Malaria

Malaria Introduction

INTRODUCTION

- Malaria is a potentially life threatening parasitic disease caused by parasites known as Plasmodium viviax (P.vivax), Plasmodium falciparum (P.falciparum), Plasmodium malariae (P.malariae)and Plasmodium ovale (P.ovale)
- It is transmitted by the infective bite of Anopheles mosquito
- Man develops disease after 10 to 14 days of being bitten by an infective mosquito
- There are two types of parasites of human malaria, Plasmodium vivax, P. falciparum, which are commonly reported from India.
- Inside the human host, the parasite undergoes a series of changes as part of its complex life cycle. (Plasmodium is a protozoan parasite)
- The parasite completes life cycle in liver cells (pre-erythrocytic schizogony) and red blood cells (erythrocytic schizogony
- Infection with P.falciparum is the most deadly form of malaria.

HISTORICAL PERSPECTIVE

Malaria has been a major public health problem in India. Intermittent fever, with high incidence during the rainy season, coinciding with agriculture, sowing and harvesting, was first recognized by Romans and Greeks who associated it with swampy areas. They postulated that intermittent fevers were due to the 'bad odour' coming from the marshy areas and thus gave the name 'malaria' ('mal'=bad + 'air') to intermittent fevers. In spite of the fact that today the causative organism is known, the name has stuck to this disease.

MAGNITUDE OF THE PROBLEM

Malaria is a public health problem in several parts of the country. About 95% population in the country resides in malaria endemic areas and 80% of malaria reported in the country is confined to areas consisting of 20% of the population residing in tribal, hilly, difficult and inaccessible areas. The Directorate of National Vector Borne Disease Control Programme (NVBDCP) has framed technical guidelines/ policies and provides most of the resources for the programme. Indicators have been developed at national level for monitoring of the programme and there is uniformity in collection, compilation and onward submissions of data. Passive surveillance of malaria is carried out by PHCs, Malaria Clinics, CHCs and other secondary and tertiary level health institutions that patients visit for treatment. Apart from that, ASHA- a village volunteer is involved in the programme to provide diagnostic and treatment services at the village level as a part of introduction of intervention like Rapid Diagnostic Tests and use of Artemisinin Combination Therapy (ACT) for the treatment of Pf cases.

The countrywide malaria situation as reflected in surveillance data from 1995-2022 is given in the following Table: 1.

Table 1: Countrywide Epidemiological Situation (1995 – 2022)

Years	Pop. In (000)	Total Malaria Cases (Million)	P.Falciparum Cases (Million)	PF%	API	Deaths Due to Malaria
1995	888143	2.93	1.14	38.84	3.29	1151
1996	872906	3.04	1.18	38.86	3.48	1010
1997	884719	2.66	1.01	37.87	3.01	879
1998	910884	2.22	1.03	46.35	2.44	664
1999	948656	2.28	1.14	49.96	2.41	1048
2000	970275	2.03	1.05	51.54	2.09	932
2001	984579	2.09	1.00	48.20	2.12	1005
2002	1013942	1.84	0.90	48.74	1.82	973
2003	1027157	1.87	0.86	45.85	1.82	1006
2004	1040939	1.92	0.89	46.47	1.84	949
2005	1082882	1.82	0.81	44.32	1.68	963
2006	1072713	1.79	0.84	47.08	1.66	1707
2007	1087582	1.51	0.74	49.11	1.39	1311
2008	1119624	1.53	0.78	50.81	1.36	1055
2009	1150113	1.56	0.84	53.72	1.36	1144
2010	1167360	1.60	0.83	52.15	1.37	1018
2011	1194901	1.31	0.67	50.74	1.10	754
2012	1211509	1.07	0.53	49.98	0.88	519

2013	1221640	0.88	0.46	52.61	0.72	440
2014	1234995	1.10	0.72	65.55	0.89	562
2015	1265173	1.17	0.78	66.61	0.92	384
2016	1283303	1.09	0.71	65.44	0.85	331
2017	1315092	0.84	0.53	62.70	0.64	194
2018	1337617	0.43	0.21	48.19	0.32	96
2019	1349006	0.34	0.16	46.36	0.25	77
2020	1372316	0.19	0.12	63.84	0.14	93
2021	1385500	0.16	0.10	62.79	0.12	90
2022	1396937	0.18	0.10	57.26	0.13	83

(P)=Provisional

The case load, though steady around 2 million cases annually in the late nineties, has shown a declining trend since 2002. When interpreting API, it is important to evaluate the level of surveillance activity indicated by the annual blood examination rate. At low levels of surveillance, the Slide Positivity Rate (SPR) may be a better indicator. The SPR (not shown in table) has also shown gradual decline from 3.50 in 1995 to 0.19 in 2020. The reported Pf cases declined from 1.14 million in 1995 to 0.12 million cases in 2020. The Pf % has gradually increased from 39% in 1995 to 63.84% in 2020.

The number of reported deaths has been levelling around 1000 per year. The mortality peak in 2006 was related to severe malaria epidemics affecting Assam caused by population movements.

Country Scenario of Epidemiological Indicators for Malaria

The data in following **Table 2** shows that Annual Parasite Incidence (API) rate has consistently come down from 2.12 per thousand in 2001 to 0.25 per thousand in 2019 but confirmed deaths due to malaria have been continuously down during this period between 1707 and 77. The table below shows the information on indicators by which malaria prevention/ control activity in India is monitored and evaluated. Slide Positivity Rate (SPR) and Slide falciparum Rate (SfR) have reduced over the years 2001-2019.

Table 2: Epidemiological Indicators for Malaria in India (2001-2022)

Ye ar	Population (in '000)	Blood Smear	Positive cases	Pf Cases	ABE R	API	SPR	SFR	Deaths

		Examined							
2001	984579	90,389,019	2,085,484	1,005,236	9.18	2.12	2.31	1.11	1005
2002	1013942	91,617,725	1,841,229	897,446	9.04	1.82	2.01	0.98	973
2003	1027157	99,136,143	1,869,403	857,101	9.65	1.82	1.89	0.86	1006
2004	1040939	97,111,526	1,915,363	890,152	9.33	1.84	1.97	0.92	949
2005	1082882	104,143,806	1,816,569	805,077	9.62	1.68	1.74	0.77	963
2006	1072713	106,725,851	1,785,129	840,360	9.95	1.66	1.67	0.79	1707
2007	1087582	94,928,090	1,508,927	741,076	8.73	1.39	1.59	0.78	1311
2008	1119624	97,316,158	1,526,210	775,523	8.69	1.36	1.57	0.80	1055
2009	1150113	103396076	1563,574	839,877	8.99	1.36	1.51	0.81	1144
2010	1167360	106040223	1495817	779549	9.21	1.37	1.41	0.74	1018
2011	1194901	109313294	1310656	665004	9.12	1.10	1.20	0.61	754
2012	1211580	109048884	1067824	533695	9.00	0.88	0.98	0.49	519
2013	1221640	113445106	881730	463846	9.26	0.72	0.78	0.41	440
2014	1234995	124066331	1102205	722546	10.05	0.89	0.89	0.58	562

2015	1265173	121141970	1169261	778821	9.58	0.92	0.97	0.64	384
2016	1283303	124933348	1085823	711502	9.74	0.85	0.87	0.57	331
2017	1315092	125977799	844558	529530	9.58	0.64	0.67	0.42	194
2018	1337617	124475724	429928	207198	9.31	0.32	0.35	0.17	96
2019	1349006	134230349	338494	156940	9.95	0.25	0.25	0.12	77
2020	1372316	97177024	186532	119088	7.08	0.14	0.19	0.12	93
2021	1385500	114391977	161753	101566	8.26	0.12	0.14	0.09	90
2022	1396937	152083001	176522	101068	10.89	0.13	0.12	0.07	83

BSE : Blood Smear Examined **P=Provisonal**
ABER : Annual Blood Smear Examination Rate (percentage of blood smears examined in a year of total population)

Fig 1: Trend of Malaria Cases And Deaths 2001-2022

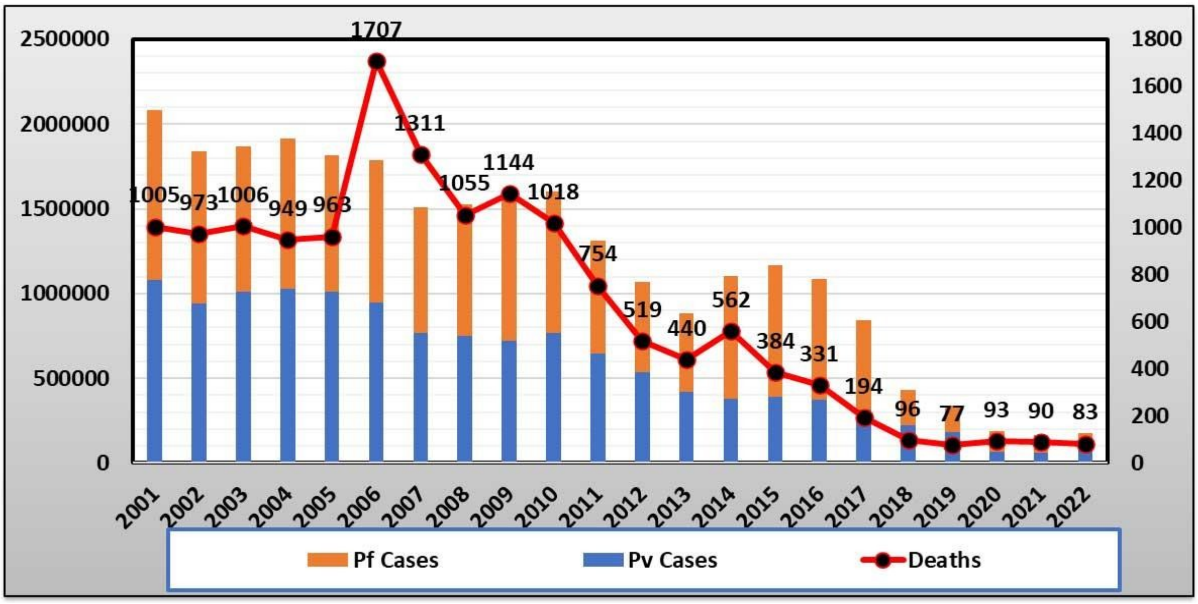


Fig 1 shows that the cases have consistently declined from 2.09 million to 0.19 million during 2001 to 2020. Similarly Pf cases have declined from 1.0 to 0.12 million cases during the same period. Less than 2000 deaths were reported during all the years within this period with a peak in 2006 when an epidemic was reported in NE States. The country SPR has declined from 2.31 to 0.19 and SFR has declined from 1.11 in 2001 to 0.12 in 2020. This indicates declining overall endemicity of malaria in the country.

SYMPTOMS OF MALARIA

- Typically, malaria produces fever, headache, vomiting and other flu-like symptoms.
- The parasite infects and destroys red blood cells resulting in easy fatigue-ability due to anemia, fits/convulsions and loss of consciousness.
- Parasites are carried by blood to the brain (cerebral malaria) and to other vital organs.
- Malaria in pregnancy poses a substantial risk to the mother, the fetus and the newborn infant. Pregnant women are less capable of coping with and clearing malaria infections, adversely affecting the unborn fetus

SYMPTOMS OF SEVERE AND COMPLICATED MALARIA

The priority requirement is the early recognition of signs and symptoms of severe malaria that should lead to prompt emergency care of patient. The signs and symptoms that can be used are non-specific and may be due to any severe febrile disease, which may be severe malaria, other severe febrile disease or concomitant malaria and severe bacterial infection.

The symptoms are a history of high fever, plus at least one of the following:-

- Prostration (inability to sit), altered consciousness lethargy or coma
- Breathing difficulties
- Severe anaemia
- Generalized convulsions/fits
- Inability to drink/vomiting
- Dark and/or limited production of urine

Patients with prostration and/or breathing difficulties should, if at all possible, be treated with parenteral antimalarials and antibiotics. Oral treatment should be substituted as soon as reliably possible. Frequent monitoring of laboratory parameters is essential - blood sugar, blood urine, fluid balance, associated infection, etc. Drugs that increase gastro intestinal bleeding should be avoided.

SIGNS OF SEVERE AND COMPLICATED MALARIA

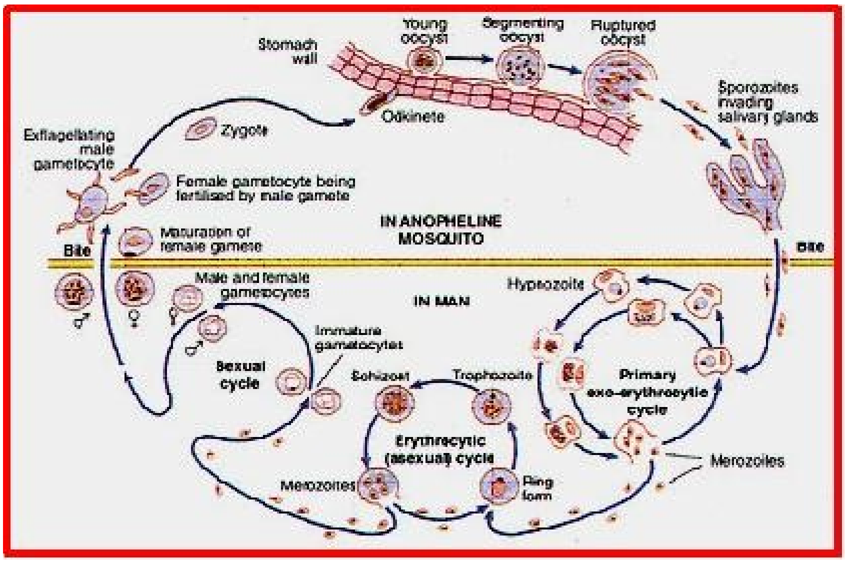
Cerebral malaria, defined as unarousable coma not attributable to any other cause in a patient with falciparum malaria

- Generalized convulsions.
- Normocytic anaemia.
- Renal failure.
- Hypoglycaemia.
- Fluid, electrolyte and acid-base disturbances.
- Pulmonary oedema.
- Circulatory collapse and shock ("algid malaria").
- Spontaneous bleeding (disseminated intravascular coagulation).
- Hyperpyrexia.
- Hyperparasitaemia.
- Malarial haemoglobinuria.

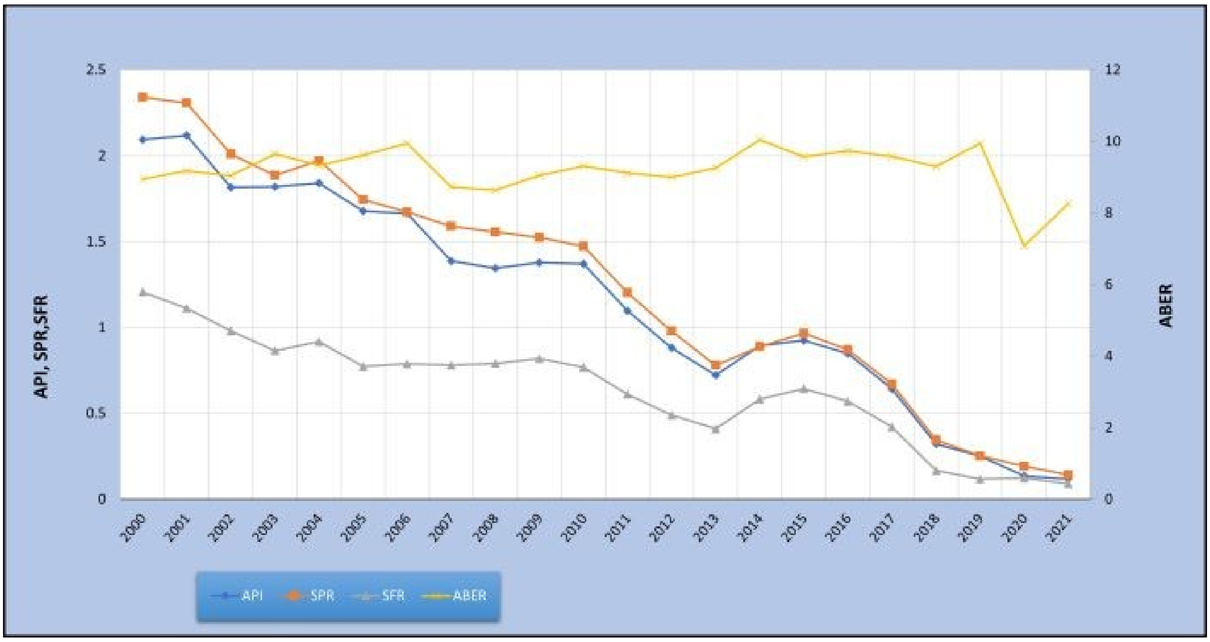
RISK FOR SEVERE COMPLICATIONS

- In areas of low transmission - all age groups are vulnerable but adults develop more severe and multiple complications. The transmission pattern in most parts of India is usually low, but intense transmission is seen in north-eastern states and large areas of Orissa, Chattisgarh, Jharkhand and Madhya Pradesh.
- In areas of high transmission - children below 5 years, visitors, migratory labour.
- Association of pregnancy-pregnant women are less capable of coping with and clearing malaria infections, adversely affecting the unborn fetus.

LIFE CYCLE OF MALARIA PARASITE IN MAN AND MOSQUITO



TREND OF MALARIA PARAMETERS IN INDIA (2001- 2020(P))



API=Annual Prasite Insidence | SPR=Slide Positivity Rate | SFR= Slide Falsiparum Rate | ABER=Annual Bloodslide Examination Rate

- Malaria Situation in India From 2021:https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/77275128201754377913.pdf

Monthly Epidemiological Situation (MES): https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/67257180221754378128.pdf

District Level Data Malaria Cases and Death: https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/62270322291720010405.pdf

Monthly Malaria Information System (MMIS)

Sl. No.	Year/Month	Monthly Malaria Information System (MMIS)

1	**2025 (till April)**	MMIS Report Country May 2025 MMIS CAT 1 May 2025 MMIS CAT 2 May 2025 MMIS CAT 3 May 2025
2	**2024 (till December)**	MMIS Report Country Dec. 2024 MMIS CAT 1 Dec.2024 MMIS CAT 2 Dec 2024 MMIS CAT 3 Dec. 2024
3.	**2023 (till October)**	MMIS Report Country October 2023 MMIS CAT 1 October 2023 MMIS CAT 2 October 2023 MMIS CAT 3 October 2023
4.	**2022 (till December 2022)**	MMIS CAT 1 December 2022 MMIS CAT 2 December 2022 MMIS CAT 3 December 2022
5.	**2021 (till December 2021)**	MMIS CAT 1 December 2021 MMIS CAT 2 December 2021 MMIS CAT 3 December 2021
6.	**2020 (till December 2020)**	MMIS Cat 1 - December 2020 MMIS Cat 2 - December 2020 MMIS Cat 3 - December 2020

Reporting Formats for Malaria (M1-M4) & ASHA: https://ncvbdc.mohfw.gov.in/Doc/Malaria-reporting-formats-M1-M4.pdf

Reporting Formats for Vector Control (VC1-VC6): https://ncvbdc.mohfw.gov.in/Doc/Malaria-reporting-formats-VC1-VC6.pdf

Web Based Malaria (MIS) Malaria Format: https://ncvbdc.mohfw.gov.in/Doc/Web%20based%20Malaria%20(MIS)%20Malaria%20format.

Web Based Malaria (MIS) Vector Control Format: https://ncvbdc.mohfw.gov.in/Doc/Web%20based%20Malaria%20(MIS)%20Vector%20Control%20format.pdf

Malaria Annual Report -2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024

VECTORS OF MALARIA

- There are many vectors of malaria
- Anopheles culicifacies is the main vector of malaria
- It is a small to medium sized mosquito with **Culex** like sitting posture

1. **Feeding Habbits**
    - It is a zoophilic species
    - When high densities build up relatively large numbers feed on men
2. **Resting habits**
    - Rests during daytime in human dwellings and cattlesheds
3. **Breeding places**
    - Breeds in rainwater pools and puddles, borrowpits, river bed pools, irrigation channels, seepages, rice fields, wells, pond margins, sluggish streams with sandy margins.
    - Extensive breeding is generally encountered following monsoon rains.
4. **Biting time**
    - Biting time of each vector species is determined by its generic character, but can be readily influenced by environmental conditions.
    - Most of the vectors, including **Anopheles culicifacies,** start biting soon after dusk. Therefore, biting starts much earlier in winter than in summer but the peak time varies from species to species.

MALARIA CONTROL STRATEGIES

1. Early case Detection and Prompt Treatment (EDPT)

- EDPT is the main strategy of malaria control - radical treatment is necessary for all the cases of malaria to prevent transmission of malaria.
- Chloroquine is the main anti-malaria drug for uncomplicated malaria.
- Drug Distribution Centres (DDCs) and Fever Treatment Depots (FTDs) have been established in the rural areas for providing easy access to anti-malarial drugs to the community.
- Alternative drugs for chloroquine resistant malaria are recommended as per the drug policy of malaria.

2. Vector Control

(i) Chemical Control

- Use of Indoor Residual Spray (IRS) with insecticides recommended under the programnme
- Use of chemical larvicides like Abate in potable water
- Aerosol space spray during day time
- Malathion fogging during outbreaks

(ii) Biological Control

- Use of larvivorous fish in ornamental tanks, fountains etc.
- Use of biocides.

(iii) Personal Prophylatic Measures that individuals/communities can take up

- Use of mosquito repellent creams, liquids, coils, mats etc.
- Screening of the houses with wire mesh
- Use of bednets treated with insecticide
- Wearing clothes that cover maximum surface area of the body

4. Community Participation

- Sensitizing and involving the community for detection of Anopheles breeding places and their elimination
- NGO schemes involving them in programme strategies
- Collaboration with CII/ASSOCHAM/FICCI

5. Environmental Management & Source Reduction Methods

- Source reduction i.e. filling of the breeding places
- Proper covering of stored water
- Channelization of breeding source

6. Monitoring and Evaluation of the programme

- Monthly Computerized Management Information System(CMIS)
- Field visits by state by State National Programme Officers
- Field visits by Malaria Research Centres and other ICMR Institutes
- Feedback to states on field observations for correction actions.

Urban Malaria Scheme(UMS)

INTRODUCTION

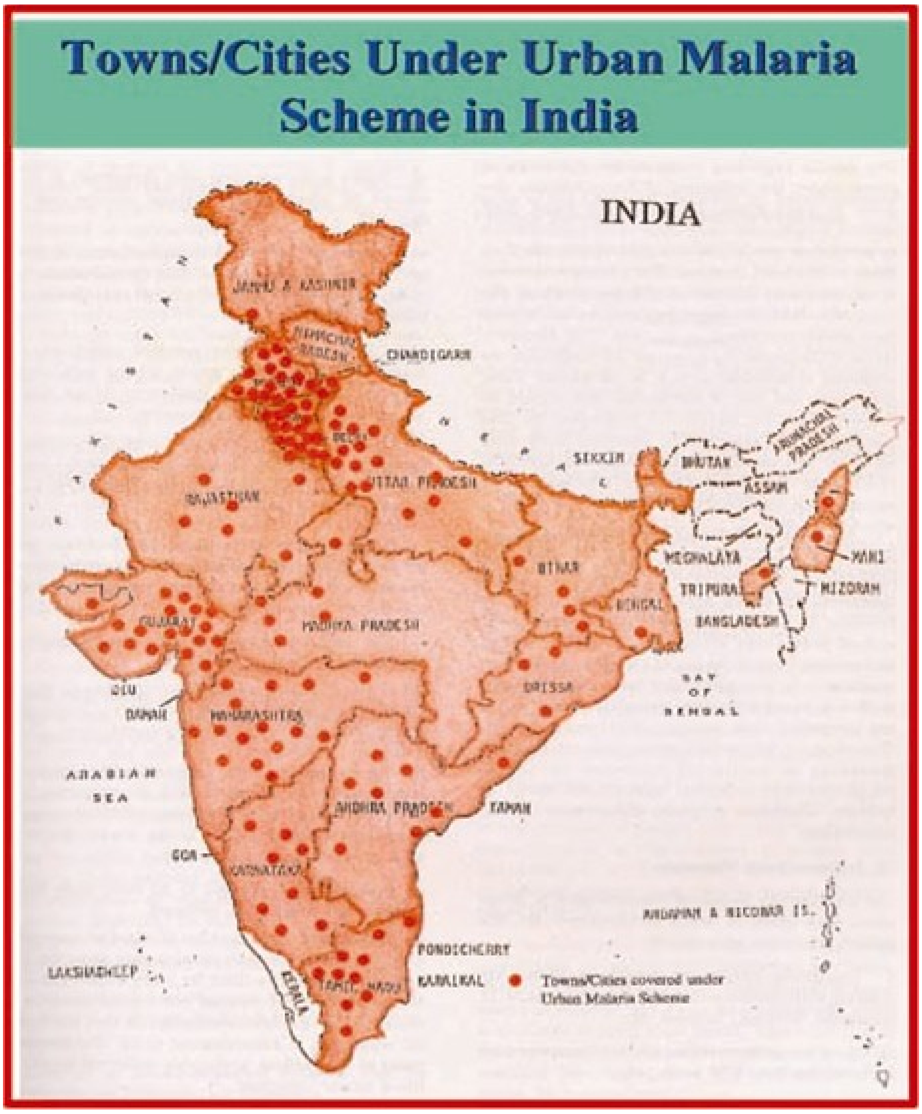
CONTROL OF MALARIA IN URBAN SITUATION

Malaria in urban areas was considered to be a marginal problem restricted to mega towns only and was considered that local bodies are capable of handling it. Therefore while launching the National Malaria Eradication Programme in 1958, Urban Malaria was not included. By 1970s, incidence of rural malaria came down drastically i.e. 0.1 to 0.15 million cases per year but the urban town reported rising trend. Madhok Committee in 1970, investigated the problem and assessed that 10 to 12% of total cases were contributed by urban areas. The committee recommended anti larval measures for containment of urban malaria, because it was feared that proliferation from urban to rural may spread and nullify the gains already made.

HISTORICAL BACKGROUND

The control of malaria in the urban areas was thought of an important strategy as a programme complimentary to the NVBDCP for rural areas. Modified Plan of Operation (MPO) was designed and submitted to the Cabinet to tackle the malaria situation in both urban and rural areas in the country simultaneously. Under MPO, it was decided to initiate anti-larval and anti-parasitic measures to abate the malaria transmission in urban areas. The proposal to control malaria in towns named as Urban Malaria Scheme was approved during 1971 and it was envisaged that 131 towns would be covered under the scheme in a phased manner. This scheme was sanctioned during November, 1971 and the expenditure on this scheme is treated as plan expenditure in centrally sponsored sector. The central assistance under this scheme was treated 100 per cent grant to the State Governments in kind.

At present, Urban Malaria Scheme is protecting 142.9 million population from malaria as well as from other mosquito borne diseases in 131 towns in 19 States and Union Territory.



OBJECTIVES

The main aim is the reduction of the disease to a tolerable level in which the human population can be protected from malaria transmission with the available means.

The Urban Malaria Scheme aims at :

a) To prevent deaths due to malaria.

b) Reduction in transmission and morbidity.

NORMS

1. The towns should have a minimum population of 50,000.
2. The API should be 2 or above.
3. The towns should promulgate and strictly implement the civic by-laws to prevent/eliminate domestic and peri-domestic breeding places

URBAN MALARIA SITUATION:

Epidemiological and disease specific background

About 10% of the total cases of malaria are reported from urban areas. Maximum numbers of malaria cases are reported from Chennai, Vishakapatnam, Vadodara, Kolkata, New Mumbai, Vijayawada etc. The comparative epidemiological profile of malaria during 2005-2019 in all urban towns of the country is as follows:

Comparative Epidemiological profile of malaria in 19 States under UMS during 2005-2021

Year	**Population**	**Total cases**	**P.f**	**P.F %**	**SPR**	**SFR**	**Deaths**
2005	102423064	135249	14905	11.02	2.33	0.26	96
2006	105782505	129531	17278	13.34	2.07	0.28	145
2007	112448027	102829	18038	16.82	1.92	0.32	125
2008	113334073	113810	18963	13.42	1.66	0.22	102
2009	114699850	166065	31134	18.75	2.98	0.56	213
2010	115159555	74908	7587	18.75	2.98	0.56	31
2011	130316971	142502	13910	9.77	2.07	0.21	147
2012	130329138	82554	8236	9.98	1.35	0.14	69
2013	131279000	65568	5463	8.33	1.04	0.09	26
2014	133857000	142376	10343	7.2	1	0.08	21
2015	148181952	28821	2679	9.29	0.38	0.035	17

2016	107953339	23374	1873	8.01	0.39	0.031	16
2017	117940161	9292	756	8.13	0.24	0.02	20
2018	116965378	26105	1721	6.59	0.68	0.04	6
2019	137391947	31735	1606	5.06	0.42	0.02	2
2020	141759779	17038	1938	11.37	0.49	0.06	1
2021	142595106	26747	7961	29.76	0.59	0.18	0

Control Strategies under Urban Malaria Scheme:

Under the scheme, Malaria Control strategy will comprise of (i) Parasite control & (ii) Vector control

1. **Parasite control:** Treatment is done through passive agencies viz. hospitals, dispensaries both in private & public sectors and private practitioners. In mega cities malaria clinics are established by each health sector/ malaria control agencies viz. Municipal Corporations, Railways, Defence services
2. **Vector control comprises of the following components**

- Source reduction
- Use of larvicides
- Use of larvivorous fish
- Space spray
- Minor engineering
- Legislative measure

The control of urban malaria lies primarily in the implementation of urban byelaws to prevent mosquito breeding in domestic and peri-domestic areas, or residential blocks and government/commercial buildings, construction sites. Use of larvivorous fish in the water bodies such as slow moving streams, lakes, ornamental ponds, etc. is also recommended. Larvicides are used for water bodies, which are unsuitable for use of larvivorous fish. Awareness campaigns are also undertaken by Municipal Bodies/Urban area authorities.

The control measures recommended under UMS are as below:

a. Source reduction (Guidelines for Source Reduction)

Environmental methods of controlling mosquito breeding including source reduction minor engineering works, by filling ditches, pits, low lying areas, streamlining, canalizing, desilting, deweeding, trimming of drains, water disposal and sanitation, emptying water containers once in a week and observing weekly Dry Day etc.

b. Anti-larval methods

Chemical

Recurrent anti-larval measures at

weekly intervals

with approved chemical larvicides to control the vector mosquitoes are recommended. The following chemical larvicides are used in the Urban Malaria Scheme programme:

- Temephos

- Bti (WP & 12 AS)

Biological Control (**Guidelines for Larvivorous fish**)

In some urban areas larvivorous fish like Gambusia and Guppy are also used in certain situations where the chemical control is not feasible. Biological larvicide, Bacillus thuringiensis israelensis either wettable powder or aqueous suspension are also used for control of aquatic stages of vector mosquitoes.

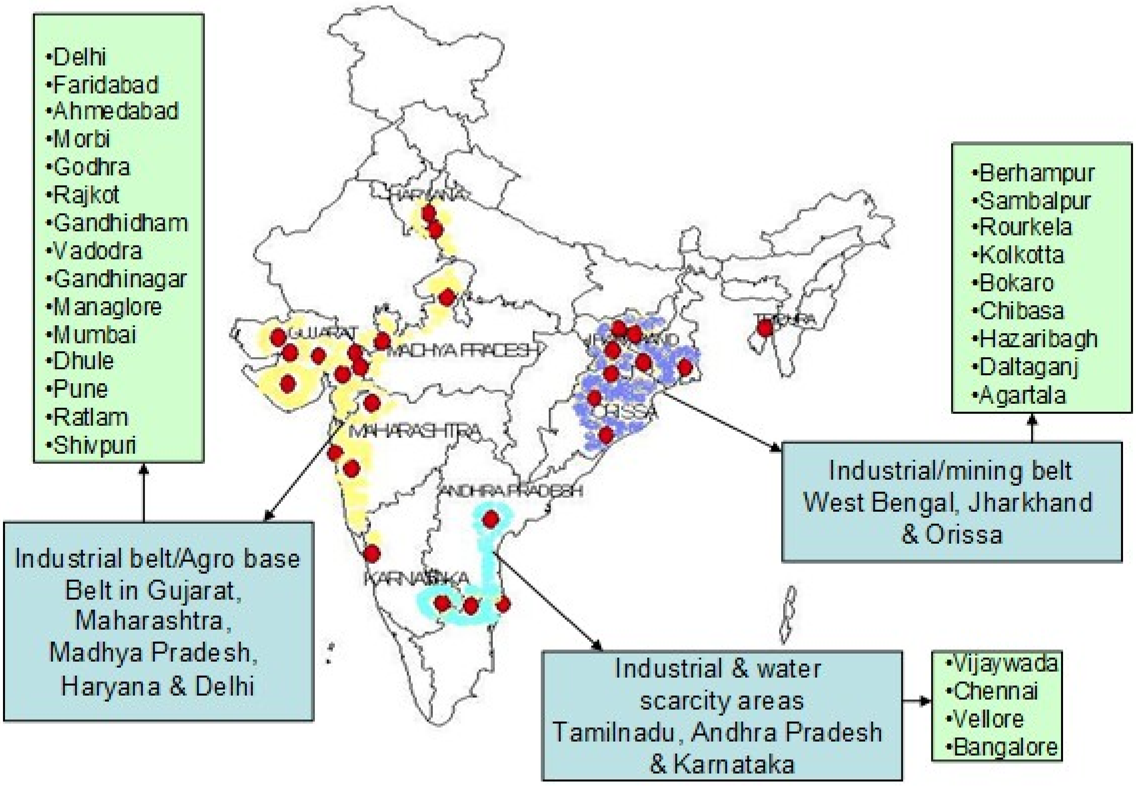
Aedes larvae **Anopheles larvae** **Culex larvae**

Gambusia affinis *Poecilia reticulata (GUPPY)*

1. Aerosol Space Spray

Space spraying of pyrethrum extract (2%) in 50 houses in and around every malaria and dengue positive cases to kill the infective mosquitoes is recommended.

High Risk towns:



Emerging Problem of Malaria in Urban Areas

1. The proportion of urban population to the total population has increased in the last few decades. This has been triggered by rural "push" (for earning livelihood and "urban pull" (for availibbng both medicare/ education opportunities) phenomenon.
2. Haphazard and unplanned growth of towns has resulted in creation of "urban slum" with poor housing and sanitary conditions promoting vector mosquito breeding potential for malaria, filaria and dengue fever/ Dengue haemorrhagic fever.
3. Restricted water supply has led to water storage practices in artificial containers which have generated breeding potential of An.stephensi vectors of urban malaria and Aedes aegypti, the vector of DF/DHF.

4. With rapid growth of population in urban towns, existing staff strength has not corresponding strengthening and is therefore inadequate for service delivery.
5. Anti-larval activities are restricted to chemical control. The focus is not on integrated source reduction measures.
6. Towns not under UMS are also contributing maximum malaria cases in Mangalore.
7. Due to population pressure all cities are expanding and parallel cities have come up and epidemic situations prevail. Gurgaon, Navi Mumbai, Noida.
8. Old villages in expanding urban centres were kept out of overall development (sullage & sewage disposal) with unrestricted land use maintain high mosquitogenic potential.
9. Development project activities without health impact assessment have resulted in malaria outbreaks in short terms and endemic malaria with foci of P.falciparum resistance strains in long term.
10. Inadequate trained man-power for Control of Vector Borne Diseases.

Minutes of the Meeting of the Technical Specification Committee Meeting -Bti (AS): https://ncvbdc.mohfw.gov.in/Doc/minutes-technical-specification.pdf

Long Lasting Insecticidal Nets (Llins) Distributed to the Beneficiaries of Various States Under the Dte. of National Vector Borne Disease Control Programme (2016-2018): https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/52894878351583237427.pdf

DENGUE

WHAT IS DENGUE

Dengue is a fast emerging, outbreak-prone, and mosquito-borne viral fever. The incidence of Dengue is increasing in recent years with repeated outbreaks from many States and newer areas. At present, except Ladakh all the States and Union Territories are reporting Dengue cases

- Dengue is a viral disease
- It is transmitted by the infective bite of Aedes Aegypti mosquito
- Man develops disease after 5-6 days of being bitten by an infective mosquito
- Dengue Fever is a severe, flu-like illness
- Person suspected of having symptoms of dengue fever must see a doctor at once

SIGNS & SYMPTOMS OF DENGUE FEVER

- Abrupt onset of high fever
- Severe frontal headache
- Pain behind the eyes which worsens with eye movement
- Muscle and joint pains
- Loss of sense of taste and appetite
- Measles-like rash over chest and upper limbs
- Nausea and vomiting

Severe Dengue Symptoms of may be like

- Frequent vomiting with or without blood
- Bleeding from nose, mouth & gums and skin rashes
- Sleepiness and restlessness
- Patient feels thirsty and mouth becomes dry
- Rapid weak pulse
- Difficulty in breathing

DENGUE SITUATION IN INDIA

Dengue Cases and Deaths in the Country since 2019

Sl. No.	Affected States/UTs	2019		2020		2021		2022		2023		2024		2025*	
		C	D	C	D	C	D	C	D	C	D	C	D	C	D
1	**Andhra Pradesh**	5286	0	925	0	4760	0	6391	0	6453	0	5555	2	513	0
2	**Arunachal**	123	0	1	0	7	0	114	0	130	0	20	0	0	0

	Pradesh														
3	**Assam**	196	0	33	0	103	0	1826	2	8208	7	2271	0	47	0
4	**Bihar**	6712	0	493	2	633	2	13972	32	20224	74	10157	16	70	0
5	**Chattisgarh**	722	0	57	0	1086	0	2679	10	2412	0	3523	2	25	0
6	**Goa**	992	0	376	0	649	0	443	1	512	3	567	3	23	0
7	**Gujarat**	18219	17	1564	2	10983	14	6682	7	7222	7	7891	6	326	0
8	**Haryana**	1207	0	1377	0	11835	13	8996	18	8081	11	6469	9	13	0
9	**Himachal Pradesh**	344	2	21	0	349	0	3326	1	1989	0	3359	0	6	0
10	**J & K**	439	0	53	0	1709	4	8269	18	6403	10	6876	1	4	0
11	**Jharkhand**	825	0	79	0	220	1	290	0	2578	4	1528	0	59	0
12	**Karnataka**	16986	13	3823	0	7393	7	9889	9	19300	11	32886	27	923	0
13	**Kerala**	4652	16	4399	5	3251	27	4432	29	17426	153	20674	128	1417	4
14	**Lakshadweep**	0	0	0	0	1	0	67	0	445	0	513	0	12	0
15	**Madhya Pradesh**	4189	2	806	0	15592	11	3318	2	6979	0	10224	6	122	0
16	**Meghalaya**	82	0	4	0	129	0	26	0	114	0	74	0	8	0
17	**Maharashtra**	14907	29	3356	10	12720	42	8578	27	19034	55	19385	40	1159	0

18	**Manipur**	359	0	37	0	203	0	503	4	2548	0	2463	5	50	0
19	**Mizoram**	42	0	67	0	83	0	1868	5	2060	2	744	1	98	0
20	**Nagaland**	8	0	1	0	24	0	154	0	4943	2	42	0	0	0
21	**Odisha**	3758	4	496	0	7548	0	7063	0	12845	1	9892	0	76	0
22	**Punjab**	10289	14	8435	22	23389	55	11030	41	13687	39	6260	13	53	0
23	**Rajasthan**	13706	17	2023	7	20749	96	13491	10	13924	14	12514	5	169	0
24	**Sikkim**	444	0	11	0	243	1	264	0	311	0	374	0	39	0
25	**Tamil Nadu**	8527	5	2410	0	6039	8	6430	8	9121	12	27378	13	5535	2
26	**Tripura**	114	0	24	0	349	0	56	0	1447	0	1198	0	81	0
27	**Telangana**	13331	7	2173	0	7135	0	8972	0	8016	1	10077	0	267	0
28	**Uttar Pradesh**	10557	26	3715	6	29750	29	19821	33	35402	36	15868	9	305	0
29	**Uttrakhand**	10622	8	76	1	738	2	2337	0	4320	17	494	0	0	0
30	**West Bengal***	NR	NR	5166	0	8264	7	67271	30	30683	4	441	0	NR	NR
31	**A& N Island**	168	0	98	0	175	0	1014	3	846	0	59	0	93	0
32	**Chandigarh**	286	0	265	0	1596	3	910	1	454	0	349	0	0	0

33	**Delhi**	5077	0	1269	0	13089	23	10183	9	16866	19	10585	11	186	0
34	**D&N Haveli**	1491	2	248	0	547	0	685	0	1178	0	403	0	8	0
35	**Daman & Diu**	625	2	71	0	279	0	228	0	284	1	278	0	12	0
36	**Puduchery**	2030	2	633	1	1625	1	1673	3	2790	2	2128	0	344	0
	Total	**157315**	**166**	**44585**	**56**	**193245**	**346**	**233251**	**303**	**289235**	**485**	**233519**	**297**	**12043**	**6**

*Provisional till March 2025

PERIOD OF COMMUNICABILITY

The female **Ae**. **aegypti** usually becomes infected with the dengue virus when it takes a blood meal from a person during the acute febrile (viremia) phase of dengue illness.

After an extrinsic incubation period of 8 to 10 days, the mosquito becomes infected. The virus is transmitted when the infected female mosquito bites and injects its saliva into the wound of the person bitten. The cycle of dengue continues by this process. Dengue begins abruptly after an intrinsic incubation period of 4 to 7 days (range 3—14 days). There is also evidence of vertical transmission of dengue virus from infected female mosquitoes to the next generation.

AGE & SEX GROUP AFFECTED

- All age and sex groups bitten by an infected mosquito can get Dengue.

VECTOR OF DENGUE FEVER

VECTOR OF DENGUE

- Aedes mosquitoes are a vector of dengue fever.
- It is a small mosquito, black with white stripes and is approximately 3-5 mm in size.
- It takes about 7 to 8 days to develop the virus in its body and transmit the disease

Feeding Habit

- Day biter
- Mainly feeds on human beings in domestic and peri domestic situations.
- Bites repeatedly and multi person feeder per blood meal.

Resting Habit

- Rests in the domestic and peridomestic situations
- Rests in the dark corners of the houses, on hanging objects like clothes, umbrella, etc. or under the furniture

Breeding Habits and places

- Aedes mosquito breeds in any type of man-made containers or storage containers having even a small quantity of water.
- Eggs of Aedes can live without water for more than one year.

Favourite Breeding Places

- Desert coolers, Drums, Jars, Pots, Buckets, Flower vases, Plant saucers, Tanks, Cisterns, Bottles, Tins, Tyres, Roof gutters, Refrigerator drip pans, Cement blocks, Cemetery urns, Bamboo stumps, Coconut shells, Tree holes and many more places where rainwater collects or is stored.

VECTOR CONTROL MEASURES

PERSONAL PROPHALATIC MEASURES

- Use of mosquito repellent creams, liquids, coils, mats etc.
- Wearing of full sleeve shirts and full pants with socks
- Use of bednets for sleeping infants and young children during day time to prevent mosquito bite

2. **BIOLOGICAL CONTROL**
    - Use of larvivorous fishes in ornamental tanks, fountains, etc.
    - Use of biocides
3. **CHEMICAL CONTROL**
    - Use of chemical larvicides like abate in big breeding containers
    - Aerosol space spray during day time
4. **ENVIRONMENTAL MANAGEMENT & SOURCE REDUCTION METHODS**
    - Detection & elimination of mosquito breeding sources
    - Management of roof tops, porticos and sunshades
    - Proper covering of stored water
    - Reliable water supply
    - Observation of weekly dry day
5. **HEALTH EDUCATION**
    - Impart knowledge to common people regarding the disease and vector through various media sources like T.v., Radio, Cinema slides, etc.
6. **COMMUNITY PARTICIPATION**
    - Sensitilizing and involving the community for detection of Aedes breeding places and their elimination

MANAGEMENT OF DENGUE CASE

Early reporting and diagnosis of the suspected dengue fever

- Management of dengue fever is symptomatic & supportive

- In severe dengue cases, the following treatment is recommended
    - Replacement of plasma losses
    - Correction of electrolyte and metabolic disturbances
    - Blood transfusion

DO'S AND DON'TS

- Remove water from coolers and other small containers at least once in a week
- Use aerosol during day time to prevent the bites of mosquitoes
- Do not wear clothes that expose arms and legs
- Children should not be allowed to play in shorts and half sleeved clothes
- Use mosquito nets or mosquito repellents while sleeping during day time
- Stagnant water in drains, garbage and coolers more than a week is alarm for dengue

GOI INITIATIVES FOR DENGUE AND CHIKUNGUNYA

Government of India has taken various steps for prevention and control of Dengue and Chikungunya in the country as detailed below:

1. Developed guidelines and operational manuals for technical guidance to the States and other stakeholders for effective implementation of programme. All guidelines are available in Guidelines tab.
2. Established Sentinel Surveillance Hospitals with laboratory support for augmentation of diagnostic facility for Dengue in endemic State(s) in 2007 which has been increased to 805 in 2023 .All these are linked with 17 Apex Referral Laboratories with advanced diagnostic facilities for back up support.
3. Ensuring the functional diagnostic facility (SSH/ARL) and availability of kits is the responsibility of the respective State Programme Officers, NVBDCP. Provided technical Guidelines for prevention and control, case management & effective community participation to the States for implementation.
4. To maintain the uniformity and standard of diagnostics IgM MAC ELISA test kits are provided through National Institute of Virology (NIV), Pune to the in identified SSHs on receipt of requirement from the respective states. Cost is borne by GOI.
5. Since 2007, every year in the 1st quarter NCVBDC prepares the tentative allocation of test kits based on the previous epidemiological situation of Dengue and Chikungunya in the states and communicate to both NIV, Pune and States. Buffer stocks are also maintained to meet any exigency.
6. Trainings are imparted for capacity building of programme managers on implementation of National guidelines for prevention and control of Dengue and Chikungunya and to deal with outbreak or upsurge situations.
7. Monitoring of disease situation for detection of any impending outbreak at initial stage and to contain further spread by timely implementation of preventive measures.
8. Advisories were issued to sensitize the States for preparedness to deal with any future outbreak.
9. Under National Health Mission, budgetary support is provided to the States/UTs for Dengue and Chikungunya control activities.

https://ncvbdc.mohfw.gov.in/Doc/SSH-Dengue-Chikungunya-869.pdf (list of hospitals)

State- Wise Igm Kit Allocation Proposed During 2025 : https://ncvbdc.mohfw.gov.in/Doc/State-wise-tentative-allocation-dengue-chikungunya-IgM-kits-2025.pdf

FAQs: https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/52545681531535010918.pdf

FILARIASIS

FILARIASIS

Filariasis

Filariasis is caused by several round, coiled and thread-like parasitic worms belonging to the family filaridea. The disease is caused by the nematode worm, either Wuchereria bancrofti or Brugia malayi and transmitted by ubiquitous mosquito species Culex quinquefasciatus and Mansonia annulifera/M.uniformis respectively. The disease manifests often in bizarre swelling of legs, and hydrocele and is the cause of a great deal of social stigma. Filariasis is caused by several round, coiled and thread-like parasitic worms belonging to the family filaridea. These parasites after getting deposited on skin penetrate on their own or through the opening created by mosquito bites to reach the lymphatic system.

Bancroftian Filariasis

The lymphatic vessels of the male genitalia are most commonly affected in bancroftian filariasis, producing episodic funiculitis (inflammation of the spermatic cord), epididymitis and orchitis. Adenolymphangitis of the extremities is less common. Hydrocele is the most common sign of chronic bancroftian filariasis, followed by lymphoedema, elephantiasis and chyluria. The swelling involves the whole leg, the whole arm, the scrotum, the vulva or the breast. The fluid of hydrocele and chyluric patients may contain microfilariae, even when they are absent from the blood. Chyluria occurs intermittently and is more pronounced after a heavy meal. It is often symptomless, but some patients complain of fatigue and weight loss, resulting from loss of fat and protein.

Brugian Filariasis

Lymphadenitis (swollen and painful lymphnode) occurs episodically, most commonly affecting one inguinal lymph node at a time. The infection lasts for several days and usually heals spontaneously. The frequency of episodes may vary from 1-2 attacks per year to several attacks per month. Sometimes lymphadenitis is followed by a characteristic retrograde lymphangitis. The infection may spread to the surrounding tissues, and occasionally involves the whole thigh or entire limb. The infected lymph node may become an abscess, ulcerate, and heal with fibrotic scarring. The acute clinical course with its complications may last from several weeks to 3 months. Characteristically, elephantiasis involves the leg below the knee but occasionally it affects the arm below the elbow. Genital lesions or chyluria (milky color urine) do not occur in brugian filariasis.

LYMPHATIC FILARIASIS (LF)

Lymphatic Filariasis (LF), commonly known as elephantiasis is a disfiguring and disabling disease, usually acquired in childhood. In the early stages, there are either no symptoms or non-specific symptoms. Although there are no outward symptoms, the lymphatic system is damaged. This stage can last for several years. Infected persons sustain the transmission of the disease. The long term physical consequences are painful swollen limbs (lymphoedema or elephantiasis). Hydrocele in males is also common in endemic areas.

Due to damaged lymphatic system, patients with lymphoedema have frequent attacks of infection causing high fever and severe pain. Patients may be bed-ridden for several days and normal routine activities become difficult. Such attacks not only cause acute physical suffering but also directly impede the earning capacity of the individual. Lymphatic filariasis is estimated to be one of the leading causes of disability worldwide. Elimination of the disease is an important tool for poverty alleviation and economic development.

FILARIA VECTORS

C.quinquefasciatus is the vector of W.bancrofti in the mainland. C.quinquefasciatus breeds in association with human habitations and is the domestic pest mosquitoes, preferring polluted waters, such as sewage and sullage water collections including cess pools, cess pits, drains and septic tanks. In the absence of such type of water collections, they can breed in comparatively clean water collections also.

The eggs are laid in rafts containing 150-40 eggs each depending on quality and quantity of blood meal taken. At the optimum temperature of 250C to 300C, the eggs hatch within 24 to 48 hours. The youngest stage is the first instar larva which moults to subsequent instars each within 24-48 hours at optimum temperature. There are four instars in the larval stages, and all the instars are voracious eaters, taking anything and everything of microscopic size into the buccal cavity by instant vibration of its feeding brushes. They are mainly bottom feeders but may feed from the surface also.

The IV instar at the end of its stage gives rise to a comma shaped pupa, which lasts upto 24-48 hours at optimal condition. Pupae do not feed but are very active, respiring through its pair of breathing trumpets. The pupa emerges into an adult mosquito, through a longitudinal slit formed between the two trumpets. The entire cycle from egg to emergence of adult is completed in 10-14 days.

TRANSMISSION OF LYMPHATIC FILARIASIS

TRANSMISSION OF LYMPHATIC FILARIASIS

The adult produces millions of very small immature larvae known as microfilariae, which circulate in the peripheral blood with marked nocturnal periodicity. The worms usually live and produce microfilariae for 5-8 years.

Adult Filarial Worms (Macrofilariae) inhabiting lymphatic system of man

Lymphatic filariasis is transmitted through mosquito bites.

The persons having circulating microfilariae are outwardly healthy but transmit the infection to others through mosquitoes.

The persons with chronic filarial swellings suffer severely from the disease but no longer transmit the infection.

" In India, 99.4% of the cases are caused by the species - Wuchereria bancrofti whereas Brugia malayi is responsible for 0.6% of the problem."

" In the adult stage, filarial worms live in the vessels of the lymphatic system. Lymphatic system is the network of lymph nodes and lymph vessels that maintains the fluid balance between the tissues and the blood which is an essential element of the body's immune defense system. "

LIFE CYCLE OF FILARIA PARASITE

Man is the definitive host i.e. where the mature adult male and female parasites mate and produce microfilariae whereas the mosquito is the intermediate host. The adult parasites are usually found in the lymphatic system of man. They give birth to as many as 50,000 microfilariae per day, which find their way into blood circulation. The life span of microfilaria is not exactly known which preferably may survive up to a couple of months

The parasite cycle in the mosquito begins when the microfilariae are picked up by the vector mosquitoes during their feeding on the infected person (microfilaria carrier). The microfilaria in mosquito develops into three stages and under optimum conditions of temperature and humidity; the duration of the cycle in the mosquito (extensive incubation period) is about 10-14 days. When the infective mosquito feeds on other human host, the infective larvae are deposited at the site of mosquito bite from where the infective larvae get into the lymphatic system. In the human host, the infective larvae develop into adult male and female worms. The adult worms survive for about 5-8 years or sometimes as long as 15 years or more.

MAGNITUDE OF DISEASE

Filariasis has been a major public health problem in India next only to malaria. The disease was recorded in India as early as 6th century B.C. by the famous Indian physician, Susruta in his book **Susruta Samhita**. In 7th century A.D., **Madhavakara** described signs and symptoms of the disease in his treatise 'Madhava Nidhana' which hold good even today. In 1709, Clarke called elephantoid legs in Cochin as **Malabar legs**.

The **discovery** of microfilariae (mf) in the peripheral blood was made first by **Lewis in 1872** in Calcutta (Kolkata).

Indigenous cases have been reported from about 339 districts in 20 States/Union Territories.

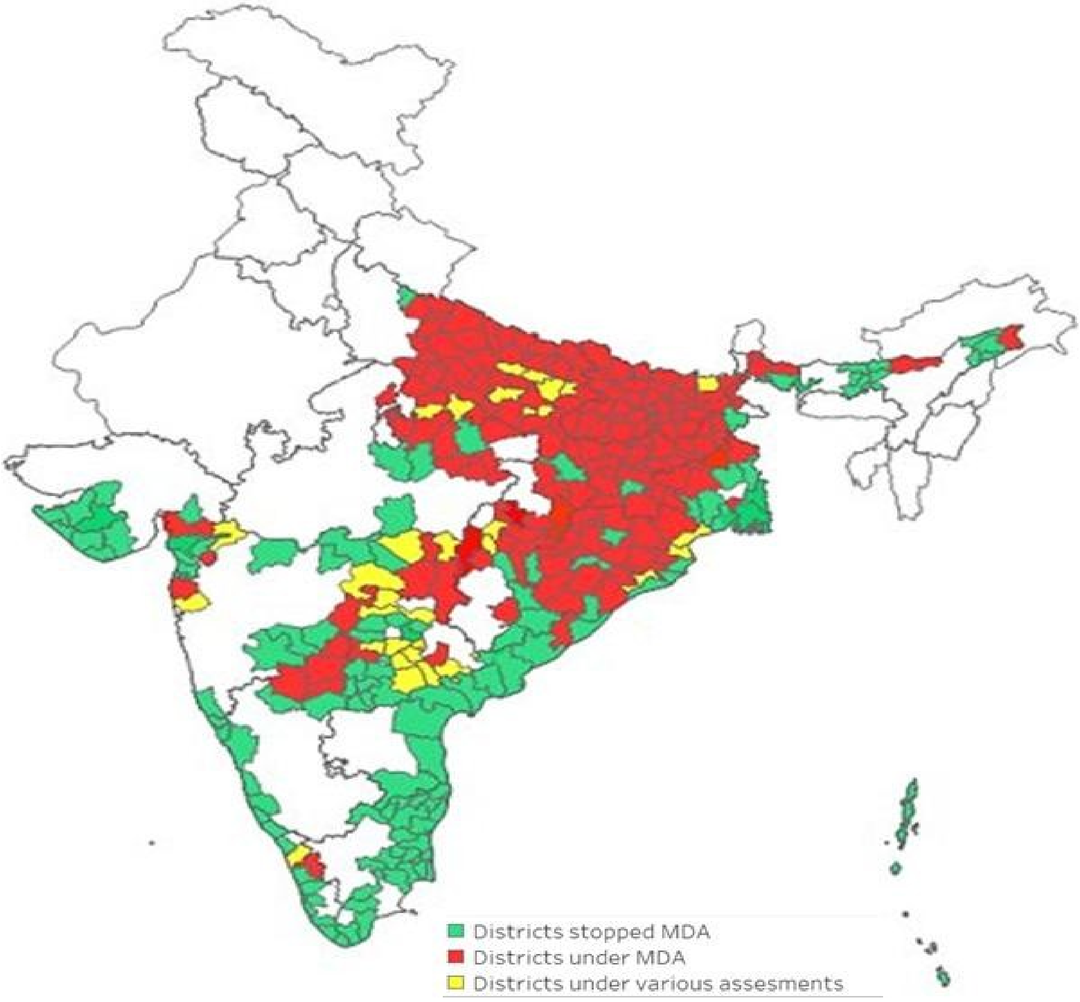
As of 2023, 6.19 lakhs Lymphedema and 1.26 lakhs Hydrocele Cases reported.

The North-Western States/UTs namely Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Chandigarh, Rajasthan, Delhi and Uttaranchal and North-Eastern States namely Sikkim, Arunachal Pradesh, Nagaland, Meghalaya, Mizoram, Manipur and Tripura are known to be free from indigenously acquired filarial infection

Cases of filariasis have been recorded from Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Jharkhand, Karnataka, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal, Pondicherry, Andaman & Nicobar Islands, Daman & Diu, Dadra & Nagar Haveli and Lakshadweep.

FILARIA ENDEMIC DISTRICTS

Back



NATIONAL FILARIA CONTROL PROGRAMME

After a pilot project in Orissa from 1949 to 1954, the National Filaria Control Programme (NFCP) was launched in the country in 1955 with the objective of delimiting the problem, to undertake control measures in endemic areas and to train personnel to man the programme. The main control measures were mass DEC administration, antilarval measures in urban areas and indoor residual spray in rural areas.

NFCP Strategy

- Recurrent anti-larval measures at weekly intervals.
- Environmental methods including source reduction by filling ditches, pits, low lying areas, deweeding, desilting, etc.
- Biological control of mosquito breeding through larvivorous fish.
- Anti-parasitic measures through 'detection' and 'treatment' of microfilaria carriers and disease persons with DEC by Filaria Clinics in towns covered under the programme.

