PREVALENCE OF ANEMIA AND MALNUTRITION AND THE SOCIO ECONOMIC FACTORS ASSOCIATED WITH IT AMONG PREGNANT AND LACTATING WOMEN AND THEIR CHILDREN (3-5 years of age) IN THREE MANDALS OF ADILABAD

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Introduction

Anemia is the condition of having a lower-than-normal number of red blood cells or quantity of hemoglobin. Anemia diminishes the capacity of the blood to carry oxygen. Patients with anemia may feel tired, fatigue easily, appear pale, develop palpitations, and become short of breath. Children with chronic anemia are prone to infections and learning problems. The main causes of anemia are bleeding, hemolysis (excessive destruction of red blood cells), underproduction of red blood cells (as in bone marrow diseases), and underproduction of normal hemoglobin (as in sickle cell anemia and in iron deficiency anemia). Women are more likely than men to have anemia because of menstrual blood loss. In children, anemia is most commonly due to insufficient iron in the diet.

The objective of this report is to study the prevalence of anemia and malnutrition and the socio economic factors associated with same among pregnant and lactating mothers and their children of 3-5 years of age.

Anemia during pregnancy is a major public health problem throughout the world, particularly in developing countries. Nutritional anemia was defined as a condition in which the hemoglobin content of the blood is lower than normal as a result of deficiency of one or more essential nutrients. In India anemia is the second most common cause of maternal deaths accounting for 20% of total maternal deaths. It also significantly increases the maternal morbidity, foetal and neonatal mortality and morbidity including premature delivery and low birth weight.

A healthy diet is associated with a successful pregnancy. Malnourished mothers are at increased risk of complications and death during pregnancy and child birth. In addition, their children are prone to having low birth weight, fail to grow at a normal rate and have higher rates of diseases and early death. Various maternal behaviours and experiences before, during and after pregnancy are associated with adverse health outcomes for both the mother and the infant.

Lactating mothers are susceptible to anemia because of maternal iron depletion during lactation as well as blood loss during childbirth. Studies have shown that, although breast milk is not a good source of iron, the quality of breast milk is maintained at the expense of maternal stores. Postpartum anemia is highest in mothers who are anemic during pregnancy. Furthermore, lactating mothers are highly susceptible to iron depletion if the energy and nutrient intake in their diets is inadequate.

Following are the normal hemoglobin levels for different cohorts according to WHO standards:

WHO, 2008

Table. Normal haemoglobin range for different cohorts

Cohort	Normal Hemoglobin Range
New born	**17g/dl to 22g/dl**
1 week of age	**15g/dl to 20 g/dl**
1 month of age	**11g/dl to 15g/dl**
Children	**11g/dl to 13 g/dl**
Adult females	**12g/dl to 18g/dl**
Women after middle age	**11.7g/dl to 13.8g/dl**
Pregnant women	**11 g/dl to 13g/dl**

NUTRI FOOD BASKET

Malnutrition and anemia is a silent emergency and one of the most common causes of morbidity and mortality among children and adolescent throughout the world. To address the high prevalence of anemia and malnutrition amongst the tribal population in Telengana, an affordable 'Nutri-Food Basket" of smart food developed by ICRISAT, especially for children and women was tested on field. This project was commissioned by the Government of Telengana.

The overarching objective of this project is to sensitize and provide the tribal population with affordable and available nutritious food products to supplement their existing diet. Improved dietary diversity and overall nutritional intake is expected to benefit underweight children and improve the haemoglobin levels of the presently anemic population.

Course of Action

The data from the latest National Family Health Survey (2017) shows that the tribal populations in the target districts are highly anemic and survive on a basic staple diet which lacks diversity and hence is not nutritionally balanced. The purpose of NFB is to provide additional energy, protein, fat and micronutrients to the target population through consumption of food products formulated using locally available ingredients. The Nutri-Food basket comprised of:

- Ready-to-cook upma (sorghum semolina, pulses and condiments) mix

- Ready-to-cook kichidi (sorghum and millet semolina, pulses and condiments) mix

- Energy Dense Cookies (sorghum, millet and pulses)

- Energy and Nutri Dense Food (EDNF) – A spread made from groundnuts, chickpeas and sorghum.

These products were developed and validated by the ICRISAT Nutriplus Knowledge (NPK) Program of AIP. They were tested for acceptability among select members of the target population at Anganwadis (mother and childcare centers).

The products provided were ready to eat and ready to cook forms consumed by children (6 months to 5 years), adolescent girls, and pregnant and lactating mothers. The food basket is designed to diversify and supplement the existing diets of the target population.

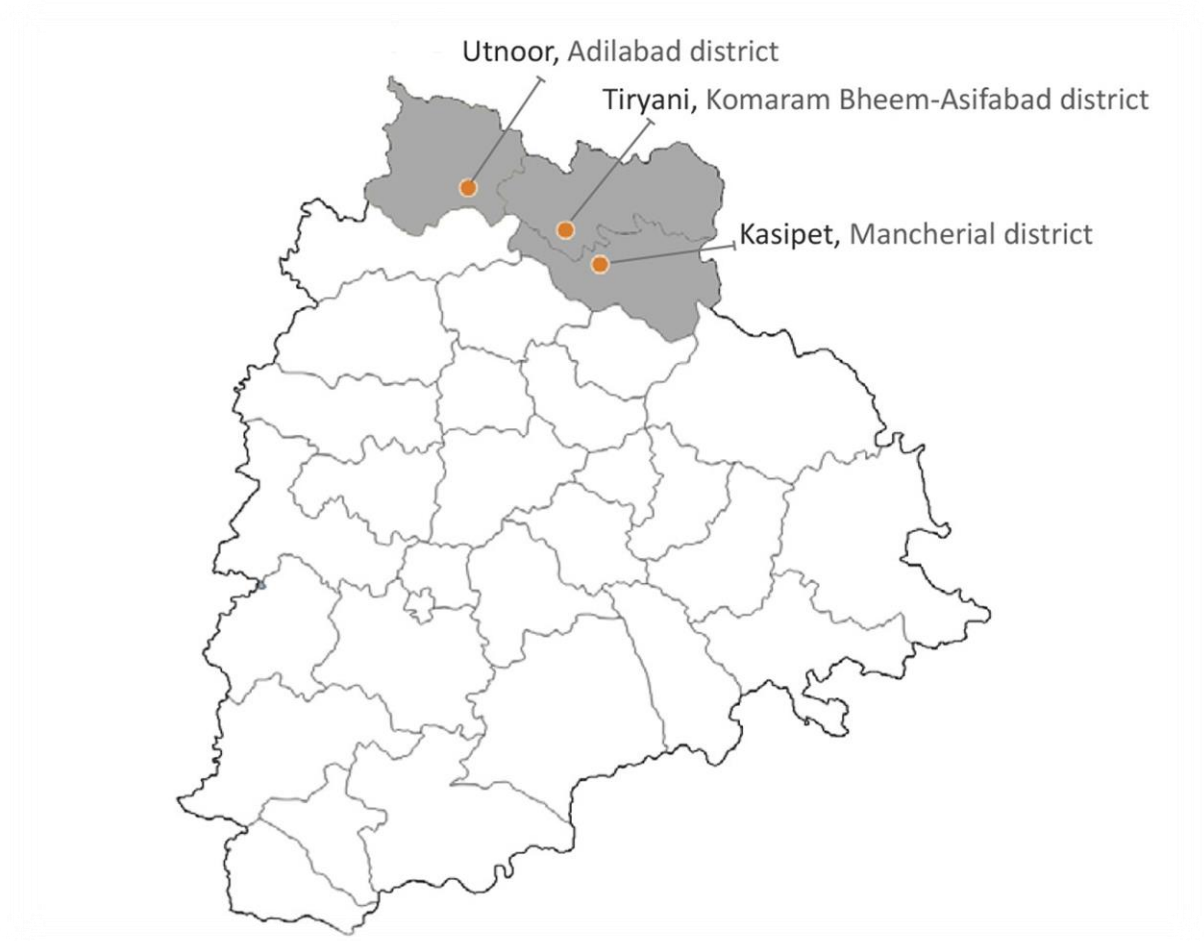
This project is in its phase and covers three mandals/blocks in three districts. Product acceptability studies for the Nutri-Food Basket were conducted and baseline studies were carried out to understand and document the existing nutritional and health

status of the representative target population. Out of the 5300 selected respondents 4800 received food-based intervention, while the rest comprised the control group.

