8	7.4	20
Halba	Bastar	69	0	0.0	-	-	21
Halba	Bastar	95	3	3.6	-	-	PS
Halba	Durg	365	4	1.0	-	-	PS
Kodaku	Sarguja	400	7	1.8	-	-	22
Oraon	Ambikapur	411	-	-	55	13.4	20
Oraon	Raigarh & Surguja	215	0	0.0	-	-	PS
Pando	Sarguja	458	5	1.1	-	-	22
Madhya Pradesh State							
Primitive Tribes:							
Baiga	Mandla	547	-	-	25	4.5	25
Baiga	Dindori	1011	34	3.4	-	-	22
Baiga	Jabalpur	297	10	3.4	-	-	PS
Baiga	Shahdol	219	4	1.8	-	-	PS
Bharia	Chhindwara	185	22	12.1	-	-	PS
Scheduled Tribes:							
Barela	Khargone	309	-	-	18	5.8	20
Barela	Nimar	316	18	5.7	-	-	23
Bhil	Jhabua	120	-	-	8	6.7	26
Bhil	Ratlam	444	-	-	15	3.4	20
Bhil	Jhabua	752	-	-	34	4.5	20
Bhil	Nimar	316	11	3.4	-	-	23

Tribe/Caste	Place/Dist.	No. Tested	M+F		M		
			n	%	n	%	Reference
Bhilala	Jhabua	319	-	-	23	7.2	20
Bhilala	Nimar	313	13	4.3	-	-	23
Gond	Betul	299	9	3.0	-	-	24
Gond	Chhindwara	158	5	3.1	-	-	PS
Gond	Jabalpur	3224	0	0.0	-	-	PS
Gond	Damoh	321	30	9.3	-	-	23
Gond	Seoni	286	5	1.7	-	-	PS
Gond	Chhindwara	349	13	3.7	-	-	PS
Gond	Balaghat	311	4	1.3	-	-	PS
Gond	Shahdol	252	8	3.2	-	-	PS
Kol	Satna	290	13	4.5	-	-	PS
Korku	Khandwa	301	4	1.3	-	-	23
Korku	Betul	296	8	2.7	-	-	24
Korku	Chhindwara	250	14	5.6	-	-	PS
Korku	Nimar	301	4	1.3	-	-	23
Panika	Shahdol	210	6	2.8	-	-	23
Patelia	Jhabua	155	-	-	4	2.6	20
Pradhan	Dindori	226	11	4.9	-	-	PS
Scheduled Castes:							
Balai (SC)	Khandwa	276	2	0.7	-	-	23
Balai (SC)	Nimar	637	6	1.0	-	-	23
Basod (SC)	Betul	123	3	2.4	-	-	24
Basod (SC)	Chhindwara	150	0	0.0	-	-	PS
Chamar (SC)	Shahdol	195	5	2.6	-	-	23
Chamar (SC)	Damoh	339	6	1.8	-	-	PS
Jharia (SC)	Jabalpur	148	0	0.0	-	-	PS
Katiya (SC)	Chhindwara	181	7	3.9	-	-	PS
Mehra (SC)	Betul	325	7	2.0	-	-	24
Mehra (SC)	Seoni	216	4	1.8	-	-	PS
Mehra (SC)	Balaghat	219	3	1.4	-	-	PS
Mehra (SC)	Chhindwara	114	3	2.6	-	-	PS
Other Back- Ward Castes	Chhindwara	58	4	6.9	-	-	PS

M=Males; F=Females; SC=Scheduled Castes; PS=Present Study.

Table-3 shows the distribution of G6PD deficiency in primitive tribes, other tribes and scheduled castes of Chhattisgarh and Madhya Pradesh. Among the primitive tribes of Chhattisgarh, the frequency of G6PD deficiency was as low as 0% among the Birhor tribe of Raigarh and as high as 21.5% among the Kawars of Raipur. The frequency of G6PD deficiency varied from tribe to tribe (Table-3). Almost similar picture emerged out in scheduled tribes of Chhattisgarh.

Of the two primitive tribes studied from Madhya Pradesh, the frequency of G6PD deficiency was recorded 3.4% in Baiga and 12.1% in Bharia tribes. The frequency of G6PD deficiency varied from 1.3% to 9.3% among the scheduled tribes of Madhya Pradesh. Almost similar scenario of G6PD deficiency (range 0-6.9%) was presented by the scheduled castes of Madhya Pradesh (Table-3).

DISCUSSION

The most salient finding of the present study is the rampant prevalence of hereditary hemolytic disorders like sickle cell hemoglobinopathy, β-thalassemia syndrome and G6PD enzyme deficiency in Central region of India (Table 2 and 3). These defective genes have not only penetrated the scheduled caste and scheduled tribe communities, but general caste groups have also been equally affected making them a major genetic and public health challenge in the region. The high frequency prevalence of homozygous sickle cell disease in different vulnerable communities of the region (Table-2) indicates the sufferings of a large number of affected cases at birth, which put a major clinical burden on the health care and management machinery of the country (3,4).

The Central-Eastern part of India has/had been a major reservoir of rampant endemic malaria for both *Plasmodium falciparum* and *Plasmodium vivax* species leading to high morbidity and mortality in the vulnerable communities. The constant lethal effect of these virulent parasites in the region in the past might have given some pressure on the host to evolve some natural protective mechanism against the dreadful disease of malaria. It is presumed that erythrocytic moiety might have probably undergone some change to counter the lethal effects of malaria in the recent past. It seems that different abnormal hemoglobin variants, β-thalassemia syndrome and G6PD enzyme deficiency are the directed mutations against the malaria malady as the heterozygotes or carriers of these genetic traits do not suffer severely from the dreadful malaria (10-12).

The findings of present study show that when the frequency of sickle cell allele decreases in the malaria endemic cross-section of caste/tribal population, the frequency of G6PD enzyme deficiency and β-thalassemia allele increases and vice versa. This trend for an inverse relationship between sickle cell disorders and G6PD deficiency, and sickle cell disorders and β-thalassemia in major scheduled caste/tribal communities of Central India, could be fascinating one. This medical aspect is important from an evolutionary biological background. This could be an excellent starting point for molecular analyses to determine the signature of selection in the genomic regions of the β-globin and G6PD genes. This may further provide a mechanism for how selection operates against malaria when two mutations occur in the same geographical region. It is apparent from the present study that natural selection had played a major role initially in favor of sickle cell, β-thalassemia and G6PD mutations so that they have probably evolved as a protective mechanism against the lethal effects of malaria in this part of the country. Since the selection favors the mutation with least cost to the population [as the clinical manifestations of G6PD deficiency are mild (do not result in a complete loss of enzyme activity) against the sickle cell disease with high morbidity and mortality in the region], it seems that the replacement of the sickle cell allele for β-thalassemia and G6PD deficiency alleles is occurring in the major scheduled castes/tribes of Chhattisgarh/Madhya Pradesh in Central India. These findings are consistent with our previous studies (13, 14) carried out in the state of Orissa in Central-Eastern India.

The G6PD deficiency, the most common enzyme deficiency in humans, is thought to protect against *Plasmodium falciparum* infection. There is a remarkable overlap between geographical regions that have a population with a high frequency of G6PD deficiency and where malaria is or was endemic (12). In clinical field studies, fewer *Plasmodium falciparum* parasites were found in children heterozygous for G6PD deficiency (that is with one variant and one normal copy of the G6PD gene), than in children with normal copies of the gene (10). Furthermore, G6PD deficient children had fewer episodes of life-threatening malaria than did children in whom G6PD activity was normal (11). Experiments *in vitro* revealed that *Plasmodium falciparum* is able to invade G6PD deficient red blood cells but does not mature normally (15). Parasitized G6PD deficient red blood cells are phagocytosed more readily by macrophages than are parasitized red cells with normal G6PD activity (16). The imperative contention of the present study gets further impetus and support from the above clinical laboratory studies carried out in this direction.

The high prevalence of hemolytic genetic disorders in the studied populations can also be partly attributed to the practice of consanguineous marriages, religious conversions that permit marriage among blood relatives, practice of caste/tribe endogamy, small breeding population size, territorial endogamy, population migrations due to drought, epidemics, malarial endemicity in geographical and ecological niches, founder effect, genetic drift, etc. On the other hand, increased homozygosity of recessively inherited traits and intra- and inter-caste/tribal genetic variability in allele frequency testify their genetic isolation - forming localized gene pools, and genetic admixture in these populations. These observations are further strengthened by the variability in the allele frequency of sickle cell hemoglobinopathy, β-thalassemia syndrome, and G6PD deficiency in Baiga, Bhil, Gond, Halba, Kamar, Kurku and Mehra communities in Chhattisgarh and Madhya Pradesh (Table 2 and 3). Further, it is evident that there is a tremendous genetic burden of abnormal hemoglobin variants, β-thalassemia syndrome and G6PD deficiency in Central India.

The sickle cell anemia and β-thalassemia are important inherited blood disorders with multi-system problems and shortened life span of individuals. They impose a heavy genetic load on innocent and poor caste/tribal communities and governmental health care machinery. These genetic diseases have no cure but can be prevented. The people should be made aware of the right kind of information, management and treatment based on the facilities available (17, 18). There is an urgent need for the mass awareness. Prevention can be possible once awareness spreads. There is an increased demand for the prevention and alleviation of the sufferings of the affected people especially the poor and underprivileged scheduled castes/tribes in India.

This study has multifaceted public health importance from different angles. Inherited hemolytic disorders cause a high degree of hemolytic anemia/pallor, recurrent fever, clinical jaundice, frequent infections, painful crisis, splenomegaly, osteoporosis, femoral necrosis, etc. and are responsible for the high infant and maternal morbidity, mortality, neonatal and fetal wastage. The victims include the infants, growing children, adolescent girls, pregnant women and a large chunk of ignorant and poor people. This causes a considerable economic as well as human resource development loss and contributes significantly towards the sufferings and hindrance of overall development in aboriginal communities in India.

CONCLUSION

Indigenous communities in India constitute about 8.2% of the population with 635 tribes and subtribes including 75 primitive tribal groups as per 2001 census. There are 46 scheduled tribes in the undivided state of Madhya Pradesh that constituted about 23% of the total population of India. They are mostly forest dwellers inhabiting foothills and inaccessible hilly tract with bountiful natural resources at their disposal for sustenance. Health scenario of these indigenous people is the most frustrating and neglected milieu in India. This study presents the public health challenges of sickle cell disorders, β-thalassemia syndrome and G6PD deficiency in scheduled caste and scheduled tribe communities of Central India.

High prevalence of sickle cell disorders, β-thalassemia syndrome and G6PD deficiency was observed in primitive tribes, scheduled castes and tribes of Chhattisgarh and Madhya Pradesh. Heterozygous sickle cell disease was predominantly high in Hill Maria (22.5%), Maria (20.2%) and Muria (14.9%) primitive tribes of Bastar district, followed by Gond (20.5%), Patelia (20.5%), Halba (19.0%), Bhatra (13.1%) and Dhurwa (6.2%) scheduled tribes of Chhattisgarh. The G6PD deficiency was high in those tribes such as Kawar (21.5%), Oraon (13.4%) and Hill Korwa (8.4%) of Chhattisgarh that have low frequency of sickle cell disorders.

The frequency of sickle cell disorders was high in Baiga (22.3%) and Bharia (13.2%) primitive tribes, with preponderance of the sickle cell carriers and low frequency of β-thalassemia trait (0-3.6%) in Madhya Pradesh. The frequency of sickle cell hemoglobinopathy fluctuated between 4.1% to 34.0% among the scheduled tribes of Madhya Pradesh. Among the scheduled castes, the frequency of sickle cell disorders varied from 4.4% to 37.9% inclusive of heterozygotes and homozygotes along with the sickle cell-β-thalassemia (3.9%). The frequency of β-thalassemia trait was variable between 0-10.0 percent among the scheduled castes of Madhya Pradesh. The G6PD deficiency was recorded 3.4% in Baiga and 12.1% in Bharia primitive tribes. The range of G6PD deficiency was between 1.3% to 9.3% among the scheduled tribes and 0% to 6.9% in scheduled castes of Madhya Pradesh.

From public health point of view, the inherited hemolytic disorders cause a high degree of hemolytic anemia/pallor, recurrent fever, clinical jaundice, frequent infections, painful crisis, splenomegaly, osteoporosis, femoral necrosis, etc. and are responsible for the high infant and maternal morbidity, mortality, neonatal and fetal wastage. There is an urgent need of community/preventive medicine for the mass awareness and community genetic counseling.

There seems to be a trend towards an inverse relationship between the sickle cell allele and G6PD deficiency, and sickle cell and β-thalassemia allele in a cross-section of malaria endemic (*Plasmodium falciparum*) caste/tribal communities of Central India. When the frequency of sickle cell allele decreases in a cross-section of malaria endemic caste/tribal population, the frequency of G6PD enzyme deficiency and β-thalassemia allele increases and vice versa. Natural selection had played a major role in favor of sickle cell, β-thalassemia and G6PD mutations so that they had probably evolved as a protective mechanism against the lethal effects of malaria.

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Chapter 24

A GENETIC STUDY OF SIX TYPICAL FAMILIES OF THE SICKLE CELL DISEASE

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The sickle cell disease is a genetically inherited hematological disorder commonly encountered in the Central-Southern region of India. It causes high degree of morbidity, mortality and fetal wastage in the underprivileged and vulnerable people. The gene frequency of sickle cell allele has been reported to be 4.3% in India. There is a dearth of typical phenotypic studies in India on the heterosis, mode of inheritance, clinical manifestations and hematological profile of various sickle cell disorders encountered in the affected families. This study highlights the genetic inheritance in six typical families of sickle cell disease with varied sickle cell phenotypes prevalent in the Central-Eastern region of India. Some intervention and prevention aspects of the different phenotypes of the sickle cell disease have been discussed for amelioration in the affected families and communities in the state of Orissa, India.

