The association between iron supplementation during pregnancy and childhood and anemia status among one to five year old children in India

Professional publication framework

By: Monica Steffi Thomas

Advising team:

Vahe Khachadourian, MD, MPH

Anahit Demirchyan, MD, MPH

Gerald and Patricia Turpanjian School of Public Health

American University of Armenia

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Abstract

Background: The prevalence of anemia among children six to fifty-nine months of age varies from 38% to 78% in different states of India. The National Nutritional Anemia Control (NNAC) program tries to combat anemia by providing supplementation for both pregnant women and children (one to five years old).

Objectives: The study sought to identify whether iron and folic acid supplementation of mothers during their pregnancy and for children (aged from one to five years) provided in the scope of NNAC program decreased the rate of anemia among children in India.

Methods: Secondary data analysis was performed using the data from the "National Family Health Survey 2005 – 06 (NFHS – 3)". Descriptive analysis of the selected characteristics in the total sample and by child's anemia status was done. The confounders of the associations of interest were identified through univariate logistic regression analyses. Multivariable logistic regression models were used to identify the adjusted associations between child's anemia status and iron supplementation (during pregnancy and during childhood) while controlling for the identified confounders of each association. Finally, a model of significant predictors of anemia among 6 – 59 month old children was fitted.

Results: The multivariable logistic regression analysis with 6 – 59 months old child's "anemia status" as the outcome and mother's "supplementation during pregnancy" as the independent variable did not show any statistically significant association (p=0.785). Similarly, the multivariable logistic regression with 12 – 59 months old child's "anemia status" as the outcome and "supplementation during childhood" as the independent variable did not show any statistically significant association (p=0.788). The variables which had significant association with "anemia status of the child" in the fitted model were age of the child (OR=0.96; 95% CI

0.96 – 0.96), age of mother at 1st birth (OR=1.49; 95% CI 1.40 – 1.58), anemia of mother (OR=1.82; 95% CI 1.63 – 2.03), family's wealth index (OR=1.57; 95% CI 1.29 – 1.92), type of caste or tribe of the household (OR=1.14; 95% CI 1.02 – 1.27), highest educational level of the mother (OR=1.33; 95% CI 1.15 – 1.54), birth weight of the child (OR=0.83; 95% CI 0.75 – 0.94), diet diversity score (OR=0.95; 95% CI 0.92 – 0.98) and sex of the child (OR=0.83; 95% CI 0.74 – 0.92).

Conclusions and recommendations: The current schedule of iron supplementation during pregnancy and childhood should be revised and reinforced. A more holistic approach is required in combating childhood anemia in India, including creating awareness among families on the importance of mother's age (over years) at her first birth, diet diversity of a child and preventing maternal anemia, as well as specifically targeting vulnerable sections of the population (backward castes, low wealth index households).

Contents

Background

Anemia is a condition in which body doesn't have ample healthy red blood cells to carry sufficient oxygen to tissues and organs.[1] "Prevalence of anemia among children (under age five) is the percentage of children (under age five) whose hemoglobin level is less than 110 grams per liter at the sea level".[2] When compared to other age groups, children between six and fifty-nine months have a disproportionately higher level of anemia.[3] The prevalence of anemia among children under five worldwide was 43.1% in 2011.[4] The prevalence of anemia among children six to fifty-nine months of age varies from 38% to 78% in different states of India.[5] Its prevalence is the highest in children from six to thirty-five months of age (79%).[5] In 2011, the prevalence of anemia among children six to fifty-nine months of age was 59% in India.[4] Although most of the anemic cases have iron deficiency anemia, anemia is a multifactorial disease, and its causes vary by geography, age, and sex.[6] These causes reflect complex interactions between nutrition, infectious diseases and other factors; thus making the task of finding the determinants of anemia challenging.[3]

In young children, the signs of anemia, among other symptoms, include stunted growth and development, and behavioral problems.[7] Iron deficiency anemia has specific effects like stunted psychomotor development and cognitive impairment.[8,9] Many studies have been conducted to find the determinants of anemia, the sets of which vary depending on the region of the study. The determinants identified so far are age of the child[10,11,12,13,14], exclusive breastfeeding duration[15], literacy of parents[13,15], household income[11,13,15,16], caste of the household[17,18], geographical location[13,16], anemia of mother[10,15,16], nutritional status of the child[10,11,14,15,16], and diarrhea[15]. Anemia results in significant losses in terms of disability adjusted life years, premature death, and production losses.[19]

Iron supplementation is a part of WHO guidelines in combating anemia and it has been successfully implemented in many countries to treat and prevent anemia.[20] A randomized controlled trial of iron supplementation among Brazilian preschool children showed 15% decrease in anemia rates after ten months of iron supplementation.[21] A randomized, placebo controlled clinical trial showed that iron supplementation significantly reduced iron deficiency anemia among Honduran infants (four to nine months).[22] Similarly, a double blinded randomized study showed that iron supplementation had a significant impact in improving the iron status among six to thirty six month old Togolese children.[23] Another double blinded, placebo-controlled trial done among 289 preschoolers showed that iron supplementation reduced the prevalence of anemia from 37.2% to 16.2% ($p < 0.001$).[24] Thus iron supplementation can be used to decrease the prevalence of anemia.

Nutritional Anemia Prophylaxis Program

The Ministry of Health and Family Welfare of India launched the Nutritional Anemia Prophylaxis Program in 1970 and as anemia continued to become prevalent among children, in 1991, the program was reassigned as the National Nutritional Anemia Control (NNAC) Program.[25] The program is implemented through primary health centers and sub centers, and aims at decreasing the prevalence and incidence of anemia among the susceptible sections of the population, namely “pregnant and lactating women, intrauterine device (IUD) users, and children in the one-to-five year age group”.[26] It focuses on three important strategies: “promotion of regular consumption of foods rich in iron, provisions of iron and folate supplements in the form of tablets to the high risk groups, and identification and treatment of severely anemic cases”.[26]

The program recommends:

- Pregnant women to have one big tablet (containing 100 mg iron and 500 mg folic acid) per day for 100 days after the first trimester of pregnancy. The same dose is recommended for lactating mothers.[26]
- Preschool children (one to five years old) to take one small tablet (containing 20 mg iron and 100 mg folic acid) per day, two times a week for ~100 days every year.[26]

A study evaluating the program in Andhra Pradesh found that only 19% of the pregnant women and 1% of the child beneficiaries had received their supplementations.[27] The study further showed that the main reasons for the poor coverage included inadequate and irregular supplies of the supplements and incomplete registration of beneficiaries by the health centers.[27] The chemical analysis of the supplements also found out that 30% of them had less than recommended iron levels and none of them had the recommended folic acid levels.[27] Another study evaluated the program in the Dharwad taluk and found that there was an irregular supply and 10% of the subjects had not received the tablets even once.[28] The prevalence of anemia among Indian children from 6 – 35 months in 2005 was 79%, whereas in 1998 it was 74%. The increase in the rates of anemia clearly demonstrated the need for strengthening the program. WHO guidelines suggest that if the prevalence of anemia among children aged six to twenty three months is greater than 40% (in India it is 54%)[4]; daily iron supplementation (10 – 12.5 mg elemental iron) for three consecutive months in a year should be given from six to twenty-four months of age.[29] In the same way, daily iron supplementation (30 mg elemental iron) for three consecutive months in a year should be given for children from twenty-four to fifty-nine months.[29] The prevalence of anemia in the age group of under five year old children is 59% in India (greater than 40%).[4] WHO guidelines also suggest that if the prevalence of anemia among pregnant women is greater than 40% (in India it is 54%)[4,30]; daily supplementation (30 – 60 mg of elemental iron and 400 mcg folic acid) is indicated throughout pregnancy starting as early as possible.[31] As it is evident from the above-mentioned, the iron and folic acid supplementation schedule applied in India differs in some extent from the WHO recommendations in both the dosage and duration.