24 enumerators (50% were women) from the target were trained in data collection using tablets. They were taught techniques for building rapport with the respondents, taking informed consent, collecting data on socio-economic status and dietary diversity and asking questions for data validation.

The enumerators were also trained in taking anthropometric measurements using standard measurement instruments and using the Pulse CO- Oximeter for recording haemoglobin and oxygen levels (non-invasive method), pulse rate and perfusion index.

Figure 1. Three mandals of three districts of Telengana state



II. Literature Review

- **The Global Food Policy Report of 2016 by IFPRI**
    - The report emphasizes on the food crisis that we are facing today and the methods that have been implemented over the years that enhances the extent of food security for a sustainable future.
    - Millennium Development Goals (MDG) is an ambitious agenda designed to improve human wellbeing worldwide.
    - Sustainable Development Goals (SDG) : 17 goals and 169 targets will anchor the global development agenda for the next 15 years
        - SDG 1: No Poverty
        - SDG 2: Zero Hunger
        - SDG 3: Good Health and Well-being
        - SDG 4: Quality Education
        - SDG 5: Gender Equality
        - SDG 6: Clean Water and Sanitation
        - SDG 7: Affordable and Clean Energy
        - SDG 8: Decent Work and Economic Growth
        - SDG 9: Industry, Innovation and Infrastructure
        - SDG 10: Reduced Inequality
        - SDG 11: Sustainable Cities and Communities
        - SDG 12: Responsible Consumption and Production
        - SDG 13: Climate Action

- SDG 14: Life Below Water
- SDG 15:: Life on Land
- SDG 16: Peace and Justice Strong Institutions
- SDG 17: Partnerships to achieve the Goal

- The 21st UN conference in Paris marked a new approach in coping with climate change. The goal is to keep the average global temperature below 2℃ maybe even 1.5℃.
- Weather extremes poses a threat to food security. Its necessary to build a food system that works for people and the planet.
- A productive food system has the following features:
  - Efficient : Produces more food with fewest resources
  - Inclusive: Making sure that the opportunities and economic growth reaches the poor, women, youth, small holders who have important roles to play in ending hunger and malnutrition.
  - Climate smart: It must be climate friendly as food system is said to be responsible for 1/5th of the greenhouse gas emissions.
  - Sustainable: Efficiently meets current and emerging demand for food without jeopardizing the availability of scarce natural resources.
  - Nutrition and health driven: To provide nutritious diet to all the people and reduce the micronutrient deficiency in people.
  - Business-friendly: Global, national and local food systems must be supported by well-functioning markets and partnerships in food supply chains and by an environment

that allows food system entrepreneurs to promote long term market based solutions.

    - Food system index: It is a measure needed to help measure progress in the above six dimensions and to quantify changes in the many moving parts of the food system

- Small holder farmers have a vital role to play in the global food security and nutrition and in supporting a range of development and climate change goals. Strengthening the resilience and commercial viability of these farmers, particularly women and youth can increase their capacity to contribute to these global goals.
- Small holders are vulnerable to climate shocks. They have limited capacity to adapt to climatic shocks.
- Leverage climate smart agriculture to achieve boarded development goals.
- The Global Initiative on Food loss and waste (SAVE FOOD) is the largest worldwide initiative to fight food loss and waste.
- It is built up on 4 pillars:
    - Research and assessment
    - Support for evidence based policies
    - Awareness raising
    - Coordination of global donors
- Sound management of freshwater can unlock potential to improve food security, nutrition and health.
- Countries will need to explore greener energy paths to address climate change. Opportunities for achieving both green energy

and food security goals include solar and hydropower in Africa, biofuels in poor countries and energy saving cook stoves.

- A 70% increase in production is required to prevent an increase in food prices and food insecurity by 2050. This will require substantial investments in technologies and infrastructure to increase productivity.
- Food systems requires more energy. Feeding a population of 9.6 billion people will require 20% increase over the world's current energy supply.
- Reducing emissions despite rising energy demand is a challenging task.
- The emissions intensity of energy tends to rise as poor countries develop towards upper middle income status, it then falls as countries develop further.
- Various countries including India and Indonesia have used low pol prices as an opportunity to reduce fuel subsidies.
- Global Hunger Index (GHI): Extensive measurement and tracking of hunger globally and by country and region provides evidence of progress and setbacks over time and allows for assessment of the drivers of these changes.
- A global convergence toward Western style diets that are high in calories, protein and animal based foods poses challenges for food security and sustainability.
- Overconsumption increases the size of the food gap and contributes to overweight and obesity.
- Once just a problem of high income countries overweight and obesity are on the rise in low and middle income countries.

- Animal based protein production is typically more resource intensive and has greater environmental impacts than plant based protein production.
- Three potential diet shifts that could contribute to a sustainable food future were analyzed using the GlobAgri biophysical model:
    - Reduce overconsumption of calories
    - Reduce overconsumption of protein by reducing consumption of animal based foods
    - Reduce beef consumption specifically

- **The Determinants of Individual Diets and Nutritional Status in Six villages of Southern India**
    - It is a report on the in depth analysis on the research done by Ryan et al. in the year 1974 and 1975. The report incorporates the description of the procedures, constraints, stratums and finally the conclusions that have been implemented in the research.
    - The paper is divided into three sections
        - Methodologies employed in the selection of villages and households
        - Techniques in conducting dietary anthropometric, clinical and time allocation studies
        - Analysis of the data
    - The villages were chosen to represent patterns, land use, irrigation etc. Villages which had special programs or being in close proximity to towns and villages or having more than normal resource from outside were not chosen.

The 6 villages selected were

    - Aurapalle (Andhra Pradesh)
    - Dokur (Andhra Pradesh)
    - Sholapur (Maharashtra)
    - Kalman (Maharashtra)
    - Kanzara (Maharashtra)
    - Kindheda (Maharashtra)
- Household sampling procedure:
    - Samples were categorized by socio economic factors or farm size
    - The cultivated group was divided into strata with each stratum having identical number of households. 10 households were selected at random.
    - An agricultural economist with rural background was stationed in each village to interview the panel of 40 households.
    - Data were regularly obtained on cropping patterns, use of inputs, family labor, draft power, incomes, expenditures, assets, liabilities, crop yields.
- Diet and nutrition survey:
    - 3 post graduates in nutrition were appointed to gather data on food consumption, time allocation from subsample of selected families.
    - Nutrient value of diet which was provided was calculated. The nutrients chose were: calcium, protein, iron, β carotene, thiamine, riboflavin, niacin, ascorbic acid, lysine and sulphur amino acid (SAA).
- Anthropometry and clinical assessments:

    - Weight, height, arm circumference, triceps skinfold were recorded of each member of the family.
- Methods of Analysis: Grouping done on dissimilarities/similarities in agroclimatic and socio economic characteristics of the villages:
    - Farm size
    - Season(Lean/Surplus)
    - Sex(dummy)
    - Age
    - Birth order
    - Family size
    - Morbidity(dummy)
    - Education of mother
    - Degree of disability
    - Participation rate of mother
    - Caste rank
- Nutrient Status:

From the analysis of mean intakes of energy and associated nutrients that from the proportions receiving less than 50% of the RDA for Indians that there are major deficiencies of energy, vitamins and minerals in the diets of the villagers.