INTRODUCTION

The sickle cell disease is an inherited monogenic hematological disorder commonly encountered in the Central-Southern region of India. No genetic disease could be as simple as the sickle cell anemia. It is a simple disease but there is no cure. In the absence of any cure, the majority of the sickle cell patients have a miserable and short life span (1). Instances of sudden death in such cases have also been reported. This genetic disease is responsible for considerable morbidity and mortality (2, 3). A majority of the cases need the first blood transfusion between one to three years of age reflecting a high morbidity in the preschool age. At this age, cross infection is more common, which could precipitate a sickle cell crisis (1, 4).

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The anemia in sickle cell trait (AS) is mild and infrequent and one must look for other causes of anemia in them like iron deficiency, parasitic infestations, malaria, etc.

The sickle cell disease affects the ability of red blood corpuscles (RBCs) to carry oxygen to various parts of the body by acquiring the shape of a sickle. This distortion in shape and size of cells leads to increased blood viscosity and blocking of the small vessels, resulting in devastating pain. The pain originates virtually at any time in any organ of the body in joints or bones. The disease carries the risk of debilitating fatigue, blindness, organ damage, and cardiac stroke within a life span of just about 20-30 years (1). The symptoms of the disease include anemia, hand-foot syndrome and infection. The clinical course of these patients is punctuated by episodes of "crisis" and increased susceptibility to serious infections because of functional asplenia. The usual complications are vaso-occlusive crises (severe pain in almost all parts of the body), hemolytic crises (yellow eyes, jaundice or hepatic infection), aplastic crises (diminished production of RBCs) and the deadliest of complications, the sequestration crises (blood suddenly goes to spleen) (1).

The sickle cell disease is highly prevalent in certain ethnic groups, scheduled castes and scheduled tribes in India (5-8). Dunlop and Mazumder (9) in tea garden laborers of Assam; and Lehmann and Cutbush (10) in Nilgiri Hill tribes of South India first reported the sickle cell disorders in India in 1952. The cumulative allele frequency of three predominantly prevalent hemoglobin variants, namely, sickle cell, hemoglobin E and hemoglobin D has been found to be 5.35% in India (11, 12). The average gene frequency of the sickle cell allele has been recorded to be 4.3% in India (11). More than 350 population groups were studied, and the gene prevalence rate for sickle cell was found to be staggering between 0-44 percent (5), with the highest allele frequency being 22.5 to 44.4 percent in central India (11, 13).

To the best of our knowledge so far, no study has reported the actual typical examples of the different sickle cell phenotypes in the affected families with mode of inheritance, clinical manifestations and hematological profile in India. This study for the first time presents six typical families of sickle cell disease along with varied hemoglobin variants encountered and prevalent in the Central-Eastern region of India.

OUR STUDY

This study is based on index cases of sickle cell disease and/or β-thalassemia trait or other hemoglobin variant encountered in the routine referred cases attending our Centre for detailed investigations from different peripheral Primary Health Centres (PHCs) and Hospitals in the state of Orissa. All the index cases and their other available family members such as parents, brother/sister were also subjected to clinical examination and investigation after taking informed consent for genetic/marriage counseling. Background information for each family such as name, age, sex, caste, native place, reproductive history, family pedigree, and clinical signs and symptoms were also recorded.

About 2-3 ml. intravenous blood samples were collected using ethylene diamine tetra acetic acid (EDTA) as anticoagulant by disposable syringes and needles from each individual under aseptic conditions after obtaining the informed consent. All the signs and symptoms related to sickle cell disease were recorded on a pre-designed proforma after clinical examination. Laboratory investigations were carried out following the standard procedures after cross checking for quality control from time to time. Hematological parameters were studied by using an automated Blood Cell Counter (Model: MS4, Melet Schloesing Laboratories, Cergy-Pontoise Cedex, France).

The sickling test was performed by using freshly prepared sodium metabisulphite solution as reducing agent for the presence or absence of sickle cell hemoglobin (14). The routine hemoglobin lysate electrophoresis was carried out on cellulose acetate membrane (CAM) in Tris-EDTA-Borate buffer at pH 8.6 and quantification of A_2 fraction of hemoglobin was done by elution method (15). The value more than 3.5% of A_2 fraction of adult hemoglobin was taken as cut off point for determining the β-thalassemia trait. Estimation of fetal hemoglobin was done as described by Weatherall (15).

The diagnosis of sickle cell-β-thalassemia was based on the findings of hemoglobin (Hb) A, F, S and A_2 on electrophoresis under acidic and alkaline media, elevated HbA_2 levels (>3.5%), and family study. In view of the inverse relationship between HbA_2 and HbF levels, the high levels of HbF are very common in Indian sickle cell patients. All the blood samples were further subjected for confirmation to hemoglobin variant analysis (made for Bio-Rad Diagnostics Group, Hercules California, USA).

OUR FINDINGS

Family 1

Table 1. Summary of hematological findings of a Chasa family from Deogarh district in Western Orissa, India

Parameters	Father	Mother	Offspring (Son)
Name*	Duryodhan Gadnaik	Pushpa Gadnaik	Ashutosh Gadnaik
Age (in years)	48	37	15
Sex	M	F	M
Hb. (g/dl)	13.5	7.5	13.5
RBC (10^6/μl)	5.6	2.5	5.3
HCT (%)	48.4	21.7	40.6
MCV (fl)	77.8	86.2	76.5
MCH (pg)	24.1	29.7	25.4
MCHC (g/dl)	31.1	34.5	33.2
WBC (10^3/μl)	7.0	6.3	8.4
Sickling Test	-ve	+ve	+ve
Hb. Electrophoresi s (Alkaline, pH 8.6)	$A+A_2$	$S+F+A_2$	$A+S+A_2$
Hb. A_2 (%)	2.0	1.3	2.0
Hb. F (%)	0.7	15.5	1.0
Hb. AA (%)	97.3	0.0	60.0
Hb. S (%)	0.0	83.2	37.0
Diagnosis	Normal	Sickle Cell Disease	Sickle Cell Trait

*Changed

A 37 years old married woman belonging to Chasa (agricultural) community of Deogarh district in Western Orissa was referred to us for detailed investigations. She had moderate pallor (Hb 7.5 g/dl) with mild jaundice and had enlarged spleen of 4 cm below the costal margin with hepatomegaly (2 cm). She had no other complaints. She had only one son. The propositus (Pushpa Gadnaik) and her family details are presented in Table-1 Peripheral blood smear showed hypochromia and occasional target cells. The sickling test was positive. Her red cell indices like RBC count ($2.5.10^6/\mu l$), hematocrit (21.7%), and MCH (29.7pg) were found low. Hemoglobin electrophoresis on cellulose acetate membrane at pH 8.6 showed a thick band at the position of S trailing towards anode but below the position of adult hemoglobin band and a thin band in the A_2/E region. The percentages of these bands on quantification were: 83.2 and 1.3, respectively and there was no adult hemoglobin. Her 48 years old husband who accompanied her was also induced to undergo hematological investigations after taking informed consent. He was found normal after investigations. The fetal hemoglobin was high in propositus (15.5%). She had taken blood transfusion only once at the time of delivery of her son. Her 15 years old son was also tested and found a case of sickle cell trait. Thus, the proband (Pushpa Gadnaik) was diagnosed as a case of sickle cell disease.

Family 2

A five years old boy from Khandayat (warrior) agricultural community in Nayagarh district of coastal Orissa born of a non-consanguineous marriage was found severely anemic with a hemoglobin of 5.0 g/dl and had repeated history of jaundice and whole blood transfusion, varying from one to 2 units almost every year since the age of 2 years. He had hand and foot syndrome at the age of 10 months with cough, cold and fever lasting for 4-5 days. Recurrent attacks of fever with pains in knee and elbow for 4-5 times a year. On examination, he had no hemolytic facies or any skeletal abnormality. He had enlarged spleen of 4 cms with hepatomegaly (3 cm). The propositus (Chandan Nayak) and his family details are presented in table 2 (see also figure 1). Peripheral smear showed normocytosis, leucocytosis and occasional target cells. The sickling test was positive. Hemoglobin electrophoresis on cellulose acetate membrane at pH 8.6 showed a thick band at S position and a faint band in the A_2/E region. On quantitation, the percentages of these bands were 69.2 and that of adult A_2 fraction 1.6. Father showed this S band to be 74.4% (sickle cell disease) and mother had 27.0% (sickle cell trait). The propositus had 29.2% fetal hemoglobin, whereas, both parents (father: 23.8%; mother: 1.1%) and an elder sister had 2.8%. The low indices of RBC count ($1.8\ 10^6/\mu l$), HCT (15.9%), MCH (27.7pg) and MCHC (31.4g/dl) were observed in the index case. His elder sister aged 9 years was found to be sickle cell trait (Fig.1). His 34 years old father had enlarged spleen (4 cm) and liver (3 cm) with moderate pallor but was never transfused. His red cell indices were also low (Table-2). His mother had mild anemia and was a case of sickle cell trait. Thus, the propositus (Chandan Nayak) was diagnosed as a case of sickle cell disease (Table-2).

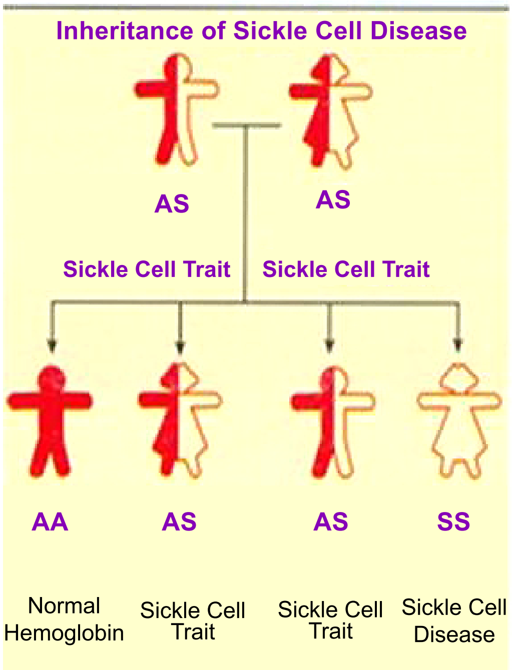

Figure 1. A family with sickle cell disease. Father and son with sickle cell disease. Mother and daughter with sickle cell trait.

Table 2. Summary of hematological findings of a Khandayat family from Nayagarh district of coastal Orissa, India

Parameters	Father	Mother	Offspring	
			Daughter	Son
Name*	Niranjan Nayak	Premlata Nayak	Spandan	Chandan
Age (in years)	34	29	9	5
Sex	M	F	F	M
Hb. (g/dl)	9.4	11.4	8.0	5.0
RBC ($10^6/\mu l$)	3.8	5.0	5.7	1.8
HCT (%)	32.3	37.7	27.2	15.9
MCV (fl)	84.1	75.8	84.0	86.6
MCH (pg)	24.4	22.8	14.1	27.7
MCHC (g/dl)	29.1	30.2	29.4	31.4
WBC ($10^3/\mu l$)	9.5	10.7	9.0	35.9
Sickling Test	+ve	+ve	+ve	+ve
Hb. Electrophoresis (Alkaline, pH 8.6)	S+F+A_2	A+S+A_2	A+S+A_2	S+F+A_2
Hb. A_2 (%)	1.8	2.0	1.9	1.6
Hb. F (%)	23.8	1.1	2.8	29.2
Hb. AA (%)	0.0	69.9	63.9	0.0
Hb. S (%)	74.4	27.0	31.4	69.2
Diagnosis	Sickle Cell Disease	Sickle Cell Trait	Sickle Cell Trait	Sickle Cell Disease

* Changed.

Family 3

Table 3. Summary of hematological findings of a Gudia family from Nayagarh district of coastal Orissa, India

Parameters	Father	Mother	Offspring		
			Daughter	Daughter	Son
Name**	Harihar Sahu	Ahalya Sahu	Susama*	Mamata	Santosh
Age (in years)	54	48	9	18	15
Sex	M	F	F	F	M
Hb. (g/dl)	12.6	11.1		4.0	6.4
RBC ($10^6/\mu l$)	4.0	4.3		1.1	1.9
HCT (%)	36.6	34.7		11.9	18.1
MCV (fl)	91.0	80.9		86.7	96.8
MCH (pg)	31.2	25.8		35.3	34.2
MCHC (g/dl)	34.4	31.8		33.6	35.3
WBC ($10^3/\mu l$)	7.5	9.5		35.1	18.2
Sickling Test	+ve	+ve		+ve	+ve
Hb. Electrophoresis(Alkaline, pH 8.6)	$A+S+F+A_2$	$A+S+F+A_2$		$S+F+A_2$	$S+F+A_2$
Hb. A_2 (%)	2.2	1.9		2.3	2.2
Hb. F (%)	1.3	1.1		20.0	24.1
Hb. AA (%)	62.4	55.9		0.0	0.0
Hb. S (%)	34.1	41.1		77.7	73.7
Diagnosis	Sickle Cell Trait	Sickle Cell Trait		Sickle Cell Disease	Sickle Cell Disease

* Presumed to be a case of sickle cell disease. Died with jaundice, fever, joint pains and chest pains.
** Changed.

A 15 years old boy belonging to Gudia (scheduled caste) community of Nayagarh district in coastal Orissa was referred to us for detailed investigations. He had severe pallor (Hb 6.4 g/dl), cough, wasting and recurrent fever with history of repeated blood transfusions at the interval of one month since 2 years of age. He had first pain attack (dactylitis) at the age of 2 years and severe jaundice at 14 years. On examination he had hemolytic face and skeletal abnormality. He had enlarged spleen of 6 cms below the costal margin with hepatomegaly (4 cm). The propositus (Santosh Sahu) and his family details are presented in table 3. Peripheral blood smear showed anisocytosis, poikilocytosis, hypochromia, and occasional target cells. The sickling test was positive. Hemoglobin electrophoresis on cellulose acetate at pH 8.6 showed a thick band at S position and a faint band in the A_2/E region. On quantitation, the percentages of these bands were 73.7 and 2.2 that of adult hemoglobin A_2. Father showed this S band to be 34.1% (sickle cell trait) and mother had 41.1% (sickle cell trait). The propositus had high level of fetal hemoglobin (24.1%), whereas, both parents (father: 1.3%; mother: 1.1%) had normal fetal hemoglobin. The low indices of HCT (18.1%), MCH (34.2pg) and MCHC (35.3g/dl) were observed in the index case. Of the two elder siblings of the proband, one (Susama) died at the age of 9 years with jaundice, fever, joint and chest pains, was presumed to be a case of sickle cell disease, whereas, the other (Mamata) is a transfusion dependent confirmed case of sickle cell disease who had retarded growth, 2-3 pain attacks every year, history of jaundice and epistaxis, enlarged spleen (2 cm) and liver (3 cm) with no bone lesion. She had no menarche even at the age of 18 years. The secondary sexual characters were under-developed. Both parents although sickle cell carriers but clinically normal had never received any blood transfusion. Thus, the proband (Santosh) was diagnosed as a case of sickle cell disease (see table 3).