Conceptual framework for inter-relationship of anemia and iron supplementation for the child:
Anemia can be caused by different factors including iron deficiency, folic acid deficiency, chronic diseases, sickle cell disease, infections (malaria and schistosomiasis) and other diseases.[3] Iron deficiency is the most typical cause of anemia.[6] The bone marrow requires iron to produce hemoglobin which is essential for the production of red blood cells. Concentration of hemoglobin in blood one to three days after birth is 18.5g/dl, the highest level ever present during the entire life.[32] At about four months, a gradual shift occurs and the rapid growth needs of the infant result in a decrease of hemoglobin concentration.[32] By the end of six months, the hemoglobin concentration is 11.5g/dl; indicating the necessity of iron supplementation to maintain a mean of 12.5g/dl along with meeting the physiological growth needs of the infant.[32]

Conceptual framework for influence of maternal anemia on anemia of the child:
A study shows that the anemia status of the child depends on the mother's anemia status during pregnancy, while controlling for morbidity, feeding practices and socio economic status.[33] Studies also show how the serum ferritin level of the child is closely related to the anemia status of the mother.[34,35] Further studies have shown that iron levels in the breast milk are less if the mother is anemic, thus predisposing the child to anemia.[36] A study in Germany, showed that anemia during pregnancy is a risk factor for maternal anemia during early postpartum period.[37]

Study aims

The first aim of this study is identifying whether there is significant difference in anemia rates between those children whose mothers followed the iron supplementation schedule during pregnancy in accordance with NNAC program and those whose mothers did not follow it. If the study identifies a difference in favor to the NNAC program, this may urge additional efforts to increase the coverage of the NNAC program, thereby greatly reducing the burden of anemia. The second aim of this study is to identify whether there is significant difference in anemia rates between those children who follow the iron supplementation schedule in accordance with NNAC program and those who do not follow it. The third aim is to find the predictors of anemia among 6 – 59 months old children in India.

Research questions:

- Does folic acid and iron supplementation for the mother during pregnancy have an effect on 6 – 59 months child's anemia status?
- Does iron supplementation during pre-school years (from one to five years) have an effect on 12 – 59 months child's anemia status?
- What are the predictors of anemia among 6 – 59 months old children in India?

Methods

Secondary data analysis was performed using the data from the "National Family Health Survey 2005 – 06 (NFHS – 3)".

National Family Health Survey 2005-06 (NFHS – 3)

National Family Health Survey (NFHS – 3) was carried out in 2005 – 06 by the International Institute for Population Sciences (IIPS) under the supervision of the Government of India. It was a household survey collecting data on the characteristics of population, health and nutrition. The

NFHS – 3 samples were nationally representative and included 109,041 households, 74,369 men (15 – 54 years), and 124,385 women (15 – 49 years). There were three survey schedules (Household, Woman's, and Man's) with different questionnaires to analyze their respective characteristics. All three surveys were carried out under the governance of the Ministry of Health and Family Welfare, with the International Institute for Population Sciences, Mumbai, as the prime agency. The survey was accompanied with testing of more than 200,000 adults and young children for anemia, using the HemoCue instrument. Young children included those between six to fifty-nine months of age at the time of the survey. The fieldwork for NFHS – 3 was carried out from December 2005 to August 2006 and the exact period varied across states of India.

Target population:

- Children between six to fifty-nine months of age who were included in the NFHS – 3 (2005 – 06) to address the first and third research questions of the study.
- Children between twelve to fifty-nine months of age who were included in the NFHS – 3 (2005 – 06) to address the second research question of the study (the association between iron supplementation during one to five years and child's anemia status).

Only a subsample consisting of the youngest children in families between the age of six and fifty-nine months (for the first and third aims) and between the age of twelve and fifty-nine months (for the second aim) was taken from the dataset; as information on certain intervening variables (folic acid and iron supplementation during pregnancy, child's diet diversity and excessive fatigue as a sign of anemia of mother during pregnancy) was available only for the last child.

Inclusion criteria for study subjects:

- Being included in NFHS – 3 2005 – 06 survey.

- Being a child aged six to fifty-nine months (twelve to fifty-nine months for the second research question).
- Being the last child in the family.

Variables:

The **outcome variable was**:

- Presence or absence of anemia in a child.

The **exposures of interest were**:

- Iron and folic acid supplementation of mother during pregnancy.
- Iron and folic acid supplementation of child (between twelve to fifty-nine months of age).

Possible covariates and confounders:

1. Age of the child:

Several studies show that the age group of twenty-four months and below is strongly associated with anemia of the child.[10,11] It is also associated with iron supplements taken by the child as according to the National Nutritional Anemia Control Program; the supplements are only a part of the recommendations and are not strongly enforced among older children. Thus the child may not be given supplements by the parents after a few years of supplementation.

2. Literacy of parents:

Studies show that the literacy of parents have a strong negative association with anemia status of the child.[13,15] The main reason for this is that more literate parents are better aware about the prevalence of anemia and thus follow the supplementation guidelines for both mother and child better.

3. Household income:

Studies show that lower household income is associated with anemia in the child.[11,16] The pathway for this association can be low literacy of parents and thus indirectly lower consumption of the supplements by mother and child, as well as low likelihood of iron-rich food consumption of the child.

4. Caste of the household:

Studies clearly show that scheduled caste and scheduled tribe (most disadvantageous) are independent risk factors for the development of anemia in the child.[17,18] Different castes tend to have different awareness and perception about taking iron supplements and child feeding practices. This is also related to the cultural beliefs attached to it.

5. Current anemia of mother (hemoglobin below 110 g/l):

Studies in different countries show that an anemic mother is more likely to have an anemic child.[10,15,16] However, a different direction of association between this variable and child's anemia is also possible as mothers who are anemic might be extra cautious in following the guidelines for iron supplementation for their children.

6. Women before the age of eighteen years becoming mothers:

Mothers under eighteen years are at a higher risk of developing maternal anemia and thus having an anemic child.[38,39] A possible reason for higher rate of pregnancy anemia among teenagers is that they are more likely to have less knowledge on the requirements of pregnancy and thus are less adherent to taking supplements or giving those to the baby.