- Measuring Protein content:

Samples of major food grains had been obtained and were brought to ICRISAT for protein analysis to ascertain whether the nutritive values of these grains are accurate reflection of nutrient content actually consumed in the villages.

- Results of time allocation analysis:

The results of time allocation analysis was presented in terms of the average time spent by men, women, and children on eight main activities that were mentioned previously.

- Conclusions:
  - The diets of people living in these six SAT villages of Maharashtra and Andhra Pradesh were mostly deficient in energy, calcium, β- carotene, B complex vitamins and ascorbic acid.
  - Those with larger families, other things being equal, as nutritional intakes of children were found to be generally lower in these families, except for Vitamin A.
  - Landless and small farm households, other things being equal, as nutrient intakes of children were worse in these households.
  - Households where mothers have no formal education as it was found that vitamin A and calcium were higher among children of educated mothers.

III. Descriptive Analysis

Village Overview

The survey was performed in 38 villages of the 3 selected mandals Utnoor, Kasipet and Tiryani. The following are the list of villages where the survey was conducted.

Table 1. Selected Villages of the 3 mandals

Mandal	District	Village Name
Utnoor	**Adilabad District**	**1. Beersaipet** **2. Chanduri** **3. Dantanpally** **4. Ghanpur** **5. Hasnapur** **6. Lakkaram** **7. Luxetpet** **8. Nagapur** **9. Narsapur-b** **10. Pulimadugu** **11. Salewada-b** **12. Salewada-k** **13. Shyampur** **14. Umri** **15. Utnoor** **16. Yanda**
Tiryani	**Komaram-Bheem Asifabad District**	**1. Devaiguda** **2. Gandalpalli** **3. Gambiraopet** **4. Ginnedhari** **5. Kannepalli** **6. Mangi** **7. Manikyapur** **8. Pangidi Madara** **9. Rompalli** **10. Sungapur** **11. Tiryani** **12. Ullipittadorli**
Kasipet	**Mancherial District**	**1. Demaraopet** **2. Devapur** **3. Kasipet** **4. Komitichenu** **5. Konur** **6. Malkapalli**

		7. **Mutyampalli** 8. **Pallamguda** 9. **Peddanpalli** 10. **Sonapur**

Household Characteristics

The following deductions were made from the complete data of the baseline survey.

Table 5. Total number of women in various categories in the target population.

Details

- Total number of women- **4879**
  - Married = **4646**
  - Separated = **20**
  - Divorced = **2**
  - Widowed = **211**
- Classification based on literacy
  - Cannot read and write =**1917**
  - Can sign (write) only=**531**
  - Can read only=**20**
  - Can read and write=**2410**
- Classification based of the level of education
  - No school =**4454**
  - Primary level classes 1-5 =**1106**
  - Secondary level classes 6-10 =**1237**
  - Technical or vocational training =**34**
  - Intermediate= **467**
  - Graduation /University (BSc/BA/B.Com/B.Tech)= **268**
  - Post-Graduation =**40**
  - Adult literacy only (no formal education) =**2**
  - Religious only (no formal education)=**0**
  - Others= **8**
- Classification based on household type
  - Male and Female adult= **3558**
  - Female adult only= **191**
  - Male adult only= **898**
- Classification based on religion
  - Muslim= **213**
  - Hindu= **4353**
  - Christian= **28**
  - Buddhist= **53**
  - Navbuddha= **1**
  - Others = **1 (Odisi)**

- Classification based on caste category
    - FC- Forward Caste= **92**
    - BC- Backward Caste= **1286**
    - SC- Scheduled Caste= **705**
    - ST- Scheduled Tribe= **2540**
    - NT – Nomadic Tribe= **7**

*Unmarried women were not taken into consideration as this study only contemplates nutritional statuses of women and their children.

Methodology

Data source

The present study uses baseline data of ICRISAT's ongoing NUTRI-FOOD BASKET research program. As part of the NFB study, household level surveys collected data on village, caste, as well as individual-level data on gender, age, and anthropometric measurements.

The data from the NFB study was cleaned thoroughly before analysis. In this study, only those pairs of mothers and children were selected who's haemoglobin and anthropometric data was available. The total resulting sample size that was used in the statistical analysis was 645.

Body mass index (BMI) were calculated from height and weight measurements and categories were created based on WHO classifications. The z scores for stunted, wasted and underweight children were computed from WHO Anthro software. All computations were done using R 3.3.2 , WHO Anthro 3.2.2.1and Excel 2013

Framework of Analysis

Method of Study

The dependent variable used in the study were Hemoglobin content and the growth factor which was taken as BMI for mothers and the Z-scores to measure the growth of the children.

Literacy of the mother as well as the head of the household was deemed to be influencing the nutritional level of the child from various studies.

The haemoglobin level fluctuates with the physiological status hence it was taken as an independent variable.

Per capita income and the household size is another important determinant of nutritional status of an individual.

The prevalence of Thalassemia is common in the tribal population of India and since it is genetic it might spread to the offspring of Thalassemic parents. Hence the variable of Blood relation with spouse was taken into account in this study.

The source of drinking water (piped or unpiped) and usage of toilets were representative of hygienic habits that may influence the nutritional status as improper sanitation and cleanliness may cause adverse effects on the nutrition of an individual.

The analysis was done in 3 stages.

In the first stage the nutritional statuses of all the females were collaborated and the regression model was constructed in order to detect the prevalence of multicollinearity in the model.

The second stage of the analysis was to detect if the health status of the child was dependent on the health status of the mother. This analysis was done by the method of χ^2 test of independence (Chi square test of independence).

The third stage of the analysis was to check which among the socio economic factors influences the dependent variable and by how much. This was done by creating a Multinomial Logit Regression model.

Stage I

Multicollinearity is a statistical phenomenon in which multiple independent variables show high correlation between each other. This diminishes the reliability of the regression model and creates redundant information. It is essential to eliminate multicollinearity from a regression model in order to get precise results.

In the following model the nutritional statuses of the all the women were collaborated in order to decide whether there is any correlation between the socio economic factors and the health statuses of the individuals.

For the given study the linear regression model is given by

$$Y_i = \beta_o + \beta_i X_i + \varepsilon_i \qquad \text{where } i=1, 2\ldots$$

Here Y is the haemoglobin level which is taken as the dependent variable in this case and was considered as a dummy variable, “0” signifying ideal haemoglobin content and “1” signifying abnormal haemoglobin content in the blood.

β_o is the baseline regression coefficient in the model

β_i (i=1, 2…) are the regression coefficients of the independent variables.

Literacy of the individual, marital status, physiological status, sex, and age were taken as the predictor variables.

The fields Sex, Marital status, Physiological status (Pregnancy/Lactating/Adolescent) are categorical and hence we use them as dummy variables.

Sex: In the case of a male child, this variable took the value of unity or "0" otherwise.

Marital Status: Married-1; Single/ Never Married-2

Separated – 3; Divorced -4; Widowed-5

Status: Pregnant-1; Lactating-2; Adolescent -3;

To check whether multicollinearity exists within the independent variables the variation inflation factors (VIF) were calculated for each of the independent variables taking the haemoglobin level as the dependent variable. The formula for VIF is given by

$$VIF = 1/ (1-R^2)$$

Stage II

In the second stage the objective was to determine whether the health status of the child depends upon the health status of the mother. To do so, we performed the χ^2 test of independence.

At first, the mother and child pairs were obtained from the data that was in hand. Since the anthropometric and clinical data of children of age 3-5 years were available, the pairs obtained had mothers who had children of the concerned age group. There were a total of 645 pairs of mothers and children found and from these pairs, the number of healthy and unhealthy individuals were identified and the following contingency table was constructed.