Family 4

Table 4. Summary of hematological findings of a Mali family from Ganjam district of coastal Orissa, India

Parameters	Father	Mother	Offspring (Son)
Name*	Biswanath Patra	Laxmi Patra	Harekrushna
Age (in years)	48	40	15
Sex	M	F	M
Hb. (g/dl)	16.0	10.5	6.5
RBC (10^6/μl)	6.0	6.1	3.7
HCT (%)	48.9	36.3	23.9
MCV (fl)	81.3	59.4	63.8
MCH (pg)	26.5	17.1	17.2
MCHC (g/dl)	32.5	28.9	27.2
WBC (10^3/μl)	6.9	12.7	17.5
Sickling Test	+ve	-ve	+ve
Hb. Electrophoresis (Alkaline, pH 8.6)	$A+S+A_2$	$A+A_2$	$A+S+F+A_2$
Hb. A_2 (%)	1.9	5.5	5.9
Hb. F (%)	0.7	0.5	15.8
Hb. AA (%)	60.8	94.0	9.3
Hb. S (%)	36.6	0.0	69.0
Diagnosis	Sickle Cell Trait	β-Thalassemia Trait	Sickle Cell-β^+ Thalassemia

* Changed.

A 15 years old boy belonging to Mali caste (Other Backward Caste) from Ganjam district of Coastal Orissa was referred to us for detailed investigations. He had severe pallor (Hb 6.5 g/dl), icterus, cough, wasting and recurrent fever with history of jaundice (for 5-6 days), joint pains and repeated blood transfusions at the interval of one month since 2 years of age. He was looking weak and had retarded growth and development. On examination, he had hemolytic face or skeletal abnormalities. He had enlarged spleen of 3 cms below the costal margin with hepatomegaly (2 cm). The propositus (Harekrushna Patra) and his family details are presented in table 4. Peripheral blood smear showed anisocytosis, poikilocytosis, hypochromia, and occasional target cells. The naked eye single tube red cell osmotic fragility test (NESTROFT) and sickling test were positive. Hemoglobin electrophoresis on cellulose acetate membrane at pH 8.6 showed a thick band in the S position with upward trailing and another band at A_2/E region was observed. On quantitation, the percentage of these bands was 69.0, HbA_2 (5.9), fetal (15.8) and that of adult hemoglobin 9.3. Mother showed HbA_2 band to be 5.5% (β-thalassemia trait) with sickling test negative and father had sickling positive (sickle cell trait) with 1.9% of HbA_2. Both parents had normal fetal hemoglobin (father: 0.7%; mother: 0.5%), whereas, the propositus had high (15.8%) fetal hemoglobin. The low indices of MCV (63.8fl), HCT (23.9%), MCH (17.2pg) and MCHC (27.2g/dl) were observed in the index case. Prior to proband, there were two consecutive abortions and a 4 months fetal wastage. Both parents were clinically normal and had never taken any blood transfusion. There was some proportion of adult hemoglobin (9.3%) in the propositus. Thus, the propositus (Harekrushna Patra) was diagnosed as a case of double heterozygous condition of sickle cell-β^{+}Thalassemia (see table 4).

Family 5

Table 5. Summary of hematological and clinical findings of a Khandayat family from Khurda district of coastal Orissa, India

Parameters	Father	Mother	Offspring (Son)
Age (in years)	27	23	1
Sex	M	F	M
Hb. (g/dl)	11.2	12.6	9.4
RBC ($10^6/\mu l$)	4.5	2.4	3.6
HCT (%)	35.0	15.0	28.0
MCV (fl)	69.0	61.9	60.9
MCH (pg)	24.6	31.0	30.0
MCHC (g/dl)	27.5	19.3	19.3
WBC ($10^3/\mu l$)	6.3	12.9	4.7
Sickling Test	-ve	+ve	-ve
Hb. Electrophoresis (Alkaline, pH 8.6)	$A+A_2$	$S+E+A_2$	$A+E+F+A_2$
Hb. A_2 (%)	6.6	26.2	65.7
Hb. F (%)	1.4	4.8	7.3
Hb. AA (%)	92.0	-	27.0
Hb. S (%)	-	69.0	-
Diagnosis	β-Thalassemia Trait	Sickle Cell-E Disease	Hemoglobin-E-β^{++}Thalassemia

Table 5 presents the summary sheet of hematological and clinical features of an index case with mother having double heterozygosity for two structural hemoglobin variants (abnormal hemoglobins, SE) in Orissa. A year old male child with mild anemia and recurrent fever who had become transfusion dependent was referred to us for complete hematological investigations. He had enlarged spleen (2 cm) without hepatomegaly. His sickling test was found negative. Almost all the red cell indices were below normal range, i.e., hemoglobin level (9.4g/dl), RBC counts ($3.6.10^6/\mu l$), HCT (28%), MCV (60.9fl), MCH (30pg), and MCHC (19.3 g/dl). After alkaline (pH 8.6) electrophoresis, it was known that he had raised A_2/E (65.7%) and fetal hemoglobin (7.3%) with minor A band. The father of this child had although reduced red cell indices but except the raised hemoglobin A_2 (6.6%) level, no other abnormality detected and designated as β-thalassemia carrier. The mother had reduced red cell indices with enlarged spleen (3 cms) and history of jaundice. She had sickling test positive. Alkaline (pH 8.6) electrophoresis showed two thick bands at the position of A_2/E

(26.2%) and S (69.0%) with raised fetal hemoglobin (4.8%). Hence, she was a case of double heterozygosity or sickle cell-E disease. There was some proportion of adult hemoglobin (27.0%) in the propositus. Hence, the propositus (son) was diagnosed as a case of hemoglobin E-β^{++}Thalassemia.

Family 6

A four years old male child with splenomegaly (3 cm) and hepatomegaly (6 cm) having pallor, icterus, recurrent fever and history of jaundice and transfusion was sent to us for investigations. All the red cell indices were much reduced and the sickling test was positive. The alkaline electrophoresis showed a single thick band at the position of S with slightly raised fetal hemoglobin. The father of the child showed almost normal red cell indices and healthy-built of the body. His sickling test was negative, but on alkaline (pH 8.6) electrophoresis there was a thick band like homozygous sickle cell at the position of S. Hence, he was recorded as a carrier of hemoglobin D. The mother showed all the red cell indices reduced and the sickling test positive. After electrophoresis, she was found a carrier of sickle cell disease. Further, hemoglobin variant analysis showed that the child had sickle cell-D disease (see table 6).

Table 6. Summary of hematological and clinical findings of an Agharia family from Sundargarh district of Western Orissa, India

Parameters	Father	Mother	Offspring (Son)
Age (in years)	25	22	4
Sex	M	F	M
Hb (g/dl)	12.2	11.2	5.6
RBC (10^6/μl)	4.6	3.4	3.6
HCT (%)	32.0	21.2	18.3
MCV (fl)	69.1	61.9	56.9
MCH (pg)	29.6	26.0	21.2
MCHC (g/dl)	27.5	23.3	19.3
WBC (10^3/μl)	6.4	7.6	4.4
Sickling Test	-ve	+ve	+ve
Hb. Electrophoresis (Alkaline, pH 8.6)	A+D+A_2	A+S+A_2	(D+S)+F+A_2
Hb. A_2 (%)	2.2	2.8	1.7
Hb. F (%)	0.6	1.8	7.3
Hb. D (%)	27.5	0.0	0.0
Hb. S (%)	0.0	30.6	91.0
Hb. AA (%)	69.7	64.8	0.0
Diagnosis	Hemoglobin D Trait	Sickle Cell Trait	Sickle Cell Disease

DISCUSSION

The sickle cell disease is most commonly encountered hematological abnormality in India. It is well documented that the gene for sickle cell hemoglobin is located on the short arm of chromosome 11 and has an autosomal recessive inheritance (8, 13, 16). The sickle cell disease manifests in two forms, viz. heterozygous (carrier, trait or single dose) and homozygous (sickle cell disease or anemia, double dose or sufferer). When two carriers of sickle cell marry, the chance of having a homozygous sickle cell disease offspring is 25% in every pregnancy. To the best of our knowledge, no study reported the typical mode of inheritance, clinical manifestations and hematological profile of various prevalent sickle cell disorders in the affected families in India. This study presents for the first time six typical families with sickle cell disease from the state of Orissa in Central-East Coast of India.

The clinical, genetic and molecular aspects of sickle cell disease patients sharing identical genotypes exhibit considerable heterogeneity in clinical symptomatology and prognosis (4). Some of the common symptoms seen in patients suffering from sickle cell disease are listed as follows: anemia, intermittent jaundice, severe joint pains, recurrent fever and infections. Most prominent diagnostic features in our patients include the occurrence of splenomegaly and hepatomegaly with abdominal and chest pains. In girls, if they survive up to adolescence, the menarche is delayed depending upon the nutritional status and other psychosocial conditions (1, 17, 18). The symptoms usually appear as early as six months of age to five years and increase the severity of illness with advancing age (1). Careful recording of history, presence of the above mentioned symptoms and vulnerable caste/tribe constitute basis for diagnosis of sickle cell anemia in Orissa. Most of the patients remain asymptomatic and do not require frequent blood transfusions. In some cases even with retarded growth, the body functions probably get adjusted at low levels of hemoglobin. The available treatment strategies can broadly be divided into five categories: anti-sickling agents, vaso-active drugs, enhancing fetal hemoglobin production, stem cell or bone marrow transplantation and gene therapy.

Diagnosis of sickle cell carriers and sufferers is possible by careful clinical examination of the patient supported by laboratory investigations. The study of peripheral blood smear for the red cell morphology showed anisocytosis, poikilocytosis, hypochromia, and occasional target cells. The low indices of MCV, HCT, MCH and MCHC were observed in cases of sickle cell disease. Raised fetal hemoglobin is a characteristic feature of Indian sickle cell disease patients, which probably ameliorates the severity of the disease. The clinical and hematological manifestations of sickle cell disease (SCD) patients vary according to the haplotypes associated with sickle cell mutation in the different ethnic groups and geographical location. Within the same region also, the different food habits and family characteristics of the patient may influence the clinical course of the illness (1, 4). The Asian/Indian haplotype is associated with the higher fetal hemoglobin (HbF) levels and the milder course than the African haplotypes (1, 19).

Molecular diagnosis of Hb D, HbE or Hb S gene is required in the first trimester of the antenatal period of pregnancy along with characterization of β-thalassemia mutations in the region. The establishment of the prenatal diagnostic facilities and services: genetic/marriage counseling, are the ultimate aims to be achieved in the state of Orissa.

In developing countries like India, simple, rapid and inexpensive yet reliable at alkaline pH laboratory tests are necessary, particularly, when screening has to be carried out on large populations located in remote and inaccessible geographical areas (18, 20). Such techniques have been developed that are suitable for field as well as laboratory work and require minimum amount of blood (only a few drops). The results are available within an hour and the test is very cost effective. The tests include: solubility test or sickling test, hemolysate electrophoresis at alkaline pH using cellulose acetate membrane or starch-agarose gel (18).

The present study highlights the co-inheritance of β-thalassemia/HbD/HbE and sickle cell hemoglobin gene, which is wide spread in Southern and Western Orissa. It is a pity that a large number of such double heterozygosity cases remain mostly undiagnosed or misdiagnosed, wrongly interpreted and mismanaged leading to premature death without proper treatment in the state of Orissa. For bringing awareness, motivation for carrier detection to reduce the genetic burden, and intervention in affected families and communities need to be launched vigorously in Orissa.

INTERVENTION AND PREVENTION

In sharp contrast to other developed countries of the world, countless Indians are not even aware of the sickle cell disorder. There are several ways to minimize the suffering. A regular intake of folic acid tablets reduces the trauma considerably and improves the life span. Patients complying with the medication are less likely to experience sickle cell crisis or infection. The prevalence of malnutrition and non-compliance to medications increase their susceptibility to infection and crisis (4, 18). The study suggests that efforts of the health care providers in educating and motivating the patients to follow compliance and improved nutrition would further reduce morbidity and mortality in the community.

The clinical manifestation and severity in sickle cell anemia are dependent not only on the haplotype in that region but also influenced by the patient characteristics. There are several interesting features such as absence of severe anemia, male preponderance, persistence of palpable spleen, etc. and avoidable conditions such as presentation at critical condition or at old age, presence of protein energy malnutrition (PEM), and an alarming incidence of non-compliance of medication (17). Each of these features needs to be taken care of. The main predictor of crisis or infection is the presence of PEM and non-compliance of medication.

It is also difficult to convince the upper castes that sickle cell disease is confined to specific castes only. The general concept held by majority of the people is that sickle cell disease is confined to scheduled tribes and lower castes only. Rather, the sickle cell gene is widely prevalent throughout India irrespective of caste, creed, and religion, and has penetrated even in different upper-castes and communities. What is needed is an area-specific and exclusive control program in the affected regions (7, 18). It is also necessary to inform and involve medical practitioners who have failed to adequately guide patients. Every primary health centre (PHC) should have diagnostic facilities and a genetic laboratory should be accessible free of cost to the poor and underprivileged people (6). Immunization of the affected children is a must.