7. Breastfeeding status and duration:

Studies show that exclusive breastfeeding for the child protects the child from subsequently developing anemia when "maternal anemia status, birth weight, gestational age and cord clamping are normal".[40] This can be further explained by the fact that breast milk's iron is far more easily absorbed by the child.[41]

8. Diet diversity of child:

Studies show that poor dietary diversity is associated with a higher prevalence of anemia.[42,43] It is due the direct relation of the micronutrient intake with the diet diversity.

9. Recent diarrhea in child:

Studies show that recent diarrhea (two weeks or a week before the time of interview) is associated with anemia of the child.[15,44] This may be because of poor absorption of iron or blood loss from intestines due to diarrhea.

10. Child undernutrition:

Studies show that stunting and wasting of the child are associated with his/her anemia status[11,45] It can be explained by the relation between dietary nutrient consumption and the growth of the child.

11. Household heating and cooking fuel:

Studies show that the use of bio-fuels for heating and cooking in households has been associated with higher risk of anemia and stunting among children.[46,47] There are also other studies which show that the use of biomass fuel is also associated with higher rates of maternal anemia.[48]

12. Sequential number of child in the family:

Studies show that higher birth order of a child is positively associated with the anemia status of the child.[49,50]

Data collection and analysis:

Secondary data collection was done from the NFHS – 3 databank and the entire analysis was done using SPSS version 16 statistical software package. The data was analyzed by conducting logistic regression analysis as the outcome variable was dichotomous. Descriptive data analyses of the selected characteristics (means and SDs for continuous variables and proportions for categorical variables) were done among the total sample comparing the groups of six to fifty-nine month old children that have and don't have anemia. The statistical significance of the difference between these characteristics was measured using the *chi-square test* for categorical variables; while using the student t-test for continuous variables. For logistic regression analysis, the categorical variables with more than two categories were either dichotomized or dummy variables were created. Crude associations of all the variables with $P< 0.25$ in the descriptive analyses with anemia as the outcome were evaluated by univariate logistic regression analyses (in both the groups of six to fifty-nine and twelve to fifty-nine months old children). As a next step, all those variables significantly associated with child's anemia status were entered into univariate logistic regression analyses (treating supplementation during pregnancy for six to fifty-nine month old children and supplementation of the child for twelve to fifty-nine month old children) to identify the confounders of the associations of interest. Following identification of confounding variables, multivariable logistic regression was applied to evaluate the adjusted associations of interest (the association of "supplementation of the mother and the anemia status of the child" and "supplementation of the child with anemia status of the child").

The large sample size of this study resulted in ample significant associations, therefore, in addition to the statistical significance; the student investigator further assessed the findings by their practical relevance (effect size). Effect size helps to find the magnitude of the difference, whereas the statistical significance helps to find whether that difference happened by chance.[51] Effect size can be set at 0.5 standardized difference between the means in the compared groups, as it signifies a moderate difference.[51] The effect size was calculated by comparing the change of odds ratio of the main association while adding each variable in the multivariable model. Only those variables that produced a 5% or more change of odds ratio of the main association were included in the final multivariable logistic regression model.

Logistical Considerations:

There were no extra expenses required during this study as an already available database was used for the analysis.

Ethical considerations:

This study had minimal risk as it included analysis of a publicly available dataset that had no identifiables.

Resources:

There was a requirement of a computer system and SPSS to efficiently manage and analyze data. An electronic data extraction form (attached as an Appendix) was developed by combining the required questions from the original questionnaire used in the survey. The required questions were all those that have information pertaining to the independent, dependent, and intervening variables. This was developed to make the data extraction from the dataset easier.

Results

The entire dataset was cleared up to get the target population of last-born six to fifty-nine month old children which included 29,916 cases in total. As Table 1 shows, the sample consisted of 54.3% male and 45.7% female children. Of all the 16 variables analyzed, gender was the only variable that was not statistically significantly (P = 0.7) associated with anemia status. It was seen that 67.3 % of mothers were taking iron and folic acid supplementation while only 6.1% of children (12 – 59 months) were taking iron and folic acid supplementation. Children in the group without anemia had mothers with secondary education in 44.4% of cases and no education in 29.2% of cases in contrast to the group with anemia: 36.0% and 42.9%, respectively (P <0.001). Fathers of children without anemia had no education in 15.9% of cases whereas fathers of those with anemia in 25.4% of cases (P <0.001). When comparing the wealth index of households, 20% of children in the anemic group had the poorest wealth index whereas in the non-anemic group, only 10.3% had the poorest health index (P <0.001). Wood and liquefied petroleum gas (LPG) were the main types of fuel used for cooking and were used by 42.8% and 37.7% of families, respectively, among the group without anemia in contrast to 51.4% and 23.9% of families among the group with anemia (P <0.001). As Table 2 shows, the mean age of children in the group without anemia was 34.2 (SD 15.2) months; whereas the mean age of children in the anemic group was 26.0 (SD 14.1) months, which was significantly lower (P<0.001).

As demonstrated in Tables 3 and 4, the identified confounders between anemia and supplementation during pregnancy were age of respondent at 1st birth, anemia of mother, months of breastfeeding, child's birth order, wealth index, type of caste or tribe of the household, type of cooking fuel, highest educational level of the mother, highest educational level of the father, birth weight of the child, diet diversity score, and iron supplementation of the child. As Table 5 shows, the multivariable logistic regression with "anemia status" as the outcome (six to fifty-nine months) and supplementation during pregnancy as the independent variable controlled for all the identified confounders that produced >5% change in the odds ratio of the main association when being included in the model did not show any statistically significant association (P=0.785).

Based on the results provided in Tables 6 and 7, the identified confounders between anemia and supplementation of the child were age of respondent at 1st birth, anemia of mother, months of breastfeeding, child's recent diarrhea, child's birth order, wealth index, type of caste or tribe of the household, type of cooking fuel, highest educational level of the mother, highest educational level of the father, child's diet diversity score, and iron supplementation of the mother. As Table 8 shows, the multivariable logistic regression with "anemia status" as the outcome (twelve to fifty-nine months) and child's supplementation as the independent variable controlled for all the identified confounders that produced >5% change in the odds ratio of the main association when being included in the model did not show any statistically significant association (P=0.788).

Next, a model of significant predictors of "anemia status of the child" among six to fifty-nine months old children was fitted (Table 9). It identified that when controlled for all other significant variables, for every one month increase in age of the child the risk of anemia in child decreases by 4%. Mothers who were less than eighteen years old at the time of their first delivery had 1.49 times higher odds for their child being anemic than mothers who were more than eighteen years. Current anemia of the mother (hemoglobin <120g/l) increased the likelihood of the child being anemic by 1.82 times as compared to non-anemic mothers. Children belonging to households with poor and middle wealth index had, respectively, 1.57 and 1.18 times higher odds of being anemic as compared to children from households with rich wealth index. Scheduled caste, scheduled tribe and other backward caste households had 1.14 times higher odds of the child being anemic as compared to any other caste households. Mothers whit no or primary education had 1.33 times higher odds for their child being anemic as compared to mothers with secondary or higher education. Children whose birth weight was more than 2500 grams had 17% decreased risk of being anemic as compared to children whose birth weight was less than 2500 grams. Each one unit increase of diet diversity score decreased the risk of the child of being anemic by 5%. Female children had 17% lower risk of being anemic as compared to male children.