Table 10.Contingency Table

FIELDS	HEALTHY CHILD	UNHEALTHY CHILD	TOTAL
HEALTHY MOTHER	381	95	476
UNHEALTHY MOTHER	85	84	169

TOTAL	**466**	**179**	**645**

Now the hypothesis is given as follows,

H_0: The health status of the child is independent of that of the health status of the mother

H_1: The health status of the mother influences the health status of the child.

The χ^2 test of independence was applied to the above contingency table and the following expected values were derived

Table 10.Expected Values

Expected Values	HEALTHY CHILD	UNHEALTHY CHILD	TOTAL
HEALTHY MOTHER	**343.9007752**	**132.0992248**	**476**
UNHEALTHY MOTHER	**122.0992248**	**46.90077519**	**169**
TOTAL	**466**	**179**	**645**

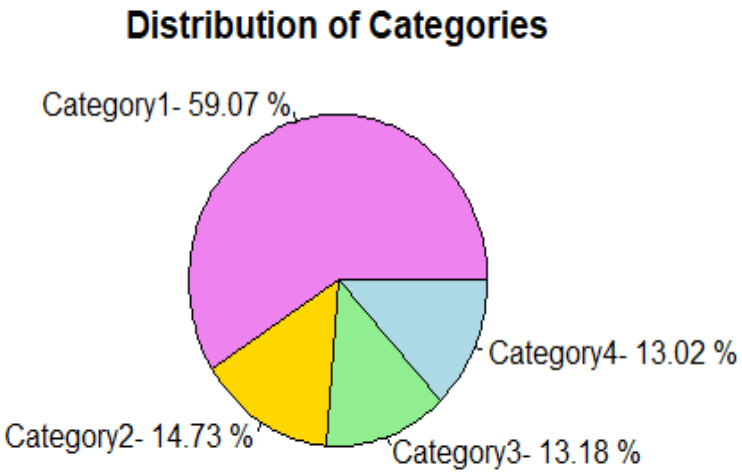
The χ^2 value was found to be **1.18119E-13** which is well below 0.01. Hence we can reject the null hypothesis and conclude that the health of the child is dependent on the health of the mother with 1% level of significance.

Stage III

The objective in this stage was to determine the extent of influence of socio economic factors on the health of the mothers and children of 3-5 years of age.

The since there were more than 2 outcomes, the dependent variable was categorized as follows:

Category 1: Healthy mother - Healthy child
Category 2: Healthy mother- Unhealthy child
Category 3: Unhealthy mother – Healthy child
Category 4: Unhealthy mother – Unhealthy child



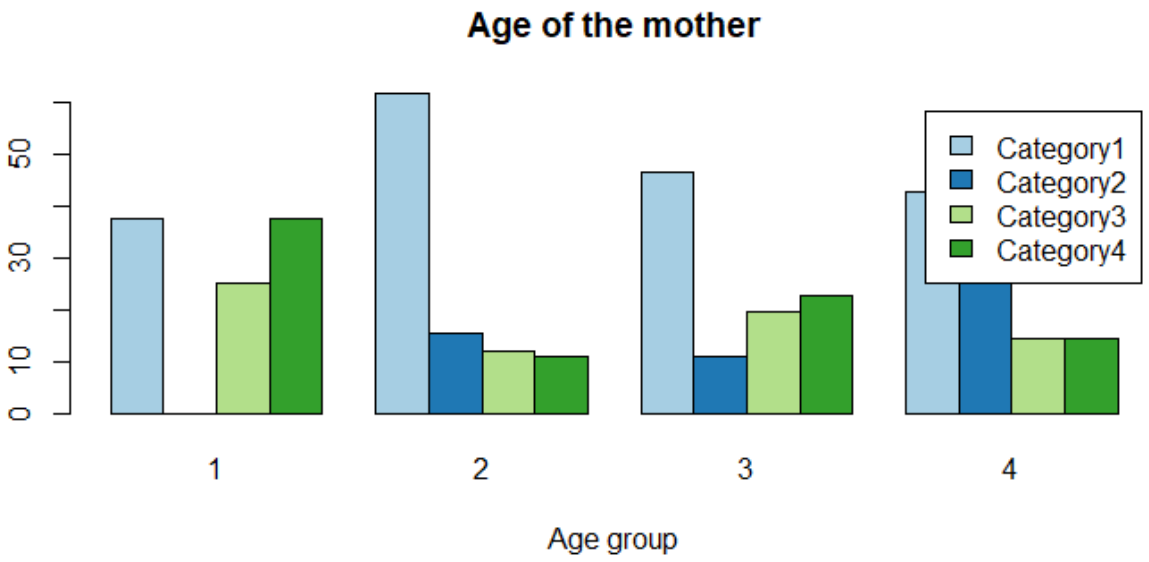
The categorical variable was taken as the dependent variable and Multinomial Logit Regression was performed since there are 4 outcomes of this dependent variable.

The independent variables taken were: Literacy of the mother, Status of the mother (pregnant or lactating), Age of the mother, Household size, Per capita Income (per annum), Related by blood (with husband), Literacy of the head of the household, Using Toilet, Source of drinking water

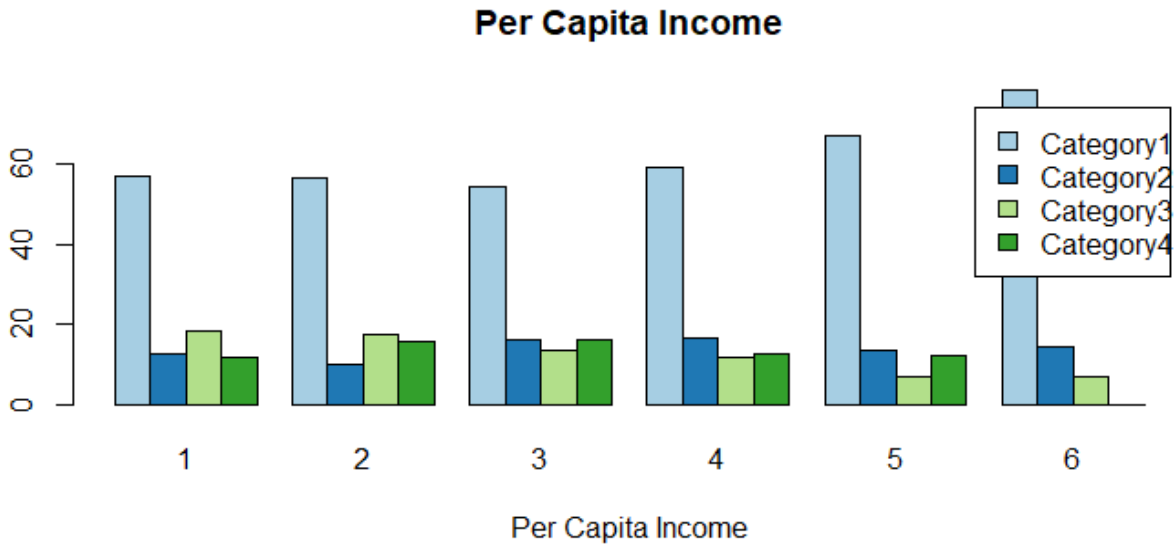
Table 11. Indicators of predictor variables

Predictor Variables	Indicators
Literacy of the mother	**1. Can't read/write** **2. Can write only** **3. Can read only** **4. Can read and write**
Physiological Status of the mother	**1. Pregnant** **2. Lactating**
Age of the mother	**1. Upto 20** **2. Between 20-30** **3. Between 30-40** **4. Above 40**
Household Size	**1. Upto 3** **2. Between 3-6** **3. More than 6**
Per Capita Income	**1. Upto 5000** **2. Between 5000-7500** **3. Between 7500-10000** **4. Between 10000-20000**

