STATUS OF YOUNG MOTHER'S NUTRITION BY WEALTH AND EDUCATION AND ITS ASSOCIATION WITH BIRTH WEIGHT IN INDIA

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Abstract

This study investigated the changing pattern of association between demographic, socio-economic and behavioral factors with maternal health (Body Mass Index (BMI) and Anemia) among the Young Indian mothers (aged 15-19, 20-24) over the period of last two decades between 1998 and 2015 and the associated nexus between young mothers' nutritional status and birth weight of their children. NFHS, 2015-16 & 1998-99 served the purpose of this study.

Education and wealth showed decreased association with BMI over the period. Drinking pattern showed an increased level of association with BMI but not with anemia. Young Mothers aged 20-24 are obtaining greater gains in overcoming the Low Birth Weight of their infants as compared to mothers aged 15-19yrs. BMI and anemia level of mother's determine their children's birth weight largely and shows weak association over time.

So BMI & anemia determine birth weight and educated mothers and rich mothers are less likely to have low BMI.

Introduction

Young mothers are most disadvantaged group in Indian Society suffering from poor nutritional and health status (Bradbury Bruce, 2006). Youth is a period of rapid growth and development. Approximately 50% of the adult body weight and 15% of final adult height is attained during adolescence, along with changes in body shape and composition; as a result nutrition during this period is very important for overall growth. (Rah et.al, 2008). According to WHO poor nutrition starts before birth and generally continues into young and adult life and can span generations (WHO, 2006). It has been found that chronically malnourished girls are more likely to remain undernourished during young and adulthood and when pregnant, are more likely to deliver low birth weight babies (King, 2003). An inadequate supply of nutrients during gestation is probably the single most important environmental factor affecting pregnancy outcome and previous studies suggest that group of young girls who conceive within two years of menarche and who constantly enter pregnancy with low nutrient reserves and short inter-pregnancy gap are tend to be at high risk of having low birth weight babies and even becomes risky for mothers. (King, 2003).

In South Asian countries such as Bangladesh and India, chronic under nutrition among women is very common and is significant burden on public health as well. Also it is notified that young girls in developing countries like India exhibit poor growth and nutritional status. Stunting and thinness are prevalent among 48% and 60% of young girls respectively. (Rah et.al, 2008). Anemia among pregnant women has serious health implications. Anemia in young girls affects their physical work capacity and reproductive physiology. (Toteja et.al, 2006). A number of studies from India reveals that prevalence of anemia among young girls are fairly high nearly 70% and anemia is less prevalent among those women from high socio economic groups and more in low socio economic groups. (WHO,2006).

Maternal under nutrition, including chronic energy and micronutrient deficiencies, is prevalent in many regions, especially in south-central Asia, where in some countries more than 10% of women are shorter than 145 cm. Maternal under nutrition—i.e., body-mass index of less than 18·5 kg/m²—ranges from 10% to 19% in most countries from this region. (Black et.al, 2008). Similarly a serious problem of maternal under nutrition is evident in most countries in sub-Saharan Africa, south-central and southeastern Asia, and in Yemen, where more than 20% of women have a body-mass index of less than 18·5 kg/m². With a higher prevalence of low body-mass index around 40% in women, the situation can be considered critical in India. At the same time due to poor nutrition, maternal short stature and low body-mass index have independent adverse effects on pregnancy outcomes (Black et.al, 2008). On the other hand the poor nutritional status among young girls has

important implications for physical work capacity and adverse reproductive outcomes. When women enters with large iron deficit and is subjected to the added demands for iron during pregnancy, it may be too late to address the problem. (Toteja et.al, 2006).

Previous studies also confirmed that nutritional status of Indian women is inadequate of the total married girls 33% are too thin and 11% are short (Paul et.al, 2006). More than 75%women are anemic. The reported prevalence of anemia among pregnant women from large scale surveys range from 45% - 70%. But it has even disclosed that there is a well-known, large persistent association between education and health, this has been observed in many countries and many of the time periods which seemed to have effected a wide range of health issues (Cutler & Muney, 2006). Education plays a much more important causal role for females in accounting for gaps in obesity rates, exercise, and employment (Conti,Heckman & Urzua, 2014). Women's education level has been consistently identified as a strong predictor of woman's health and it is even mentioned that from the Chilean experiment, it is evident that the increase in the percentage of first-time pregnancies at advanced ages (30 years old or more) was directly associated with the MMR after controlling for parallel changes in education years (Koch et.al, 2013).

Under nutrition or poor nutritional status of women is also associated with poor birth outcomes. However, some age groups appear to be more susceptible than others. Mainly the young mothers of age group 15-19 years are highly susceptible to this. Birth weight is a reliable index of intra uterine growth retardation (IUGR) and a major factor determining child survival, future physical growth and mental development (Negi , et.al, 2006).

A multifactorial inter-relationship exists between the environment in which pregnant mothers live and the growth of the fetus and this relationship has prompted public health personnel to suggest that birth weight distribution and the proportion of babies born with a low birth weight (LBW) be considered as indicators of socio economic development; LBW is found to be one of the major causes of high mortality and morbidity rates. Worldwide, out of 139 million live births, about 23 million infants had low birth weight i.e., birth weight less than 2.5 kg. In India, the prevalence of LBW infants is about 39%, as compared to 4.5% in industrially developed countries. The perinatal mortality among LBW infants is about 8 times higher than that in infants weighing more than 2.5kg (Negi , et.al, 2006).

There are even other several factors affecting birth weight and birth size like birth order, smoking, drinking, ANC care. But the main focus of this study is to see the effect on birth weight and birth size, taking into consideration only two important mother's nutritional indicators i.e. Body Mass Index (BMI) and Hemoglobin level (Anemia). According to M.S Kramer anemia among mothers is highly associated with under nutrition resulting in Low Birth Weight babies(M.S Kramer, 1987). Even height, weight, gestational weight gain and smoking and drinking causes LBW. It is even seen that Anemia affects the whole nutritional status of youth (Chaudhury and Dhage,1993).

The main aim of the study is to check change in association between the determinants and health indicators of mother over the time period and also to see that how much the association between has decreased or increased. The second part of the study explores the effect of Young Mother's BMI and Anemia on Birth Weight and associated changes in Determinants over time.

The primary focus of the study is to check the correlates of nutrition (BMI, Anemia) among young mothers and to mainly observe the education and wealth gradient of maternal health across India. Further we check that how the determinants of maternal health (nutrition) have changed over the years. With time the wealth or income disparity has increased over the years or not which has a severe effect on nutritional stature of young mothers. This in turn affected the birth outcome situation in India.

India with a population of 1 billion people has many challenges in improving the health and nutrition of its citizens. In developing countries like India, children and adults especially the youth are vulnerable to malnutrition because of low dietary intakes, inadequate distribution of food within the household. Discrimination on food distribution is a common phenomenon in all households in India

In the same direction, mother's nutritional status is indeed an important criterion to be considered in all aspects which has already put significant burden on public health in India. In the above context the focus of the research is to understand the status of young mother's nutrition. The primary objectives are to examine the levels and changes in young mother's BMI and anemia levels over time and across states and to identify the determinants of BMI and anemia and the changes in association of those determinants over time.

DATA AND METHODOLOGY

DATA

The data source that has been used for this research study is National Family Health Survey for two different rounds that is round 2 (1998-99) and round 4 (2015-2016). A nationally representative survey, NFHS-4 is the add-up in the series that is being conducted since NFHS-1 (1992-93). NFHS is Indian DHS, a national representative survey; it provides data on population, health, and nutrition.

Data for Body Mass Index, hemoglobin levels, anemia levels were taken from both the rounds of NFHS.. Our study is carried out for only young woman lying in age groups between 15-19 and 20-24, married. Other than the main focus variables we have also considered the other controlling variables from these two rounds viz. levels of highest education, wealth index, weight, religion, caste, age group, smoking, chewing tobacco, alcohol consumption.