Discussion

Iron and folic acid supplementation of mothers during pregnancy and preschool years (one to five years) did not have any effect on the anemia status of the child in this study. The identified significant anemia predictors among six to fifty-nine month old children included younger age of the child, young age of mother at the first delivery (less than years), anemia of mother (<120g/l), family's lower wealth index, backward caste, lower educational level of mother, low birth weight of the child, low diet diversity score of the child and male sex of the child.

There may be various reasons for no significant association between iron supplementation of child and anemia status. There was a very low rate of the children being supplemented (6.1%); which might have introduced a bias as a higher proportion of those who took the supplements belonged to groups which were protective (rich and forward castes households). The questionnaire (refer to Appendix) also had not framed the question of asking the mother about her child's supplementation very aptly (by asking if the child was taking supplements currently); which might have introduced an instrumental error resulting in misclassification of children who received supplements according to the existing recommendations. The non – significant association may also be due to the ineffectiveness of the NNAC program because of inadequate and irregular supplies of the supplements[27], incomplete registration of beneficiaries by the health centers[27] and poor bioavailability of iron and folic acid in the supplements[28]. The reasons for the ineffectiveness of iron supplementation of the mother on the anemia status of the child may include inadequate dosage or duration of the supplements; as these are not in line with WHO's recommendation of "daily supplementation (30 – 60 mg of elemental iron and 400 mcg folic acid)", which is indicated "throughout pregnancy starting as early as possible". It may also be due to improper dosage of iron and folic acid in the supplements as seen in other studies.[27]

Age as a predictor of anemia status in the child is an important finding as the NNAC program does not include six to twelve month old children who have a very high predisposition of being anemic. Young age of the mother (less the eighteen years) at her first pregnancy produces higher risk for her child to be anemic, which is consistent with other studies.[16] Studies show that India has a high level of early childbearing (before the age of eighteen years) which is associated with poor nutritional status of the mother and thus contributes to anemia.[39] Wealth index of the household is associated with anemia status of the child as seen in other countries[3], which may be related to ability to provide better nutrition and better health services to the child. There is also a dose response relationship within the category of "Wealth index of the family"; as the poorest households had the highest risk and the middle households had higher risk of the child being anemic as compared to the rich category. Children of scheduled caste, scheduled tribe and other backward castes have increased risk of anemia[17] which may be due to social and economic disadvantages of these castes. Children of mothers with higher education are at lower risk of anemia,[13] which may be related to better nutrition status of both the mother and the child.

The sequential number of the child in the family[49], breastfeeding duration[40] and type of cooking fuel[47] are not found to be associated with anemia in this study, which is inconsistent with other studies.

Recommendations

The NNAC program should have a more holistic approach to address the high anemia prevalence in India. Its target groups should include children starting from six months of age, households with poor wealth index and lower caste. It should also bring awareness about the ill effects of early childbearing on the child. Mothers should be educated about how their anemia status can affect the anemia status of the child. NNAC program should also focus on improving the diet diversity of children.

References

1. Anemia Causes, Types, Symptoms, Diet, and Treatment. http://www.webmd.com/a-to-z-guides/understanding-anemia-basics#3. Accessed May 28, 2017.
2. *World Development Indicators*. Fifteenth. Washington, D.C; 2011.
3. Balarajan Y, Ramakrishnan U, Özaltin E, Shankar AH, Subramanian S V. Anaemia in low-income and middle-income countries. *Lancet*. 2017;378(9809):2123-2135.
4. Prevalence of anemia among children (% of children under 5) | Data. http://data.worldbank.org/indicator/SH.ANM.CHLD.ZS. Accessed May 28, 2017.
5. Kotecha P V. Nutritional anemia in young children with focus on Asia and India. *Indian J Community Med*. 2011;36(1):8-16.
6. Kassebaum NJ, Jasrasaria R, Naghavi M, et al. A systematic analysis of global anemia burden from 1990 to 2010. *Blood*. 2014;123(5):615-624.
7. What Are the Signs and Symptoms of Iron-Deficiency Anemia? - NHLBI, NIH. https://www.nhlbi.nih.gov/health/health-topics/topics/ida/signs. Accessed May 28, 2017.
8. Walter T, de Andraca I, Chadud P, Perales CG. Iron deficiency anemia: adverse effects on infant psychomotor development. *Pediatrics*. 1989;84(1):7-17.
9. Lozoff B, Beard J, Connor J, Felt B, Georgieff M, Schallert T. Long-lasting neural and behavioral effects of iron deficiency in infancy. *Nutr Rev*. 2006;64(5 Pt 2):S34-S43; discussion S72-S91.
10. Ayoya MA, Ngnie-Teta I, Séraphin MN, et al. Prevalence and Risk Factors of Anemia among Children 6–59 Months Old in Haiti. *Anemia*. 2013;2013:1-3.
11. Gebreegziabiher G, Etana B, Niggusie D. Determinants of Anemia among Children Aged 6–59 Months Living in Kilte Awulaelo Woreda, Northern Ethiopia. *Anemia*. 2014;2014:1-9.
12. Osório MM, Lira PIC, Ashworth A. Factors associated with Hb concentration in children aged 6–59 months in the State of Pernambuco, Brazil. *Br J Nutr*. 2004;91(02):307.
13. Bharati S, Pal M, Chakrabarty S, Bharati P. Socioeconomic Determinants of Iron-Deficiency Anemia Among Children Aged 6 to 59 Months in India. *Asia Pacific J Public Heal*. 2015;27(2):NP1432-NP1443.
14. Barreto ML. Childhood anemia prevalence and associated factors in Salvador , Bahia , Brazil Prevalência e fatores associados à ocorrência da anemia em pré-escolares na cidade de Salvador , Bahia , Brasil. 2004;20(6):1633-1641.
15. Agho KE, Dibley MJ, D'Este C, Gibberd R. Factors associated with haemoglobin concentration among Timor-Leste children aged 6-59 months. *J Heal Popul Nutr*. 2008;26(2):200-209.
16. Khan JR, Awan N, Misu F. Determinants of anemia among 6–59 months aged children in Bangladesh: evidence from nationally representative data. *BMC Pediatr*. 2016;16(1):3.
17. Vart P, Jaglan A, Shafique K. Caste-based social inequalities and childhood anemia in India: results from the National Family Health Survey (NFHS) 2005–2006. *BMC Public*

Health. 2015;15(1):537.