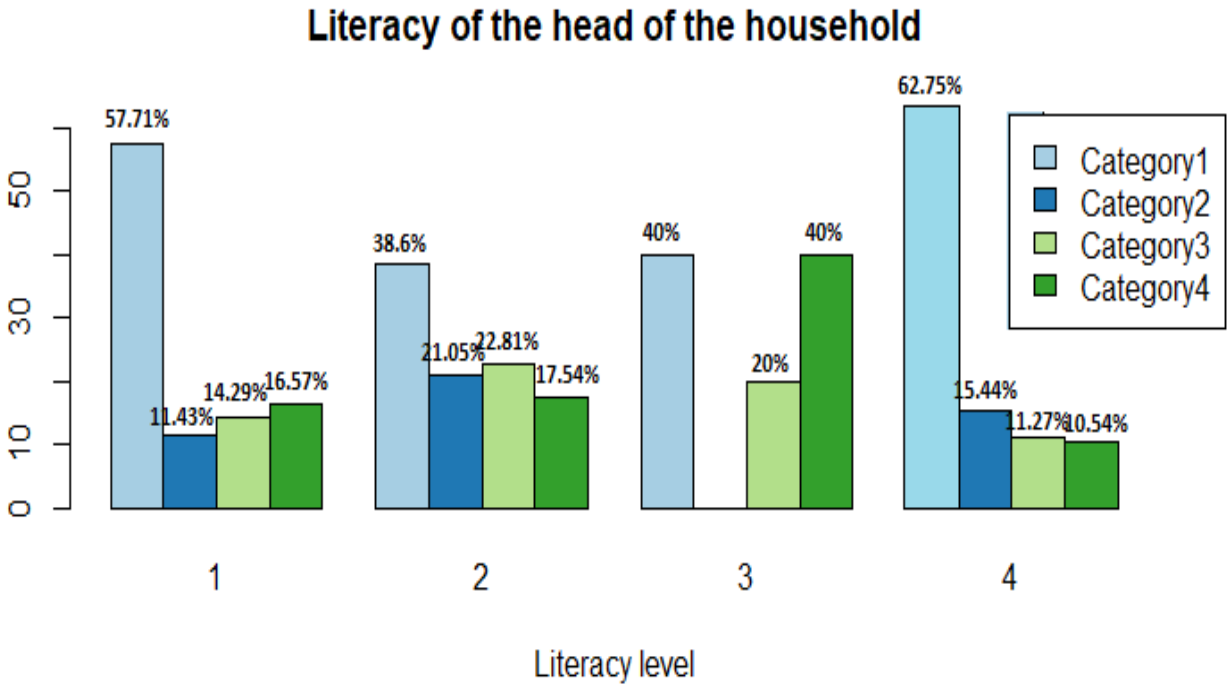
	5. Between 20000-50000 6. Above 50000
Related by blood with spouse	0. Not related 1. Related by blood
Literacy of the head of the household	1. Can't read/write 2. Can write only 3. Can read only 4. Can read and write
Using Toilet	0. Using Toilet 1. Not Using Toilet
Source of drinking water	0. Piped 1. Unpiped

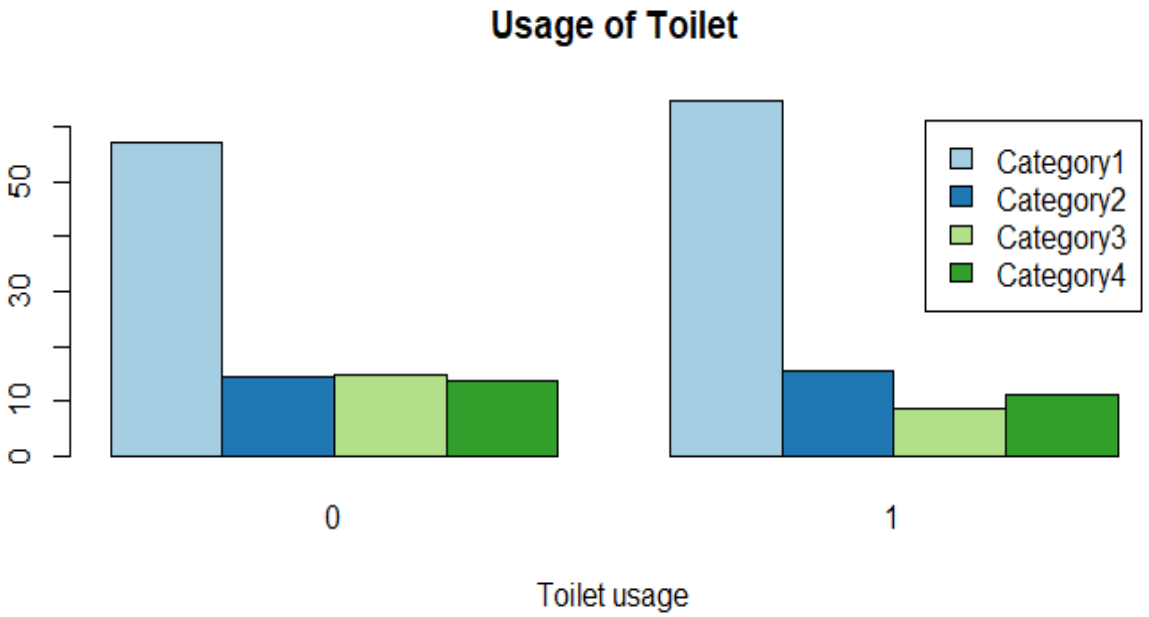


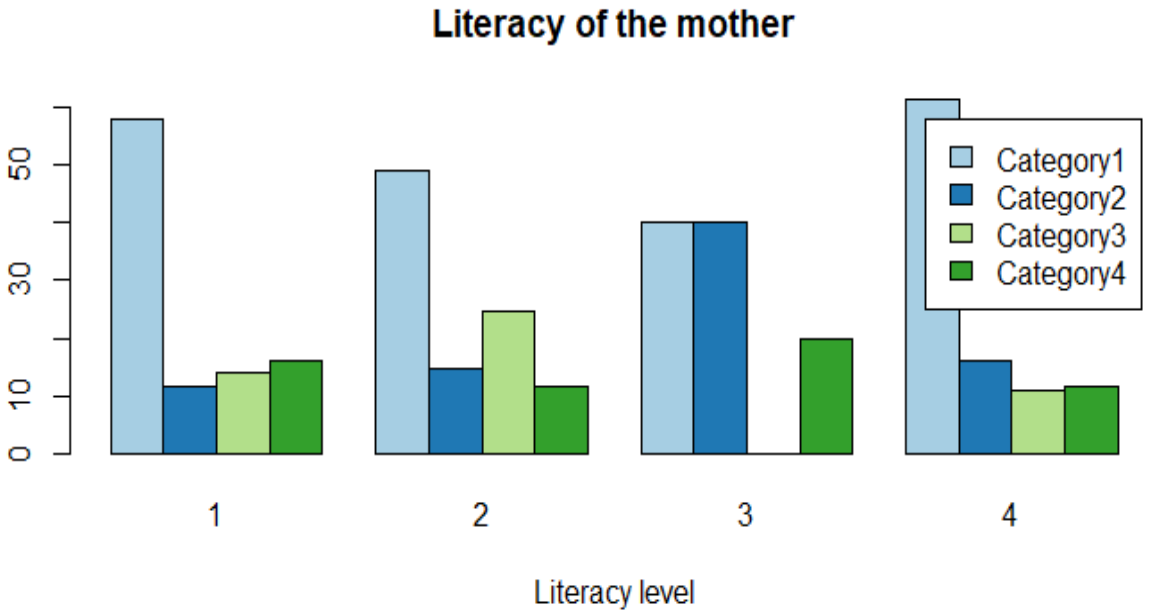
- The per capita income was found to have a positive impact on the health statuses i.e. more the per capita income of the individual, it is more likely that the sample would belong to the category 1, in other words both the mother and child will be healthy.



- The literacy of the head of the household also showed a similar kind of trend. More the literacy level of the head of the household, more is the chance of the sample falling under category 1.