METHODOLOGY

We have conducted the research for the women belonging to age group 15-19 and 20-24 years considering them as young mothers. We use this objective assessment information on BMI of women and anemia criteria to examine the change in determinants of mother's nutrition over the years.

The prevalence rates were calculated to check the change in prevalence rate over the years. We have calculated mean BMI and mean hemoglobin level for both the rounds to show the change over the years. BMI was divided into three categories- low, normal and high and whereas anemia was divided into four categories- severe, moderate, low and not Anemic.

We have appended the two sets of data NFHS 2 and NFHS 4 and have created pooled data set for further calculations. Statistical models are explained below.

To show the changing pattern of BMI we have created a bi-variate table showing change in mean BMI level over the years with respect to different categories of education and wealth index. Similarly we have employed the same for calculating hemoglobin levels.

We have created two tables for both the age groups to show the decadal and yearly change in prevalence rate of Low BMI and Anemia. We have taken states for the rows and categories for the columns. Then by using that we have shown the change in prevalence rate over time and yearly change in prevalence rate for each state.

The association between BMI and its determinants are calculated using the multiple regression model, where the dependent variable that is the BMI is continuous and all the other independent variables are categorical. The model used is-

$$Yi = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + C$$

Where βi is the regression coefficient, i represent the ith mother in the sample. For our study we have considered Y to be the BMI of women which is continuous and X_1 X_2 X_3… X_n are the sets of independent variables viz. highest education, wealth index, religion, region, caste, age group, smoking, chewing tobacco, alcohol consumption. Calculated β coefficients were shown to check the association between the two variables. Similarly the same was done for measuring the association between hemoglobin level and its determinants, where the dependent variable or Y is taken to be the hemoglobin level, which also shows continuous values.

To check the change in association over time, we chose to run "a" regression (areg) model in STATA. We have absorbed the impact of variable time which we had already created while appending. This variable contained two categories i.e. 1- 1998 and 2- 2015. For this model we had to create separate dummy variables for each category of the independent variables for each separate time period that is 1998 and 2015 specifying time. STATA, while running areg absorbed time 1 while calculating the association for time 2 and vice versa. At the end it provided the table showing association between the outcome and predictor variable for both the years, helping us to measure the change in association overtime.

$$Yi = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + C\ (Time)$$

Next we have created a bi variate table similar to the BMI and Anemia table showing change in mean Birth Weight overtime for each categories of BMI i.e. Low BMI (<18.5 kg/m2), Normal BMI (18.51-24.99 kg/m2) and High (>25 kg/m2).

We have created two tables for both the age groups to show the decadal and yearly change in prevalence rate of Low Birth Weight. We have taken states for the rows and categories for the columns. Then by using that we have shown the change in prevalence rate over time for each state.

To show the association between Birth weight and BMI, Anemia we have fitted a simple binary logistic regression model. In this case the birth weight is the dependent variable which is divided into two categories i.e. Low birth weight (<2.5kg) and Normal or High birth weight (>=2.5kg). The corresponding independent variables are also taken to be categorical in this case. The model used is-

$$Yi = ln\,[pi/(1-pi)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots + \beta_n X_n$$

Where Yi is the dependent dichotomous (0 or 1) variable which shows the log odds of Birth Weight, $\beta 0$ represents the intercept term of the model, βi (where i=1,2,3….n) is the coefficient of ith variable and Xi (where i= 1,2,3… n) is the ith independent variable.

For this objective also we have used the Pooled data set to calculate the change in impact of BMI and Anemia. In this case also we have created dummies for each category of the independent variable and for each time period i.e. 1998 and 2015 specifying time. We ran a logistic regression model where all the independent variables i.e. all the categories of BMI and Anemia were in time specified dummies. STATA while operating the regression, the dependent variable switched from 0 to 1 for all the independent variables separately. Time was fixed for each independent dummy variable. As a result a table was generated by STATA showing the association between BMI, Anemia and Birth Weight, for different time periods which helped us to understand the change in association over time easily.

The decomposition method outlined in this part of study, known as the Oaxaca decomposition (Oaxaca 1973), explains the gap in the means of an outcome variable between two groups. The gap is decomposed into that part that is due to group differences in the magnitudes of the determinants of the outcome in question, on the one hand, and group differences in the effects of these determinants, on the other. The decomposition of Birth Weight was studied with respect to different BMI and Anemia.

RESULTS

Change in Basic characteristics of Young Mothers

Proportion of mothers (15-19) having no education decreased over the years from 26.3% to 15.1% whereas the proportion share remained almost same for the 20-24 age group of mothers (1.1a). On the other hand the percentage of highly educated mothers has decreased over the years. Though the reduction is low (2.2% to 1.7%) among the 15-19 age groups of mothers but the proportion almost got halved (18.1% to 9.9%) for 20-24 age group (1.1a). It is also observed that the percentage of mothers belonging to the poor category have increased over the years substantially to 53.5% from 37.6% in the 15-19 years age group and with a 5 point increase the percentage reached to 41.1% from 36.4% for the 20-24 age group mothers (1.1a). In the similar direction, the proportion of young mothers from the rich wealth quintile has shown a decline over the time for both the age groups. On the contrary, though the percentage of young mothers in the urban areas declined but the percentage in rural areas increased.

Change in Health Index of Young Mothers over time

Prevalence of low BMI among young mothers decreased over the years from 45.9-34.7 in the 15-19 age group and 36.9-29.2 in the 20-24 age groups of mothers (1.1b). On the contrary, the prevalence of high BMI has increased from 2.6-6.3 for age 15-19 years and from 6.5 -9.9 for age 20-24 years. It is also observed that though the prevalence of anemia has shown a decrease from 72.2% to 60.5% for the 15-19 age group and 64.6 to 57.7% over the last two decade but still it confirmed that the prevalence remained substantially high among the young mothers across India (1.1b).

Change in mean BMI level by education and wealth groups

Estimations suggest a clear education and wealth gradient of BMI status among the young mothers over the two time period. With higher educational qualification and wealth status, an increase in the mean BMI level is observed among the young mothers in both the rounds of the survey. Across the years, for each category of education, the mean BMI level increased except the highest education category of young young mothers. Over the years for the no education category an increase of 0.6kg/m^2 is observed whereas an increase of 0.8 Kg/m^2 and 0.3Kg/m^2 is observed for the primary and secondary education category of young young women respectively (1.1c). The improvement in BMI among old young women are observed to be 0.3kg/m^2, 0.6kg/m^2, 0.4kg/m^2 and 0.6kg/m^2 for no education, primary education and higher education category respectively (1.1c).

Similarly, mean BMI level has also increased across the years for each category of wealth quintiles (poor, middle and rich) for both the groups of mothers. For the young youngs, mean BMI showed an increase of

0.4kg/m^2 in the poor, 0.4 Kg/m^2 in the middle and 1.2 Kg/m^2 in the rich categories of mothers. And among the old young mothers, it has been observed that the mean BMI level has decreased by 0.2kg/m^2 in the poor and has increased by 0.3kg/m^2 and 1.3kg/m^2 for middle and rich categories (1.1c).

Change in mean Hemoglobin level by education and wealth groups

Mean hemoglobin level increases with increase in educational qualification and increase in wealth index categories for both the rounds of NFHS and for both the young groups old as well as young (1.1d).

Over the years, mean hemoglobin level has increased for each category of education and wealth, projecting the decrease in Anemia level. With respect to education, an increase of 1.2g/dl, 1.4g/dl, 1.1g/dl, and 1.7g/dl in hemoglobin level for no education, primary, secondary and higher categories for young youngs has been observed. Similarly, an increase of 1.3g/dl, 1.1g/dl, 1.09g/dl, and 1 g/dl for the no education, primary, secondary and higher categories of education has been noticed for the old young mothers (1.1d).