18. Goswmai S, Das KK. Socio-economic and demographic determinants of childhood anemia. *J Pediatr (Rio J)*. 2015;91(5):471-477.
19. Plessow R, Arora NK, Brunner B, et al. Social Costs of Iron Deficiency Anemia in 6-59-Month-Old Children in India. *PLoS One*. 2015;10(8):e0136581.
20. Pasricha SR, Hayes E, Kalumba K, Biggs BA. Effect of daily iron supplementation on health in children aged 4-23 months: A systematic review and meta-analysis of randomised controlled trials. *Lancet Glob Heal*. 2013;1(2):e77-e86.
21. Coutinho GG, Cury PM, Cordeiro JA. Cyclical iron supplementation to reduce anemia among Brazilian preschoolers: a randomized controlled trial. *BMC Public Health*. 2013;13(1):21.
22. Domellöf M, Cohen RJ, Dewey KG, Hernell O, Rivera LL, Lönnerdal B. Iron supplementation of breast-fed Honduran and Swedish infants from 4 to 9 months of age. *J Pediatr*. 2001;138(5):679-687.
23. Berger J, Dyck JL, Galan P, et al. Effect of daily iron supplementation on iron status, cell-mediated immunity, and incidence of infections in 6-36 month old Togolese children. *Eur J Clin Nutr*. 2000;54(1):29-35.
24. Palupi L, Schultink W, Achadi E, Gross R. Effective community intervention to improve hemoglobin status in preschoolers receiving once-weekly iron supplementation. *Am J Clin Nutr*. 1997;65(4):1057-1061.
25. Kapur D, Nath Agarwal K, Kumari Agarwal D. Nutritional anemia and its control. *Indian J Pediatr*. 2002;69(7):607-616.
26. Kumar A. National nutritional anaemia control programme in India. *Indian J Public Health*. 43(1):3-5, 16.
27. Vijayaraghavan K, Brahmam GN, Nair KM, Akbar D, Rao NP. Evaluation of national nutritional anemia prophylaxis programme. *Indian J Pediatr*. 57(2):183-190.
28. Malagi U, Reddy M, Naik RK. Evaluation of National Nutritional Anaemia Control Programme in Dharwad (Karnataka). *J Hum Ecol*. 2006;20(4):279-281.
29. World Health Organization. *Guideline Daily Iron*.; 2016. http://apps.who.int/iris/bitstream/10665/204712/1/9789241549523_eng.pdf?ua=1.
30. Stoltzfus RJ, Dreyfuss ML. *Guidelines for the Use of Iron Supplements to Prevent and Treat Iron Deficiency Anemia*.; 1998.
31. World Health Organization. *WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience*.; 2016.
32. Hoffman R. *Hematology : Basic Principles and Practice*. Fifth. Philadelphia, PA: Saunders/Elsevier; 2013. http://www.123library.org/book_details/?id=112759.
33. Colomer J, Colomer C, Gutierrez D, et al. Anaemia during pregnancy as a risk factor for infant iron deficiency: report from the Valencia Infant Anaemia Cohort (VIAC) study. *Paediatr Perinat Epidemiol*. 1990;4(2):196-204.
34. Tekinalp G, Oran O, Gürakan B, et al. Relationship between maternal and neonatal iron

stores. *Turk J Pediatr*. 38(4):439-445.

35. De Benaze C, Galan P, Wainer R, Hercberg S. [Prevention of iron-deficiency anemia in pregnancy using early iron supplementation: a controlled trial]. *Rev Epidemiol Sante Publique*. 1989;37(2):109-118.

36. Lauwers J. Mentoring and precepting lactation consultants. *J Hum Lact*. 2007;23(1):10-12.

37. Bergmann RL, Richter R, Bergmann KE, Dudenhausen JW. Prevalence and risk factors for early postpartum anemia. *Eur J Obstet Gynecol Reprod Biol*. 2010;150(2):126-131.

38. Najati N, Gojazadeh M. Maternal and neonatal complications in mothers aged under 18 years. *Patient Prefer Adherence*. 2010;4:219-222.

39. Goli S, Rammohan A, Singh D. The Effect of Early Marriages and Early Childbearing on Women's Nutritional Status in India. *Matern Child Health J*. 2015;19(8):1864-1880.

40. Chaparro CM. Setting the stage for child health and development: prevention of iron deficiency in early infancy. *J Nutr*. 2008;138(12):2529-2533.

41. Saarinen UM, Siimes MA, Dallman PR. Iron absorption in infants: high bioavailability of breast milk iron as indicated by the extrinsic tag method of iron absorption and by the concentration of serum ferritin. *J Pediatr*. 1977;91(1):36-39.

42. Thando P Gwetu, Meera K Chhagan, Claire J Martin, Myra Taylor MC and SK. Anemia, Iron Deficiency and Diet Independently Influence Growth Patterns of School Aged Children in South Africa. *Acad J Pediatr Neonatol*. 2016;1(3):1-8.

43. Woldie H, Kebede Y, Tariku A. Factors Associated with Anemia among Children Aged 6–23 Months Attending Growth Monitoring at Tsitsika Health Center, Wag-Himra Zone, Northeast Ethiopia. *J Nutr Metab*. 2015;2015:1-9.

44. Howard CT, de Pee S, Sari M, Bloem MW, Semba RD. Association of diarrhea with anemia among children under age five living in rural areas of Indonesia. *J Trop Pediatr*. 2007;53(4):238-244.

45. Muchie KF. Determinants of severity levels of anemia among children aged 6–59 months in Ethiopia: further analysis of the 2011 Ethiopian demographic and health survey. *BMC Nutr*. 2016;2(1):51.

46. Demirchyan A, Petrosyan V, Sargsyan V, Hekimian K. Prevalence and Determinants of Anemia among Children Aged 0-59 Months in a Rural Region of Armenia: A Case-Control Study. *Public Health Nutr*. 2015;62(1):1-10.

47. Mishra V, Retherford RD. Does biofuel smoke contribute to anaemia and stunting in early childhood? *Int J Epidemiol*. 2007;36(1):117-129.

48. Page CM, Patel A, Hibberd PL. Does Smoke from Biomass Fuel Contribute to Anemia in Pregnant Women in Nagpur, India? A Cross-Sectional Study. Thatcher TH, ed. *PLoS One*. 2015;10(5):e0127890.

49. Rivera Damm R, Ruiz Astorga MR, Carrillo de Jiménez H, Hernández Alvarado AB, Sosa Curiel S. [Prevalence of anemia in a sample of school children in Durango City]. *Bol Med Hosp Infant Mex*. 36(3):507-517.

50. Sinha N, Deshmukh PR, Garg BS. Epidemiological correlates of nutritional anemia

among children (6-35 months) in rural Wardha, Central India. *Indian J Med Sci*. 2008;62(2):45-54.