It is difficult to convince people because of ignorance about the consequences of the disease. To stop spread of the malady further in rural and tribal areas, genetic counseling should be provided to avoid the marriage between the two carriers or sufferers (6, 13). Even if they marry and conceive, the birth of the affected offspring must be avoided by using prenatal diagnostic techniques (termination of such pregnancies is approved by the Government of India).

Unfortunately neither the diagnostic nor the above mentioned treatment facilities are available in the rural and tribal remote areas (18). Most of the facilities are beyond the reach of a common man. Although the tribal and rural health problem is grave, the Health Department is unable to provide them with any health care for several reasons. Teachers and medical students who have sufficient knowledge about the subject are mostly unwilling to work in tribal/backward areas. Ultimately, the patients approach traditional healers in whom they have complete faith and confidence (7). Since there is no specific treatment except the palliative available for the disease, the only alternative is prevention. Therefore, we can undertake such preventive measures like health education and genetic counseling. Studies carried out in Cyprus, Greece and the UK for similar types of disease (Thalassemia) using such preventive strategies have shown promising results.

Tests for prenatal diagnosis such as amniocentesis, cord blood or chorionic villi sampling, fetal biopsy, non-invasive technology, etc. already exist to check a fetus for sickle cell during pregnancy. But some couples have strong personal objections to abortion when a pregnancy is already established. Pre-implantation genetic diagnosis (PGD) could provide couples with another way to avoid passing on sickle cell disease. A couple who is carrier of sickle cell disease has twin babies who are completely free of the sickle cell gene with the application of a technique called pre-implantation genetic diagnosis (PGD), in which fertilized embryos are tested for the disorder before implantation in the woman's uterus (21). Further refinement in this technology will become a powerful diagnostic tool in the assistive reproductive technology (ART) in the near future.

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SECTION FOUR: PARASITES

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Chapter 25

PREVALENCE AND TREATMENT OF BANCROFTIAN FILARIASIS IN A RURAL POPULATION

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ABSTRACT

Lymphatic filariasis caused by nematode parasites affects 119 million people in tropical and subtropical countries. There is no safe and effective drug available to combat the adult worms and eliminate filarisis. We have already reported antifilarial effect of two homeopathic drugs, Cina and Filarinum against fillariasis in two endemic villages of Bankura, West Bengal. In the present study, we have made an epidemiological survey of lymphatic filariasis in these villages. We have also extended our study by treatement of filarial patients with two homeopathic drugs, Filarinum and Acacia and followed CONCERT. We prepared Filarinum 200, Filarinum 1M and Acacia 30 in the laboratory. A sample population of 452 was surveyed in two villages. Of these, 12.83% suffered from microfilaraemia and 26.99% from filarial disease.

All three potentized drugs were found to be highly effective against bancroftian filariasis while both Filariumn 200 and Filariamn 1M reduced microfilaraemia by 28% to 100% and 20% to 100%, respectively. Acacia 30 reduced microfilaraemia by 15% to 82%. Potentized Filariaman also showed a marked reduction in morbidity. Further we observed Filarial Dance Sign (FDS) in microfilaraemic and diseased patients before treatment. The FDS was minimized with few dead nests in the same patients after treatment. All three drugs did not show any side reactions. Rather, the drugs reduced SGPT level in the patients.

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INTRODUCTION

Approximately 1.3 billion people are at risk of lymphatic filariasis and 120 million are affected in 83 countries (1). Lymphatic filariasis is a major health problem in the endemic areas of India with 40% of global burden (2). This disease, mainly caused by a nematode parasite Wuchereria bancrofti and transmitted through the vector mosquito culex quinquefasciatus, occurs in individuals of all ages and sexes. The parasite always multiples within the definitive host body i.e., man and hence appropriate control measure lies in the treatment of filariasis patients. Filarial disease manifestation involves adenolymphangitis, lymphoedema and elephantiasis. Economic loss in India caused by lymphatic filariasis is nearly $1.5 billion every year (3). DEC and Ivermectin have shown antifilarial effect. A bacterial endosymbiont i.e., Wolbachia in filarial worms is also targeted with an antibiotic doxycycline to reduce filarial infection (4, 5) but the results so far obtained with such drugs are far from the goal (6, 7). Still there is no antifilarial drug acting safely and in an effective manner to kill the adult worms causing filariasis. Sukul et al. (8, 9) found antifilarial effect of a potentized homeopathic drug, Cina against canine dirofilariasis. Rudra et al. (10) observed antifilarial effect of Cina and Filariamm in human filariasis in a comparative manner. The objective of the present study is to see the efficacy of different potencies of Filariamn and Acacia against micrifilaracmic and oedematous patients. The study has been conducted in two villages of Bankura district, West Bengal.

OUR STUDY

Filarinum: Blood was taken by finger prick from a known microfilaraemic patient with microfilarial density 2500/ml, and a thick smear was prepared on a slide. The smear was allowed to dry at room temperature, and then scrapped and mixed with an equal amount of lactose powder. The mixture was triturated in a mortar and pestle for 10 minutes. A sample of 5 mg from this mixture was dissolved in 5 ml 90% ethanol and designated as Filarinum mother tincture from which Filarinum 200 C and Filarinum 1M were prepared by successive dilutions and successions (10). Each potency was soaked in sucrose globules and kept in vials for treatment. Before starting treatment of the patients, both Filarinum 200 and Filarinum 1M were administered orally one dose daily for 30 days on a batch of 10 rats. The authors also consumed the drugs once daily for 30 days. No adverse effect was observed. While 29 microfilaraemic patients were treated with Filarinum 200, 17 patients were given Filarinum 1M. Duration of treatment was 120 days, and blood sampling was done on days 60, 90 and 120 from the onset of treatment.

Acacia: Air dried funicles of Acacia auriculiformis were powered and extracted with 90% ethanol at room temperature. The ethanolic extract was allowed to evaporate under reduced pressure and the residue was finally dried over anhydrous calcium chloride (11). The dried residue after being dissolved in 90% ethanol at 0.5 mg/ml is designated as Acacia mother tincture. This mother tincture was potentized by successive dilutions and successions following the standard procedure, and Acacia 30 was prepared (10). This drug was given to 5 microfilaraemic patients. Duration was 120 days and sampling was done on day 30 and 120 from the day of starting treatment.

Identification of microfilaraemic and diseased persons and their treatment

Blood samples were collected between 2000 to 2300 hours by finger prick (12) with consent from all the individuals. The number of surveyed population was 452 in two villages namely Radhakrishnapur and Pitraboni under Gangajal Ghanti Block of Bankura district, West Bengal. The study period was from March, 2009 to March, 2010. Thick smear of blood was prepared on slides immediately after finger prick. Dry smear was dehaemoglobinized in distilled water and stained with Giemsa, and observed under microscope. Microfilaraemic persons were identified from the positive slides. The patients willing to take our medicine were advised to take one dose (1 globule no.40) of a homeopathic potency daily in morning on empty stomach. Mf densities of the treated patients were monitored on day 30 day 60, day 90 and day 120 according to the type of drug used and availability of the patients in the surveyed place. Identification of microfilaraemic persons and the allocation of their treatment are presented in a flow diagram (Figure 7) following consolidated standard of reporting trials (CONSORT).

Each individual was clinically examined to see the symptoms of filariasis and asked about subjective symptoms. Physical examination of males included the legs, arms, genitals and the lymph glands in the groin and axillae. Examination of the females was restricted to the legs and arms. To measure the oedema a measuring tape was used to take the girth of both affected and normal legs at four fixed points i.e., 10 cm from the great toe and 12 cm, 20 cm and 30 cm from the heel following the Manual for Clinicians published from Vector Control Research Centre (Indian council of Medical Resurch) of Pondichery (13, 14). The patients were asked to take Filarinum 200 or Filarinum 1M one dose daily in the morning on empty stomach for 6 months. All the patients under study did not take any other medicines during the period of treatment and observation. Flow diagram of drug trials against lympoedema patients is presented in in Figure 8.

Leukocyte count and SGPT were done in four patients (two microfilaraemic, two oedematos in legs) before and after treatment. Ultrasonography of the scrotal region was performed by Logic Alfa USG Machine with a frequency of 10 Mhz in four patients in order to observe the Filarial Dance Sign (FDS). Ultrasonography was done by the Sonologist, Dr.Somnath Chatterjee. The names and address of all the patients under survey were recorded. The survey was conducted by Dr. Swapan Kumar Rudra accompanied by registered medical practitioners, Dr CR Chakraborty, MBBS and Dr B Pakhira, BHMS. The local village heads and other influential personalities were also present on several occasion.

FINDINGS

The age and sex prevalence of microfilaraemia and clinical filariasis in two villages of Bankura surveyed is presented in table 1. Among the males 15.27% showed microfilaraemia and 21.37% disease symptoms. The highest incidence of microfilaraemia occurred in the age group 15-25 and clinical filariasis in the age group 26-40. Among the females 9.47% showed microfilaraemia and 34.73% with disease symptoms.

Table 1. The prevalences of microfilaraemia and of clinical filariasis in two vilages of Bankura district, W.B., India

Males				Females			All Subjects		
Age (years)	No. examined	% microfilaraemic	% with clinical disease	No examined	% microfilaraemic	% with clinical disease	No examined	% microfilaraemic	% with clinical disease
≤14	58	10.34	0	41	12.19	2.43	99	11.11	1.01
15-25	54	22.22	16.66	31	9.69	9.67	85	17.64	14.11
26-40	78	16.66	32.05	60	8.33	43.33	138	13.04	36.95
41-55	41	17.07	31.7	36	5.55	66.66	77	11.68	48.05
56-70	28	7.14	28.57	20	15	55	48	10.41	39.58
71-80	3	0	33.33	2	0	50	5	0	40
Total/*Avg.	**262**	***15.27**	***21.37**	**190**	***9.47**	***34.73**	**452**	***9.47**	***26.99**

Table 2. Filarial disease manifestations observed in the surveyed population of two villages of Bankura district, West Bengal, India

	Males									Females						
	ADL No (%)	HYD No (%)	Lymphoedema No(%)							ADL No(%)	Lymphoedema No(%)					
Age			Scrotal Lym	Lym In arms	Lymphoedema in legs						Lym In arms	Lymphoedema in legs				
					Gr.I	Gr.II	Gr. III	Gr.IV	Total			Gr.I	Gr.II	Gr. III	Gr.IV	Total
≤14	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(2.43)	0(0)	0(0)	0(0)	1(2.43)
15-25	2(3.70)	5(9.25)	1(1.85)	0(0)	1(1.85)	0(0)	0(0)	0(0)	1(1.85)	0(0)	1(3.22)	2(6.45)	0(0)	0(0)	0(0)	2(6.45)
26-40	1(1.28)	6(7.69)	7(8.97)	0(0)	3(3.85)	4(5.12)	3(3.84)	1(1.28)	11(14.10)	3(5.0)	2(3.33)	9(15.0)	9(15.0)	3(5.0)	0(0)	21(35.0)
41-55	2(4.87)	1(2.43)	4(9.75)	1(2.43)	0(0)	4(9.75)	1(2.43)	0(0)	5(12.19)	0(0)	0(0)	8(22.22)	11(30.55)	4(11.11)	1(2.77)	24(66.66)
56-70	1(3.57)	0(0)	3(10.71)	0(0)	2(7.14)	0(0)	2(7.14)	0(0)	4(14.28)	1(5.0)	0(0)	0(0)	4(20.0)	6(30.0)	0(0)	10(50.0)
71-80	0(0)	0(0)	0(0)	0(0)	0(0)	1(33.33)	0(0)	0(0)	1(33.33)	0(0)	0(0)	0(0)	0(0)	1(50.0)	0(0)	1(50.0)
Total (Avg)	6(2.29)	12(4.58)	15(5.72)	1(0.38)	6(2.29)	9(3.43)	6(2.29)	1(0.38)	22(8.39)	4(2.10)	3(1.57)	20(10.52)	24(12.63)	14(7.36)	1(0.52)	59(31.05)
ADL=	Adenolymphangitis															
Lym=	Lymphoedema															
HYD=	Hydrocele															
Gr=	Grade															
Gr.I=	Oedema completely reversible															
Gr.II=	Oedema partially reversible															
Gr.III=	Oedema irreversible with thickened skin															
Gr.IV=	Oedema with nodules															

The highest incidence of microfilaraemia occurred in the age group 56-70 followed by the age group of 14. Mf rate in females was lower during their reproductive period i.e., from 15-45 years. The age group 41-55 was most affected with filariasis.

Clinical filariasis observed among the population surveyed is given in Table 2 showing age prevalence and percent of disease symptoms in both sexes. Adenolymphangitis without oedema was found only in a few cases of males and females. Hydrocele and scrotal lymphoedema were observed in 4.19% and 6.10%, respectively and together formed half of the total disease manifestation in males. Hydrocele occurred highest in the age group of 15-25 years. Hydrocele gradually turns to scrotal lymphoedema due to prolonged presence of filarial worms in inguinal nodes. Here the hydrocele cases decreased with age which was found reversed of scrotal lymphoedema. Oedema in arms is detected in one male aged 47 and in three females aged 21-28. Arm involvement in filariasis is less due to preferential fiting sites of the vector mosquitoes having the legs (14). Percentage of lymphoedema is almost double in females than that in males. Among the patients, grade (Gr) II oedema was the highest in number. This Gr II occurred in the age group of 26-40 in males and 41-55 in females. The Gr I leg oedema was found 2.29% in males and 10.52% in females. Gr IV oedema was seen in one male and 2 females in this study area (see table 2).

Figure 1 shows the effect of treatment with potentized drugs in microfilaraemic patients, and Figure 2 the effect of treatment with Acacia 30. The reduction of mf density after treatment with Filarinum 200 on day 60, day 90 and day 120 is shown in Figure 3.

Reduction was found to the highest (95-100%) on day 120 as observed in 12 patients. There was an increase in mf density of 50-67% in 2 persons on day 60. The effect of treatment with Filarinum IM on mf patients is shown in Figure 4. An increase in mf density was noticed in two persons on day 60. Figure 5 shows the reduction of mf density following treatment with Acacia 30. One person showed an increase of mf density on day 30.