Respondents belonging to the poor category of wealth index have experienced a decrease in hemoglobin level over the years by 0.2g/dl. For the middle and rich categories of old young mothers it has increased by 0.3g/dl, and 1.3g/dl respectively. For the young youngs, an increase in the hemoglobin level by 0.4g/dl for poor category, by 0.4g/dl for middle category and by 1.2 g/dl for rich category has been observed over the years.

Changes in young mother's BMI and Anemia levels across states for both the age group of mothers.

Table 1.1e gives the understanding of the change in prevalence of mother's BMI level and anemia status across the states of India. We found that for the states like Jammu &Kashmir, Punjab, New Delhi, Haryana, Bihar, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Rajasthan and Goa the prevalence of Low BMI among 15-19 age groups of mothers have increased over the years whereas it has decreased for all the other remaining states. On the other hand, prevalence of anemia has decreased over the years for Jammu & Kashmir, New Delhi, Haryana, Arunachal Pradesh, Nagaland, Sikkim, and Goa whereas it has increased for rest of the states.

Similarly, for the age group of 20-24 years we found that the prevalence of Low BMI decreased over the years for all states except that of New Delhi, Bihar, Tripura, and Assam.

Whereas the prevalence rate of anemia decreased in the state of Himachal Pradesh, New Delhi, West Bengal, Arunachal Pradesh, Tripura, Meghalaya, Nagaland Assam, and Kerala over the years. For overall India we could observe that the prevalence rate of anemia has decreased over the years of last two decades.

Determinants of BMI status among young mothers aged 15-24

Beta (β) value from the multivariate linear (OLS) regression analysis identifying the determinants of BMI status among young mothers across India has been estimated (1.2a). The adjusted coefficients show the association between the variable and BMI status. The result suggest that age, location, social class, religion, educational attainment, wealth status of the mother, region the mother belong from and drinking emerged to be the statistically significant predictors of BMI status among the mothers.

The estimated β coefficient for age showed that compared the 15-19 age groups of mothers; mothers in the age group of 20-24 have better BMI status. Location wise young mothers in the rural areas showed poor BMI status than those from the urban areas and from urban to rural areas BMI status among mothers decreased by 0.44 units (β=-0.44; p-value<0.01; 95% CI: -0.52:-0.37). Categories of caste also showed a significant association with BMI status and we found that compared the socially excluded groups like scheduled caste (SC) and scheduled tribe (ST) those mothers from OBC and General category are having better BMI status. Empirically, compared the SC (ref. group) mothers OBC and general category of mothers are having 0.16 (β=0.16; p-value<0.01; 95% CI: 0.08-0.24) and 0.41 (β=0.41; p-value<0.01; 95% CI: 0.31-0.51) unit more BMI level among them. The religion association of BMI status indicated that compared the Hindu young mothers, Muslim mothers are having 0.49 unit more BMI and mothers from the other religious groups are having 0.64 unit more BMI among them. The BMI status of young mothers also clearly indicated an increasing BMI status with increasing level of educational attainment except the primary educated mothers. We found that women with higher education category are having 0.88 units more BMI than the reference group of women who do not have any education whereas the secondary educated mothers are having 0.34 units more BMI level. Wealth status of the mothers is another important factor which predicts BMI status of the mother and the association is also highly statistically significant. It is observed that mothers from the rich wealth quintile are having 1.02 (β=1.02; p-value<0.01; 95% CI: 0.31-0.51) unit more BMI level than the poor mothers and the mothers from the middle

wealth quintile are having 0.44 (β=0.44; p-value<0.01; 95% CI: 0.36-0.52) unit more BMI level. The regional pattern of BMI status showed that only the mothers from the Southern part of India are having better BMI level that of those mothers from the Northern region, otherwise all the regions (East, West and Central) are showing lower status of BMI level than the Northern India. Drinking status among the young mothers also showed a statistically significant association with BMI status of the mothers and it is found that mothers who drink are having higher BMI (β=0.58; p-value<0.01; 95% CI: 0.31-0.85) than those mothers who do not drink. Among the other behavioral factors, chewing tobacco and smoking cigarettes did not show a statistically significant association with BMI status of the mothers.

Pattern of change in the determinants of BMI

Table 1.2b is showing the Determinants of change in BMI between NFHS 2 and NFHS 4. The association between mother's age group and BMI level has seemed to have increased over the years. The impact of age group on BMI has increased over the years.

Next as we move to the social factors we found that during NFHS 2, in the rural areas, BMI decreased by 0.65(β=0.65; p-value<0.01; 95% CI: -0.87,-0.43) units compared to urban places and for NFHS 4 it has decreased by 0.34 units(β=0.34; p-value<0.01; 95% CI: -0.42, -0.26). This indicates that the association between the place of residence of the mothers and BMI of women has decreased over the period of time.

Caste did not have any significant association with BMI during NFHS 2 where as we can see that a significant association has developed during NFHS 4.

Though from the previous table we found that education have a significant effect on BMI of young mothers, but here we can see that the association has decreased over the years for no education-secondary education gap and has increased for no education- higher education gap. As compared to no education category to secondary and higher for NFHS 2, we found BMI level is increasing by 0.73(β=0.73; p-value<0.01; 95% CI: 0.42, 1.04) and 1.54(β=1.54; p-value<0.01; 95% CI: 1.14, 1.93) units whereas it is increasing by 0.36(β=0.36; p-value<0.01; 95% CI: 0.27, 0.44) and 0.92 (β=0.92; p-value<0.01; 95% CI: 0.79, 1.05) units for NFHS 4. Whereas for wealth index we found that over the years the association between BMI and wealth index has decreased for the rich-poor gap and there was no association between rich middle gap during NFHS 2 but has developed during NFHS 4. It is observed that during NFHS 2 as compared to Rich, for Poor category BMI level has decreased by 0.4(β=0.4; p-value<0.01; 95% CI: -0.64, -0.15) units. Whereas during NFHS 4 BMI has decreased by 1.31(β=1.31; p-value<0.01; 95% CI: -1.39, -1.23) units.

However for the behavioral factors there was no association between drinking and BMI during NFHS 2 but during NFHS 4 it has developed. Whereas there was association between chewing tobacco and BMI during NFHS 2 but during NFHS 4, no association is found between them.

Hemoglobin level and its Determinants

Table 1.2c gives the empirical association between Hemoglobin level and its factors for Young married woman having at least one child. Similar to the BMI table this table also takes into consideration the socio economic factors to get the adjusted estimates. We can observe from the table that age group of woman have significant impact on hemoglobin level. For age group 20-24, we find hemoglobin level to increase by 0.07(β=0.07; p-value<0.01; 95% CI: 0.02, 0.12) units as compared to 15-19.

For the social factors like caste, we found that as compared to SC, for ST category we find hemoglobin level to be decreasing by 0.05(β=0.05; p-value<0.01; 95% CI: -0.11, 0) units and for the OBC and General categories we found hemoglobin level increased by 0.11(β=0.11; p-value<0.01; 95% CI: 0.07, 0.15) and 0.19 (β=0.19; p-value<0.01; 95% CI: 0.14, 0.24) units respectively. For the category of religion we found that as compared to Hindu mothers, Muslim mothers and mothers from the other religious groups are having better hemoglobin level and among Muslim mothers the level 0.16(β=0.16; p-value<0.01; 95% CI: 0.11, 0.21) units more whereas among the others it is 0.27(β=0.27; p-value<0.01; 95% CI: 0.21, 0.33) units more respectively.

For education we find that with increase in education, hemoglobin level among the mothers are also increasing, i.e. as compared to no education for primary, secondary and higher education we find that the hemoglobin increases by 0.15(β=0.15; p-value<0.01; 95% CI: 0.1, 0.2), 0.21(β=0.21; p-value<0.01; 95% CI: 0.17, 0.25) and 0.35 (β=0.35; p-value<0.01; 95% CI: 0.28, 0.41) units respectively. Similarly for wealth index we find that with comparison to poor for middle and rich category, hemoglobin level increases by 0.08(β=0.08; p-value<0.01; 95% CI: 0.04, 0.12) and 0.12 (β=0.12; p-value<0.01; 95% CI: 0.08, 0.16) units. The table shows that Hemoglobin level have increased during NFHS 4 by 1.27(β=1.27; p-value<0.01; 95% CI: 1.21, 1.33) units when compared to NFHS 2. Which means Anemia level have decreased over the years.