51. Sullivan GM, Feinn R. Using Effect Size - or Why the P Value Is Not Enough. *J Grad Med Educ*. 2012;4(3):279-282.

Tables

Descriptive analysis of the selected characteristics by "anemia status" among the last born 6-59 month old children in India (based on National Family Health Survey 2005-2006 (NFHS 3) data)

Table 1: For categorical variables

Characteristic	No anemia (Hb		Anemia (Hb		P value*	Total sample	
	Number	Percentage	Number	Percentage		Number	Percentage
Sex of the child							
Male	4158	54.9	9215	54.7	0.700	16246	54.3
Female	3412	45.1	7632	45.3		13670	45.7
Age of the child							
6 - 23.9 month old	2104	27.8	8522	50.6		10626	43.5
24 - 41.9 month	2674	35.3	5411	32.1		8085	33.1
42 - 60 month old	2792	36.9	2914	17.3		5706	23.4
Highest educational level of mother							
No education	2213	29.2	7228	42.9	<0.001	11345	37.9
Primary	1032	13.6	2450	14.5		4170	13.9
Secondary	3362	44.4	6067	36.0		11645	38.9
Higher	963	12.7	1102	6.5		2755	9.2
Highest educational level of father							
No education	1190	15.9	4236	25.4	<0.001	6646	22.2
Primary	956	12.8	2595	15.6		4233	14.1
Secondary	3954	53.0	8003	48.0		14549	48.6
Higher	1367	18.3	1840	11.0		4158	13.9
Wealth index							
Poorest	783	10.3	3361	20.0	<0.001	4815	16.1
Poorer	1029	13.6	3212	19.1		5086	17.0
Middle	1472	19.4	3438	20.4		5981	20.0
Richer	1839	24.3	3598	21.4		6724	22.5
Richest	2447	32.3	3238	19.2		7310	24.4
Type of caste or tribe of the household							
Scheduled caste	1090	15.2	3227	20.0	<0.001	5100	17.0
Scheduled tribe	1019	14.2	2420	15.0		4628	15.5
Other Backward	2339	32.7	5828	36.1		9736	32.5
None of them	2714	37.9	4649	28.8		9088	30.4
Child's recent diarrhea(last two weeks)							
No	6915	91.4	14762	87.7	<0.001	26370	88.1
Yes, last two weeks	650	8.6	2074	12.3		3188	10.7
Birth weight							
Less than 2500 gm	1405	34.5	2708	38.6	<0.001	4885	16.3
More than 2500	2672	65.5	4315	61.4		8472	28.3

Characteristic	No anemia (Hb		Anemia (Hb		P value*	Total sample	
	Number	Percentage	Number	Percentage		Number	Percentage
Type of cooking fuel							
Electricity	40	0.5	84	0.5	<0.001	170	.6
LPG, natural gas	2852	37.7	4024	23.9		8839	29.5
Biogas	34	0.4	66	0.4		114	.4
Kerosene	269	3.6	615	3.7		1134	3.8
Coal, lignite	133	1.8	283	1.7		487	1.6
Charcoal	49	0.6	91	0.5		173	.6
Wood	3238	42.8	8662	51.4		14542	48.6
Straw/shrubs/grass	250	3.3	755	4.5		1097	3.7
Agricultural crops	176	2.3	492	2.9		748	2.5
Animal dung	527	7.0	1769	10.5		2602	8.7
Other	0	0.0	4	0.0		5	0.0
Iron and folic acid supplementation of mother during pregnancy							
No	1893	25.2	5447	32.5	<0.001	9308	31.1
Yes	2672	65.5	4315	61.4		20146	67.3
Iron supplementation of child (between twelve and fifty nine months)							
No	7011	93.1	15822	94.3	<0.001	27646	92.4
Yes	521	6.9	954	5.7		1820	6.1

***** p-values from Chi-square test

Table 2. For continuous variables

Characteristic	No anemia (Hb ≥110g/l)		Anemia (Hb <110g/l)		P value*	Total		
	Mean	Standard deviation	Mean	Standard deviation		Number	Mean	Standard deviation
Age of the child (months)	34.2	15.2	26.0	14.1	<0.001	29916	28.5	15.4
Age of mother at first birth (years)	20.8	4.1	19.8	3.6	<0.001	29916	20.2	3.9
Hemoglobin test result (g/dl) of mother	119.3	16.2	113.1	17.2	<0.001	28232	142.1	134.3
Months of breastfeeding	21.1	12.4	19.1	11	<0.001	29583	20.9	15.1
Child's diet diversity score	3.0	1.7	2.6	1.6	<0.001	19824	2.6	1.6
Child's birth order	2.6	1.7	2.8	1.8	<0.001	29916	2.5	1.5

* p values from Anova test.

For the first research question:

Table 3: Univariate logistic regression of the selected characteristics with "anemia status of the child" as the outcome among the last born 6-59 month old children in India (based on NFHS 3 data)

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Age of the child (months)				
6 - 23.9 month old	3.88	3.61	4.16	<0.001
24 - 41.9 month old	1.93	1.80	2.07	<0.001
42 - 60 month old	1.00	reference		
Age of respondent at 1st birth (< 18 years)	1.45	1.36	1.55	<0.001
Anemia of mother (<120 g/dl)	1.97	1.86	2.08	<0.001
Months of breastfeeding	0.98	0.98	0.99	<0.001
Child's birth order	1.07	1.05	1.09	<0.001
Child's recent diarrhea(last two weeks)	1.21	1.16	1.27	<0.001
Wealth Index				
Poor	2.27	2.13	2.42	<0.001
Middle	1.46	1.36	1.57	<0.001
Rich	1.00			
Type of caste or tribe of the household				
Scheduled caste, Scheduled tribe, Other Backward Class	1.50	1.42	1.59	<0.001
Any other class	1.00	reference		
Type of cooking fuel				
Electricity, LPG, natural gas and biogas	0.45	0.41	0.49	<0.001
Kerosene, Coal, Lignite, Charcoal, Wood	0.82	0.76	0.89	<0.001
Straw/shrubs/grass, Agricultural crops, Animal dung	1.00	reference		
Highest educational level of the mother				
No education and Primary	1.79	1.70	1.90	<0.001
Secondary and Higher	1.00	reference		
Highest educational level of the father				
No education and Primary	1.72	1.62	1.82	<0.001
Secondary and Higher	1.00	reference		
Birth weight of the child (≥2500 grams)	0.83	0.77	0.90	<0.001
Diet diversity score	0.84	0.82	0.86	<0.001
Iron and folic acid supplementation of mother during pregnancy	0.70	0.65	0.74	<0.001
Iron supplementation of child	0.81	0.72	0.90	<0.001

Table 4: Univariate logistic regression of the selected characteristics with "iron and folic acid supplementation during pregnancy" as the outcome among the last born 6-59 month old children in India (based on NFHS 3 data)