List of State-Wise LF Endemic Districts:
https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/12145485381746781807.pdf

Morbidity Management: https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/LFmorbidity-management.pdf

VL/LF Newsletter 2024:https://ncvbdc.mohfw.gov.in/Doc/VL-LF-Newsletter-December-2023.pdf

Guidelines for Drug Administrator-LF:https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/1038689491533040805.pdf

Use of Albendazole 400 Mg Tablets as Co-Administration for Lymphatic Filariasis Programme -DCGI Letter :https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/Albendazole-DCGI-Letter.pdf

Facilitator Guide for Refusal Conversion for Training of Drug Administrators and Supervisors: https://ncvbdc.mohfw.gov.in/Doc/Guidelines/Fil//Facilitator-Guide-for-Refusal-Conversion-Eng.pdf

Refusal Conversion Strategies and Response: https://ncvbdc.mohfw.gov.in/Doc/Guidelines/Fil/Refusal-Conversion-Eng.pdf

Progress towards ELF Since 2004 in India

Progress towards ELF Since 2004 in India

- **2004**: National campaign of Mass Drug Administration (MDA) with DEC - launched in 202 districts.
- **2006**: NTF recommended DEC+Albendazole in country.
- **2007**: MDA programme was further scaled up to cover all 256 districts
  - WHO increased donation of Albendazole
  - Medical colleges and ICMR/NCDC involved to assess
  - Financial allocation increased to Rs. 50-60 cr per annum
  - IEC/BCC intensified under overall NHM
- **2013**: Validation started through Transmission Assessment Survey (TAS)
- **2016**: Integration with NDD campaign (Feb & Aug)

- **2018**: 10th GALEF meeting held & launched Accelerated Plan of Elimination of Lymphatic Filariasis (APELF)

- **2018**: Triple Drug Therapy (IDA) i.e. DEC + Albendazole + Ivermectin in scheduled districts in phase wise manner.

- **2019**: Revision of financial norms for morbidity management of Lymphoedema Patient from Rs. 150 to Rs. 500
- **2020 -** Expansion of IDA (Domestic procurement of Ivermectin)
- **2021 –** Introduction of Block Level Strategy
- **2022 -** Approval and securing funds for implementation of block level strategy and first Independent Joint Monitoring mission on LF in November 2022.
- **2023 -** LF Symposium held on 13th January 2023 with launch of enhanced 5-pronged strategy with bi-annual MDA.
- **2024** - Launch of Revised ELF guidelines by Shri Prataprao Jadhav, Hon'ble Minister of State (Independent Charge) of Ministry of AYUSH and Ministry of Health & Family Welfare, Government of India along with the launch of August 2024 MDA campaign.
- **2025 -** National Lymphatic Filariasis Training of Trainer on Revised ELF Guidelines along with effectiveness of LF IEC workshop.

Mass Drug Administration (MDA)

- Five-pronged strategy – "Five-pronged Strategy" : https://ncvbdc.mohfw.gov.in/Doc/Five-pronged-Strategy-LF.pdf
- List of Medical Colleges Engaged in LF Programme : https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/49002614281746685871.pdf
- Summary of CES for – (**2023**):https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/47316237511746702002.pdf
- (**2024**): https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/90749419571746696591.pdf

February 2024 State-wise MDA Coverage

State	Total Population	Eligible Population	Population consumed the Drug	% Eligible population	% Total population
Andhra Pradesh	128864	117977	112357	87%	95%
Assam	1237242	1097269	988890	80%	90%
Bihar	69825964	59352069	58951007	84%	99%
Chhattisgarh	14336569	12759787	1165873381	81%	91%
Gujarat	546685	511184	496218	91%	97%
Jharkhand	20581307	18050718	16297094	79%	90%
Karnataka	1867473	1718729	1597804	86%	93%
Kerala	399910	354390	353942	89%	100%
Madhya Pradesh	5556727	5056622	4676425	84%	92%
Maharashtra	5518925	5149881	4968439	90%	96%
Odisha	3618119	3457538	3272756	90%	95%
Uttar Pradesh	10949972	10183474	9910936	91%	97%
West Bengal	12117016	11026485	9655108	80%	88%

TAS Cleared Districts

Year wise TAS details status				
Year wise	**TAS-I**	**TAS-II**	**TAS-III**	**Grand Total**

2013	5			5
2014	34			34
2015	41			41
2016	24	19		43
2017	14	25		39
2018	7	43	17	67
2019	4	16	23	43
2020		14	14	28
2021	3	3	23	29
2022	3	5	29	37
2023	2	3		5
2024	2	1	2	5
2025	2			2
Grand Total	**141**	**129**	**108**	**378**

Japanese Encephalitis

What is Japanese Encephalitis?

Japanese Encephalitis (JE) is a zoonotic viral disease which is caused by the JE virus. The virus is transmitted from animals, birds, pigs, particularly the birds belonging to family Ardeidae (eg. cattle egrets, pond herons etc.) to man by the Vishnui group of **Culex** mosquitoes. It may result in febrile illness of variable severity and affects the central nervous system causing severe complications, seizures and even death. The Case Fatality Rate (CFR) of this disease is high and those who survive may suffer with various degrees of neurological sequelae.

Why is JE called Zoonotic Disease?

JE is basically a disease of animals. Pigs and birds, particularly those belonging to Family Ardeidae (e.g. cattle egrets, pond herons, etc.) are natural hosts. The virus is generally maintained in the enzootic cycle and appears as focal outbreaks under specific ecological conditions. Infection in human beings is caused as a result of spill-over of infection from the zoonotic cycle. At low vector density level, the virus circulates in ardeid birds-mosquito ardeid bird cycle. However, at the commencement of monsoon season and/or increased availability of surface area mosquito breeding places e.g. rice field, irrigation canals etc., the vector population builds up rapidly, the virus from wild birds through vector mosquito species spreads to peridomestic birds and then to mammals like cattle and pigs, etc. and eventually spills over to man.

What are signs and symptoms of JE?

JE virus infection presents classical symptoms similar to any other virus causing encephalitis. It may result in febrile illness of variable severity associated with neurological symptoms ranging from headache to meningitis or encephalitis. Symptoms can include headache, fever, signs of meningitis, stupor, disorientation, coma, tremors, paralysis (generalized), hypertonia, loss of coordination, etc. Clinically it is difficult to differentiate between JE and other viral encephalitis.

How is Japanese Encephalitis transmitted?

The JE virus is transmitted from animals, birds, pigs, particularly the birds belonging to family Ardeidae (eg. Cattle egrets, pond herons etc.) to man by **Vishnui** group **Culex** mosquito. Pigs play an important role in the natural cycle and serve as an amplifier host since they allow virus multiplication manifold without suffering from disease and maintain prolonged high level viraemia. Due to prolonged viraemia, mosquitoes get the opportunity to get infected from pigs easily. Man is a dead-end host in the transmission cycle due to low and short-lived viraemia. Mosquitoes do not get infection from JE patient. There is no human to human transmission of JE.

Vectors of Japanese Encephalitis in India

Japanese encephalitis virus isolation has been made from a variety of mosquito species. **Culicine** mosquitoes mainly **Vishnui** group of **Culex** (Culex tritaeniorhynchus, Culex vishnui and Culex pseudovishnui etc.) are the chief vectors of JE in different parts of India. Culex vishnui subgroup is very common, widespread and breed in water with luxuriant vegetations mainly in rice field and the abundance of vectors is related to rice cultivation, shallow ditches and pools. These vectors are primarily outdoor resting in vegetation and other shaded places but in summer may also rest in indoors.

Japanese encephalitis virus isolation has been reported from various mosquito species found in India, including:

1. Culex tritaeniorhynchus
2. Culex vishnui
3. Culex pseudovishnui
4. Culex bitaeniorhynchus
5. Culex epidesmus
6. Culex fuscocephala
7. Culex gelidus
8. Culex quinquefasciatus
9. Culex whitmorei
10. Anopheles barbirostris
11. Anopheles paeditaeniatus
12. Anopheles subpictus
13. Mansonia annulifera
14. Mansonia indiana
15. Mansonia uniformis

How is JE diagnosed?

JE/AES Case Definition

Suspected JE case:

Acute onset of fever not more than 7 days duration.

and

Change in mental status which may be

-New onset of seizures (excluding febrile seizures) or

-Other early clinical findings –irritability, somnolence or abnormal behaviour greater than that seen with usual febrile illness

Laboratory confirmed JE case:

A suspected case with any one of the following markers:

- Presence of JE virus specific IgM antibody in a single CSF sample or serum detected by IgM Capture ELISA specific for JE.
- Detection of JE virus nucleic acid detection in blood, CSF or tissue by RT PCR or any other sensitive and specific NAAT

- Detection of four fold or greater difference in IgG antibody titre in paired sera collected 14 days apart.
- JE Virus isolation from brain tissue, CSF, serum, blood or plasma
- JE Antigen detection by immunofluorescence

What is the treatment of Japanese Encephalitis?

Management of Encephalitis is essentially symptomatic. To reduce severe morbidity and mortality, it is important to identify early warning signs (irritability, somnolence or abnormal behaviour greater than that seen with usual febrile illness and/or new onset of seizures (excluding simple febrile seizures) and refer patients to nearest Govt. health facility.

Currently, there is no specific antiviral treatment for Japanese encephalitis (JE) that can directly target the virus. Therefore, the management of JE primarily focuses on supportive care to relieve symptoms and complications. Here are the key aspects of treatment for Japanese encephalitis:

1. **Hospitalization:**Severe cases of JE often require hospitalization for close monitoring and medical care. This is particularly important for patients with neurological complications or those experiencing severe symptoms.
2. **Supportive care:**Supportive measures are provided to manage symptoms and help the patient to fight the infection. These may include:

- Medications for fever and pain relief:Acetaminophen (paracetamol) may be given to reduce fever and relieve headache or body aches. Nonsteroidal anti-inflammatory drugs (NSAIDs) are generally avoided due to the risk of bleeding complications.
- Fluid management:Adequate hydration is essential, especially if the patient has high fever, vomiting, or diarrhoea. Intravenous fluids may be administered if necessary.

Is there a vaccine for Japanese Encephalitis?

As per Govt. of India guidelines, 2 doses of JE vaccine have been approved in UIP to be given one along with measles at the age of 9 months and the second dose with DPT booster at the age of 16-24 months w.e.f. April, 2013. JE vaccination in routine immunization has been included in 334 districts out of 355 districts which are considered as endemic districts.

The adult JE vaccination was started in 42 districts of three states where JE incidence is occurring among the adult population, namely Assam (9 districts), Uttar Pradesh (7 districts) and West Bengal (26 districts). JENVAC JE vaccine is used for adult population (15+) in India.

What is the extent of problem of Japanese Encephalitis in India and control activities of JE?

JE viral activity has been widespread in India. The first evidence of presence of JE virus dates back to 1952. First case was reported in 1955.

Here are some key points about the extent of the problem of Japanese encephalitis in India:

Japanese Encephalitis (JE) continues to pose a significant public health problem in India. The first evidence of JE viral activity was documented by Virus Research Centre (VRC-NIV) in 1952. The first human JE case was reported in India in 1955 in Vellore, Tamil Nadu. A major outbreak occurred in 1973 and 1976 in the Burdwan district of West Bengal. In 1978, JE cases started appearing in the North Eastern States (Assam). In 2003, JE was included under National Vector Borne Disease Control Programme (NVBDCP). Since then, JE and Acute Encephalitis Syndrome (AES) have been reported in 355 districts across 24 States/UTs in India.

1. **Endemic regions:** The number of endemic States / UTs have been increased in recent years. Some of the NE States have been included in endemic zone e.g. Assam, Meghalaya, Manipur etc. Other endemic states include Jharkhand, Bihar, Odisha, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Telangana, Karnataka, Tamil Nadu etc. Almost 30-50% of total JE incident cases are found only in Assam in recent years. Outbreaks have been reported from different parts of the country. It is endemic in 355 districts of 24 States/UTs.
2. **Seasonal outbreaks:**JE cases in India often follow a seasonal pattern, with increased transmission during the monsoon (July to August) and post-monsoon period (October to November) when breeding places and mosquito population are increased. Outbreaks typically occur from July to October, peaking during the rainy season.
3. **High burden of cases:**JEV is the main cause of viral encephalitis in many countries of Asia with an estimated 68 000 clinical cases every year (WHO). India accounts for a significant proportion of JE cases in Asia. The exact number of cases can vary from year to year, but several thousand cases are reported annually. However, it is worth noting that the reported numbers may not fully reflect the actual burden.
4. **Impact on vulnerable population:**Japanese encephalitis primarily affects children and individuals living in rural areas, especially those involved in agricultural activities. Children under the age of 15 are particularly susceptible to severe forms of the disease, and the infection can lead to long-term neurological complications or death.
5. **Vaccination efforts:**In response to the burden of Japanese encephalitis, India has implemented vaccination programme in endemic areas. Vaccination coverage has been expanded in recent years, targeting children in endemic regions to reduce the incidence of the disease. Adult vaccination has been started in 3 high prevalent States (Assam, West Bengal and Uttar Pradesh).
6. **Vector control measures:**Mosquito control programme, including larval source reduction, use of insecticide-treated bed nets, and community-based initiatives including awareness campaign are important strategies for prevention and control of JE in affected areas.

Efforts are ongoing to enhance surveillance, improved access to vaccination, and strengthen vector control measures to control JE and mitigate the impact of Japanese encephalitis in India. Public health authorities continue to work towards reducing the burden of the disease through comprehensive prevention and control strategies.

Action taken by Govt. of India towards prevention & control of AES/JE

The steps taken by Govt. of India towards prevention and control of AES/JE are as follows:-

- JE vaccination in Routine vaccination was covered to 334 districts and Adult vaccination covered in 42 of Assam, West Bengal and Uttar Pradesh.
- Re-orientation training course on AES/JE case management is a continuing process. Such orientating training courses were carried out in endemic states.
- Advisories are being sent to all the endemic states before the transmission season.
- The diagnostic facilities have been strengthened to 171 Sentinel Surveillance Hospitals (SSHs) and 15 Apex Referral Laboratories (ARLs). These have been supplied with diagnostic kits, free of cost from National Institute of Virology (NIV), Pune.
- The programme activities and epidemiological situation of all endemic states are reviewed before the transmission season. Guidelines on clinical management of JE was developed.

Chikungunya

Facts about the Chikungunya

FACTS

- Chikungunya (chik'-en-GUN-yah), also called chikungunya virus disease or chikungunya fever, is a viral illness that is spread by the bite of infected mosquitoes.
- The disease resembles dengue fever, and is characterized by severe, sometimes persistent, joint pain (arthiritis), as well as fever and rash. It is rarely life-threatening.
- Chikungunya occurs in Africa, India and Southeast Asia. It is primarily found in urban /peri-urban areas.
- There is no specific treatment for chikungunya.
- Prevention centers on avoiding mosquito bites in areas where chikungunya virus may be present, and by eliminating mosquito breeding sites.

1. What is Chikungunya?

Chikungunya (also known as chikungunya virus disease or chikungunya fever) is a debilitating, but non-fatal, viral illness that is spread by the bite of infected mosquitoes. It resembles dengue fever.

2. Which are the states affected by Chikungunya?

In 2006 Chikungunya re-emerged in the Country. Almost all States are affected by Chikungunya.

3. When was chikungunya epidemic outbreak occurred in the past?

In India a major epidemic of Chikungunya fever was reported during the last millennium viz.; 1963 (Kolkata), 1965 (Pondicherry and Chennai in Tamil Nadu, Rajahmundry, Visakhapatnam, and Kakinada in Andhra Pradesh; Sagar in Madhya Pradesh; and Nagpur in Maharashtra) and 1973, (Barsi in Maharashtra). Thereafter, sporadic cases also continued to be recorded especially in Maharashtra state during 1983 and 2000.

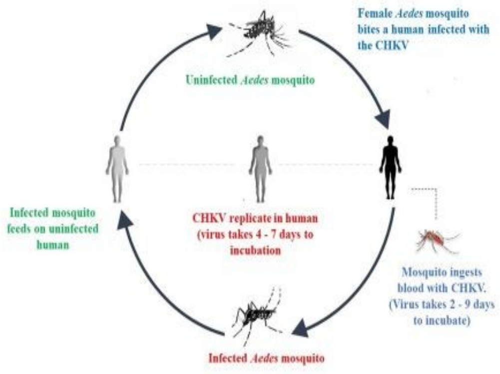
4. What is the infectious agent that causes Chikungunya?

Chikungunya is caused by the chikungunya virus, which is classified in the family Togaviridae, genus Alphavirus.

5.How is Chikungunya spread?

Chikungunya is spread by the bite of an Aedes mosquito, primarily Aedes aegypti. Humans are thought to be the major source, or reservoir, of chikungunya virus for mosquitoes. Therefore, the mosquito usually transmits the disease by biting an infected person and then biting someone else. An infected person cannot spread the infection directly to other persons (i.e. it is not a contagious disease). Aedes aegypti mosquitoes bite during the day time.

TRANSMISSION CYCLE



6. Where is chikungunya found?

Chikungunya occurs mainly in Africa and Southeast Asia. It is sustained by the human-mosquito-human transmission cycle

7. What are the symptoms of chikungunya?

Chikungunya usually starts suddenly with fever, chills, headache, nausea, vomiting, joint pain, and rash. In Swahili, "chikungunya" means "that which contorts or bends up". This refers to the contorted (or stooped) posture of patients who are afflicted with the severe joint pain (arthritis) which is the most common feature of the disease. Frequently, the infection causes no symptoms, especially in children. While recovery from chikungunya is the expected outcome, convalescence can be prolonged and persistent joint pain may require analgesic (pain medication) and long-term anti-inflammatory therapy. Infection appears to confer lasting immunity.

8. How soon after exposure do symptoms appear?

The time between the bite of a mosquito carrying chikungunya virus and the start of symptoms ranges from 4 to 7 days.

9.How is chikungunya diagnosed?

Chikungunya is diagnosed by blood tests (ELISA). Since the clinical appearance of both chikungunya and dengue are similar, laboratory confirmation is important especially in areas where dengue is present. These tests are conducting by identified SSHs (783) & ARLs (17) by IgM kits supplied by NIV to the identified SSHs & ARLs.

10. Who is at risk for chikungunya?

Anyone who is bitten by an infected mosquito can get chikungunya.

11.What is the treatment for chikungunya?

There is no specific treatment for chikungunya.

NCVBDC recommends to follow Clinical Management of Chikungunya Fever – 2016 available at https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/77728737401531912419.pdf

12. How common is chikungunya globally?

The first recognized outbreak occurred in East Africa in 1952-1953. Soon thereafter epidemics were noted in the Philippines (1954,1956 & 1968), Thailand, Cambodia, Vietnam, India, Burma, and Sri Lanka. Since 2003, there have been outbreaks in the islands of the Pacific Ocean, including Madagascar, Comoros, Mauritius , and Reunion Island . In January 2006, in an epidemic that is currently ongoing in Reunion Island, over ten thousand cases have been reported. It is suspected that many cases of chikungunya are either misdiagnosed or go unreported.

13.How can chikungunya be prevented?

There is neither chikungunya virus vaccine nor drugs are available to cure the infection. Prevention, therefore, centres on avoiding mosquito bites. Eliminating mosquito breeding sites is another key prevention measure. To prevent mosquito bites, do the following:

- Use mosquito repellents on skin and clothing
- When indoors, stay in well-screened areas. Use bed nets if sleeping in areas that are not screened or air-conditioned.
- When working outdoors during day times, wear long-sleeved shirts and long pants to avoid mosquito bite.

14.How can Aedes mosquito breeding be controlled?

(a) Source reduction Method

1. By elimination of all potential vector breeding places near the domestic or peri-domestic areas.
2. Not allowing the storage of water for more than a week. This could be achieved by emptying and drying the water containers once in a week.

- Straining of the stored water by using a clean cloth once a week to remove the mosquito larvae from the water and the water can be reused. The sieved cloth should be dried in the sun to kill immature stages of mosquitoes.

(b) Use of larvicides

1. Where the water cannot be removed but used for cattle or other purposes, Temephos can be used once a week at a dose of 1 ppm (parts per million).
2. Pyrethrum extract (0.1% ready-to-use emulsion) can be sprayed in rooms (not outside) to kill the adult mosquitoes hiding in the house.

(c) Biological control

1. Like introduction of larvivorous fish, namely Gambusia and Guppy in water tanks and other water sources.

For details follow Integrated Vector Management 2022. Link is https://ncvbdc.mohfw.gov.in/Doc/Guidelines/Manual-Integrated-Vector-Management-2022.pdf

Chikungunya Situation in India

Chikungunya Cases in the Country since 2019

Sl. No.	Affected States/UTs	2018		2019		2020		2021		2022		2023		2024		2025*	
		No. Susp	No. of co	No. Susp	No. of co	No. Susp	No. of co	No. Susp. chi	No. of co	No. Susp. chi	No. of co	No. Susp. chi	No. of co	No. Susp. chi	No. of co	No. Susp	No. of co

		. Chik. cases	nf. cases	. Chik. cases	nf. cases	. Chik. cases	nf. cases	k. cases	nf. Cases	k. cases	nf. Cases	k. cases	nf. Cases	k. cases	nf. Cases	. Chik. cases	nf. Cases
1	**Andhra Pradesh**	622	79	832	88	318	28	753	48	1611	26	441	17	4213	266	1313	45
2	**Arunachal Pd.**	507	1	332	55	0	0	0	0	0	0	9	0	16	2	0	0
3	**Assam**	3	3	0	0	0	0	2	2	0	0	100	16	69	16	0	0
4	**Bihar**	156	156	594	594	38	38	40	40	67	67	23	23	520	520	54	9
5	**Chhattisgarh**	0	0	0	0	0	0	0	0	252	1	66	5	751	122	43	11
6	**Goa**	455	77	867	366	64	15	114	12	868	106	861	8	353	10	82	2
7	**Gujarat**	10601	1290	8084	669	8120	1061	32372	4044	20855	1046	24124	513	29143	702	3829	64
8	**Haryana**	62	3	0	0	930	14	765	21	2425	242	9472	612	2766	55	23	1
9	**Himachal Pradesh**	-	-	-	-	-	-	-	-	253	6	696	19	61	13	29	1
10	**Jharkhand**	3405	851	1691	169	627	157	1064	215	2113	249	7154	762	4780	320	834	33
11	**Karnataka**	20411	2546	43698	3664	16111	1326	40134	2188	65340	2312	72662	1910	78217	2954	8892	238
12	**Kerala**	77	77	109	109	2302	752	3030	334	1511	81	1099	31	889	29	130	6
13	**Madhya Pd.**	3211	1609	2749	756	1871	133	3822	397	4252	399	8947	315	13677	1321	1303	113
14	**Meghalaya**	44	2	114	48	3	0	0	0	0	0	128	16	169	19	10	0
15	**Mizroram**	93	10	0	0	34	0	0	0	195	53	511	44	194	3	0	0
16	**Maharashtra**	9884	1009	5158	1646	4258	782	21680	2526	14785	1087	31181	1702	57509	5854	9109	592
17	**Manipur**	2	0	40	3	0	0	0	0	0	0	0	0	0	0	0	0
18	**Nagaland**	Non Endemic										72	1	6	1	0	0
19	**Odisha**	0	0	242	21	15	2	0	0	0	0	0	0	107	18	29	0
20	**Punjab**	736	25	372	11	25	0	644	144	1087	469	6574	2072	2258	224	191	5
21	**Rajasthan**	254	254	365	365	1015	1015	1157	1157	212	212	305	305	1268	1268	119	119
22	**Sikkim**	384	28	1126	95	253	13	457	32	1863	4	1116	2	673	1	29	0
23	**Tamil Nadu**	284	284	623	623	1461	224	3654	153	4365	181	4805	222	3091	674	1258	242
24	**Telangana**	1954	489	5352	1358	364	183	220	76	6608	107	761	51	13592	452	795	83
2	**Tripura**	68	75	11	12	45	27	948	20	88	17	155	18	286	36	8	3

5		3		05	5	4				5		7	8	4	0	8	
26	**Uttar Pradesh**	58	58	72	72	53	53	70	70	200	200	10615	1401	1077	1077	69	69
27	**Uttarakhand**	29	7	1	1	0	0	3	1	2000	593	269	17	1164	552	208	71
28	**West Bengal****	52	23	NR	NR	391	82	154	20	1533	148	762	32	1734	163	NR	NR
29	**A& N Island**	205	27	702	53	610	16	187	0	65	0	654	32	0	0		
30	**Chandigarh**	357	4	82	0	0	0	397	7	3600	155	415	8	537	1	0	0
31	**D&N Haveli**	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
32	**Delhi**	407	407	520	520	126	126	112	112	61	61	153	153	7447	344	11	11
33	**J&K**	1	1	0	0	1	1	7	7	37	5	4042	892	1606	326	33	1
34	**Lakshadweep**	NR	NR	NR	NR	-	-	-	-	103	0	127	0	525	1	135	0
35	**Puducherry**	2876	361	7084	794	3980	276	7284	264	11440	239	10363	108	8904	262	2260	22
	Total	**57813**	**9756**	**81914**	**12205**	**43424**	**6324**	**119070**	**11890**	**148587**	**8067**	**200064**	**11477**	**240180**	**17930**	**30876**	**1741**

NR =Not reported || Susp. = Suspected || Chik.=Chikungunya || * Provisional till 31st March 2025

**2023: WB reported data till 13.9.2023

Tuberculosis

1. **What is tuberculosis?**

Tuberculosis (TB) is an infectious disease caused by the bacteria Mycobacterium tuberculosis. TB usually affects the lungs, but it can also affect other parts of the body, such as the brain, the kidneys, the spine, etc.,

2. **How do I know if I have TB?**

Symptoms of TB are usually specific to the site affected by the bacteria. Although there are some symptoms common to all types of TB, an indicative list of symptoms is given hereunder (if you experience any symptoms associated with TB, you must visit a health centre and get yourself tested immediately):

Symptoms of Pulmonary TB or lung TB:

- Persistent cough for two weeks or more
- Chest pain
- Shortness of breath
- Blood in sputum

Symptoms of Extra Pulmonary TB depend on the site/organ affected:

- Brain TB/meningitis-vomiting, severe headache, neck stiffness etc
- Lymph node TB - enlarged lymph nodes
- Bone TB – Pain and tenderness around affected bone area
- Abdominal TB – abdominal pain, intestinal swelling, intestinal obstruction

Common symptoms

- Weight loss
- Fatigue
- Evening rise of temperature (Fever)
- Night sweats

3. **What do I do if I notice symptoms of TB; is TB diagnosis and treatment expensive?**

Under the National TB Elimination Program, all diagnostic and treatment services across the country are free of cost. These services are available at all public health facilities, and a large number of private facilities as well. Do not allow any delays for yourself or anyone you know to get screened for TB, it will ensure patients receive the right treatment early and cut TB transmission within families and close contacts.

4. **How do I locate a TB diagnostic centre in my district?**

You can download the TB Aarogya Saathi app on your phone and go to “Health Facilities” to find both government and private sector TB health centres in your districts. You can also find the names and contact numbers of point persons at those health facilities. You could also call the toll-free number 1800- 11- 6666 for further help and information.

5. **What is extrapulmonary TB?**

Extrapulmonary tuberculosis (EPTB) refers to TB infection that occurs outside of the lungs. While pulmonary TB affects the lungs, extrapulmonary TB can affect other parts of the body. It is caused by mycobacterium tuberculosis bacteria, just like pulmonary TB, but instead of the lungs, it impacts organs or tissues such as:

1. Lymph nodes: Commonly known as tuberculous lymphadenitis.
2. Pleura: The membrane surrounding the lungs, leading to pleural TB.
3. Bones and joints: Known as skeletal or osteoarticular TB, which can affect the spine (Pott's disease).
4. Genitourinary system: Including the kidneys and reproductive organs.
5. Central nervous system: Tuberculous meningitis is a serious form where TB affects the brain and spinal cord.
6. Pericardium: The membrane around the heart.
7. Gastrointestinal tract: Including the intestines or peritoneum.

In India, EPTB accounts for 20-24% of all cases, and in the pediatric age-group accounts around 44% of cases.

6. **How is TB diagnosed?**

TB is diagnosed by demonstrating TB bacteria in a clinical specimen taken from the patient. While other investigations may strongly suggest tuberculosis as the diagnosis, they cannot confirm it. Pulmonary TB is diagnosed through sputum smear microscopy and/or Chest X-Ray. In Extra-pulmonary TB it is usually difficult to demonstrate TB bacteria, hence the diagnosis is made based on clinical suspicion and special tests depending on the organ affected. For instance, TB of the lymph nodes is diagnosed by a special test called FNAC (Fine Needle Aspiration Cytology).
In addition, NAAT (nucleic acid amplification test) is increasingly being used for diagnosing TB. They are highly accurate and rapid molecular tests. In addition to detecting TB, it also detects drug resistance to one of the potent anti-TB drugs, Rifampicin.

7. **Is TB curable?**

TB is curable if the prescribed drugs are taken regularly for the complete duration.

8. **Is TB always infectious?**

Microbiologically confirmed pulmonary TB patients (people with lung TB) are infectious. However, these patients don’t remain infectious, if at least 2 weeks of Anti-TB medicines are adhered to. It is important to complete the entire duration of medication. In comparison, if it's a case of TB affecting other organs (other than the lung), then they are not infectious.

Wearing a mask potentially cuts transmission of the disease/infection, therefore person who has cough for any duration (even if not yet tested) is encouraged to wear a mask.

9. **How does TB spread? Am I likely to spread the infection if I share food or shake hands with someone too?**

TB spreads when a person with active lung TB talks, sings, coughs, or sneezes releasing TB bacteria in the air, in the vicinity of susceptible individual. However, TB does not spread through handshakes, using public toilets, sharing food and utensils, and casual contact. TB patients can continue living their normal lives after treatment completion. They should cover their mouth and nose while coughing and sneezing as a practice.

10. **How long does it take to recover from TB?**

The duration and nature of TB treatment depend upon the resistance to drugs available for treatment. For drug-sensitive TB patients, the treatment is generally six months. Some patients might have resistance to one or few of the drugs used to treat TB. In that case, the treatment might be longer. After the diagnosis of TB, patients are offered cascade testing to check if they are resistant to any line of TB drugs. Patients may be diagnosed with DR-TB (Drug-Resistant, MDR-TB (Multi-Drug Resistant), pre-XDR (pre-extensively drug-resistant TB), or XDR-TB (Extensively drug-resistant TB) depending upon the TB drugs they are resistant to. In case there are any side effects to the treatment, do not stop medication and consult your doctor immediately. Another critical point to remember is that for the first two years after recovering from TB, a patient must conduct a regular follow-up with one's doctor.

11. **What kind of stigma is associated with TB?**

In India, a variety of stigma, misinformation and myths surround TB. A lot of times people believe a TB patient has done something "wrong" because of which they have contracted the disease. Certain misconceptions, like the belief that TB patients are perpetually infectious, persist. TB is falsely considered a "family disease" due to its possible spread within households. Women with TB may face heightened stigma. However, none of these beliefs, information is accurate, and it is the duty of each individual to ensure TB patients receive a supportive environment to complete their treatment.

12. **I have TB. What kind of diet should I follow?**

TB patients should consume a protein-rich, nutritionally diverse and balanced diet that has all nutrients in the required proportions. For example, the diet may include cereals (maize, rice, sorghum, millets, etc.); pulses (peas, beans, lentils, etc.); oil; sugar, egg, fish etc.

13. **What kind of social support am I entitled to from the government especially to address nutrition needs?**

India is one of the few countries that have a universal social support programme for all TB patients. Under the "Nikshay Poshan Yojana", the Government of India provides a direct benefit transfer of Rs. 1000 each month to TB patients for the entire duration of their treatment as nutrition support. Nutrition is a key component of TB treatment and plays a catalytic role in ensuring TB patients successfully complete treatment. In case you are facing any issues in receiving your nutritional benefits, you can call the toll-free number 1800- 11- 6666 for further help and information.

14. **Who can be affected by TB?**

Anyone can be affected by TB but there are few conditions that increase the likelihood of developing active TB disease. These include:

- Close prolonged contact with a person with Pulmonary TB
- Being in an overcrowded environment
- Smoking
- HIV infection
- Malnutrition
- Diabetes patients
- Patients on immunosuppressive drugs (anti-cancer, corticosteroids etc.)
- Certain lung diseases like silicosis which causes scarring of the lungs

15. **Should a TB patient be dealt with differently within the household and/or community?**

TB patients, must be supported through their recovery and encouraged to complete their treatment and to take a nutritious diet. There is no need to ostracize TB patients or spread unverifiable and incorrect information about the disease. With complete and correct treatment, TB is completely treatable.

16. **What do I do if my family member has TB?**

As a caregiver, ensure that TB patients complete their prescribed treatment and take a nutritious diet during and post their treatment. If they have lung TB and you were in close prolonged contact with them, contact your nearest health centre to take professional advice. You can find the centres through the “Health Facilities” section in the TB Aarogya Saathi app.

17. **What are the side effects of TB drugs?**

Not everyone suffers from the side effects of TB drugs. But sometimes TB patients can have adverse reactions to drugs, and these may include nausea, vomiting, gastritis, itching etc. In this case, the patient should contact their treatment provider and not stop the treatment. Incomplete treatment can lead to drug resistance.

18. **How are TB and COVID-19 related? Can one disease act as a risk factor for the other?**

TB and COVID-19 both primarily affect the lungs although TB is caused by bacteria and COVID-19 by a virus. Many symptoms of COVID-19 and TB are similar as well. Therefore, if you have symptoms such as cough, fever, and difficulties in breathing, get yourself tested for both COVID-19 and tuberculosis.

19. **How are TB and HIV related?**

HIV is the strongest risk factor for tuberculosis among adults as it adversely affects the immune system. An HIV-positive person is 20-40 times more likely to develop TB disease once infected as compared to an HIV-negative person.

20. **Can TB be cured in HIV co-infected patients?**

TB is curable in patients who suffer from HIV using the same medicines which are used to treat HIV-negative TB patients. However, HIV/TB co-infected patients require additional medications such as Antiretroviral Therapy (ART) and Co-trimoxazole preventive therapy (CPT) to prevent other opportunistic infections.

21. **How is it assessed whether the patient is responding to TB treatment?**

The response to treatment in the case of patients with pulmonary TB is assessed by follow-up sputum examinations/culture done at regular intervals over the course of treatment. The sputum examination is also done at the end of the treatment to declare the patient cured. The response in extra-pulmonary TB patients is assessed through clinical improvement and follow-up investigations such as X-rays, CT scans, etc. depending on the site affected.

22. **Since the treatment duration is long, what happens if a patient shifts their place of residence?**

There is a provision of 'Transferring Out' to ensure continuity of treatment and care services if a patient shifts their residence to anywhere in the country. The patient simply needs to inform the programme officials in the district where s/he was originally notified about her/his location change. The details are automatically updated via the Ni-kshay system. All medications and social support benefits can then be availed by the patient in the new location of residence. The remaining treatment is then continued at the treatment centre or unit nearest to the new residence of the patient.

21 I have a regular doctor who is my family physician. Can I go to him/her for guidance on TB?

You can consult any certified MBBS doctor for medical advice. They are best placed to diagnose and provide treatment. It is important to remember that TB is diagnosed through appropriate sputum examinations and/or molecular diagnostic testing.

IDDCP

Iodine Deficiency Disorder Control Programme (IDDCP)

Rationale:

The National Iodine Deficiency Disorders Control Programme (NIDDCP) started in our state in Dec '1989. It is a 100% Central Plan Scheme. Iodine Deficiency Disorders are a group of diseases starting from a visible goitre in the neck to many physical and mental disorders like dwarfism. Cretin, squint, abortion, stillbirths and impaired mental functions due to low intake of Iodine in food.

Objectives :

- The aim of the programme is to prevent Iodine Deficiency Disorders like the incidence of Goitre: Physical & Mental disorders cretinism & deaf mutism etc. in the State.
- To conduct the I.D.D Surveillance through Medical Colleges/Research Institutions in endemic districts as per guide line of Govt. of India.

Strategies:

- Assess the magnitude& distribution of I.D.D Prevalence.
- Identify high-risk populations.
- Monitoring progress towards achieving long-range goals to create awareness among the people through I.E.C activities regarding use and benefits of Iodised Salt.
- Evaluation of Control Programmes.

Activities:

- Health Education & Publicity
  - IEC through observation of Global 100 Prevention Day on 21st October.
  - IEC through Electronic media.
  - IEC through Sensitisation Seminars
  - Public awareness Camp on IDD
- IDD/GOITRE Survey
  - IDD/Goitre Survey work to be undertaken in remaining un-surveyed 20 districts as per Guideline of Govt. of India in phased manner taking help of 3 Medical Colleges of the State. So, 20 districts have got to be surveyed within a period of 5 years.
- Establishment of IDD Monitoring Laboratory
  - As per Govt. of India Guideline - for analysis of Salt Samples and Urine samples, an IDD Monitoring Laboratory.

NVBDCP

National Vector Borne Disease Control Programme (NVBDCP)

Rationale:

Vector Borne Diseases like Malaria and Filaria pose immense public health concern and continue to be major causes of significant morbidity and mortality in the state. These diseases are prevalent both in rural and urban areas mostly among lower socio-economic groups of the population, the marginalized and disadvantaged. The dynamics of these diseases are largely determined by eco-epidemiological, socio-economic and water management systems. Children, young adults, representing economically productive sections and pregnant women are the most vulnerable groups, although all age groups are affected. However Dengue and Chikungunya are recently emerging diseases.

For the malaria control Programme, out of 30 districts, 13 are covered under financial support from World Bank and 16 districts from GoI and state govt. to accelerate anti-malaria activities and improve delivery of services especially in remote and inaccessible pockets.

Objectives :

Government of India in its National Health Policy (2002) has pledged commitment to reduce mortality on account of malaria by 50% by 2010 & additional 10% by 2012 and efficient morbidity control and elimination of lymphatic filariasis (ELF) by 2015

Strategies:

Early Diagnosis and Complete Treatment (EDCT)

- To facilitate early diagnosis and complete treatments to malaria positive cases especially diagnosis of Pf cases through RDT and treatment with Artemesinin based combination therapy (ACT)
- Microscopic Centers to examine the blood slides at CHC, SDH and DHH level.
- Providing adequate anti malarial drugs, RDKs, microslides, pricking needles and other accessories.
- Establishment of FTD (Fever Treatment Depots) at village level
- Engagement of Van Samrakshan Samiti (VSS) animators as FTD in deep forest areas through community involvement and ensuring availability of antimalarial drugs and diagnostic tools with these functionaries.
- As a state initiative, Artesunate injection was provided to referral hospitals for treatment of complicated malaria cases.

Integrated Vector Management (IVM)

- Indoor Residual Spray (IRS) twice in year during transmission season in selected high risk areas having API>5 with DDT 50% and SP 5%
- Distribution of Long Lasting Insecticidal Nets (LLIN) in high risk areas having API>2 in a cluster approach
- Impregnation of community owned bed nets with suitable insecticide.
- Biological control through larvivorous fish
- Elimination of vector breeding sources

Supporting strategies

- Capacity building of medical, para medical, NGO/CBO and community volunteers
- Suitable health communication programme and Public Partnership Initiative (PPP)
- Engagement of suitable manpower addition

Activities:

EDCT (Early Diagnosis and Complete Treatment)

Establishment of FTD (Fever Treatment Depots), through community involvement and ensuring availability of antimalarial drugs to these functionaries. The new initiatives like ACT and Rapid Diagnostic Kits (RDK) have been introduced. These are being used in high endemic villages with poor health and communication infrastructure. Establishment sentinel surveillance sites at DHH/SDH/CHC to monitor Pf trend , treatment of severe and complicated malaria

IVM (Integrated Vector Management)

IRS:

Indoor Residual Spray (IRS) is an important measure for transmission risk reduction. This is being applied selectively in high risk pockets with DDT & synthetic pyrethroids. Emphasis has been given to meticulously follow the microplans, advance intimation to community, training of personnel and adequate supervision.

LLIN/ITN

In order to reduce man mosquito contact, use of LLIN / treated bed nets with suitable insecticide which has knock down and repellant effect has been introduced in the project. LLIN have been first time introduced in 2009-10 in Orissa and so far 18.99 lakh LLINs have been distributed through a cluster approach. Under MO Mashari scheme LLINs are being provided to pregnant women in high burden areas and ITNs to boarders of tribal residential school though out the state.

Larvivorous fish (Biological Control Agent)

Use of larvivorous fish in identified water bodies with mosquito larvae is cost effective and eco-friendly vector control measure. To prolifer fish (Gambusia affinis) hatcheries has been established at District level & Block level. Mapping of breeding sites has been done for release of fish in those sites prior to monsoon.

Capacity building (Training)

To enhance performance of different categories of personnel in the progrmme different training courses are being organized.

B.C.C. (Behaviour Change Communication)

Behaviour change communication is being undertaken in the state for enhancing awareness, empowerment and mobilization in the community in respect of malaria and other vector borne diseases. For building up support for the programme among intersectoral partner organisations, influential sectors of society (Corporate houses, political representatives, social activists, media, non-health sector departments etc.) intersectoral collaboration workshops have been suggested. For dissemination of messages, a multimedia strategy has been developed including print media, display media, electronics media, IPC & Folk media etc. Further advocacy workshops at different level have been suggested for enhancing social mobilisation.

Operational Research

Resistance status of parasites to the conventional antimalarials and resistance status of vector mosquitoes to different insecticides used in the programme is an essential component to be studied at regular intervals. Further impact assessment of LLIN /ITN use and BCC activities under the Programme also planned to be evaluated periodically.

New initiatives

Public - Private Partnership: Partnership with private sector, Non-Governmental Organisations (NGOs), Faith Based Organisations (FBOs), Community Based Organisations (CBOs) & local self Government (PRIs) are being taken up under the programme.

Monitoring Supervision

To facilitate monitoring of Programme implementation at field level, visits of state level, district level and block level officers as well as specially designed check lists have been circulated and funds under mobility support for all categories of staff has been reflected in the action plan. Rapid monitoring mechanisms like Lot Quality Assurance Sampling (LQAS) has been made operational in 18 districts.

IDSP

Integrated Disease Surveillance Programme (IDSP)

Rationale:

The project development objective is to improve the information available to the government health services, NGO sector, medical colleges and private health care providers on a set of high-priority diseases and risk factors, with a view to improve the on-the-ground responses to such diseases and risk factors.
Specifically, the project aims:

- To establish a decentralized state based system of surveillance for communicable and non-communicable diseases, so that timely and effective public health actions can be initiated in response to health challenges in the country at the state and national level.
- To improve the efficiency of the existing surveillance activities of disease control programs and facilitate sharing of relevant information with the health administration, community and other stakeholders so as to detect disease trends over time and evaluate control strategies.

The project will assist the Government of India and the states and territories to:

- Start/ strengthen surveillance for a limited number of health conditions and risk factors
- Strengthen data quality, analysis and links to action
- Improve laboratory support
- Train stakeholders in disease surveillance and action
- Decentralize surveillance activities
- Ensure greater coordination between various sectors
- Integrate disease surveillance at the state and district levels, and involve communities and other stakeholders.

Integrated Disease Surveillance Program (IDSP) is intended to be the backbone of public health delivery system in the country. It is expected to

- Provide Essential data to monitor progress of on going disease control programs and help in optimizing the allocation of resources.
- Be able to detect early warning signals of impending outbreaks and help initiate an effective response in a timely manner.
- Monitor trends of chronic diseases/ risk factors for non-communicable diseases.
- Prevent potential outbreaks.
- Facilitate the study of disease patterns in the country and identify emerging and reemerging diseases.
- Evaluating interventions, for example, vaccination programs.

- Play a crucial role in obtaining political and public support for the health programs in the country. Surveillance data can be effectively used for the purpose of social mobilization to help the public participate actively in controlling important diseases.

List of Core diseases: A total of 13 diseases both communicable and non-communicable have been included for the surveillance as per the decision of the IDSP committee. These have been grouped as per the types of surveillance into

- Regular surveillance
- Sentinel surveillance
- Regular periodic surveys

Objectives

- To improve information availability for a set of high priority diseases.
- To strengthen existing data system on communicable and non-communicable diseases through improved surveillance.

Strategies:

Regular Surveillance:

Vector Borne Disease: 1. Malaria (Other vector-borne diseases under this group) Like Dengue, JE, Leishmaniasis, Chikungunniya etc.

Water Borne Disease: 2. Acute Diarrhoeal Disease (Cholera)

Respiratory Diseases: 3.Typhoid:

4.Tuberculosis

Vaccine Preventable Diseases: 5.Measles

Diseases under Eradication: 6.Polio

Other Conditions: 7.Road Traffic Accidents (Link up with Police Computers)

Other International Commitments 8.Plague

Unusual Clinical Syndromes: 9.Menigoencephalitis / Respiratory Distress, Hemorrhagic fevers and other undiagnosed conditions

Sentinel Surveillance:

Sexually transmitted diseases / Blood borne: 10. HIV / HBV, HCV

Other Conditions: 11. Water Quality

12. Outdoor Air Quality(Large Urban Centres)

Regular Periodic Surveys:

NCD Risk Factors: 13.Anthropometry,Physical Activity, Blood Pressure, Tobacco, Nutrition, Blindness

& any other unusual Health condition.

GOI may include in a public health emergency – subject to agreement at the next joint project review mission; project funds could be used for these surveillance activities.

State Specific Diseases under Surveillance (Provisional)

The following state specific diseases (provisional) will be kept under surveillance since they are of public health concern for the state of Orissa.

- Filariasis
- Leprosy

Administrative and technical structure at state level in IDSP:

State Surveillance Committee

A state surveillance committee has been set up under the chairmanship of the Health Secretary to oversee all the surveillance activities in the state and will be administratively responsible for program activities in the state. The chairmanship by the Health Secretary is vital considering that the coordinating role of this committee with other departments during large-scale epidemics is going to be very vital and it was felt that the Health Secretary would be in a better position to do so.

State Surveillance Unit

Joint DHS (PH) is the State Surveillance Officer, State Epidemiologist, Surveillance Medical Officer will assist the State Surveillance Officer. Data Entry is managed by 3 DEOs, One Administrative Asst. and One Helper is in position. State Finance Manager of Orissa State Health & FW Society will manage the work of Consultant Finance. Consultant Training will be recruited soon.

The function of the State Surveillance unit

- Collation and analysis of data received from districts and transmitting to Central Surveillance Unit.
- Coordinating activities of rapid response teams and deputing them to the field.
- Monitoring and reviewing the activities of the district surveillance units including checks on validity of data, responsiveness and functioning of the laboratories.
- Coordinating the activities of the state public health laboratories, medical colleges and other state level institutions.
- Sending regular feedback to the district units on the trend analysis of data.
- Coordinating all training activities under the project.
- Organizing meeting of the State surveillance committee.

District Surveillance Committee

The district surveillance committee will be responsible for the regular running of the program at the district level. The district surveillance committee will be chaired by the District Collector / District -Magistrate.

District Surveillance Unit

Asst. District Medical Officer (Public Health) is the District Surveillance Officer. Data Entry is done by the existing DEOs dealing with disease surveillance activities. Administrative Asst. and Account Asst. has been reallocated within the existing staffs.

The functions of the district surveillance unit

- Collation and analysis of data received from districts and transmitted to the State Surveillance Unit.
- To constitute rapid response teams and deputing them to the field whenever needed.
- Implementing and Monitoring all project activities.
- Coordinating with public health laboratories, medical colleges, NGOs and private sectors.
- Sending regular feedback to the reporting units on analysis of data.
- Coordinating training and IEC activities within the district.
- Organizing meetings of the district surveillance committee

Activities:

Project Activities

- Upgradation of Laboratories
- Information Technology and Communication
- Human Resources and Development
- Operational Activities and Response
- Monitoring and Evaluation
- Funds released on the basis of National PIP where in 30 District HQ Hospitals and 157 CHCs have been taken into consideration.
- The State PIP duly projected 314 Block PHC / CHCs. The funds provided to the State under different components like Training, Operational Cost IEC activities, etc. are adequate.

- Central Surveillance Unit vide their Letter No. T.18015/27/2004-IDSP Dt. 25/09/06 allowed the States to incur the expenditure under various components as per the approved guidelines and utilize the funds available with them irrespective of the component wise allocation.
- State Surveillance Unit, Orissa has given a proposal for reallocation of funds for training components to Central Surveillance Unit and utilize the funds available with the State within October 2006 to March 2007.

Activities

- Civil Works: - Civil works of the District surveillance Unit and State Surveillance Unit an amount of Rs. 43,40,000/- released. For District Public Health Lab and State Public Health Lab an amount of Rs. 43,40,000/- released. (Total – Rs. 86,80,000/-)
- Furniture and Fixtures: - An amount of Rs. 18,60,000/- has been released to the District surveillance Unit and State Surveillance Unit for furniture and fixtures. For District Public Health Lab and State Public Health Lab an amount of Rs. 18,60,000/- released. (Total – Rs. 37,20,000/-)
- Operational Cost: - In the operational cost component, an amount of Rs. 6,28,000/- has been released to the Peripheral Surveillance Unit and Rs. 7,50,000/- released to the District Surveillance Unit and Rs. 1,22,000/- for State Surveillance Unit released. (Total - Rs. 15,00,000/-)
- IEC Activities: - An amount of Rs. 15,00,000/- has been released to the State Surveillance Unit for printing of Oriya Manual for Health Workers, Printing of Reporting Formats & Registers for IDSP.

Training

- At the State level, training of District & State Surveillance team members has been completed by National Institute of Epidemiology, Chennai.
- Out of 125 members, 119 have been trained till December 2006.
- For training of other categories
  - Medical Officers
  - Health Worker (M&F) & Health Supervisors (M&F) and Pharmacists
  - Laboratory Technician
  - Data Entry Operators
- An amount of Rs. 1,13,25,758/- has been worked out keeping the duration of training constant and reducing financial norms on per diem, refreshment, travel, contingency etc. As the amount exceeds the amount projected in the National PIP, Central Surveillance Unit is being requested to approve the same to conduct all categories of training within the month of March 2007.

Laboratory Equipment & Consumables

- Laboratory assessment of district laboratories in relation to space, equipment, personnel and tests undertaken is underway.
- After lab assessment, the central surveillance unit will provide major lab equipment and other minor lab equipment & consumables will be procured locally in consultation with the other disease control programmes like Malaria, TB etc.

Office Equipments

The State is allowed to procure telephones and air conditioners initially and other equipment like Photocopiers, OHP, Fax, LCD Projectors etc were to be procured centrally and supplied to the States. But now Central Surveillance Unit has intimated that all the office equipment and lab equipment like auto clave and hot air oven, UPS etc. have been decentralized and will be procured by the State.

Personnel

Existing Staff of State Disease Surveillance Cell redeployed under IDSP and will be paid remuneration from October 2006 onwards from IDSP. At the District Surveillance Unit, the Administrative Asst. and the Account Asst. have been identified from within the existing staff and will be provided incentives.

SCD (AP rural south india)

Epidemiology of Sudden Cardiac Death in Rural South India

Abstract

Background

Sudden cardiac death (SCD) is a common initial presentation of coronary artery disease (CAD). Despite the growing epidemic of CAD in India, the epidemiology of SCD is largely unknown.

Objective

The objective of the study was to define the prevalence and determinants of sudden cardiac deaths in rural South India.

Methods

Prospective mortality surveillance was conducted in 45 villages (180,162 subjects) in rural South India between January 2006 and October 2007. Trained multipurpose health workers sought to do verbal autopsies within 4 weeks of any death. Detailed questionnaires including comorbidities and circumstances surrounding death were recorded. SCD was adjudicated using the modified Hinkle-Thaler classification.

Results

A total of 1916 deaths occurred in the study population over the 22 month time period and verbal autopsy was obtained in 1827 (95%) subjects. Overall mean age of the deceased was 62 ± 20 years and 1007 (55%) were men.

Cardiovascular and cerebrovascular diseases together accounted for 559 deaths (31%), followed by infectious disease (163 deaths, 9%), cancer (126 deaths, 7%) and suicide (93 deaths, 5%).

Of the 1827 deaths, after excluding accidental deaths (89 deaths), 309 deaths (17%) met criteria for SCD. Cardiovascular disease was the underlying causes in the majority of the SCD events (231/309 (75%)). On multivariate analyses, previous MI/CAD ($p < 0.001$, OR 14.25), hypertension ($p < 0.001$, OR 1.84), and age groups between 40-60 yrs ($p=0.029$) were significantly associated with SCD.

Conclusion

Sudden cardiac death accounted for up to half of the cardiovascular deaths in rural Southern India. Traditional cardiovascular risk factors were strongly associated with SCD.

Keywords: Epidemiology, Sudden Cardiac Death, Rural South India, Andhra Pradesh

Introduction

India is the second most populous country in the world with an estimated population of over 1 billion. Rapid industrialization and urbanization have resulted in tremendous growth in the economy over the last decade. Concurrently, India has also seen an exponential rise in prevalence of diabetes, obesity and hypertension- partly related to better life expectancy, lifestyle changes and smoking habits [1,2]. The last decade has also seen significant change in mortality trends with chronic disease replacing infectious disease as the leading cause of death [3] and the World Health Organization has declared India the coronary artery disease (CAD) capital of the world [1]. Sudden cardiac death (SCD), defined, as sudden unexpected death occurring within 1 hour of onset of symptoms, is a common initial manifestation of CAD [4]. The majority of SCD events are attributable to cardiovascular causes even in the absence of a history of cardiac disease [5]. Recently, large epidemiologic studies have reported on the impact of CAD on mortality in India using population-based cohorts, and in selected high-risk groups [6,7]. However, the proportion of cardiovascular deaths that are SCD events and the risk factor profile of the individuals at risk for SCD in India remain largely unknown. The majority of the population lives in rural areas with little or minimal access to health care, with regional differences in disease prevalence and risk factors which are different from the aggregate national data [8,9]. Published data regarding mortality statistics for SCD are of limited applicability as most of the studies were performed in urban settings. The Andhra Pradesh Rural Health Initiative (APRHI) mortality surveillance system that exists in 45 villages in East Godavari District provided a unique opportunity to study SCD incidence and predictors in a rural setting. The purpose of our study was to define the epidemiology of SCD in rural Andhra Pradesh, India.

Methods

The data for this study was collected as part of the APRHI, a collaborative effort established in 2002 between the Byrraju Foundation (Hyderabad, India) [10], the Centre for Chronic Disease Control (New Delhi, India) [11], the CARE Foundation (Hyderabad, India) [12], The George Institute for International Health, University of Sydney (Sydney, Australia) [13], and the School of Population Health, University of Queensland (Brisbane, Australia) [14]. Specifically, the verbal autopsy data for this study were collected between January 2006 and 30th September 2007 from 45 villages (population 180,162) in East and West Godavari. The methodologies for data collection used in this study and the validity of the methods have been previously published [3]. The study was approved by the Ethics Committees of the CARE Foundation, Hyderabad, India and the University of Sydney, Australia. Informed consent was obtained from the next of the kin (respondent) prior to the collection of any data.

Mortality Surveillance System

The construct and the design of the mortality surveillance have been previously published [3]. Briefly, the system was designed to record, and assign causes to all deaths in a defined population. Surveillance was conducted throughout the year on a prospective basis. A multipurpose health worker under the supervision of a field coordinator collected all mortality data from each village using a verbal autopsy tool. The multipurpose health workers were usually natives of the same village, had at least 10 yrs of schooling and were provided with training in the use of the verbal autopsy tool. In addition to the initial training, the MPHW also had re-training sessions at 6 monthly intervals. To ensure complete recording of deaths an information network comprising of the village headman, the Government auxiliary nurse, priests, cremation staff, other community leaders and the village midwife was established in each village. The MPHWs interacted with the information network in addition to their direct interaction with the villagers on a day-to-day basis.

Verbal Autopsy Tool

The verbal autopsy method was used to determine causes of death.[7] The verbal autopsy method used in this study has been validated [3,15-17,31-33] and has been shown to be useful in developing countries. The tool consisted of both structured and unstructured questions including a detailed narrative provided by the respondent. The respondent was carefully chosen by the MPHW to be the most reliable source of information based on the proximity of the family member to the deceased relative. To avoid recall bias the interview of the close relative or caregiver of the deceased was sought within 4 weeks of death in the majority of the deaths. Detailed questionnaires including comorbidities and an unstructured narrative on the circumstances surrounding the death were recorded. Medical history of the deceased was collected by the MPHW during the interview process with prompts to inquire about symptoms, treatment and medical procedures undergone by the deceased. Wherever possible, the data were verified by abstracting information from medical documents held in the home.

Cause of Death

The cause of death was ascertained based on the data collected by the MPHW. A -trained physician assessed each autopsy questionnaire and selected a cause from a restricted list of diseases derived from the International Classification of Diseases- 10 (ICD-10) [18]. Special algorithms developed for the Registrar General of India's sample registration system were used by the physician in defining the cause of death from the data collected by the MPHW.

Adjudication of SCD

SCD was adjudicated based on Modified Hinkle-Thaler classification [4,19]. Death was considered to be secondary to SCD if it fell in any one of the four categories: 1) death occurring suddenly and unexpectedly within 1 h of cardiac symptoms in the absence of prior cardiac illness, 2) Death occurring within 1 h of the onset of cardiac symptoms in the setting of stable cardiac disease; 3) Unexpected death during sleep; and 4) death occurring unexpectedly within 24 h after last being seen alive. Two physicians who were trained in Internal Medicine and held Masters Degrees in Public Health made adjudications of SCD from the verbal autopsies. A third physician who is a trained electrophysiologist (HT) supervised the entire adjudication process and resolved disparities in the event of disagreement in the cause of death. All the deaths were adjudicated as SCD or Non-SCD events using the above definition, in addition to sub-classifying the deaths in to the individual ICD-10 diseases. Accidental deaths, suicides and traumatic deaths were not included under sudden deaths.

Statistical Analyses

All data analyses for research aims were performed using Statistical Analysis Software version 9.2 (SAS 9.2). Cause of death was ascertained based on the verbal autopsy. A p value of < 0.05 was considered to be significant. The cardiac risk factors including gender, age group, diabetes, hypertension, prior

MI, alcoholism and smoking were analyzed to determine their association in predicting SCD. The significant variables were then included in a multivariate analysis.