Again for the regional differences the country has been divided into separate regions of North, South, East, West and North East to check the effect of regions on hemoglobin level in a holistic way. We find that as compared to north for other regions the hemoglobin level is increasing by 0.14(β=0.14; p-value<0.01; 95% CI: 0.09, 0.19) (East), 0.75(β=0.75; p-value<0.01; 95% CI: 0.68, 0.81) (North East), 0.33(β=0.33; p-value<0.01; 95% CI: 0.28, 0.38) (West), 0.36(β=0.36; p-value<0.01; 95% CI: 0.31, 0.42) (South), 0.27(β=0.27; p-value<0.01; 95% CI: 0.22, 0.32) (central).

Similarly we find that for normal weight and overweight the hemoglobin level to be increasing by 0.14 (β=0.14; p-value<0.01; 95% CI: 0.11, 0.17) and 0.25 (β=0.25; p-value<0.01; 95% CI: 0.19, 0.31) units respectively when compared to underweight category.

Determinants of change in Hemoglobin level

First from the table we can see that association between age group and Hemoglobin level was insignificant during NFHS 2 and significant for NFHS 4 (1.2d).

Interestingly we find that association between location of woman and hemoglobin level has shown a change in direction over the years. Previously during NFHS 2 it had shown a positive relation whereas for NFHS 4 it is showing a negative relationship. During NFHS 2 as compared to urban areas the hemoglobin was increasing by 0.13(β=0.13; p-value<0.01; 95% CI: 0.02, 0.25) units for rural areas, whereas for NFHS 4 it is decreasing by 0.05 (β=0.05; p-value<0.01; 95% CI: -0.09, -0.01) units (1.2d).

As we consider religion we find that for the Hindu Muslim gap, association has decreased over the years and for the Hindu and Other religion gap, association seemed to be insignificant during NFHS 2 and is significant during NFHS 4.

For the SC OBC gap and SC-ST gap we find that the association has decreased over the years. Whereas for SC-General gap association seemed to have increased over the years.

We can even find out that the association between Hemoglobin level and education has changed over the years. We found that for no education - secondary education gap and no education- higher education gap the association with education has decreased over the years whereas for Primary education the association has decreased over the years when compared to No education category. We can see that during 1998-99 as we moved from no education to secondary and higher education, Hemoglobin level has increased by 0.52 (β=0.52; p-value<0.01; 95% CI: 0.36, 0.68)and 0.75 (β=0.75; p-value<0.01; 95% CI: 0.54, 0.95) units and during 2015-16 it has increased by 0.24 (β=0.24; p-value<0.01; 95% CI: 0.2, 0.29) and 0.33 (β=0.33; p-value<0.01; 95% CI: 0.26, 0.4)units (1.2d).

For association with wealth index we find that there was no significant association between wealth and hemoglobin level during early years but during NFHS 4 we found that significant association has developed for rich and poor gap.

Next while exploring the biological factors, we found that association between weight of the young mother and hemoglobin level has decreased over the years (1.2d).

Change in Mean Birth Weight by BMI

Table 2.1a makes it evident that with increase in BMI levels, mean birth weight has also increased. It is lowest for woman having low BMI both for age group 15-19 and age group 20-24. But as we see over the years we find that mean birth weight has increased for all the categories of BMI except for high BMI category. Over the years birth weight has reduced for high BMI category for both the age groups. This is mainly due to the fact of obesity coming into effect. Obesity leads to birth of low birth weight babies.

Change in Birth Weight of infants across states born to mothers of both the age groups

This table gives us an understanding of change in birth weight prevalence over the years and across the states of the country for both age groups of mothers. For Low Birth weight we find that for states like Himachal, Haryana, Orissa, Meghalaya, Nagaland, Sikkim, Rajasthan, Goa, Andhra Pradesh and Karnataka prevalence rate have increased. In India as a whole we find that prevalence of Low Birth weight has decreased over the years for 15-19 age groups of mothers. (2.1b).

Similar to the last table, this table also shows the change in prevalence rates over the years for age group 20-24. New Delhi, Meghalaya and Goa are the only states which show an increase in the prevalence rate of Low birth weight over the years. For over all India the prevalence rate of having Low Birth Weight Babies have decreased over the years (2.1b).

Association of BMI, Anemia and other determinants with Birth Weight

BMI has a significant effect on Birth outcomes. We find that odds of having low birth weight babies are 1.15 and 1.44 for woman having normal and low BMI as compared to High. Low birth weight babies are 15% more likely to occur to woman with Normal BMI and 44% more likely to occur to woman having Low BMI than that of woman with high BMI. We can see that chances of having low birth weight babies are most for woman with Low BMI (2.2a).

We can understand that the impact of Anemia is significant on Birth weight. Only severe and moderate anemia can affect birth outcomes. There is no significant difference between the impact of mild and not anemic. We found that the odds of having low birth weight babies are 1.55 for woman with severe anemia which means that they are 55% more likely to occur to woman with severe anemia than that of woman who is not anemic. Whereas LBW babies are 14% more likely to occur to woman with moderate Anemia when compared to woman who are not anemic (2.2a).

We have observed that mothers of age 20-24 are 7% less likely less likely to have low birth weight babies when compared to mothers of age 15-19 years. Other than our main focus of study, we find that as education of a woman decreases the likelihood of having low birth weight babies. Low birth weight babies are 21% and 34% less likely to occur to woman with secondary and higher education when compared to woman with no education respectively (2.2a).

We have used time as an independent variable to measure the impact of time on birth weight. We even found that the likelihood of having low birth weight babies have decreased over the years. Low birth weight babies are 20% less likely to occur to woman during 2015-16 than 1998-99 (2.2a).

It is also observed that chances of having low birth weight babies are maximum for the first birth order and is minimum for second and third order, Whereas it again increases after the third birth order. Low birth weight babies are 11% less likely to occur for second birth order and 8% less likely to occur for third birth order and more.

We can also observe that location of woman and none of the behavioral factors have significant impact on Birth size and Birth weight.

Change in Association between BMI, Anemia and Birth weight over time

Impact of BMI has changed over the years on birth weight. We can deduce that the likelihood of having low birth weight babies for woman with low and normal BMI have decreased over the years. During NFHS 2 the odds of having low birth weight babies was 1.62 and 1.39 respectively for woman having low and normal BMI and during NFHS 4 the odds are 1.53 and 1.19 respectively. It means that the chances of having low birth weight babies for woman with Low BMI was 62% more likely and for woman with Normal BMI it was 39% more likely. But now we can see that during NFHS 4 the chances or likelihood have reduced over the years. Low birth weight babies are now 53% and 19% more likely to occur to woman with Low and Normal BMI (2.2b).

For Anemia we can notice that the association with Birth Weight has decreased over the years. During NFHS 2 the chances of having low birth weight babies was 2.9 times more likely to occur to woman with severe anemia and 48% more likely to occur to woman with moderate anemia. Whereas during NFHS 4 we can observe that association has decreased over the time. Women with severe and moderate anemia are 37% and 15% more likely to have low birth weight babies. Likelihood of occurrence of low birth weight babies for women with Anemia seemed to have decreased during NFHS 4 (2.2b).

Blinder Oaxaca Decomposition of Birth Weight with respect to BMI and Anemia

The difference in Birth weight when observed with respect to BMI, it is 0.11 units (2.2c). Blinder Oaxaca decomposition helps to decompose the difference or the gap in birth weight between two groups of women in terms of their BMI status and the difference was further decomposed into explained and unexplained parts by that particular explanatory variable (BMI status of woman). Prediction 1 gives the average response of Birth Weight for those women who do not fall the low BMI category whereas prediction 2 is the average response of the counter category. The basic difference between the two groups was found to be 0.11 units. Further decomposition of this difference through this specific variable showed us that only 18.18% of the total difference can be explained by BMI status of women, whereas rest of the part remained unexplained and can be explained by other factors affecting Birth Weight which was not the aim of the study (2.2c).