Usage of Toilet
0
10
30
50
Category1
Category2
Category3
Category4
0
1
Toilet usage


Literacy of the mother
0
10
30
50
Category1
Category2
Category3
Category4
1
2
3
4
Literacy level

Step IV:

In this chapter we want to study the impact socio economic factors on the growth and physical conditions of the mothers and their children with respect to their age. Growth is an important determinant of nutrition. The BMI is the metric currently used for defining anthropometric height/weight characteristics in adults and for categorizing them into groups viz. underweight, normal, overweight or obese. The distribution of the growth indexes are as follows

- BMI< 18.5 – Underweight
- 18.5< BMI < 25 – Normal
- BMI > 25 – Overweight

BMI can be calculated using the weights (in kg) and heights (in metres) of adults. The formula for calculating BMI is,

$$BMI = weight/ (height)^2$$

BMI was taken as the growth indicator of mothers in this regression but for the growth indicators of children we used the z-scores as it is used to assess the growth considering the child's age and measurement. Here we have taken 3 growth indicators for children,

- Height for age
- Weight for age
- Weight for height

These indicators are used to measure nutritional imbalance resulting in under nutrition (assessed from underweight, wasting and stunting) and overweight. Child growth is internationally recognized as an important indicator of nutritional status and health in populations.

The percentage of children with a low height for age (stunting) reflects the cumulative effects of under nutrition and infections since and even before birth. This measure can therefore be interpreted as an indication of poor environmental conditions or long-term restriction of a child's growth potential. The percentage of children who have low weight for age (underweight) can reflect 'wasting' (i.e. low weight for height), indicating acute weight loss, 'stunting', or both. Thus, 'underweight' is a composite indicator and may therefore be difficult to interpret.

The indicators are defined as follows,

• Underweight: weight for age < –2 standard deviations (SD) of the WHO Child Growth Standards median

• Stunting: height for age < –2 SD of the WHO Child Growth Standards median

• Wasting: weight for height < –2 SD of the WHO Child Growth Standards median

• Overweight: weight for height > +2 SD of the WHO Child Growth Standards median

Cut-off values for public health significance

Indicator	Prevalence cut-off values for public health significance
Underweight	< 10%: Low prevalence 10-19%: Medium prevalence 20-29%: High prevalence ≥ 30%: Very high prevalence
Stunting	< 20%: Low prevalence 20-29%: Medium prevalence 30-39%: High prevalence ≥ 40%: Very high prevalence
Wasting	< 5%: Acceptable 5-9%: Poor 10-14%: Serious ≥ 15%: Critical

Reference: WHO, 1995.

Now, our objective was to observe the influence of growth level of mothers on the growth of their children. A multinomial regression model was constructed taking growth variable of the mothers as the dependent variable with the following indicators,

- 1 – Normal Growth
- 2 – Underweight

- 3 – Overweight

In order to observe the association with the growth of children we take the dummy variables of stunting, wasting and underweight as independent variables and fit the model.

To verify the results of the regression we apply the Chi square test of independence for the response variable with each independent variables.

The p values of each association is given in the following table and the hypothesis taken for each test is,

H_0: The physical growth of the mother does not influence the growth of the child

H_1: The physical growth of the mother determines the growth of the child

Results

Detection of Multicollinearity:

The regression statistics obtained can be seen in the table. We are concerned with the R value since it will help us calculate the Variation Inflation Factor (VIF).

Table 8. Regression Statistics

Regression Statistics	
Multiple R	0.104876
R Square	0.010999
Adjusted R Square	0.008881
Standard Error	25.87624
Observations	2341

The VIF for each of the independent values were calculated. If the VIF values are less than 3 then it denotes that there is no multicollinearity in the given model.

Table 9.Coefficients and VIF values

Fields	***Standard Error***	***t Stat***	***VIF***
Haemoglobin	**4.841941**	**17.72555**	**1.011121**
Literacy	0.450937	1.585262	1.123717
Marital Status	2.145684	0.964661	1.122814
Status	0.142638	0.268619	1.123739
Sex	1.506183	0.687492	1.123739
Age	0.12287	2.589175	1.119978

The above table shows that the VIF values of the independent variables are all less than 3 and since the corresponding p-values are also non-significant, we can conclude that there is no sign of multicollinearity in the above regression model.

Chi Square Test for health of mothers and children:

The chi square test of independence was performed to detect weather there is any correlation between the health status of the mother and the health status of the children when the haemoglobin level is concerned.

The hypothesis is given as follows,

H_0: The health status of the child is independent of that of the health status of the mother

H_1: The health status of the mother influences the health status of the child.

Table 10.Expected Values

Expected Values	HEALTHY CHILD	UNHEALTHY CHILD	TOTAL
HEALTHY MOTHER	343.9007752	132.0992248	476
UNHEALTHY MOTHER	122.0992248	46.90077519	169
TOTAL	466	179	645

The χ^2 value was found to be **1.18119E-13** which is well below 0.01. Hence we can reject the null hypothesis and conclude that the health of the child is dependent on the health of the mother with 1% level of significance.

Chi square test of independence for each of the independent variables with a categorical variable taken as the response variable:

The following table gives the p values obtained by applying Chi square test taking each independent variable in association with the dependent variable. The results were compared with the results of the regression analysis.

INDEPENDENT VARIABLES	P-VALUES FROM CHISQ TEST
Literacy of the Mother	**0.0788****
Status (P/L)	**0.8521**
Age of the mother	**0.8337**

Household Size	**0.0073******
Per Capita Income (per annum)	**0.6431**
Related by blood	**0.7194**
Literacy of the head of the household	**0.0122*****
Using Toilet	**0.1694***
Source of Drinking water	**0.7653**
Marital Age	**0.9385**

The significant variables obtained by applying the Chi square test of independence were Literacy of the mother, Household Size, Literacy of the head of the household and Usage of toilet.

Chi square test to check the correlation between BMI of mothers and Stunted, wasted and Underweighted children

The p values when the physical growth of mothers was compared with each of the independent variables (wasted/stunted/underweight) using chi square test with 2 degrees of freedom are given below.

Predictor Variables	**P values**
Wasted	**0.002441737*****
Stunted	**0.0113494****
Underweight	**0.022724163****
Significance level 1%-*** 5%-** 10%-*	

The *p*-value indicates that these variables are not independent of each other and that there is a statistically significant relationship between the categorical variables.

Hence we reject H_0 as the p values are less than 0.05 which is the alpha level associated with 95% confidence interval.

Multinomial Logit Regression of Categorical Variable with socio economic factors:

Table 6. contains the absolute values thus obtained from the regression model. The positive/negative sign signifies how the factors influence the health statuses of the individuals.

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	(Intercept)	Literacy	Status	`Age Group`	`HH Category`	`Per capita`	`Related by blood`	`Literacy of the head of the household`	`Using Toilet`	`Source of drinking water`	`Marital Age`
2	-1.3060116	0.90649009	-0.6187318	0.8792631	-0.4757497	-0.03626415	-0.1797736	-0.1822003	-0.4814381	-0.6786265	0.02652233
3	-0.7069457	-0.18406466	-0.4236125	1.4670619	-0.6610428	-2.17325115	0.7091717	-0.7241806	-1.4318421	-0.8516174	0.29515933
4	-1.2517153	-0.09366664	-0.2686167	2.0284373	-1.4551801	-0.95485646	-0.3845665	-1.6599432	-0.3088228	0.1088970	0.52542697

Figure 2. Absolute values

The following table # contains the p values associated with each of the factors indicating their significance. Here we notice that Per capita income, age group, Literacy of the head of the household, HH category and Toilet usage have small p values implying high significance.