Results

A total of 1916 deaths occurred in the population over the 22 month time period of the study. The population had a literacy of approximately 54% and a mean household monthly income of US$ 50. The majority of the population worked as laborers in the agriculture and aquaculture industry. Of the 1916 deaths, verbal autopsy was recorded in 1827 (95%) subjects. Table 1 shows the baseline characteristics of the study population. Overall mean age of the deceased was 62 ± 20 years and 1007 (55%) were men. The majority of deaths (79%) occurred at home and women were more likely to die at home compared with men ($p<0.01$).

Table 1.

Comparison of characteristics of deceased due to sudden and non sudden death

Variable	Deceased due to Sudden Death, n (%)	Deceased due to Non Sudden Death, n (%)	Total, n (%)
Total	309 (17)	1518 (83)	1827 (100)
Gender*			
Men	191 (62)	816 (54)	1007 (55)
Women	118 (38)	702 (46)	820 (45)
Diabetes*	60 (19)	171 (11)	231 (13)
Hypertension*	148 (48)	425 (28)	573 (31)
Age Group			
Less than 20 years	2 (1)	67 (4)	69 (4)
20 to 29 years	6 (2)	91 (6)	97 (5)
30 to 39 years	14 (5)	105 (7)	119 (7)
40 to 49 years*	37 (12)	134 (9)	171 (9)
50 to 59 years*	52 (17)	139 (9)	191 (10)
60 to 69 years*	70 (23)	272 (18)	342 (19)
70 years and above*	128 (41)	710 (47)	838 (46)
Previous MI*	122 (39)	56 (4)	178 (10)
Alcohol	24 (8)	101 (7)	125 (7)
Prior history of Cerebro Vascular Accident	11 (4)	71 (5)	82 (4)
Smoking	29 (9)	130 (9)	159 (9)
Education			
Illiterate	88 (28)	489 (32)	577 (32)
Literate without formal training	24 (8)	108 (7)	132 (7)
Below primary (<class 5)	67 (22)	380 (25)	447 (24)
Middle (class 5 - 10)	82 (27)	337 (22)	419 (23)
Secondary (completed class 11 - 12)	37 (12)	153 (10)	190 (10)
Graduate and above	10 (3)	47 (3)	57 (3)
District			
West Godavari	208 (67)	1043 (69)	1251 (68)
East Godavari	101 (33)	475 (31)	576 (32)

* Variables with p value < 0.05

% Percentage approximated to the nearest whole number

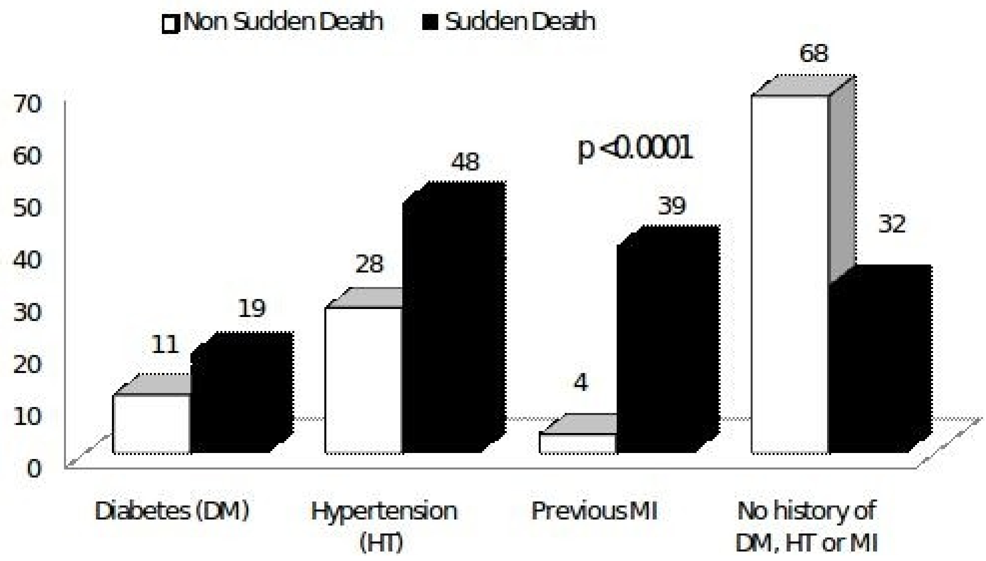
The majority of both sudden and non-sudden deaths occurred at home. More importantly 85% of the sudden and non-sudden deaths were witnessed with the responder present at the time of the death with the spouse or child of the deceased present at the time of death in most cases.

In the entire cohort, cardiovascular and cerebrovascular diseases together accounted for 559 deaths (31%), followed by infectious disease (163 deaths, 9%), cancer (126 deaths, 7%) and suicide (93 deaths, 5%). Of the 1827 deaths, after excluding accidental deaths (89 deaths), 309 deaths (17%) met criteria for SCD. Of the 1827 deaths, 309 deaths (17%) met criteria for SCD and were adjudicated as SCD events.

Predictors of SCD

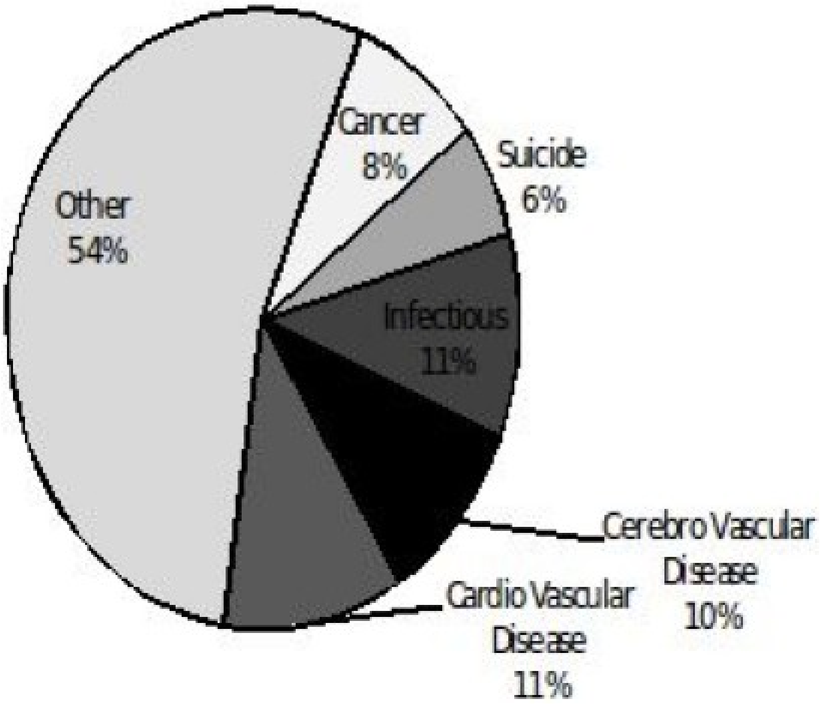
Shown in Figure 1 is the prevalence of cardiovascular risk factors among sudden and non-sudden deaths. Subjects experiencing SCD were significantly more likely to have hypertension, diabetes and a history of myocardial infarction/coronary artery disease ($p<0.01$ for all). A third of SCD events (96/309) were preceded by chest pain. Cardiovascular disease was the underlying cause in the majority the deaths that were adjudicated as SCD events (231/309 (75%)), followed by cerebrovascular disease and other unspecified causes accounting for the remainder of deaths (Figure 2a). In contrast, cardiovascular disease accounted for only 11.4% (173/1518) of the 1518 non SCD deaths. Cerebrovascular disease, cancer, suicide and infectious causes accounted for (10%, 8%, 6% and 11% respectively) of the non-SCD deaths (Figure 2b).

Figure 1.



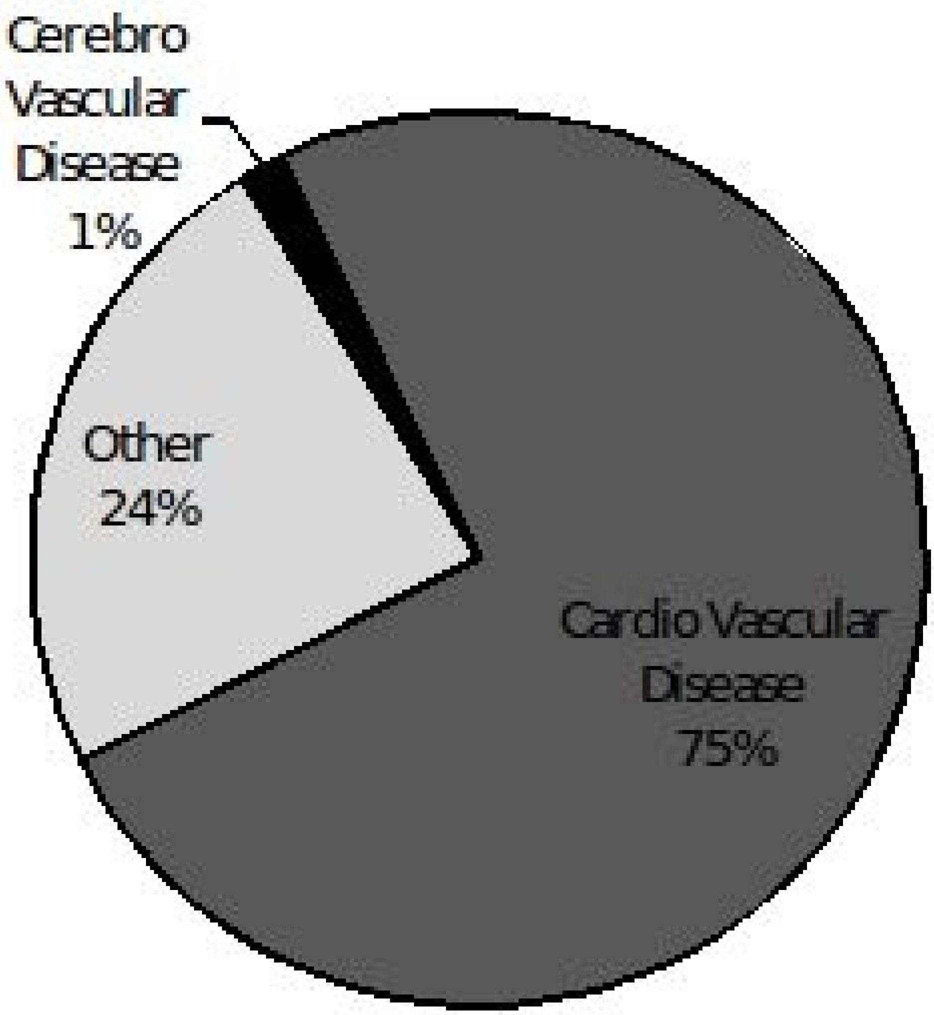
Prevalance of Cardiovascular risk factors among sudden and non sudden deaths.

Figure 2a.



Chief underlying cause of death in non-sudden death

Figure 2b.



Chief underlying cause of death in sudden death

Table 2 presents data on the measures of association of the different covariates in predicting SCD. On univariate analyses, gender, age between 40-70 yrs, diabetes, hypertension, and prior MI/CAD were significantly associated with SCD. The association of age with SCD is shown in Figure 3. The proportion of deaths attributable to SCD and non-SCD were similar until the age of 40 when there was a significant increase in SCD events, which declined after the age of 70. On multivariate analyses that included the significant univariate predictors, previous MI/CAD, hypertension and age groups between 40-60 yrs were significantly associated with SCD.

Table 2.

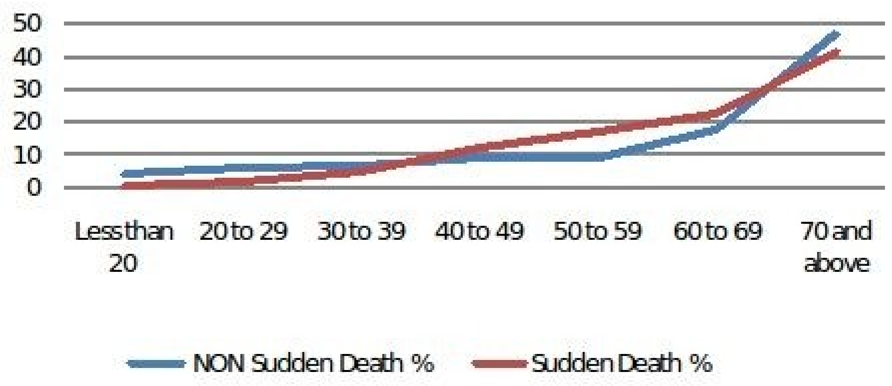
Covariates and their measures of association in predicting Sudden Cardiac Death (SCD)

Variable	Univariate Analysis		Multivariate Analysis	
	Odds Ratio	p (95%CI)	Odds Ratio	p (95%CI)
*Prior history of Cerebro Vascular Accident	0.748	0.379 (0.39 - 1.43)	—	—
*Education (Reference - Graduate Level Education)				
Illiterate	0.846	0.648 (0.41 - 1.74)	—	—
Literate without formal training	1.044	0.916 (0.46 - 2.36)	—	—
Below primary (<class 5)	0.829	0.614 (0.40 - 1.72)	—	—
Middle (class 5 - 10)	1.144	0.716 (0.55 - 2.36)	—	—
Secondary (completed class 11 - 12)	1.137	0.744 (0.53 - 2.46)	—	—
*Smoking	0.98	0.564 (0.91 - 1.05)	—	—
*Alcohol	0.99	0.475 (0.97 - 1.01)	—	—
Gender (Reference - Male)				
Female	**0.72**	**0.009 (0.56 - 0.92)**	0.81	0.140 (0.61 -1.07)
Agegroup (Reference - Less than 20 years)				
20 to 29 years	2.2	0.341 (0.43 - 11.27)	1.59	0.581 (0.30 - 8.34)
30 to 39 years	4.46	0.052 (0.98 - 20.26)	2.56	0.231 (0.55 - 11.91)
40 to 49 years	**9.24**	**0.003 (2.16 - 39.50)**	**5.15**	**0.029 (1.19 - 22.32)**
50 to 59 years	**12.52**	**0.000 (2.96 - 52.95)**	**6.29**	**0.013 (1.47 -27.03)**
60 to 69 years	**8.61**	**0.003 (2.06 - 36.01)**	3.57	0.086 (0.84 - 15.22)
70 years and above	**6.03**	**0.013 (1.46 - 24.93)**	3.21	0.109 (0.77 - 13.42)
Diabetes	**1.47**	**0.012 (1.09 - 1.99)**	0.94	0.725 (0.66 - 1.34)
Hypertension	**2.36**	**<0.0001 (1.84 - 3.03)**	**1.84**	**0.0001 (1.35 - 2.53)**
Previous MI	**17.03**	**<0.0001 (11.99 - 24.19)**	**14.25**	**<0.0001 (9.93 - 20.43)**

Significant associations have been presented in bold

* Variables not included in multivariate analysis

Figure 3.



Age Distribution non sudden and sudden deaths

Discussion

Our study has several important findings. Firstly, sudden cardiac death appears to account for over half of all cardiovascular deaths in a large population based cohort in rural South India. Secondly, the risk of SCD appears to be highest between the ages of 40-60 yrs. Traditional cardiovascular risk factors such as prior MI, and hypertension are independently associated with SCD. Finally, literacy, gender, diabetes, and smoking habit do not seem to affect SCD.

India is in the middle of a major economic and industrial transition. The associated lifestyle and dietary changes have led to rise in smoking habits, hypertension, obesity, diabetes and in turn, coronary artery disease (CAD) [1,2]. CAD accounts for 1.5 million deaths annually and several studies have shown younger age of onset of CAD in India [29,30]. A significant proportion of deaths in CAD are possibly sudden cardiac deaths (SCD), although the exact prevalence of SCD is unknown. The reported prevalence of SCD in Western populations has ranged between 10-12% [20-22], whereas the prevalence in our study was 17%. The difference in the prevalence can be in part due to the high prevalence of cardiovascular risk factors in India and age at manifestation of the risk factors between the two groups [23]. Reports from South India have documented a high prevalence of hypertension (27.2%), diabetes mellitus (16.3%) and hyperlipidemia (30.3%). Further the prevalence of multiple cardiovascular risk factors (smoking, hypertension, dyslipidemias, diabetes and metabolic syndrome) rapidly escalates by age of 30-39 years. Moreover, lack of primary prevention and risk factor modification practices might amplify the differences seen in the prevalence between the Western and South Indian cohorts.

The higher prevalence of SCD might also be due to absence of the "chain of survival" i.e. emergency medical services in rural areas, and lack of awareness of the symptoms of myocardial infarction. Of note, the respondents reported chest pain shortly before death, occurring in a third (31%) of the individuals who had SCD events. The risk of SCD is high in the setting of an acute myocardial infarction and revascularization, by means of thrombolysis and/or primary angioplasty might affect the risk of SCD. The lack of access to medical care is also reflected by the fact that the majority of SCD subjects died at home, despite the fact that a substantial proportion of patients had no antecedent illness and SCD were unexpected. Thus the differences in health care infrastructure, access and utilization may have a role in influencing the prevalence of SCD in rural India.

The prevalence of cardiovascular risk factors such as hypertension, diabetes, and CAD was significantly higher in the SCD group compared with the non-SCD group. These data are consistent with prior reports that have shown strong association between coronary artery disease and SCD. In fact the epidemiology of SCD to a great extent parallels that of CAD. Prior autopsy studies have revealed coronary occlusion in up to 80% of SCD events [5]. It is thought that acute coronary occlusion due to plaque rupture creates an ischemic substrate with a high risk for ventricular fibrillation. Aggressive risk factor modification and life style changes for primary prevention of CAD have been shown to reduce the incidence of sudden cardiac death. Two thirds of the patients experiencing SCD event had at least one cardiovascular risk factor identified in our study suggesting a possible role for preventive strategies targeting hypertension and diabetes in reducing the SCD prevalence.

Smoking has been independently associated with SCD [25]. Smoking cessation has been shown to reduce the likelihood of sudden death. It is also known that once CAD occurs the independent effect of smoking on SCD decreases [26-28]. We, however, did not find an association between smoking and SCD in our study. Smoking habit may have been underreported due to social taboos, however, the exact reasons for this are unclear and these results need to be validated in subsequent studies.

Clinical Implications

Our study highlights the high prevalence of SCD in rural India. Given the higher prevalence of coronary risk factors in urban settings, it is conceivable that the prevalence is even higher in the urban population. The majority of SCD events were associated with treatable coronary risks such as hypertension and diabetes. Aggressive risk factor modification in this population may favorably affect SCD related mortality although this hypothesis needs to be tested. Improving access to emergency care, educating the public on symptoms of myocardial infarction and basic cardiopulmonary resuscitation (CPR) practices have proven to be effective in the Western world and SCD in India is unlikely to be an exception. Although not specifically sought during verbal autopsy data collection, the lack of mention of any form of resuscitation in all the deaths analyzed was striking. The majority of SCD events occurred at home and were witnessed in 85% of cases This is not surprising, since CPR practices are virtually non-existent outside hospital settings and awareness of SCD is poor among the general public, more so in rural regions. The results of our study underscore the need for measures to reduce the burden of SCD and improving outcomes following an SCD event by way of establishing the "chain of survival", including public education on CPR practices.

Limitations

The verbal autopsy tool for our study was not specifically designed to investigate SCD events. Further, the data regarding risk factors were collected from the respondents, which lends itself to error in reporting. Even though the MSWs conducted interviews of the respondents at the earliest possible time, with in 4 weeks of death, there is a potential chance of recall bias. However, random error in collection of data about risks is likely to result in systematic underestimates of the associations with outcomes and not over estimates. Nevertheless, the adjudication of SCD was based solely on the chronology of events leading to the death, which was described in great detail in the unstructured narrative by the respondent. The exact underlying cause of sudden death could not be differentiated in some cases, which is a limitation of the study. The MPHWs received extensive training to ensure accurate collection of data and unbiased recording of the chronology of events surrounding death as narrated by the respondent. MPHW were specifically trained to extract risk factor information via structured questions. In addition, the MPHWs used a symptom list and enquired about treatment and medical procedures performed and also verified available and associated documents. More importantly, the accuracy of data collection and the adjudication that followed have been previously verified [3]. Another important limitation is that data regarding physical activity, obesity and hyperlipidemia, which may have a bearing on cardiovascular disease, were not collected in this study.

In conclusion, SCD appears to be a significant mode of death in rural India and accounts for more than half of the cardiovascular deaths. The SCD prevalence is higher than in Western countries, probably related to higher prevalence of cardiovascular risk factors, lack of preventive care and inadequate health care access. More importantly, there is a strong association between traditional CAD risk factors and SCD events. Primary prevention strategies aimed at control of hypertension and diabetes might impact the prevalence of SCD.

Coronary Artery Disease

Profile of coronary artery disease in indian rural youth

Abstract

Aims

To study the risk factors, clinical and angiographic profile of Indian rural youth (under 35yrs) presenting with Premature Coronary Artery Disease (PCAD).

Subjects

and Methods: The PCAD registry had 1628 patients who were aged below 35 years, of which 681 patients satisfied the entry criteria. The data was analysed by statistical software R version 3.5.0.

Results

The study enrolled 681 patients after satisfying the entry criteria. The mean age of patients was 30.85 years. There were 405 (59.5%) aged between 30 and 35 yrs, 205 (30.1%) between 25 and 30 yrs, 64 (9.4%) between 20 and 25 yrs and 7 (1.0%) were aged less than 20 yrs. Majority of them were males, 617 (90.6%). Nearly 411 (60.4%) were smokers, 56patients (8.2%) were diabetics and 97 (14.2%) were hypertensives. Around 441 (64.8%) patients had low HDL cholesterol levels and 218 (32.0%) had elevated triglyceride levels. Abdominal obesity was seen in 443 (65.1%) patients. Most common clinical presentation was ST elevation myocardial infarction (STEMI) seen in 536 (78.7%) patients. Around 40% patients had recanalized/non obstructive/thrombotic/normal coronaries on coronary angiogram.

Conclusions

Conventional risk factors such as smoking, low HDL levels and abdominal obesity play a major role in the causation of premature coronary artery disease among the rural youth. Thrombotic milieu in the coronaries was commonly noted in coronary angiograms. Lack of awareness, combined with urbanisation of rural lifestyle could be responsible for increasing incidence of premature coronary artery disease in rural youth.

Keywords: Premature coronary artery disease, Prospective observational study, Smoking, Low HDL, Abdominal obesity, Rural youth, Under 35years

1. Introduction

Atherosclerosis is a chronic inflammatory condition which starts at young age and depends on many factors, mainly abnormal lipid metabolism.[1] Studies have shown that atherosclerotic plaques or their precursors can be seen even in children younger than 10 years.[2] In later life unhealthy nutrition, smoking, alcohol consumption, obesity, sedentary lifestyles and family history of cardiovascular disease accelerates atherosclerotic disease.[2]

Premature coronary artery disease by definition occurs at a younger age (before the age of 55 years in men and 65 years in women).[3] In its severe form, it occurs below the age of 40 years.[4] Indians are prone to CAD at a much younger age.[5] Approximately 50% of first heart attacks occur before 55 years and 25% occur before 40 years of age.[6]

Despite wide heterogeneity in the prevalence of risk factors across different regions, CVD is the leading cause of death in all parts of India, including the poorer states and rural areas.[7] The disease transition in India in the past 2 decades resembles the accelerated epidemiological transition model.

The prevalence of ischemic heart disease in 1960 in urban India was 2% and increased 7-fold to ≈14% by 2013.8, 9, 10, 11, 12, 13, 14, 15, 16 Similarly, it more than quadrupled in rural areas, from 1.7% to 7.4% between 1970 and 2013.14, 15, 16 Kumar et al showed the prevalence of coronary heart disease among males in the villages was 1.7% and among females 1.5%.[17] Hypertension, diabetes, obesity and physical inactivity were significantly more common in the urban areas, while the rate of tobacco smoking is significantly higher in the rural areas. The alcohol consumption rates for the urban and rural communities were comparable.[18] In the urban areas of India, the prevalence of diabetes mellitus has almost doubled in the past 20 years, from 9% to 17% and in rural areas it has nearly quadrupled, from 2% to 9%.[19] The prevalence of hypertension in adult Indians is estimated to be 30% (34% in urban areas and 28% in rural areas).[20] The Prospective Urban and Rural Epidemiological (PURE) study had also noted low educational status in rural setup, which translates to lower rates of awareness, treatment and control of risk factors for cardiovascular disease (CVD).[21] Studies have shown that awareness and control of conventional risk factors are poor in rural regions in comparison with urban regions.[22] A large ACS registry from Kerala noted that nearly >40% of patients with ST-segment elevation MI reached the healthcare facility after 6 h of symptom onset, also the optimal in-hospital and at discharge medical care was worse in rural areas than in urban areas.[23]

There are several population studies highlighting demographic and socio-economic CV risk factors in the young. There is paucity of data on PCAD especially, in those aged below 35 yrs, more so from rural background. Therefore, we have analysed the other risk factors, clinical presentation and angiographic profile in Indian rural youth from the ongoing premature CAD registry at our institute.

2. Subjects and Methods

The PCAD registry is a prospective multisite descriptive observational study examining a cohort of young Indian adults aged ≤40 years with CAD from the point of index admission till a period of 5 years. This is registered under the Clinical Trials Registry of India (CTRI/2018/03/012,544).

Our study included all patients aged ≤35 years with index admission for ischemic heart disease, as proven by.

Inclusion criteria:

(1) Documented episode of acute coronary syndrome by history of typical chest pain, clinical examination, cardiac bio-markers, diagnostic ECG changes and coronary angiogram

(2) Chronic stable angina with evidence of CAD on coronary angiogram.

Exclusion criteria:

(1) patients with myocarditis, cardiomyopathies, and pulmonary embolism

(2) patients with previous history of ischemic heart disease or on medications such as antiplatelets and statins

(3) patients with chronic kidney disease or liver failure

(4) patients with history of use of oral contraceptives and or steroids.

For all patients detailed demographic data, history of various risk factors, clinical presentation, primary method of management, course in hospital and echo on admission were documented. Coronary angiographic profile and mode of intervention (if any) were all documented.] Diabetes was diagnosed by ADA 2020 definition.[24]

Body mass index was calculated as body weight (kg) divided by height squared (m) by IDF criteria.[25]

2.1. Statistical methods

The qualitative data were summarized by count and percentage, while quantitative data were tabulated by descriptive statistics such as mean, median and standard deviation (SD). The data were analysed by R statistical analysis and computing language version 3.5.1 (R core team, 2018) which is released under the GNU General Public License (GPL), version 2, published by the Free Software Foundation.

3. Results

A total of 3450 patients (<40 yrs) were registered under the PCAD registry during the 3yrs (2017–2020), of this 1628 patients were aged 35 yrs or younger.

3.1. Demographic characteristics

Of the registry, 681 patients (41.8%) satisfied the entry criteria. The mean age of patients was 30.85 years. There were 405 (59.5%) aged between 30 and 35 yrs, 205 (30.1%) between 25 and 30 yrs, 64 (9.4%) between 20 and 25 yrs and 7 (1.0%) were aged less than 20 yrs. Majority of patients were inhabitants/migrants from villages of districts of surrounding districts. Around 145 (21.3%) from Tumkur, 114 (16.7%) from Chikkaballapur, 66 (9.7%) from Bangalore rural and Ramanagar and 61 (8.9%) from Bellary district. Around 193 (28.3%) of them were farmers, 160 (23.5%) were drivers, 78 (11.5%) were manual labourers and 52 (7.7%) were home makers. There were 156 (22.9%) graduates, 166 (24.4%) were educated till 12th standard and 247 (36.3%) till 10th standardand 112 patients (16.4%) had no formal education.494 patients (72.5%) were covered under the government social security schemes and belonged to below poverty line category. The group had 63 (9.3%) vegetarians.

3.2. Risk factor characteristics

Majority of them were males, 617 (90.6%). Nearly 411 (60.4%) were smokers, 209 (30.7%) gave history of alcohol consumption, 56 patients (8.2%) were diabetics and 97 (14.2%) were hypertensives. Physical parameters showed that 286 patients (41.9%) had normal BMI, while 220 patients (32.3%) had high BMI (159 overweight, 61 obese), 166 patients (24.4%) had BMI which according to the revised BMI classification for south Asian Indians comes under the category of overweight. Therefore, abnormal BMI was noted in 58% patients. Going by waist-hip ratio definition, 443 patients (65.1%) had abdominal obesity.

Mean total cholesterol of entire study population was 185.967 ± 47.11, LDL was 115.913 ± 84.81 mg/dl, HDL was 32.943 ± 9.64, TG was 168.475 ± 87.11. Around 441 patients (64.8%) had low HDL cholesterol levels, 218 (32.0%) had elevated triglyceride levels, 92 (13.5%) had elevated LDL cholesterol and68 patients (9.9%) had elevated total cholesterol levels. The predominant form of dyslipidaemia was low HDL cholesterol with high triglycerides.

3.3. Clinical and angiographic characteristics

Most common clinical presentation was ST elevation myocardial infarction (STEMI) seen in 536 (78.7%) patients (445(83.1%) patients presented with anterior wall MI and 91 (16.9%) presented with inferior wall MI), followed by unstable angina/Non-ST elevation MI in 108 (15.9%) patients. In patients presenting with STEMI, 14 patients (2%) underwent primary PCI, 92% were thrombolysed with streptokinase, while 6% were thrombolysed with Tenecteplase. The time from onset of symptoms to presentation to hospital was within 3 h in 64 patients (9.4%), between 3 and 6 h in 174 patients (25.5%), between 6 and 12 h in 297 patients (43.6%) and more than 12 h in 146 patients (21.3%).

Around 481 patients (71%) underwent coronary angiogram. Of which 211 (31%) had obstructive coronary artery disease, 27 patients (4%) had normal coronaries, 183 (27%) had recanalized coronaries, 40 (6%) had mild non flow limiting atherosclerotic plaques and 20 (3%) had only thrombus. Of 481 patients, 377 (78.4%) had LAD lesions, 54 (11.2%) had RCA lesions, 23 (4.8%) had LCX lesions and 27 patients had normal coronaries.

Of the group 449 (65.9%) were continued on optimal medical therapy and follow-up, whereas 211 patients (31%) had significant CAD requiring PCI (201) or CABG (10), 18 patients (2.6%) were discharged on triple antithrombotics in view of high thrombus burden and advised check angiograms on follow up. There were 3 deaths in the group, due to refractory cardiogenic shock. The left ventricular (LV)ejection fraction recorded, showed adequate systolic function (>55%) in 200 (29.4%) patients, mild LV systolic dysfunction (45–54%) in 295 (43.3%), moderate LV systolic dysfunction (30–44%)in122 (17.9%), while it was severe LV dysfunction (<30%) in 64 (9.4%) patients.

The study group had seven patients who were aged under 20 yrs. All were males, three of them were smokers, two had family h/o CAD and one of them was a diabetic. All of them presented with STEMI, four with anterior wall and three with inferior wall MI. All received thrombolysis with streptokinase on admission. Only six underwent CAG and all had recanalized culprit vessel indicating presence of predominant thrombus in the coronaries.

4. Discussion

In Global Registry of Acute Coronary Events study, the prevalence of young ACS was 6.3%; in Thai ACS registry, it was 5.8%; in Spain registry, it was 7%.26, 27, 28 In a study in south Indians by Iragavarapu et al it was 10.4%.[29] Our PCAD registry shows a higher prevalence of 16%. Of this 41.8% of the registry population belonged to rural PCAD group.

4.1. Demographic and risk factor characteristics

The population under study had predominantly males (90.6%) with average age of 30.85 years. Majority of patients (91.8%) were non vegetarians. Among traditional cardiovascular risk factors, most common risk factor was smoking present in 60.4% of patients, similar to observations in INTERHEART study, more so in rural Indians as noted by several studies.[18,30, 31, 32] It was noted that 58% had an abnormal BMI of which only 9% were obese. There were 8.2% diabetics and 14.2% hypertensives. Our findings were similar to previous studies which showed that prevalence's of hypertension, obesity and diabetes mellitus were lower in the rural population whereas smoking was common.[18] Abdominal obesity was seen in 65.1% patients, similar to other studies noted in rural population.[32]

The rural group had a low educational status with only 22.9% graduates and 16.4% had no formal education. The PURE study had also noted low educational status in rural setup which translates to lower rates of awareness, treatment and control of risk factors for CVD.[21]

Lipid abnormalities are well known to increase the risk of CAD. The predominant form of dyslipidemia found in the young rural population was low HDL cholesterol in 64.8% and high triglycerides in 32.0%. Only 13.5% had elevated LDL cholesterol and 9.9% had elevated total cholesterol levels.

Our findings were similar with those of Pais et al, and others who reported high triglycerides and low HDLcholesterol with normal LDL cholesterol in their cases.[18,32,33] The lower HDL-C and higher triglyceride levels were found prominently in young Indians.[29,34] Low levels of HDL cholesterol have been shown to be a powerful risk factor for CAD.[18,32] Alcohol consumption was noted in 30.7% cases, similarly the consumption of alcohol by rural men was lower compared to urban men.[18]

4.2. Clinical and angiographic characteristics

The most common acute coronary presentation was STEMI (78.7%), also noted in other studies.[29,35] Only 34.9% presented within 6 h to hospital with majority presenting late to hospital indicating lack of awareness and delayed referral.[23]

In patients presenting with STEMI, 98% were thrombolysed. Around 29% did not consent for coronary angiograms, 31% had obstructive coronary artery disease and remaining 40% had either normal coronaries (4%)/recanalized coronaries (27%)/mild non flow limiting plaques (6%)/only thrombus (3%). The presence of obstructive coronary artery disease was lesser indicating a predominantly thrombotic milieu commonly seen among smokers. Cigarette smoke exposure creates an imbalance of antithrombotic/prothrombotic factors and profibrinolytic/antifibrinolytic factors that support the initiation and propagation of thrombosis.[36]

Nearly 72.7% patients had an LV ejection fraction (LVEF) of greater than 45% of which 29.4% had normal LV function. Remaining 27.3% patients had moderate to severe LV dysfunction. Young CAD patients are noted more often to have normal to mild LV dysfunction.[35,37] Conventional risk factors such as smoking, abdominal obesity and low HDL levels need to be recognized as important risk factors in young rural PCAD patients.

In India, underdiagnosis and underreporting of CVD is frequently seen among rural people.[38] Economically underprivileged patients with CVD less often receive evidence-based treatments. The distribution of the healthcare workforce, between rural and urban India is not uniform. The earlier notion that the rural population is less prone to CVD is slowly dwindling due to rapid urbanisation of rural lifestyles.

Studies have shown that awareness and control of conventional risk factors are poor in rural regions in comparison with urban regions.[22] Improving the human resource capacity for the prevention and control of CVD should be a national priority, and efforts should be made to ensure equitable distribution of available resources in both rural and urban settings.[39]

5. Conclusion

Conventional risk factors such as smoking, low HDL levels and abdominal obesity play a major role in the causation of premature coronary artery disease among the rural youth. Lack of awareness, combined with urbanisation of rural lifestyle could be responsible for increasing incidence of premature coronary artery disease in them. A multifaceted strategy is the need of the hour. Various awareness programmes highlighting the CV risk factors with focus on primary prevention are required. Aiming at bridging the urban-rural health services gap, by incorporating telemedicine services for immediate diagnosis and treatment are needed. It will also ensure early stabilisation of patients and urgent referral of high-riskcases. Such services will play a key role in assisting the rural primary healthcare doctors and other frontline health workers in CVD risk management.

Cardiovascular disease

Cardiovascular disease

Abstract

Background

Heart attack and stroke are problems already faced by some urban populations of India, but less is known about cardiovascular disease and risk factors in rural areas. The aim of the study was to investigate the levels and management of major cardiovascular risk factors and the prevalence of cardiovascular disease in two villages in rural Andhra Pradesh, India.

Methods

A cross-sectional survey was done by selecting a random sample stratified by age and gender from each village using census lists compiled in 2002. For each individual, trained study staff administered a Telugu-translation of a structured questionnaire, performed a brief physical examination and collected a fasting venous blood sample. Weighted estimates of mean (or percentages with) risk factor levels in the population were calculated and are reported with confidence intervals unless otherwise specified.

Results

Data was collected from 345 adults aged 20 to 90. The average household size was 4.2 and the mean combined household income was about Indian Rupees 25,454 (US$580) per year. The mean systolic blood pressure was 116 (114–117) mm Hg, diastolic blood pressure 73 (114–120) mm Hg, total cholesterol 4.6 (4.5–4.7) mmol/L, HDL-cholesterol 0.8 (0.8–0.9) mmol/L, LDL-cholesterol 3.2 (3.1–3.3) mmol/L and triglyceride 1.3 (1.2–1.4) mmol/L. The prevalence of current smoking was 19.9% (15.4–24.4%), hypertension 20.3% (16.2–24.4%), diabetes 3.7% (1.8–5.5%), overweight 16.9% (12.3–21.5%) and obesity 4.4% (1.9–6.8%). A medical diagnosis of cardiovascular disease (previous heart attack, stroke or angina) was reported by 2.5% (1.1–3.9%) and a further 1.1% (0.1–2.1%) had angina by the ‘Rose’ classification.

Conclusions

The possibility of increasing cardiovascular risk factors and prevalence of vascular disease in areas of rural India represent a public health concern. Larger and repeated epidemiological studies focusing on chronic diseases are required to inform treatment and prevention strategies suitable for use in these areas and other resource poor settings.

BP

Prevalence of Hypertension Among the Rural Adult Population in India

Abstract

Hypertension is a major cause of premature death worldwide. Studies have shown that the rural adult population in India is also experiencing this burden. To determine the overall pooled prevalence of primary hypertension in the adult rural population of India, an extensive search was conducted in various databases such as MEDLINE/PubMed, IndMED, EBSCO, CINAHL, and Google Scholar from 01/01/2014 to 16/05/2024. The studies were reviewed by two authors independently, assessing their quality and extracted data using pre-coded spreadsheets. The pooled estimates of hypertension prevalence were calculated using the Der Simonian-Laird random effects model, and subgroup, sensitivity analyses, and meta-regression were performed. In the final review, a total of 10 studies involving 30757 subjects were included. The combined pooled estimate of hypertension prevalence was 24% (95% CI: 19, 29) and there was a significant level of heterogeneity observed among the studies (I^2=98%, Q=572.07, df=9, p<0.01). Subgroup analyses found that factors such as the year of study, region, type of BP apparatus used, sampling strategy, and BP measurement techniques had a significant impact on the prevalence of hypertension. Further analysis by meta-regression revealed that none of these covariates had a substantial influence on the prevalence (R^2=0.21, Q=572.07, df=9, p-value<0.01). The prevalence of hypertension in adult rural populations exhibited a consistent upward trend over a period of 10 years from 2014 to 2024. Concerned policymakers should focus on the changing health needs of the rural adult population of India.

Keywords: adults, cross-sectional studies, epidemiology, hypertension, india, meta-analysis, meta-regression, prevalence, rural, systematic review

Introduction and background

Hypertension is a leading cause of premature death worldwide [1]. As per WHO, the global target for noncommunicable diseases includes reducing the prevalence of hypertension by 33% between 2010 and 2030 [2]. Hypertension is the biggest risk factor for disease burden globally. In India, hypertension has become a prominent risk factor for mortality, with studies showing an increasing prevalence of hypertension [3]. Kearney et al. predicted that the burden of hypertension in India will almost double from 118 million in 2000 to 213.5 million by 2025 [4]. A previous systematic review reported prevalence rates of hypertension in urban and rural areas of India ranging from 13.9% to 46.3% and 4.5% to 58.8%, respectively [4]. India has seen a significant shift in disease burden from communicable to non-communicable diseases over the past two decades [5]. NCDs now account for more than 60% of total deaths, with stroke and CVD making up nearly 30% [6]. According to NFHS-5 (2019-2021), the prevalence of hypertension among women in rural India is 20.2%, and among men, it is 22.7% [7]. In India, hypertension prevalence conducted in communities over a period of three to six decades showed an increase of 30% in the urban population and 10% in the rural population [8]. The environment in which a person lives has a significant impact on their overall health, and there is a correlation between hypertension, obesity, and various modifiable socio-economic factors such as occupation, income, education, lifestyle, and living standards [9]. The prevalence of hypertension is relatively higher in urban subjects compared to rural subjects [10]. While there is considerable research on hypertension among urban adults, there is a lack of studies on the prevalence and factors associated with hypertension in rural areas. This paper aims to address this gap by exploring the current state of hypertension among rural adults in India and its implications for public health interventions and policy-making. Understanding the burden of hypertension in rural areas is crucial for developing targeted interventions and improving overall health outcomes in these communities. Conducting systematic reviews specifically focused on rural areas will provide a comprehensive understanding of the burden and impact of hypertension in these populations. This information can guide policymakers in developing interventions and programs tailored to the specific needs of rural communities. With this in mind, this study was planned to conduct systematic reviews on the prevalence of hypertension among rural adults in India from 2014 to 2024 (10 years).

Review

Methodology

Search Strategy for Literature

Two authors conducted the literature search separately. Any disagreements regarding the inclusion of studies, assessment of quality, and extraction of data were resolved by the third author. We conducted a literature search using databases such as Medline/PubMed, IndMED, CINHAL, EBSCO, and Google Scholar using both the Medical Subject Headings (Mesh) and specific keywords including “prevalence,” “epidemiology,” “hypertension,” “pulmonary arterial hypertension,” “essential hypertension,” “adults,” ‘’rural population’,’ and “India.” Boolean search operators like “AND" and “OR” were applied throughout the searching process. We conducted a literature search up until 16/05/2024. The review protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO) 2024 database under the number CRD42024541065 (Amendments: IndMED database was added to the protocol on 16/05/2024).

Assessment of Quality and Extraction of Data

Two authors correctly evaluated the quality of each article using Jonna Briggs Institute modified critical appraisal checklists. Two authors independently extracted the participants' characteristics age groups of participants, sex, region, prevalence, first author of the study, study place location, year of study, sampling scheme, sample size, type of BP apparatus, number of BP readings recorded, and classification cut-offs onto pre-coded spreadsheets. We extracted the data at the lowest possible level of disaggregation. We presented this review in accordance with the PRISMA statement.

Statistical Analysis

The meta-analysis focused on the proportion of subjects classified as having hypertension. We analyzed using R and R Studio (META & METAFOR) version 4.1.1 for Forest Plot and examined heterogeneity between studies using I^2 statistics and Cochran's Q test. We calculated all pooled estimates using the Der Simonian-Laird random effects model and reported them as a proportion with 95% CI. We visually inspected the funnel plots and set the statistical significance at a p-value less than 0.05. We conducted a meta-regression using a random intercept and a fixed slope regression analysis (maximum likelihood estimation method) and determined the regression coefficients, their 95% CI, and sensitivity analyses by excluding studies of inferior quality and those with smaller sample sizes, then implemented each strategy sequentially.

Results

The flow of article selection is shown in Figure 1. Finally, 10 articles were included in the review. Every study that was included was cross-sectional in nature. 30757 participants in all were enrolled in the study, of whom 10019 (5824 females and 3925 men) had hypertension. For 270 participants, there was insufficient information available about sex. The main characteristics of the study were compiled (Table 1). All other studies included a homogeneous age group (mainly above 18 to 60 years), with the exception of two that included a slightly younger age group (18-29 years and 20-30 years). Eight studies were found to be of high quality based on the quality assessment (Table 2). The study's locations were divided into five regions: north, south, west, northeast, and northwest, based on their geographic location. Studies showed a wide range of methodological variations. Most of the studies used a mercury sphygmomanometer, numerous blood pressure recordings, a random sampling technique, and a 140/90 mm Hg categorization cut-off. In a study conducted in Tamil Nadu with a sample size of 154, the prevalence of hypertension for both sexes combined (n=10 studies) ranged from as low as 7% to as high as 51% in Nagaland with 209 participants [8,9].

Table 1. Characteristics of included studies in the review.

JNC, Joint National Committee Guidelines; ING, Indian Clinical Practice Guidelines

Characteristics of included studies in the review

Sl. no	First author	Publication yea	Time period	BP apparatu	BP reading	JNC/ING	Cut-off us	Number of subjects	Age includ	Age group	Gender	Place of stu	Region (sub grou	Sampling Sch	Sample siz	Included

		r		s	s		ed	having hypertension (prevalence of hypertension)	ed			dy (state)	p)	eme	e	
1	Boornem A et al. [8]	2024	July 2023 to August 2023	Mercury	3	JNC	≥ 140/90	11 (7%)	18 to 29 years	Not available	Not available	Tamil Nadu	SOUTH	Multistage sampling technique	154	Yes
2	Tsukru V et al. [9]	2023	Not available	Mercury	2	JNC	≥ 140/90	106 (50.7%)	18 - 50 years	NA	M-63 (30.1%); F-43 (20.5%)	Nagaland	NORTHEAST	Not available	209	Yes
3	Asadullah M et al. [10]	2022	2017-2019	Electronic	2	JNC	≥ 140/90	224 (26.9%)	30 - 60 years	Not available	Not available	Haryana State	NORTH	Multistage cluster random sampling	832	Yes

4	Basu P et al. [11]	2019	January 2017 and December 2017	Electronic	2	Indian National Guidelines	≥ 140/90	2407 (34.45%)	30 - 60 years	Not available	M-1013 (14.5%); F-1394 (19.95%)	Udaipur district of Rajasthan	NORTHWEST	Not available	6985	Yes
5	Gupta A et al. [12]	2016	July 2013 to December 2013	Mercury	2	JNC	≥ 140/90	310 (43.6%)	18 - 59 years	18-29-13 (1.8%), 30-39-53 (7.46%), 40-49-73 (10.28%), 50-59-171 (23.94%)	M-119 (16.7%); F-191 (26.9%)	Panemangalore, Karnataka	SOUTH	Stratified random sampling	710	Yes
6	Kavi A et al. [	2019	January 2013 to Jun	Mercury	2	JNC	≥ 140/90	261 (26.6%)	20 and 60 years	20-29-17 (1.73%), 30-	M-133 (13.5%); F-128	Karnataka, India	SOUTH	Simple random sam	980	Yes

	13]		e 2015							39-48 (4.89%), 40-49-88 (8.97%), >50-108 (11.02%)	(13.06%)			pling		
7	Kini Set al. [14]	2016	October 2011-October 2013	Mercury	2	JNC	≥ 140/90	35 (3%)	20-30 years	Not available	Not available	Karnataka, India	SOUTH	Stratified sampling	1152	Yes
8	Kumar S et al. [15]	2015	December 2008 to April 2009	Mercury	2	JNC	≥ 140/90	117 (20.38%)	18-58 years	18-27-13 (2.26%), 28-37-23 (4%), 38-47-29 (5.05%), 48-	M-61 (10.6%); F-56(9.75%)	Nagpur	WEST	Systematic random sampling	574	Yes

										57-14 (2.43%), 58-38 (6.62%)						
9	Mallika MV et al. [16]	2015	3 months from 18-01-2010	Mercury	2	JNC	≥ 140/90	6360 (35.14%)	18 - 59 years	Not available	M-2398 (13.2%); F-3962 (21.9%)	Kerala, South India	SOUTH	Not available	18100	Yes
10	Zafar KS et al. [17]	2017	January 2016 to June 2016	Mercury	3	JNC	≥ 140/90	188 (17.72%)	18 to 40 years	18-29-132 (12.44%), 30-40-56 (5.27%)	M-138 (13%); F-50 (4.7%)	Uttar Pradesh, India	NORTH	Not available	1061	Yes

Table 2. Subgroup analysis of the pooled prevalence of hypertension among rural adults using methodological factors.

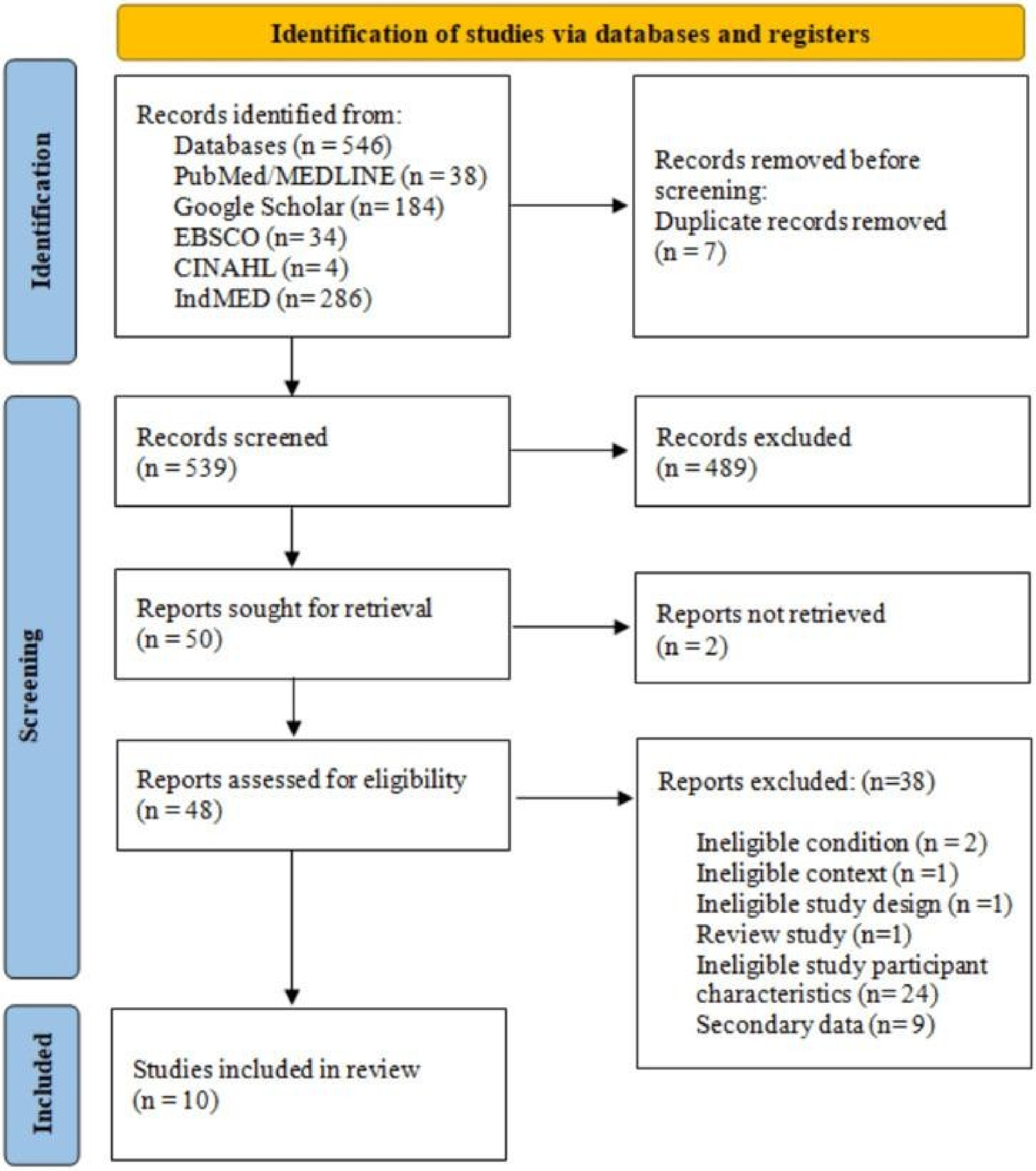
P-value <0.05 is statistically significant. In subgroup analysis year, region, BP guidelines, and sampling strategy are found to be statistically significant with the prevalence of hypertension among rural adults in India.

BP apparatus, blood pressure measuring apparatus; BP guidelines = Joint National Committee Guidelines (JNC), Indian Clinical Practice Guidelines (ING)

Variable		Proportion	95% CI	I^2	Cochran's Q	p-value
All studies		24	0.19;0.29	98	572.07	<0.01
Subgroup analysis						
Year wise	2015	27	0.15;0.44	98	122.07	<0.01
	2016	14	0.01;0.78			
	2017	18	0.15;0.20			
	2019	31	0.23;0.39			
	2022	27	0.24;0.30			
	2023	51	0.44;0.58			
	2024	7	0.04;0.12			
Region	South	18	0.10;0.29	98	83.72	<0.01
	West	20	0.17;0.24			
	North	22	0.14;0.32			
	Northeast	51	0.44;0.5			

			8			
	Northwest	34	0.33;0.36			
BP apparatus	Mercury	21	0.15;0.30	98	2.84	0.09
	Electronic	31	0.24;0.39			
BP guidelines	JNC	22	0.16;0.30	98	9.22	<0.01
	ING	34	0.33;0.36			
Sampling strategy	Random	17	0.10;0.29	98	5.76	0.02
	Not available	33	0.28;0.38			
No. of BP readings	2	27	0.22;0.32	98	3.63	0.06
	3	12	0.05;0.27			

Figure 1. PRISMA flow chart of selection of studies for meta-analysis.



PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analysis

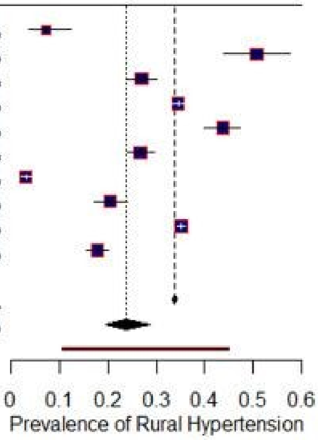
Random Effects Pooled Estimate of the Prevalence of Hypertension

The prevalence of hypertension in the adult rural population of India was estimated to be 24% (95% CI: 19% to 29%) (Figure 2). Significant heterogeneity was observed among the studies (I^2=98% and Cochran's Q=572.07, df=9, p<0.001). The pooled estimate of hypertension in males was 32% (95% CI; 24.9% to 40%), while in females it was 27% (95% CI; 22.4% to 32.1%).

Figure 2. Random effects pooled estimate of the prevalence of hypertension among the rural adult population of India.

Study	Event	Total	Proportion	95% C.I.	Weight (random)
BooRnem AR, 2024 [8]	11	154	0.07	[0.04; 0.12]	6.7%
Tsukru V, 2023 [9]	106	209	0.51	[0.44; 0.58]	9.8%
Asadullah M, 2022 [10]	224	832	0.27	[0.24; 0.30]	10.5%
Basu P, 2019 [11]	2407	6985	0.34	[0.33; 0.36]	10.9%
Gupta A, 2016 [12]	310	710	0.44	[0.40; 0.47]	10.6%
Kavi A, 2019 [13]	261	980	0.27	[0.24; 0.30]	10.6%
Kini S, 2016 [14]	35	1152	0.03	[0.02; 0.04]	9.2%
Kumar S, 2015 [15]	117	574	0.20	[0.17; 0.24]	10.2%
Mallika MCV, 2015 [16]	6360	18100	0.35	[0.34; 0.36]	10.9%
Zafar KS, 2017 [17]	188	1061	0.18	[0.15; 0.20]	10.5%
Total (common effect, 95% CI)	**10019**	**30757**	**0.34**	**[0.33; 0.34]**	
Random effects Model			**0.24**	**[0.19; 0.29]**	**100.0%**
Prediction interval				**[0.11; 0.45]**	

Heterogeneity: $Tau^2 = 0.1568$; $Chi^2 = 572.07$, df = 9 ($P < 0.01$); $I^2 = 98\%$



The studies found that the pooled prevalence of hypertension among adults in rural India showed statistically significant heterogeneity ($p<0.01$).

Subgroup Analyses

We included all studies in subgroup and sensitivity analyses. From 2014 to 2024, the prevalence of hypertension was 24% (27% to 7%). This increase was statistically significant ($p<0.05$). The region-wise prevalence of hypertension from south to northwest (18% to 34%) was also found to be statistically significant ($p<0.05$). The type of blood pressure apparatus and the prevalence of hypertension between mercury and electronic sphygmomanometers (21% vs. 31%) was not statistically significant ($p>0.05$). The blood pressure measurement guidelines that used Joint National Committee Guidelines (JNC) and those studies that used Indian Clinical Practice Guidelines (ING) (22% vs. 34%) had a significant statistical association with the prevalence of hypertension ($p<0.05$). The studies that used random sampling strategy and non-random sampling strategy (17% vs. 33%) were found to be significantly associated with hypertension ($p<0.05$). The studies that used two blood pressure readings and three blood pressure readings (27% to 12%) were not associated with hypertension ($p>0.05$) (Table 3).

Table 3. Quality assessment of studies by JBI critical appraisal method included in the review.

A smaller sample size study was Boornema AR, 2024 [8]. Low-quality study was Tsukuru V, 2023 [9].

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total score	Percentage
Boornema AR, 2024	2	2	2	2	2	2	2	2	2	18	100%

[8]											
Tsukuru V, 2023 [9]	2	0	0	2	2	2	2	2	2	14	77.77 %
Asadullah M, 2022 [10]	2	2	2	2	2	2	2	2	2	18	100%
Basu P, 2019 [11]	2	0	1	2	2	2	2	2	2	15	83.33 %
Gupta A, 2016 [12]	2	2	2	2	2	2	2	2	2	18	100%
Kavi A, 2019 [13]	2	2	2	2	2	2	2	2	2	18	100%
Kini S, 2016 [14]	2	2	2	2	2	2	2	2	2	18	100%
Kumar S, 2015 [15]	2	2	2	2	2	2	2	2	2	18	100%
Mallika MCV, 2015 [16]	2	0	1	2	2	2	2	2	2	15	83.33 %
Zafar KS,	2	0	1	2	2	2	2	2	2	15	83.33 %

2017 [17]									
%	100	60	60	100	100	100	100	100	100

Meta-Regression Analysis

The covariates that had a p-value <0.20 in the subgroup analysis were included in a random effects meta-regression analysis. However, none of the covariates were found to be statistically significant. The overall model, which had an $R^2=0.21$, was also not significant with a p-value >0.01 (Table 4).

Table 4. Random effects meta-regression analysis, the effect of covariates on the prevalence of hypertension.

$R^2=21\%$, $I^2=98.68\%$, Q=394.64, df=5, p< 0.001.