However we also observed that the difference in mean Birth Weight with respect to Anemia is 0.14 units. Out of which only 35.71% of the difference can be explained by Anemia and rest unexplained part can be explained by other factors affecting Birth Weight (2.2c).

DISCUSSION

This paper examined the health of the young mothers in terms of BMI status and hemoglobin level across India during the last two decade. The primary focus was to understand the change in the health status of the mothers based on education and wealth and its determinants over time and its impact on child birth in India.

In this population-based study of young women who became mothers at a very early stage of childbearing age, low BMI and anaemia rates were high at 30% and 58.49%, respectively. About 1.04% of the women were severely anaemic, and about 15.99% were moderately anaemic. Low BMI status of women was associated with individual-level factors such as age; younger mothers of age 15-19 were experiencing the more risk of being below normal BMI. Along with several other individual and household level factors, educational attainment of the mother, household's wealth status showed high association and were inversely associated with BMI and anaemia status. Though the pattern of associations remained the same across time but the intensity of association has changed and reduced. Compared with women living in urban areas, women residing in villages were more likely to be of low BMI and anaemic. It has been also examined the impact of low BMI and anemia on Birth weight. This is also evident that chances of having Low birth weight babies are more to woman having Low BMI and Severe Anemia. Only Severe and Moderate Anemia affects birth weight whereas there is no significant difference between the impact of Mild and No Anemia. Over the years we have found that chances of having low birth weight babies have decreased for women with Low BMI, Severe and Moderate Anemia. This is because we have found that Anemia level has decreased over the years between NFHS 2 and NFHS 4 for Young Mothers. It was also observed that 18.18% of the difference in Birth Weight is affected by Mothers BMI and 35.71% of the difference is affected by anemia.

The risk of being poor health among the young mothers was lower in the North East and Southern India and in the urban areas. Maternal anaemia and nutrition (BMI status) was found to be positively associated with individual-level factors including increasing age, higher educational attainment; and household level factors like higher household wealth across the two survey periods. Our findings highlight the importance of household, community-level factors and individual-level factors on likelihood of the young mothers to be of good health.

The present study documented the prevalence of low BMI and anaemia among women who became mothers at a very early stage of their child bearing age in India during the last two decades. And this study contributes to the understanding young mothers' health over the period of time to help identify the causes of poor health among those women who are under privileged in terms of the different contextual factors. The study findings are also consistent with the previous studies (Toteja et.al, 2006 & Black et.al, 2008) and this study additionally adds to the existing knowledge of women health considering the temporal change with a special focus to the young mothers. However, the rate of low BMI and anaemia among women in India as a whole is declining but still the group of young mothers' health has not improved well; the proportion of women who are low BMI (BMI<18·5 kg/m^2) has declined from 45.96% to 34.79% between 1998-99 and 2015-16 for mothers in 15-19 years age group. It has declined to 29.2% from 36.92% for 20-24 age groups. Similarly the proportion of women who are anaemic has declined from 72.24% to 60.55% for woman in 15-19 years age group and to 57.79 from 64.65% for woman in age group 20-24 years age group between 1998-99 and 2015-16. This study other than identifying the determinants of BMI and anemia, explored the change in association between the determinants of BMI and Anemia. It is observed that anemia levels have decreased over the years and the prevalence of Low BMI have also decreased as well. Education and Wealth have significant impact on BMI as well as Anemia. With increasing educational status among the mothers we found that BMI and Hemoglobin level also increased. This is because they become more conscious about health when more exposed to education. Dietary intake of woman improves among the educated mother due to awareness. We also found wealth status affects BMI and Anemia. Poor people tend to be less exposed to good health than middle and rich. But we even found that the significant influence of education on BMI which has decreased over the years for no education-secondary education gap and has increased for no education- higher education gap. Even for hemoglobin level also we observed that the association with education has decreased over the years.

However we even found that wealth index have significant effect on BMI and the association has decreased for the rich-poor gap and there was no association between rich middle gap during NFHS 2 but has developed during NFHS 4. This is mainly because over the years, proportion of people belonging to poor is increasing.

Income disparity has increased and as a result of which the standard of living is also getting affected. Rich are getting richer and poor is getting poorer.
For Hemoglobin level we found that there is no proper association with wealth index except for the rich-poor gap which has developed during NFHS 4.
It is even observed in the study that BMI did not have any association with drinking of alcohol during NFHS 2 but have developed new association during NFHS 4. This implies that alcohol consumption among woman have increased over the years. It is even evident that there was association of BMI with chewing tobacco prevalent during NFHS 2 but during NFHS 4 there is no significant association observed between them.
As for anemia, it is found that there is association between hemoglobin level and body weight. But over the years it is observed that the association has decreased between them.

The present study has several limitations. Due to the cross-sectional nature of the study we were not able to check the causality. The data on mother's height, weight and other covariates were collected at a certain time and have not been observed over time treating all the study objects as a cohort. So, it was not exactly feasible to check the causal relationship of the factors on nutritional status of young mothers. At the same time educational status and wealth do have a reverse causation on nutritional status of a person. There are several other risk factors like household food security, intake of micronutrients, type of physical activity mothers are involved in, media exposure and decision-making ability are the set of factors play a crucial role on nutrition and should be considered for nutritional assessment of the mothers. Though we used wealth as a proxy for the overall economic condition of the household but it does not give a clear and exact idea of the food consumption. However, wealth is used as an economic well being of the household. At the same time the disease information of the mothers is also not available through the data which is another important factor to determine the health and nutritional status of a person.

The potential strength of the study is that it is based upon large sample size which comes through a nationally representative population based survey. And the survey data provided enough sample to execute a unit level analysis for the young mothers for India. We explored a set of socio-economic and demographic variables that may affect health status among women and included in the framework. Though public health interventions are making efforts to improve maternal health to reduce maternal mortality but still a larger proportion of the women are suffering from poor health and young mothers are at more risk. BMI status of the mother is a major predictor of foetal growth and maternal poor health increases the risk of stillbirth and neonatal death. Low BMI and anaemia is also associated with increased risk of catching different infections and increases the risk of complications during pregnancy like labour and postpartum complications such as pre-eclampsia and haemorrhage. To combat the situation of low BMI and anaemia among young mothers who became delivered at a very early stage of their life, India needs to employ multidimensional intervention programmes based on identified individual-, household and community-level socio demographic and economic risk factors that affect maternal nutritional status. Schemes like National Rural Health Mission, Reproductive Maternal New born and Child Health +Young in India are working on the maternal and child Nutrition care. Mother and Child Protection cards of Ministry of Health and Family Welfare and Ministry of Woman and Child Development is used by all states as a tool for monitoring and improving the quality of MCH and Nutrition interventions. In India there are some schemes and programs which have the following interventions to promote women's nutrition: counselling on adequate nutrition during antenatal and postnatal contacts; and provision of iron–folic acid supplements to pregnant women. India may consider replacing iron–folic acid by multiple-micronutrient supplements to all pregnant women, provision of calcium supplementation to those at risk of low intake and provision of balanced energy–protein supplementation to pregnant women as needed, as recommended in the second Lancet series on maternal and child nutrition (Bhutta ZA, Das JK, Rizvi A et al. (2013)). Regular systematic monitoring and surveillance of the social trajectory of nutritional status is essential to develop an appropriate strategy to reduce the burden of malnutrition in India.