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	(Intercept)	Literacy	Status	`Age Group`	`HH Category`	`Per capita`	`Related by blood`	`Literacy of the head of the household`	`Using Toilet`	`Source of drinking water`	`Marital Age`
2	0.1915486	0.3646765	0.5360930	0.37925866	0.6342527	0.97107173	0.8573303	0.85542555	0.6302052	0.4973746	0.9788407
3	0.4796002	0.8539627	0.6718484	0.14235922	0.5085849	0.02976142	0.4782179	0.46895487	0.1521890	0.3944265	0.7678722
4	0.2106736	0.9253740	0.7882247	0.04251564	0.1456194	0.33965029	0.7005586	0.09692588	0.7574563	0.9132842	0.5992864

Figure 3. p Values

Multinomial logistic regression is used to model nominal outcome variables, in which the log odds of the outcomes are modelled as a linear combination of the predictor variables.

The following table represents the coefficients that were obtained from the Multinomial logit regression model taking Category 1 as the base outcome in R studio software (version 1.0.143). The base outcome a lower or upper limit used for baseline comparison. Category 1 represents healthy mothers having healthy children.

Predictor Variables under Study	**Category 2**	**Category 3**	**Category 4**

Literacy of the mother	**0.0864**	**-0.0171**	**-0.0121**
Status(P/L)	**-0.1262**	**-0.1501**	**0.0883**
Age of the mother	**0.2817**	**0.3970***	**0.5801*****
Household Size	**-0.1058**	**-0.1571**	**-0.3481***
Per Capita Income (per annum)	**-0.0310**	**-0.1934*****	**-0.1119**
Related by blood	**-0.0416**	**0.1992**	**0.0888**
Literacy of the head of the household	**-0.0312**	**-0.0706**	**-0.1809****
Using Toilet	**-0.1165**	**-0.4855***	**-0.0768**
Source of drinking water	**-0.2508**	**-0.3227**	**0.0577**
Marital Age	**-0.0013**	**0.1034**	**0.1630**
Significance level at 1% - ** 5% - *** 10% - ** 20% - ***			

The regression coefficients when BMI of mothers was taken as dependent variable with the variables of children being stunted were taken as independent variables:

The Z scores were calculated using WHO Anthro software (version 3.2.2.1)

Table. Format of WHO Z score for children

ID	Sex	Age (m)	Weight (kg)	Height (cm)	WHZ	HAZ	WAZ	BAZ
1	Female	36	7.8	74	-1.75	-5.53	-4.52	-0.93
2	Male	48	13.1	101.2	-2.25	-0.51	-1.76	-2.27
3	Male	60	12.6	105.2	-3.59	-1.03	-2.86	-3.6
4	Male	48	10.8	88.5	-1.89	-3.54	-3.3	-1.31
5	Female	48	12.8	98.3	-1.61	-1.03	-1.7	-1.61
6	Male	48	13	94.8	-0.94	-2.03	-1.82	-0.71
7	Male	36	8.9	74.8	-0.93	-5.74	-3.89	0.25
8	Female	48	9.1	87.9	-3.38	-3.44	-4.24	-3.04
9	Female	48	10.7	78.3	0.86	-5.67	-3.13	1.41
10	Female	48	11.3	90.8	-1.47	-2.77	-2.69	-1.21
11	Female	60	14.2	105.3	-1.93	-0.87	-1.76	-1.89
12	Male	48	19.1	121.1	0	4.24	1.21	-2.04
13	Female	60	13.8	96.1	-0.3	-2.8	-1.97	-0.23
14	Female	60	12.8	93.8	-0.68	-3.28	-2.54	-0.5
15	Female	48	11.8	92	-1.23	-2.49	-2.34	-1.01

Following deductions were made from the overall data

- Number of wasted children – 126
- Number of stunted children – 329

- Number of underweight children – 314

The coefficients of Multinomial Logit regression when BMI of mothers was taken as d ependent variable and Z scores for stunted, wasted and underweight children was ta ken as the dependent variable

Coefficients when Normal growth of the mother (1) as the base outcome				
Predictors	**(Intercept)**	**Wasted**	**Stunted**	**Underweight**
Underweight	**-0.6229035**	**0.6532429*** **	**-0.1986583 ***	**-0.1598685**
Overweight	**-1.2708152**	**-0.4474229**	**-0.5688437**	**-0.2753312**
Significance level	**1%-*** **	**5%-** **	**10%-***	

The above table illustrates that the coefficient associated with underweight mothers and wasted children is significant at 1% level and the same with stunted children is si gnificant at 10% level.
Hence we can conclude that there is a high possibility that underweight mothers have stunted or wasted children.

V. Conclusion

- By comparing the health statuses of mothers and their children using the Chi square test of independence we conclude that the health status of a child is dependent of the health status of the mother (when the health status is taken as a proxy for hemoglobin content in the blood).
- Age of the mother, Literacy of the head of the household, household size and Per capita income were significantly associated with the nutrition of children.
- From the analysis it was interpreted that when the mother is healthy there is very less chance of the child being unhealthy.
- Age had a significant association with the health of the individuals as it negative impact on the health of the mothers and children. Implies that, mothers of lesser age were found to be healthier and having healthy children as well.
- The per capita income was found to have a positive impact on the health statuses. Mothers with higher per capita income were expected to be healthier and also having healthy children.
- The literacy of the head of the household also showed a significant association with the health of the individuals.
- The household size also showed a positive influence on the health status of the mothers and children. Hence the samples belonging to a households with greater size had healthy counterparts.

- The regression analysis of the BMI of the mothers and the z scores of the children showed a high degree of correlation especially when underweighted mothers were associated with wasted and stunted children which brings us to the conclusion that for underweight mothers have a high risk of having wasted or stunted children.
- The chi square test between the dependent variable and physical growth of the children showed statistical significance implying that the physical growth of the child is highly dependent of that of the mother.

VI. Discussion

- There are a few key limitations to acknowledge in the development of this report that may contribute to understanding the results of this study. Because the NFB research is ongoing, only the baseline data was available. Further insights can be gathered by comparing it with the endline data to analyse the change in nutritional aspects of the sample after the intervention.
- While the literature study suggested that undernutrition is not the cause of anemia, the correlation between the two variables were not analysed. The analysis could have provided further insights for the research.
- Including measurements for dietary diversity as well as biochemical measurements from blood tests or urine samples can provide insight into other aspects of nutritional status. Including these in the assessment of nutritional status may have yielded different outcomes.

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IX. Appendix

Data collection/ Sampling method

The data collection was done by the trained enumerators and was done with the consent of the participants. The data collection had several phases. The objective was to collect data concerned with the health of the individuals and all the other (socio-economic) factors associated with it. Hence apart from the clinical and anthropometric data, household information, yearly income of the household, dwelling characteristics and other personal information was gathered for all the individuals. The baseline clinical data of women and children were collected in the Aanganwadi centres. The clinical data covered all the medical and health information as to whether the individual is suffering from a disease, going through any medical treatment, has any physical disabilities et cetra.

In addition to this anthropometric measurements were taken for each individuals using standard procedures. Height, weight, BMI, MUAC, Oxygen level in the blood were some of the measurements that were taken. The enumerators were trained to gather as accurate measurements as possible.

Following are the formats of questionnaires used in the survey.