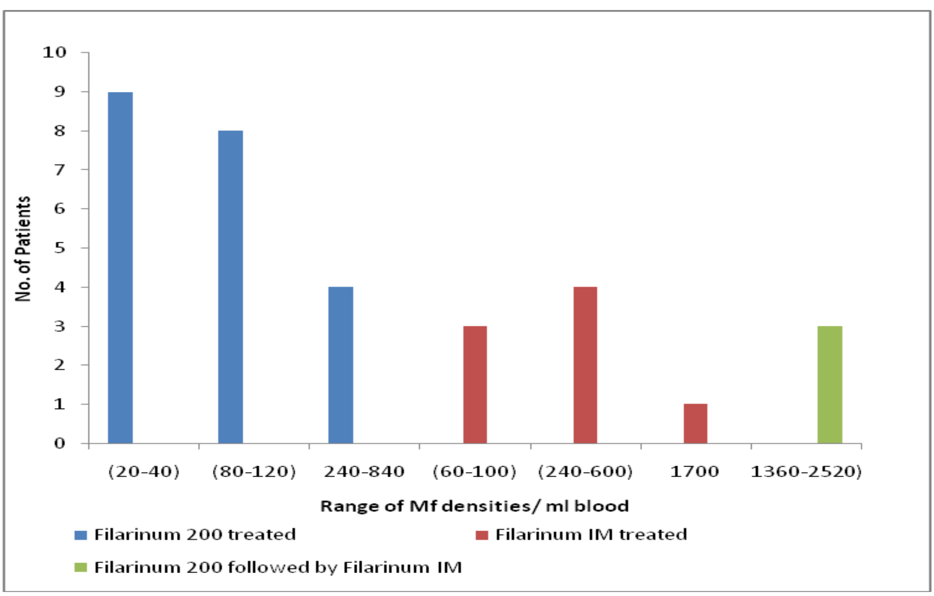

Figure 1. Mf density /ml. blood in 3 groups for treatment with Fliarinum 200, Filarinum 1M, Filarinum 200 followed by Filarinum 1M.

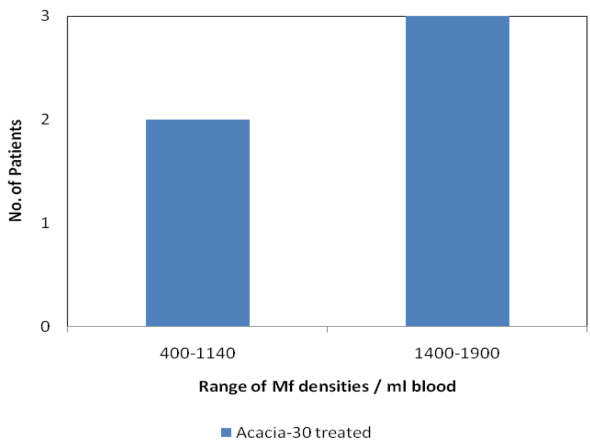

Figure 2. Mf density /ml. blood for Acacia 30 treatment.

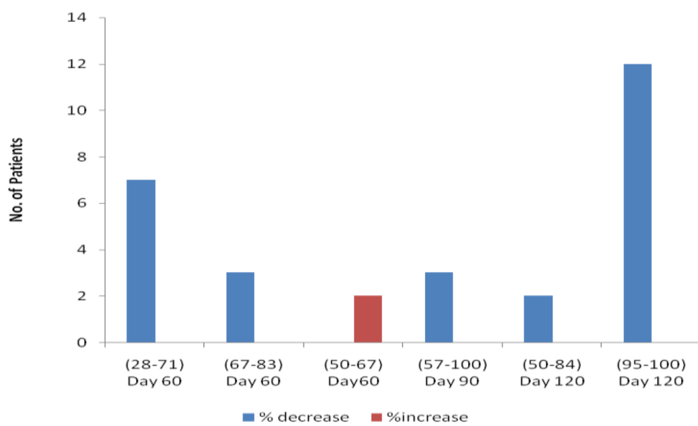

Figure 3. Range of percent decrease and increase in Mf density on day 60, day 90 and day 120 after treatment with Filarinum 200.

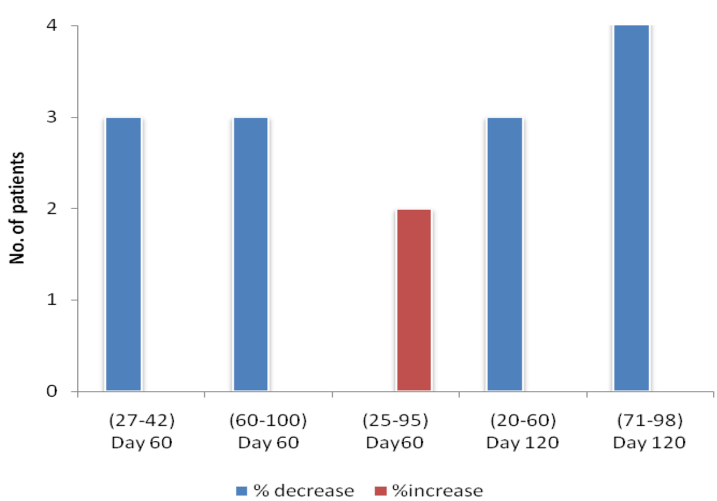

Figure 4. Range of percent decrease and increase in Mf density on day 60 and day 120 after treatment with Filarinum IM.

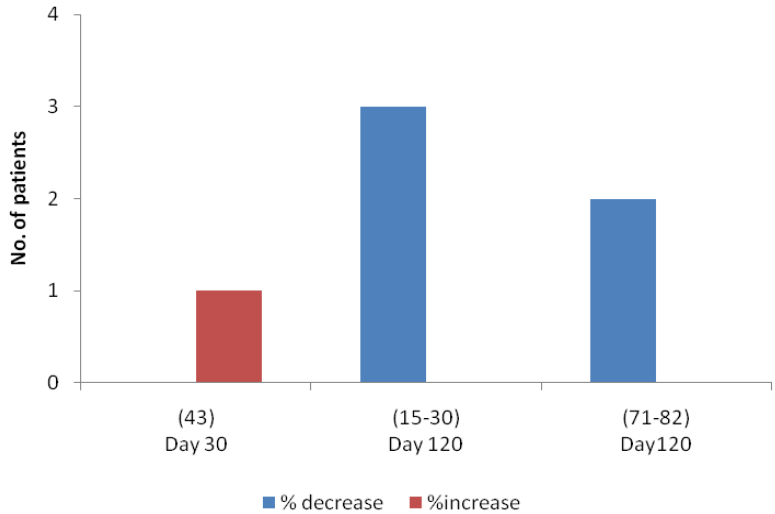

Figure 5. Range of percent increase and decrease in Mf density on day 30 and day 120 after treatment with Acacia 30.

Figure 6 shows the percentage of reduction in different grades of lymphoedema in legs following treatment with Filarinum 200, Filarinum IM and Filarinum 200 followed by Filarinum IM. The reduction of lymphoedema was 46-77% in Gr II, 36-59% in Gr III and 15% in Gr IV following treatment with Filarinum 200 for 180 days. Filarinum IM (15 days with drug and 15 days with placebo in each month) reduced lymphoedema by 30-50% in Gr II and 3-13% in Gr III. Treatment with Filarinum 200 for 60 days followed by Filarinum IM for 120 days resulted in reduction of lymphoedema by 48-78% in Gr II and 30-42% in Gr III.

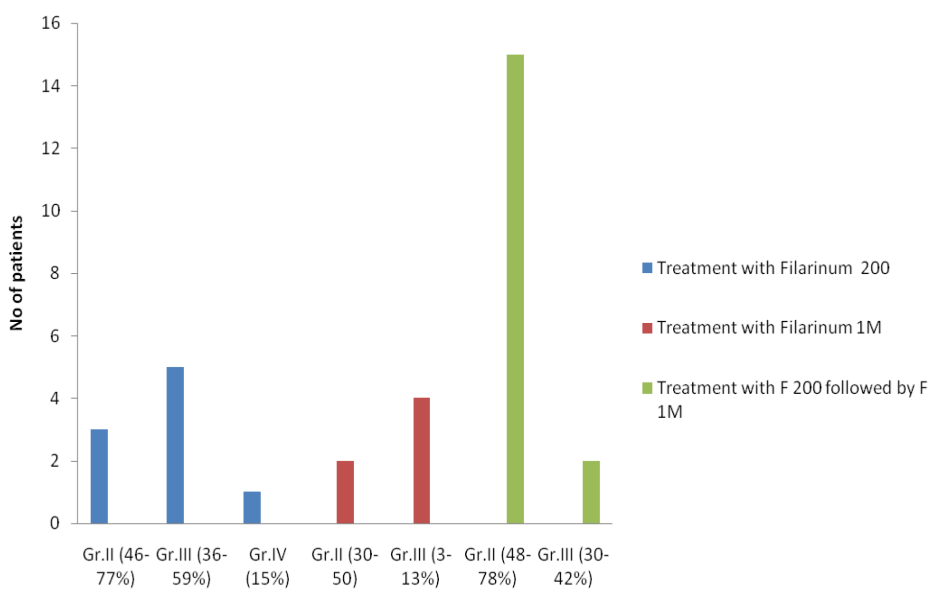

Figure 6. Range of percent decrease of lymphoedema in legs treated with different potencies of Filarinum.

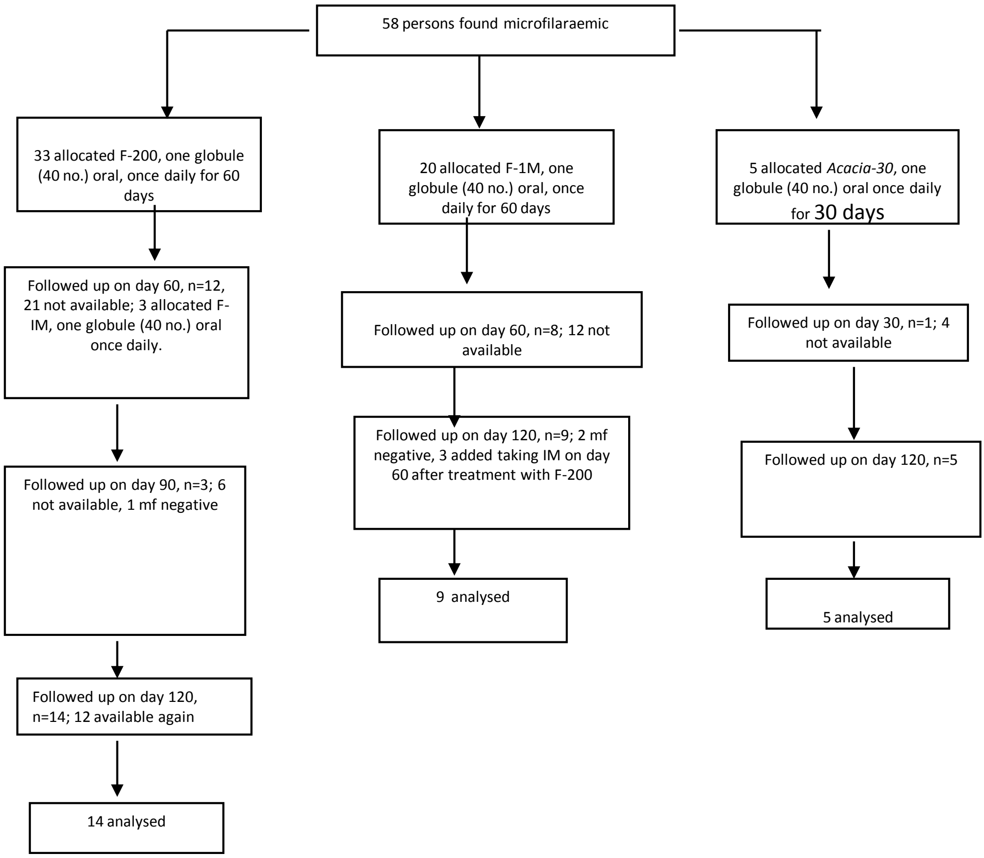

Figure 7. Flow diagram showing detection of microfilaraemia and treatment with drugs among 452 persons surveyed.

There was a reduction of eosinophil count and SGPT following treatment with Filarinum 200 and Filarinum 1M (see table 3). Of the four patients subjected to USG, two showed no FDS and another two with less number of adult worm nests.

Table 3. Eosinophil count and SGPT of patients before and after treatment with Filarinum 200 and Filarinum1M

Patient No	Eosinophil		SGPT	
	Before	After	Before	After
1.(Mf)	8	3	53	29
2.(Mf)	4	1	55	49
3.(Diseased)	6	2	48	38
4.(Diseased)	10	7	36	26

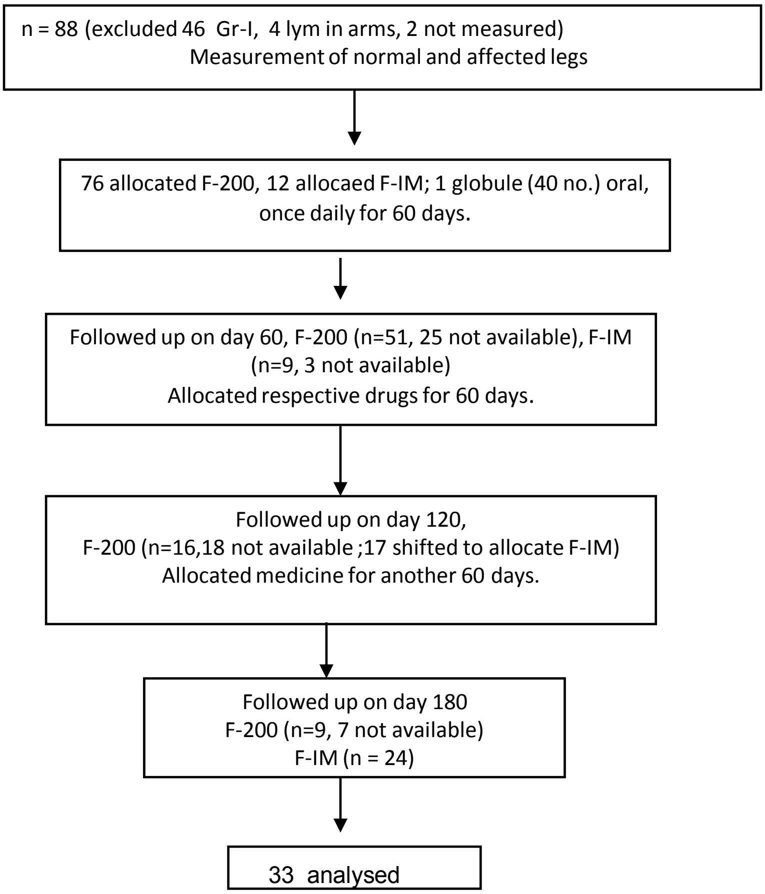

Figure 8. Flow diagram of a trial of F-200, F-IM and both against lymphoedema (in Legs).