Variable	Estimate	SE	Z-values	P-value	95% CI	
Region	0.2684	0.8921	0.3009	0.7635	1.4801	2.0169
Year	0.0838	0.7834	0.1070	0.9148	1.4516	1.6192
BP guidelines	0.0045	1.1302	0.0040	0.9968	2.2106	2.2196
Sampling strategy	0.7401	0.7630	0.9699	0.9699	0.7554	2.2356
Intercept	2.7528	1.6096	1.7102	0.0872	5.9076	0.4020

Sensitivity Analyses

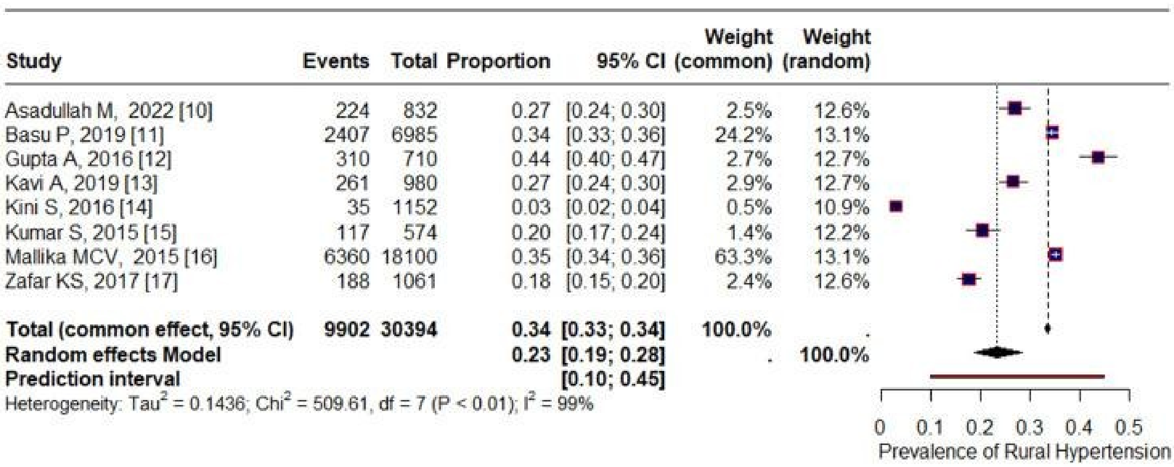
During our analysis, we performed a sensitivity analysis by systematically excluding individual studies to identify any factors contributing to heterogeneity. The results showed that the overall pooled estimates did not vary significantly when each study was removed. However, when we excluded a low-quality study, the pooled estimate slightly decreased from 24% to 22%. Conversely, when we excluded a study with less sample size, the pooled estimate slightly increased from 24% to 26% and when both low-quality and less sample size studies were removed then the pooled estimate was 23% (Table 5, Figure 3).

Table 5. Pooled prevalence of hypertension among rural adults after sensitivity analyses.

After removing low-quality and small sample size studies, the sensitivity analysis found statistically significant heterogeneity ($p<0.01$) in relation to the prevalence of hypertension among rural adults in India.

Variable	Proportion	95% CI	I^2	Cochran's Q	P-value
Removal of low-quality study	22	0.17;0.26	99	545.86	<0.01
Removal of less sample size study	26	0.21;0.31	99	535.60	<0.01
Removal of both low quality and less sample size studies	23	0.19;0.28	99	509.61	<0.01

Figure 3. Forest plot of pooled estimate after removing both low-quality and less sample size studies.



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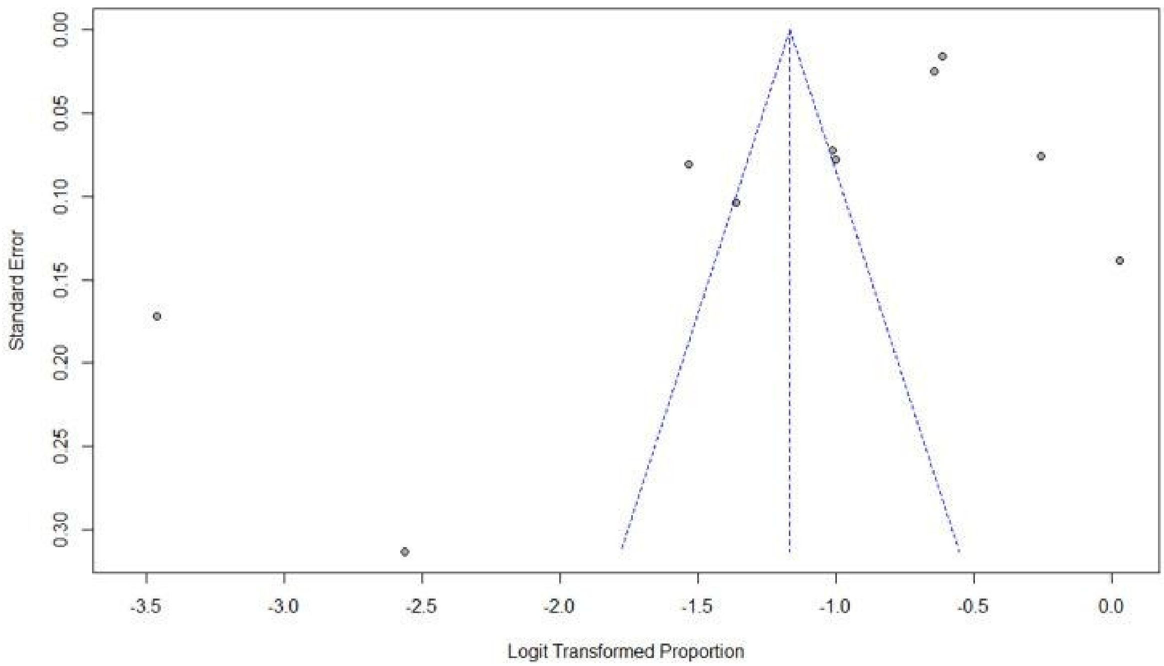
After removing Boornema AR and Tsukru [8,9]. The heterogeneity among the studies was found to be statistically significant (p-value <0.01).

Publication Bias

The publication bias does not have a substantial impact on a meta-analysis of prevalence studies, we found several smaller studies with significant effects, which we found out in our sensitivity analysis. Additionally, the funnel plot indicated slight asymmetry, but with a p-value of 0.063 from Egger's test; there was no clear evidence of publication bias or any bias that may have gone unnoticed (Figure 4).

Figure 4. Funnel plot of prevalence of hypertension among rural adults in India.



The funnel plot indicated slight asymmetry from Egger's test; there was no clear evidence of publication bias with a p-value of 0.063.

Discussion

The findings of this study, which included a systematic review and meta-analysis of data from 10 studies involving a total of 30757 participants, revealed that out of the 10019 individuals with hypertension, there were 5824 females and 3925 males. The overall pooled prevalence of hypertension among the rural adult population in India was found to be 24% (19% to 29%). The studies had significant heterogeneity between them, which can be explored by subgroup analysis.

In a study conducted by Anchala R et al. in 2014, they reported a hypertension prevalence of 27.6% (95% CI; 23.2% to 32.0%) among rural adults in India, which was higher than the pooled prevalence of 24% found in our study. The discrepancy in prevalence estimates could be attributed to the inclusion of individuals above the age of 60 in their study [18].

Another study done by Midha T et al., 2000-2012 years, reported the prevalence of hypertension as 17.9% (95% CI;17.5%-18.3%) among rural adults in India, which was lower than our study (24%) and shows a significant increase in the prevalence of hypertension from 17.9% to 24% from 2000 to 2024 [19].

The study done by Bansal SK in Uttarakhand villages in 2010 reported a higher prevalence of hypertension of 32.3% (95% CI; 23.8% to 30.9%), which might be due to the inclusion of more than 15 years and ≥60 years of age group in their study [20].

Another study conducted by Yun Hang et al., from 2000 to 2018, reported a prevalence of hypertension of 24.4% (95% CI; 23.8-30.9), which corresponds similarly to our results of 24% among rural adults in India [21].

Another study conducted by Chowdary et al. reported a low prevalence of 15% (95% CI; 13% to 16%); this variation may be due to the fact that the majority of the studies included were ≥35years (13 studies), ≥25 years (11 studies) and ≥18 years (8 studies) and reported low prevalence compared to our study (24%) [22].

Systematic review and meta-analysis done by Nasir Sani (2000-2021), West Africa, and Bao et al., China (1959-2018), reported a higher prevalence of hypertension of 27.4% and 26% than our study (24%), which might be due to inclusion of more than 60 years age group and variation in socio-demographic, genetic, and cultural practices between West Africa, China, and India [23,24].

In our study, the pooled estimate of hypertension was higher among males and age group >30 years; similar results were reported by the published studies [11-17,25,26].

The univariate analysis revealed significant associations between methodological factors and the prevalence of hypertension. The factors included were region, blood pressure classification, year, and sampling strategy, and none of them influenced prevalence when the meta-regression model was applied (R^2=0.21%).

Strengths and limitations

The main strength was the standard search strategy followed, Jonna Briggs institute critical appraisal done, and explored heterogeneity by subgroup analysis. The inclusion of a large sample size allowed us to obtain an accurate and precise estimate of the pooled prevalence of hypertension. Several covariates were associated with pooled estimates in univariate analysis and applied meta-regression for the influence of the covariates on hypertension. No evidence of publication bias.

Two studies did not report male and female populations in the study; different sampling strategy methods were used, which caused errors in estimation; calibration of the BP apparatus was not reported, and a smaller number of studies were included in the review (10 studies).

Future research directions/implications

To enhance future research on the rural adult population, it is crucial to study issues like detailed lifestyle factors, dietary patterns, and personal habits of the rural adult population, majority of them were adopting urban lifestyles due to rapid urbanization and industrialization.

Conclusions

The prevalence of hypertension among rural adults in India is a pressing public health issue that requires targeted interventions and policies. By addressing common risk factors and improving awareness and access to healthcare services, healthcare professionals can work toward reducing the burden of hypertension in rural populations. Continued research and collaborative efforts are essential to effectively tackle this growing health challenge in rural India.

Cancer

Rural-urban disparity in cancer burden and care

Abstract

Background

Cancer incidence and mortality vary across the globe, with nearly two-thirds of cancer-related deaths occurring in low- and middle-income countries. The rural-urban disparity in socio-demographic, behavioural, and lifestyle-related factors, as well as in access to cancer care, is one of the contributing factors. Population-based cancer registries serve as a measure for understanding the burden of cancer. We aimed to evaluate the rural-urban disparity in cancer burden and care of patients registered by an Indian population-based cancer registry.

Methods

This study collected data from Varanasi, Uttar Pradesh, India, between 2017 and 2019. Sex and site-specific age-standardised rates for incidence and mortality per 100,000 population were calculated. Rural-urban disparities in cancer incidence and mortality were estimated through rate differences and standardised rate ratios (with 95% confidence intervals). Univariable and multivariable regressions were applied to determine any significant differences in socio-demographic and cancer-related variables according to place of residence (rural/urban). Crude and adjusted odds ratios with 95% confidence intervals were calculated.

Results

6721 cancer patients were registered during the study duration. Urban patients were older and had better literacy and socioeconomic levels, while rural patients had higher odds of having unskilled or semi-skilled professions. Diagnostic and clinical confirmation for cancer was significantly higher in urban patients, while verbal autopsy-based confirmation was higher in rural patients. Rural patients were more likely to receive palliative or alternative systems of medicine, and urban patients had higher chances of treatment completion. Significantly higher incidence and mortality were observed for oral cancer among urban men and for cervical cancer among rural women. Despite the higher incidence of breast cancer in urban women, significantly higher mortality was observed in rural women.

Conclusions

Low- and middle-income countries are facing dual challenges for cancer control and prevention. Their urban populations experience unhealthy lifestyles, while their rural populations lack healthcare accessibility. The distinctness in cancer burden and pattern calls for a re-evaluation of cancer control strategies that are tailor-made with an understanding of urban-rural disparities. Context-specific interventional programmes targeting risk-factor modifications, cancer awareness, early detection, and accessibility to diagnosis and care are essential.

Supplementary Information

The online version contains supplementary material available at 10.1186/s12885-024-12041-y.

Keywords: Registries, Disparity, Incidence, Mortality, Cancer, Low-and middle-income countries

Background

Globally, cancer is one of the leading causes of mortality; two-thirds of these deaths occur in low- and middle-income countries [1]. Moreover, large variations are reported in cancer incidence, patterns, and mortality among different regions of a country [2]. The disparity in the continuum of cancer care, especially among rural populations, has significantly contributed to this disproportion globally [3]. India is a culturally diverse country, with two-thirds of its population (833 million) residing in rural regions and displaying large regional and rural-urban variations in lifestyles, mortality, and morbidity rates [4, 5]. Moreover, rural areas continue to suffer from challenges related to inadequate accessibility, affordability of healthcare, and underutilization, compounded by the absence of robust health information systems. In contrast, urban regions have witnessed significant improvements in these aspects [3, 6]. A staggering majority (80%) of the elderly with unmet healthcare needs are concentrated in the rural regions of India [5]. Lifestyle and behavioural risk factors are also increasing, especially in urban areas, leading to an epidemiological transition in the country.

Due to the lack of organized health information systems and weak cause-of-death registration systems, population-based cancer registries (PBCRs) serve as a measure for understanding the state and national-level burden of cancers in India and are recognised as vital components of national cancer control programmes [7]. However, there is currently an urban predominance in cancer coverage by cancer registries [8]. Hence, to understand the rural-urban disparity in cancer burden and care, registry-based studies from Indian settings that are predominantly rural are needed.

The Government of India (GOI) is committed to universal health care coverage, which requires the identification of disparities, their drivers, and the mitigation of them through targeted policy interventions [9]. Therefore, we aimed to study the rural-urban disparity in burden and care of over 6,000 patients who were registered by the PBCR in an Indian setting between the years 2017 and 2019 so that future cancer control planning in the country will be more considerate of the existing urban-rural differences.

Methods

Study settings and population

Varanasi district

The estimated population of Varanasi is 4 million (40,05,176), with rural predominance (57%), in an area of 1535 square km. The rural-urban classification is based on the Census of India. The district has eight rural blocks with 1295 villages and 90 urban wards, which are not adequately covered by conventional cancer screening programmes. There is an established three-tier healthcare delivery and referral system as per the National Health Mission of the GOI. The district has three government-supported tertiary cancer care centres (two TCCs and one apex medical college) and a few private centres equipped with cancer-related diagnostic and treatment facilities, all of which are concentrated in the urban parts of the district. The rural residents need to travel at least 6 to 24 miles to reach these TCCs, and have limited transportation facilities. (Fig. 1) [7, 10].

Fig. 1.

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Distribution of cancer incidence (I), mortality (M) and tertiary cancer treatment centres in Varanasi district, Uttar Pradesh, India

Varanasi population-based cancer registry

The Varanasi PBCR was established in 2017, as a part of PBCRs operated by the Tata Memorial Centres (TMC). It provides representative statistics for cancer burden in the Uttar Pradesh state of Northern India, which is the most populous state of India and is predominantly rural with poor health indicators. The TMC has an agreement with the district health administration to conduct cancer registration. Through an active registration process, data on cancer cases are collected from various sources in the district through a pre-defined proforma and entered into the CanReg5 software of the International Agency for Research on Cancer (IARC). Field investigators were trained in data extraction and entry methods, and are periodically monitored by the faculty of the Centre for Cancer Epidemiology, TMC [7, 10]. Quality control was ensured through systematic and random checks, duplication removal, re-abstraction of 5% of randomly selected cases, retraining of the staff, and calculating data quality indices for completeness. (Supplementary Table 1) [11, 12].

Urban-rural definition

As per the Census (2011), India’s classification for urban regions includes:

(i) All places with a municipality, corporation, cantonment board, or notified town area committee,

(ii) All other places that satisfy the following criteria: (a) minimum population of 5000; (b) at least 75% of the working male population engaged in non-agricultural pursuits; (c) a population density of at least 400 persons per square kilometre [13].

Statistical analysis

Cancer incidence and mortality data from 2017 to 2019 were obtained from the PBCR, Varanasi district of Uttar Pradesh state of India. The extracted data included demographic information for the age, gender, place of residence, religion, education, mother tongue, occupation, and monthly income. The tumour details included topography and morphology of the primary site of cancer, basis of diagnosis, type of treatment taken, treatment status, and the outcome in the form of death of the patient. Malignancies were classified according to the International Classification of Diseases for Oncology, Version III (ICD-O) [7, 10].

We calculated the sex and site-specific cancer burden through crude and age-adjusted rates (AAR) for incidence (AAIR) and mortality (AAMRs) per 100,000 population and cumulative risk (probability that an individual will be diagnosed with cancer for 0–74 years of age group) for rural and urban regions. The AARs were computed by using the direct standardisation method with the World Standard Population 2000 as a reference. The rural-urban disparities in cancer incidence and mortality were quantitatively assessed with two disparity measures; Rate difference (RD; AAR of rural population ─ AAR of urban population) [14] and Standardised Rate Ratio (SRR; AAR of rural population /AAR of urban population, with 95% confidence intervals) [15]. Univariable and multivariable regressions were used to assess any significant difference in the socio-demographic and cancer-related variables according to the place of residence (rural/urban). Variables found significant on univariable analysis (p-value < 0.2) [16] were entered into the multivariable regression model after excluding collinearity. Crude and adjusted odds ratios (OR) with a 95% confidence interval (CI) were calculated. The level of statistical significance for the multivariable regression was set at a p-value of less than 0.05. The data were entered into MS Excel and analysed using the Statistical Package for Social Sciences (SPSS, version 21).

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of our research.

Results

Socio-demographic profile of patients with cancer

Out of 6721 patients registered under the Varanasi PBCR (2017–2019), 2.3% (156) were in the paediatric age group (0–14 years) and were excluded from further analysis. Among 6565 adult patients, 73.8% (4848) were 45 years or older, more than half were males (3670, 55.9%), and one-fifth were illiterate (1370, 20.9%). Most of the study participants were Hindus (5774, 88.0%) by religion and had Hindi as their mother tongue (6099, 92.9%) (Supplementary Table 2).

Cancer burden

The leading cancer sites in men were the mouth, tongue, trachea bronchus and lung, prostate, liver, and gallbladder, with AAIR as 19.1, 5.3, 3.6, 3.4, 3.4, 3.4 per 100,000 respectively. For women, the leading cancer sites were the breast, cervix, gallbladder, ovary, mouth, and liver, with AAIR as 13.7, 8.4, 7.3, 3.6, 2.5, 2.5 per 100,000 respectively. The overall leading primary sites are given in Supplementary Table 3. The lifetime risk for developing cancer (0–74 years) was the highest for mouth and breast among men and women, respectively.

Rural-urban comparisons for cumulative risk for some of the leading sites are given in Supplementary Table 3.

Rural-urban disparities

On multivariable analysis, older cancer patients (45 years and older) had about 1.5 to 2 times higher odds of belonging to an urban area compared to the rural area. Similarly, the odds of literacy were higher in urban patients than in rural patients. Patients using non-Hindi dialect were higher in rural patients compared to their urban counterparts. Also, the proportion of farmers, unskilled, semi-skilled, and skilled workers was lower among urban patients, but that of professional and semi-professional workers was higher when compared to rural patients. The odds of being in lower middle, and upper and upper middle socio-economic class were 1.4 times higher among urban patients than rural patients. Diagnostic and clinical record confirmation for cancer diagnosis was significantly higher in urban patients, while verbal autopsy confirmation was higher in rural patients. Furthermore, we observed that the odds of receiving palliative or alternative systems of medicine were significantly higher for rural patients compared to their urban counterparts. Additionally, the odds of treatment completion were significantly higher for urban patients. A significantly higher proportion of patients were alive at the time of follow-up among urban residents compared to the rural ones. (Table 1)

Table 1.

Rural-urban differences in the distribution of adult patients with cancer ($N = 6565$)

Variable	**Rural (*n* =**	**Urban (*n* =**	**Crude**		**Adjusted**	
			OR	**p-**	**OR**	**p-**

	3220)	3345)	(95%CI)	value	(95%CI)	value
Age groups (completed years)						
15–29	206 (53.2)	181 (46.8)	Reference		Reference	
30–44	649 (48.8)	681 (51.2)	1.2 (0.9–1.5)	0.125	1.3 (1.01–1.7)	0.040*
45–59	1237 (50.9)	1195 (49.1)	1.1 (0.9–1.4)	0.387	1.5 (1.2–1.9)	0.002*
≥ 60	1128 (46.7)	1288 (53.3)	1.3 (1.0-1.6)	0.017*	2.0 (1.5–2.6)	< 0.01*
Sex						
Female	1472 (50.8)	1423 (49.2)	Reference		Reference	
Male	1748 (47.6)	1922 (52.4)	1.1 (1.0-1.2)	0.010*	0.9 (0.7–1.1)	0.284
Educational qualification						
Illiterate	852 (62.2)	518 (37.8)	Reference		Reference	
Literate	811 (55.1)	660 (44.9)	1.3 (1.1–1.5)	< 0.01*	1.3 (1.1–1.5)	0.003*
Up to secondary	1200 (45.7)	1426 (54.3)	1.9 (1.7–2.2)	< 0.01*	1.7 (1.5-2.0)	< 0.01*
Senior secondary or higher	335 (32.8)	686 (67.2)	3.4 (2.8-4.0)	< 0.01*	2.4 (2.0–3.0)	< 0.01*
No information/unknown	22 (28.6)	55 (71.4)	4.1 (2.5–6.8)	< 0.01*	2.8 (1.5-5.0)	0.001*
Religion						
Hindu	3054 (52.9)	2720 (47.1)	Reference		Reference	

Others	166 (21.0)	625 (79.0)	4.2 (3.5-5.0)	< 0.01*	6.5 (5.3–7.9)	< 0.01*
Mother tongue						
Hindi	2874 (47.1)	3225 (52.9)	Reference		Reference	
Others	346 (74.2)	120 (25.8)	0.3 (0.2–0.4)	< 0.01*	0.3 (0.2–0.4)	< 0.01*
Occupation						
Unemployed, student, house-wife	1388 (51.8)	1290 (48.2)	Reference		Reference	
Farmer, skilled worker, semi-skilled worker, unskilled worker, others	1507 (55.8)	1192 (44.2)	0.8 (0.8–0.9)	0.003*	0.7 (0.6–0.9)	0.004*
Profession, semi-professional, clerical, government employee, private employee	319 (27.9)	824 (72.1)	2.8 (2.4–3.2)	< 0.01*	1.8 (1.4–2.3)	< 0.01*
No information	6 (13.3)	39 (86.7)	7.0 (2.9–16.6)	< 0.01*	4.2 (1.7–10.7)	0.002*
Monthly Income						
Lower	1693 (58.4)	1208 (41.6)	Reference		Reference	
Lower middle	964 (42.8)	1289 (57.2)	1.9 (1.7–2.1)	< 0.01*	1.4 (1.3–1.6)	< 0.01*
Upper and upper middle	320 (34.9)	596 (65.1)	2.6 (2.2-3.0)	< 0.01*	1.4 (1.2–1.7)	< 0.01*
No information/unknown	243 (49.1)	252 (50.9)	1.4 (1.2–1.7)	< 0.01*	1.1 (0.9–1.4)	0.226
Basis of diagnosis						
Clinical	207 (38.4)	332 (61.6)	Reference		Reference	
DCO	9	27	1.9 (0.9-	0.113	2.4	0.041*

	(25.0)	(75.0)	4.0)		(1.03–5.6)	
Radiology	312 (47.7)	342 (52.3)	0.7 (0.5–0.9)	< 0.01*	0.8 (0.6-1.0)	0.052
Cytology	345 (49.7)	349 (50.3)	0.6 (0.5–0.8)	< 0.01*	0.7 (0.5–0.9)	0.005*
Verbal autopsy	835 (75.8)	266 (24.2)	0.2 (0.1–0.2)	< 0.01*	0.3 (0.2–0.3)	< 0.01*
Histology of primary	1512 (42.7)	2029 (57.3)	0.8 (0.7-1.0)	0.060	0.8 (0.7-1.0)	0.065
Treatment						
No treatment	168 (50.9)	162 (49.1)	Reference		Reference	
Surgery	242 (45.7)	288 (54.3)	1.2 (0.9–1.6)	0.134	0.9 (0.7–1.3)	0.817
RT	86 (46.2)	100 (53.8)	1.2 (0.8–1.7)	0.308	0.9 (0.6–1.4)	0.782
CT	499 (49.0)	520 (51.0)	1.1 (0.8–1.4)	0.540	0.9 (0.7–1.2)	0.704
Multi-modality	1084 (43.4)	1414 (56.6)	1.3 (1.1–1.7)	0.010*	1.0 (0.8–1.4)	0.614
Other alternative system	154 (64.2)	86 (35.8)	0.6 (0.4–0.8)	0.002*	0.7 (0.4–0.9)	0.045*
Palliative	766 (60.9)	492 (39.1)	0.7 (0.5–0.8)	0.001*	0.7 (0.5–0.9)	0.020*
No information/unknown	221 (43.8)	283 (56.2)	1.3 (1.0-1.7)	0.046*	1.0 (0.7–1.4)	0.828

Treatment status						
Not completed	1522 (56.1)	1190 (43.9)	Reference		Omitted due to collinearity	
Complete	627 (42.8)	838 (57.2)	1.7 (1.5–1.9)	< 0.01*		
Ongoing	611 (44.2)	770 (55.8)	1.6 (1.4–1.8)	< 0.01*		
Not applicable	168 (50.9)	162 (49.1)	1.2 (0.9–1.5)	0.072		
No information/unknown	292 (43.1)	385 (56.9)	1.7 (1.4-2.0)	< 0.01*		
Status						
Alive	946 (39.9)	1423 (60.1)	Reference		Reference	
Dead	2274 (54.2)	1922 (45.8)	0.6 (0.5–0.6)	< 0.01*	0.7 (0.7–0.8)	< 0.01*

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*Significant association

DCO- death certificate only, RT- Radiotherapy, CT- Chemotherapy

Rate differences for incidence and mortality of leading cancer sites

The incidence rates of liver, other and unspecified sites (O&U), gallbladder, penis, trachea, bronchus, and lung cancers were higher in rural males, while incidence rates of mouth, tongue, oesophagus, prostate, and colon cancers were higher in urban males. Rural women had higher incidence rates of cervix uteri, gallbladder, liver, O&U, and mouth cancer and urban women had higher incidence rates of breast, ovary, corpus uteri, colon, and oesophageal cancer (Figures 2 and 3).

Fig. 2.

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Rate differences in cancer incidence among male patients with cancer residing in rural versus urban areas of Varanasi, 2017–2019. ($N = 3785$)

Fig. 3.

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Rate differences in cancer incidence among female patients with cancer residing in rural versus urban areas of Varanasi, 2017–2019. (N = 2936)

Similar trends were observed in mortality, with rural males having higher mortality from O&U, liver, gallbladder, trachea, bronchus, and lung cancer and urban males having higher mortality from mouth, tongue, oesophagus, stomach, larynx, and colon cancer. Women living in rural areas had higher mortality from cervix uteri, gallbladder, liver, breast, O&U, and mouth cancer and those living in urban areas had greater mortality from corpus uteri, ovary, colon, and oesophagus cancer (Figures 4 and 5).

Fig. 4.

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Rate differences in cancer mortality among male patients with cancer residing in rural versus urban areas of Varanasi, 2017–2019. (N = 3785)

Fig. 5.

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Rate differences in cancer mortality among female patients with cancer residing in rural versus urban areas of Varanasi, 2017–2019. ($N = 2936$)

Standardised risk ratios for incidence and mortality of leading cancer sites

We observed a significantly lower all-site cancer incidence (about 25%) and mortality (about 20%) among rural men compared to urban men. No substantial difference in all-site cancer incidence was observed between urban and rural women; however, mortality was about 20% higher among rural women. Rural men had 60–65% lower incidence and 50–60% lower mortality for oesophagus and colon cancers. Also, rural men had 40–45% lower incidence and 25–40% lower mortality for tongue and mouth cancers. Despite about a 35% lower incidence of prostate cancer in rural men, we observed a minimal difference in mortality. Compared to urban men, rural men had about a 50% higher incidence of liver cancer, a 10% higher incidence of gallbladder cancer, and about 45–65% higher mortality for these cancers (Table 2).

Table 2.

Standardised rate ratio for incidence and mortality of the leading cancer sites among the rural vs. urban population, Varanasi, India, 2017–2019. ($N = 6721$)

Cancer sites	Incidence rate (AAR per 100,000)				Standardised Rate Ratio (95% Confidence Interval)			
	Rural		Urban		Male		Female	
	Male	Femal	Male	Femal	Inciden	Mortali	Inciden	Mortali

		e		**e**	**ce**	**ty**	**ce**	**ty**
All sites	60.8	59.0	81.7	63.2				
					0.74	0.79	0.93	1.18
					(0.73–0.75) *	(0.77–0.80) *	(0.92–0.95) *	(1.16–1.21) *
	15.0	2.9	24.3	2.3				
Mouth					0.62	0.74	1.25	1.53
(C03-06)					(0.60–0.63) *	(0.72–0.77) *	(1.16–1.35) *	(1.40–1.67) *
	3.9	1.4	7.1	1.5				
Tongue					0.56	0.60	0.97	1.02

(C01-02)					(0.53–0.59) *	(0.56–0.64) *	(0.88–1.06)	(0.91–1.15)
	0.1	12.7	-	15.9	-	-		
Breast							0.80	1.13
(C50)							(0.77–0.83) *	(1.08–1.19) *
	-	10.3	-	6.9	-	-		
Cervical							1.49	1.74
(C53)							(1.43–1.55) *	(1.65–1.83) *

	-	3.2	-	4.5	-	-		
Ovary							0.70	0.83
(C56)							(0.66–0.75) *	(0.76–0.91) *
Corpus uteri (C54)	-	0.6	-	1.9	-	-		
							0.32	0.09
							(0.28–0.36) *	(0.07–0.12) *
	2.8	-	4.1	-			-	-
Prostate					0.67	0.96		

(C61)					(0.63–0.71) *	(0.90–1.03)		
	0.6	0.3	1.7	0.9				
Colon					0.35	0.46	0.28	0.42
(C18)					(0.31–0.39) *	(0.39–0.53) *	(0.23–0.33) *	(0.34–0.52) *
Oesophagus (C15)	1.3	0.7	3.1	1.3				
					0.41	0.41	0.51	0.66
					(0.38–0.45) *	(0.37–0.44) *	(0.45–0.58) *	(0.57–0.77) *

	4.1	3.0	2.7	1.9				
Liver (C22)					1.53 (1.44–1.63) *	1.64 (1.53–1.75) *	1.55 (1.43–1.67) *	1.82 (1.68–1.97) *
Gallbladder (C23-24)	3.5	8.7	3.2	6.2	1.10 (1.04–1.17) *	1.45 (1.35–1.55) *	1.42 (1.35–1.48) *	1.52 (1.45–1.60) *

*Significant difference

Compared to urban women, rural women had about 50% or higher incidence of cervical, liver, and gallbladder cancer and 50% or lower incidence of corpus uteri, oesophagus, and colon cancer. At least 50% or higher mortality among rural women was observed for cervical, liver, gallbladder, and mouth cancer. About 70% lower incidence and 90% lower mortality were reported for ovarian cancer in rural women. Significantly higher mortality for breast cancer was observed in rural women, despite about 20% lower incidence. (Table 2)

Discussion

The growing burden of cancer and the required continuum of care are facing inequalities and inequities around the world, and one such example is the rural-urban disparity in cancer [17]. Rural residence, though a simple variable, encapsulates a complex surrogate for several potential explanatory factors like access to care, lifestyle, environmental exposure, and various socioeconomic factors [18]. Disparity in cancer outcomes due to rurality is well documented [3, 14, 19, 20]. Moreover, rapid advances in cancer care will further widen the disparity in outcomes for rural patients without directed effort to understand and address barriers to high-quality care in these regions [6]. Understanding the context of this disparity will reveal the specific needs of the population [18], especially for resource-constrained countries like India, which has the largest growing population with a predominantly rural background. Through this paper, we analysed the urban-rural disparity in cancer burden and care for over 6,000 patients in Northern India who were registered under the PBCR of the Varanasi district from the Uttar Pradesh state of India.

Disparities in the age distribution

We observed that the adult cancer patients aged 45 years and above significantly belonged to urban regions of the district, while the younger patients (aged 15–29 years) were from rural backgrounds. The significantly higher proportion of cancer among younger rural patients can be partly explained by tobacco use, which accounts for approximately 30% of cancers in India [20]. Furthermore, Global Adult and Youth Tobacco Surveys (GATS and GYTS) have reported an early age of tobacco initiation and a higher prevalence of tobacco use, especially in rural populations [21, 22]. Inadequate services for tobacco and alcohol cessation counselling in rural areas exacerbate this problem [23]. Fully-functional adolescent health clinics are the need of the hour and should offer habit cessation counselling as well as screening for common cancers in young adults.

On the other hand, increasing age itself is an independent risk factor for cancer and better access to health care in urban regions is contributing to increased life expectancy, and thereby an increased elderly population in the urban regions [24]. This can somewhat explain the significantly higher proportion of cancer in elderly urban patients. Also, poor access to diagnostic facilities, especially for the rural elderly population, can be another explanation for this distribution. We observed a significantly higher proportion of cancers from O&U among the rural patients, which further highlights this diagnostic disparity. It is therefore imperative to expand the existing facilities in urban areas given the high burden of cancer and simultaneously establish and strengthen facilities for cessation counselling, diagnosis, and treatment in underserved rural areas. Measures such as telemedicine, mobile screening units, mobile health applications, etc. should also be taken to address the barriers to accessing the facilities by the elderly population in both urban and rural areas.

Disparities in the socio-cultural distribution

We observed a significant difference in the religion of patients; where compared to the rural patients, who were predominantly Hindu, the urban patients belonged to other religions. Our finding is supported by the Indian Census, which reported that religious minorities tend to migrate and live in urban areas for social security [25, 26]. On the other hand, the rural patients predominantly spoke the local vernacular language compared to urban patients, who could communicate in the common Hindi language. Language and cultural barriers to cancer treatment and symptom management have been reported among rural patients with cancer [27]. Patient navigation systems can help overcome this linguistic and cultural barrier [28].

There was a significant difference in the type of profession among the patients, where the proportion of professionals and semi-professionals was significantly higher in urban patients while farming, un-skilled, semi-, and skilled professions were predominant in rural patients. Previous studies have reported the success of workplace screening in urban populations and community screening in rural populations and future cancer control policies should implement screening strategies accordingly [29, 30].

The educational and socio-economic status were significantly higher in the urban patients, confirming the prevalent socio-economic disparity in the urban-rural population. Educational and socio-economic status are important factors associated with better health literacy, health-seeking behaviour, screening participation and adherence, early stage at diagnosis, compliance with treatment, and follow-up thereby resulting in an overall better survival of the cancer patients. This disparity in accessing cancer care is further worsened in rural populations because of the large proportion of the uninsured population, high out-of-pocket expenditure, and avoidance of seeking care, as many are daily wagers and face illness-related unemployment and increased travel time to access healthcare facilities [31].

These socio-demographic factors also influence lifestyle, dietary, behavioural, and environmental factors, as well as healthcare-seeking behaviour and treatment compliance, all of which are decisive entities for cancer survival. It is important to acknowledge urban-rural variability in these factors while designing cancer control programmes. Additionally, realising the spirit of universal health coverage for cancer care is vital to bridge the divide and prevent the resulting impoverishment among already poor and marginalised rural patients with cancer.

Disparities in cancer burden

The overall incidence of cancer in rural areas was lower compared to urban areas, but mortality was higher in rural areas, especially among women. Our findings align with previous national studies. In rural cancer registries (Barshi), the AAIR is nearly one-third of urban PBCRs [32]. Another study noted that the AAIR in urban Punjab PBCRs (Chandigarh and SAS Nagar) is almost twice that in rural PBCRs (Mansa and Sangrur) [19]. Similar trends are observed in Nepal, where the urban (Kathmandu) registry showed 1.6 times higher AAR among males and 1.9 times higher AAR among females in comparison to the rural (Rukum) registry [33]. Conversely, a study in China revealed significantly higher AAIR in rural men, primarily attributed to oesophageal cancer [14]. Developed countries, like those in North America, consistently reported higher all-site incidence rates in urban populations compared to rural ones [34].

A complex interplay of rurality with sociodemographic, lifestyle, dietary, behavioural, and environmental factors that affect the screening participation, incidence, and prognosis of the disease is seldom recognised and addressed. Additionally, rural women face several cultural and social barriers, which further aggravate the misery [3, 35]. This was evident from our findings, where out of the three preventable cancers among women for which screening is recommended in the National programme, two (oral and cervical) had a higher incidence and all three (oral, breast, and cervical) had a higher mortality among rural women. Previous Indian studies have highlighted the inequalities in socioeconomic factors and healthcare utilisation concerning cancer screening in urban and rural populations [5, 36, 37]. Given the above findings, cancer awareness generation and screening activities must acknowledge the dissimilar socio-demographic background characteristics of urban and rural populations and design strategies accordingly.

Furthermore, various healthcare-related factors such as (i) poor access to cancer treatment facilities, (ii) greater likelihood to receive treatment at smaller hospitals, (iii) lower probability of guideline-concordant treatment practices, (iv) lack of genomic testing and staging, (v) disparity in cancer treatment modalities and quality, (vi) treatment attrition, (vii) significant shortage of specialists, (viii) limited supportive and rehabilitative resources, and (ix) inadequate cancer care navigation are more pronounced in rural regions and contribute to higher mortality [39, 39]. Healthcare services in urban areas of India generally receive a larger share of public resources, resulting in lower rural health infrastructure investment coupled with issues of ill management, staff absenteeism, and poor capacity-building efforts [3, 38, 39].

Disparities in the leading cancer sites

We observed a significant difference in the standardised rate ratios for the site-specific cancers for rural and urban patients. Similar observations have been reported from previous cancer registries of India, Nepal, China, and the United States (US) [14, 19, 33, 40]. The significantly higher AAR for liver cancer in rural patients can be partially attributed to a greater prevalence of alcohol use in the rural Indian population. This is compounded by an earlier age at the onset of alcohol consumption, frequent episodes of heavy drinking, and the consumption of non-brewed alcoholic beverages [23]. Also, a greater prevalence of hepatitis B infection and a similar prevalence of non-alcoholic fatty liver disease, which are known risk factors for liver cancer, have been reported among rural Indian residents compared to the urban population [41]. The National Cancer Registry Programme has also reported that liver cancer was highest in the northeastern cancer registries (Papumpasre, West Arunachal, Aizwal, Mizoram) [11] which have a predominantly rural population (81.64%) [42] Similarly, China [14] and US [43] have also reported higher AAR for liver cancer in their rural populations.

Significantly higher AAR of gallbladder cancer in both male and female rural patients can be partly explained by higher mustard oil consumption, the prevalence of cholelithiasis, chronic typhoid infection, and the consumption of snails, which are often contaminated with liver flukes [44, 45]. Arsenic in groundwater has recently been linked to gallbladder cancer, and untreated groundwater consumption is more prevalent in rural areas than urban areas, which might further explain the rural predominance of gallbladder cancer [46]. Several studies from India (cancer registries and case-control studies) have reported rural background as a risk factor for gallbladder cancer [44, 47]. However, studies from countries such as Nepal [33] and Chile [48] have reported urban predominance for gallbladder cancer, which has been explained by the higher prevalence of gallstones, obesity, and hormone use in their urban regions [33, 48].

We observed significantly higher incidence rates for colon and oesophageal cancer in both men and women with urban backgrounds compared to their rural counterparts. Higher prevalence of obesity, inadequate physical activity, salt and red meat consumption, diabetes, and low consumption of fibre among urban residents could partly decipher the higher incidence rates in the urban population [49]. Our findings are in line with studies from India that have reported a rising trend in registries established in metropolitan regions (predominantly urban population) such as Delhi, Chennai, Mumbai, and Banglore [50], and studies from China [14, 51]. In contrast, studies from the US show a rural preponderance for colon cancer, which has been attributed to higher red meat consumption, obesity, a lack of physical activity, and lower cancer screening adherence in their rural populations [34, 52]. The urban preponderance of oesophageal cancer observed in our study can be attributed to the increased prevalence of gastroesophageal reflux disease, low fruit and vegetable intake, and obesity, coupled with prevalent tobacco and alcohol use in urban areas [49, 53]. However, Indian registries from another northern state (Punjab) reported a higher AAR of oesophageal cancer in rural registries (Mansa, Sangrur) in comparison to urban registries (SAS Nagar, Chandigarh) [19]. In addition, studies from China also reported a higher preponderance of oesophageal cancer in the rural population [14]. This distinction underscores the heterogeneity in the prevalence of key risk factors, namely tobacco smoking, alcohol consumption, and dietary factors, across intra- and inter-country regions.

We observed that trachea, bronchus, and lung cancer incidence rates were higher in rural patients, which could be explained by indoor air pollution due to biomass burning, exposure to second-hand smoke at home, and tobacco and beedi smoking, which are more prevalent in rural regions of Uttar Pradesh than urban areas [54, 55]. However, our findings are in contrast with rural registries from other states such as Maharashtra (Barshi) and Punjab (Mansa and Sangrur), which reported lower AAR for lung cancer, and urban registries (Chandigarh, SS Nagar, Trivandrum, Chennai, and Delhi), which reported higher incident rates [18, 54]. In addition, several urban registries from eastern African countries (Malawi, Zimbabwe, Uganda, and Kenya) have also reported a high burden of lung cancer [56]. Our finding is in line with registries from Korea [57], China [14], and the US [34], which reported rural predispositions for lung cancer incidence. These diverse observations underscore how various factors, including smoking, indoor and outdoor air pollution, and the utilization of lung cancer screening, interact in different contexts, leading to the urban-rural disparity in lung cancer incidence.

Both penile cancer in men and cervical cancer in women share some of the risk factors, including infection with the Human Papilloma Virus, increasing age, poor hygiene, tobacco use, multiple sexual partners, low education, and socio-economic status. Most of these factors are predominant in rural areas, thereby explaining the high rates of these cancers in rural patients in our study [58, 59]. Cervical cancer predominance in rural women has been unanimously reported in several registry studies from India [19, 60], Nepal [33], Sub-Saharan Africa [61], China [51] and the US [62]. Despite a lower incidence of prostate cancer, rural men had almost similar cancer-related mortality as urban patients, which is worrisome and could be due to a wide urban-rural gap in screening as well as treatment facilities and modalities. Previous Indian research has shown lower screening rates among rural patients, and rural patients with prostate cancer are less likely to receive definitive treatment than their urban counterparts [63–65]. Systematic reviews, which mostly used data from high-income countries, showed that rural-urban differences in prostate cancer incidence and mortality were confirmed. It was found that while incidence was higher in urban men, mortality was higher in rural men. This was partly because of the systemic barriers that made it take longer for men to get diagnosed and treated for prostate cancer [66, 67].

A negative rural-urban risk difference in the incidence of endometrial, breast, and ovarian cancer can be attributed to a relatively greater prevalence of risk factors like obesity, metabolic syndrome, nulli-and-low parity, late pregnancy, infertility, use of hormones, early age at menarche, and poor lifestyles like inadequate physical activity, a high-fat diet, and alcohol and tobacco use in urban areas than in rural regions [68]. Our findings are in line with the observations from other Indian PBCRs where breast cancer was the leading cancer in registries of urban agglomerations [19] and cervix cancer was the leading cancer in rural registries like Barshi, Mizoram, Tripura, Pasigat, Nagaland, Cachar, Osmanabad, and Beed [68]. The urban preponderance of these women's cancers associated with a hormonal etiology has been reported in several studies from Nepal [33], Egypt [69], China [70], and the US [34].

We observed that, despite significantly lower breast cancer incidence in rural women, higher mortality was observed in them compared to their urban counterparts. This signifies the rural-urban disparities in the early detection of breast cancer, delayed care seeking, and treatment initiation. Previous Indian studies reported that rural women are less likely to get screened and more likely to present at late stages of breast cancer compared to their urban counterparts [35, 71]. Furthermore, the significantly higher incidence of breast, endometrial, ovarian, and colon cancers in urban female patients hints towards further research for understanding the genetic predisposition and genetic screening and counselling.

We observed that mouth cancer was the predominant cancer in our study population. Surprisingly, despite well-documented higher tobacco use in rural parts of India and Uttar Pradesh [21, 22], we observed a statistically significant higher incidence and mortality of mouth cancer in urban men. Previous studies comparing the incidence rates of oral cancer have also shown significantly higher incidence in urban PBCRs compared to rural PBCRs [72]. Additionally, analysis of a national representative survey also reported higher rates of tobacco-related cancer deaths in urban than rural men [35]. This can be explained to a certain extent by several factors. Firstly, poor cancer screening coverage was reported in the national survey [63] where the oral cancer screening rates were lower in the rural population, thus reflecting the impact of poor screening coverage on the cancer incidence distribution. The second explanation can be the significantly higher proportion of the elderly in our urban study population, and as discussed previously, age itself is an important independent risk factor for carcinogenesis. Thirdly, studies from India have reported that most of the oral cancers detected in rural populations are in advanced stages with poor 5-year survival [38, 73]. Previously, a review on oral cancer burden in India reported variations in the AAR of oral cancer in rural men across many registries. One explanation cited was the lack of transportation, which hinders seeking diagnosis and care in rural populations [73]. Therefore, this contradicting finding from our study underscores the rural-urban disparity in the early detection of oral cancer in this region. Registry from China [14] reported higher AAR in urban men while the North American Registries [34] reported higher incidence in rural men, and both attributed this difference to the higher tobacco consumption in their urban and rural populations, respectively.

Disparities in the cancer care continuum

We observed a smaller number of cancer confirmations through only death certificates (DCO), where no other clinical records of the patients were available, and these DCO cases were mostly seen in urban patients. Cancer confirmation by verbal autopsy constituted a relatively larger portion of cancer registrations and was seen mostly in rural patients. These findings reflect poor record maintenance, weak medical certification of the cause of death, and various challenges associated with cancer registration in the study region, especially in the rural population compared to the urban population [7]. Furthermore, the proportion of urban patients who had microscopic verification for cancer confirmation (71.1%) was higher than that of rural patients (57.7%). In addition, we observed a higher proportion of incomplete treatment among rural patients with cancer. This can be partly attributed to the reliance on alternative systems of medicine, cancer fatalism, and poor health and cancer literacy, which are the pragmatic challenges present predominantly in the rural parts of our study settings. We observed that definitive treatment, including multi-modality treatment, was significantly higher in urban patients. A recent Indian survey reported that the average number of patients with cancer attending public outpatient service management was higher in urban areas. Moreover, the survey reported a lower proportion of facilities for cancer screening and inpatient and outpatient cancer management services in rural areas compared to their urban counterparts [23]. Hence, it is imperative to engage multi-sectoral stakeholders to develop patient advocacy networks, especially for rural resource-deprived regions, to improve healthcare seeking and compliance as well as prevent treatment attrition.

A significantly higher proportion of rural patients were receiving palliative care than their urban counterparts. The lack of organized screening, diagnostic, and referral facilities in rural areas, resulting in delayed diagnosis, can explain this difference. Strategies to improve their accessibility and affordability will aid in the early detection and downstaging of cancers. Furthermore, 138 Indian organizations providing hospice and palliative care services are concentrated in large cities and regional cancer centres, except for Kerala. Therefore, it necessitates long-distance journeys for rural patients to access palliative care in urban settings [74]. Thus, there is a pressing need to introduce palliative care at the primary health care level.

Limitations

This was a newly established PBCR; hence, we had limited follow-up information to analyse and describe 5-year survivals for leading cancer sites. In addition, the case ascertainment completeness indices such as the proportion of microscopic verification, DCO, and AAIR of childhood cancers reflected under-registration by 10–20% within the different blocks of the district, especially among the rural, elderly, and paediatric (especially girl child) populations, partly due to the disparity in accessibility of the services [75]. Since we could utilise only the incidence-based data, information related to some important variables such as staging of cancer, health insurance status, co-morbidities, and risk factors such as lifestyle, dietary behaviour, and environmental factors could not be evaluated to explain the observed disparities. Lastly, we cannot generalise these observations to reflect the extent of the nationwide rural-urban disparity in cancer incidence and patterns.

Strengths

To the best of our knowledge, this is the first of its kind study from India that has analysed the risk of site-specific cancers and the disparities in the social-demographic characteristics of patients with cancer, cancer burden, and patterns among the rural and urban populations. Owing to the longitudinal data, we could analyse the urban-rural disparity in terms of overall and site-specific cancer mortality.

Conclusion

Low- and middle-income countries face two distinct challenges when it comes to cancer prevention and control: in their urban areas, unhealthy lifestyle changes that are linked to an increased risk of cancer are being observed, and in their rural areas, a lack of access to healthcare leads to delayed diagnosis and poor survival. Based on these findings, we recommend context-specific interventional programmes targeting risk-factor modifications, cancer awareness, early detection, and accessibility to diagnosis and care. These observed geographical and social variations for the specific cancer sites warrant further research to understand the causation of cancer. Our study reflects this distinctness in cancer burden and pattern, especially for the female population, and calls for a re-evaluation of cancer control strategies that are tailor-made with an understanding of urban-rural disparities. We are further planning to study the completeness of the cancer registry in the coming years.

Migraine

Headache disorders and public ill-health in India

Abstract

Background

Primary headache disorders are among the commonest disorders, affecting people in all countries. India appears to be no exception, although reliable epidemiological data on headache in this highly populous country are not available. Such information is needed for health-policy purposes. Our aim was to estimate the prevalence of each of the headache disorders of public-health importance, and examine their sociodemographic associations, in urban and rural populations of Karnataka, south India.

Methods

In a door-to-door survey, 2,329 biologically unrelated adults (aged 18–65 years) were randomly sampled from urban (n = 1,226) and rural (n = 1,103) areas in and around Bangalore and interviewed by trained researchers using a pilot-tested, validated, structured questionnaire. ICHD-II diagnostic criteria were applied.

Results

The observed 1-year prevalence of any headache was 63.9 %, with a female preponderance of 4:3. The age-standardised 1 year prevalence of migraine was 25.2 %; prevalence was higher among females than males (OR: 2.1 [1.7-2.6]) and among those from rural areas than urban (OR = 1.5 [1.3-1.8]). The age-standardized 1 year prevalence of TTH was 35.1 %, higher among younger people. The estimated prevalence of all headache on ≥15 days/month was 3.0

%; that of pMOH was 1.2 %, five-times greater among females than males and with a rural preponderance.

Conclusions

There is a very high 1 year prevalence of migraine in south India (the mean global prevalence is estimated at 14.7 %). Explanations probably lie in cultural, lifestyle and/or environmental factors, although the observed associations with female gender and rural dwelling are usual. Levels of TTH, pMOH and other headache on ≥15 days/month are similar to global averages, while the very strong association of pMOH with female gender requires explanation. Until another study is conducted in the north of the country, these are the best data available for health policy in a population of over 1.2 billion people.

Keywords: Headache disorders, Migraine, Tension-type headache, Medication-overuse headache, Epidemiology, Population-based study, Prevalence, Health policy, Global Campaign against Headache

Background

Headache is one of the commonest symptoms, and primary headache disorders are among the most ubiquitous disorders, affecting people in all countries [1]. India appears to be no exception [2]. The Global Burden of Disease Study 2010 (GBD2010) found tension-type headache (TTH) and migraine to be the 2nd and 3rd most prevalent disorders worldwide [3].

Nevertheless, knowledge of the prevalence of headache disorders, on which reiterations of the Global Burden of Disease Study depend, remains substantially incomplete. Historically, it has been gathered predominantly from the high-income countries of Western Europe and North America [1], leaving vast geographical areas almost data-free. Notable among these have been South

East Asia, and in particular India. Neuroepidemiological studies in India have included headache only as one of multiple conditions of enquiry under the broad spectrum of neurological disorders [4]. There have been hospital-based studies of migraine [5, 6], but these do not provide information on prevalence or reveal the characteristics and impact of disorders in the population [7]. Yet India is home to over 16 % of the world's inhabitants [8]. Lack of knowledge of the prevalence of and burden attributable to headache disorders among such a large community has an impact on the quality and meaning of global statistics [3]. In India itself, it stands in the way of effective health-care policy and planning, the delivery of services and the means of remedy.

Across the world, the knowledge gap is slowly being filled by a series of population-based studies supported by *Lifting The Burden* (LTB) [9, 10], a UK-registered nongovernmental organization conducting the Global Campaign against Headache [11] in official relations with the World Health Organization [12]. Methodology has been developed for this purpose [7, 13]. We undertook a population-based survey in southern India (Karnataka State) as part of this series. We focused on the headache disorders of public-health importance: migraine, TTH, medication-overuse headache (MOH) and other causes of headache occurring on ≥15 days/month. This paper describes the 1 year prevalence of these disorders in this population; subsequent papers will report headache-attributed burden.

Methods

The methodology of the study has been published in detail previously [14] and is described only briefly here. The institutional ethics committee of the National Institute for Mental Health and Neuro-Science (NIMHANS) approved the study protocol. Informed consent was obtained from all participants.

The cross-sectional survey sampled from urban and rural areas in and around Bangalore: Kempegowdanagara, an urban administrative ward in the city of Bangalore, and Uyamballi and Doddaaladahalli, two large villages located 75–80 Km from Bangalore. A team of trained interviewers travelled to these communities and selected households through multistage cluster sampling. Interviewers called at each chosen household, listed all adult members (aged 18–65 years), selected one by simple random sampling and interviewed that person using a structured questionnaire. This instrument was an adaptation of the HARDSHIP questionnaire [13], translated into the local language (Kannada) in accordance with LTB's translation protocol for hybrid documents [15]. It included demographic enquiry and a headache screening question ("Have you had headache during the last year?") for all participants, followed by diagnostic questions based on the International Classification of Headache Disorders, 2nd edition (ICHD-II) [16] and enquiries into burden for those reporting headache. Any participant reporting more than one headache type was asked to focus only on the one that was subjectively the most bothersome for purposes of description, diagnosis and prevalence counting. In the previously conducted validation study, the diagnostic part of the questionnaire had a specificity and sensitivity for migraine of 85 % (95 % CI: 81–89) and 63 % (52–72), and for TTH of 81 % (76–86) and 57 % (48–65) [14].

The survey continued in each community until the requisite sample (>1,000 biologically unrelated individuals from each stratum [urban and rural]) was achieved.

Statistics and analyses

Data were entered into a secure database and statistical analyses performed using EPI INFO [17] and SPSS 15 [18].

Diagnoses were made not by the interviewers but by computerized algorithm [13] from the recorded survey responses. Participants reporting headache on ≥15 days/month were first separated, and described as a distinct group, with those also reporting regular use of acute headache medication on >10 days/month considered to have probable MOH (pMOH). To all others, the algorithm applied ICHD-II diagnostic criteria [16] in the order: migraine, TTH, probable migraine, probable TTH. Cases of migraine and probable migraine, and of TTH and probable TTH, were then combined for prevalence estimation and further analyses [7]. Remaining cases were unclassified.

We used proportions, 95 % confidence intervals (CIs), medians, means and standard deviations (SDs) to summarise the distributions of variables and chi-squared, Student's t-test or ANOVA to test for significance of differences. We calculated odds ratios (ORs) to test for associations in bivariate analysis, and adjusted odds ratios (AORs) using multivariate logistic regression. We set the level of significance at 5 %.

Results

There were 2,329 participants (1,141 [49.0 %] male, 1,188 [51.0 %] female, mean age 38.0 [±12.7] years, 1,103 [47.4 %] from rural areas and 1,226 [52.6 %] urban). The overall participation rate was 92.6 % (eligible population n = 2,514). While there were few actual refusals (25 urban, nil rural), the key reason for non-participation (103 urban, 57 rural) was unavailability for interview even after three contacts. The distributions of gender, age and habitation in the participating sample have been described, and were comparable to those of the population of Karnataka [14].

Prevalence

The crude 1 year prevalence of any headache (n = 1,488) in the study population was 63.9 %, with female preponderance (73.0 % *versus* 54.4 % in males; OR = 2.3 [1.9-2.7]) and rural preponderance (71.2 % *versus* 57.3 % urban; OR = 1.8 [1.6-2.1]). Further analyses in this manuscript are by headache type.

The crude 1 year prevalence of migraine (n = 597) was 25.6 % (95 % CI: 23.9-27.4 %; 10.8 % [9.7-12.2 %] definite, 14.8 % [13.4-16.3 %] probable). Prevalence was higher among females (32.4 %) than males (18.6 %; OR = 2.1 [1.7-2.6]) and among those from rural areas (29.7 %) than urban (21.9 %; OR = 1.5 [1.3-1.8]) (Table 1).

Table 1.

One-year prevalence of migraine by age, gender and habitation (N = 597)

Age (years)	One-year prevalence n (%) [95 % CI]								
	Urban habitation			Rural habitation			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
18-25	23 (17.6) [12.0-25.0]	27 (21.8) [15.4-29.8]	50 (19.6) [15.2-24.9]	16 (19.0) [12.1-28.7]	29 (25.9) [18.7-34.7]	45 (23.0) [17.6-29.3]	39 (18.1) [13.6-23.8]	56 (23.7) [18.7-29.5]	95 (21.1) [17.6-25.1]
26-35	32 (18.7) [13.6-25.2]	69 (32.5) [26.6-39.1]	101 (26.4) [22.2-31.0]	28 (20.6) [14.6-28.1]	63 (40.4) [33.0-48.2]	91 (31.2) [26.1-36.7]	60 (19.5) [15.5-24.3]	132 (35.9) [31.1-40.9]	192 (28.4) [25.2-32.0]
36-45	25 (15.2) [10.5-21.5]	51 (35.7) [28.3-43.8]	76 (24.8) [20.3-29.9]	42 (26.3) [20.0-33.6]	53 (41.1) [33.0-49.7]	95 (32.9) [27.7-38.5]	67 (20.7) [16.6-25.4]	104 (38.2) [32.7-44.1]	171 (28.7) [25.2-32.5]
46-55	13 (13.5) [8.1-21.8]	17 (24.6) [16.0-36.0]	30 (18.2) [13.0-24.8]	11 (14.7) [8.4-24.4]	36 (36.4) [27.6-46.2]	47 (27.0) [21.0-34.1]	24 (14.0) [9.6-20.0]	53 (31.5) [25.0-38.9]	77 (22.7) [18.6-27.5]
56-65	2 (4.1)	10	12	20	30	50	22	40	62

	[1.1-13.7]	(14.9) [8.3-25.3]	(10.3) [6.0-17.2]	(26.7) [18.0-37.6]	(39.0) [28.8-50.1]	(32.9) [25.9-40.7]	(17.7) [12.0-25.4]	(27.8) [21.1-35.6]	(23.1) [18.5-28.5]
All	95 (15.5) [12.9-18.6]	174 (28.3) [24.9-32]	269 (21.9) [19.7-24.3]	117 (22.1) [18.8-25.8]	211 (36.8) [33.0-40.8]	328 (29.7) [27.1-32.5]	212 (18.6) [16.4-20.9]	385 (32.4) [29.8-35.1]	597 (25.6) [23.9-27.4]

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Table 1 shows migraine prevalence in the sample by age, which peaked in both genders in the range 35–45 years. A second rise was exhibited by males over 56 years, driven entirely by the rural population in which it was statistically significant (chi-squared = 18.99; $p < 0.001$); a small and statistically insignificant second peak was seen in rural females. The age-standardized 1 year prevalence of migraine (against Karnataka's state population [8]) was 25.2 %.