RECOMMENDATION

These results present evidence of the burden of low BMI and anaemia among young mothers aged in between 15-24in India. Though India has seen rapid economic growth in the last decade but still maternal has not improved comprehensively. A large portion of the young mothers carries the burden of malnourishment and the risk of maternal morbidity and mortality. Educational attainment and wealth status does play a significant role to determine the health of young mothers. There is interplay of other socio-demographic correlates also on women health and nutrition. As maternal nutrition plays a major role in foetal growth and birth outcomes. Thus maternal health and nutrition should be giving due public health importance to prevent pregnancy complications, different maternal morbidities, adverse birth outcomes and maternal mortality specially among the rural poor women whose food intake does not meet daily dietary requirement and at the same time who do not have access to health care facility. Previous studies in different country settings also argued and showed that mother's nutritional history through her life trajectory and during pregnancy is crucial for the healthy birth outcome. So, undernourishment among women must be controlled, iron tablets and other micro nutrients must be given to the pregnant woman with proper medical checkup. Proper policies and interventions must be made to increase the awareness among women about maternal nutrition and pregnancy. Nutrition education should be provided to young girls and the women of reproductive age. Media could also be used to air the necessary information on the importance of dietary intake on pregnancy outcome. Though there are several ongoing health policies which had immense impact, those must be continued and must be spread to a greater level to improve the health of the young mothers.

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Table 1.1a Change in Basic Characteristics of Young Mothers over time

YOUNG MOTHER'S BACKGROUND CHARACTERISTICS (NFHS 2 & 4)

	YOUNG MOTHERS (15-19)(in %)		YOUNG MOTHERS (20-24)(in %)	
	1998-99	**2015-16**	**1998-99**	**2015-16**
HIGHEST EDUCATION				
l. No education	26.36	15.18	16.17	16.51
ll. Primary	26.45	12.07	16.92	13.33
lll. Secondary	44.91	71	48.81	60.21
IV. Higher	2.29	1.75	18.1	9.95
WEALTH INDEX				
I. Poor	37.66	53.5	36.4	41.19
III. Middle	19.19	25.29	20.79	24.28
IV. Rich	43.16	21.2	42.8	34.53
RELIGION				
l. Hindu	80.18	81.52	79.99	83.45
ll. Muslim	16.2	13.87	13.47	12.16
VI. Others	3.62	4.61	6.54	4.39
CASTE				
l. SC	18.7	25.92	17.4	22.99
ll. ST	5.8	13.56	5.38	11.31
lll. OBC	37.37	40.84	38.43	46.13
IV. GENERAL	38.13	19.68	38.79	19.57
TYPE OF RESIDENCE				
l. Urban	29.01	19.86	41.37	26.26
ll. Rural	70.99	80.14	58.63	73.84

Table 1.1b Change in Health Index of Young Mothers over time

	HEALTH INDEX MODULAR FOR INDIA			
	YOUNG MOTHERS (15-19)(in %)		YOUNG MOTHERS (20-24)(in %)	
	1998-99	**2015-16**	**1998-99**	**2015-16**
WEIGHT				
l. UNDER WEIGHT	65.69	52.88	51.76	43.85
II. NORMAL WEIGHT	32.7	42.11	42.33	47.1
III. OVER WEIGHT	1.61	5	5.91	9.05
BMI				
l. LOW BMI	45.96	34.79	36.92	29.2
ll. NORMAL BMI	51.35	58.89	56.53	60.83
III. HIGH BMI	2.68	6.32	6.55	9.96
ANEMIA LEVEL				
I. ANEAMIC	72.24	60.55	64.65	57.79
II. NOT ANEAMIC	27.76	39.45	35.35	42.21
ANEMIA LEVEL				
I. SEVERE	5.18	2.13	5.83	1.42
II. MODERATE	56.77	22.04	55.73	24.97
III. MILD	38.05	75.84	38.43	73.62
N	599	4233	2806	40509

Table 1.1c Change in Mean BMI level by Education and Wealth Groups, India 1998-2015

BI-VARIATE ANALYSIS SHOWING CHANGE IN MEAN BMI LEVEL FOR DIFFERENT CATEGORIES OF EDUCATION AND WEALTH

	YOUNG MOTHER (15-19)		YOUNG MOTHER (20-24)	
VARIABLES	MEAN BMI		MEAN BMI	
Education	**1998-99**	**2015-16**	**1998-99**	**2015-16**
No education	18.61	19.28	19.44	19.8
Primary	18.99	19.82	19.4	20.03
Secondary	19.55	19.87	20.19	20.68
Higher	21.71	19.97	21.04	21.67
Wealth Index				
Poor	18.99	19.41	19.94	19.73
Middle	19.52	19.96	20.2	20.57
Rich	19.26	20.53	20.2	21.57
INDIA	19.21	19.77	20.1	20.52
N	599	4233	2806	40509

Table 1.1d Change in Mean Hemoglobin level by Education and Wealth Groups, India 1998-2015

BI-VARIATE ANALYSIS SHOWING CHANGE IN MEAN HEMOGLOBIN LEVEL FOR DIFFERENT CATEGORIES OF EDUCATION AND WEALTH

VARIABLES	YOUNG MOTHER (15-19) MEAN HEAMOGLOBIN LEVEL		YOUNG MOTHER (20-24) MEAN HEAMOGLOBIN LEVEL	
Education	**1998-99**	**2015-16**	**1998-99**	**2015-16**
No education	9.95	11.15	9.8	11.19
Primary	9.92	11.33	10.25	11.43
Secondary	10.35	11.48	10.45	11.54
Higher	10.03	11.76	10.69	11.69
Wealth Index				
Poor	10.05	11.28	10.37	11.33
Middle	10.08	11.56	10.49	11.53
Rich	10.22	11.57	10.3	11.65
INDIA	10.13	11.41	10.36	11.48
N	599	4233	2806	40509

Changes in young mother's BMI and Anemia levels across states for both the age group of mothers.

Table 1.1e

STATES	YOUNG MOTHERS (15-19)				YOUNG MOTHERS (20-24)			
	Low BMI		Anemia		Low BMI		Anemia	
	Change	Yearly Change	Change	Yearly Change	Change	Yearly Change	Change	Yearly Change
NORTHERN STATES								
J&K	30.61	1.8	58.44	3.44	-21.91	-1.29	-16.93	-1
Himachal Pradesh	-3.38	-0.2	-2.71	-0.16	-9.24	-0.54	3.9	0.23
Punjab	8.49	0.5	26.72	1.57	-0.42	-0.02	-16.08	-0.95
New Delhi	49.76	2.93	-65.81	-3.87	6.46	0.38	6.55	0.39
Haryana	8.74	0.51	14.76	0.87	-20.34	-1.2	-1.21	-0.07
Uttar Pradesh	-18.82	-1.11	-40.34	-2.37	-3.83	-0.23	-0.77	-0.05
EASTERN STATES								
Bihar	24.65	1.45	-0.49	-0.03	4.43	0.26	-4.66	-0.27
Orissa	-21.49	-1.26	-26.87	-1.58	-14.71	-0.87	-16.94	-1
West Bengal	-30.04	-1.77	-8.31	-0.49	-13.92	-0.82	3.85	0.23
NORTH EAST								
Arunachal Pradesh	15.78	0.93	9.47	0.56	-1.25	-0.07	1.91	0.11
Tripura	-36.58	-2.15	-9.52	-0.56	8.12	0.48	2.84	0.17
Manipur	12.57	0.74	-22.69	-1.33	-7.87	-0.46	-11.25	-0.66
Meghalaya	9.98	0.59	-3.84	-0.23	-15.48	-0.91	20.8	1.22
Mizoram	0.09	0.01	-22.2	-1.31	-10.16	-0.6	-29.08	-1.71
Nagaland	29.51	1.74	23.14	1.36	-13.09	-0.77	1.09	0.06
Sikkim	-13.52	-0.8	15.5	0.91	-1.2	-0.07	-20.45	-1.2
Assam	24.83	1.46	-2.22	-0.13	4.85	0.29	2.48	0.15
WESTERN STATES								
Rajasthan	6.38	0.38	-25	-1.47	-8.52	-0.5	-25	-1.47
Maharashtra	-22.21	-1.31	-28.44	-1.67	-8.3	-0.49	-15.25	-0.9
Goa	12.94	0.76	24.27	1.43	-24.18	-1.42	-31.74	-1.87
Gujarat	-5.68	-0.33	-5.72	-0.34	-3.98	-0.23	-10.35	-0.61
SOUTHERN STATES								
Andhra Pradesh	-20.75	-1.22	-14.82	-0.87	-14.54	-0.86	-13.75	-0.81
Karnataka	-9.59	-0.56	-19.08	-1.12	-14.43	-0.85	-12.6	-0.74
Kerala	-14.25	-0.84	-31.94	-1.88	-13.42	-0.79	0.08	0
Tamil Nadu	-4.08	-0.24	-1.6	-0.09	-13.44	-0.79	-8.61	-0.51
CENTRAL STATES								
Madhya Pradesh	-10.09	-0.59	-4.09	-0.24	-6.17	-0.36	-12.44	-0.73
India	-11.17	-0.66	-11.69	-0.69	-7.72	-0.45	-6.86	-0.4