DISCUSSION

Rudra and Chandra (16) reported prevalence of microfilaraemia and filariasis in eight villages of Bankura district. In the present study area covered two new villages, the persons suffering from micrifilaraemia and filariasis are higher in number than those observed in earlier study. Brabin (17) reported earlier that prevalence of infection became consistently lower in females during their reproductive age due to sex hormones. The adenolymphangitis or acute filarial lymphangitis may be explained as just at the end of non-inflammatory phase of lymphatic dialation due to the death of adult worms whether or not as a result of DEC treatment (18). Hydrocele gradually turns to scrotal lymphoedema due to prolonged presence of filarial worms in inguinal nodes.

Since the potentiged drugs have produced very high reduction in microfilaraemia, there is a possibility that the adult worms were severely affected or even killed due to the effect of the treatment. Earlier we observed very significant reduction in micrifilaraemia and filariasis with Filarinun 200. Here we see that the higher potency i.e Filarinum 1M is equally effective in this respect. The effect of Acacia 30 is slightly less than that of potentized Filariunm, though Acacia showed strong antifilrial effect on canine dirofilariasis (11, 19).

Potentized drugs used are not expected to contain any original drug molecules. For this they do not produce any direct effect either on adults or on larvae. The filarial worms are known to cause immunosuppression (20). It is possible that the potentized drugs might have removed immunosuppression leading to vigorous immune reaction of the host to filatrial antigens. This has resulted in reduction of mf in the blood. Acute inflammatory episodes, known as ADLA (Acute Dermato Lymphangio Adenitis) are induced by bacteria. ADLA serves as a trigger for further clinical manifestation and of filarial morbidity like lymphoedema (7). Potentized filarinum might have stimulated immune reaction against filarial and associated antigens and thereby reducing lymphoedema.

The rise in mf count in some cases after treatment indicates that the drugs have induced a very high physiological stress on the adult worms which increased the rate of discharge of mf in blood. That the drugs used are totally safe is evidenced by reduction of eosinophilia and SGPT levels in treated patients. The number of adult worm nests observed in USG before treatment has became reduced after the treatment. This result further confirms death of adult worms after treatment.

Since the potentized drugs are relatively inexpensive and safe, they can be used globally for the control of bancroftian filariasis.

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We gratefully acknowledge the contribution of Dr CR Chakraborty, MBBS (Ex-CMOH, Bankura) and Dr B Pakhira, BHMS for their enthusiastic presence in the field survey and Dr S Chatterjee, Sonologist for doing USG of the patients. We would also like to thank the NGO co-ordinators Sri A Sengupta, Sri U Dana (Support Health & Human), Sri P Dey (Health Centripetal) and other members for their dynamic cooperation. We are thankful to the village people who made the survey successful with their active participation and cooperation.

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SECTION FIVE: NUTRITION

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Chapter 26

GENUS CASSIA AND ANTIDIABETIC POTENTIAL

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Diabetes mellitus is characterized by hyperglycemia, altered metabolism of lipids, carbohydrates and proteins. Type-2 diabetes constitutes 90% of the total diabetics in most countries with nearly 80% of the burden in developing countries. Insulin and other oral hypoglycemic drugs are most widely used for the diabetes, but they also have various side effects. Many medicinal plants have been found to be successfully used to manage diabetes. Plants belonging to genus Cassia are used extensively in various parts of the world against a wide range of ailments. Scientific studiers done on various species of Cassia, demonstrates their potential in the treatment of diabetes mellitus. This review summarizes the potential of Cassia species plants reported to possess antidiabetic activity.

INTRODUCTION

Diabetes mellitus is a metabolic disorder; it consists of a group of disease characterized by hyperglycemia, altered metabolism of lipids, carbohydrates and proteins (1). The pathophysiology of the diabetic mellitus involves decrease in the circulating concentration of insulin (insulin deficiency) and a decrease in the response of peripheral tissues to insulin (insulin resistance). These abnormalities lead to alterations in the metabolism of carbohydrates, lipids, ketones, and amino acids; the central feature of the syndrome is hyperglycemia (2).

It is estimated that there has been an explosive increase in the diabetes in the last two to three decades. Diabetes has become a major health concern worldwide with over 190 million suffering from disease, now with a potential to have 324 million by 2025. Type-2 constitutes

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90% of the total diabetics in most countries with nearly 80% of the burden in developing countries. The World Health Organization has predicted that the major burden will occur in the developing countries. There will be a 42% increase from 51 to 72 million in the developed countries and 170% increase from 84 to 228 million, in the developing countries (3).

Particularly in India, there are currently 50 million people with diabetes, which are projected to increase by 90 million in the 2030. The fear of diabetic epidemic looms with statements in the press that read, as "Every fifth Indian and every fifth diabetic will be an Indian". The fact confirmed by reports from the World Health Organization (WHO) shows that India has the largest number of diabetic subjects in the world (4).

Insulin and other oral hypoglycemic drugs are most widely used for the diabetes but they also have various side effects like hypoglycemia, weight gain (sulphonyl urea), lactic acidosis with bigunoids and of these drug cause liver and renal damage. In spite of the introduction of new hypoglycemic agents, diabetes and the related complications continue to be a major medical problem. However, allopathic treatment for diabetes helps to control the disease to an extent but regular medication and constant medical supervision always leads to non patient compliance (4). This has been the rationale for the development of new antidiabetic drugs, includes drugs from herbal plants. Many indigenous Indian medicinal plants have been found to be successfully used to manage diabetes (5-7).

This review summarizes the features of cassia species plants reported to possess antidiabetic activity. Plants belonging to Cassia species are used extensively in various parts of the world against a wide range of ailments, the synergistic action of its metabolite being probably responsible for the plants beneficial effects. Cassia invites attention of researchers worldwide for its pharmacological activities ranging from antidiabetic to other various diseases. Cassia is a large genus of around 500 species of flowering plants in the family Fabaceae and is widely distributed throughout Asia including India, Mauritius, China, East Africa, South Africa, America, Mexico, West Indies and Brazil (8).

CASSIA AURICULATA LINN

C auriculata, commonly known as 'Tanner's Cassia'. It grows abundantly all over India (9). It is reported to possess antidiabetic, hypoglycemic and antihyperglycemic (10-12), anticancer (13), antibacterial (14), hypolipidemic (15), antioxidant (16), hepatoprotective (17), antispasmodic (18) and antipyretic (19) activities.

Flowers of C auriculata contain ß-sitosterol, kaempferol and proanthocyanidin dimer. Leaves of the plant are reported to contain keto alcohols, ß-sitosterol, kaempferol and emodin. Pod husk contains ß-sitosterol, chrysophanol, emodin, rubiadin and nonacosan-6-one (20).

Dinex, a poly herbal formulation prepared from the mixture of the aqueous extracts of C auriculata in combination with Eugenie jabalona, Gymnema sylvesre, Momordica charantia, Azadirachia indica, Aegle marmelos, Withania somnifera and curcuma longa. It showed significant ($p<0.05$) hypoglycaemic activity in both normal and diabetic animal (21).

Diasulin a, poly herbal drug prepared from C auriculata, Coccinia indica, Curcuma longa, Emblica officinalis, Gymnema sylvestre, Momordica charantia, Scoparia dulcis, Syzigium cumini, Tinospora cardifolia and Trigonella foenum showed significant ($p<0.05$) effect in lowering blood glucose and increasing plasma insulin level in alloxan diabetic rats and decrease in the content of cholesterol, triglycerides, free fatty acids and phospholipids at dose 200 mg/kg b.wt p.o.for 30 days when compared with diabetic control rats with normal rats (22).

Administration of aqueous extract of C auriculata flowers at 0.15, 0.30 and 0.45 g/kg b. wt p.o. for 30 days, suppressed the elevated blood glucose and lipid levels in diabetic rats. The antihyperlipidaemic and antidiabetic activity of aqueous extract of C auriculata flowers at doses of 0.45 g/kg was at par with glibenclamide (23).

An exploratory study showed that chronic administration of the ethanol: water (1:1) leaf extract of C. auriculata in alloxan induced diabetic rats; significantly ($P<0.01$) reduced the serum glucose level. The extract was found to inhibit the body weight reduction induced by alloxan administration.24 Aqueous extract of leaves, stems, flowers and roots of Cassia auriculata demonstrated antidiabetic activity at 250 mg/ kg b. wt p.o. in alloxon induced diabetic rat (10).

A study reported that ethanol and methanol extract of C. auriculata leaves and flowers significantly ($p<0.001$) controlled the increase in blood glucose levels in alloxan induced diabetic rats. The antihyperglycemic effect was attributed to the stimulation of the insulin secretion from the ß cells or regeneratation of the same (25).

Hydromethanolic, n-buthanol and ethyl acetate fractions of C. auriculata flowers showed significant ($p<0.001$) reduction in blood glucose level in Alloxon treated rats. However, n-buthanol fraction was highly effective and results are comparable with reference drug phenformin. Alloxon treated rats showed substantial weight loss as compare to treated group rats (26).

In yet another study, aqueous extract of C. auriculata significantly suppressed the elevated glucose and lipid levels at doses of 150, 300,500 mg/kg b.wt p.o. for 30 days in diabetic rats and also demonstrated anti-nociceptive activity in mice and 500mg/kg was found comparable to the standard reference drugs (27).

CASSIA TORA LINN

C tora is popularly known as sickle senna, sickle pod, coffee pod or foetid cassia. The seeds of the plant are rich in chrysophanic acid and anthraquinone glucosides, glucoobtusifolin and glucoaurantioobtusifolin. Pods are reported to contain sennosides (20).

An investigational study reported that 10% of C tora in diet lowered plasma glucose level, and this effect was as acute as seen even at the first week of feeding. The butanolic fraction of the methanol extract decreased plasma glucose levels, and the decrease was shown at the 4th day of feeding (28). Emodin and obtusifolin isolated from an ethyl acetate soluble extract of the seeds of C tora exhibited a significant ($p<0.05$) in vitro inhibitory activity against advanced glycation end products (29).

The serum glucose level in the C tora seeds butanol fraction group shows a slower uprising in the glucose curve and the postprandial rise of glucose was significantly ($p<0.05$) reduced and delayed after loading maltose orally and decrease fasting serum glucose level in diabetic rats. C tora seeds butanol fraction does not influence the insulin secretion from the pancreas of the normal rats, but in the diabetic rats the insulin secretion was significantly ($p<0.05$) stimulated from the pancreas (30).

In a study 15 type II diabetic subjects were given C tora fiber supplement consisting of 2 g of soluble fiber extracted from C tora. 200 mg of a-tocopherol, 500 mg of ascorbic acid, and 300 mg of maltodextrin, C. tora supplements moderately (P<0.1) decreased the serum total cholesterol, serum triglycerides levels and low-density lipoprotein-cholesterol. But there were no effect on fasting blood glucose, hemoglobin, blood urea nitrogen, creatinine, and activities of serum aspartate aminotransferase and alanine aminotransferase (31).

CASSIA FISTULA LINN

C fistula is medicinal plant belonging to family Fabaceae. It is commonly known as 'Aragbadh'. In English it is called Indian laburnum. Leaves of the drug contain sennosides A and B. Bark and heartwood are reported to contain leucoanthocyanidin, fistucacidin, barbaloin and rhein. Stem-bark contains lupeol, ß-sitosterol and hexacosanol (20).

Administration of hexane extract of C fistula bark were evaluated in streptozotocin induced diabetic rats at the doses of 0.15, 0.30 and 0.45 g/kg b.wt for 30 days. The extract demonstrated significant antihyglycemic and antilipidemic effects, which were attributed to antioxidant and polyphenol content present in the extract (32).

CASSIA KLEINII W AND A

C kleinii is an herb which grows as a weed and commonly cultivated. It is commonly known as malam-todda-vadi (20).

In a study, leaf and root water suspension of C kleinii significantly (p<0.05) increased tolerance for glucose at a dose of 500 mg/kg b.wt.p.o. The hypoglycemic effect of alcoholic extract of the leaf of C kleinii was found to be effective at a dose 200 mg/kg b.wt.p.o in the fasted rats. As well as the alcoholic extract exhibited concentration dependent antihyperglycemic effect in glucose loaded rats. The alcoholic extract was found to be effective as insulin (5 U/kg) in lowering glucose level in alloxon induced diabetic rats (33).

In streptozotocin induced diabetic rats, the alcoholic extract of the C. kleinii leaf at dose 200 mg/kg b wt. p.o. showed significant antidiabetic property as evident from body weight, serum glucose, lipids, cholesterol and urea, and liver glycogen levels. The effect of alcoholic extract was found to be comparable with glibenclamide. The antihyperglycemic activity was found predominately in the chloroform fraction of the alcoholic extract at dose 25 mg/kg b.wt p.o (34).

CASSIA GLAUCA LAM

Bark and leaves are used in diabetic and gonorrhea in the folklore medicine (35).