The crude 1 year prevalence of TTH (n = 811) was 34.8 % (95 % CI: 32.9-36.8 %; 26.6 % [24.9-28.5 %] definite, 8.2 % [7.2-9.4 %] probable). Prevalence was similar between genders but higher among those from rural areas (38.4 %) than urban (32.2 %) (Table 2; chi-squared = 7.73; $p < 0.005$). TTH prevalence declined steadily from 40.1 % in those aged 18–25 years to 28.7 % in those over 56. This was reflected in both genders and in both urban and rural habitations (Table 2). The age-standardized [8] 1 year prevalence of TTH was 35.1 %.

Table 2.

One-year prevalence of tension-type headache by age, gender and habitation (N = 811)

Age (years)	One-year prevalence n (%) [95 % CI]								
	Urban habitation			Rural habitation			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
18-25	44 (33.6) [26.1-42.0]	48 (38.7) [30.6-47.5]	92 (36.1) [30.4-42.1]	34 (40.5) [30.6–51.2]	55 (49.1) [40.0-58.2]	89 (45.4) [38.6-52.4]	78 (36.3) [30.1-42.9]	103 (43.6) [37.5-50.0]	181 (40.1) [35.7-44.7]
26-35	55 (32.2) [25.6-39.5]	68 (32.1) [26.2-38.6]	123 (32.1) [27.6-36.9]	54 (39.7) [31.9-48.1]	55 (35.3) [28.2-43.0]	109 (37.3) [32.0-43.0]	109 (35.5) [30.4-41.0]	123 (33.4) [28.8-38.4]	232 (34.4) [30.9-38.0]
36-45	55 (33.5) [26.8-41.1]	51 (35.7) [28.3-43.8]	106 (34.5) [29.4-40.0]	57 (35.6) [28.6-43.3]	48 (37.2) [29.4-48.2]	105 (36.3) [31.0-42.0]	112 (34.6) [29.6-39.9]	99 (36.4) [30.9-42.3]	211 (35.4) [31.7-39.3]
46-55	26 (27.1) [19.2-36.7]	20 (29.0) [19.6-40.6]	46 (27.9) [21.6-35.2]	26 (34.7) [24.9-45.9]	38 (38.4) [29.4-48.2]	64 (36.8) [30.0-44.2]	52 (30.4) [24.0-37.7]	58 (34.5) [27.8-42.0]	110 (32.4) [27.7-37.6]
56-65	11 (22.4) [13.0-35.9]	17 (25.7) [16.5-36.9]	28 (24.1) [17.3-32.7]	26 (34.7) [24.9-45.9]	23 (29.9) [20.8-40.8]	49 (32.2) [25.3-40.0]	37 (29.8) [22.5-38.4]	40 (27.8) [21.1-35.6]	77 (28.7) [23.6-34.4]
All	191 (31.0) [27.7-35.0]	204 (33.4) [29.6-37.0]	395 (32.2) [29.7-34.9]	197 (37.5) [33.2-41.4]	219 (38.9) [34.3-42.3]	416 (38.4) [34.9-40.6]	388 (34.0) [31.1-36.8]	423 (36.2) [32.9-38.4]	811 (35.1) [32.9-37.8]

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There were 12 cases (0.5 %) of unclassified episodic headache.

The overall prevalence of all types of headache on ≥15 days/month (n = 68) was 3.0 % (95 % CI: 2.3-3.7). About 40 % of such cases were pMOH, of which the observed prevalence was 1.2 % (n = 28). While numbers were small, this disorder again showed a rural preponderance (1.5 % *versus* 0.9 % urban). More striking was the gender difference (Table 3): overall, prevalence was five times greater among females than males, while in urban areas pMOH appeared to be almost uniquely a disorder of females. There was not a clear age-relationship, but generally the highest prevalences were reported by those aged >56 years (4.2 % by females overall, and 4.5 % by urban females) (Table 3).

Table 3.

One-year prevalence of probable medication-overuse headache by age, gender and habitation (N = 28)

Age (years)	One-year prevalence n (%) [95 % CI]								
	Urban habitation			Rural habitation			Total		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
18-25	0 [0.0-2.8]	3 (2.4) [0.8-6.9]	3 (1.2) [0.4-3.4]	1 (1.2) [0.2-6.4]	2 (1.8) [0.5-6.3]	3 (1.5) [0.5-4.4]	1 (0.5) [0.1-2.6]	5 (2.1) [0.9-34.8]	6 (1.3) [0.6-2.9]
26-35	1 (0.6) [0.1-3.2]	1 (0.5) [0.1-2.6]	2 (0.5) [0.1-1.9]	1 (0.7) [0.1-4.0]	5 (3.2) [1.4-7.3]	6 (2.1) [0.9-4.4]	2 (0.7) [0.2-2.3]	6 (1.6) [0.7-3.5]	8 (1.2) [0.6-2.3]

36-45	0 [0.00-2.3]	1 (0.7) [0.1-3.9]	1 (0.3) [0.1-1.8]	0 [0.0-2.3]	1 (0.8) [0.1-4.3]	1 (0.3) [0.1-1.9]	0 [0.0-1.2]	2 (0.7) [0.2-2.6]	2 (0.3) [0.1-1.2]
46-55	0 [0.00-3.8]	2 (2.9) [0.8-9.9]	2 (1.2) [0.3-4.3]	0 [0.0-4.9]	3 (3.0) [1.0-8.5]	3 (1.7) [0.6-4.9]	0 [0.0-2.2]	5 (2.9) [1.3-6.8]	5 (1.5) [0.6-3.4]
56-65	0 [0.0-7.3]	3 (4.5) [1.5-12.4]	3 (2.6) [0.9-7.3]	1 (1.3) [0.2-7.2]	3 (3.9) [1.3-10.8]	4 (2.6) [1.0-6.6]	1 (0.8) [0.1-4.4]	6 (4.2) [1.9-8.8]	7 (2.6) [1.3-5.3]
All	1 (0.2) [0.0-0.9]	10 (1.6) [0.9-2.9]	11 (0.9) [0.5-1.6]	3 (0.6) [0.2-1.7]	14 (2.4) [1.5-4.1]	17 (1.5) [0.9-2.5]	4 (0.4) [0.1-0.9]	24 (2.0) [1.4-2.9]	28 (1.2) [0.8-1.7]

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Among other types of headache on ≥15 days/month (overall prevalence 1.7 %; n = 40) there was a two-fold female preponderance but no apparent relationship with age or habitation (Table 4).

Table 4.

One-year prevalence of other headache on ≥15 days/month by age, gender and habitation (N = 40)

Age (years)	One-year prevalence n (%) [95 % CI]								
	Urban habitation			Rural habitation			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
18-25	4 (3.1) [1.2-7.6]	2 (1.6) [0.4-5.7]	6 (2.4) [1.1-5.0]	1 (1.2) [0.2-6.4]	3 (2.7) [0.9-7.6]	4 (2.0) [0.8-5.1]	5 (2.3) [1.0-5.3]	5 (2.1) [0.9-4.9]	10 (2.2) [1.2-4.0]
26-35	0 [0.0-2.2]	5 (2.4) [1.0-5.4]	5 (1.3) [0.6-3.0]	0 [0.0-2.7]	4 (2.6) [1.0-6.4]	4 (1.4) [0.5-3.5]	0 [0.0-1.2]	9 (2.4) [1.3-4.6]	9 (1.3) [0.7-2.5]
36-45	3 (1.8) [0.6-5.2]	5 (3.5) [1.5-7.9]	8 (2.6) [1.3-5.1]	3 (1.9) [0.6-5.4]	3 (2.3) [0.8-6.6]	6 (2.1) [1.0-4.5]	6 (1.9) [0.9-3.9]	8 (2.9) [1.5-5.7]	14 (2.3) [1.4-3.9]
46-55	1 (1.0) [0.2-5.7]	1 (1.4) [0.2-7.7]	2 (1.2) [0.3-4.3]	1 (1.3) [0.2-7.2]	3 (3.0) [1.0-8.5]	4 (2.3) [0.9-5.8]	2 (1.2) [0.3-4.2]	4 (2.4) [0.9-5.9]	6 (1.8) [0.8-3.8]
56-65	0 [1.1-7.3]	0 [0.0-5.4]	0 [0.0-3.2]	1 (1.3) [0.2-7.2]	0 [0.0-4.8]	1 (0.7) [0.1-3.6]	1 (0.8) [0.1-4.4]	0 [0.0-2.6]	1 (0.4) [0.1-2.1]
All	8 (1.3) [0.7-2.6]	13 (2.1) [1.2-3.6]	21 (1.7) [1.1-2.6]	6 (1.1) [0.5-2.4]	13 (2.3) [1.3-3.8]	19 (1.7) [1.1-2.7]	14 (1.2) [0.7-2.0]	26 (2.2) [1.5-3.2]	40 (1.7) [1.3-2.3]

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Associations

Table 5 shows a number of sociodemographic variables and their distributions among those with and without headache; it highlights the differences between the headache types. While there were no significant differences in mean age, multivariate analysis (Table 6) shows that all headache and TTH were more prevalent in younger people. The female predilection for migraine, headache on ≥15 days/month and, especially, pMOH is clearly demonstrated in Table 5, while the AORs in Table 6 emphasise this. All specific types of headache showed an association with rural dwelling (Table 1, Table 2, Table 3, and Table 5), although this remained significant and highly so ($p = 0.002$) only for migraine in multivariate analysis (Table 6).

Table 5.

Association of headache disorders with sociodemographic variables

Variable	No headache (n = 841)	Migraine (n = 597)	Tension-type headache (n = 811)	pMOH (n = 28)	Other headache on ≥15 d/m (n = 40)
Age (years)					
18-25	15.1 %	12.1 %	17.5 %	7.1 %	20.0 %
26-35	26.2 %	27.8 %	26.5 %	35.7 %	25.0 %
36-45	21.9 %	29.8 %	27.5 %	14.3 %	30.0 %
46-55	19.4 %	16.9 %	16.3 %	17.9 %	17.5 %
56-65	17.5 %	13.4 %	12.2 %	25.0 %	7.5 %
Mean age (SD)	39.2 (13.5)	38.1 (12.0)	36.9 (12.4)	40.8 (15.2)	35.1 (11.3)
Gender					
Male	61.8 %	35.5 %	47.8 %	14.3 %	35.0 %

Female	38.2 %	64.5 %	52.2 %	85.7 %	65.0 %
Habitation					
Rural	37.8 %	54.9 %	51.3 %	60.7 %	47.5 %
Urban	62.2 %	45.1 %	48.7 %	39.3 %	52.5 %
Household income (INR per month)					
Median	5,500	4,000	4,000	2,750	6,000
Occupation					
Professional or semi-professional	6.9 %	5.2 %	5.1 %	0.0 %	5.0 %
Clerical, shop owner, farmer	33.1 %	25.5 %	26.8 %	7.1 %	17.5 %
Skilled or semi-skilled worker	46.6 %	62.2 %	58.8 %	71.4 %	67.5 %
Unskilled worker	2.9 %	1.3 %	1.5 %	10.7 %	2.5 %
Unemployed	10.6 %	5.9 %	7.9 %	10.7 %	7.5 %
Education					
Professional or (post)graduate	16.3 %	9.3 %	12.5 %	0.0 %	10.0 %
Post-high, high or middle school	47.6 %	41.5 %	47.1 %	35.6 %	50.0 %
Primary school	7.7 %	9.0 %	7.9 %	7.1 %	5.0 %
Illiterate	28.3 %	40.0 %	32.6 %	57.1 %	35.0 %

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pMOH: probable medication-overuse headache; d/m: days/month

Table 6.

Multivariate logistic regression analysis for associations with sociodemographic variables

Variable	Any headache		Migraine		Tension-type headache		pMOH		Other headache on ≥15 d/m	
	AOR	***p***	**AOR**	***p***	**AOR**	***P***	**AOR**	***p***	**AOR**	***p***
Age 18–35 years (reference ≥36 years)	1.2	0.043	0.9	0.841	1.2	0.039	1.0	0.958	0.9	0.770
Habitation rural (reference urban)	1.8	<0.0001	1.5	0.002	1.2	0.08	2.1	0.139	1.5	0.359
Gender female (reference male)	2.3	<0.0001	2.1	<0.0001	1.1	0.548	5.9	0.001	1.9	0.065

Income ≤ INR 5,000 per month (reference >5,000)	1.1	0.452	1.1	0.718	1.1	0.287	0.712	0.492	0.5	0.12

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pMOH: probable medication-overuse headache; d/m: days/month

Table 5 presents indicators of socioeconomic status. These are not easily analysed, but those with headache tended to have lower household incomes and be less well educated than those without, trends that were greatly magnified in those with pMOH. The data on employment are complex; of note only is that, among those with pMOH, none were professional and only two of 28 (7.1 %) were in the category of clerical, shop owner or farmer. There were no associations with income surviving multivariate analysis: in Table 6, we used the median income of the sample (INR 5,000/month) to create upper and lower income categories.

Discussion

With well over one billion people [8], India is behind only China in its proportion of the world's population (16.7 %). This study was the first large-scale community-based survey exclusively of headache in India. In other words, the findings will fill a large knowledge void not only for the country but also globally.

Over two-thirds of India's inhabitants live in villages, the remaining 31 % in towns and urban agglomerations [8]. Our primary purpose in gathering knowledge of headache was to demonstrate the need for headache services, and this established the importance of fully representing both urban and rural populations in our survey. By the same token, this was not an easy environment in which to conduct epidemiological studies. Accordingly we invested heavily in careful methodology [14]: we had a large sample and a high participation rate (>90 %), which would have reduced the likelihood of participation bias; the survey instrument was developed after field testing in a pilot study (and has since, in various adaptations, been used with success in many other countries, cultures and languages [13]); the field investigators were rigorously trained and supervised; there was strong emphasis on quality control; we undertook a validation study in a sub sample of participants.

The observed 1 year prevalence of any headache in the study population (63.9 %), which had the usual female preponderance of close to 4:3, was in keeping with and higher than many reports from other countries [1]. In fact this statistic (1 year prevalence of any headache) is highly variable, being very susceptible to cultural tendencies reflected in the reporting (or not) of mild and/or occasional episodic headache.

The 1 year age-standardised prevalence of migraine was 25.2 %, considerably higher among females than males and higher among those from rural areas than urban. The 25.2 % is remarkable. While GBD2010 found migraine to be the third commonest disease in the world, it estimated the global prevalence at a much lower 14.7 % [3]. On the other hand, the literature review by Stovner et al. showed that reported migraine prevalence varied widely country by country

[1], explicable to a large extent by methodological differences (population of interest, sampling techniques, selection of respondents, interview methods and diagnostic approach) [7] and therefore only in part by true variation (attributable to genetics, culture, lifestyle or environment). Among the now several studies supported by LTB which have employed similar methodology (including sampling technique), estimates of migraine prevalence have been 9.3 % in China [19], 20.8 % in Russia [20] and 22.9 % in Zambia [21]. All of these included both definite and probable migraine, which is methodologically correct provided that (as has always been the case) the latter have been shown not to meet criteria for definite TTH [7]. Our estimate of 25.2 % puts this southern State in India beyond this range, which is the most important finding of this study: the prevalence of migraine is very high. Because of the careful methodology and quality assurance, we believe this to be real, and largely explained in India by the latter factors referred to above: culture, lifestyle and environment. Our observed gender differential is reported almost universally. The higher prevalence in rural areas may be related to socioeconomic conditions (diet, stress and relative poverty [22, 23]) or to lack of availability and utilization of health-care facilities. The relationship between migraine prevalence and age showed an unusual second increase after age 56 years, but in the rural population only. While it was significant ($p < 0.001$) in men only, the fact that it was reflected among women suggests a real effect and, perhaps, a greater influence of those same socioeconomic influences among older people. We do not know.

Studies to elucidate the causes of this very high migraine prevalence should be given high priority, because some of them may be remediable.

There is not much to be said about TTH: the age-standardized 1 year prevalence of 35.1 % is well within the range reported from other countries [1]. The focus only on the most bothersome headache in any participant reporting more than one headache type was likely to have caused some under-reporting of TTH. This disorder showed no associations except with age: somewhat interestingly, this is a disorder more prevalent among younger people (male and female) in this country. We have no explanation for this other than to suggest that, to the extent TTH is a stress-related disorder, younger people might be more stressed in India (or older people cope better).

The estimated prevalence of all headache on ≥15 days/month was 3.0 %, equal to the global mean [1, 24], while that of pMOH was 1.2 %. Estimates of pMOH prevalence vary around the world, up to 7 % [22], but most are within 1–1.5 % [25]. The rural preponderance (which was not significant) might happen because of less easy access to health care, but no great difficulty in obtaining analgesics over-the-counter – the most common cause of MOH. What is striking is the five-fold greater prevalence among females than males. A gender difference is usual, but not one this great. We suspect it reflects a culturally-determined gender difference in health-care seeking behaviour, such that females in this part of India rely more than males on self-management and over-the-counter medication. Furthermore, because of low importance attached to headache, females, especially in rural areas, would receive little encouragement to seek health care for it. It should be remembered that the literacy rate in India is considerably lower in females (64.6 %) than males (81.0 %) [26], and this is emphasized in rural areas.

The crucial point of discussion is the issue of extrapolation: how representative are these findings of India? In truth we do not know: India is multicultural and geographically and environmentally diverse. In terms of filling the knowledge gap – for the Global Burden of Disease Study, for example – until now that gap has covered the entire South-East Asia Region! For health policy-makers in India, here are data. We recommend that at least one more study be done, in the north of the country, which may be sufficient if its findings are similar. Meanwhile, although these data are only from parts of a single State in the south of the country, they are the best information available for the entire country and its population of over 1.2 billion people [8].

Conclusions

This was a carefully conducted study with considerable methodological strengths. It has shown a very high 1 year prevalence of migraine in south India, probably explained at least partly by cultural, lifestyle and/or environmental factors. Some of these may be remediable, a possibility that calls for further studies as a high priority. Levels of TTH, pMOH and other headaches on ≥15 days/month are similar to global averages. A strong association of pMOH with female gender requires explanation. Until another study is conducted elsewhere in the country, these are the best data available to inform health policy for more than 1.2 billion people.

AIDs

Trends of HIV prevalence in rural South India

Abstract

Background:

India, with its large number of migrant workers, had a large number of people affected by HIV. This included antenatal women who are a vulnerable population. The Government of India along with nongovernmental organizations worked on a large number of programs to screen and decrease mother-to-child transmission. This in turn has brought down the prevalence of HIV.

Materials and Methods:

Retrospective analysis of data from the block being provided with healthcare was carried out over a period of 14 years from January 2002 to December 2016.

Results:

The observed HIV prevalence was 5.9 per 1000 in 2002 and showed a declining trend to 1.2 per 1000 in 2016.

Conclusion:

Consistent work at health education and preventive methods has helped bring down the prevalence of HIV over the years.

Keywords: Community, HIV, South India

Introduction

Globally, 36.9 (31.1–43.9) million people were estimated to be living with HIV in 2017. This is an increase from previous years and is thought to be because more people are currently receiving the life-saving antiretroviral therapy (ART). There were 1.8 (1.4–2.4) million new cases of HIV infection globally each year, showing a 47% decline from the 3.4 (3.1–3.7) million in 1996.[1] India has been categorized as a nation with a low prevalence of HIV with seroprevalence rates of less than 1%,[2] and the adult HIV incidence has decreased by more than 50% from 2001 to 2013. The current prevalence of HIV among antenatal women in the country is 0.35%, which also shows a declining trend.[2]

The first case of immunodeficiency virus in India was reported in Chennai in 1986.[3] In 1987, the National AIDS Control Programme (NACP) was launched under the Ministry of Health and Family Welfare, Government of India, to coordinate national responses to the spread of infection. Its activities included surveillance, blood screening, and health education for HIV. To prevent mother-to-child transmission (MTCT) of HIV, the most important source of HIV in children less than 15 years of age, the Prevention of Parent-To-Child Transmission (PPTCT) program was launched under the NACP in 2002. PPTCT is the largest national antenatal screening program in the world.[4]

The NACO Technical Estimate Report (2015) estimated that 35,255 of 29 million annual pregnancies in India occur in HIV-positive women. In the absence of any intervention, an estimated (2015) 10,361 infected babies will be born annually. The PPTCT program aims to prevent the perinatal transmission of HIV from the HIV-infected mother to her newborn baby. The program entails counseling, testing, and treatment of pregnant women.

In India, the diagnosis and treatment of HIV is largely concentrated in areas with high HIV prevalence; Tamil Nadu is one of these states. However, the seroprevalence rate in Tamil Nadu, which was 1.6% among antenatal women in 2001, has come down to 0.5% in 2005.[5]

Prevention of HIV in India has been based on the assumption that the principal drivers of the epidemic are individuals in high-risk groups, such as commercial sex workers and men who have sex with men.[6] Though targeting these high-risk groups has remarkably lowered the prevalence of HIV, it is uncertain whether these methods can be used in rural populations where these high-risk groups form a minority. Therefore, other strategies to lower HIV prevalence in rural populations are necessary.

Direct measurement of HIV incidence involves following up a seronegative population with repeated HIV tests, which is tedious. Therefore, an indirect estimation of the prevalence can be made from a population of people who may have recently been exposed, such as antenatal mothers. The aim of this study was to measure the prevalence of HIV among antenatal mothers and its change over a period of 14 years.

Materials and Methods

This study is a retrospective, cross-sectional study. It was approved by the Institutional Review Board of Christian Medical College. The data included and analyzed in this study were collected from the PPTCT program as conducted in the Kaniyambadi block (population, 108,000) between January 2002 and December 2016 by the Department of Community Health, Christian Medical College.

Pregnant women identified by the health workers were registered and encouraged to visit the mobile clinics for antenatal care. Once they are registered, blood was collected for routine investigations including HIV and HBsAg and antenatal care was given by our mobile health teams, led by a doctor, which visited each village at least once a month. A few antenatal women did not register with us.

All women were offered screening for HIV under the PPTCT program, and an opt-out procedure was followed. HIV testing was performed according to World Health Organization (WHO) recommendations.[7] First, a rapid test was performed. If it was positive, the sample was retested. If both the tests were positive, both the patient and her husband were called to the base hospital. Detailed pretest counseling was done and blood was drawn for repeat rapid test and Western blot. If the rapid test was positive, the sample was sent to the Department of Virology, Christian Medical College, Vellore, for confirmation with Western blot.

Results

During the study period, 32,088 pregnancies were registered for antenatal care in the peripheral clinics. A total of 29,985 antenatal women were tested for HIV, whereas 2103 women received antenatal care from other healthcare providers. Of all the samples tested, 55 (0.18%) tested positive for HIV. The observed HIV prevalence which was 5.9 per 1000 in 2002 had declined to 1.2 per 1000 in 2016. No women tested positive for HIV between 2012 and 2015 [Table 1]. The data analyzed are presented in 5-year blocks in Table 2 to remove the fluctuation in annual rates caused by the small numbers of HIV-positive women detected each year [Figure 1].

Table 1.

HIV prevalence in Kaniyambadi block

Year	No. positive	No. screened	Prevalence	95% CI	
				Lower	Upper
2002	9	1514	0.594	0.207	0.9817
2003	7	2089	0.335	0.087	0.5829
2004	7	2310	0.303	0.079	0.5272
2005	2	2068	0.097	0	0.2307
2006	5*	2127	0.235	0.029	0.4409
2007	8*	2196	0.364	0.112	0.6163
2008	4*	2038	0.196	0.004	0.3884

2009	4	2152	0.186	0.004	0.3679
2010	3*	2012	0.149	0	0.3177
2011	4*	2210	0.181	0.004	0.3582
2012	0	2035	0	0	0.147
2013	0	2007	0	0	0.147
2014	0	1766	0	0	0.17
2015	0	1840	0	0	0.163
2016	2	1621	0.123	0	0.2944

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*Includes patients who have been tested more than one time in subsequent pregnancies. CI: Confidence interval

Table 2.

HIV prevalence in 5-year blocks in Kaniyambadi

Year	**No. positive**	**No. screened**	**Prevalence**	**95% CI**	
				Lower	**Upper**
2002-2006	30	10108	0.3	0. 191	0.403
2007-2011	23	10608	0.22	0.128	0.305
2012-2016	2	9269	0.02	0	0.051

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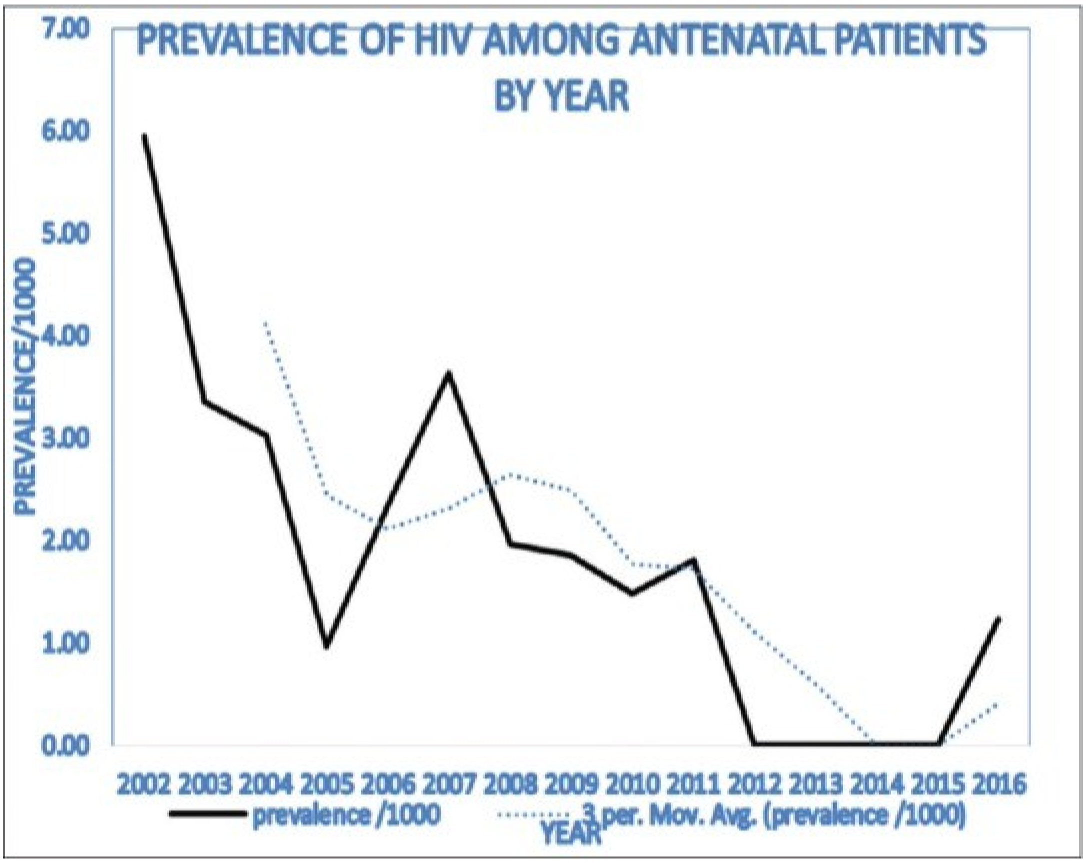
CI: Confidence interval

Figure 1.



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A graph showing the decline in HIV prevalence over the years

A declining trend in HIV prevalence was also seen in the hospital setting where a total of 37,244 pregnant women were tested. The prevalence of HIV which was 3.7 per 1000 women in 2004 had declined to 0.31 per 1000 women in 2016 [Table 3].

Table 3.

Prevalence of HIV in pregnant women attending the hospital

Year	Positive	Tested	Prevalence	95% CI	
				Lower	Upper
2004	6	1623	0.37	0.0744	0.665
2005	5	2186	0.229	0.028	0.429
2006	7	2271	0.308	0.08	0.536
2007	3	2752	0.109	0	0.232
2008	5	2982	0.168	0.021	0.315
2009	3	3207	0.094	0	0.199
2010	3	3056	0.098	0	0.209
2011	3	3293	0.091	0	0.194
2012	7	3140	0.223	0.058	0.388
2013	1	3063	0.033	0	0.097
2014	2	3259	0.061	0	0.146
2015	2	3134	0.064	0	0.152
2016	1	3278	0.031	0	0.09

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CI: Confidence interval

A declining trend was seen in both primi- and multigravid women [Table 4].

Table 4.

Prevalence of HIV among primi- and multigravid women

Primi				Multigravid			
Year	**Positive**	**Total**	**Prevalence (95% CI)**	**Year**	**Positive**	**Total**	**Prevalence (95% CI)**
2003	2	852	0.235 (0.000, 0.560)	2003	5	1237	0.404 (0.051, 0.758)
2004	5	1008	0.496 (0.000, 0.930)	2004	2	1302	0.154 (0.000, 0.366)
2005	2	926	0.216 (0.000, 0.515)	2005	0	1142	0.000 (0.000, 0.263)
2006	2	958	0.209 (0.000, 0.498)	2006	1	1169	0.086 (0.000, 0.253)
2007	5	1018	0.491 (0.062, 0.921)	2007	1	1178	0.085 (0.000, 0.251)
2008	1	1014	0.099 (0.000, 0.292)	2008	0	1024	0.000 (0.000, 0.293)
2009	3	1064	0.282 (0.000, 0.601)	2009	1	1088	0.092 (0.000, 0.272)

2010	1	986	0.101 (0.000, 0.300)	2010	1	1026	0.097 (0.000, 0.288)
2011	3	1059	0.283 (0.000, 0.630)	2011	0	1151	0.000 (0.000, 0.261)
2012	0	959	0.000 (0.000, 0.313)	2012	0	1076	0.000 (0.000, 0.279)
2013	0	917	0.000 (0.000, 0.327)	2013	0	1090	0.000 (0.000, 0.275)
2014	0	817	0.000 (0.000, 0.367)	2014	0	949	0.000 (0.000, 0.316)
2015	0	821	0.000 (0.000, 0.365)	2015	0	1019	0.000 (0.000, 0.294)
2016	0	748	0.000 (0.000, 0.401)	2016	2	873	0.229 (0.000, 0.401)

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CI: Confidence interval

Discussion

India, being a country with poor socioeconomic development and a large number of migrant workers, seems to have a rise in HIV epidemic.[8] A large number of programs have been used by the Government of India to screen for HIV and to prevent MTCT of HIV.

The prevalence of HIV in Tamil Nadu and other southern states of India seems to be declining. This is in contrast to earlier studies where the prevalence was found to be higher in Tamil Nadu than expected, involving even populations that were not at high risk.[9] The prevalence of HIV in the community was found to range from 1.8% to 7.4% in earlier studies.[9,10] Various studies have reported a decline in HIV prevalence across the country,[11,12] whereas other studies have reported an increasing trend, such as the study by Gupta *et al.* that reports an increase from 0.7% in 2003–2004 to 0.9% in 2005–2006.[13] Our study showed a declining trend in HIV prevalence among pregnant women.

The decline in HIV prevalence could be attributed to the various interventions done by the Department of Community Health of CMC, Vellore, which might have decreased the rates of transmission in the community. A few such interventions are as follows: barbers were educated on the need to use disposable blades in their practice and were given certificates of their compliance for displaying to their clientele; traditional dais were introduced to sterile techniques of conducting deliveries and to the use of disposable needles and syringes; newly married couples were counseled about safe sex practices and the use of condoms; school children were educated about HIV, modes of its spread, and safe sex practices; and health education was conducted among the masses about HIV and the prevention of its spread. In addition, programs to screen for sexually transmitted diseases were conducted among women in the reproductive age group.

What primary care physicians need to know is that the Government of India has a well-structured approach to controlling HIV in India. Screening of antenatal women is essential in preventing the MTCT which can occur. Health teaching to both the woman and her husband on safe sex practices is also essential in keeping the prevalence of HIV low. Primary care physicians, being the first contact point of the patient with the health system, play an important role in the education of women and their families.

The Government of India is committed to eliminating new HIV among children. Based on the new WHO guidelines, NACO will provide lifelong ART to all pregnant and breastfeeding women regardless of their CD4 count and the clinical stage of their disease.

Conclusion

There is a decrease in new cases of HIV among antenatal women over the years. However, it is difficult to give one single intervention credit for it. A multipronged approach that improved awareness among different groups of people and involved various organizations such as the WHO, government bodies, and various nongovernmental organizations including our community health department has helped in decreasing the prevalence of HIV in Kaniyambadi block. This approach could be a model which other developing countries with high prevalence rates of HIV could follow.

STDs

Prevalence and Incidence of Sexually Transmitted Infections among South Indians at Increased Risk of HIV Infection

Abstract

Sexually transmitted infections (STIs) have been identified as cofactors of HIV transmission. Greater understanding of local STI burdens can assist in the development of more effective STI and HIV prevention strategies. The aim of this study is to determine the prevalence and incidence of STIs among South Indian men and women identified to be at increased risk for HIV infection. Individuals at increased risk for HIV infection were enrolled in a prospective longitudinal study in Chennai, India ($n = 480$) between August 2002 and December 2003. Participants were enrolled from patients seeking services at an sexually transmitted disease (STD) clinic and a confidential HIV testing and counseling program. The most common prevalent STIs were herpes simplex virus (HSV)-2 (50% of women, 29% of men), syphilis (11% of women, 8% of men), and *Trichomonas vaginalis* (6% of women). At enrollment, women, participants with no schooling, participants with greater than four sex partners, and single participants were found to be at increased risk for HSV-2 infection ($p < 0.05$). The two most common incident STIs at 12 months were HSV-2 with 12% of men and 8% of women testing positive and hepatitis B with 2% of men and 5% of women testing hepatitis B surface antigen (HBsAg) positive. In this cohort of South Indian men and women with a high background prevalence of HSV-2, suppressive therapy against herpes replication may have a substantial impact in reducing both HSV-2 transmission and HIV acquisition. With the high incidence of STIs, targeted prevention and clinical management strategies among individuals practicing high risk behaviors may help to slow the continued spread of HIV in India.

Introduction

It is currently estimated that India has 2–3 million individuals infected with HIV, and the primary mode of HIV transmission has been via heterosexual contact.[1,2] HIV transmission has been shown to be strongly associated with repeated sexually transmitted infections (STIs) and sexual behavior[3–6] HIV and STIs are linked in that both are transmitted by unprotected sexual behavior, the presence of an STI can facilitate the acquisition and transmission of HIV infection, and some STI pathogens may be more virulent in the presence of HIV-related immunodeficiency. The prompt diagnosis and subsequent treatment of an STI can decrease an individual's risk of HIV infection. However, Indian women may face significant cultural barriers to seeking HIV and STI testing due to the fear of negative reactions from their families and communities.[7]

The relative prevalence and risk of developing specific STIs can vary widely across different regional settings.[8,9] It has been suggested that STI treatment interventions can contribute substantially to the prevention of HIV infection in populations with early and concentrated sexually transmitted HIV epidemics.[8,10] In India, the prevalence of HIV remains relatively low at 0.91%.[2] Recent studies conducted in different parts of India have documented high rates of STIs within various groups, such as men who drink alcohol and engage in high-risk behavior,[11] men who have sex with men,[12] female sex workers,[13] and injection drug users[14] as well as individuals attending STI clinics[15,16]; however, there is a dearth of longitudinal data on the development of STIs.[17]

Given the synergistic transmission of STIs and HIV, the present study was undertaken to determine the prevalence and incidence of different STIs and to delineate the risk factors associated with STI transmission among individuals who were identified to be at increased risk for HIV infection in Chennai, India.

Methods

Setting

Y.R. Gaitonade Centre for AIDS Research and Education (YRG CARE) is a large HIV tertiary care community-based center in Chennai, India.[18] Since 1996, it has provided a continuum of care for over 10,000 HIV-infected individuals. Services at YRG CARE include voluntary counseling and testing (VCT), integrated medical services for the treatment of HIV and related illnesses, prevention programs, and nutrition counseling. YRG CARE is also a site for the

U.S. National Institutes of Health multisite AIDS Clinical Trials Group (ACTG) and Health Prevention Trials Network (HPTN) clinical trials. This study received ethical approval of the free-standing YRG CARE Institutional Review Board (IRB).

Subjects

Four hundred eighty high-risk HIV-negative individuals who were 18 years or older, residing in or near Chennai, and who were identified to be at increased risk for HIV infection were recruited for this study between August 2002 and December 2003. Individuals were recruited from within patients seeking services at the STD clinic at Stanley Medical College (Chennai) or as part of YRG CARE's confidential HIV testing and counseling program.[19] All participants tested negative for HIV antibodies at enrollment. All participants received treatment free of charge for any STIs diagnosed as part of this study. Participants completed a risk assessment questionnaire at enrollment, and provided blood samples for serologic testing at baseline, at 6 months, and at 12 months. Two hundred seven (43.1%) individuals of the initial cohort provided repeat samples for STI analysis at 12 months. The characteristics of the men and women who presented at follow-up were not significantly different from the individuals at baseline.

Enrollment criteria

Men were enrolled who met at least one of the following self-reported criteria: STI within the past 6 months; sex with a female sex worker at least 5 times in the last 1 year; or vaginal sex with an HIV-infected partner at least once a week over the past 6 months. Women were enrolled who met at least one of the following self-reported criteria: five or more male sex partners in the last year; a current male sex partner who injected drugs in the last year; a new diagnosis of syphilis, *Chlamydia trachomatis*, Neisseria gonorrhea, first episode of genital herpes, pelvic inflammatory disease (PID) and/or Trichomoniasis in the last year; or exchange of sex for money or drugs in the last year.

Diagnostic tests

Blood samples were collected from consenting participants at each study visit. Urine was collected from consenting men, and from women if they refused endocervical swab collection. Laboratory tests of urine or vaginal secretions included Multiplex PCR for *Chlamydia trachomatis* and *Neisseria gonorrheae* (Roche Diagnostics, Basel, Switzerland). Enzyme-linked immunosorbent assay (ELISA) were run on plasma samples for hepatitis B surface antigen (HBsAg; Hepanostika HBsAg Uni-Form II, Biomerieux, The Netherlands), and for herpes simplex (HSV)-2 antibodies (Focus Diagnostics, Cypress, CA). A 1.1 cutoff was used to determine HSV-2 seropositivity. Rapid plasma reagin (RPR) (Span Diagnostics, Surat, India) was performed for Treponema pallidum. The range of RPR titers was 1:1–1:128; RPR repeat titers were not performed. Particle agglutination (TPPA; Serodia, Japan) was done to confirm diagnoses. For female participants, *Trichomonas vaginalis* In-Pouch culture was performed on vaginal secretions (BioMed Diagnostics, White City, OR).

Statistical analysis

Prevalence of STIs was calculated at baseline, and incidence of STIs was calculated at 12 months based on participants who had both baseline and 12-month samples available. Relative risks were then calculated both at baseline and 12 months to assess the specific demographic risks associated with prevalent and incident STIs. Statistical analyses were performed with SPSS software (version 13.0; SPSS, Chicago, IL). A *p* value less than 0.05 was considered statistically significant.

Results

At the time of enrollment, of the 480 high-risk HIV-uninfected individuals; 49% were male, with a mean age of 31 years; 88% identified Tamil as their mother language. Twenty-three percent were single, 54% married, 18% living with a partner, and 5% widowed or divorced. Close to a fifth (18%) reported no formal education and 21% were unemployed (Table 1).

Table 1.

Demographic Characteristics of Study Participants at Enrollment ($N = 480$)

	Male (%)* (n = *236)	***Female (%)* (n = *244)***
Mean age range (years)	32 (20–76)	33 (19–56)
Ethnicity/language		
Tamil	90	86
Telugu	9	9
Others	1	5
Marital status		
Single	45	2
Married	47	60
Living with partner/not married	6	30
Divorced or widowed	2	18
Education level		
No schooling	6	28
Primary/middle/vocational school	62	66
High school or higher	31	6
Employment status		
Unemployed	11	31
Full time	69	35
Part time	20	34

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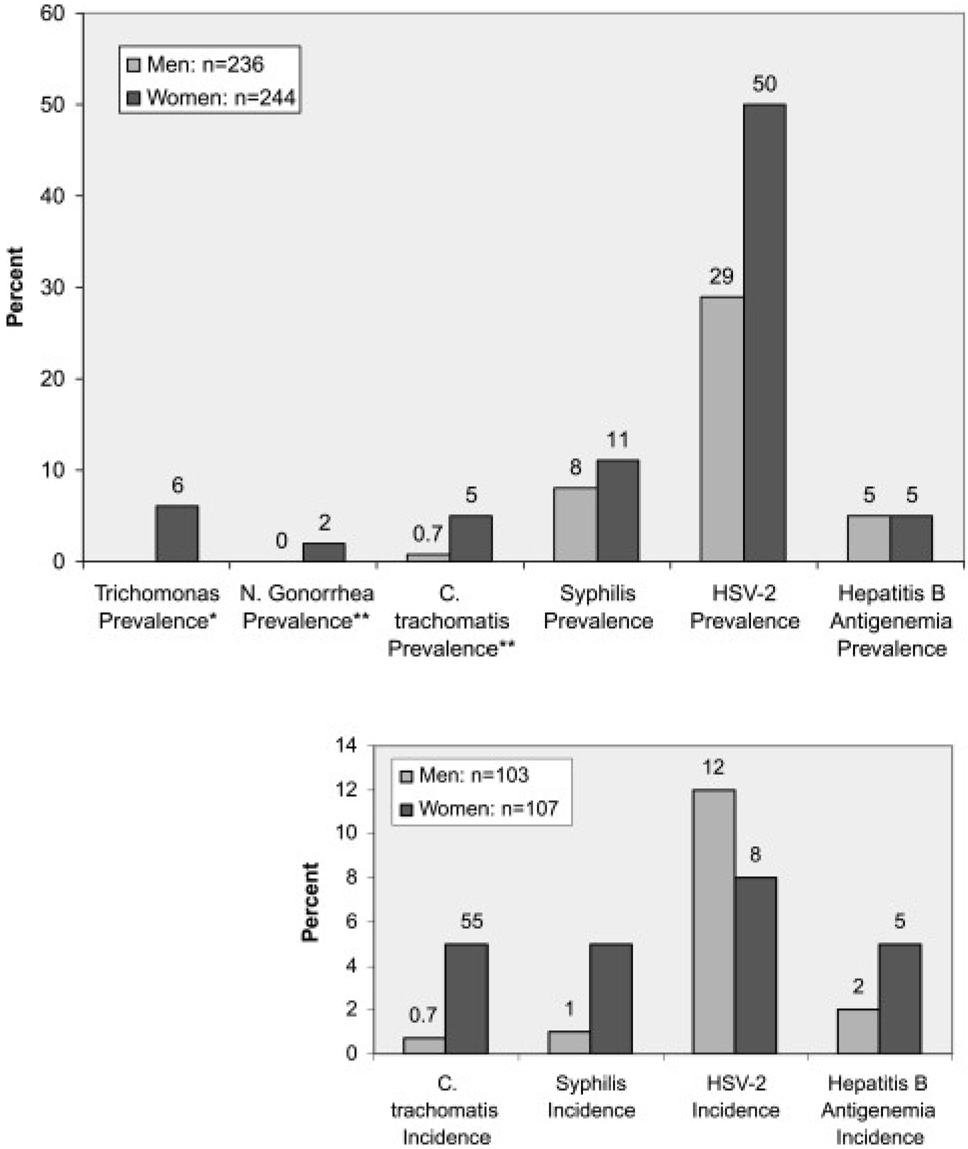
Over two fifths of men (42.6%) had nonprimary female sexual partners, 12.7% of men had a primary female sexual partner, 3.2% of men had ever had males as their sexual partners, 8.6% of men had both female and male sexual partners, and 9.8% of men disclosed no current sexual partner. Over two-fifths of women (46.2%) had a primary male sexual partner, 52.5% of women had non-primary male sexual partners, and 1.3% disclosed no current sexual partner.

At the time of enrollment into the study, 50% of women and 29% of men tested positive for HSV-2, 11% of women and 8% of men for syphilis, 6% of women for *Trichomonas vaginalis*, 5% of women and 0.65% of men for *Chlamydia trachomatis*, 2% of women for *Neisseria gonorrheae*, and 5% of women and 5% of men for HBsAg (Fig. 1).

FIG. 1.



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Prevalence at enrollment ($n = 480$) and incidence after 12 months ($n = 207$) of sexually transmitted infections (STIs) and Hepatitis B among study patients. *NA, not applicable for male participants; **126 participants (81 men and 45 women) refused to provide urine or vaginal secretions for testing at enrollment

At the time of enrollment, women were 8 times more likely to test positive for chlamydia (relative risk [RR]: 7.8, 95% confidence interval [CI]: 1.01–60.0, $p = 0.01$) and were 1.7 times more likely to test positive for HSV-2 (RR: 1.7, 95% CI: 1.35–2.17, $p = 0.0001$) than men. Participants who never went to school were 9 times more likely to test HbsAg positive (RR: 8.95, 95% CI: 1.80 – 44.5, $p = 0.005$), twice as likely to test positive for syphilis (RR: 1.9, 95% CI: 1.08-3.61, $p = 0.03$), 1.7 times more likely to test positive for chlamydia (RR: 1.7,95% CI: 1.3–2.1, $p = 0.001$), and 1.6 times more likely to test positive for HSV-2 (RR: 1.6, 95% CI: 1.3–2.1, $p = 0.0001$) than those participants who had undergone some formal education. Unemployed participants were 1.6 times at risk to test positive for syphilis (RR: 1.6, 95% CI: 1.3–2.03, $p = 0.001$) than employed participants. Married participants were less likely to be infected with HSV-2 (RR: 0.7, 95% CI: 0.61–0.95, $p = 0.01$) than single participants. Participants who had greater than four sexual partners in the past 6 months were more likely to be infected with syphilis (RR: 2.74, 95% CI: 1.43–5.28, $p = 0.01$) and HSV-2 (RR: 1.32, 95% CI: 1.02–1.70, $p = 0.04$) than those participants who had less than four partners in the past 6 months.

At the end of the 12-month follow-up period, HSV-2 was the most common incident STI with 8% of women and 12% of men testing positive (Fig. 1). One percent of men and 5% of women tested positive for syphilis, 1% of men and 3% of women for *Chlamydia trachomatis*, and 2% of men and 5% of women for HBsAg. Participants who had undergone no formal education were four times more likely to develop a new syphilis infection (RR: 4.00, 95% CI: 1.26–12.68, $p = 0.03$) than those participants with some formal education. There was no association between number of current sexual partners, gender, employment, or marriage status with the risk of developing any of the other STIs accessed in this study.

Discussion

This study demonstrates the high prevalence of untreated STIs, including syphilis, HSV-2, and hepatitis B, with high rates of incident sercoversion of Hepatitis B and HSV-2 after 1-year of follow-up in a population of South Indians at increased risk of HIV infection. Recent studies have documented varying rates of STIs among South Asian cohorts. In a cohort of slum dwellers in Bangladesh, a high rate (>5%) of syphilis was documented.[20] A study conducted among high-risk women in Western India found similar rates of trichomoniasis and chlamydia as this study, but much higher rates of N. gonorrhea.[13] Recent studies conducted in western and southern India have identified a high prevalence of HSV-2[14],[15] However, an earlier multination study among antenatal clinic patients found relatively lower rates of HSV-2 among Indians with Indian women having lower rates of HSV-2 than their male counterparts.[9]

In addition to unprotected sexual intercourse, STIs have been shown to be independent facilitators of HIV transmission and acquisition.[3] In this study, having more than four sexual partners in the past 6 months was significantly associated with HSV-2 and syphilis infection at enrollment. Although four times as many women had a primary sexual partner compared to men, women had equal or higher prevalence of all STIs accessed. Women were significantly more likely to test positive for HSV-2 and syphilis than men. This suggests that many of the high-risk Indian women in this study may have been infected by their male partners. The epidemiology of HSV-2 has been shown to differ between men and women with a greater probability of transmission from male-to-female than female-to-male.[6,21] Men with genital HSV-2 have been shown to have more recurrences than women, which may explain the higher rates of male-to-female transmission,[22] but a substantial number of HSV-2 transmissions may occur from asymptomatic partners as well. The findings of the current study suggest that HIV and STD prevention programs should promote women-controlled safer sex measures. Studies conducted in other Asian settings have similarly noted the need for gender-specific STI interventions in light of gender-related differences in HIV-related perceptions and sexual behaviors.[23,24]

Through laboratory testing the current study likely provided diagnosis to many asymptomatic individuals who did not know their infectious status. Current Indian treatment guidelines recommend VDRL and HIV testing of patients engaging in high-risk activities as part of routine STI care to be delivered through general health services.[25] Prior studies from India have shown that a large number of individuals with STIs may be harboring asymptomatic STIs,[13,26] which could contribute to the silent transmission to the community. Another study from western India found that reported symptoms had little correlation with the presence of actual infection.[27] In this scenario, STI screening programs that target symptomatic individuals may not be adequate without laboratory-based testing.

The current study documented a high incidence of HBsAg positivity among study participants. A prior study in this part of India documented a similar level HBsAg community seroprevalence (5.7%).[28] Although the vaccine is available upon request in India, there is currently no routine hepatitis B vaccination program in place. Since sexual activity is the most commonly reported risk factor among persons with acute hepatitis B, STI clinics can serve as a particularly effective venue for delivering Hepatitis B vaccinations.[29,30] The findings of the present study support the need for a more proactive approach to vaccinate uninfected adults at risk for hepatitis B.

Greater findings of STI prevalence and incidence in diverse regional settings may help in the design of more effective HIV prevention strategies. A recent meta-analysis suggested that in areas of high HSV-2 prevalence, a high proportion of HIV in the general population is attributable to HSV-2.[6] In areas such as India with a high prevalence of HSV-2, as documented in this study, suppressive antiviral therapy solely against HSV-2 may have an impact on HIV transmission and acquisition.[31,32] Over the past decade, there has been substantial evidence to demonstrate that certain STIs enhance the transmission of HIV, although not all STI interventions may reduce HIV transmission.[10] Various models have suggested that STI treatment may have the greatest impact on HIV transmission rate early in a regional HIV epidemic.[10] In India where the national prevalence of HIV infection remains below 1%, programs should be developed that aggressively treat STIs in individuals at high-risk for HIV infection.

Due to the documented synergy between HIV and STIs, it has been suggested that the rapid diagnosis and treatment of STIs could serve as a cost-effective HIV prevention strategy.[4] In this study population, with the high incidence of syphilis and prevalence of other treatable STIs, targeted bacterial STI management strategies may help to slow the continued spread of HIV in India. However given the high rates of HSV-2 in this study population, for which there is no cure, this approach may require modification. Additionally, sexual histories and partner management should be a standard component of clinical care at STI clinics and centers providing voluntary counseling and testing (VCT) services for HIV. The prevalence rates of certain STIs, such as HSV-2 and syphilis in this study, may be high enough to warrant universal screening.

Malnutrition

Individual, household, programme and community effects on childhood malnutrition in rural India

Abstract

The children living in rural areas of India disproportionately suffer from malnutrition compared with their urban counterparts. The present article analyses the individual, household, community and programme factors on nutritional status of children in rural India. Additionally, we consider the random variances at village and state levels after introducing various observed individual-, household- and programme-level characteristics in the model. A multilevel model is conducted using data from the National Family and Health Survey 2. The results show that maternal characteristics, such as socio-economic and behavioural factors, are more influential in determining childhood nutritional status than the prevalence of programme factors. Also, it was found that individual factors show evidence of state- and village-level clustering of malnutrition.

Keywords: malnutrition, children, programme components, rural, India

Introduction

Childhood malnutrition levels are alarmingly high around the world, particularly in developing countries. While over 97% of children survive through preschool years in developed countries, 20–25% of children in developing countries die before reaching their fifth birthday (UNICEF 2004). Underweight children are at increased risk of mortality and morbidity (Mosley & Cowley 1991; , Griffiths *et al.* 2002), and the risk of mortality increases with the severity of malnutrition. Worldwide, it is estimated that approximately 55% of the deaths of children under 5 years of age are due to malnourishment (UNICEF 2004).

Even greater percentages of children survive malnutrition, the consequences of which last a lifetime. For example, children who are malnourished have a greater risk of stunting and impaired brain development, which in turn affects their ability to accrue skills critical to their life chances (UNICEF 2004). There is evidence that nutritional status is correlated with IQ level (Horton 1986), and that children who are malnourished at an early age are more likely to have reduced educational attainment (Pollit 1984). Children who suffer from malnutrition are vulnerable to retarded development, physical incapacity, emotional disturbances and, in some cases, mental defects (Lichter 1997). Further, adults who survived malnutrition as children are more vulnerable to the development of physical and intellectual impairments, and they are more likely to suffer from higher levels of chronic illness and disability (UNICEF 1998; Smith & Haddad 2000).

The quality of future human resources largely depends on children. Therefore, improving the nutritional level of children should be considered a priority area that produces social and economic returns. The importance and significance of this area of research is summarized by Dreze & Sen (1989, p. 33), who suggest that, 'though quieter than famine, it (persistent under-nutrition) kills many more people slowly in the long run than famines do'.

A recent UNICEF (2004) report has documented that over 16% of children under 5 years of age in developing countries are severely malnourished. About 90% of these children live in South Asia, with a high percentage 'anemic, weak and vulnerable to diseases and more likely to have learning problems if they ever go to school' (UNICEF 2004, p. 17). Recent statistics have shown that about 28% of the children under 5 years of age in developing countries are estimated to be underweight, with almost half of these children (about 45%) living in South Asia (UNICEF 2004). Children in India are at some of the greatest risk of all children in the region. More specifically, in India, about 30% of infants are born with low birthweight (less than 2500 g). A recent national survey reports that about 47% of the children under 5 years of age were born moderately to severely underweight, 46% of children are moderately to severely stunted, and approximately 16% are moderately to severely wasted (IIPS & ORC 2000).

The disparity in childhood nutritional levels is a result of the complex interplay of a multiplicity of factors (Mosley 1984; Bronte-Tinkew & Dejong 2004), including socio-economic and demographic factors (Rajaram *et al*. 2003). Demographic factors that appear to be important in overcoming childhood malnutrition include birth order (Horton 1988), breastfeeding practices (Victoria *et al.* 1984), and sex differentials (Sen & Sengupta 1983; Schoenbaum *et al.* 1995; Mishra *et al.* 1999; , Marcoux 2002; , Pande 2003; Mishra *et al.* 2004). Specifically, firstborns are the most distinctive group in birth order, receiving heavy doses of parental attention and thus having a better nutritional status than higher-order births (Behrman 1988). In fact, the adverse effects of shorter birth intervals often lead to maternal depletion, which affects fetal growth and, in turn, leads to an increased likelihood of prematurity (Miller 1989). The lack of adequate care for the child may result in a higher incidence of illness and hence affect nutritional status.

In additional to demographic and family planning factors, another approach to the issue of disparity in childhood nutrition is through socio-economic factors. In this body of literature, researchers have often emphasized social and economic factors at the individual and contextual levels which are likely to influence the normal growth of children (Griffiths *et al.* 2002; Bronte-Tinkew & Dejong 2004). Household structure has been the focus of many studies on child malnutrition (Blake 1981; Lloyd 1994; Thomson *et al.* 1996; , Wu 1996; Mayer 1997; Bronte-Tinkew & Dejong 2004).

While there are numerous studies on child malnutrition in India, the majority of these studies have looked at the contributions of individual-level (socio-economic and family planning) characteristics. A growing body of literature considers the importance of understanding determinants of childhood malnutrition through an integrated analysis that considers linkages between demographic, family planning and household structures. Zottarelli *et al.* (2006) found that individual characteristics of the child, such as birth order, sex and age, as well as household factors, such as consanguinity and place of residence, helped explain the likelihood of stunting in Egypt.

Taking this one step further, it is becoming increasingly apparent that analysis of determinates of childhood malnutrition must consider incorporating contextual and programme-level characteristics in the study of childhood malnutrition. Indeed, one may argue that childhood nutritional levels are nested within the household, which in turn is nested within programme and community characteristics. For example, Fernandez *et al.* (2002) incorporated a multilevel analysis of a UNICEF model of immediate causes (measles incidents and calorie supply per capita), underlying causes (food production per capita, low birthweight, infant mortality and access to safe drinking water), and basic causes (public expenditure on education, Gross National Product per capita, adult literacy, debt service and urban population) of childhood malnutrition to identify regional variations in determinants of wasting between Asia, Africa and Latin America. More recently, Rao *et al.* (2004) discussed the nutritional status of children in the north-eastern states of India, where individual-, household- and district-level variations were considered. Despite the movement towards developing a model recognizing the contextual nature of child undernutrition, such as the UNICEF model (1990), these studies have failed to include programme-level variables within the community, such as access to healthcare facilities and programmes and availability of health professionals. Programme and community characteristics that include the healthcare supply environment have been found to be important in maternal health care in rural India (Sunil *et al.* 2006) and in children's nutritional status in rural Nepal (Hotchkiss *et al.* 2002).

Thus, in the present study we have incorporated individual-, household-, programme- and community-level factors in the outcome of childhood malnutrition in rural India. Further, we discuss the clustering of childhood malnutrition at village and state levels. A number of studies on the statistical analysis of child mortality risks identified family- and community-level clustering of child mortality (Sastry 1996, 1997). If such clustering exists for child mortality, one could reasonably expect the same for the nutritional status of children. Thus, in this study we focus on the presence of correlated outcomes among children residing in the same community and state. Multilevel modelling will allow for the presence of clustering to be examined. The estimates from such a model will provide estimates of the magnitude and importance of community- and state-level effects that are not captured by the other commonly used multivariate techniques.