Table 1.2a BMI and its Determinants, by Multivaririate regression analysis

VARIABLES	COEFFICIENT	CI
Age group		
15-19®		
20-24	0.57***	(0.47,0.66)
Location		
Urban®		
Rural	-0.44***	(-0.52,-0.37)
Caste		
SC ®		
ST	0.03	(-0.08,0.13)
OBC	0.16***	(0.08,0.24)
General	0.41***	(0.31,0.51)
Religion		
Hindu®		
Muslim	0.49***	(0.39,0.58)
Others	0.64***	(0.52,0.76)
Education		
No education®		
Primary	0.05	(-0.05,0.15)
Secondary	0.34***	(0.25,0.42)
Higher	0.88***	(0.76,1.01)
Wealth index		
Poor®		
Middle	0.44***	(0.36,0.52)
Rich	1.02***	(0.94,1.1)
Time		
NFHS 2®		
NFHS 4	1***	(0.88,1.11)
Region		
North®		
East	-0.57***	(-0.66,-0.47)
North east	-0.07	(-0.2,0.06)
West	-0.67***	(-0.77,-0.58)
South	0.45***	(0.34,0.55)
Central	-0.73***	(-0.83,-0.63)
Drinks alcohol		
No®		
Yes	0.58***	(0.31,0.85)
Chew tobacco		
No®		
Yes	-0.2	(-0.48,0.09)
Smokes cigarettes		
No®		
Yes	0.14	(-0.52,0.8)

*p = <0.1, **p < .05, ***p < .01. N= 48099, R^2= 0.08

Table 1.2b Determinants of change in BMI, by Multivariate regression analysis absorbing Time, India 1998-2015

VARIABLES	COEFFICIENT	CI
AGE-GROUP		
15-19 in NFHS 2 & in NFHS 4®		
20-24 in NFHS 2	0.51**	(0.22,0.8)
20-24in NFHS 4	0.55***	(0.45,0.65)
LOCATION		
Urban in NFHS 2 & in NFHS 4®		
Rural in NFHS 2	-0.65***	(-0.87,-0.43)
Rural in NFHS 4	-0.34***	(-0.42,-0.26)
CASTE		
SC in NFHS 2 & in NFHS 4®		
ST in NFHS 2	0.25	(-0.22,0.72)
ST in NFHS 4	-0.17**	(-0.27,-0.07)
OBC in NFHS 2	0.22	(-0.11,0.55)
OBC in NFHS 4	0.08**	(0,0.16)
General in NFHS 2	0.23	(-0.09,0.56)
General in NFHS 4	0.26***	(0.16,0.36)
RELIGION		
Hindu in NFHS 2 & in NFHS 4®		
Muslim in NFHS 2	0.8***	(0.46,1.14)
Muslim in NFHS 4	0.55***	(0.45,0.65)
Others in NFHS 2	0.7***	(0.31,1.1)
Others in NFHS 4	0.85***	(0.74,0.97)
EDUCATION		
No education in NFHS 2 & in NFHS 4®		
Primary in NFHS2	-0.05	(-0.42,0.31)
Primary in NFHS 4	0.07	(-0.03,0.18)
Secondary in NFHS 2	0.73***	(0.42,1.04)
Secondary in NFHS 4	0.36***	(0.27,0.44)
Higher in NFHS 2	1.54***	(1.14,1.93)
Higher in NFHS 4	0.92***	(0.79,1.05)
WEALTH INDEX		
Rich in NFHS 2 & in NFHS 4®		
Poor in NFHS 2	-0.4**	(-0.64,-0.15)
Poor in NFHS 4	-1.31***	(-1.39,-1.23)
Middle in NFHS 2	0.01	(-0.27,0.3)
Middle in NFHS 4	-0.71***	(-0.8,-0.63)
DRINKS ALCHOHOL		
No in NFHS 2 & in NFHS 4®		
Yes in NFHS 2	0.84	(-0.16,1.83)
Yes in NFHS 4	0.55***	(0.29,0.82)
CHEWING TOBACCO		
No in NFHS 2 & in NFHS 4®		
Yes in NFHS 2	-0.41*	(-0.87,0.06)
Yes in NFHS 4	-0.24	(-0.63,0.14)
SMOKES CIGARETTES		
No in NFHS 2 & in NFHS 4®		

Yes in NFHS 2	0.02	(-1.39,1.44)
Yes in NFHS 4	0.35	(-0.41,1.11)

*p = <0.1, **p < .05, ***p < .01. N= 48099, R^2= 0.07

Table 1.2c Hemoglobin level and its Determinants, by Multivariate regression Analysis

VARIABLES	COEFFICIENT	CI
Age group		
15-19®		
20-24	0.07**	(0.02,0.12)
Location		
Urban®		
Rural	-0.03	(-0.06,0.01)
Caste		
SC ®		
ST	-0.05**	(-0.11,0)
OBC	0.11***	(0.07,0.15)
General	0.19***	(0.14,0.24)
Religion		
Hindu®		
Muslim	0.16***	(0.11,0.21)
Others	0.27***	(0.21,0.33)
Education		
No education®		
Primary	0.15***	(0.1,0.2)
Secondary	0.21***	(0.17,0.25)
Higher	0.35***	(0.28,0.41)
Wealth index		
Poor®		
Middle	0.08***	(0.04,0.12)
Rich	0.12***	(0.08,0.16)
Time		
NFHS 2®		
NFHS 4	1.27***	(1.21,1.33)
Region		
North®		
East	0.14***	(0.09,0.19)
North east	0.75***	(0.68,0.81)
West	0.33***	(0.28,0.38)
South	0.36***	(0.31,0.42)
Central	0.27***	(0.22,0.32)
Weight		
Under weight®		
Normal	0.14***	(0.11,0.17)
Over weight	0.25***	(0.19,0.31)

*p = <0.1, **p < .05, ***p < .01. N= 48099, R^2= 0.07

Table 1.2d Determinants of change in Hemoglobin level, by Multivariate regression analysis absorbing Time, India 1998-2015