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Age of the child (months)				
6 - 23.9 month old	0.93	0.87	0.99	0.04
24 - 41.9 month old	0.96	0.89	1.03	0.25
42 - 60 month old	1.00	reference		
Age of respondent at 1st birth (< 18 years)	0.52	0.49	0.55	<0.001
Anemia of mother (<120 g/dl)	0.96	0.91	1.01	0.170
Months of breastfeeding	0.99	0.99	0.99	<0.001
Child's birth order	0.73	0.72	0.75	<0.001
Child's recent diarrhea(last two weeks)	1.01	0.97	1.05	0.409
Wealth Index				
Poor	0.25	0.24	0.27	<0.001
Middle	0.45	0.42	0.48	<0.001
Rich	1.00	reference		
Type of caste or tribe of the household				
Scheduled caste, Scheduled tribe, Other Backward Class	0.54	0.51	0.58	<0.001
Any other class	1.00	reference		
Type of cooking fuel				
Electricity, LPG, natural gas and biogas	4.43	4.08	4.81	<0.001
Kerosene, Coal, Lignite, Charcoal, Wood	1.39	1.30	1.49	<0.001
Straw/shrubs/grass, Agricultural crops, Animal dung	1.00	reference		
Highest educational level of the mother				
No education and Primary	0.26	0.25	0.27	<0.001
Secondary and Higher	1.00	reference		
Highest educational level of the father				
No education and Primary	0.37	0.36	0.39	<0.001
Secondary and Higher	1.00	reference		
Birth weight of the child (≥2500 grams)	1.20	1.09	1.33	<0.001
Diet diversity score	1.21	1.19	1.24	<0.001
Iron supplementation of child	3.64	3.15	4.21	<0.001

Table 5: Association between "anemia status of the child" and "iron and folic acid supplementation during pregnancy" controlled for the identified confounders among the last born 6-59 month old children in India (based on NFHS 3 data)**

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Supplementation during pregnancy	0.97	0.83	1.14	**0.785**
Age of respondent at 1st birth (years)	0.96	0.94	0.97	<0.001
Child's birth order	1.00	0.95	1.04	0.990
Wealth Index				
Poor	1.46	1.18	1.80	<0.001
Middle	1.15	0.97	1.36	0.103
Rich	1	Reference		
Type of cooking fuel				
Electricity, LPG, natural gas and biogas	0.82	0.65	1.03	0.093
Kerosene, Coal, Lignite, Charcoal, Wood	0.95	0.76	1.19	0.684
Straw/shrubs/grass, Agricultural crops, Animal dung	1	Reference		
Highest educational level of the mother				
No education and Primary	1.26	1.08	1.46	0.003
Secondary and Higher	1	Reference		
Highest educational level of the father				
No education and Primary	1.11	0.95	1.31	0.184
Secondary and Higher	1	Reference		
Birth weight of the child (≥2500 grams)	0.88	0.78	0.98	0.020
Diet diversity score	0.89	0.87	0.92	<0.001

* The association is adjusted for only those variables that were statistically significant in the univariate logistic regression analysis with both the outcome and the independent variable and which changed the odds ratio of the main association by 5%..

For the second research question:

Table 6: Univariate logistic regression of the selected characteristics with "anemia status of the child" as the outcome among the last born 12-59 month old children in India (based on NFHS 3 data)

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Age of the child (months)				
6 - 23.9 month old	3.91	3.61	4.23	<0.001
24 - 41.9 month old	1.91	1.78	2.05	<0.001
42 - 60 month old	1.00	Reference		
Age of respondent at 1st birth (< 18 years)	1.46	1.35	1.56	<0.001
Anemia of mother (<120 g/dl)	1.88	1.77	2.00	<0.001
Months of breastfeeding	0.99	0.98	0.99	<0.001
Child's birth order	1.07	1.06	1.09	<0.001
Child's recent diarrhea(last two weeks)	1.23	1.16	1.29	<0.001
Wealth Index				
Poor	2.32	2.16	2.48	<0.001
Middle	1.50	1.39	1.63	<0.001
Rich	1.00	reference		
Type of caste or tribe of the household				
Scheduled caste, Scheduled tribe, Other Backward Class	1.51	1.42	1.61	<0.001
Any other class	1.00	reference		
Type of cooking fuel				
Electricity, LPG, natural gas and biogas	0.44	0.40	0.49	<0.001
Kerosene, Coal, Lignite, Charcoal, Wood	0.82	0.75	0.89	<0.001
Straw/shrubs/grass, Agricultural crops, Animal dung	1.00	reference		
Highest educational level of the mother				
No education and Primary	1.85	1.74	1.96	<0.001
Secondary and Higher	1.00	reference		
Highest educational level of the father				
No education and Primary	1.77	1.66	1.88	<0.001
Secondary and Higher	1.00	reference		
Birth weight of the child	0.84	0.77	0.91	<0.001
Diet diversity score	0.82	0.80	0.84	<0.001
Iron and folic acid supplementation of mother during pregnancy	0.68	0.64	.0 73	<0.001
Iron supplementation of child	0.81	0.72	0.91	.001

Table 7: Univariate logistic regression of the selected characteristics with "iron supplementation of the child" as the outcome among the last born 12-59 month old children in India (based on NFHS 3 data)

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Age of the child (months)				
6 - 23.9 month old	1.07	0.94	1.23	0.287
24 - 41.9 month old	1.04	0.91	1.19	0.545
42 - 60 month old	1.00	reference		
Age of respondent at 1st birth (< 18 years)	0.58	0.50	0.66	<0.001
Anemia of mother (<120 g/dl)	0.87	0.78	0.97	0.011
Months of breastfeeding	0.98	0.98	0.99	<0.001
Child's birth order	0.80	0.77	0.83	<0.001
Child's recent diarrhea(last two weeks)	1.10	1.03	1.19	0.005
Wealth Index				
Poor	0.31	0.27	0.36	<0.001
Middle	0.50	0.43	0.58	<0.001
Rich	1.00	reference		
Type of caste or tribe of the household				
Scheduled caste, Scheduled tribe, Other Backward Class	0.80	0.72	0.89	<0.001
Any other class	1.00	reference		
Type of cooking fuel				
Electricity, LPG, natural gas and biogas	3.74	3.05	4.59	<0.001
Straw/shrubs/grass, Agricultural crops, Animal dung	1.71	1.39	2.10	<0.001
Kerosene, Coal, Lignite, Charcoal, Wood	1.00	reference		
Highest educational level of the mother				
No education and Primary	0.38	0.34	0.43	<0.001
Secondary and Higher	1.00	reference		
Highest educational level of the father				
No education and Primary	0.49	0.43	0.55	<0.001
Secondary and Higher	1.00	reference		
Birth weight of the child (≥2500 grams)	0.98	0.86	1.12	0.845
Diet diversity score	1.20	1.15	1.24	<0.001
Iron and folic acid supplementation of mother during pregnancy	3.64	3.15	4.21	<0.001

Table 8: Association between "anemia status of the child" and "iron supplementation during childhood" controlled for the identified confounders among the last born 12-59 month old children in India (based on NFHS 3 data)*

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Supplementation of the child	1.01	0.90	1.14	**0.788**
Age of respondent at 1st birth (years)	0.96	0.95	0.97	<0.001
Wealth Index				
Poor	1.52	1.38	1.68	<0.001
Middle	1.15	1.04	1.26	0.003
Rich	1	reference		
Type of cooking fuel				
Electricity, LPG, natural gas and biogas	0.77	0.69	0.86	<0.001
Kerosene, Coal, Lignite, Charcoal, Wood	0.90	0.82	0.98	0.024
Straw/shrubs/grass, Agricultural crops, Animal dung	1	reference		
Highest educational level of the mother				
No education and Primary	1.17	1.08	1.26	<0.001
Secondary and Higher	1	reference		
Highest educational level of the father				
No education and Primary	1.17	1.08	1.26	<0.001
Secondary and Higher	1	reference		
Iron and folic acid supplementation of mother during pregnancy	0.90	0.84	0.97	0.006

* The association is adjusted for only those variables that were statistically significant in the univariate logistic regression analysis with both the outcome and the independent variable and which changed the odds ratio of the main association by 5%..