Data and methods

The present study utilizes data from the National Family and Health Survey 2 (NFHS-2), the second national sample survey, conducted in India in 1998–99. The NFHS, comparable to demographic and health surveys conducted in many other countries, was undertaken by various consulting organizations in collaboration with population research centres. Details on data collection and sampling procedure followed are available in the International Institute for Population Sciences & ORC Macro (2000).

The NFHS-2 used three types of questionnaires: Household, Woman's and Village Questionnaires. An important feature is the information available on height and weight of children in the context of utilization of maternal care services and other socio-economic characteristics of the mother. For the children born during the 3 years preceding the survey, a data file (called *kids*) combines the information from the Household and Woman's Questionnaires and was generated from the original dataset. We used this data file to examine the nutritional status of children in rural India. In addition, we merged the *kids* data file with *village* data file to obtain the selected village-level variables for further analysis. Due to missing values in the explanatory variables, the number of children varies in the analysis.

To assess the nutritional status of individual children, the World Health Organization (1995) recommends the use of *Z*-score indicators based on the child's sex, weight, height and age. The *Z*-score indicators of weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) are generally used to evaluate the nutritional status of children. A *Z*-score of less than −2.00 is commonly used to indicate malnutrition and is followed in the present study as well. Following is the proposed basic multilevel logistic model to be used for identifying the malnutrition among children in rural India:

$$\log\left[\frac{\pi_{ijk}}{1-\pi_{ijk}}\right] = \beta x_{ijk} + v_{jk} + s_k$$

where, π_{ijk} is the expected probability that child 'i' in village 'j' in state 'k' is malnourished; x_{ijk} is the vector of characteristics considered at individual, village and state levels, and v_{jk} and s_k represent effects of unobserved factors (error terms) at state and village levels and follows normal distribution with mean zero. The standard assumption is that the observed responses y_{ijk}∼

Bernoulli (π_{ijk}). The analysis was conducted with SAS version 8.1 (SAS Inc. 2004).

Results

Table 1 presents the distribution of anthropometric indices according to background characteristics of the children and their parents. Approximately half of the children (48.3%) born in the rural areas in India suffer from stunting or chronic malnutrition, and 16.2% of children suffer from wasting or acute malnutrition. A long list of variables are used in the present study, and several need specific mention in describing the differentials in stunting (HAZ), wasting (WHZ) and underweight (WAZ). The composite index, WAZ, shows that about half of the children (49.4%) in rural India suffer from being underweight.

Table 1.

Percentage of children with *Z*-scores below −2 SD for various anthropometric indices in rural India, 1998–2000

Characteristics	WHZ (wasting/acute)	HAZ (stunting/chronic)	WAZ (composite)	Number of cases
Birth order				
1	15.6	43.5	43.7	4913
2	16.0	45.4	47.6	4487
3	14.9	49.3	50.1	3411
4	17.7	51.1	52.5	2066
5+	18.1	56.6	57.7	3224
Sex of the child				
Male	16.3	47.1	47.8	9500
Female	16.2	49.5	51.1	8601

Age of the child				
<6 months	9.6	16.8	12.4	3176
6–11 months	13.7	33.4	39.6	2997
12–23 months	22.7	60.6	61.5	6126
24–35 months	14.4	60.1	61.8	5802
Duration of breastfeeding				
<6 months	9.9	21.3	17.5	3660
6–11 months	14.2	36.5	41.7	3575
12–23 months	20.6	59.8	60.9	7417
24–35 months	15.8	64.1	66.4	3449
Education of mother				
Illiterate	17.4	55.2	55.5	11 475
Literate, <middle complete	16.0	41.3	45.3	3355
Middle school complete	13.6	35.6	36.7	1524
High school complete and above	11.2	27.1	27.8	1747
Height of mother				
<145 cm	17.8	62.7	61.7	2324
145–150 cm	17.1	53.3	53.3	5139
151–160 cm	15.6	44.0	46.1	9574
160+ cm	14.6	30.7	32.5	1064
Mass media exposure				
None	18.4	54.8	56.0	9370
One or two media	14.3	44.6	45.3	7036
Three or four media	12.7	27.3	29.5	1695
Smoke/chew tobacco/consume alcohol				
No	16.1	47.6	48.7	16 400
Yes	17.6	54.7	56.1	1701

Caste of the household head				
Scheduled caste	16.5	53.1	54.4	3877
Scheduled tribe	22.0	53.2	55.5	1889
Other backward caste	17.2	48.1	50.1	6080
None of them	13.4	43.9	43.6	6255
Standard of living index				
Low	19.9	53.9	56.8	7437
Medium	14.4	47.2	48.0	8545
High	11.0	32.7	28.9	2119
Received IFA tablets/syrups for three or more months and consumed all of them				
Not received	16.4	53.2	52.9	9737
Received, but not consumed all	16.4	46.4	49.7	1521
Received and consumed all	15.9	41.7	44.3	6843
Received two or more TT injections during pregnancy				
No	17.2	55.5	55.4	5992
Yes	15.8	44.7	46.4	12 108
Any IEC activity organized in the village				
No	15.5	51.4	51.1	11 096
Yes	17.4	43.3	46.6	7005
Availability of health professional in the village				
No	17.4	49.5	52.0	8310
Visiting health professional	16.8	48.1	49.1	2317
Within the village	14.7	46.9	46.5	7474
Distance to nearest government health facility				
Within the village	15.4	43.9	45.9	4651
1–4 km	15.2	50.4	50.0	5247
5–9 km	16.4	49.1	49.9	4639

10+ km	18.6	49.7	52.3	3564
Distance to nearest private health facility				
Within the village	14.8	45.0	45.0	5290
1–4 km	14.8	49.8	50.8	4687
5–9 km	16.5	51.2	51.6	3156
10+ km	19.0	48.4	51.3	4968
Availability of *anganwadi* centre in the village				
No	16.1	51.5	51.1	6617
Yes	16.3	46.4	49.4	11 484
Total	16.2	48.3	49.4	18 101

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HAZ, height-for-age *Z*-score; IEC, information, education and communication; IFA, iron and folic acid; TT, tetanus; WAZ, weight-for-age *Z*-score; WHZ, weight-for-height *Z*-score.

Four variables related to individual child characteristics are considered in the analysis and are presented in Table 1. These characteristics include birth order, sex, age and duration of breastfeeding. The prevalence of acute, chronic and composite malnutrition was greater when the birth order was higher. Female children had a greater prevalence of being stunted and underweight than did male children, and an approximately equal incidence of wasting. There was a greater prevalence of malnutrition in older children compared with younger children. Finally, children who were breastfed longer had a greater frequency of malnutrition on all three indices.

In addition to the characteristics of the child, several variables related to the child's mother are found to be important in describing differentials in nutritional levels. As expected, the prevalences of stunting, wasting and underweight were greater for children of mothers who are illiterate, and lowest among children of mothers with high school or more education. A similar trend is found in the other maternal characteristics, such as mother's height and mother's mass media exposure. Another behavioural variable used is the mother's smoking/chewing of tobacco and/or consuming alcohol. Specifically, children of mothers who consume tobacco and/or alcohol have a greater prevalence of being malnourished, compared with children of mothers who refrain from tobacco and alcohol consumption.

Two characteristics of the household, the standard of living index and caste/tribe of the household head, were used to examine the differentials in the nutritional status of the children in rural India. The standard of living index shows a negative inverse trend on the malnutrition indicators. In other words, children in households with a low standard of living have a higher prevalence of malnourishment than children living in households with medium and high standards of living. Further, the prevalence of malnutrition is found to be greater among children belonging to scheduled tribes and scheduled castes.

The next set of variables presents the differentials in malnutrition levels according to selected programme- and community-level variables. Acute, chronic and composite measures of malnutrition have a lower occurrence among children whose mothers' consumed iron and folic acid (IFA) tablets, as compared with the prevalence of malnutrition in children born to mothers who had not received and/or had not consumed IFA tablets during pregnancy. Likewise, the prevalence of malnutrition was lower for children born to women who received tetanus (TT) shots during pregnancy. Communities with IEC (information, education and communication) activities organized within the village had lower incidences of stunting and underweight but a slightly higher prevalence of wasting. The availability of a healthcare professional in the village decreased the prevalence of malnutrition in children. The percentage of children experiencing malnutrition is lower among children born in villages where there is a private or public healthcare facility. Also, the prevalences of stunting and wasting are lower among children born in villages where there are *mahila mandal* [1] or *anganwadi* centres,[2] compared with the prevalence among children born in villages where no such organizations are present.

The overall distribution of the prevalence of malnutrition in rural areas of India is provided in Table 2. The percentage of children in rural areas experiencing acute malnutrition (wasting) ranges from 5.0% in the states of Haryana and Sikkim to 28.7% in rural New Delhi. Additionally, approximately one-quarter of the children born in rural areas of Maharashtra and Orissa suffer from acute malnutrition. The percentage of children in each state experiencing chronic malnutrition or stunting ranges from 18.8% in Goa to 56.6% in Uttar Pradesh. Further, in six of the states (Bihar, Haryana, Madhya Pradesh, Rajasthan, Uttar Pradesh and New Delhi), more than half of the children living in rural areas can be classified as chronically undernourished. Considering the composite index of malnutrition, the lowest percentage of children in rural areas calculated as underweight is found in Sikkim at 21.1%. Madhya Pradesh had the highest percentage of underweight children, with 58.4%. Seven other states (Bihar, Maharashtra, Orissa, Rajasthan, West Bengal, Uttar Pradesh and New Delhi) had more than half of the children living in rural areas classified as both chronically and acutely malnourished.

Table 2.

Percentage of children with *Z*-scores below −2 SD for various anthropometric indices in rural India, 1998–2000, by state

State	WHZ (wasting/acute)	HAZ (stunting/chronic)	WAZ (composite)
Andhra Pradesh	9.2	41.8	40.6
Assam	13.7	49.7	35.2
Bihar	21.4	54.9	54.9
Goa	12.2	18.8	30.2
Gujarat	19.5	46.3	49.2
Haryana	5.0	52.8	35.5
Himachal Pradesh	17.6	42.4	44.8
Jammu & Kashmir	12.7	40.9	37.1

Karnataka	21.8	39.6	46.6
Kerala	11.4	22.4	26.9
Madhya Pradesh	20.4	54.6	58.4
Maharashtra	24.9	43.9	52.9
Manipur	8.0	32.5	27.5
Meghalaya	13.3	45.6	37.2
Mizoram	15.5	35.5	33.1
Nagaland	11.7	34.5	26.4
Orissa	24.6	44.8	55.4
Punjab	7.0	42.1	31.7
Rajasthan	12.4	54.6	52.2
Sikkim	5.0	32.9	21.1
Tamil Nadu	20.2	30.8	38.6
West Bengal	14.7	44.8	52.6
Uttar Pradesh	11.2	56.6	53.1
New Delhi	28.7	50.5	50.8
Arunachal Pradesh	8.4	27.3	25.5
Tripura	12.9	36.8	40.1

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Based on state weights.

The first panel in Table 3 shows the odds ratios of individual-, household-, programme- and community-level factors on acute malnutrition (wasting). Although the odds ratios are found to be statistically significant at $P < 0.05$, it may not be reflected in the calculation of the confidence interval. Compared with the next two analyses, only a few variables are statistically significant. At the individual level, the age of the child and the duration of breastfeeding are found to be significant. A number of maternal and household characteristics are found to be important. Specifically, mother's education, and her consumption of tobacco and/or alcohol, as well as the household standard of living, have significant odds on acute malnutrition of children. The only variable of statistical significance at the programme/community level is the presence of IEC activities in the village.

Table 3.

Results of multilevel model for children with height-for-age *Z*-score below −2 SD in rural India, 1998–2000

	WHZ		**HAZ**		**WAZ**	
	Exp(B)	**95% CI**	**Exp(B)**	**97% CI**	**Exp(B)**	**95% CI**
Individual characteristic						
Birth order						
1	0.91	0.79, 1.04	0.92	0.82, 1.03	0.81	0.72, 0.91
2	0.90	0.78, 1.03	0.95	0.85, 1.06	0.89	0.80, 1.00
3	0.81	0.70, 0.94	0.98	0.87, 1.10	0.89	0.79, 1.00
4	0.88	0.75, 1.03	0.97	0.85, 1.10	0.88	0.78, 1.01
Sex of the child						
Male	1.03	0.95, 1.13	0.97	0.90, 1.04	0.90	0.84, 0.96
Age of the child						
<6 months	0.97	0.70,	0.11	0.09,	0.08	0.06,

		1.35		0.14		0.10
6–11 months	1.14	1.48, 0.87	0.37	0.31, 0.45	0.44	0.37, 0.53
12–23 months	1.97	2.30, 1.69	1.15	1.03, 1.28	1.12	1.00, 1.25
Duration of breastfeeding						
<6 months	0.62	0.45, 0.86	0.79	0.64, 0.98	0.77	0.62, 0.95
6–11 months	0.77	0.59, 1.00	0.75	0.62, 0.91	0.73	0.61, 0.88
12–23 months	0.82	0.69, 0.98	0.83	0.73, 0.94	0.78	0.69, 0.88
Education of mother						
Literate, <middle complete	0.91	0.79, 1.03	0.78	0.71, 0.86	0.83	0.75, 0.92
Middle school complete	0.77	0.64, 0.93	0.68	0.59, 0.78	0.70	0.61, 0.80
High school complete and above	0.63	0.51, 0.78	0.52	0.45, 0.61	0.54	0.46, 0.63
Height of mother						
145–150 cm	0.98	0.85, 1.14	0.70	0.62, 0.79	0.74	0.65, 0.84
151–160 cm	0.88	0.77, 1.02	0.46	0.41, 0.52	0.54	0.48, 0.61
160+ cm	0.87	0.69, 1.09	0.24	0.20, 0.29	0.30	0.25, 0.36
Mass media exposure						
One or two media	0.90	0.81, 1.01	0.95	0.87, 1.03	0.91	0.84, 0.99
Three or four media	0.89	0.72, 1.10	0.80	0.68, 0.94	0.74	0.63, 0.87
Smoke/chew tobacco/consume alcohol						
Yes	0.85	0.73, 0.99	1.16	1.03, 1.30	1.04	0.92, 1.17

Household characteristics						
Caste of the household head						
Scheduled tribe	1.15	0.98, 1.36	0.93	0.81, 1.07	0.85	0.74, 0.98
Other backward caste	1.03	0.90, 1.17	0.94	0.85, 1.05	0.99	0.89, 1.10
None of them	0.91	0.79, 1.04	0.85	0.76, 0.95	0.76	0.68, 0.85
Standard of living index						
Medium	0.81	0.73, 0.90	0.90	0.83, 0.98	0.84	0.77, 0.91
High	0.85	0.70, 1.03	0.63	0.55, 0.73	0.55	0.48, 0.63
Programme and community characteristics						
Received IFA tablets/syrup for three or more months and consumed all tablets/syrup						
Received and consumed all	1.00	0.90, 1.13	0.95	0.87, 1.03	0.99	0.90, 1.08
Received, but not consumed all	0.97	0.82, 1.16	0.98	0.85, 1.12	1.08	0.94, 1.24
Received two or more TT injections during the pregnancy						
Yes	0.93	0.84, 1.04	0.90	0.83, 0.98	0.89	0.82, 0.97
Any IEC activity organized in the village						
Yes	1.18	1.05, 1.33	0.91	0.83, 1.00	1.07	0.97, 1.17
Availability of health professional in the village						
Within the village	0.98	0.86, 1.13	1.04	0.93, 1.16	0.98	0.88, 1.09
Visiting health professional	1.03	0.88, 1.20	1.01	0.89, 1.15	0.95	0.84, 1.07
Distance to nearest government health facility						
Within the village	0.87	0.74, 1.02	0.95	0.83, 1.08	0.85	0.75, 0.97

1–4 km	0.89	0.75, 1.04	0.97	0.85, 1.10	0.87	0.77, 0.99
5–9 km	0.95	0.80, 1.11	0.96	0.84, 1.09	0.88	0.77, 1.00
Distance to nearest private health facility						
Within the village	0.98	0.83, 1.16	1.02	0.89, 1.16	1.01	0.89, 1.15
1–4 km	0.91	0.77, 1.06	1.03	0.90, 1.16	1.06	0.94, 1.20
5–9 km	0.94	0.80, 1.10	1.10	0.97, 1.26	1.07	0.94, 1.22
Availability of *anganwadi* centre in the village						
Yes	0.97	0.86, 1.09	1.01	0.92, 1.11	1.04	0.95, 1.14
Constant	0.24	0.18, 0.34	4.09	3.08, 5.43	4.70	3.49, 6.32
Number of cases (unweighted)	17 466		17 466		17 466	

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HAZ, height-for-age Z-score; IEC, information, education and communication; IFA, iron and folic acid; TT, tetanus; WAZ, weight-for-age Z-score; WHZ, weight-for-height Z-score.

The indicator of chronic malnutrition (stunting) is shown in the second panel in Table 3. At the individual level, the odds of chronic malnutrition among rural children increase with the age of the child, and decrease with mother's educational level and with the height of the mother. Mothers who smoke cigarettes, chew tobacco and/or consume alcohol during pregnancy have 1.16

times higher odds of having chronically malnourished children, compared with women who do not use these products. Duration of breastfeeding is also found to have a significant influence on rural malnutrition in India. At the household level, the odds of chronic malnutrition decline with increases in the standard of living. Two variables show statistical significance at the programme and community levels. First, women who received two or more TT injections during pregnancy have lower odds of having chronically malnourished children, compared with women who did not receive these shots during their pregnancy. Second, children who are living in villages with organized IEC programmes are likely to have lower chronic malnutrition compared with children living in villages where no such programmes exist.

The third panel of Table 3 shows the effects of individual and programme factors on the composite index of malnutrition – a combination of both chronic and acute malnutrition – in rural India. All individual factors are found to be statistically significant. The odds of being underweight decrease with higher birth orders and increase with the age of the child. Individual-level variables, such as mother's educational level, height of the mother, and mass media exposure, and the household variable of standard of living, show a monotonic decline of odds of being underweight. Two variables at the programme and community level are found to be significant. The women who have received two or more TT injections during pregnancy are 0.89 times less likely to have underweight children compared with women who did not receive TT injections. The odds of being underweight also increase with the increased distance to nearest government health facility. That is, for women who live in a village with a government health facility, the odds are 0.89 times less for having an underweight child, compared with women who live at least 10 km away from the nearest government health facility.

The final analysis examines how far the random variances at various levels change after introducing the observed characteristics of individual, household, programme and community variables into the model. These random variances at village and state levels are presented in Table 4. First, we introduced individual and household characteristics into the model. Then building the model, we included individual, household and programme characteristics. Finally, all the characteristics were included and considered in the analysis in order to examine how random variances changes.

Table 4.

The effects of individual-, programme- and community-level variables on the state- and village-level variances

Variables included	WHZ		HAZ		WAZ	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Only individual variables						
Between-state variation	0.2534	0.0782	0.2455	0.0727	0.2842	0.0834
Between-village variation	0.2896	0.0397	0.2029	0.0253	0.1666	0.0244
Individual + programme variables (like IFA, TT, BF)						
Between-state variation	0.2596	0.0807	0.2459	0.0732	0.2928	0.0859
Between-village variation	0.2999	0.0404	0.2023	0.0254	0.1656	0.0244
Individual + programme + community variables						
Between-state variation	0.2668	0.0826	0.2378	0.0709	0.2872	0.0844
Between-village variation	0.2974	0.0404	0.2042	0.0254	0.1678	0.0245

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BF, breastfeeding; HAZ, height-for-age *Z*-score; IFA, iron and folic acid; TT, tetanus; WAZ, weight-for-age *Z*-score; WHZ, weight-for-height *Z*-score.

The results suggest that the introduction of programme- and community-level variables does not produce much change in the random variances at state and village. This is consistent for the three nutritional measures considered in the analysis. The results clearly indicate that the programme and community variables considered in the analysis are not important in explaining the nutritional status of rural children in India. In other words, individual and household characteristics explain the nutritional status among rural children better than programme- and community-level variables.

Conclusion

Without doubt it can be argued that children born in rural areas of India are at great risk for undernourishment, and the prevalence of chronic undernutrition is higher than that of acute undernutrition. Further, the rural areas of the northern states (namely Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and New Delhi) have a higher prevalence of chronic malnutrition compared with other regions of the country collectively. These states, including Orissa, also have higher concentrations of underweight children born in rural areas. Over half of the children born in rural areas of these states suffer from chronic and underweight malnutrition.

The vulnerability of rural children is linked to individual background characteristics and maternal behaviours. Surprisingly, a longer duration of breastfeeding, which is often found to have a protective influence on child health, was found to be statistically significant. It is unclear from the way the data were collected whether the longer duration of breastfeeding is prolonged exclusive breastfeeding, or whether the mothers supplement breastmilk with other foods as the child ages and has changing nutritional demands. More research is needed on this material behaviour to understand its influence on child malnutrition. In this study, maternal behaviour (tobacco and/or alcohol consumption, and mass media exposure) and characteristics of the mother (height and education) were other important determinants of childhood malnutrition. Further, household characteristics (standard of living) were also found to be of significance to the child's vulnerability to malnutrition. These findings lend support to previous studies on childhood malnutrition in India (e.g. Pal 1999; Arnold *et al*. 2004; , Radhakrishna & Ravi 2004) and extend research to focus on the malnutrition across the rural areas of India.

Additionally, the models examined consider the context in which the children and households exist by considering programme- and community-level factors. This would be expected as the child is nested within the household, while the household is nested within the community. However, while a few variables at the programme and community levels were found to be significant, none of these variables seemed to have a greater impact on nutritional indicators than the individual and household characteristics. Therefore, the relationship between the child and the community may be more complex than is captured in this model. Further, despite these findings, it should be noted that household-level variables, such as standard of living, education levels and access to media, are all influenced by factors beyond the household.

While the present study results resemble other nutritional studies conducted in this region, differences do exist. One of the reasons for this difference is attributed to the variations in the analytical models used in previous studies. For example, Rao *et al.* (2004) showed that IEC programmes have significant effect on nutritional status of children in selected north-eastern states in India. In the present study, we found that, although the presence of IEC programmes in rural villages showed 0.91 times decline in stunting or chronic malnutrition, a reverse effect was observed for acute malnutrition and underweight. Similarly, Roy *et al.* (2004) emphasized the importance of antenatal care services and location of health facility in nutrition inequalities in selected states in India. Their study results showed a strong correlation between these variables and nutritional indicators. In the present study, after controlling for variations at different levels (such as programme and community), the variables such as presence of health facility, availability of health professional in the village, and distance to nearest government/private health facility were not statistically significant in determining the nutritional status of children in rural areas. This lack of consistency in research findings, especially as multilevel models are used, suggests that there may be a more complex interaction of various levels influencing the nutritional status of children. Clearly, more research is needed that would address the complex relationships between programme and community factors and the households and children within the communities.

Even after controlling for the observable characteristics at various levels, unexplained variations in the nutritional status among children at the state and village levels remain significant. In particular, the state-level variances are marginally higher for all the nutritional measures, except for weight-for-height. In other words, there appears to be a clustering in the prevalence of undernutrition at various levels, such as village and state. The evidence of a state-level clustering effect, as well as the clustering of village level, suggests that unexplained factors should be sought at state level as well as at the lower levels in future analysis.

There is a complex interplay between factors inside and outside of the household. As noted, and consistent with other findings, individual and household characteristics are important in understanding the presence of malnutrition. While some of these factors originate within the household (duration of breastfeeding), they are linked, directly or indirectly, to community resources outside of the household. Future research is needed to examine the nature of the household–community relationship in a manner that allows for comparisons between state and region.

Diabetes

Urban–Rural Differences in the Prevalence of Diabetes Among Adults in Haryana, India

Abstract

Introduction

Diabetes is a multifactorial disease with far-reaching consequences. Environmental factors, such as urban or rural residence, influence its prevalence and associated comorbidities. Haryana—a north Indian state—has undergone rapid urbanisation, and part of it is included in the National Capital Region (NCR). The primary aim of the study is to estimate the prevalence of diabetes in Haryana with urban–rural, NCR and non-NCR regional stratification and assess the factors affecting the likelihood of having diabetes among adults.

Methods

This sub-group analysis of the Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) study (a nationally representative cross-sectional population-based survey) was done for Haryana using data from 3722 participants. The dependent variable was diabetes, while residence in NCR/non-NCR and urban–rural areas were prime independent variables. Weighted prevalence was estimated using state-specific sampling weights and standardized using National Family Health Survey-5 (NFHS-5) study weights. Associations were depicted using bivariate analysis, and factors describing the likelihood of living with diabetes were explored using a multivariable binary logistic regression analysis approach.

Results

Overall, the weighted prevalence of diabetes in Haryana was higher than the national average (12.4% vs. 11.4%). The prevalence was higher in urban (17.9%) than in rural areas (9.5%). The prevalence of diabetes in rural areas was higher in the NCR region, while that of prediabetes was higher in rural non-NCR region. Urban–rural participants' anthropometric measurements and biochemical profiles depicted non-significant differences. Urban–rural status, age and physical activity levels were the most significant factors that affected the likelihood of living with diabetes.

Conclusions

The current analysis provides robust prevalence estimates highlighting the urban–rural disparities. Urban areas continue to have a high prevalence of diabetes and prediabetes; rural areas depict a much higher prevalence of prediabetes than diabetes. With the economic transition rapidly bridging the gap between urban and rural populations, health policymakers should plan efficient strategies to tackle the diabetes epidemic.

Supplementary Information

The online version contains supplementary material available at 10.1007/s13300-024-01602-w.

Keywords: Diabetes, Behavioural risk factors, Epidemiological transitions, Non-communicable diseases, Urbanisation

Key Summary Points

Proximity to the national capital places Haryana at an elevated risk for diabetes and prediabetes.

Urbanisation has reduced urban–rural disparities in diabetes, especially evident in the National Capital Region (NCR) and non-NCR areas of Haryana.

The weighted prevalence of diabetes in Haryana exceeds the national average.

Diabetes prevalence was notably higher in urban areas compared to rural areas, with targeted interventions recommended for the NCR and non-NCR regions in urban settings.

A noteworthy prevalence of prediabetes in rural and urban locales within the non-NCR segment of Haryana presents a compelling focal point for further scientific investigation and intervention strategies.

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Introduction

Diabetes mellitus, a chronic metabolic disorder characterised by elevated blood glucose levels, remains a substantial public health concern worldwide. It is a leading cause of cardiovascular diseases, kidney failure, blindness and lower limb amputations [1]. In 2021, the global age-standardised total diabetes prevalence was 6.1% and is expected to reach 10% by 2050 if the current trend continues [2]. According to the International Diabetes Federation, approximately 537 million adults worldwide were living with diabetes in 2021, and this number is projected to be 784 million by 2045 [3]. The prevalence of diabetes and prediabetes remains slightly higher in India at 7.3% and 10.3%, respectively, with substantial variations at provincial levels [4]. The high burden in India equates to 8.5 million excess deaths, 42.7 million years of life lost (YLL) and 2.6 trillion US dollars in lost gross domestic product [5]. This alarming trend underscores the urgency of addressing diabetes and its associated complications, or else the rising burden can easily overwhelm the health system if not checked in time.

Diabetes is a complex and multifactorial disease with far-reaching consequences [6]. Of numerous factors contributing to the natural history of the disease, previous studies have shown a substantial difference in the prevalence of diabetes based on the resident's regional and urban/rural status [7–9]. To address urban–rural disparities in diabetes prevalence, it is essential to delve into the contributing factors. Contrasting theories have been reported that explain the prevalence disparities in urban and rural areas. Existing literature corroborates a higher prevalence of diabetes in the urban populations compared to their rural counterparts and attributes this difference to a more sedentary lifestyle in the former, worsened by access to high-calorie, processed foods and increased stress in urban settings [10]. These factors exacerbate the risk of obesity and type 2 diabetes. Further, environmental factors such as air pollution and exposure to toxins have also been shown to impact diabetes risk. Urban areas often have higher pollution levels, which may further exacerbate diabetes risk [11].

At the same time, the prevalence of diabetes is also increasing in rural areas. Rural areas may have more physically demanding lifestyles and access to healthier, locally sourced foods. At the same time, some other studies explain higher prevalence in rural areas as a result of frequent barriers in accessing healthcare services due to geographical distances, limited healthcare facilities and workforce shortages. This can result in delayed diagnosis and inadequate management of diabetes. Further, it is known that lower socioeconomic status in rural areas, attributed to lower average incomes and reduced access to education and employment opportunities, contributes to higher diabetes prevalence [12]. Certain cultural norms and behaviours may contribute to the different rates of diabetes in urban and rural areas. However, rapid strides in communication and changes in lifestyle are contributing to decreasing differences in epidemiology in the two areas. A previous study depicted non-significant differences in the eating habits of urban and rural areas in Punjab—a northern state of India [13]. Therefore, studying urban–rural differences in the prevalence of diabetes and associated comorbidities in different sociocultural contexts seems essential.

Haryana is a northern state of India with common boundaries with Delhi's National Capital Territory (NCT). The state has undergone a rapid economic transition over the last few years owing to the inclusion of most areas of Haryana as a part of the National Capital Region (NCR), a planning region centred upon the NCT in India which includes a mix of urban and rural areas. The development is substantial in urban and rural areas, leading to striking lifestyle changes on a similar scale. Therefore, it is intriguing to see the effect of economic development on the prevalence of diabetes and its risk factors in urban and rural areas, as well as NCR and non-NCR of Haryana. Within this context, the Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) research offers precise and thorough state- and national-level data on the prevalence of diabetes and other metabolic noncommunicable diseases in India, such as obesity, hypertension and dyslipidemia at the state and rural–urban levels through a cross-sectional, population-based survey of adults aged ≥ 20 years. Therefore, the primary aim of the study was to estimate the prevalence of diabetes in Haryana with urban–rural, NCR and non-NCR regional stratification and to assess the factors affecting the likelihood of having diabetes among adults as a sub-group analysis of the ICMR-INDIAB dataset.

Methods

Study Design

This is a sub-group analysis of the ICMR-INDIAB study, which was a cross-sectional study conducted in 31 states and Union-Territories/NCT of India in five phases by sampling 33,537 urban and 79,506 rural residents (overall *n* = 113,043) using a stratified multistage sampling design [14, 15].

Study Area

This study was conducted in Haryana during the fourth phase of the ICMR-INDIAB study between December 2018 and July 2019. Haryana is a gateway to North India, which occupies 1.37% of the total geographical area and account for less than 2% (25,351,462) of India's population. It has 22 administrative districts, of which 14 are under the NCR. The primary occupation has been agriculture, the literacy rate is about 75% and is among the most prosperous states in India, having one of the highest per capita incomes in the country.

Sample Size and Sampling Design

The sample size for Haryana was calculated as 4000 (consisting of 2800 rural and 1200 urban inhabitants), after assuming an expected diabetes prevalence of 10% in urban and 4% in rural areas, allowing a relative precision of 20% of the estimated prevalence, an α error of 5% and a non-response rate of 20%. A three-level stratification based on each state's geography, population size and socioeconomic status (SES) was used to obtain a representative sample. The primary sampling units were villages in rural areas and census enumeration blocks in urban areas. Using a systematic sampling method, 24 and 56 households were selected from urban and rural areas. The door-to-door assessment was done, and from each household, one individual was selected on the basis of the World Health Organization (WHO) Kish method to avoid selection bias with respect to sex and age. Finally, 3722 participants were included in the current analysis because of incomplete data.

Study Variables

Dependent Variable

The presence or absence of diabetes was the primary dependent variable without differentiating it into type 1 or 2 diabetes mellitus (DM). Fasting capillary blood glucose (CBG) was measured using a glucose meter (One Touch Ultra, Lifescan, Johnson & Johnson, Milpitas, CA, USA) after at least 8 h of overnight fasting. A participant was identified as living with DM if they had a physician diagnosis of diabetes or had high blood glucose levels i.e. capillary fasting blood glucose levels of at least 126 mg/dl, 2 h post-oral glucose load of ≥ 220 mg/dl, or both [16]. Prediabetes was defined as the presence of fasting blood glucose levels of ≥ 110 mg/dl or 2 h post-oral glucose load levels of ≥ 160 mg/dl. In individuals with self-reported diabetes, only fasting glucose was measured [16]. A venous sample was collected from the participants to assess the glycated hemoglobin (HbA1c) lipid profile (cholesterol, triglycerides, high-density lipoproteins) and serum creatinine.

Independent Variables

A pre-tested validated questionnaire collected information about the socioeconomic parameters and behavioural factors. The structured questionnaire was administered to 100 subjects for validation, and good reproducibility was observed after correlation analysis [14]. We included and categorised age (20–44, 45–59, and 60 and above), gender (male, female), residence (rural, urban), region of Haryana as per Government of Haryana notification (NCR and Non NCR regions) [17], religious beliefs (Hindu, others), marital status (currently in union, not in union), education status (nil, until primary, up to higher secondary, higher than secondary), occupation (manual labour, skilled workers: sale/clerical/managers/professionals, and unemployed), SES using 2011 revised Kuppuswamy's scale for urban areas, and house type and the Standard of Living Index (SLI) per the National Family Health Survey-3 (NFHS-3) in rural areas (poor, middle class and upper class) [18], h/o hypertension as per the 7th report of the Joint National Committee [19], body mass index (BMI) using WHO Asia Pacific Guidelines to define overweight and obesity (i.e. normal or underweight, overweight/obese) [20, 21], physical activity levels (sedentary or light activity style, active or moderately active style, and vigorous or vigorous active style) as per Madras Diabetes Research Foundation Physical Activity Questionnaire (MPAQ) [22], current tobacco or alcohol user and consuming extra salt in the diet. Another section in the questionnaire collected information about participants' knowledge of diabetes, organs affected and methods of prevention of diabetes. Anthropometric parameters (body weight, height, waist circumference and blood pressure) and biochemical parameters (cholesterol, triglyceride, high-density lipoproteins, serum creatinine) were measured using standard protocols [14, 15].

Statistical Analysis

Data were analysed using SPSS version 28.0. Sampling weights were derived on the basis of the design weight and individual response rate and normalised at the state level to obtain standard state weights as per the parent study. The details can be found elsewhere [23, 24]. Descriptive statistics were used to depict the estimates as weighted proportions or means ± standard deviations (SD). Furthermore, to achieve comparable estimates with the results from the primary study, re-weighted prevalence rates for urban–rural in NCR and non-NCR regions were achieved by multiplying the weighted prevalence of each sub-group from the ICMR-INDIAB dataset by the corresponding weight in the National Family Health Survey-5. Bivariate analysis was done using Student's unpaired *t* tests, one-way analysis of variance (ANOVA) or chi-square tests. Adjusted odds ratios depicting the likelihood of having diabetes were derived along with their 95% confidence intervals (CI) using a multi-variable binary logistic regression analysis approach. A p value of < 0.05 was considered statistically significant for all statistical tests.

Ethical Approval

The study was ethically approved by the Institutional Ethics Committee of Madras Diabetes Research Foundation vide letter number MDRF/NCT/02-08/2018, dated 2 March 2018. Informed consent was obtained from all the participants before the interview was initiated, and their blood samples were drawn. Participants with abnormal biochemical profiles were ensured a standard of care by linking them to the nearest government health centre per pre-defined protocols. This study was conducted in accordance with the Helsinki Declaration of 1964 and its later amendments.

Results

A total of 3722 participants (2345 in non-NCR and 1377 in NCR) were included in the final analysis. Table 1 shows the study participants' sociodemographic characteristics and risk behaviours segregated by their NCR residential status. A large proportion of the participants were 20–44 years old (58.5%), married (82.3%), educated up to higher secondary (40%) and had low SES (44.0%). A significantly greater proportion of the participants in NCR districts resided in urban areas than those living in non-NCR districts. Other significant differences between NCR and non-NCR districts were religious beliefs, current tobacco use (higher in NCR regions), adding extra salt to the diet (higher in NCR) and awareness of diabetes (higher in non-NCR districts).

Table 1.

Sociodemographic characteristics of the study participants

	Non-NCR	**NCR**	**Total**	**Chi-square (*p* value)**
	Count (%)	**Count (%)**	**Count (%)**	
Total	1377 (100)	2345 (100)	3722 (100)	
Age category				
20–44	801 (58.2)	1378 (58.8)	2179 (58.5)	4.768 (0.092)
45–59	369 (26.8)	566 (24.1)	935 (25.1)	
60 and above	207 (15)	401 (17.1)	608 (16.3)	
Gender				

Male	679 (49.3)	1097 (46.8)	1776 (47.7)	2.225 (0.136)
Female	698 (50.7)	1248 (53.2)	1946 (52.3)	
Residence				
Rural	1022 (74.2)	1625 (69.3)	2647 (71.1)	10.236 (< 0.001)
Urban	355 (25.8)	720 (30.7)	1075 (28.9)	
Religious beliefs				
Hindu	1132 (82.2)	2041 (87.0)	3173 (85.2)	16.086 (< 0.001)
Others	245 (17.8)	304 (13.0)	549 (14.8)	
Marital status				
Currently in union	1119 (81.3)	1943 (82.9)	3062 (82.3)	1.51 (0.22)
Not in union	258 (18.7)	402 (17.1)	660 (17.7)	
Education status				
Nil	358 (26)	682 (29.1)	1040 (27.9)	
Up to primary	271 (19.7)	442 (18.8)	713 (19.2)	
Up to higher secondary	571 (41.5)	919 (39.2)	1490 (40)	
Higher than secondary	177 (12.9)	302 (12.9)	479 (12.9)	4.392 (0.22)
Occupation				
Manual labour	467 (33.9)	716 (30.5)	1183 (31.8)	5.125 (0.08)
Skilled workers	143 (10.4)	238 (10.1)	381 (10.2)	
Unemployed	767 (55.7)	1391 (59.3)	2158 (58.0)	
Socioeconomic status				
Upper class	199 (15.5)	297 (13.4)	496 (14.2)	3.587 (0.17)

Middle class	518 (40.4)	946 (42.7)	1464 (41.9)	
Lower class	564 (44)	974 (43.9)	1538 (44.0)	
History of hypertension				
No	1040 (76.2)	1822 (78.2)	2862 (77.5)	1.877 (0.17)
Yes	324 (23.8)	508 (21.8)	832 (22.5)	
BMI category				2.582 (0.27)
Normal or underweight	594 (41.3)	1071 (44)	1665 (43)	
Overweight/obese	783 (56.9)	1274 (54.3)	2057 (55.3)	
Physical activity levels				1.084 (0.78)
Active or moderately active style	347 (25.1)	613 (26)	960 (25.7)	
Sedentary or light activity style	1012 (73.5)	1694 (72.2)	2706 (72.7)	
Vigorous or vigorous active style	18 (1.3)	38 (1.6)	56 (1.5)	
Current tobacco user				
No	1135 (82.4)	1730 (73.8)	2865 (77)	36.639 (< 0.001)
Yes	242 (17.6)	615 (26.2)	857 (23)	
Current alcohol users				
No	1271 (92.4)	2146 (91.6)	3417 (91.9)	0.907 (0.341)
Yes	104 (7.6)	198 (8.4)	302 (8.1)	
Adding extra salt in diet				
Yes	184 (13.4)	409 (17.5)	593 (16)	10.451 (< 0.001)
No	1185 (86.6)	1932 (82.5)	3117 (84)	
Knowledge about diabetes				
Yes	1347	2140	3487	69.699 (0.000)

	(98.1)	(91.3)	(93.8)
No	26 (1.9)	205 (8.7)	231 (6.2)

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BMI body mass index, *NCR* National Capital Region

The overall weighted prevalence of diabetes, as depicted in Table 2, was 12.4% (95% CI 7.5–17.5). The prevalence was higher in urban areas (17.9%) than in rural areas (9.5%). The overall prevalence of prediabetes (18.2%, 95% CI 12.0–24.5) was greater than that of diabetes in both rural and urban areas. A similar trend was seen in both NCR and non-NCR regions, where prediabetes was more prevalent than diabetes in both urban and rural areas except the urban NCR region (Supplementary Table S1). Compared to rural areas, urban areas had a greater prevalence of diabetes in both NCR (9.7% vs. 19.5%) and non-NCR (8.9% vs. 14.0%) regions. Table 3 depicts the prevalence of diabetes in urban and rural areas per different sociodemographic characteristics. The prevalence of diabetes increased significantly with age in rural areas. But in urban areas, the prevalence was marginally higher in the 45–59 age group than ≥ 60 years. Diabetes was more prevalent among those who were illiterate and skilled workers (compared to manual labourers and unemployed) in rural areas. A significant proportion of people with high SES in both rural and urban areas were living with diabetes. High prevalence was seen among those who were overweight or obese, hypertensive and/or had a sedentary lifestyle, irrespective of the place of residence.

Table 2.

Weighted prevalence of diabetes in the state of Haryana standardised using NFHS-5 weights

	Haryana		Rural area		Urban area	
	Unweighted counts	**Weighted prevalence (95% CI)**	**Unweighted counts**	**Weighted prevalence (95% CI)**	**Unweighted counts**	**Weighted prevalence (95% CI)**
Sample size	3722		2647		1075	
Prediabetes	789	18.2 (12.0–24.5)	541	18.0 (12.6–23.5)	248	18.5 (10.8–26.2)
Diabetes	485	12.4 (7.5–17.5)	294	9.5 (5.7–13.4)	191	17.9 (10.7–25.1)

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CI confidence interval

Table 3.

Weighted prevalence of diabetes in urban and rural areas of Haryana as per different sociodemographic characteristics

	Total	Rural		Urban	
		***n* (row)**	***p* value**	***n* (row)**	***p* value**
Sample	3722	2647		1075	
Regions of Haryana			0.41		0.23

Non-NCR region	176 (12.8)	120 (11.7)		56 (15.8)	0.23
NCR region	309 (13.2)	174 (10.7)		135 (18.8)	
Gender			0.11		0.07
Male	206 (11.6)	129 (10.1)		77 (15.5)	
Female	279 (14.3)	165 (12.1)		114 (19.7)	
Age group (completed year)			< 0.001		< 0.001
20–44	196 (9)	128 (8.2)		68 (11.1)	
45–59	174 (18.6)	96 (14.9)		78 (26.9)	
60 and above	115 (18.9)	70 (16)		45 (26.5)	
Religious beliefs			0.21		0.47
Hindu	413 (13)	235 (10.8)		178 (18)	
Others	72 (13.1)	59 (12.8)		13 (14.9)	
Marital status			0.691		0.64
Currently in union	399 (13)	239 (11)		160 (18)	
Not in union	86 (13)	55 (11.6)		31 (16.6)	
Educational status			0.018		0.09
Nil	162 (15.6)	113 (13.6)		49 (23.7)	
Up to primary	93 (13)	63 (11.7)		30 (17.1)	
Up to higher secondary	173 (11.6)	99 (9.5)		74 (16.7)	

Higher than secondary	57 (11.9)	19 (8.3)		38 (15.2)	
Occupational status			0.028		0.051
Manual labour	116 (9.8)	84 (9)		32 (13)	
Skilled workers	59 (15.5)	23 (13.7)		36 (16.9)	
Unemployed	310 (14.4)	187 (12.1)		123 (20)	
Socioeconomic status			< 0.001		< 0.001
Upper class	153 (30.8)	85 (25.4)		68 (42)	
Middle class	101 (6.9)	66 (6.3)		35 (8.6)	
Lower class	135 (8.8)	85 (7.6)		50 (11.8)	
BMI category			< 0.001		< 0.01
Normal or underweight	170 (10.6)	109 (9.3)		61 (14.1)	
Overweight/obese	313 (15.2)	183 (12.8)		130 (20.7)	
Current tobacco user			0.06		0.99
No	391 (13.6)	232 (11.8)		159 (17.8)	
Yes	94 (11)	62 (9.2)		32 (17.8)	
Current alcohol user			0.38		0.66
No	448 (13.1)	274 (11.3)		174 (17.6)	
Yes	37 (12.3)	20 (9.3)		17 (19.5)	
Hypertension			<		<

			0.001		0.001
No	316 (11)	191 (9.4)		125 (15.1)	
Yes	166 (20)	101 (17.1)		65 (27)	
Physical activity			< 0.001		0.02
Active or moderately active style	80 (8.3)	49 (7.1)		31 (11.4)	
Sedentary or light activity style	402 (14.9)	244 (12.8)		158 (19.8)	
Vigorous or vigorous active style	3 (5.4)	1 (2.3)		2 (16.7)	
Heard about diabetes			0.36		0.46
Yes	462 (13.2)	277 (11.3)		185 (18)	
No	23 (10)	17 (9.1)		6 (13.6)	
Think that more people are being affected by diabetes			0.24		0.02
Yes	423 (13.6)	245 (11.5)		178 (18.4)	
No	9 (23.7)	5 (18.5)		4 (36.4)	
Don’t know	30 (8.7)	27 (9.2)		3 (5.9)	
Can diabetes affect other organs			< 0.001		< 0.001
Yes	305 (16.5)	167 (13.8)		138 (21.6)	
No	13 (12.6)	10 (13.9)		3 (9.7)	
Don’t know	144 (9.4)	100 (8.5)		44 (12.3)	
Can diabetes be prevented			0.04		0.51
Yes	253 (14.5)	137 (12.1)		116 (19.1)	

No	40 (15.1)	32 (15.2)		8 (14.5)	
Don't know	169 (11.5)	108 (9.8)		61 (16.7)	
Can diabetes be prevented by					
Diet	223 (15.4)	117 (12.6)	0.25	106 (20.3)	0.05
Exercise	130 (16.2)	58 (12.3)	0.89	72 (21.9)	0.06

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BMI body mass index, *NCR* National Capital Region

More people in urban than rural areas knew that diabetes can affect other organs. A significant proportion of people living with diabetes in rural areas thought that it was not preventable. More people in urban than rural areas knew about the preventive effect of diet and exercise on diabetes. The urban–rural differences in the weighted prevalence of diabetes per proximity to NCR are summarised in Supplementary Table S2. In the rural areas of the non-NCR region, diabetes was more prevalent among those who were unemployed and followed a religion other than Hindu. In the urban area of NCR region, diabetes was more prevalent among overweight or obese people.

Table 4 compares the anthropometric measurements and biochemical profile of all the participants, specifically those who were living with diabetes in urban and rural areas. The people living with diabetes in rural areas were significantly younger than those residing in urban areas. Compared to urban areas, the mean HbA1c levels were higher in rural areas (7.4 ± 2.3 vs. 7.9 ± 2.4, $p = 0.66$), but fasting glucose was lower (167.1 ± 69.7 vs. 152.7 ± 71.7, $p = 0.54$) among patients with diabetes. Overall, the anthropometric measurements and biochemical profile of urban–rural depicted non-significant differences and were comparable except for the serum creatinine levels (Table 4).

Table 4.

Urban–rural variations in the anthropometry and biochemical profile of the participants, and specifically among the people living with diabetes

	Total population			**People living with diabetes**		
	Urban	**Rural**	***p* value**	**Urban**	**Rural**	***p* value**
Age (years)	43.4 ± 14.3	42.3 ± 14.4	0.036	49.2 ± 12.8	47.5 ± 14	0.036
Blood glucose levels						
Fasting (mg/dl)	109.7 ± 40.7	102.1 ± 31.7	0.543	167.1 ± 69.7	152.7 ± 71.7	0.543
2 h Post-load (mg/dl)	123.7 ± 39.5	116.8 ± 33	0.306	175.3 ± 73.6	159.6 ± 68.6	0.306
HbA1c	6.4 ± 1.8	6.3 ± 1.8	0.655	7.4 ± 2.3	7.9 ± 2.4	0.655
Anthropometry						
Systolic BP (mmHg)	128.5 ± 17.7	127.8 ± 17.7	0.42	133.9 ± 19.5	133.3 ± 19.8	0.42
Diastolic BP (mmHg)	82.4 ± 10.4	82.1 ± 10.3	0.851	84.5 ± 11.1	83.9 ± 11	0.851
Body mass index (kg/m^2)	24.2 ± 4.8	23.8 ± 4.5	0.711	25.4 ± 5	25 ± 4.9	0.711
Waist circumference (cm)	87.6 ± 12.9	86.7 ± 12.2	0.218	90 ± 14	90.8 ± 13.2	0.218
Physical activity (MET)	1.6 ± 0.1	1.6 ± 0.1	0.473	1.6 ± 0.1	1.6 ± 0.1	0.473
Biochemical profile						
Cholesterol	185.1 ±	178 ±	0.47	186.6 ±	182.7 ±	0.47

	49.2	44.3		58.9	44.6	
Triglyceride	154 ± 97.3	150.6 ± 110	0.205	158.7 ± 103	174.6 ± 135.4	0.205
High-density lipoproteins	41.2 ± 10.1	41.2 ± 10.9	0.54	40.2 ± 10.7	41.4 ± 10.4	0.54
Serum creatinine	0.7 ± 0.3	0.7 ± 0.2	0.026	0.7 ± 0.5	0.7 ± 0.2	0.026

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BP blood pressure, *HbA1c* glycated hemoglobin, *MET* metabolic equivalent of task

Table 5 depicts the multivariable binary logistic regression results and identifies the factors that affect the likelihood of living with diabetes. People living in rural areas are less likely to live with diabetes than in urban areas (aOR 0.6, 95% CI 0.5–0.7). Ageing was a significant predictor of diabetes. People aged 45–59 years and ≥ 60 years have a higher likelihood (aOR 2.3, 95% CI 1.8–2.9; and aOR 2.4, 95% CI 1.8–3.1) of living with diabetes than 20–44-year-olds. Compared to participants with a sedentary lifestyle, those doing vigorous physical activity had about 30% less likelihood of living with diabetes (aOR 0.7, 95% CI 0.3–0.9) times the risk of diabetes. Gender, education, occupation and SES were not significant predictors of diabetes. Other risk factors like alcohol, tobacco and high BMI did not significantly affect the odds of living with diabetes.

Table 5.

Binary logistic regression analysis to identify factors associated with diabetes in Haryana

	Adjusted OR (95% CI)	***p* value**
Region		
Non-NCR region	Reference value	
NCR region	0.8 (0.7–1)	0.072
Residence		
Urban	Reference value	
Rural	0.6 (0.5–0.7)	< 0.001
Age groups (completed years)		
20–44	Reference value	
45–59	2.3 (1.8–2.9)	< 0.001
≥ 60	2.4 (1.8–3.1)	< 0.001
Sex		
Male	Reference value	
Female	1.2 (0.9–1.6)	0.26
Religious beliefs		
Others	Reference value	
Hindu	0.9 (0.7–1.2)	0.571
Marital status		
Not in union	Reference value	
Currently in union	0.9 (0.7–1.2)	0.376
Educational status		
Nil	Reference value	
Up to primary	1.1 (0.8–1.4)	0.717
Up to higher secondary	0.8 (0.6–1.1)	0.165
Higher than secondary	1 (0.7–1.4)	0.862
Occupational status		
Unemployed	Reference value	
Manual labour	1.1 (0.8–1.5)	0.598
Skilled workers	1.2 (0.8–1.7)	0.412

Socioeconomic status		
1	Reference value	
2	0.9 (0.7–1.3)	0.624
3	0.9 (0.6–1.2)	0.4
BMI status		
Normal/underweight	Reference value	
Overweight/obese	1 (0.8–1.2)	0.656
Current tobacco user		
No	Reference value	
Yes	1.1 (0.9–1.5)	0.306
Current alcohol users		
No	Reference value	
Yes	1.2 (0.8–1.7)	0.445
Level of physical activity		
Active or moderately active style	Reference value	
Sedentary or light activity style	0.8 (0.6–1)	0.108
Vigorous or vigorous active style	0.7 (0.3–0.9)	< 0.001

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BMI body mass index, *CI* confidence interval, *NCR* National Capital Region, *OR* odds ratio

Discussion

With India being amongst the countries with the highest diabetes burden, it is crucial to concurrently focus on the clinical and epidemiological determinants to mitigate this silent public health problem. Our sub-national analysis presents some interesting findings. First, the weighted prevalence of diabetes in Haryana was higher than the national average (12.4% vs. 11.4%), even after segregating urban (17.9% vs. 16.4%) and rural (9.5% vs. 8.9%) data [15]. Second, the prevalence of diabetes was higher in urban areas, and even higher in the urban areas of NCR region. Third, the prevalence of diabetes in the rural areas was higher in the NCR region, but prediabetes was observed to be highest in the rural areas of the non-NCR region. Fourth, urban and rural participants' anthropometric and biochemical profiles are comparable. Lastly, urban–rural status, higher age and lower physical activity levels were the most significant factors that affected the likelihood of living with diabetes.

The higher prevalence of diabetes in Haryana is a cause of concern. Meanwhile, the NFHS-5 estimates the prevalence of diabetes to be around 6.5% (95% CI 6.4–6.6) [25]. The differences in the estimates can be attributed to methodological differences. NFHS-5 checked 'random sugar' while both fasting and post-load glucose were measured in ICMR-INDIAB. Diabetes was more prevalent in urban areas than rural areas, irrespective of the proximity to the NCR region, similar to other studies [15, 26, 27]. Many studies have documented the rise in the prevalence of diabetes over time [26, 28]. A surveillance study conducted in Haryana found that 11.4% of men and 9.4% of women in urban areas and 3.9% of men and 1.6% of women in rural areas had diabetes in 2005. This has now escalated to the current estimates in a little over a decade, with a relative change of around 35% and 109.6% in urban areas and 158.9% and 656.5% in rural areas [28]. Furthermore, 9 in 50 participants had prediabetes (18.2%), which is also higher than the national average (15.3%) [15]. Prediabetes was on the rise in both rural and urban areas, with the highest prevalence reported in rural non-NCR regions (19.5%) followed by urban non-NCR regions (19.4%). However, no significant urban–rural differences in the prevalence of prediabetes were reported at the national level [15]. The mean fasting blood glucose has also increased in the population. In our study, the mean fasting capillary glucose (FCG) was 109.7 mg/dl and 102.1 mg/dl in urban and rural areas compared to 100.8 mg/dl in urban and 90 mg/dl in rural areas as per previous estimates [28]. These points towards greater impairment of fasting glucose and a higher risk of prediabetes.

We observed significant socioeconomic disparities in the prevalence of diabetes. The risk of diabetes increases with age [4, 29, 30]. People ≥ 60 years had 2.4 times the risk of diabetes than the 20–44 years age group. Many factors explain the increasing prevalence with age [31]. Contrary to the findings from the national study, women reported a higher prevalence than men in the current study [23]. However, the effect of sex on the prevalence was non-significant on logistic regression. Most previous studies report a higher prevalence of diabetes in men [4, 29, 30]. The rising prevalence in women reflects the lesser protective effect of female physiology, as stated in the past [28]. Changing lifestyles, dietary patterns and obesity in women may also contribute to this trend. The sex differences in the prevalence of diabetes are reversed according to the stage of reproductive life, and there are more women with diabetes after menopause. Also, women show more impaired glucose tolerance after a meal. Therefore, considering only fasting blood glucose as a screening and excluding post-prandial blood glucose values in calculating the prevalence of diabetes in women can lead to underestimating a much more evident phenomenon [11]. Diabetes was more prevalent among the illiterate participants. In other studies, educational status has also been significantly linked to diabetes [26, 30]. The high prevalence of diabetes in urban areas may be attributed to awareness about diabetes, increased screening and better health facilities. Living in an urban area was an independent predictor of diabetes, similar to other studies [4, 26, 29]. Compared to the poor, people with high SES are at a greater risk of diabetes, but not in our study [4].

Obesity and a sedentary lifestyle are a result of economic transition and urbanisation. The prevalence of obesity was higher among people living with diabetes in urban areas (20.7%) than in rural areas (12.8%). Both abdominal and generalised obesity increases the risk of diabetes, especially among Indians [4, 26, 29, 32]. However, obesity was not a significant predictor in our study. Vigorous physical activity was protective against diabetes. A similar finding was observed in another study where people following a sedentary lifestyle had 2.3 times (1.95–2.71) the rates of self-reported diabetes than those doing vigorous activity [26]. Lack of physical activity may lead to obesity, increasing the risk of diabetes. Smoking and alcohol were not related to diabetes in our study. A considerable proportion of people are at risk of developing diabetes in future. The high prevalence of prediabetes coupled with poor access to health services will contribute to a rise in morbidity and mortality due to diabetes in rural areas. This calls for greater investment in screening and early diagnosis of the syndrome.

This study has particular strengths and limitations. It is amongst the largest studies with a representative sample from Haryana, making the results policy-relevant and generalisable. Data were collected by trained investigators using standard techniques, which made the results reliable. The methodology restricted us from differentiating between type 1 and type 2 diabetes. The prevalence was based on a single reading and capillary blood glucose estimation and not venous blood samples as a result of logistic constraints. However, the current analysis was limited by the number of variables in the original survey. Apart from hypertension and obesity, no other comorbidities were considered in this analysis. Also, we did not comprehensively ascertain the role of dietary patterns on diabetes prevalence in urban and rural areas, as it is a relevant component necessitating separate evaluation. Furthermore, our knowledge continues to expand about different variables that can affect diabetes epidemiology, PM2.5 and gut microflora being some of them. The cross-sectional nature of the study prevents us from making causal inferences.

Our study results have specific policy implications and recommendations emerging from it. By comprehensively examining these disparities and the underlying factors, we can pave the way for more effective prevention, management and policy initiatives. Our study depicts specific interesting findings that can inform the development of interventions to address the unique needs of urban and rural populations. Stakeholders can use this research to draft policies addressing the root causes of urban–rural disparities in diabetes and comorbidities, such as improving healthcare infrastructure in rural areas and implementing strategies to promote healthier lifestyles. Understanding the cultural and behavioural factors influencing diabetes risk can guide the development of targeted health education programs that resonate with urban and rural communities. The increased prevalence in rural areas is concerning and demands more efforts through better public health preparedness, regular screening, uninterrupted supply of medicines, and logistics support to screen for emerging micro- and macrovascular complications.

Conclusion

We depict a higher prevalence of diabetes in Haryana than the national average. While urban areas continue to have a higher prevalence of diabetes and prediabetes, rural areas may catch up because of an increase in the prevalence of prediabetes, which must be addressed promptly. As economic transition rapidly bridges the gap between urban and rural populations, the health system should also gear up to identify risk factors and tackle them in all regions of the state.