VARIABLES	COEFFICIENT	CI
AGE-GROUP		
15-19 in NFHS 2 & in NFHS 4®		
20-24 in NFHS 2	0.09	(-0.05,0.24)
20-24 in NFHS 4	0.03*	(-0.02,0.08)
LOCATION		
Urban in NFHS 2 & in NFHS 4®		
Rural in NFHS 2	0.13**	(0.02,0.25)
Rural in NFHS 4	-0.05**	(-0.09,-0.01)
CASTE		
SC in NFHS 2 & in NFHS 4®		
ST in NFHS 2	0.47***	(0.24,0.71)
ST in NFHS 4	0.08**	(0.02,0.13)
OBC in NFHS 2	0.28**	(0.11,0.44)
OBC in NFHS 4	0.14***	(0.1,0.18)
General in NFHS 2	0.22**	(0.05,0.39)
General in NFHS 4	0.24***	(0.19,0.29)
RELIGION		
Hindu in NFHS 2 & in NFHS 4®		
Muslim in NFHS 2	0.55***	(0.38,0.72)
Muslim in NFHS 4	0.11***	(0.06,0.16)
Others in NFHS 2	0.1	(-0.09,0.3)
Others in NFHS 4	0.45***	(0.39,0.51)
EDUCATION		
No education in NFHS 2 & in NFHS 4®		
Primary in NFHS2	0.3**	(0.11,0.48)
Primary in NFHS 4	0.19***	(0.13,0.24)
Secondary in NFHS 2	0.52***	(0.36,0.68)
Secondary in NFHS 4	0.24***	(0.2,0.29)
Higher in NFHS 2	0.75***	(0.54,0.95)
Higher in NFHS 4	0.33***	(0.26,0.4)
WEALTH INDEX		
Rich in NFHS 2 & in NFHS 4®		
Poor in NFHS 2	-0.01	(-0.13,0.12)
Poor in NFHS 4	-0.11***	(-0.15,-0.07)
Middle in NFHS 2	0.1	(-0.05,0.25)
Middle in NFHS 4	0.003	(-0.05,0.04)
WEIGHT		
Under weight in NFHS 2 & in NFHS 4®		
Normal in NFHS 2	0.36***	(0.24,0.47)
Normal in NFHS 4	0.13***	(0.1,0.16)
Over weight in NFHS 2	0.41**	(0.15,0.66)
Over weight in NFHS 4	0.23***	(0.17,0.29)

*p = <0.1, **p < .05, ***p < .01. N= 48099, R^2= 0.05

Table 2.1a Change in Mean Birth Weight by BMI, India 1998-2015

Young Mothers (15-19)		
VARIABLES	**MEAN BIRTH WEIGHT**	
BMI	**1998-99**	**2015-16**
Low BMI	2.67	2.67
Normal BMI	2.73	2.77
High BMI	3.14	3
INDIA	2.72	2.74
N	599	4233
Young Mothers (20-24)		
Low BMI	2.7	2.7
Normal BMI	2.81	2.8
High BMI	2.97	2.9
INDIA	2.78	2.78
N	2806	40509

Table 2.1b Change in Birth Weight of infants across states born to mothers of both the age groups

STATES	YOUNG MOTHERS (15-19) Low Birth Weight		YOUNG MOTHERS (20-24) Low Birth Weight	
	Change	Yearly Change	Change	Yearly Change
NORTHERN STATES				
J&K	-87.76	-5.16	-20.31	-1.19
Himachal Pradesh	7.95	0.47	-20.73	-1.22
Punjab	-38.93	-2.29	-0.21	-0.01
New Delhi	-56.29	-3.31	2.57	0.15
Haryana	5.18	0.3	-2.54	-0.15
Uttar Pradesh	-29.44	-1.73	-1.02	-0.06
EASTERN STATES				
Bihar	-24.13	-1.42	-13.52	-0.8
Orissa	16.58	0.98	-0.04	0
West Bengal	-13.49	-0.79	-6.38	-0.38
NORTH EAST				
Arunachal Pradesh	-20.49	-1.21	-20.19	-1.19
Tripura	-28.55	-1.68	-5.69	-0.33
Manipur	-0.38	-0.02	-0.56	-0.03
Meghalaya	26.23	1.54	10.92	0.64
Mizoram	-12.73	-0.75	-3.63	-0.21
Nagaland	17.67	1.04	-1.68	-0.1
Sikkim	4.99	0.29	-16.86	-0.99
Assam	-13.96	-0.82	-10.07	-0.59
WESTERN STATES				
Rajasthan	1.65	0.1	-13.1	-0.77
Maharashtra	-13.87	-0.82	-4.64	-0.27
Goa	13.44	0.79	0.54	0.03
Gujarat	-1.91	-0.11	-3.76	-0.22
SOUTHERN STATES				
Andhra Pradesh	0.8	0.05	-3.95	-0.23
Karnataka	4.97	0.29	-5.09	-0.3
Kerala	-3.89	-0.23	-8.29	-0.49
Tamil Nadu	-5.95	-0.35	-2	-0.12
CENTRAL STATES				
Madhya Pradesh	-4.74	-0.28	-15.28	-0.9
India	-5.71	-0.34	-4.09	-0.24

Table 2.2a Impact of BMI, Anemia and other Determining variables on Birth Weight

Determinants	OR	CI
BMI		
High BMI®		
Normal BMI	1.15***	(1.3,1.58)
Low BMI	1.44**	(1.05,1.27)
Anemia level		
Not anemic ®		
Severe	1.55***	(1.27,1.9)
Moderate	1.14***	(1.06,1.22)
Mild	1.01	(0.96,1.07)
Age		
15-19®		
20-24	0.93*	(0.86,1)
Location		
Urban®		
Rural	0.97	(0.91,1.03)
Caste		
SC®		
ST	0.9**	(0.83,0.97)
OBC	0.91**	(0.86,0.97)
General	0.95	(0.88,1.03)
Religion		
Hindu®		
Muslim	0.88**	(0.82,0.96)
Others	0.66***	(0.6,0.73)
Education		
No education®		
Primary	0.94	(0.87,1.02)
Secondary	0.79***	(0.74,0.84)
Higher	0.66***	(0.59,0.73)
Wealth index		
Poor®		
Middle	0.96	(0.91,1.02)
Rich	0.99	(0.93,1.06)
Time		
NFHS 2®		
NFHS4	0.8***	(0.73,0.88)
Birth order		
1 order®		
2 order	0.89***	(0.85,0.94)
3 order +	0.92*	(0.84,1)
Place of delivery		
Home®		
Institutional	0.87**	(0.79,0.95)
Others	0.87	(0.5,1.51)

Delivery by caesarian section		
No ®		
Yes	1.13***	(1.06,1.2)
Smoking		
No®		
Yes	1.06	(0.58,1.93)
Drinking alchohol		
No®		
Yes	0.97	(0.79,1.2)
Chewing tobacco		
No®		
Yes	0.88	(0.69,1.13)

*p = <0.1, **p < .05, ***p < .01. N= 48099

Table 2.2b Change in Association between BMI, Anemia and Birth weight over time $$

VARIABLES	**OR**	**CI**
Nutritional characteristics		
Anemia level		
Not anemic in NFHS 2 & in NFHS 4®		
Severe in NFHS 2	2.9***	(1.98,4.26)
Severe in NFHS 4	1.37**	(1.08,1.75)
Moderate in NFHS 2	1.48***	(1.23,1.78)
Moderate in NFHS 4	1.15***	(1.07,1.24)
Mild in NFHS 2	1.09	(0.89,1.35)
Mild in NFHS 4	1.03	(0.98,1.09)
BMI		
High BMI in NFHS 2 & in NFHS 4®		
Low BMI in NFHS 2	1.62***	(1.33,1.97)
Low BMI in NFHS 4	1.53***	(1.39,1.69)
Normal BMI in NFHS 2	1.39***	(1.17,1.65)
Normal BMI in NFHS 4	1.19***	(1.08,1.3)

*p = <0.1, **p < .05, ***p < .01. N= 48099 , $$ All other variables controlled

Table 2.2c Blinder Oaxaca Decomposition of Birth Weight with respect to BMI and Anemia

BMI			*Anemia*		
BIRTH WEIGHT	**Coefficient**	**Percent explained**	**BIRTH WEIGHT**	**Coefficient**	**Percent explained**
Prediction_1 (not Low BMI)	2.81***		Prediction_1 (No Severe Anemia)	2.78***	
Prediction_2 (Low BMI)	2.70***		Prediction_2 (Severe Anemia)	2.63***	
Difference	0.11***		Difference	0.14***	
Decomposition			Decomposition		
Explained	0.02***	18.18	Explained	0.05***	35.71
Unexplained	0.09***		Unexplained	0.09**	

*p = <0.1, **p < .05, ***p < .01. N= 49405