For the third research question:

Table 9: Multivariate logistic regression model of anemia predictors among the last born 6-59 month old children in India (based on NFHS 3 data)

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Age of the child (months)	0.96	0.96	0.96	<0.001
Young age of mother at first birth (< 18 years)	1.49	1.40	1.58	<0.001
Anemia of mother (<120 g/dl)	1.82	1.63	2.03	<0.001
Wealth Index				
Poor	1.57	1.29	1.92	<0.001
Middle	1.18	1.01	1.38	.032
Rich	1	reference		
Type of caste or tribe of the household				
Scheduled caste, Scheduled tribe, Other Backward Class	1.14	1.02	1.27	.019
Any other class	1	reference		
Highest educational level of the mother				
No education and Primary	1.33	1.15	1.54	<0.001
Secondary and Higher	1	reference		
Birth weight of the child	0.83	0.75	0.94	.002
Diet diversity score	0.95	0.92	0.98	.006
Sex of the child (female)	0.83	0.74	0.92	.001

Appendix

<u>Database extraction form</u>

<u>WOMAN'S QUESTIONNAIRE:</u>

SECTION 1: RESPONDENT'S BACKGROUND

106. Have you ever attended school?

YES 1

NO . . . . 2 (Go to 109)

107. What is the highest standard you completed?

STANDARD . . . .

104. In what month and year were you born?

MONTH . . . .

DON'T KNOW MONTH 98

YEAR . . . .

DON'T KNOW YEAR 9998

SECTION 2: REPRODUCTION

209. CHECK 208:

Just to make sure that I have this right: you have had in TOTAL _____ births during your life.

Is that correct?

(PROBE AND YES NO CORRECT 201-208 AS NECESSARY)

207. How many boys have died?

BOYS DEAD . . . .

And how many girls have died?

GIRLS DEAD . . . .

IF NONE, RECORD '00'.

215. In what month and year was (NAME) born?

(This should be checked for all first born babies to calculate the age of the mother during her first pregnancy)

SECTION 4: PREGNANCY, DELIVERY, POSTNATAL CARE AND CHILDREN'S NUTRITION

422. During this pregnancy, were you given or did you buy any iron folic acid tablets or syrup? SHOW TABLETS/SYRUP. (Only for last birth)

YES 1

NO . . . . .2 (SKIP TO 424)

DON'T KNOW 8

423. During the whole pregnancy, for how many days did you take the tablets or syrup? (Only for last birth)

DON'T KNOW 998

(IF ANSWER IS NOT NUMERIC, PROBE FOR APPROXIMATE NUMBER OF DAYS.)

- The supplement should be taken for 46 days at least to consider the case as following the supplementation schedule.

437. How much did (NAME) weigh at birth?

[Child]

KG FROM CARD KG

KG FROM RECALL

DON'T KNOW 99998

(Record weight in kilograms from health card if available.)

472. For how many months did you breastfeed (NAME)?

MONTHS . . . .

DON'T KNOW 98

479. Now I would like to ask you about liquids (NAME FROM 478) drank yesterday during the day or at night. (Only for last birth)

Did (NAME FROM 478) drink: YES NO DK

a. Plain water?	1	2	8
b. Commercially produced infant formula?	1	2	8
c. Any other milk such as tinned, powdered, or fresh animal milk?	1	2	8
d. Fruit juice?	1	2	8
e. Tea or coffee?	1	2	8
f. Any other liquids?	1	2	8

480. Now I would like to ask you about the food (NAME FROM 478) ate yesterday during the day or at night, either separately or combined with other foods. (Only for last birth)

Did (NAME FROM 478) eat:	YES	NO	DK
a. Any porridge or gruel?	1	2	8
b. Any commercially fortified baby food such as Cerelac or Farex?	1	2	8
c. Any bread, roti, chapati, rice, noodles, biscuits, idli, or any other foods made from grains?	1	2	8
d. Any pumpkin, carrots, or sweet potatoes that are yellow or orange inside?	1	2	8
e. Any white potatoes, white yams, cassava, or any other foods made from roots?	1	2	8
f. Any dark green, leafy vegetables?	1	2	8
g. Any ripe mangoes, papayas, cantaloupe, or jackfruit?	1	2	8
h. Any other fruits or vegetables? ?	1	2	8
i. Any liver, kidney, heart or other organ meats?	1	2	8
j. Any chicken, duck or other birds?	1	2	8
k. Any other meat?	1	2	8
l. Any eggs?	1	2	8
m. Any fresh or dried fish or shellfish?	1	2	8
n. Any foods made from beans, peas, or lentils?	1	2	8
o. Any nuts?	1	2	8

p. Any cheese, yogurt or other milk products? 1 2 8

q. Any food made with oil, fat, ghee or butter? 1 2 8

r. Any other solid or semi-solid food? 1 2 8

SECTION 5: IMMUNIZATION, HEALTH, AND WOMEN'S NUTRITION

507. Is (NAME) currently taking iron pills or iron syrup (like this/ any of these)? SHOW COMMON CAPSULES/SYRUPS. [Child]

YES 1

NO 2

DON'T KNOW 8

518. Has (NAME) had diarrhea in the last 2 weeks? [Child]

YES 1

NO . . . . 2 (SKIP TO 532)

DON'T KNOW 8

SECTION 8: HUSBAND'S BACKGROUND AND WOMAN'S WORK

803. Did your (last) husband ever attend school?

YES 1

NO 2

804. What was the highest standard he completed?

STANDARD . . . .

DON'T KNOW 98

HOUSEHOLD QUESTIONNAIRE

46. Is this a scheduled caste, a scheduled tribe, other backward class, or none of them?
SCHEDULED CASTE 1

SCHEDULED TRIBE 2

OBC 3

NONE OF THEM 4

48 What type of fuel does your household mainly use for cooking?

ELECTRICITY 01

LPG/NATURAL GAS 02

BIOGAS 03

KEROSENE 04

COAL/LIGNITE 05

CHARCOAL 06

WOOD 07

STRAW/SHRUBS/GRASS 08

AGRICULTURAL CROP WASTE 09

DUNG CAKES 10

OTHER 96 (SPECIFY)

66. Does this household have a BPL card?

YES 1

NO 2

DON'T KNOW 8

HAEMOGLOBIN MEASUREMENT OF CHILDREN BORN IN 2001 OR LATER:

Presence or absence of anemia in the child (below the age of six years) at time of interview.

HAEMOGLOBIN AND HIV FOR WOMEN 15-49:

Presence or absence of anemia in the women at time of interview.