Timely measures can efficiently contribute to improved public health outcomes and a reduction in the burden of this chronic disease on individuals and healthcare systems alike.

Typhoid

Geographic Pattern of Typhoid Fever in India

Abstract

Background

Typhoid fever remains a major public health problem in India. Recently, the Surveillance for Enteric Fever in India program completed a multisite surveillance study. However, data on subnational variation in typhoid fever are needed to guide the introduction of the new typhoid conjugate vaccine in India.

Methods

We applied a geospatial statistical model to estimate typhoid fever incidence across India, using data from 4 cohort studies and 6 hybrid surveillance sites from October 2017 to March 2020. We collected geocoded data from the Demographic and Health Survey in India as predictors of typhoid fever incidence. We used a log linear regression model to predict a primary outcome of typhoid incidence.

Results

We estimated a national incidence of typhoid fever in India of 360 cases (95% confidence interval [CI], 297–494) per 100 000 person-years, with an annual estimate of 4.5 million cases (95% CI, 3.7–6.1 million) and 8930 deaths (95% CI, 7360–12 260), assuming a 0.2% case-fatality rate. We found substantial geographic variation of typhoid incidence across the country, with higher incidence in southwestern states and urban centers in the north.

Conclusions

There is a large burden of typhoid fever in India with substantial heterogeneity across the country, with higher burden in urban centers.

Keywords: enteric fever, geospatial model India, salmonella, typhoid fever, public health, vaccination

Typhoid fever has an estimated global incidence of 11–21 million cases annually, resulting in 120 000–160 000 deaths [1–4]. Enteric fever is an acute febrile illness caused by ingestion of the bacterium *Salmonella enterica* serotype Typhi (*S* Typhi) or serotype Paratyphi A, B or C, often through food or water contaminated with human feces [5, 6]. The severe clinical presentations of typhoid fever includes the development of sepsis, gastrointestinal bleeding, intestinal perforation, and death [7, 8].

A large proportion of the global burden of typhoid fever is concentrated in South Asia, with a high incidence in India [2–4, 9–14]. The Global Burden of Disease Study in 2017 estimated typhoid/paratyphoid incidence in India of 586 cases per 100 000 person-years [4, 15]; however, these estimates extrapolated largely from regional data, because there have been few population-based studies in India. A 1996 study in Delhi found an incidence of 976 (95% confidence interval [CI], 763–1250) cases per 100 000 person-years, whereas a 2006 study in Kolkata estimated an incidence of 265 (95% CI, 217–324) cases per 100 000 person-years [16, 17]. There have been no population-based typhoid incidence studies for more than a decade, and there have been no prior population-based studies from rural areas, where the majority of people reside. A recent meta-analysis, largely of facility-based studies, revealed that the proportion of individuals with positive blood cultures for *S* Typhi has been declining [10]. However, there remains scarce recent data on the incidence and geographic distribution of typhoid fever in India. This paucity of data is further complicated because the geographic pattern of typhoid fever is expected to be highly heterogenous within the country [10, 18, 19].

Accurate and recent estimates of typhoid fever incidence and the spatial distribution in India are essential for public health decision making such as vaccination strategies. The World Health Organization (WHO) recently approved new Vi conjugate vaccines against typhoid fever that provide high efficacy and duration of protection [20]. To address the need for locally relevant data for typhoid fever burden in India to guide policy on use of the conjugate vaccines in India, the Surveillance for Enteric Fever in India (SEFI) study was conducted [21, 22]. The SEFI is a multisite study that used both prospective cohorts and hybrid surveillance designs in 10 urban and rural locations to provide estimates on typhoid fever incidence. Although the SEFI study sites provide high-quality typhoid fever incidence data for these sites, there is a need for broader estimates of typhoid burden across India. The use of spatial modeling approaches has become increasingly common to predict epidemiologic measures (eg, incidence and prevalence) in infectious diseases (eg, malaria and schistosomiasis) in the absence of primary data [23–26]. This modeling approach aims to leverage variables from secondary datasets to predict incidence in areas without primary data on incidence, by calibrating the relationship of these variables with incidence in areas with primary data on incidence.

Although typhoid fever is common in India, the exact burden of disease and spatial heterogeneity are important to understand to guide policy decision on national vaccination with the Vi typhoid conjugate vaccines. To address this need, we applied a geospatial statistical model to estimate typhoid fever incidence across India, using data from 4 cohort studies and 6 hybrid surveillance from the SEFI study combined with a national household survey data.

METHODS

Methods Overview

We used a statistical model to predict typhoid fever incidence across India. We performed spatial data processing and interpolation to match health and demographic variables geographically to observed data on typhoid incidence from SEFI study sites. The model calibration and prediction both utilized regression analysis to estimate typhoid incidence, which was reported at a state and national level.

Study Data on Typhoid Incidence

We used data on typhoid fever incidence from the SEFI study, which was a multisite cohort (named Tier 1) and hybrid surveillance (named Tier 2) study of typhoid incidence. The SEFI study had 10 sites that each provided a site-specific typhoid incidence estimate [21, 22]. In all study sites, typhoid cases were defined as blood culture-confirmed *S* Typhi cases over the duration of the study. The Widal test was not used for diagnosis. The spatial data for catchment areas at a village level for the 10 study sites in India were provided by the SEFI study. We used spatial information on each study site using ArcGIS 10.7.1.

The Tier 1 SEFI sites (cohort study) measured clinical typhoid fever cases and included 4 cohorts. Each cohort enrolled 6000 children ages 6 months to 15 years that were observed over a 2-year observation period (October 2017–February 2019). The study sites were located in Delhi, Kolkata (West Bengal), Vadu (Maharashtra), and Vellore (Tamil Nadu). The incidence of typhoid fever was computed as the number of blood culture-confirmed cases for each site, with the denominator being the number of person-years of observation in the defined age group, with follow up censored for 15th birthday, withdrawal of consent/assent, febrile period, death, and completion of study. The incidence estimate was reported as number of cases per 100 000 person-years. We adjusted our estimate to account for consent/assent to obtain blood cultures and blood culture sensitivity [21]. Further explanation of study methodology for Tier 1 has been previously described [27].

The Tier 2 SEFI sites (hybrid surveillance study) measured hospitalized typhoid fever cases, and included 6 hybrid surveillance sites. Each site measured the number of typhoid fever cases identified in the hospital in persons 6 months and older (including adolescents and adults) over a 2-year observation period (between February 2018 and March 2020). In each hybrid surveillance study site, healthcare utilization surveys were conducted to estimate the person-years of observation to adjust the catchment population denominator when computing incidence, with the methods as previously described [22, 28]. The incidence estimate was adjusted for the 60% sensitivity of blood cultures. The Tier 2 study sites were located in Chandigarh, Nandurbar (Maharashtra), Kullu (Himachal Pradesh), Karimganj (Assam), Anantapur (Andhra Pradesh), and East Champaran (Bihar). Among the 10 study sites, Delhi, Kolkata and Vellore in Tier 1 and Chandigarh in Tier 2 are urban areas, whereas the rest are rural locations. Details of the computation process for the incidence in these 10 study sites for Tier 1 and 2 are further described in the Appendix.

Study Data on Model Predictors

The data on model predictors for typhoid fever incidence were drawn from the Demographic and Health Survey (DHS) conducted from 2015 to 2016 in India [29]. The DHS are nationally representative cross-sectional surveys on health and demographic variables that occur in many low- and middle-income countries approximately every 5 years [30]. The DHS have also been widely used by researchers and policymakers [31–33]. We extracted the following prespecified variables from the DHS that were chosen based on their potential to predict incidence of typhoid fever from prior literature: urbanicity (urban vs rural in a cluster, defined by the Indian national government), household wealth (quintile), household maternal education, household access to improved water and toilet, household size, household receipt of a third dose of the diphtheria-pertussis-tetanus vaccination (a marker of healthcare access), and anthropometric measurements (stunting and underweight). We simplified the definition of access to improved water and toilet following the Joint Monitoring Program for Water Supply, Sanitation and Hygiene [34] guidance. We defined stunting and being underweight based on the WHO Child Growth Standards using height-for-age and weight-for-age more than 2 standard deviations below a reference median, respectively. Population data were obtained from WorldPop [35]. Missing data were excluded. The variables were recoded and computed hierarchically as described in Supplementary Tables S1–S3 in the Appendix.

We performed a spatial interpolation of each DHS variable over India. Study variables were available at different levels including for each child, household, and cluster (see Supplementary Tables S2 and S3) and were each aggregated to a mean at the cluster level (ie, the primary sampling unit where the preexisting geographic area is known as census enumeration areas). For each cluster in the DHS survey, the GPS location (ie, points with latitude and longitude) at the center of each sample cluster was collected during field work or survey with variation for confidentiality inside the targeted administrative units (by up to 2 kilometers for urban locations and 10 kilometers for rural locations) [36]. The DHS survey for India in 2015 had a total of 28 395 clusters. We performed spatial interpolation using inverse distance weighting methodology for all variables from DHS (ie, cluster points) at 5 × 5-km resolution. The spatial resolution of 5 km was (1) chosen to line up with the smallest size of catchment area among the 10 study sites and (2) based on resolution of available datasets. The interpolation process was weighted by the number of households (or the number of children for certain variables) in each cluster. The spatial weights applied inverse distance with the power of 2 for the exponent of distance that controlled the significance of surrounding points on the interpolated value (ie, the weight of known points on unknown locations diminished with distance). The interpolation results were evaluated through cross-validation. The cross-validation process separated the data into a training set to calibrate the model and a test set to evaluate the predictive performance on data that were withheld from the model during the calibration. The raster output from inverse distance weighting methodology was then converted to 5 × 5-km polygon vector data to spatially intersect with study sites. The spatial data processing was implemented in ArcGIS 10.7.1.

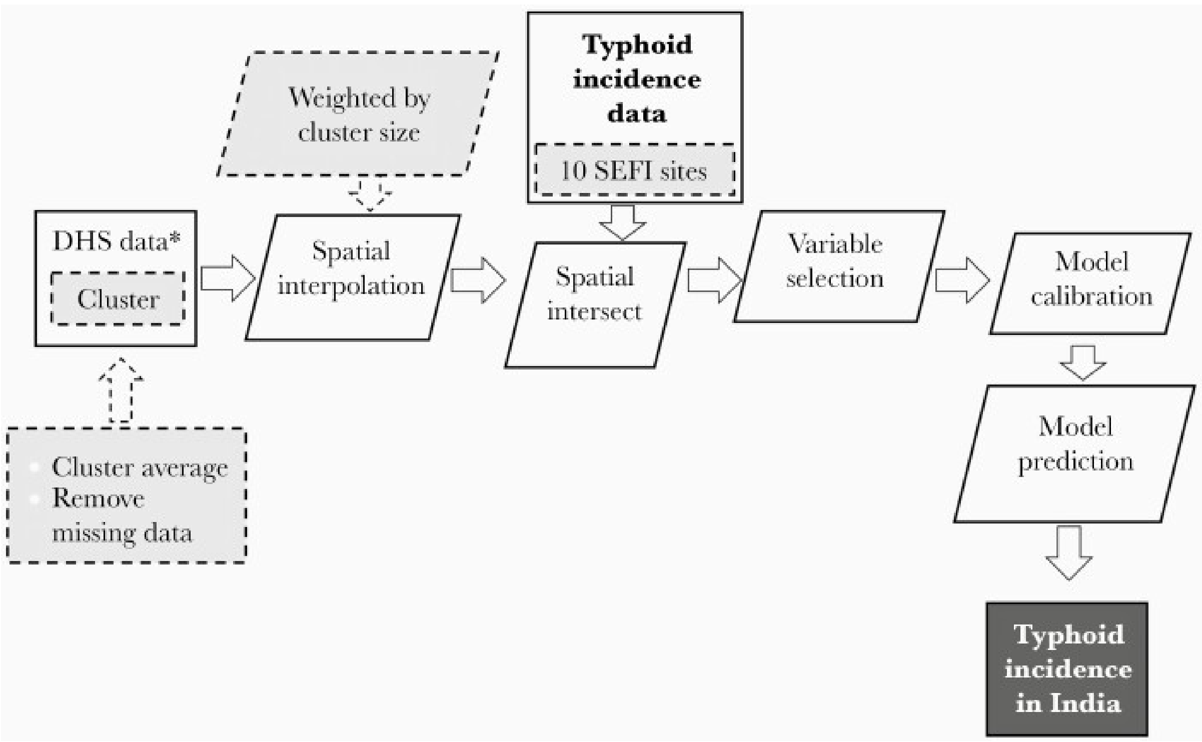
Model Calibration

We utilized a log linear regression model to estimate the relationship between typhoid incidence (dependent variable, cases per 100 000 person-years) and predictors (independent variables). We estimated the regression on the level of the study site, including the sample size of the 10 SEFI sites. For each predictor, the variable population mean of the DHS clusters overlying each SEFI study site was estimated. We selected variables by identifying the lowest Akaike Information Criterion (AIC) value, with a goal of limiting to a single variable to prevent overfitting given the limited sample size; in sensitivity analysis, we evaluated a 2–3 variable model. The final model was calibrated to the selected variable(s) at the level of the 10 SEFI sites.

Model Prediction

We utilized the calibrated log linear regression to predict the primary study outcome of typhoid incidence (cases per 100 000 person-years) at the level of a 5 × 5-km grid using the selected variable. There was a total of 160 800 grids in India. The typhoid incidence estimate was aggregated to a state level, with population weighting for each grid. Statistical analyses were implemented in R 3.6.1. The methodology of this study is presented in Figure 1.

Figure 1.



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Summary of the study design for prediction of typhoid incidence in India. The study design followed the outlined process in the figure. We used Demographic and Health Survey (DHS) data on model variables to serve as predictors of typhoid incidence. The DHS variable data were averaged at a cluster level and then interpolated on a 5 × 5-km grid. We geographically intersected the DHS model variable data with the Surveillance for Enteric Fever in India (SEFI) data on observed typhoid incidence. We calibrated a model to estimate the relationship between each DHS model variable and typhoid incidence, and then we utilized a backward selection algorithm for variable selection. When the Akaike Information Criterion was minimized, we used the selected variable(s) as the predictor of typhoid incidence for the model. The rectangles refer to input/output data. The rhomboid shape refers to data processing. The gray shaded color indicates that additional data/processing steps.

We computed the 95% uncertainty interval (UI) for the prediction of typhoid fever incidence using a resampling process that accounted for the uncertainty in the original SEFI site estimates of typhoid incidence. The process first sampled from the 95% interval on typhoid incidence for each SEFI site, which was bounded by a beta distribution. We then recalibrated the model using the 10 SEFI study site incidence estimates, repeated the typhoid incidence prediction for India, and stored the mean estimate. This process was repeated 1000 times to ensure convergence of the estimate. The final 95% UI in this study was based on the 2.5% and 97.5% percentile of this range of values. We also computed secondary study outcomes including (1) total number of national annual typhoid fever cases based on a population weighted incidence and (2) annual mortality based on a 0.2% case-fatality rate [12].

To test robustness in this analysis, we performed multiple sensitivity analyses. These included alternative variable selections and a leave-one-out analysis to determine the effect of removing 1 study site on the overall typhoid incidence prediction.

Ethic Statement

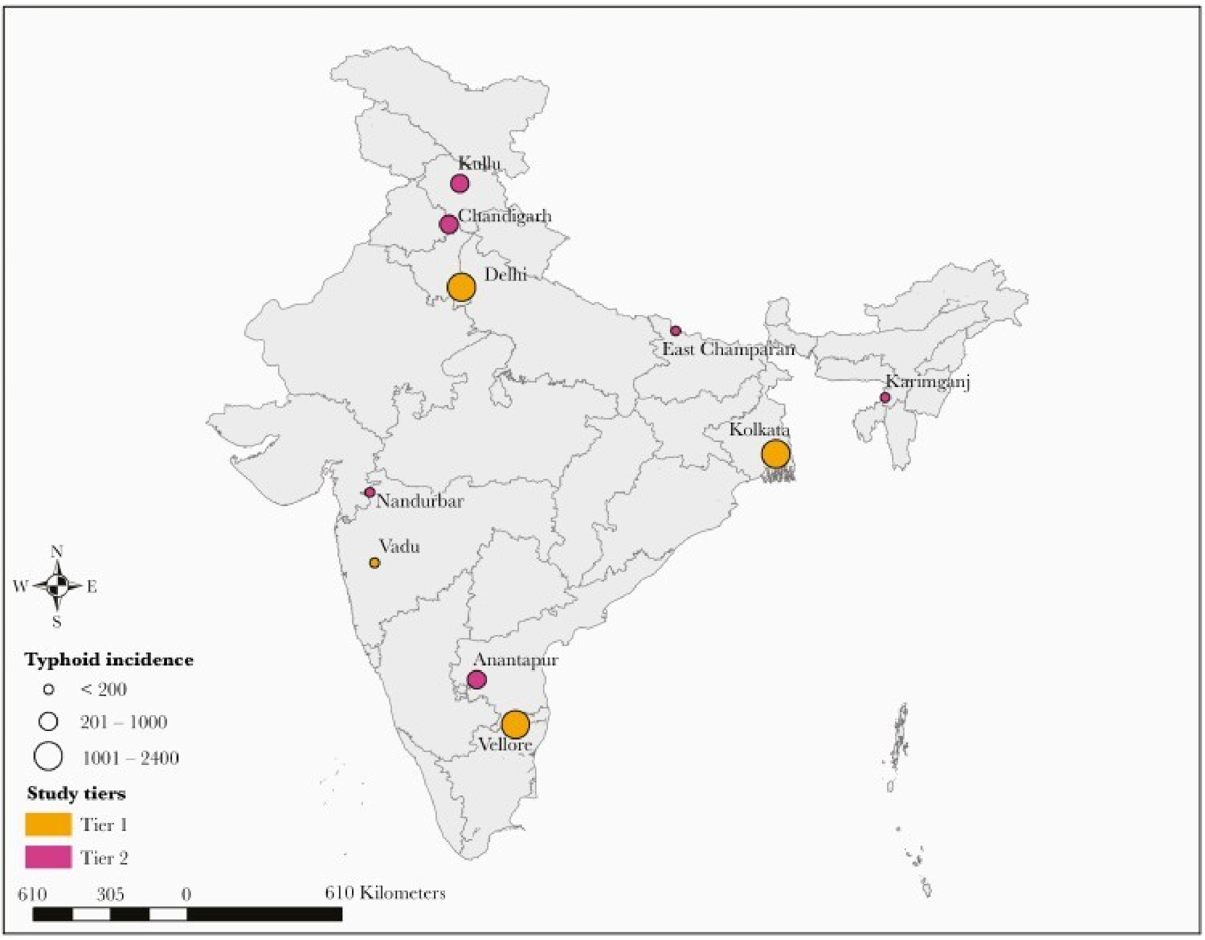
This project did not meet the definition of human subjects research at Stanford University given use of aggregated estimates of typhoid fever incidence without identifiable or person-level data. In the SEFI study, all participants provided informed consent with institutional review board approval at Christian Medical College, Vellore, as well as approval at each study site.

RESULTS

Surveillance for Enteric Fever in India Data on Typhoid Incidence

The overall mean incidence of typhoid fever in the 10 SEFI sites was 615 cases per 100 000 person-years. The location of the 10 sites and corresponding typhoid incidence is displayed in Figure 2. Typhoid incidence was higher in the cohort studies (Tier 1) with an average of 1080 cases per 100 000 person-years compared with the hybrid surveillance study (Tier 2) with an average of 304 cases per 100 000 person-years. The study sites in urban settings had a higher mean incidence of typhoid fever of 1310 cases per 100 000 person-years, compared with rural sites, which had a mean incidence of 151 cases per 100 000 person-years. Among the 10 sites, 3 had typhoid incidence below 100 cases per 100 000 person-years: 61 (95% UI, 24–125) in Vadu, 72 (95% UI, 50–133) in East Champaran, and 79 (95% UI, 59–133) in Karimganj. In addition, 3 sites had an incidence between 100 and 500 cases per 100 000 person-years: 154 (95% UI, 98–280) in Nandurbar, 266 (95% UI, 176–412) in Anantapur, and 274 (95% UI, 179–443) in Kullu. Finally, 4 sites had an incidence of over 500 cases per 100 000 person-years: 981 (95% UI, 717–1416) in Chandigarh, 1095 (95% UI, 913–1302) in Delhi, 1187 (95% UI, 998–1400) in Kolkata, and 1977 (95% UI, 1740–2236) in Vellore.

Figure 2.



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Spatial distribution of the 10 Surveillance for Enteric Fever in India (SEFI) study sites in India. The circles indicate the location of the 10 SEFI sites. The pink circles refer to 4 cohort study sites in Tier 1, and orange circles refer to 6 hybrid surveillance surveillance study sites in Tier 2. The size of the circles were categorized in 3 levels of incidence: fewer than 200 cases per 100 000 person-years (small circle), 201–1000 cases per 100 000 person-years (medium circle), and over 1000 cases per 100 000 person-years (large circle).

Variable Selection and Model Calibration

The spatial interpolation of each DHS variable is available in Supplementary Figure S1 in the Appendix. The prediction error statistic (root mean squared error) from the inverse distance weighting interpolation for each DHS variable was also displayed in Supplementary Figure S1. We performed a variable selection process of DHS variables to predict typhoid fever incidence, and identified that urban prevalence minimized the AIC. The result from the model calibration using DHS variables is summarized in Table 1. The calibrated model was able to broadly reproduce the estimated pattern of typhoid incidence in many observed settings (Table 3).

Table 1.

Univariate Regression on Predictors of Typhoid Fever Incidence

Variables	Univariate Regression Coefficient	95% CI	AIC
Urban prevalence[a]	2.83	(2.47–3.18)	4.24
Improved toilet access (binary)	2.72	(0.15–5.29)	34.35
Education level (tertile)	1.45	(−0.76 to 3.55)	36.77
Access to vaccination (3rd dose, diphtheria, tetanus, and pertussis)	6.54	(1.98–11.11)	31.79
Wealth (quintile)	0.78	(0.19–1.37)	32.61
Household size	0.02	(−0.96 to	38.64

		1.00)	
Improved water access (binary)	0.62	(−4.99 to 6.24)	38.59
Stunting prevalence	−7.68	(−11.96 to −3.39)	29.31
Underweight prevalence	−3.36	(−8.15 to 1.41)	36.51

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Abbreviations: AIC, Akaike Information Criterion; CI, confidence interval.

The model in the univariate regression was a log linear regression using the 10 study sites (N = 10). In this regression test, the dependent variable was typhoid incidence at each study site (cases per 100 000 person-years). The coefficient represents a log transformation.

[a]Urban prevalence was computed as the average of a binary urban/rural household variable at the cluster level.

Table 3.

Comparison of observed and predicted incidence of typhoid fever in SEFI study sites

Site	Original		Predicted	
	Incidence	**95 %UI**	**Incidence**	**95 %UI**
Anantapur	266	(176–412)	400	(334–543)
Chandigarh	981	(717–1416)	941	(744–1280)
Delhi	1095	(913–1302)	1313	(1010–1799)
East Champaran	72	(50–113)	80	(71–124)
Karimganj	79	(59–133)	96	(86–144)
Kolkata	1187	(998–1400)	1313	(1010–1799)
Kullu	274	(179–443)	274	(239–371)
Nandurbar	154	(98–280)	137	(120–198)
Vadu	61	(24–125)	192	(174–263)
Vellore	1977	(1740–2236)	1185	(926–1613)

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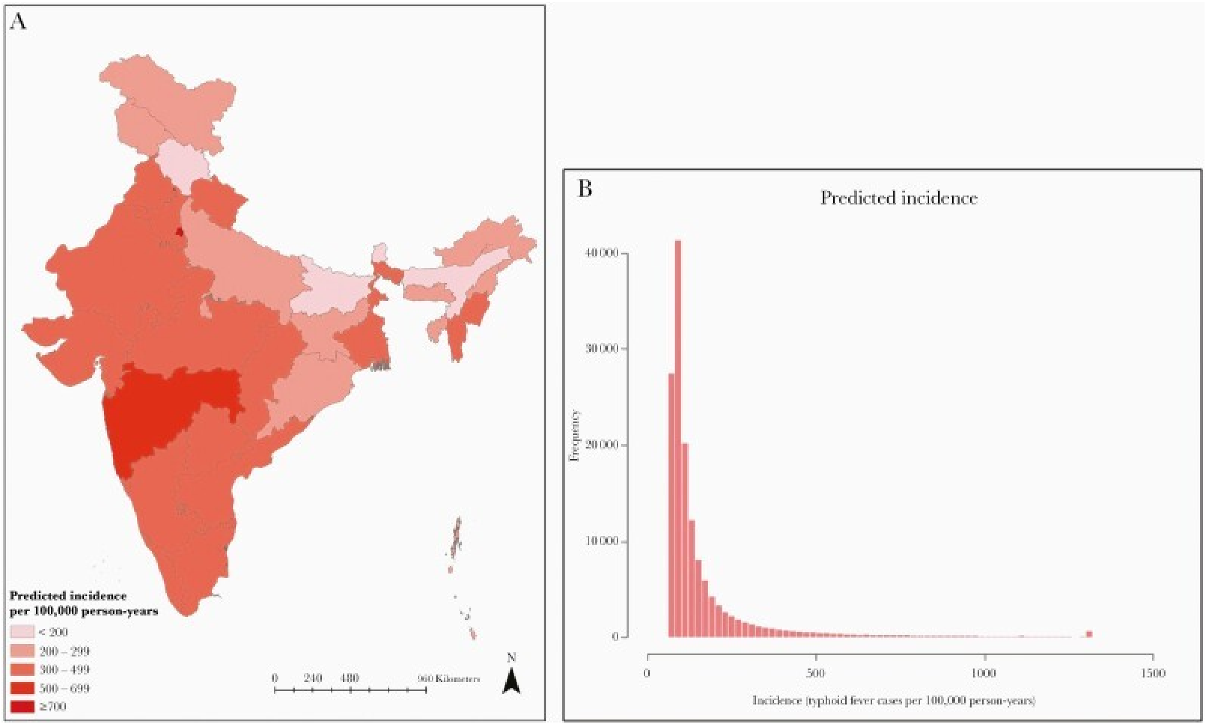
The original typhoid incidence was provided by SEFI. The predicted incidence for each site was based on the model prediction. All incidence estimates are presented as cases per 100 000 person-years.

Abbreviations: SEFI, Surveillance for Enteric Fever in India; UI, uncertainty interval

Model Prediction of Typhoid Incidence

The national incidence of typhoid fever was estimated to be 360 cases per 100 000 person-years (95% UI, 297–494), adjusted for blood culture sensitivity. Based on this incidence, we estimated 4.5 million (95% UI, 3.7–6.1 million) annual cases of typhoid fever with approximately 8930 deaths (95% UI, 7360–12 260), assuming a 0.2% case-fatality rate. The mean typhoid incidence in urban settings was 770 cases per 100 000 person-years (95% UI, 620–1040), whereas the mean incidence was 150 cases per 100 000 person-years (95% UI, 130–210) in rural settings. We noted there was substantial variation in predicted typhoid incidence across the country in Figure 3. The incidence ranged from 149 cases per 100 000 person-years (95% UI, 130–213) for Himachal Pradesh to 1245 cases per 100 000 person-years (95% UI, 963–1702) for Delhi. Table 2 summarized the predicted incidence for each state as well as the prevalence of state urbanicity. In general, there was higher incidence in southern and western states (eg, Maharashtra and Tamil Nadu) and urban centers in the north (eg, Delhi and Chandigarh), whereas there was lower incidence in rural northern states (eg, Arunachal Pradesh and Himachal Pradesh). Approximately 50% of the geographic area in the country where over 70% population reside had incidence over 100 cases per 100 000 person-years; we found that less than 10% of the geographic area of the country with approximately 25% of the country population had incidence over 500 cases per 100 000 person-years.

Figure 3.



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Predicted incidence of typhoid fever in India. We calibrated a statistical model to predict typhoid fever incidence in India using data from 10 Surveillance for Enteric Fever in India study sites. We used a log linear regression model to predict typhoid incidence across the country using secondary data obtained from Demographic and Health Survey in India. The estimated incidence was at 5 × 5-km grid level and was aggregated at state level and mapped in (a). The histogram of incidence at original grid level was visualized in (b).

Table 2.

Predicted Incidence of Typhoid Fever at a State Level in India

State	Incidence (95% UI)	%Urban Population
Andaman and Nicobar	232 (196–324)	31.5
Andhra Pradesh	390 (321–534)	38.4
Arunachal Pradesh	204 (175–286)	19.2
Assam	166 (144–235)	15.2
Bihar	162 (140–230)	13.8
Chandigarh	905 (719–1228)	90.7
Chhattisgarh	305 (253–421)	29
Dadra and Nagar Haveli	446 (369–607)	45.5
Daman and Diu	564 (455–768)	72.3
Delhi	1245 (963–1702)	97.2
Goa	400 (339–540)	56.6
Gujarat	457 (374–624)	44
Haryana	393 (326–536)	39.7
Himachal Pradesh	149 (130–213)	13.2
Jammu and Kashmir	249 (210–346)	24.1
Jharkhand	298 (248–411)	28.1
Karnataka	441 (362–602)	43.3
Kerala	429 (356–582)	44.4
Madhya Pradesh	305 (255–419)	30.7
Maharashtra	515 (418–703)	48.4
Manipur	342 (283–470)	32.8
Meghalaya	254 (211–354)	22.3
Mizoram	444 (359–609)	45.4
Nagaland	264 (224–365)	26.7
Orissa	224 (190–313)	20.8
Puducherry	659 (521–904)	55.5
Punjab	427 (353–580)	43.9
Rajasthan	307 (256–424)	30
Sikkim	199 (174–276)	21.8

Tamil Nadu	494 (407–669)	50.2
Tripura	285 (237–394)	26.4
Uttar Pradesh	282 (235–390)	27
Uttaranchal	360 (302–490)	37.4
West Bengal	395 (323–543)	36.2
Country average	360 (297–494)	34.3

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Abbreviations: UI, uncertainty interval.

All incidence estimates are presented as cases per 100 000 persons

Sensitivity Analysis

We performed multiple sensitivity analyses to determine robustness of the model prediction. We tested the effect of removing 1 study site on the overall typhoid incidence prediction, which had modest effect on the national typhoid incidence estimate. The result of sensitivity analysis was presented in

Supplementary Table S4 in the Appendix. In this analysis, we found that removal of Vellore had the largest effect on the estimate. We also tested alternative variables in the prediction model for typhoid incidence. Using a 2-variable model (ie, urban prevalence and improved toilet access), we estimated a national incidence of 364 cases per 100 000 person-years (95% CI, 287–530). A map of state variation is available in Supplementary Figure S2 in the Appendix.

Discussion

In this study, we used a geospatial statistical model to estimate the incidence of typhoid fever in India. We computed a national incidence of approximately 360 cases per 100 000 person-years with higher burden in urban centers, corresponding to 4.5 million cases and 8900 deaths annually in India. This study utilized statistical modeling of incidence data on typhoid fever from 4 cohort and 6 hybrid surveillance studies, while incorporating data from a national health survey to use as predictors of typhoid incidence. The key study limitation was a modest sample size to calibrate our model, which mainly relied on urbanicity alone to predict typhoid fever incidence. Our national estimate on incidence of typhoid fever in India is generally consistent with previous studies and supports that there is a large burden of typhoid fever in India that would benefit from national vaccination.

Our findings suggest substantial variation of typhoid incidence across the country. We found higher incidence in urban centers in the north and southwestern states and lower incidence in northern rural regions driven largely by the single model variable of urbanicity. This urban-rural disparity highlights that the burden of typhoid fever in India is predominately in larger urban centers that may be related to living conditions such as density, sanitation, and other environmental factors, although there was still typhoid fever found in rural areas. Prior epidemiologic work has demonstrated the risk of typhoid fever in urban centers [9, 19]. This suggests a higher risk in these areas, which may support prioritization of vaccination in these settings [37]. We also found a relationship between typhoid incidence and growth metrics, vaccination, and improved toilet/water; some of these variables may have a causal relationship with typhoid fever infection, but they also may only be correlated with risk factors for typhoid fever, and this analysis is limited by a small sample size.

WHO now recommends introducing typhoid conjugate vaccines in areas with high typhoid incidence [38]. Prior cost-effectiveness models have found that typhoid conjugate vaccines would be cost-effective in routine immunization programs for countries with high typhoid incidence [39, 40, 41]. The Government of India is preparing to make a decision about whether and how to introduce typhoid conjugate vaccines. Data on the burden of typhoid fever across the country are important to support these decisions. Despite substantial spatial variation, we estimated that the incidence of typhoid in all states were likely above 100 per 100 000 person-years, which has been defined as "high burden" for typhoid [3]. These findings suggest that a nationwide vaccine introduction, rather than a geographically targeted one, may be required for control of typhoid and mitigation of its health impacts in India.

The study findings should be interpreted within the limitations of the data and analysis. The study had a key limitation in sample size; we used 10 sites to calibrate the model to predict typhoid fever incidence across India, which limited the accuracy and validation of the model prediction. Measurement of typhoid fever incidence at a given location requires a resource-intensive methodology (eg, multiyear cohort study or hybrid surveillance), which limits the number of locations where typhoid incidence can be reliably estimated. We adjusted our case data for an estimated 60% sensitivity of blood cultures for diagnosis of typhoid fever. However, this adjustment could be limited because blood culture sensitivity varies across locations, and it could further result in underestimation or overestimation of typhoid incidence in certain areas. To address the concern of the influence of a single site on the overall national typhoid estimate given a small sample size, we performed sensitivity analyses and found that 1 site did not disproportionately affect the estimate. We relied upon secondary data from the DHS to predict typhoid incidence; these data required some data processing, interpolation, and aggregation to a grid level (5 × 5 km), which could introduce imprecision and bias into the estimate. An independent assessment of DHS data was done through comparison to the state urban population data from the Indian Ministry of Home Affairs [42]. Supplementary Table S5 in the Appendix shows our computed urban population and data from the national India Census, which were overall comparable. We constrained the number of predictors in the model to limit the risk of overfitting given limited data, both of which limited the model's predictive accuracy (Table 3). The model identified a negative association between typhoid incidence and being stunted or underweight (Table 1). Our urban sites (eg, Chandigarh, Delhi, Kolkata, and Vellore) had substantially higher typhoid incidence than rural sites, yet stunting and underweight are much less common in urban locations, which likely explains this negative association. Due to the small sample size for the model calibration, we were unable to perform a meaningful validation of the model prediction. In addition, the 4 study sites in Tier 1 included all children, and 3 of these sites were in urban settings. Because typhoid fever has greater risk for children, this site selection could bias our estimate towards a higher incidence given the urban settings and pediatric population included in this study. Estimation bias could have also resulted from the differences in the time frame between sample collection for SEFI and DHS. Finally, due to a limited sample size, we did not include age-specific incidence estimates, although there is likely a strong age correlate of risk.

Conclusions

There is a substantial disease burden of typhoid fever across India, with higher typhoid incidence in urban centers. This study supports immunization with the Vi conjugate typhoid vaccine to address the disease burden from typhoid fever in India.

Mental Health

Mental health services in rural India

Abstract

There has been a decline in the rural population of India from nearly 82% to about 65% over the past six decades. The National Mental Health Survey of India (2015–2016) reported a lower prevalence of mental disorders in rural areas compared with urban ones. Mental health services in the country are skewed towards the urban areas, and more families are pushed below the poverty line while getting treatment for a member with mental illness. India has expanded its District Mental Health Programme over the past two decades, and it now covers nearly all the districts in the country. Despite that, significant numbers of people with mental disorders, ranging from 70–90%, do not receive adequate treatment. This paper discusses the rural–urban divide in the mental health services, examining the problem and need, and the initiatives taken by the government of India in this direction.

Keywords: Mental health, rural, mental disorders, primary care, tele mental health

The rural–urban divide

India, located in the southern part of the Asian continent, is a vast nation with an area of 3.287 million km^2 and a population of about 1.42 billion. The population of India shows wide variation and diversity across different regions. A substantial portion of the population resides in rural areas, although there has been an increasing trend towards urbanisation since the country's independence in 1947. The rural population is split between villages and small towns, where most of the people work in agriculture or other rural occupations. According to the World Bank collection of development indicators, the rural population in India accounted for 64.13% of the total population in 2022; this is similar to the share of rural population in other South Asian countries (Bhutan 56.31%, Bangladesh 60.29%, Pakistan 62.27%, Nepal 78.55% and Sri Lanka 80.97%). The rural population of India has increased 2.5-fold in the 60 years from 1961 to 2021, while the proportion of the rural population declined from 81.97 to 68.72% (Table 1).

Table 1.

Rural population of India (World Bank data)

Year	Rural population (in millions)	Percentage of total
1961	374.1	81.97
1971	456.1	80.01
1981	545.9	76.58
1991	659.8	74.22
2001	777.7	72.08
2011	864.3	68.72
2021	909.4	64.61

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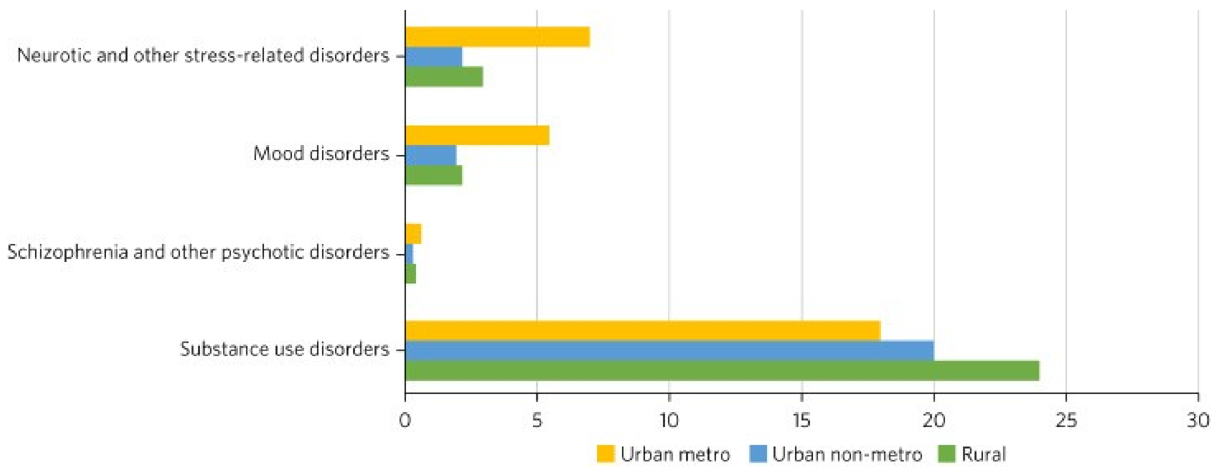
The rural–urban mental health divide presents unique challenges. In rural areas, shifting family dynamics and urban migration disrupt traditional support systems for individuals with mental health concerns. A lack of mental health infrastructure exacerbates the issue, with limited availability of professionals and resources. In addition, substance use is widespread, further affecting mental health. This compounds the need for effective rural mental health services, especially against the background of the changing family structures and urban migration. Previous literature has warned that numbers of mental health patients in rural areas will rise significantly over the next decade, owing to the growing population, shifting values, changing lifestyles, crop failures, natural disasters (drought and flood), economic crises, unemployment, lack of social support and rising insecurity.[1] This paper discusses the nature and extent of mental health problems in rural versus urban populations in India, as well as the rural–urban divide in the mental health services and the initiatives taken by the Government of India in this direction.

Burden of mental illness in India

The National Mental Health Survey (NMHS) of India (2015–2016) found variations in the prevalence of mental disorders across urban and rural areas.[2] Mental disorders were found to be twice as prevalent in urban areas compared with rural areas (13.5% *v.* 6.9%). However, the burden of substance use disorders, predominantly involving alcohol and tobacco, was higher in the rural population. Other mental disorders (Fig. 1), including schizophrenia, mood disorders and neurotic/stress-related disorders, were two to three times more prevalent in urban areas.[3] Other national level surveys have also found differences in the distribution of various psychiatric and/or substance-related illnesses. For example, according to the Global Adult Tobacco Survey 2, National Family Health Survey 5 (2019–2021) and National Non-communicable diseases Monitoring Survey (NNMS; 2018), the prevalence of tobacco use in rural areas (approximately 35–42%) was much higher than that in urban areas (approximately 20–25%). The NNMS also found the prevalence of alcohol use to be slightly higher in rural than urban areas (17% *v.* 14%).[3] These variations in prevalence have been hypothesised to be caused by either natural variation or variations in cultural understanding and reporting of symptoms suggestive of mental illness.

Fig. 1.



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Prevalence (%) of mental disorders in rural versus urban population (source: NMHS of India 2015–2016).

The treatment gap, as highlighted in the NMHS 2015–2016, was found to range from 70–92%, with the greatest treatment gap (91.8%) for tobacco use disorder.[2] These wide treatment gaps are critically influenced by lack of awareness and limited availability of mental health services, especially in rural areas, and poor affordability.

Thus, mental disorders are prevalent in urban areas, but rural areas also have significant numbers of people in need of care owing to limited availability of services. Various factors may contribute to the reported differences, including differences in stress levels, complexity of living situations, level of support systems, changing lifestyles, economic or agricultural challenges, and other issues that may affect mental health. Equitable mental health service coverage is vital to address these disparities. Ensuring equal access to mental health services in both urban and rural areas is crucial to meet the diverse needs of the population.

Mental health resources in India

According to the World Mental Health Atlas (2017),[4] India falls far short of recommended mental health standards. There are only 0.20 beds per 10 000 population, and 0.29 psychiatrists, 0.07 clinical psychologists, 0.8 psychiatric nurses and 0.06 social workers per 100 000 population, highlighting the inadequacy of mental health support. A rough estimate of the number of psychiatrists in India in the current year (2024) would be 0.7 per 100 000 population. The World Mental Health Atlas estimated that high-income countries have 120 times more psychiatrists than low-income countries, with a global median of 1.3 psychiatrists per 100 000 population.

With respect to the health infrastructure, numbers of government hospital beds in rural areas are less than half of those available in urban areas. Further, the bed/population ratio in rural areas is one-fifth of that in urban areas.[1] Regarding mental health infrastructure, India has 952 hospital-based, 1217 community-based and 240 out-patient mental health facilities, and 139 mental health facilities for children and adolescents.[4] In addition, there are 136 mental hospitals, 389 general hospital psychiatric units and 223 long-term care facilities, mostly in urban areas. However, despite progress, the country still lags behind the World Health Organization (WHO) recommended standard of one psychiatrist per 100 000 population. It is important to mention here that in the past 10 years, there has been a substantial increase in the training opportunities for psychiatrists as a part of an initiative taken by the local government. This should help to achieve the WHO recommended standard as a whole for the country, although the rural–urban divide in services may continue to be a big challenge.

Beginning of rural mental health services in India

In the mid-1960s, rural mental health services were starting to be developed in India.[5] In 1964, a weekly service was started at the Comprehensive Rural Hospital in Ballabhgarh, a small town near Delhi; this was followed by another community clinic in Mandar village near Ranchi, in eastern India, in 1967. In the 1970s, community psychiatry advanced, with medical colleges establishing clinics in collaboration with the Departments of Community Medicine. There were two key initiatives at Raipur Rani block in Haryana in North India and in Sakalwada village in Karnataka in South India, which acted as forerunners of the National Mental Health Programme of India in 1982, expanding mental health services in rural India, bridging accessibility gaps and providing training for healthcare professionals to address rural mental health challenges. Major roadblocks remained in the form of limited budgetary support, inadequate staff, lack of political commitment and lukewarm response among mental health professionals.[5] However, a major achievement followed with the evolution of the district model of providing mental healthcare, leading to the launch of the District Mental Health Programme (DMHP) in 1996 (discussed in the next section).

Current status of mental health services in rural India

According to data acquired from a national sample survey of India in July to December 2018, which also estimated catastrophic health expenditure and poverty impact due to mental illness, 22.5% of households in rural areas fell below the poverty line while a family member with mental illness underwent treatment, compared with 17% in urban areas (17%).[6]

Mental health services in India are limited, with progress primarily in some southern states such as Kerala, where psychiatric care is widely available. In most other places in the country, services in the community are offered through extension clinics at medical schools or under the DMHP. Private psychiatrists hold occasional clinics in some areas, addressing the accessibility gap. In addition, voluntary organisations and private psychiatrists organise community camps to provide on-site mental health services to rural communities, addressing their specific needs.[5]

In Karnataka, the DMHP has implemented several significant initiatives to strengthen mental healthcare services in India.[7] These initiatives represent a comprehensive approach to addressing various aspects of mental health support. The Manochaitanya Programme, also known as ‘Super Tuesdays’, offers specialised out-patient clinical services at Taluk hospitals, enhancing local access to expert mental healthcare. The Maanasadhara Programme provides day care rehabilitation services for individuals with severe mental illnesses, aiding their recovery and daily functioning. ‘Manasakendras’ serve as halfway homes, offering structured support for individuals transitioning from psychiatric institutions to community living. The Assisted Home Care Services Programme reaches out to individuals who have dropped out of treatment owing to severe mental illnesses, with mental health professionals conducting home visits to ensure continuity of care and medication adherence.[8] The Primary Care Psychiatry Programme focuses on training and supporting primary care doctors to identify and manage mental illnesses, ultimately strengthening early intervention and outcomes.[9] These initiatives collectively aim to enhance mental healthcare services in India and improve outcomes for individuals with mental illnesses throughout the country.

Telemedicine and telepsychiatry initiatives have also emerged as valuable tools in extending mental health services to remote areas. As part of the initiative, Tele MANAS (Tele Mental Health Assistance and Networking Across States) was launched on World Mental Health Day in 2022, promising a robust tele mental health infrastructure and network across the country that would make mental health services readily available and accessible to all.[10] By providing round-the-clock support and comprehensive interventions and extending services to vulnerable populations, the programme aims to address the mental health needs of the population and ultimately improve mental health outcomes throughout India. Through telemedicine platforms such as Tele MANAS, individuals in rural communities can access mental health consultations and support remotely, overcoming geographical barriers. Specific pilot projects have been undertaken by psychiatrists, focusing on innovative approaches to deliver mental health services in rural areas.

Another important initiative has been the Systematic Medical Appraisal, Referral and Treatment Mental Health Project in rural areas in the West Godavari district of Andhra Pradesh, India. This involved training primary healthcare physicians, ASHAs (accredited social health activists) and project staff in screening, diagnosing and treating depression, suicide risk and emotional problems using an electronic decision support system tool.[11] Recently, the ESSENCE (enabling translation of science to service to enhance depression care) project in Madhya Pradesh, India, has been planned to address the issue of limited capacity by training large cadres of frontline workers in low- and middle-income countries through two consecutive randomised controlled trials.[12] These projects serve as experimental models to explore and evaluate new methods of effectively reaching underserved populations.

Although progress has been made in expanding mental health services in rural India, challenges such as limited resources, infrastructure and awareness persist. However, these ongoing initiatives demonstrate a commitment to improving mental healthcare accessibility and addressing the unique needs of rural communities in India. A study from rural south India assessing the impact of community-based rehabilitation for mental illness on out-of-pocket expenditure in households with a person with severe mental illness found that the average annual cost per person decreased to Indian rupees (Rs) 492 (US$7) with community-based rehabilitation. The net annual savings for the system for 95 persons with severe mental illness covered in the study was Rs 383 755 (US $5482).[13]

Roadblocks

The roadblocks to providing mental health services in rural India include limited infrastructure, lack of adequate facilities, limited funding for mental health, workforce and inequitable distribution of resources. Stigma, discrimination, traditional and religious beliefs, and sociocultural barriers form a background for reluctance in seeking help. Low mental health literacy and lack of awareness also contribute to underutilisation of existing services. Geographical barriers, especially in hilly and tribal areas, together with poor transportation infrastructure affect access to services. Last, questionable political will, unclear plans and/or policies regarding mental health, poor training of the general health workforce, inadequate integration of mental health in primary healthcare, lack of public health skills among mental health leaders, and overburdened primary healthcare also contribute to fragmented care.[1]

Conclusion and way forward

To bridge the rural–urban mental health divide, a holistic approach is needed. Initiatives have been taken at various levels in India in this regard. Steps towards improving rural mental health services include enhancing mental health infrastructure, boosting numbers of rural mental health professionals and integrating services into primary healthcare. In addition, awareness-raising and provision of specific mental health interventions in rural areas are vital for equitable access to mental healthcare. ASHA workers are an important resource in rural areas and are involved in various national programmes. Capacity-building and training of ASHA workers to identify mental illnesses and participate in rehabilitation may be a productive step in the right direction. Other resources include traditional healers who are well trusted in rural communities. These two strategies can contribute to early identification, improved treatment-seeking and subsequent rehabilitation at a rural level.[1]

The facilitators to providing mental health services in rural India include telepsychiatry, which offers a cost-effective way to expand services in remote areas. Community engagement, involving local leaders, health workers and traditional healers, can raise awareness and facilitate service delivery. Tailoring of interventions to align with local cultural norms and beliefs enhances their acceptability and effectiveness. Integration of mental health services into primary care settings improves access and reduces stigma. Public health education programmes and awareness campaigns help to dispel myths and promote help-seeking behaviours. Innovative models of care delivery, such as the Raipur Rani project and the Sakalwara model, demonstrate the feasibility of providing services in rural areas. Integration of mental health with non-communicable diseases is a welcome step by the WHO, as it is likely to reduce stigma and subsequently the treatment gap in underprivileged and low-resource areas.

Asthma

Rural Asthma

Abstract

Purpose of Review

Asthma is the most common chronic illness of children and adolescents in the USA. While asthma has been understood to disproportionately affect urban dwellers, recent investigations have revealed rural pediatric asthma prevalence to be very similar to urban and to be more closely correlated with socioeconomic and environmental factors than geographic location or population density.

Recent Findings

Rural children experience factors unique to location that impact asthma development and outcomes, including housing quality, cigarette smoke exposure, and small/large-scale farming. Additionally, there are challenging barriers to appropriate asthma care that frequently are more severe for those living in rural areas, including insurance status, lack of primary care providers and pulmonary specialists, knowledge deficits (both patient and provider), and a lack of culturally tailored asthma interventions.

Summary

Interventions designed to address rural pediatric asthma disparities are more likely to be successful when targeted to specific challenges, such as the use of school-based services or telemedicine to mitigate asthma care access issues. Continued research on understanding the complex interaction of specific rural environmental factors with host factors can inform future interventions designed to mitigate asthma disparities.

Keywords: Rural asthma, Asthma, Pediatric asthma, Adolescents, Asthma prevalence, Asthma intervention

Introduction

Asthma is the most common chronic illness of children and adolescents in the USA [1]. It is an inflammatory disease of the airways characterized by bronchial hyperresponsiveness, mucosal edema, and airflow restriction. Clinically, asthma is manifest by episodic chest tightness, shortness of breath, cough, and wheeze. These symptoms are usually reversible with appropriate medical intervention. Symptomatology is highly variable and may differ not only from patient to patient, but exacerbation to exacerbation in the same patient. While asthma is frequently referred to as a disease, it appears to be a symptom complex caused by various combinations and interactions between host factors (e.g., genetics, sex, obesity) and environmental exposures (e.g., viral respiratory infections, allergens, air pollutants) resulting in phenotypic heterogeneity and different patterns of airway remodeling [2, 3]. Asthma is more common in children but can affect individuals of all ages.

Pediatric asthma (ages 0–17 years) [4] has previously been understood to disproportionately affect urban dwellers (see Milligan, Matsui, and Sharma for a comprehensive overview of asthma in urban children) [5]. However, recent investigations have revealed rural pediatric asthma prevalence to be very similar to suburban and urban [6••, 7••, 8••]. The distribution appears to be more closely correlated with socioeconomic and environmental factors than geographic location or population density [9, 10]. A refocus on these factors—race/ethnicity, socioeconomic status, indoor smoking, pest, and other environmental exposures—has demonstrated a more variable distribution pattern [9].

For rural children, adolescents, and their families, asthma is an important health problem with management challenges requiring locally appropriate interventions. In this review, we explore the definition of rural areas in the USA and the intersection of rurality with other demographic factors on asthma prevalence and follow with an overview of unique rural asthma triggers, barriers to healthcare access, and rurally tailored interventions with positive outcomes. We conclude with recommendations for future research.

Rurality and Demographics

Variations in what is meant by the term “rural” make it challenging to compare research that considers location in the evaluation of asthma (or any other disease process, for that matter) [11]. Moreover, how the term is defined influences policy making and resource allocation, which in turn impacts individuals and has the potential to affect healthcare outcomes. Built on geographic units such as counties, zip codes, and census tracts, in general, rural is conceptualized as everything that is not urban or suburban; specific definitions are developed by specific agencies for specific usage, such as funding for healthcare clinics in underserved locations (see Table 1 for commonly used US federal definitions). Narrowly targeted definitions of rural designed to benefit specific populations may inadvertently exclude eligible program recipients [12]. Conversely, broader definitions may cause budgetary strain by including areas with less need. In most healthcare literature, rural is an area distant from any population center of 50,000 or more inhabitants.

Table 1.

US federal definitions of rural

Organization	Definition
US Census Bureau	Rural encompasses all population, housing, and territory not included within an urban area [13]. Urban areas include urbanized areas (50,000 people or more) and urban clusters (2500–50,000 people) [14].
Office of Management and Budget (OMB)	Rural includes all counties not part of a metropolitan statistical area (MSA), one of three core-based statistical areas. An MSA is a geographical entity associated with at least one urbanized area of 50,000 people, as well as

	adjacent counties with a high degree of social and economic integration with the urban area. Counties that are designated as micropolitan (10,000 to 50,000 people) or non-metropolitan are considered rural [15].
Federal Office of Rural Health Policy	All non-metropolitan areas are considered rural, as well as areas determined to be rural by Rural-Urban Commuting Area (RUCA) codes [16]. RUCA codes are sub-county census tracts representing urbanization, population density, and daily commuting [17].

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Using the OMB definition, 14 % of US residents, or approximately 46.2 million, live in non-metropolitan counties [18]. Of this cohort, over 42% live in the South (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, and Texas) [19, 20]. In general, poverty rates are higher in rural areas; these areas are also significantly more likely to be *persistently poor*, a term indicating counties in which 20% or more of the population has been living in poverty for 30 years [19]. Eighty-five percent of the 353 persistently poor counties are non-metro [19]. Poverty rates vary widely within and between regions. For example, the largest poverty gap (a measure of poverty intensity) between non-metro/metro areas is found in the South [19]. The 2010–2014 poverty rate in the northeast non-metro area was 13.9%; the poverty rate in the non-metro South during that same period was 21.8% [19].

Racial/ethnic composition of rural communities also differs by region of the USA. Most rural areas are predominantly white, with African American-predominant communities found mostly in the South, Hispanic-predominant communities in the Southwest, and Native American communities in the Midwest/West/Alaska/Hawaii regions [21].

Rurality and Pediatric Asthma Prevalence

One of the challenges in understanding pediatric asthma prevalence lies in the way that data are collected and presented. Typically, asthma is characterized by variables such as location, gender, race/ethnicity, socio-economic status, and change over time; group comparisons facilitate our understanding of asthma burden. For example, national data showed an increasing trend in pediatric asthma prevalence from 2001 to 2009, and after plateauing, the rate began to significantly decrease to 8.3% (SE 0.3%) in 2013 [4]. Over this same period, prevalence rates increased for poor and near-poor, non-Hispanic black, and Mexican-American children and adolescents, as well as those living in the South and Midwest [4]. The increases in asthma prevalence noted in these specific demographic groups, especially for non-Hispanic blacks, accounted for the increase in asthma prevalence disparities observed from 2001 to 2012, although this trend appears to be plateauing as well [4].

However, variables do not occur in isolation. Teasing out the unique intersections of factors associated with asthma development with rurality is challenging and may contribute to previous perceptions of a rural/urban dichotomy in asthma prevalence. Studies are beginning to demonstrate rural pediatric asthma prevalence to be similar to urban (see Table 2 for selected studies comparing rural and urban pediatric asthma prevalence).

Table 2.

2010–2016 selected studies, urban vs. rural asthma prevalence

Author (publication year)	**Setting/sample**	**Urban (%)**	**Rural (%)**	**Notes**
Fedeleetal. (2016) [8••]	Florida Youth Tobacco Survey administered to public middle and high school students	Middle, 12.1; high, 10.7	Middle, 12.9; high 11.2	Findings suggested racial/ethnic disparities in rural communities; rural AA students were more likely to report a diagnosis of asthma and higher rates of ED/urgent care use as

				compared with non-Hispanic white peers.
Ownbyetal. (2015) [7••]	6994 African American youth in Detroit compared with 1514 AA youth in rural Georgia	15	13.7	The prevalence of *undiagnosed* asthma in AAyouth was also similar between groups (8.0% in Detroit and 7.5% in Georgia),
Pesek et al. (2010) [22••]	Urban and rural school districts in Arkansas	20	19	While provider-diagnosed asthma rates were similar, rural children were more likely to receive a diagnosis of chronic bronchitis (7 vs. 2%, $P < .001$) and suffer increased asthma morbidity, including recurrent trouble breathing (odds ratio [OR], 1.9; 95% confidence interval [CI], 1.5–2.2), recurrent cough (OR, 2.2; 95% CI, 1.9–2.6), recurrent chest tightness (OR, 1.8; 95% CI, 1.5–2.2), and repeated episodes of bronchitis (OR, 2.2; 95% CI, 1.7–2.8) during the preceding 2 years.
Valet etal. (2011) [6••]	117,080 children continuously enrolled in Tennessee Medicaid from birth through the sixth year of life.	11	13	Rural children had increased asthma prevalence, were more likely to utilize outpatient asthma care, and less likely to use inhaled corticosteroids as compared to their urban counterparts.

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The categories of poverty, racial/ethnic minority status, and healthcare access barriers, well-known to be associated with the higher risk of asthma, sub-optimal management, and poorer outcomes, are suffered by both rural and urban children alike. However, the specific *factors* experienced by children within those categories warrant further exploration.

Unique Locational Factors Impacting Rural Pediatric Asthma

In addition to the general asthma risk factors discussed in the previous section, there are unique factors commonly experienced by rural-dwelling children and adolescents with asthma. These include micro and macro-environmental exposures and barriers to accessing appropriate asthma care.