BASELINE survey:

NUTRI-FOOD BASKET PROJECT in tribal households of Adilabad, Telangana State, 2017

HOUSEHOLD ROSTER

ID CODE	Name of household member? [start with household head, continue with the other members of the household]	A24a: Sex: M = Male; F = Female A24b: Status: Married – 1; Single/ Never Married-2 Separated – 3; Divorced -4; Widowed-5 A24c: If married, age at marriage (completed years)			Relationship to the head of the household	Related by blood? A26 a: Y/N Eg. Spouse Son-in-law Daughter-in-law If Y, relationship		Age? (in completed years)* If age is <3 years, go to A34	For females only, indicate ... Pregnant - 1 Lactating – 2 None of the above - 0	Can you read and write?	Is [NAME] currently attending school? 1 = Yes ; 2 = No If Yes, go to A32; if No, go to A33 and continue	Has [NAME] ever attended school? Y= Yes N= No If Yes, go to A32; if No go to A33 and continue	What is the highest grade of education completed by [NAME]?	Whether member of any organization Y/N; Name of organization	TB? Y/N If Y go to A34 b	Medication for TB Y/N	Leprosy? Y/N
	A23	A24a	A24b	A24c	A25	A26 a	A26 b	A27	A28	A29	A30	A31	A32	A33	A34 a	A34 b	A34 c
1					Head												
2					Spouse												
3																	
4																	
5																	
6																	

A25: Relationship to head of household		A26b. Related by blood	A29: Literacy	A32: Education level	A31: Organizations	A34: Health
1 – Head of household 2- Spouse/partner 3 - Son/daughter 4 – Son-in-law/daughter-in-law 5 - Grandson/granddaughter 6 - Mother/Father 7 - Brother/sister 8 - Nephew/niece	9 - Nephew/niece of spouse 10 - Cousin of primary respondent 11- Brother/sister-in-law 12 - Mother/father-in-law 13 - Cousin of primary respondent's spouse 14 - Other relative 15 - Servant/Maid 16 - Labourer 17 - Other relationship (Specify)	1.Cousin 2.Maternal uncle 3.Niece 4.Others	1 - Cannot read and write 2 - Can sign (write) only 3 - Can read only. 4 - Can read and write	1 - No school 2 - Primary level classes 1-5 3 - Secondary level classes 6-10 4 - Technical or vocational training 5 - Intermediate 6 – Graduation /University (BSc/BA/B.Com/B.Tech) 7 – Post Graduation 8 - Adult literacy only (no formal education) 9 - Religious only (no formal education). 10-Others	1 - SHG 2 - PACCS 3 – Farmer cooperative 4 – Gram Panchayat 5 - MPTC 6 – Education committee 7 – Water Users Association 8 - Others (specify)	**A34a** – enumerator to ask - Whether suffering from TB?- if Y go to **A34b** – are you taking any medication – Y/N **A34c** – enumerator to observe for any symptoms of Leprosy and record

Table 4. Questionnaire for the personal information of the participants of the survey

BASELINE survey:
NUTRI-FOOD BASKET PROJECT in tribal households of Adilabad, Telangana State, 2017

YEARLY INCOME OF THE HOUSEHOLD

TYPE OF HOUSEHOLD/CARD	APL/BPL	Others
Source of Income	Annual Income (Rs)	Remark
1- Farming (if yes, please fill in cropping pattern table)		
2- Livestock		
3- Wages		
3.1 On farm		
3.2 Non-farm		
4. Business/salary/others		

Table 5. Household Income individual questionnaire

BASELINE survey:
NUTRI-FOOD BASKET PROJECT in tribal households of Adilabad, Telangana State, 2017

B. DWELLING CHARACTERISTICS

	Response	Response codes
B01.ENUMERATOR: OBSERVE (DO NOT ASK) Roof top material (outer covering):		B01:Type of roof Cement ....1 Wood.....2 Corrugated metal.....3 Plastic sheeting.....4 Thatched/vegetable matter/ sticks.....5 Mud/cow dung.....6 Tile.....7 ; Other.....8
B02.ENUMERATOR: OBSERVE (DO NOT ASK) Floor material:		B02:Type of floor Earth/mud...1; Concrete/flag stone/cement.....2 Tile/bricks.....3 Wood.....4 Other.....5
B03.ENUMERATOR: OBSERVE (DO NOT ASK) Exterior Walls:		B03: Type of walls Earth/mud.....1 Concrete/flag stone/cement....2 Tile/bricks.....3 Wood.....4 Other.....5
B04. How many rooms are there in this dwelling? (Do not count bathrooms, hallways, garage, toilet, cellar)		B06: Cooking fuel LPG .....1; Electricity .....2; Piped or liquid propane gas (biogas)....3; Kerosene...4; Charcoal.....5 Firewood....6; Animal dung....7; Agricultural crop residue...8; Other (specify) 9
B05. Does this household have electricity? Yes = Y; No = N		
B06. What is the main source of cooking fuel for your household?		
B07. Does your household have a toilet? Yes = Y; No = N		B07b. Type of toilet Flush, shared....1; Flush, private.....2 ; Ventilated improved pit latrine....3; Pit Latrine...4; Community toilet....5; Pan / bucket.....6; Open defaecation.....7; others 8
B07a. If yes, how many members use the toilet?	Adult:	
	Children:	
Bo7b. What is the main type of toilet your household uses?	Type:	
B08. What is the main source of drinking water for your household?		B08 :Drinking water source Piped into home ....1; Piped into plot/yard....2; Public tap.....3; Tube well/ borehole....4; Protected dug well.....5; Unprotected dug well .....6; River/ponds/ streams ...7; Tankers-truck/vendor .....8; Bottled water ...9; Other (specify) ..10
B08a. Who collects/fetches water? Name of family member (S)		
B08b. How much time does it take for each trip? (time in mins)		
B08c. How many trips per day?		

Table 6. Individual questionnaire for the dwelling characteristics of the individuals

Anthropometry and clinical assessments

Following table is the facsimile of the individual dietary intake and the format of the data that was used in the study.

Table 8. Individual Dietary Intake

Particulars	Serial Number of the Individual				
	1	2	3	4	5
Unique ID					
Name of the Individual					
Age in years					
Sex					
Physiological Status(P/L/C)					
Height					
Weight					
Arm circumference(MUAC)					
Body Mass Index(BMI)					

Nutrition survey

The nutritional and anthropometric data of pregnant and lactating mothers having children of the age 3-5 years. From the complete data there were 645 pairs of pregnant and lactating mothers having children of 3-5 years of age were found. The

C. NUTRITIONAL STATUS of RESPONDENT MEMBERS

No.	Write Name of the member and member ID	Member 1 Name: Member ID: Age: Pregnant/lactating	Member 2 Name: Member ID: Age: Adolescent	Member 3 Name: Member ID: Age: Child 1– Male/Female	Member 4 Name: Member ID: Age: Child 2– Male/Female
C01	WEIGHT IN KILOGRAMS:	□□.□	□□.□	□□.□	□□.□
C02	HEIGHT IN CENTIMETERS:	□□□.□	□□□.□	□□□.□	□□□.□
C03	BMI (Automatically calculated in the soft copy version)				
C04	ARM CIRCUMFERENCE IN CENTIMETERS:	□□□.□	□□□ □	□□□.□	□□□.□
C05	HAEMOGLOBIN ESTIMATION in GRAMS: Note the reading Circle the group	□□□.□ Less than 7 gs/7-9 gs/ above 9 gs	□□□.□ Less than 7 gs/7-9 gs/ above 9 gs	□□□.□ Less than 7 gs/7-9 gs/ above 9 gs	□□□.□ Less than 7 gs/7-9 gs/ above 9 gs
C06	ANY CHRONIC DISEASE : Y/N; if yes name if they know				

Table 6. Nutrient Status of the respondents.

Statement of the problem

The main purpose of this study is to find out what are the socio economic factors influence the nutritional statuses of women and children. The socio economic factors that were selected in this study were literacy of the mother, physiological status of the mother (weather pregnant or lactating), Age of the mother, Household size, per capita income, Marital age of the mother, Related by blood with the spouse, Literacy of the head of the household, Usage of Toilet, Source of drinking water.

Table 7. Facsimile of the socio economic factors used in the study

SNo	Unique ID	Name of the Member	Name of the child	Literacy of the mother	Status	Age	Household size
1							

2	
3	
4	
5	

Continuation of Table 7.

SNo	Per Capita Income	Marital Age	Related by blood with spouse	Literacy of the head of the household	Usage of Toilet	Source of drinking water
1						
2						
3						
4						
5						