Acetone extract of C glauca leaf extract caused significant (p<0.01) reduction in blood glucose level in fasted diabetic rats. Further fraction I of acetone extract showed maximum reduction in fasting blood sugar and significantly (p<0.01) improvement in the level of hepatic enzyme aspartate transaminase, alanine transaminase, creatine kinase and lactate dehydrogenase at a dose 100 mg/kg b.wt p.o. in diabetic rats 15 days after treatment (36).

Cassia alata Linn

The plant contains xanthone known as cassioolin and anthraquinones; including chrysophanol, emodin, rhein and emodin (20). The ethyl acetate extract of C. alata leaves was found to be hypoglycemic at doses 5mg/20g mice. It decreased the blood sugar level of mice by 58.3% (37).

CASSIA MARGINATA ROXB, C RENIGERA WALL EX BENTH AND C OBTUSIFOLIA LINN

Animals were fed with diets containing protein isolates of C marginata, C renigera and C obtusifolia seeds respectively for ten days. They were found to have a marked lowering effect on blood and liver cholesterol levels. Maximum lowering effect on total blood cholesterol level was observed to be 26.88% by C marginata seed proteins. The proteins of C renigera seed had lowering value of 22.5% while the proteins of C obtusifolia seed had a minimum lowering effect of 21.47% ($P<0.01$).

CONCLUSION

The genus Cassia definitely holds promise of providing potent drug for diabetes mellitus. Several species subjected to antidiabetic investigations; in animal models, have reported favorable results. C auriculata, single and in combination with other herbs, has shown potent antidiabetic and antihyperlipidaemic activities. Considering in account, the drug-resistance and cost-effectiveness, the genus Cassia can be exploited for clinical studies for justifying antidiabetic claims.

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Chapter 27

MEASURING FATNESS AMONG RURAL CHILDREN OF BENGALEE ETHNICITY: AN ALTERNATIVE WAY

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The prevalence of childhood obesity has been increasing during the last three decades. Obesity in children is a cause for concern and a new index Body Mass Abdominal Index (BMAI) has been derived by combining two separate indices – weight for height and waist circumference for height ratios. The aim was to measure the common indicators of abdominal adiposity – waist circumference (WC), waist-hip ratio (WHR), waist-height ratio (WHTR), conicity index (CI) and newly proposed body mass abdominal index (BMAI) and to study relationship with BMI. Our cross sectional study was undertaken at 20 ICDS centers in Bali Gram Panchayet, Arambag, Hooghly District of West Bengal, India. A total of 1,012 children (boys = 498; girls = 514; all Hindu by religion) aged 2-6 years were included in the present study. The measurements (in centimeters) were taken following Lohman et al. and mathematically, the BMAI was calculated by multiplying BMI with waist circumference. Pearson's correlation coefficients (r) of the adiposity measures with BMI were calculated. Results showed that no significant correlations were observed for all adiposity measures except BMAI. Moreover, the magnitude of correlations of BMAI were very high ($p < 0.001$) with BMI (boys: $r = 0.907$, girls: $r = 0.881$, sex-combined: $r = 0.894$). Our results provided clear evidence that the new index BMAI had a distinct advantage in that it relates much strongly with overall adiposity (BMI) than the other commonly used indicators of adiposity. Its use may be advantageous in studies dealing with the evaluation of nutritional status of rural preschool children.

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INTRODUCTION

Obesity is the most rapidly growing form of malnutrition in developed as well as developing countries experiencing an economic transition (1, 2). Obese children are those who are 20 percent above the normal weight for age and they are more prone to become overweight adults as the tendency of obesity in such children persists throughout the life (3). The risk of obesity is two or three times greater for an individual with a family history of obesity and increases further with severe obesity (3). The most significant long-term consequence of obesity is the tracking of obesity from childhood to adulthood and its contribution to adult obesity-related morbidity and mortality (4, 5). The prevalence of childhood obesity has been increasing during the last three decades (6). Obesity has emerged as an epidemic in developed and developing countries during the last quarter of the 20th century affecting high and middle income people (7). The epidemic of childhood obesity is a major public health problem in US, where in 2003-04, 26.2% of children aged 2-5years, 37.2% of children aged 6-11 years and 34.3% of adolescents 12-19 yrs were at risk for overweight (8). Furthermore, the risk of excess body mass and adiposity in young First Nation's children is particularly relevant given their potentially increased risk for type 2 diabetes (9, 10). The economic cost of obesity and associated co-morbidities is skyrocketing which is beyond the capacity of the best health care system in the world (11, 12). Childhood obesity has emerged only recently in India, unlike the West where it existed since long. Obesity in children as young as two years onwards have been reported from Indian populations (13). The study of Wang and Hoy (14, 15) was able to describe both overall and central fat patterning through BMI, waist circumference and multiple skinfold measures, in recognition that overall obesity without excessive central obesity can also be predictive of adverse health outcomes.

Furthermore, obesity in children is a cause for concern because it may predict adult obesity and increased risk of coronary heart disease in adult life (16). Obesity is the result of a caloric imbalance (too few calories expended for the amount of calories consumed) and is mediated by genetic, behavioral, and environmental factors (17).The adiposity in preschool children is measured by using weight for length, waist-to-height index and body mass index (BMI) (18). While BMI is the recommended method for population based screening of children for obesity it was a poor predictor of body fat for individual children (19). Currently increase in weight gain and obesity in preschool children are measured independently either by weight for length index (20), waist – to - hip ratio (21), or BMI for age (20). Another index, waist-to-height ratio relates to abdominal obesity, but recent investigations stated that this ratio should also be adjusted with optimal power of height (22). Cole (23) has already shown that weight for height should be adjusted for age (weight / heightp) by determining appropriate power of height (p). The optimal value of 'p' is 2, 3, and 2 preschool, at 11 years of age and puberty respectively. Therefore 'p' is variable throughout the infancy and childhood. There is another index, Conicity Index, which is a function of weight, height and waist circumference, but it has been shown in one of the studies that BMI is better than conicity index in predicting coronary artery disease (24). Therefore all these ratios have mathematical complexity, advantages and limitations.

To counter obesity in a population, it is important to know its incidence, trend and differentials. The nutritional status of an individual or of a population can be assessed with clinical, biochemical and anthropometric measurements. Of these anthropometry has the advantage because it is easy to perform and requires simple apparatus (25). Some agents have an affect on obesity, low physical activity, high TV watching and computer usage, high caloric diet and high income (26, 27).

A Canadian Community Health Survey, completed in 2004, reported that Aboriginal children had an obesity prevalence of 20%, which was two and one-half times national average for children (28). In a study, Ng and others (26) found that, there is a high prevalence of overweight and obesity among this sample of Aboriginal children living in northern Quebec. Of particular concern is the level of central adiposity, as demonstrated by high waist circumferences and truncal skinfold thicknesses that are associated with the development of metabolic and cardiovascular diseases. This risk profile is intensified by the accompanying low physical fitness and inadequate activity levels. Further research is necessary to investigate the extent of the impact of excess body mass and unfavorable body fat distribution on disease risk and health outcomes, in conjunction with its relationships with physical fitness and activity levels in Canadian First Nations children.

Only limited data are available from Indian subcontinent about the changes in the prevalence of obesity (29). Recent evidence indicates a disturbing trend of increasing adiposity in developed and developing countries including India (30-32). The earliest age of documentation of this trend appears to be in primary school children and preschoolers in developed countries (33, 34). It would be of interest to determine if a similar trend is observable at an earlier age and that too from a developing country like India, which is currently undergoing a nutritional transition (35).

A hypothetical index for better measuring adiposity – "Body Mass Abdominal Index" (BMAI) was proposed in a recent article (18). The new index has been derived from by combining two separate indices – weight for height and waist for height ratios. The BMAI is mostly influenced by waist circumference which will mostly include fat component. This signifies that the measurement of adiposity is better reflected in BMAI rater than BMI or Waist/Height ratio alone (18). The author (18) stated that, BMAI is a very simple index to use and all the three main body measurements – weight, height, minimum waist circumference are included. The measurement of adiposity is included in BMAI in the form of waist-to-height ratio, therefore BMAI will be an important tool in assessing cardiovascular risk factors in preschool children.

Keeping these in mind, the aim of the present study was to measure the indicators of abdominal adiposity – waist circumference (WC), waist-hip ratio (WHR), waist-height ratio (WHTR), conicity index (CI) and the newly proposed body mass abdominal index (BMAI) and study their relationship with overall adiposity as measured by BMI among the rural Bengalee preschool children from Arambag, Hooghly District, West Bengal, India.

OUR STUDY

The present cross sectional study was undertaken during the period November 2005 to December 2006, at 20 Integrated Child Development Services (ICDS) centers in Bali Gram Panchayet, Arambagh, Hooghly District of West Bengal, India. The study area consists of remote villages located approximately 100 km. from Kolkata, the capital of West Bengal.

Figure 1 shows the area of study. All children (aged 2-6 years old) living in these areas are enrolled at these centers.

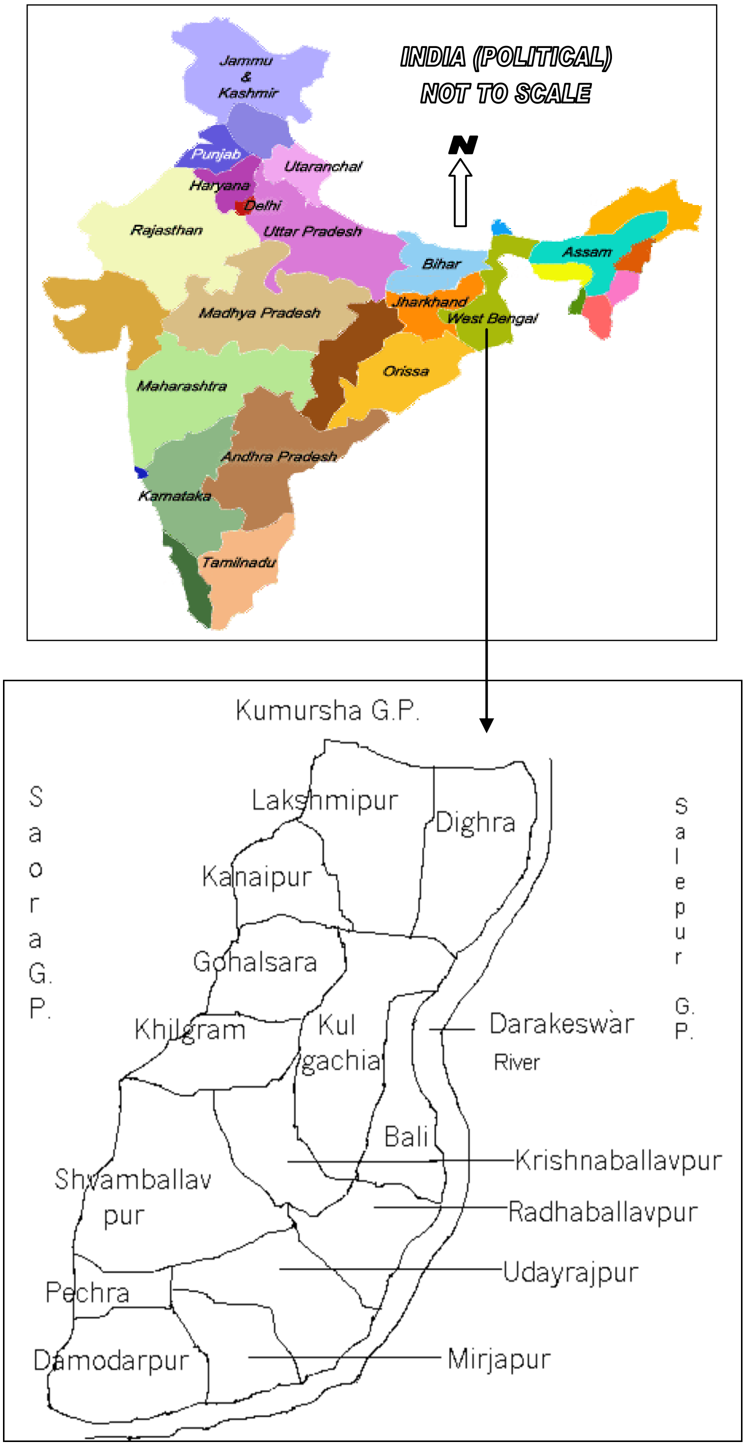

Figure 1. Area of study.

The population

A total of 1012 rural Bengalee preschool children comprising of both boys (498) and girls (514) aged 2-6 years old, enrolled in these centers were studied. All children of aged 2 years enrolled their names at these (ICDS) centers and their names get eliminated when they cross the age of 6 years. Information on a number of non-anthropometric variables such as age, sex, were collected using a pre-structured interview schedule. All the children were Hindu by religion. The age and sex distribution of the subjects is given in Table 1. All children were given a daily food supplementation, in the form of porridge, consisting of approximately 60 grams of rice and 20 grams of lentils per day. They were also fed an egg per week.

Table 1. Age and sex distribution of the subjects

Age (years)	Boys	Girls	Total
2	91	92	183
3	125	106	231
4	110	131	241
5	115	124	239
6	57	61	118
Total	498	514	1012

Anthropometric measurements

All the measurements i.e., height, weight, minimum waist circumference, maximum hip circumference were taken following standard method (36) by the first author.

Indices

Body Mass Index (BMI) – a popular indicator of generalized adiposity was calculated following the formula of World Health Organization (37).

BMI = Weight in kg/(Height)^2 in m.

Conicity index (CI) and waist – hip ratio (WHR) – two typical measures of central adiposity were derived using the standard formula.

CI = Minimum waist circumference (cm)/[(0.109 x √‾{ weight (kg) / height (m)}].

WHR = Minimum waist circumference (cm) / Maximum hip circumference (cm).

Another measure of central adiposity, waist – height ratio (WHTR) was calculated also following standard equation.

WHTR = Minimum waist circumference (cm)/height (m).

The new hypothetical index - BMAI (17) was calculated in the following way :

BMAI = Weight / Height X minimum waist circumference / Height

= Weight / $(\text{Height})^2$ X minimum waist circumference

= BMI X minimum waist circumference

where Weight is in Kg. and Minimum waist circumference and height are in meters.