Micro-Environmental Exposures and Individual Factors

The micro-environment consists of the child's immediate environment, which includes specific asthma triggers inherent to that setting [23]. For rural children and adolescents, housing factors and cigarette smoking are particularly problematic.

Housing

The quality of a child's living space is directly related to asthma outcomes—environmental control measures (e.g., mold and pest removal, air filtration, carpet removal) are part of a comprehensive approach to asthma management [2]. More than two thirds of young rural families (head of household younger than age 35) live in rental housing [24]. Rural rental properties are more likely to be single-family/small multi-family dwellings, older (35% were built before 1960), and substandard [24]. Coupled with the dearth of rural rental units and the increased likelihood of limited economic resources, families with children may have more difficulty finding affordable quality housing options. Not only do these conditions increase the probability of living with asthma triggers, but renters have less ability to mitigate these environmental exposures.

Urban children are more likely to live in multi-unit housing, which is associated with cockroach, rodent, and dust mite allergen exposure; those with asthma often demonstrate sensitization to these aeroallergens, especially children hospitalized for asthma exacerbations [25]. However, rural children with asthma also demonstrate exposure and sensitization, and it is unclear if this sensitization and subsequent asthma development is dose-dependent. One study in the rural Arkansas Delta found that even though the majority of child participants with asthma lived in single-family dwellings, most of the homes had cockroach and mouse allergens, albeit at lower concentrations than seen in urban homes [26].

Indoor air quality is an additional issue for rural children and adolescents. Children living in rural areas are more likely to reside in housing with wood-burning heat [27]. Older homes are more likely to have issues with leaking; damp environments encourage mold growth and are associated with an increased incidence of current asthma [27, 28•].

Smoking

Not only is tobacco smoking prevalence higher amongst rural inhabitants, but rural smokers are more likely to smoke 15 or more cigarettes daily [29]. Rural children are more likely to live in a home with a smoker (35 vs. 24% living in urban homes) and to be exposed to secondhand smoke in cars [30]; this exposure significantly increases ED utilization, and more than doubles the odds of hospitalization for children with asthma [31]. Rural adolescents begin smoking earlier than their urban peers and are more likely to smoke daily [30]. These adolescents are also more likely to be targeted by tobacco marketing and less likely to be exposed to anti-smoking messaging [30, 32].

Macro-Environmental Exposures

Outside air quality in rural areas is, in general, better than in urban areas, and children may experience less exposure to pollutants associated with worse asthma outcomes (such as diesel exhaust). Nevertheless, there are specific macro-environmental factors that both positively and negatively impact asthma outcomes for rural-dwelling children and adolescents.

Small Farms

With the rise of agribusiness and decline in family farming, the perception that rural children live on farms is increasingly erroneous. Farm and ranching families make up only 2% of the US population [33], and this number will likely continue to decline as the average age of the farmer (58 years in 2012) continues to climb [34]. Even so, numerous studies have demonstrated a protective benefit of small farm living on the development of asthma by rural children and adolescents [35]. Explanations for this include exposure to dust and environmental microbial agents [36–38] and increased diversity in the nasal microbiota [39]. As the variables associated with small farm living are highly correlated, it is difficult to disentangle individual variable effects. It is likely that there is an interactive, complex effect between specific genes and the environment resulting in a decreased risk of developing asthma or a protective effect on sensitization and subsequent wheeze [40]. For example, exposure to a farm environment in early childhood influences methylation patterns in asthma and IgE-related genes in peripheral blood cells [41]. Research focusing on specific environmental exposures, rather than simply farm residential status, is increasing understanding on the asthma-protective factors associated with farm living. These include living on a grain farm [42], riding horses [42], exposure to animal pens and sheds [42, 43], and consumption of unprocessed cow's milk containing higher levels of ω−3 polyunsaturated fatty acids [44, 45].

Large-Scale Farms

However, living on or near large farms does not have the same protective benefit. Children and adolescents living in rural areas are exposed to the environmental effects of a variety of commercial animal feeding operations (CAFOs) and the associated large-scale animal waste [46]. CAFOs tend to be concentrated in regional "hotspots," leading to unique community impacts depending on the type of facility. For example, swine CAFOs are concentrated in the central USA, cattle in the central to western USA, and chicken in the southeast. Close proximity to swine CAFOs increases exposure to airborne by-products of industrial hog farming, including noxious gases such as ammonia and hydrogen sulfide [47]; those with asthma are more likely to have decrements in peak flow FEV_1 in post-exposure days [48].

Barriers to Appropriate Asthma Care in Rural Areas

Barriers to accessing appropriate asthma care affects outcomes and is a key contributor to disparities suffered by certain populations. For rural children and adolescents, unique barriers include insurance status, unavailability of primary care providers and pulmonary specialists, knowledge deficits (both patient and provider), and lack of culturally tailored asthma interventions.

Insurance

While the uninsurance rate has declined significantly across all population groups since the implementation of the Affordable Care Act (ACA), rural residents are still more likely to be uninsured than urban residents (14.4 vs. 10.9% in 2015) [49] and have more limited choices of insurance providers when compared to those living in metropolitan areas [50]. Rural residents are more likely to be covered by Medicaid, a state-administered health insurance program for low-income children, pregnant women, families, and those with disabilities. They are also more likely to fall into a "coverage gap" in which their family's income is too high to qualify for Medicaid, but too low to qualify for ACA marketplace subsidies, especially if they live in states that opted out of Medicaid expansion [51].

Accessibility

Primary care physicians are less likely to practice in rural areas, with an average of 68 per 100,000 rural residents as compared to 84 per 100,000 urban residents [52]. Rural patients also have less access to specialty care. For example, children with asthma residing in Georgia frequently travel over 15 mi for primary care and between 30 and 50 mi to see a specialist [53]. Access barriers, coupled with the costs and risks associated with travel, are associated with increased ED usage and hospitalizations and more frequent exacerbations.

Knowledge Deficits

Asthma knowledge deficits on the part of children and their families are commonly seen in both urban and rural populations and lead to sub-optimal management and poorer outcomes. However, rural healthcare providers may be less aware of current National Heart, Lung, and Blood Institute (NHLBI) pediatric asthma management guidelines which can contribute to these poorer outcomes. Rural children with persistent or uncontrolled asthma are more likely to overuse rescue medications [54••], underuse inhaled corticosteroids [6••], or receive a prescription for leukotriene receptor antagonist monotherapy (i.e., Singulair®), all non-preferred treatment regimens leading to increases in ED visits for asthma exacerbations [55•]. Spirometry performed in primary care clinics rarely meets American Thoracic Society/European Respiratory Society quality criteria [56]. As rural patients are significantly more likely to be managed by primary care providers, they are at greater risk for misdiagnosis.

Cultural

Rural ethnic/racial minority children suffer poorer asthma-related quality of life than their non-Hispanic white peers [57], in part due to lower health literacy [58]. Research that considers local contexts of environmental exposures and the adaptation of asthma educational materials and programs for specific rural populations (e.g., First Nations and Inuit people, African Americans, Hispanics, migrant farmworkers) have the potential to improve uptake of knowledge and appropriate asthma practices, such as reducing indoor asthma triggers in migrant farmworker housing [59–62].

Target Interventions with Improved Asthma Outcomes

Multi-Component Interventions

While individual interventions such as educational interventions have been promising, those that include multi-components demonstrate more robust results. For example, a program targeting 20 rural western North Carolina counties and the Eastern Band Cherokee Indian Reservation included individual- and community-level asthma education and environmental assessments. After 2 years, program participants demonstrated improvements in lung function and a significant decrease in emergency department visits (158 to 4), hospitalizations (62 to 1), and average school day absences (17 to 8.8 days)

[63••]. Similar multi-component programs have also demonstrated increases in controller medicine and reduction in self-reported asthma symptoms, at low cost [64].

Provider Education

Interventions to improve patient asthma outcomes by increasing healthcare provider knowledge base are promising. As rural providers have similar access barriers as their patients, interventions designed with transportation and costs in mind have demonstrated increased acceptability and success. Targeted to clinicians working on primary care teams and school nurses, successful programs have focused on improving the ability to provide appropriate asthma education, including assessment of asthma control and inhaler technique, asthma action plan development, provision of appropriate controller medication prescriptions, and follow-up appointments [65, 66].

School-Based Interventions

School-based programs and/or the incorporation of nursing services in the management of asthma is increasingly part of interventions for rural adolescent and children [67]. These include asthma education delivered via in-school asthma classes or asthma day camps [68]. Interventions focusing on self-management behaviors beyond simple medication compliance have the most potential for improving asthma outcomes in rural children [69].

Telemedicine

Interventions addressing access to asthma specialists by rural children and adolescents have also demonstrated promise in improving asthma outcomes. In particular, management via telemedicine has shown equivalent or improved asthma outcomes for rural children and adolescents as compared to in-person specialty visits, with high patient acceptability [70•].

Conclusion

Pediatric asthma is a costly chronic disease, with recent estimates placing direct and indirect costs at over $3000 per patient annually [71] and over $56 billion total in the USA [72]. Medications and hospitalizations are the most significant direct cost drivers; work and school days missed due to asthma exacerbations account for the majority of indirect costs [73]. Asthma is the most common cause of school days missed—10.5 million days/year—with almost 60% of children with one asthma exacerbation annually missing at least 1 day of school [74].

Decreasing these personal and societal costs requires evidence-based interventions and strategies, but solutions cannot be one-size-fits-all. While environmental and socio-economic issues associated with asthma are not necessarily location-dependent, there are specific factors more commonly encountered when caring for rural children and adolescents with asthma. These include micro- and macro-environmental exposures that can be challenging to address, especially in light of the limited resources and access barriers commonly experienced by rural children and their families. However, rural communities are not homogeneous. Each rural area may have a unique mix of challenges and strengths that should be accounted for when exploring ways to improve the state of asthma for their youngest community members. Researcher and provider engagement with local community members in assessing community needs and experiences may facilitate the identification of specific local environmental, socio-economic, and host factors associated with pediatric asthma. Interventions using existing services (such as school-based nursing services) and technology (such as tele-medicine) are proving to be beneficial, cost-effective, and sustainable. The scalability of these promising, tailored strategies will require careful consideration of how healthcare policies and legislation can facilitate rural pediatric asthma management and mitigate asthma outcome disparities and costs.

Obesity

Prevalence of generalized & abdominal obesity in urban & rural India- the ICMR - INDIAB Study (Phase-I) [ICMR - INDIAB-3]

Abstract

Background & objectives:

Overweight and obesity are rapidly increasing in countries like India. This study was aimed at determining the prevalence of generalized, abdominal and combined obesity in urban and rural India.

Methods:

Phase I of the ICMR-INDIAB study was conducted in a representative population of three States [Tamil Nadu (TN), Maharashtra (MH) and Jharkhand (JH)] and one Union Territory (UT)[Chandigarh (CH)] of India. A stratified multi-stage sampling design was adopted and individuals ≥20 yr of age were included. WHO Asia Pacific guidelines were used to define overweight [body mass index (BMI) ≥23 kg/m^2 but <25 kg/m^2), generalized obesity (GO, BMI≥25kg/m^2), abdominal obesity (AO, waist circumference ≥90 cm for men and ≥80cm for women) and combined obesity (CO, GO plus AO). Of the 14,277 participants, 13,800 subjects (response rate, 96.7%) were included for the analysis (urban: n=4,063; rural: n=9737).

Results:

The prevalence of GO was 24.6, 16.6, 11.8 and 31.3 per cent among residents of TN, MH, JH and CH, while the prevalence of AO was 26.6, 18.7, 16.9 and 36.1 per cent, respectively. CO was present in 19.3, 13.0, 9.8 and 26.6 per cent of the

TN, MH, JH and CH population. The prevalence of GO, AO and CO were significantly higher among urban residents compared to rural residents in all the four regions studied. The prevalence of overweight was 15.2, 11.3, 7.8 and 15.9 per cent among residents of TN, MH, JH and CH, respectively. Multiple logistic regression analysis showed that female gender, hypertension, diabetes, higher socio-economic status, physical inactivity and urban residence were significantly associated with GO, AO and CO in all the four regions studied. Age was significantly associated with AO and CO, but not with GO.

Interpretation & conclusions:

Prevalence of AO as well as of GO were high in India. Extrapolated to the whole country, 135, 153 and 107 million individuals will have GO, AO and CO, respectively. However, these figures have been estimated from three States and one UT of India and the results may be viewed in this light.

Keywords: Abdominal obesity, combined obesity, generalized obesity, INDIAB, India

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According to the World Health Organization (WHO), obesity is one of the most common, yet among the most neglected, public health problems in both developed and developing countries[1]. According to the WHO World Health Statistics Report 2012, globally one in six adults is obese and nearly 2.8 million individuals die each year due to overweight or obesity[2]. Due to the increased risk of morbidity and mortality, obesity is now being recognized as a disease in its own right. Additionally, obesity is strongly associated with other metabolic disorders including diabetes, hypertension, dyslipidaemia, cardiovascular disease and even some cancers. The risk for these disorders appears to start[3] from a body mass index (BMI) of about 21 kg/m^2. Obesity is generally classified as generalized obesity (GO) and abdominal obesity (AO). Individuals with obesity have higher rates of mortality and morbidity compared to non obese individuals[4,5].

India, with 1.2 billion people is the second most populous country in the world and is currently experiencing rapid epidemiological transition. Undernutrition due to poverty which dominated in the past, is being rapidly replaced by obesity associated with affluence[6]. Industrialization and urbanization also contribute to increased prevalence of obesity. Studies from different parts of India have provided evidence of the rising prevalence of obesity[6,7,8,9]. However, most reports have been region specific (mostly from urban areas). Further, different studies have used different methodologies, definitions and cut-off points for defining obesity, making comparisons difficult. To date, there has been no nationally representative study on the prevalence of obesity in India. Here we present the prevalence of generalized and abdominal obesity in urban and rural India based on phase I of the Indian Council of Medical Research - India Diabetes (ICMR-INDIAB) Study, in which representative samples were obtained from three States and one Union Territory (UT) in different regions of India covering a population of 213 million.

Material & Methods

The ICMR-INDIAB study is an ongoing cross-sectional national study on the prevalence of diabetes and related disorders such as obesity and hypertension. Funded by the ICMR and the Department of Health Research (DHR), Government of India, the study plans to sample all the 28 States (now 29 States after the State of Andhra Pradesh was divided into Telangana and Andhra Pradesh) in India, 2 UTs namely Chandigarh and Puducherry and the National Capital Territory (NCT) of Delhi. The detailed methodology of the study has been published separately[10]. Briefly, this is a door-to-door survey of individuals aged 20 yr and above. Due to the complex logistics involved, the study is being done in phases. Phase I of the ICMR-INDIAB study was conducted from November 2008 to April 2010, in three States randomly selected to represent the south (Tamil Nadu-TN; population- 67.4 million), west (Maharashtra-MH; population- 112.7 million) and east (Jharkhand-JH; population- 31.5 million) of India and one UT representing northern India (Chandigarh-CH; population-1.4 million).

The sample size was calculated separately for urban and rural areas, as previous studies showed large variations in urban and rural prevalence of type 2 diabetes mellitus (approximately 10 and 4%, respectively). Using a precision of 20 per cent and allowing for a non response rate of 20 per cent, the sample size was calculated to be 2800 individuals in rural areas and 1200 individuals in urban areas, with a total sample size of 4000 individuals per State. Thus the sample size for the entire study once completed will be 1,24,000 individuals (28 States including 2 UTs and 1 NCT). Thus, 16,000 individuals from the States of Tamil Nadu, Maharashtra and Jharkhand, and the Union Territory of Chandigarh

(Phase I of the ICMR-INDIAB study) were included in this study to determine the prevalence of obesity.

Sampling strategy: A stratified multi-stage sampling design was adopted. The primary sampling units (PSUs) were villages in rural areas and census enumeration blocks (CEBs) in urban areas. Three-level stratification was done in both urban and rural areas, based on geography, population size and socio-economic status in order to obtain a representative sample of the region being studied. The estimation of the sampling error of the prevalence took into account both the multi-stage nature of the sampling design, and standardization to the age-sex composition of the 2001 Census population. A two-stage design was used in rural areas, while a three-stage design was adopted in urban areas. Ultimate stage units were households in both areas. In rural areas, the first stage of sampling involved selection of PSUs (villages) using the probability proportional to population size (PPS). In the second stage, households (n=56) were selected by systematic sampling with a random start. In urban areas, due to the large population involved, a three-stage design was used. The first stage involved selection of wards by PPS method. In the next stage, one CEB was randomly selected from each ward (the CEBs were of approximately the same size), and in the final stage, households (n=24) were selected from the CEBs by systemic sampling. In both rural and urban areas, only one individual was selected within each household using the World Health Organization (WHO) Kish method11.

For Phase I, a total of 16,607 individuals (5,112 urban and 11,495 rural) were selected from 363 PSUs (188 urban and 175 rural) of whom 14,277 individuals responded (response rate, 86%). For the present study, 13,800 of the 14,277 subjects who participated in Phase I, for whom information on anthropometric measurements such as weight, height and waist was available, were included in the analysis (urban: n=4,063; rural=9,737). The study was approved by the Institutional Ethics Committee of the Madras Diabetes Research Foundation, Chennai, Tamil Nadu, India, and written informed consent was obtained from all the participants.

In all study participants, a structured questionnaire was administered by trained field investigators to obtain data on socio-demographic parameters and behavioural aspects. Anthropometric parameters were measured using standardized techniques[12]. Height (in centimeters) was measured using a stadiometer (SECA Model 214, Seca Gmbh Co, Hamburg, Germany). The individual was asked to stand upright without shoes with his/her back against the vertical back board, heels together and eyes directed forward. Weight (in kilograms) was measured with an electronic weighing scale (SECA Model 807, Seca Gmbh Co, Hamburg, Germany) that was kept on a firm horizontal flat surface. Subjects were asked to wear light clothing, and weight was recorded to the nearest 0.5 kg. Body mass index (BMI) was calculated using the formula weight (kg)/height (m)^2.

Waist circumference (in centimeters) was measured using a non-stretchable measuring tape. Waist circumference was measured at the smallest horizontal girth between the costal margins and the iliac crest at the end of expiration.

Blood pressure was recorded in the sitting position in the right arm to the nearest 1 mmHg using the electronic OMRON machine (Omron Corporation, Tokyo, Japan). Two readings were taken five minutes apart and their mean was taken as the blood pressure.

Fasting capillary blood glucose (CBG) was determined using a One Touch Ultra glucose meter (Johnson & Johnson, Milpitas, CA, USA). Oral glucose (82.5 g, equivalent to 75 g of anhydrous glucose) was given and a 2 h post load CBG was collected. In individuals with self reported diabetes, only fasting CBG was measured.

Definitions

Overweight was defined as a BMI ≥23 kg/m^2 but <25 kg/m^2 for both genders (based on the World Health Organization Asia Pacific Guidelines) with or without abdominal obesity (AO)12.

Generalized obesity (GO) was defined as a BMI ≥ 25 kg/m^2 for both genders (based on the World Health Organization Asia Pacific Guidelines) with or without abdominal obesity (AO)12.

Abdominal obesity (AO) was defined as a waist circumference (WC) ≥ 90 cm for men and ≥ 80 cm for women with or without GO13.

Isolated generalized obesity (IGO) was defined as a BMI ≥ 25 kg/m^2 with waist circumference of < 90 cm in men and < 80 cm in women.

Isolated abdominal obesity (IAO) was defined as a waist circumference of ≥ 90 cm in men or ≥ 80 cm in women with a BMI < 25 kg/m^2.

Combined obesity (CO): Individuals with both GO and AO.

Non obese subjects: Individuals without either GO or AO

Diabetes was defined by a physician diagnosis of diabetes and current use of medications for diabetes (insulin or oral hypoglycaemic agents) and/or fulfillment of criteria laid down by the WHO Consultation Group Report, *i.e*. a fasting CBG ≥7 mmol/l and/or a 2 h post glucose CBG value ≥12.2 mmol/l[14].

Hypertension was diagnosed in subjects who were on antihypertensive medications or had a systolic BP ≥140 mmHg and/or a diastolic BP ≥90 mmHg[15].

Statistical analysis: Statistical analyses were performed using SAS statistical package (version 9.0; SAS Institute, Inc., Cary, NC, USA). One-way ANOVA or Student's *t* test were used to compare groups for continuous variables and chi-square test was used to compare proportions between two groups. Multiple logistic regression analysis was used to examine the association between various exposures and outcomes. For projections, Government of India population projections for 2011 for the respective States/UT were used[16]. For national estimates, the prevalence of three States was used (The UT was excluded as it is highly urbanized and may enormously inflate projections).

Results

Table I shows the clinical and biochemical characteristics of the study subjects. In all the four regions, urban residents had significantly higher weight, BMI, waist circumference, diastolic BP and fasting and 2 h post glucose CBG compared to rural participants. Overall, in both urban and rural areas, women had higher mean BMI values than men (Urban: women: 23.6 vs. men: 22.7 kg/m^2, *P*<0.001; Rural: women: 21.2 vs. men: 20.9, kg/m^2, *P*<0.001), but mean waist circumference values were higher in men than in women (Urban: women: 77.4 vs. men: 83.6 cm, *P*<0.001; Rural: women: 71.7 vs. men: 78.1 cm, *P*<0.001). Of the overall study population, 15.4 per cent smoked (males: 28.7 vs. females: 1.9%, *P*<0.001), while the alcohol consumption was 19.8 per cent (males: 36.3 vs. females: 3.1%, *P*<0.001).

Table I.

Clinical and biochemical characteristics of rural and urban study subjects in the four regions.

Variables	Chandigarh		Jharkhand		Maharashtra		Tamil Nadu	
	Urban (n=880)	Rural (n=2336)	Urban (n=921)	Rural (n=2286)	Urban (n=1215)	Rural (n=2594)	Urban (n=1047)	Rural (n=2521)
Age (yr)	39 ± 13	35 ± 12*	40 ± 14	40 ± 14	40 ± 14	42 ± 15*	41 ± 14	43 ±15**
Male n (%)	430 (48.9)	1214 (52.0)	471 (51.1)	1164 (50.9)	617 (50.8)	1301 (50.2)	512 (48.9)	1235 (49.0)
Height (cm)	159 ± 10	159 ± 9**	157 ± 9	155 ± 9**	158 ± 10	157 ± 9*	157 ± 9	157 ± 9
Weight (kg)	62 ± 13	58 ± 12**	56 ± 13	47 ± 9**	55 ± 12	51 ± 11**	59 ± 13	54 ± 11**
BMI (kg/m²)	24.4 ± 4.7	22.8 ± 4.5**	22.7 ± 4.6	19.2 ± 3.0**	22.2 ± 4.4	20.5 ± 3.8**	23.6 ± 4.6	21.7 ± 3.9**
Waist (cm)	83.9 ± 12.3	79.7 ± 12.5**	80.8 ± 13.6	71.3 ± 9.5**	77.3 ± 12.4	72.7 ± 12**	80.9 ± 12.2	76.2 ± 11.4**
SBP (mmHg)	130 ± 18	124 ± 16**	130 ± 19	127 ± 19**	128 ± 19	127 ± 18	130 ± 19	128 ± 19*
DBP (mmHg)	80 ± 11	77 ± 11**	78 ± 11	76 ± 11**	80 ± 12	78 ± 11**	81 ± 11	78 ± 11**
FBS (mmol/l)	5.9 ± 2.2	5.7 ± 1.9*	5.7 ± 2.3	5.1 ± 1.0**	5.7 ± 1.8	5.4 ± 1.5**	5.7 ± 2.0	5.3 ± 1.6**
2h PGBS (mmol/l)	7.1 ± 2.7	6.8 ± 2.2*	6.8 ± 2.3	6.3 ± 1.4**	6.9 ± 2.3	6.3 ± 1.9**	6.7 ± 2.5	6.3 ± 2.2**
Smoking % (SE)	13.6 (1.15)	17.7 (0.79)**	14.5 (1.16)	13.7 (0.72)	11.1 (0.90)	10.5 (0.60)	20.1 (1.23)	21 (0.81)
Alcohol % (SE)	16.4 (1.25)	17 (0.78)	18.1 (1.27)	33.6 (0.99)**	13.3 (0.97)	11.8 (0.63)	21.4 (1.27)	22.2 (0.83)
Diabetes % (SE)	14.2 (1.22)	8.4 (0.59)**	13.2 (1.18)	3.1 (0.39)**	10.4 (0.93)	6.3 (0.49)**	10.4 (0.93)	8 (0.55)**

BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; FBS, fasting blood sugar; 2h PGBS, 2 hour post glucose blood sugar; SE, standard error; P^{*}<0.05, **<0.001 compared with urban subjects

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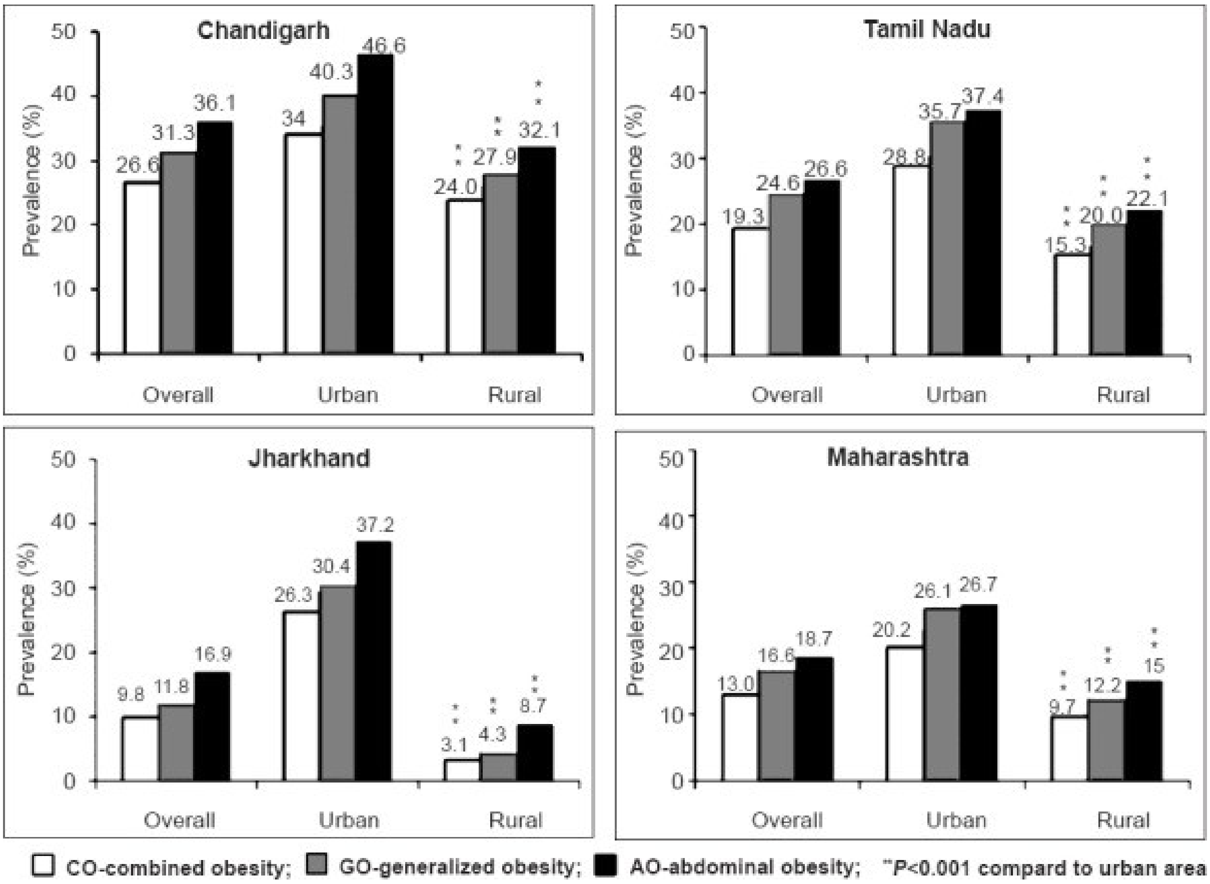
Fig. 1 presents the prevalence of GO, AO and CO in all the four regions studied. In all four regions studied, urban residents had a significantly higher prevalence of GO, AO and CO compared with the respective rural population (*P*<0.001). The overall prevalence of GO was 24.6, 16.6, 11.8 and 31.3 per cent among residents of TN, MH, JH and CH, while the corresponding prevalence of AO was 26.6, 18.7, 16.9 and 36.1 per cent. The highest prevalence of CO was observed in CH (26.6%) followed by TN (19.3%), MH (13.0%) and JH (9.8%).

Fig. 1.



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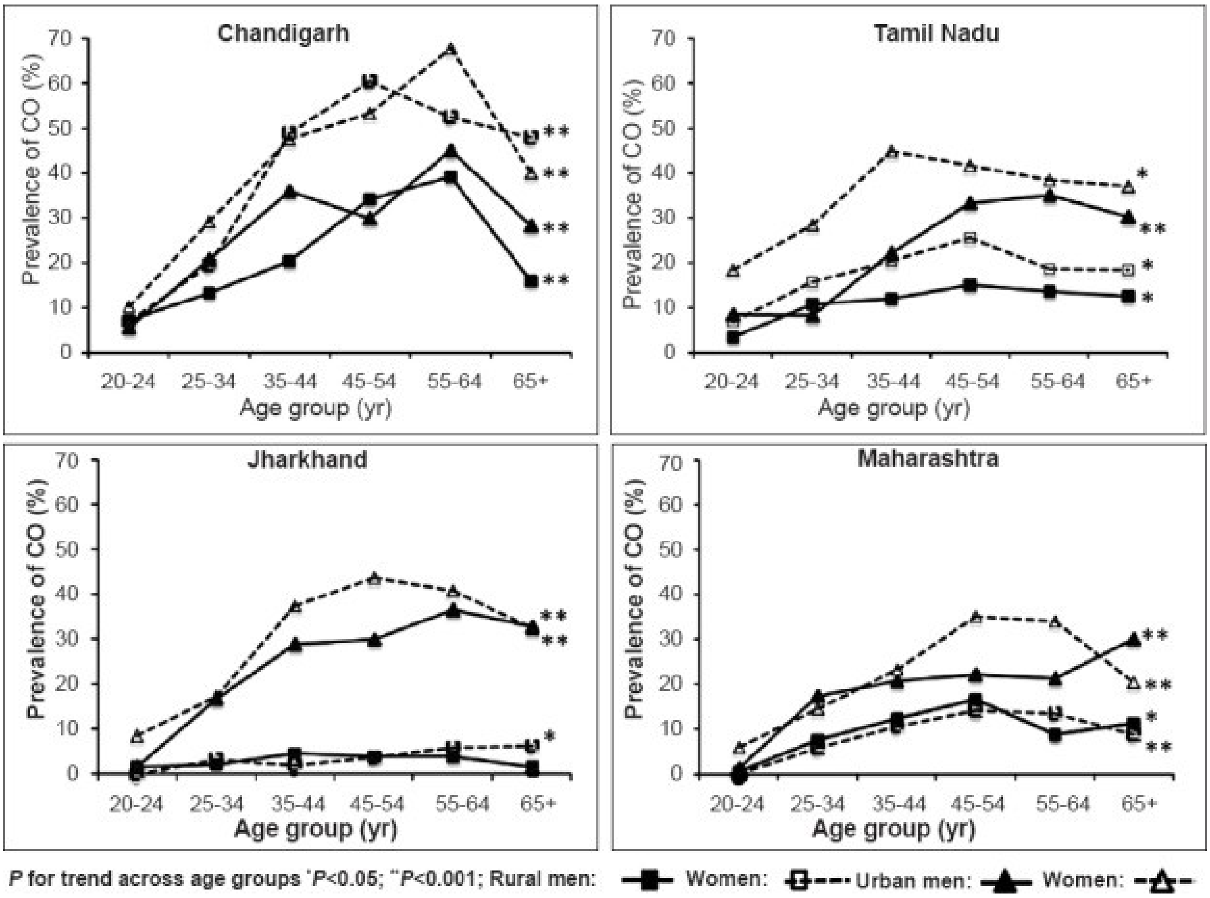
Prevalence of generalized, abdominal and combined obesity in the four regions studied.

Age and gender-specific prevalence of combined obesity in the study population is shown in [Fig. 2](#). Except in Tamil Nadu (in the 25-34 yr group) and in Chandigarh (in the 45-54 yr group), at every age interval, the prevalence of CO was higher in urban compared to the rural areas. Higher prevalence of CO was observed among women in Chandigarh and Tamil Nadu. Similar results were also obtained for GO and AO (data not shown). The overall prevalence of GO was highest in Chandigarh (women: 38.7 vs. men:24.2%, $P<0.001$), followed by Tamil Nadu (women: 28.4 vs. men: 20.6%, $P<0.001$), Maharashtra (women:

17.6 vs. men: 15.7%, *P*=0.112) and Jharkhand (women: 12.1 vs. men: 11.5%, *P*=0.606), respectively. The prevalence of AO was highest in Chandigarh (women: 44.5 vs. men: 28.0%, *P*<0.001), followed by Tamil Nadu (women: 32.3 vs. men: 20.5%, *P*<0.001), Jharkhand (women: 19.1 vs. men: 14.7%, *P*=P=0.001) and Maharashtra (women: 18.8 vs. men: 18.7%, *P*=0.965).

Fig. 2.



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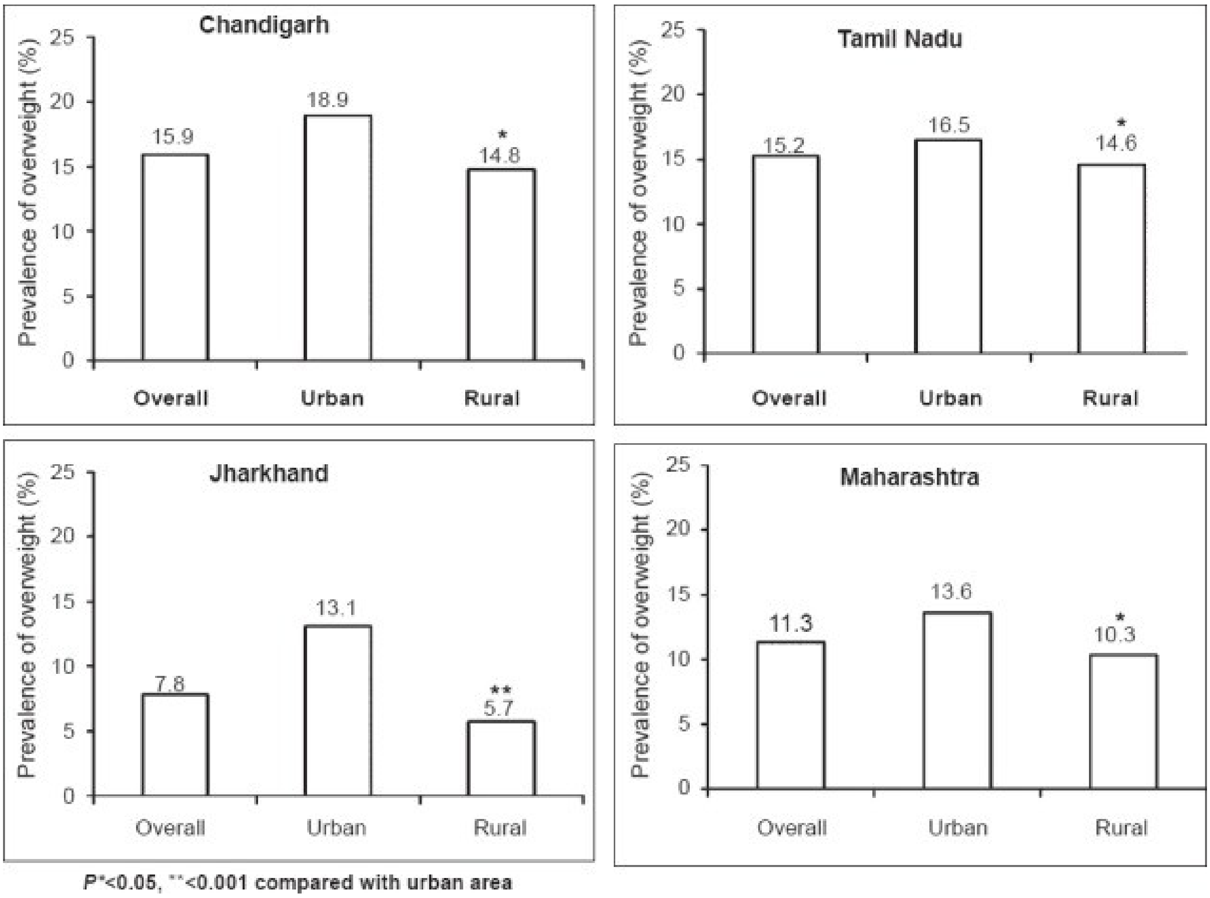
Age- and gender-specific prevalence of combined obesity in the study population.

The prevalence of IGO was significantly higher among urban residents as compared to rural residents in CH (6.4 vs. 4.1%, $P<0.001$), TN (6.9 vs. 4.7%, $P<0.05$), JH (4.1 vs. 1.2%, $P<0.001$) and MH (5.9 vs. 2.5%, $P<0.001$). The prevalence of IAO was also significantly higher among urban residents of CH, TN, JH and MH compared to rural residents [12.6 vs. 8.3% ($P<0.001$); 8.6 vs. 6.7% ($P<0.05$); 11.0 vs. 5.6% ($P<0.001$); and 6.6 vs. 5.3% ($P<0.001$), respectively].

Overall prevalence of overweight was significantly higher among urban residents of CH, TN, JH and MH compared to rural residents [urban vs. rural: 18.9 vs. 14.8% ($P<0.05$); 16.5 vs. 14.6% ($P<0.05$); 12.4 vs. 5.7% ($P<0.001$); and 13.6 vs. 10.3% ($P<0.05$), respectively] (Fig. 3).

Fig. 3.



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Prevalence of overweight in the four regions studied.

These figures, if projected to the whole country, would translate to 88 million individuals who are overweight, 135 million individuals with GO, 153 million individuals with AO and 107 million individuals with CO in India. However, these figures have been estimated from three regions and the results may be viewed in this light.

Table II describes various risk factors associated with obesity stratified by types of obesity in the study population. It was observed that obesity increased significantly with income, the proportion with GO being 11.4, 18.8 and 34.2 per cent; AO being 15.5, 20.7 and 38.7 per cent; and CO being 9.0, 14.7 and 28.6 per cent for the 1st, 2nd and 3rd income tertiles, respectively. An increasing trend in all three types of obesity was observed with increasing education status (*P*<0.001). Obesity was significantly higher among inactive subjects compared to active subjects and among those who consumed more wheat/rice compared to millets. An increasing trend in all three types of obesity was observed with glucose intolerance (*P*<0.001). The prevalence of obesity was also significantly higher in individuals with hypertension compared to those without.

Table II.

Association of the types of obesity with various factors in the study population.

Risk factors	Total n	Generalized obesity (GO)	Abdominal obesity (AO)	Combined obesity (CO)
Income n (%, SE)[a]				
1st tertile	3909	444 (11.4, 0.51)	604 (15.5, 0.58)	353 (9.0, 0.46)
2nd tertile	4764	894 (18.8, 0.57)	986 (20.7, 0.59)	702 (14.7, 0.51)
3rd tertile	3961	1354 (34.2, 0.75)##	1532 (38.7, 0.77)##	1131 (28.6, 0.72)##
Occupation n (%, SE)				
Professional/Executive/ Big business/Clerical/Medium business	903	326 (36.1, 1.6)	355 (39.3, 1.61)	257 (28.5, 1.5)
Sales/Services/Skilled manual	2720	645 (23.7, 0.82)	732 (26.9, 0.85)	515 (18.9, 0.75)
Agriculture/Self-employed	2130	328 (4.1, 0.43)	413 (13.2, 0.73)	252 (8.1, 0.6)
Household & domestic work	243	58 (23.9, 2.74)	64 (26.3, 2.82)	49 (20.2, 2.5)
Unskilled manual	1347	141 (10.5, 0.84)	161 (12.0, 0.89)	107 (7.9, 0.73)
Do not work/Unemployed	5440	1397 (25.7, 0.59)	1637 (30.1, 0.62)	1171 (21.5, 0.56)##
Education n (%, SE)				
No formal schooling	4372	582 (13.3, 0.51)	768 (17.6, 0.58)	486 (11.1, 0.48)
School education	8308	1924 (23.2, 0.46)	2171 (26.1, 0.48)	1549 (18.6, 0.43)
Technical/College education	1109	389 (35.1, 1.43)##	422 (38.1, 1.46)##	316 (28.5, 1.36)##
Physical activity n (%, SE)				
Active	9330	1703 (18.3, 0.4)	1982 (21.2, 0.42)	1359 (14.6, 0.37)
Inactive	4420	1189 (26.9, 0.67)**	1373 (31.1, 0.7)**	990 (22.4, 0.63)**
Main staple food n (%, SE)				
Millets	1265	164 (13.0, 0.95)	196 (15.5, 1.01)	125 (9.9, 0.84)
Milled wheat/White rice	12518	2732 (21.8, 0.37)**	3166 (25.3, 0.39)**	2227 (17.8, 0.34)**
Fruits & vegetables (mean servings/day)	13800	2.97	2.97	2.3
Glucose intolerance n (%, SE)[$]				
Normal glucose tolerance	10289	1741 (16.9, 0.37)	1980 (19.2, 0.39)	1341 (13.0, 0.33)
Prediabetes	1376	452 (32.8, 1.27)	541 (39.3, 1.31)	392 (28.5, 1.22)
Diabetes	1065	517 (48.5, 1.53)##	617 (57.9, 1.51)##	475 (44.6, 1.52)##
Hypertension n (%, SE)				
No	7777	1094 (14.1, 0.39)	1266 (16.3, 0.41)	839 (10.8, 0.35)
Yes	5977	1793 (30.0, 0.59)**	2084 (34.9, 0.62)**	1508 (25.2, 0.56)**

**P<0.001; ##P for trend <0.001; [a]data available for income in 12634/13800 subjects:1st tertile – < ₹ 2000, 2nd tertile – ₹ 2000-3999, 3rd tertile – ≥ ₹ 4000/month; [$]diabetes screening done in 12,730/13,800 subjects

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Table III shows multiple logistic regression analysis using GO, AO and CO as the dependent variables and various risk factors as independent variables. Female gender, hypertension, diabetes, higher SES, physical inactivity and urban residence were significantly associated with generalized, abdominal and combined obesity in all four regions studied. Age was significantly associated with AO and CO, but not with GO.

Table III.

Multiple regression of type of obesity with various factors (For pooled data)

Variables	Generalized obesity (GO) OR (95%CI) *P* value	Abdominal obesity (AO) OR (95%CI) *P* value	Combined obesity (CO) OR (95%CI) *P* value
Age (yr)	1.00 (0.99-1.01) 0.346	1.02 (1.02-1.02) <0.001	1.01 (1.00-1.01) <0.001
Gender (female)	1.77 (1.61-1.94) <0.001	1.93 (1.77-2.12) <0.001	1.88 (1.70-2.08) <0.001
Hypertension (yes)	2.47 (2.24-2.73) <0.001	2.30 (2.09-2.53) <0.001	2.49 (2.24-2.78) <0.001
Diabetes (yes)	2.63 (2.27-3.03) <0.001	2.95 (2.55-3.41) <0.001	2.84 (2.45-3.29) <0.001
Socio-economic status (high)	3.00 (2.64-3.42) <0.001	2.83 (2.51-3.20) <0.001	3.19 (2.76-3.68) <0.001
Physical inactivity (yes)	1.20 (1.06-1.28) <0.001	1.15 (1.04-1.26) <0.005	1.19 (1.07-1.32) <0.001
Urban residence (yes)	4.64 (4.08-5.27) <0.001	4.21 (3.73-4.74) <0.001	4.71 (4.09-5.42) <0.001
Region (State/UT) Jharkhand (Reference)			
Maharashtra	1.32 (1.13-1.54) <0.001	0.94 (0.81-1.08) 0.362	1.20 (1.02-1.42) 0.033
Tamil Nadu	2.19 (1.89-2.54) <0.001	1.49 (1.30-1.71) <0.001	1.90 (1.62-2.23) <0.001
Chandigarh	2.76 (2.37-3.21) <0.001	2.42 (2.11-2.79) <0.001	2.70 (2.30-3.18) <0.001

Included all variables with $P<0.20$ in univariate analysis

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Discussion

The ICMR-INDIAB study is the first study from India to estimate the prevalence of obesity (generalized and abdominal) among urban and rural residents of States of India. This study showed the following results: the highest prevalence of both types of obesity (GO and AO) was found in Chandigarh followed by Tamil Nadu, Maharashtra and Jharkhand. This is not surprising as Chandigarh has the highest per capita income among all the four regions studied and is highly urbanized, consisting primarily of the city of Chandigarh and a few peri-urban clusters.

The prevalence of GO, AO and CO were significantly higher among urban residents compared to rural residents in all the four regions studied. The National Family Health Survey-3 (NFHS-3) also reported that in India, obesity (BMI ≥ 25 kg/m^2) was more prevalent in the urban areas and in higher socio-economic groups compared to the rural areas, especially among women (Men- urban: 15.9 vs. rural: 5.6%; Women- urban: 23.5 vs. rural: 7.2%)17. According to the NFHS-3 data, in the three States studied, the percentage of women who were obese (BMI≥ 25 kg/ m^2) was highest in Tamil Nadu (24.4%), followed by Maharashtra (18.1%) and Jharkhand (5.9%) and a similar order was reported among men in the three States with 19.8, 15.9 and 5.3 per cent being obese respectively17. The Jaipur Heart Watch studies (I-IV) performed in India in rural and urban areas reported that generalized and abdominal obesity were significantly higher among the urban compared to rural population18. Another study conducted in adult population of urban Delhi and rural Ballabgarh (Haryana State), revealed that overweight was widely prevalent in the urban population (men: 35.1, women: 47.6%) compared to the rural population (men: 7.7, women: 11.3%)19. In a study conducted amongst middle-aged women in four urban and five rural locations in northern (Haryana), central (Jaipur), western (Pune), eastern (Kolkata), and southern (Kochi, Gandhigram) regions of India, age-adjusted prevalence of obesity in urban vs rural was reported to be 45.6 vs. 22.5 per cent and abdominal obesity to be 44.3 vs. 13.0 per cent, respectively20.

Asian Indians have a greater predisposition to abdominal obesity and accumulation of visceral fat and this has been termed as “Asian Indian phenotype[21,22]. In a study conducted in urban north India (New Delhi), the overall prevalence of generalized obesity was 50.1 per cent, while that of abdominal obesity was 68.9 per cent[7]. The Chennai Urban Rural Epidemiology Study (CURES) conducted in Chennai city in Tamil Nadu reported age standardized prevalence of generalized obesity to be 45.9 per cent, while that of abdominal obesity was 46.6 per cent. Isolated generalized obesity was found in 9.1 per cent while isolated abdominal obesity was reported in 9.7 per cent[8]. The present study also showed a higher prevalence of isolated abdominal obesity than isolated generalized obesity in all four regions studied. The lower prevalence noted in the urban areas of Tamil Nadu in the present study compared to the CURES could be because CURES included only Chennai which is a highly urbanized metropolitan city whereas in INDIAB smaller towns in the State of Tamil Nadu, which are less urbanized were also included.

In countries like India, the rise in obesity prevalence could be attributed to the increasing urbanization, use of mechanized transport, increasing availability of processed and fast foods, increased television viewing, adoption of less physically active lifestyles and consumption of more “energy-dense, nutrient-poor” diets[23,24,25]. This is exemplified by the higher prevalence of both GO and AO in the urban population where the above factors are more common. Among the three States and one UT studied, the difference was striking in Jharkhand with almost three times higher prevalence of obesity in the urban compared to the rural population. In Tamil Nadu, Maharashtra and Chandigarh, the urban prevalence of obesity was nearly twice as that of the rural. This is in contrast to that seen in the developed countries, where the prevalence of obesity is higher in the rural areas compared to the urban areas, which may be attributed to different stages of epidemiological health transitions experienced by different countries[26].

Nearly 70 per cent of India's population resides in rural areas. Even a small increase in prevalence of obesity in rural areas could lead to a huge increase in the number of obese individuals in India. The present study showed a marked increase in BMI values in the rural areas compared to those reported in an earlier study by Ramachandran *et al*[27] in rural south India. The increase in prevalence of obesity among the rural population may be due to rapid changes in lifestyle in rural areas.

It is noteworthy that the alcohol consumption in the rural areas of Jharkhand is almost double that in urban areas (33.6 vs. 18.1%). This is partly because the alcohol consumption was significantly higher in women in rural Jharkhand compared to the other regions. However, the reported alcohol consumption was also higher among men in Jharkhand when compared to the other regions (Rural women: Jharkhand-16.2, Chandigarh- 0.0, Maharashtra-0.4, Tamil Nadu- 0.5%; and in rural men: Jharkhand- 50.4, Chandigarh- 32.8, Maharashtra- 23.2, Tamil Nadu- 44.8%). This may be due to the large tribal population in rural Jharkhand where alcohol intake is more culturally accepted even among women[28]. However, this does not seem to have affected the prevalence of obesity in an adverse manner as the prevalence of GO, AO and CO were lowest in Jharkhand.

Many studies in India have reported higher prevalence of obesity among women[20,22,29,30,31,32]. In a study conducted in four urban and five rural locations in India among women aged 35-70 yr, the age-adjusted prevalence of obesity (BMI ≥ 25 kg/m^2) in urban and rural areas was 45.6 and 22.5 per cent, respectively[20]. The NFHS-3 data which studied urban and rural residents (all women aged 15-49 and all men aged 15-54) in 28 States of India and the National Capital Territory of Delhi during the year 2005-2006, also showed a higher prevalence of overweight (BMI ≥ 25-29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) among females than males in all the States of India[17]. The prevalence of obesity observed in women in the three States included in our study was similar to that observed in NFHS-3, with the highest prevalence in Tamil Nadu (INDIAB: 24.6 vs. NFHS-3: 20.9%), followed by Maharashtra (INDIAB: 16.6 vs. NFHS-3: 14.5%) and Jharkhand (INDIAB: 11.8 vs. NFHS-3: 5.4%). The prevalence of obesity among Indian women has increased from 10.6 per cent (NFHS-2 in 1998-1999) to 12.6 per cent (NFHS-3 in 2005-2006), i.e. an increase by 24.52 per cent in a 7 year period[33].

Our study shows that it has now increased to 24.1 per cent representing a further increase by 91.3 per cent in a 5 year period and, on the whole, an increase by 127.4 per cent over a 12 year period. As obesity, particularly in young women, can have important consequences like infertility and development of polycystic ovary syndrome (PCOS), this is of great significance[34]. Higher prevalence of obesity in young women is also worrisome because it may increase the prevalence of gestational diabetes, type 2 diabetes, hypertension and cardiovascular disease later in the life.

The strengths of this study were that the study sample was truly representative of the regions studied in terms of geography, socio-economic status and population size and the sample size was large (n=13,800). This study was perhaps the first to look at the prevalence of GO, AO and CO by studying four regions of the country. Also, for the first time, data on the prevalence of GO, AO and CO have been obtained in urban as well as rural areas, in these States of the country.

The study also had a few limitations. First, the cross-sectional nature of the design did not allow for cause-effect relationships to be made. A second limitation was that the projections made here for obesity for the country as a whole were based on data in the three States only; these may be regarded as interim and may need to be revised after the entire study is completed.

In summary, our study showed that the prevalence of obesity (generalized and abdominal) was higher in India now compared to earlier studies. The prevalence of abdominal obesity was higher than the generalized obesity and urban residents had a higher prevalence of both forms of obesity than the rural residents. This study is of significance because it shows large increases in prevalence of obesity not only in urban areas but also in rural areas in India. With further urbanization, changing lifestyle and behaviour we may expect further increase in the incidence and prevalence of obesity in India.

Eye Health

Rural Eye Health

India is home to the largest population of blind people in the world. Over 12 million people in India are blind, of which nearly 88% of the blindness was unavoidable. In majority of the cases, the primary causes are found to be cataract and refractive error. Both causes can be easily resolved with timely interventions. Cataract can be treated by a small surgery which has been taking place for at least 200 years and refractive error can be cured with a pair of glasses. Yet millions in India go blind due to lack of awareness and availability of basic infrastructure that can solve these problems. While blindness is not fatal it still is a massive contributor to poverty. Once a person goes blind, he/she becomes most vulnerable to loosing opportunities such as access to livelihood, education, financial independence and eventually respect or recognition with in the society. Therefore, a blind person has to go through these hardships only because they did not receive timely treatment.

The problem is particularly prevalent amongst marginalised communities like tribal, schedule castes, minorities and even higher amongst women in these communities. By some estimates nearly 70% of blind people live in 8 backward states of Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Rajasthan, Bihar, Jharkhand, West Bengal, and Odisha. To tackle this challenge Sightsavers is working in 100 most deprived districts of these states. As a part of its new strategy (2021-2025) which is aligned with the latest amendment to the CSR law, the organization has developed a model called “High Impact District”. Under this initiative the organization shall work systematically in ensuring that the prevalence of blindness in the identified districts called “HI Districts”, falls to less than 0.3% which is at par with the developed nations. The intervention will also contribute to the achievement of many Sustainable Development Goals (SDGs), such as poverty reduction, zero hunger, good health, quality education, gender equality, reduced inequalities, and decent work.

As of now Sightsavers has identified 17 districts in which this initiative shall be initiated, however the aim is to eventually have all 100 districts converted into HI districts. Kalahandi, Odisha & Jhabua, Madhya Pradesh are the two extremely backward districts and have high percentage of tribal population. However, irrespective of whether the literacy levels here in these 2 districts increase or not, whether tribal population have better access to land that they have called home for centuries or not, whether the people of these districts benefit out of the minerals extracted from their land, one thing for sure that will change is the fact that no one will be needlessly blind in 5 years’ time. Sightsavers shall ensure that the prevalence of blindness in these districts and many more such districts will be as low as in the developed cities of Western Europe or America.

Over a period of 5 years, Sightsavers will ensure that all the HI districts have access to affordable and quality eye care services. There are 3 strategic focus areas of HI districts-

Creating community awareness on eye health,

Strengthen eye health systems and

Creating an enabling environment for the various stakeholders to contribute to eye health.

Since all the HI districts are the districts where there have been hardly any eye health services available, there is a huge unmet demand that has built up over decades. To ensure that the prevalence of blindness is brought below 0.3% and a sustainable eye health system is established in these districts in 5 years, Sightsavers will collaborate with various stakeholders such as state governments, district authorities, and eye hospitals. The HI district program is designed to keep in view the principles of universal eye health, which entails the provision of comprehensive eye health services to everyone and the integration of eye health services into the wider health system. The program will ensure that even vulnerable groups like women, senior citizens, people with disabilities, transgenders, tribal or SC communities, and people residing in the most remote locations equitably have access to these services.

As a part of system strengthening, all the stakeholders – Govt departments, hospital partners, and local authorities will be oriented and sensitized to develop a comprehensive plan for the entire district. In every block, Sightsavers will establish vision centres, invest in necessary human resources & training clinical and non-clinical staff, conduct eye camps to provide quality health services to all individuals in each block. A referral system will be established in each district so that every person identified with some potential eye problem can avail of further treatment at private secondary and tertiary facilities or public health units such as PHCs, CHCs, and district hospitals.

Sightsavers strongly believe that only empowerment and ownership of the community can bring sustainable changes. Active participation of Panchayats, local Self-help groups, and community volunteers will create awareness on the importance of eye health and availability of services in the community and bring about a lasting change in the eye health-seeking behaviour of the community. For sustainable high-impact intervention, it is necessary to create an enabling environment for all the stakeholders to contribute. MOUs will be signed at the state level to ensure that policies are developed and implemented in alignment with principles of universal eye health. Finally, Sightsavers will engage in various activities for measuring impact, such as developing a robust MIS, collaborating for evidence generation, setting up a community-based monitoring system, and engaging in structured studies.

Sightsavers is looking for corporate and Institutions who would like to partner with Sightsavers in this High Impact journey.

Polio

Paralytic poliomyelitis in a rural area

Abstract

Background: Paralysis due to poliomyelitis is common in rural areas. The extent of paralysis, type and place of treatment and effect of local treatment on children with poliomyelitis was assessed in a house-to-house survey conducted between 1990 and 1991 in a rural area of north India.

Methods: Trained field workers conducted a house-to-house survey in 9 villages of Haryana with a total population of 22,883. All cases of deformity and muscular weakness suspected to be due to poliomyelitis were examined and details regarding immunization, diagnosis, treatment and follow up were recorded. The late consequences of neglect as well as inappropriate medical advice were also assessed by physical examination and direct questioning of the parents.

Results: Thirty-seven cases of paralytic poliomyelitis were identified indicating a prevalence rate of 1.6 per 1000 population. Of these, 97% were paralysed before they were 2 years old and 60% had a history of intramuscular injections preceding paralysis. Only 14% of them had received either partial or complete immunization. The majority of families preferred to take treatment from traditional healers or in city hospitals but not from primary health centres.

Conclusion: Despite the national immunization programme, paralytic poliomyelitis continues to be a significant problem in the villages surveyed. Primary health centres are an unreliable source of epidemiological data for paralytic poliomyelitis as villagers do not prefer to visit them for treatment of the disease. Injections given for treatment of fevers in rural areas may play a role in precipitating paralytic poliomyelitis. These findings highlight the urgency of a broad-based primary health care approach at primary health centres. Traditional healers and private practitioners should be trained to provide physiotherapy to children with polio and educated about the importance of not giving injections to children with minor fevers.

Abstract

A house to house survey was done from October 1972 to March 1974, covering 528952 individuals of urban population at Lucknow and 50,156 individuals of rural population of Unnao district, to find out the incidence of polio-like paralysis in our population. Among 12874 urban children up to 8 years old 8.2/1000 had polio-like paralysis while 4.6/1000 children of the rural population of 13554 children were affected. The incidence was significantly higher in the urban population. In the preschool age group almost 1 out of every 100 children was affected. A higher number of children were affected during 1968-9 and 1971-2, though it did not reach epidemic proportion. The findings show that paralytic polio is a serious problem in our country where poliomyelitis is endemic: this is contrary to the views generally held so far.