The BMI includes lean mass and fat components of the body and it is mostly influenced by waist circumference which will mostly include fat component. This signifies that the measurement of adiposity is better reflected in BMAI rather than BMI or Waist / height ratio alone (18).

FINDINGS

Table 2 presents the means and standard deviations of the five important conventional and one new measures of adiposity among the studied preschool children of Bali Gram panchayat, Arambag, Hooghly district, West Bengal, India. Among boys, the mean (sd) values of BMI, WC, WHR, WHTR, CI and BMAI were 13.12 kg/m^2 (1.7), 45.3 cm (2.8), 0.97 (0.05), 0.47 (0.04), 1.17 (0.07) and 5.94 kg/m (0.87), respectively. Whereas, in case of girls, the corresponding values were 13.14 kg/m^2 (1.5), 44.8 cm (2.8), 0.96 (0.05), 0.47 (0.04), 1.17 (0.07) and 5.88 kg/m (0.78), respectively. The sex combined overall values were 13.13 kg/m^2 (1.6), 45.03cm (2.8), 0.97 (0.05), 0.47 (0.04), 1.17 (0.07) and 5.91 kg/m (0.82) respectively.

Table 2. Mean values (sd) of the six measures of adiposity among the studied children

Measures of adiposity	Boys (n = 498)	Girls (n = 514)	Sex combined (N = 1012)
BMI	13.12 (1.7)	13.14 (1.5)	13.13 (1.6)
WC	45.3 (2.8)	44.8(2.8)	45.03 (2.8)
WHR	0.97 (0.05)	0.95 (0.05)	0.97 (0.05)
WHTR	0.47 (0.04)	0.47 (0.04)	0.47 (0.04)
CI	1.17 (0.07)	1.17 (0.07)	1.17 (0.07)
BMAI	5.94 (0.87)	5.88 (0.78)	5.91 (0.82)

Standard deviations are presented in parentheses.

Table 3 shows the correlation coefficient (r) of age with adiposity measures among the studied children. Overall (sex combined) waist circumference ($r = 0.402$) and BMAI ($r = 0.166$) had positively correlations with age significantly at 0.01 level ($p < 0.01$). Sex specific results also showed the same trend. However, WHR and WHTR had significant correlation with age but in a negative way. No significant correlation were found in case of CI and BMI. This has been graphically presented in figure 2.

Table 3. Pearson Correlation Coefficient (r) of age with adiposity measures among the children

Measures of adiposity	Boys (N= 498)	Girls (N= 514)	Sex combined (N= 1012)
WC	0.386**	0.427**	0.402**
WHR	-0.297**	-0.320**	-0.310**
WHTR	-0.660**	-0.680**	-0.670**
CI	-0.002	-0.035	-0.035
BMAI	0.152**	0.183**	0.166**
BMI	-0.012	-0.021	-0.015

** = p < 0.01

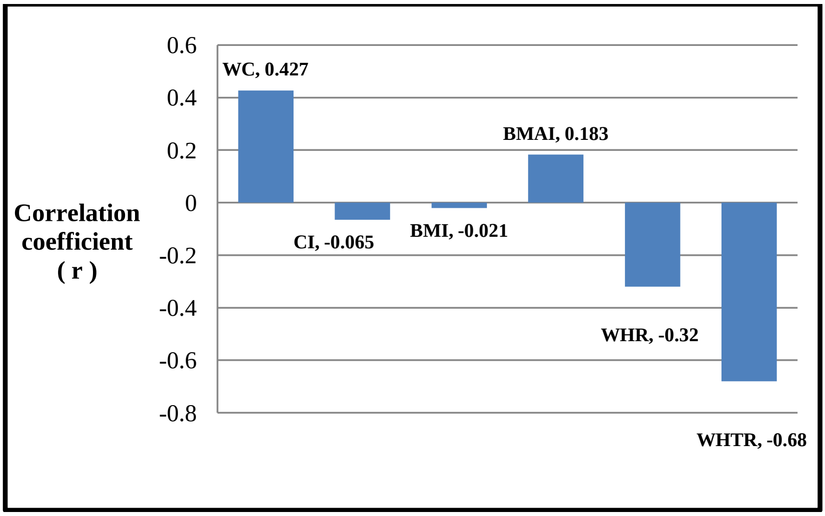

Figure 2. Correlation of age with adiposity measures.

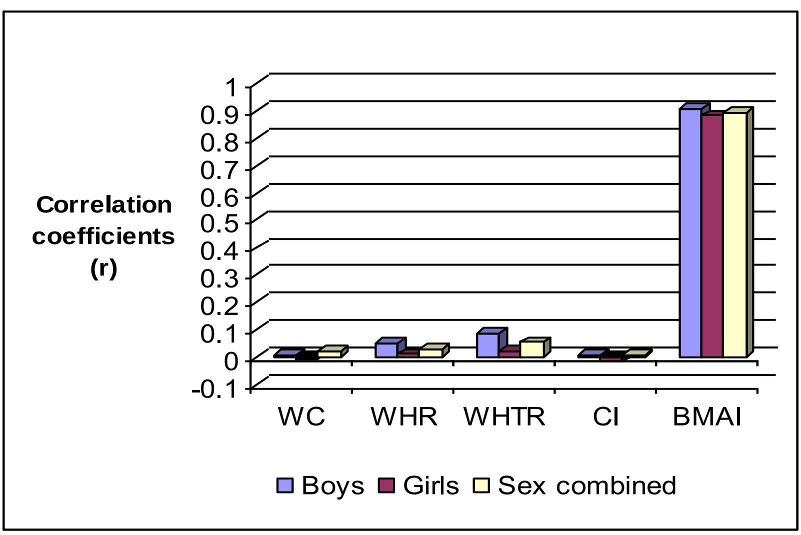

Figure 3. Correlation of BMI with WC, WHR, WHTR, CI and BMAI.

The correlation coefficients (r) of the adiposity measures with BMI are presented in table 4. From the table, it can be seen that no significant correlations were observed for all adiposity measures except BMAI. Among girls, the correlations of WC and CI with BMI were negative. Moreover, the magnitude of correlations of BMAI were very high ($p < 0.001$) with BMI (boys: r = 0.907, girls: r = 0.881, sex-combined: r = 0.894). The correlation of BMAI with BMI in case of the boys was slightly higher than the girls. This has been graphically presented in figure 3.

Table 4. Pearson Correlation Coefficients (r) of WC, WHR, WHTR, CI and BMAI with BMI among the studied children

Measures of adiposity	Boys (N= 498)	Girls (N= 514)	Sex combined (N= 1012)
WC	0.005	-0.009	0.023
WHR	0.049	0.010	0.029
WHTR	0.084	0.023	0.054
CI	0.007	-0.017	0.005
BMAI	0.907**	0.881**	0.894**

** = p < 0. 001.

DISCUSSION

Ideally, any acceptable and good adiposity measure must have a strong positive relationship with BMI which is an indicator of overall adiposity. This should be equally true for both sexes. Conversely, an adiposity measure at any particular site which does not have a strong relationship with BMI may accurately reflect regional adiposity, but it fails to relate adequately with overall adiposity (BMI). Hence, it may be of limited use in epidemiological studies, particularly those dealing with the anthropometric evaluation of nutritional status. WHTR is better than WC and BMI at predicting adiposity in children and adolescents. It can be a useful surrogate of body adiposity when skinfold measurements are not available (38).

In conclusion, our results provided clear evidence that the new index BMAI had a distinct advantage in that it relates much strongly with overall adiposity (BMI) than the other commonly used indicators of adiposity. Its use may be advantageous in studies dealing with the evaluation of nutritional status of rural preschool children. A study on2,016 rural pre-school children aged 3-5 years from randomly selected 66 Integrated Child Development Services (ICDS) centres in the Nadia District of West Bengal, India, revealed the strongest correlation ($p < 0.01$) with BMAI (boys: r = 0.856, girls: r = 0.868, sex-combined: r = 0.863). Results of linear regression of adiposity measures with BMI revealed that BMAI had the strongest significant impact (t = 76.729) on BMI (39). Thus, there is a valid justification in preferring the use of BMAI over other measures of central adiposity. Our results clearly vindicate the theoretical hypothesis propounded by Kumar (18) regarding the utility and efficacy of BMAI.

However, it is well established that there exits significant ethnic differences in the relationship between regional adiposity and overall adiposity. Thus, we suggest that similar studies, utilizing this new index, be undertaken among other ethnic groups. These would provide us with valuable results as to whether the findings obtained by us holds true across ethnic groups. This is particularly important for country like India which is ethnically heterogeneous. Lastly, it would be of much interest to investigate whether this utility of BMAI holds its validity among individuals of higher age groups also.

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SECTION SIX: ACKNOWLEDGMENTS

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Chapter 28

ABOUT THE EDITOR

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Chapter 29

About the National Institute of Child Health and Human Development in Israel

The National Institute of Child Health and Human Development (NICHD) in Israel was established in 1998 as a virtual institute under the auspicies of the Medical Director, Ministry of Social Affairs and Social Services in order to function as the research arm for the Office of the Medical Director. In 1998 the National Council for Child Health and Pediatrics, Ministry of Health and in 1999 the Director General and Deputy Director General of the Ministry of Health endorsed the establishment of the NICHD.

Mission

The mission of a National Institute for Child Health and Human Development in Israel is to provide an academic focal point for the scholarly interdisciplinary study of child life, health, public health, welfare, disability, rehabilitation, intellectual disability and related aspects of human development. This mission includes research, teaching, clinical work, information and public service activities in the field of child health and human development.

Service and academic activities

Over the years many activities became focused in the south of Israel due to collaboration with various professionals at the Faculty of Health Sciences (FOHS) at the Ben Gurion University of the Negev (BGU). Since 2000 an affiliation with the Zusman Child Development Center at the Pediatric Division of Soroka University Medical Center has resulted in collaboration around the establishment of the Down Syndrome Clinic at that center. In 2002 a full course on “Disability” was established at the Recanati School for Allied Professions in the Community, FOHS, BGU and in 2005 collaboration was started with the Primary Care Unit of the faculty and disability became part of the master of public health course on “Children and society”. In the academic year 2005-2006 a one semester course on “Aging with disability” was started as part of the master of science program in gerontology in our collaboration with the Center for Multidisciplinary Research in Aging. In 2010 collaborations with the Division of Pediatrics, Hadassah Hebrew University Medical Center, Jerusalem, Israel around the National Down Syndrome Center and teaching students and residents about intellectual and developmental disabilities as part of their training at this campus.

RESEARCH ACTIVITIES

The affiliated staff have over the years published work from projects and research activities in this national and international collaboration. In the year 2000 the International Journal of Adolescent Medicine and Health and in 2005 the International Journal on Disability and Human Development of De Gruyter Publishing House (Berlin and New York) were affiliated with the National Institute of Child Health and Human Development. From 2008 also the International Journal of Child Health and Human Development (Nova Science, New York), the International Journal of Child and Adolescent Health (Nova Science) and the Journal of Pain Management (Nova Science) affiliated and from 2009 the International Public Health Journal (Nova Science) and Journal of Alternative Medicine Research (Nova Science). All peer-reviewed international journals.

NATIONAL COLLABORATIONS

Nationally the NICHD works in collaboration with the Faculty of Health Sciences, Ben Gurion University of the Negev; Department of Physical Therapy, Sackler School of Medicine, Tel Aviv University; Autism Center, Assaf HaRofeh Medical Center; National Rett and PKU Centers at Chaim Sheba Medical Center, Tel HaShomer; Department of Physiotherapy, Haifa University; Department of Education, Bar Ilan University, Ramat Gan, Faculty of Social Sciences and Health Sciences; College of Judea and Samaria in Ariel and in 2011 affiliation with Center for Pediatric Chronic Diseases and National Center for Down Syndrome, Department of Pediatrics, Hadassah Hebrew University Medical Center, Mount Scopus Campus, Jerusalem.

INTERNATIONAL COLLABORATIONS

Internationally with the Department of Disability and Human Development, College of Applied Health Sciences, University of Illinois at Chicago; Strong Center for Developmental Disabilities, Golisano Children's Hospital at Strong, University of Rochester School of Medicine and Dentistry, New York; Centre on Intellectual Disabilities, University of Albany, New York; Centre for Chronic Disease Prevention and Control, Health Canada, Ottawa; Chandler Medical Center and Children’s Hospital, Kentucky Children’s Hospital, Section of Adolescent Medicine, University of Kentucky, Lexington; Chronic Disease Prevention and Control Research Center, Baylor College of Medicine, Houston, Texas; Division of Neuroscience, Department of Psychiatry, Columbia University, New York; Institute for the Study of Disadvantage and Disability, Atlanta; Center for Autism and Related Disorders, Department Psychiatry, Children’s Hospital Boston, Boston; Department of Paediatrics, Child

Health and Adolescent Medicine, Children's Hospital at Westmead, Westmead, Australia; International Centre for the Study of Occupational and Mental Health, Düsseldorf, Germany; Centre for Advanced Studies in Nursing, Department of General Practice and Primary Care, University of Aberdeen, Aberdeen, United Kingdom; Quality of Life Research Center, Copenhagen, Denmark; Nordic School of Public Health, Gottenburg, Sweden, Scandinavian Institute of Quality of Working Life, Oslo, Norway; The Department of Applied Social Sciences (APSS) of The Hong Kong Polytechnic University Hong Kong.

TARGETS

Our focus is on research, international collaborations, clinical work, teaching and policy in health, disability and human development and to establish the NICHD as a permanent institute at one of the residential care centers for persons with intellectual disability in Israel in order to conduct model research and together with the four university schools of public health/medicine in Israel establish a national master and doctoral program in disability and human development at the institute to secure the next generation of professionals working in this often non-prestigious/low-status field of work.

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Chapter 30

ABOUT THE BOOK SERIES "HEALTH AND HUMAN DEVELOPMENT"

Health and human development is a book series with publications from a multidisciplinary group of researchers, practitioners and clinicians for an international professional forum interested in the broad spectrum of health and human development. Books already published:

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