STATUS OF YOUNG MOTHER'S NUTRITION 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 are less likely to have low BMI.

INTRODUCTION

Individuals aged 15-24 are defined/called as youth (WHO, 2006). It has also mentioned that an imbalance between the supply of protein and energy effects nutrition status, and the body's demand to ensure optimal growth and function. And improper dietary intake may lead to malnutrition in form of low body mass index, low hemoglobin level. 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). However WHO (2006) even mentioned that poor nutrition starts before birth and generally continues into adolescent and adult life and can span generations (WHO, 2006). And 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. 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 can delay physical maturation. Youth 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). While anemia in pregnant women and young girls 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 (WHO,2006). And studies suggest that anemia is less prevalent among high socio economic groups and more in low socio economic groups. A few studies have also reported on the nutritional status of pregnant young woman which has lead to terrific birth outcomes like LBW babies and even maternal mortality. In a study done in Nepal on risks and outcomes of Youth pregnancy, 48% of girls suffered from anemia (Sharma et al., 2001). A similar situation was observed in another study done on pregnant young woman among selected tribal population in India where all of them were suffering from moderate to severe

anemia and one-third had vitamin A deficiency which had lead to birth of LBW babies. (Sharma and Sharma, 1992).

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. 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 prevalence of low body-mass index around 40% in women, the situation can be considered critical in India, Bangladesh, and Eritrea. Maternal short stature and low body-mass index have independent adverse effects on pregnancy outcomes (Black et.al, 2008).

According to Paul et.al, 2006 nutritional status of Indian women is inadequate. 33% of married girls 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 74.3%- 96.2%.

The poor nutritional status of 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).

The following are the Nutritional indicators the study includes

- ***Anthropometric Indices***
    1. Weight-for-height - Acute malnutrition (wasting)
    2. Height- for-age - Chronic malnutrition (stunting)
    3. Weight-for-age - Any protein energy malnutrition (under weight)
- ***Z-Score***
- ***Body Mass Index- weight(in kg)/height(in m)^2***
    1. Obese- 30+ kg/m^2
    2. Overweight- 25-29.9 kg/m^2
    3. Normal- 18.5-24.9 kg/m^2
- ***Micronutrients- Clinical Indicators***
    1. Iron Deficiency Anemia
    2. Vitamin A Deficiency
    3. Iodine Deficiency

Body Mass Index (BMI) is a number calculated from a person's weight and height. It is a fairly reliable indicator of body fatness for most people. It does not measure body fat directly, but research has shown that BMI correlates to direct measures of body fat, such as underwater weighing and dual energy x-ray, absorptiometry (DXA) and it can be considered an alternative for direct measures of body fat. Additionally, BMI is an inexpensive and easy-to perform method of screening for weight categories that may lead to health problems (Sattar et.al, 2013).

Under nutrition or poor nutritional status of women is 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). It is even observed nowadays that dietary sugar intake during adolescent pregnancy may affect pregnancy outcome, because puberty is associated with hyperinsulinemia and insulin resistance as well as increasing BP, consuming a diet of high sugar may be especially detrimental during adolescent pregnancy. (Lenders, 1997).

The following are the child health indicators -

- Birth Weight- Weight of the infant at birth
- Birth Size- Size of the child at birth
- Infant Mortality Rate- Number of infant deaths per 1000 live births
- Under five mortality rate- Number of deaths under five years of age per 1000 live births
- Stillbirths- Death prior to complete extraction from mother as a product of conception, irrespective of the duration of pregnancy.
- Stunting- Percent of children falling below -2 standard deviations for height-for-age.
- Underweight- Percent of children falling below -2 standard deviations for weight-for-age.

However in this study we have only considered BMI and Anemia as indicators of mother's nutrition and only Birth Weight as an indicator of child health. Due to unavailability of data on other indicators; those were dropped. Again the major limitation of birth size that it mainly depends on mother's recalling capacity and containing recall bias in the information. The main motive of the study is to see immediate effect of BMI and Anemia of mothers on child health. So we decided to consider only Birth Weight since data for stillbirth was also unavailable.

NEED FOR STUDY

The main focus of the study is to check that whether among young mothers there is any relation between BMI and Anemia with education level and wealth index; and further does BMI and Anemia has any impact on child birth outcome if so, how the association has changed over the years? We study the effects of BMI and Anemia on pregnancy outcomes in India for several reasons. With time the wealth or income disparity has increased over the years as a result this has a severe effect on nutritional stature of young mothers. Though it is true that over the years the percentage of babies born with low birth weight has decreased but still it is not low and is improving at a slow pace.
India with a population of 1 billion people has many challenges in improving the health and nutrition of its citizens. Steady declines has been noted in fertility, maternal, infant and child mortalities and prevalence of severe manifestations of nutritional deficiencies, but the pace has been slow and falls short of National Millennium Development Goals targets. This includes social inequalities, disparity in health systems between and within states and consequences of urbanization and demographic transition (Paul et.al).

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. Youth stage of life is a very critical stage, which needs to be sufficed with proper quality and quantity of food. This is well carried out among males in the

society but the women section lags behind. Unknowingly it starts having an effect on the child they give birth to.
Mother's nutritional status is indeed an important criterion to be considered in all aspects. Improper diet and nutrition of adolescent women leads to low birth weight of infants born to them. It is of alarming concern since children bear the future of any country.

OBJECTIVES

The focus of the research is to understand the effect of Young Mother's Nutrition on child born with due assumption that mother's BMI and Anemia levels remains same for past five years before survey.
1.1 To see the levels and changes in young mother's BMI and Anemia levels over time and across states.

1.2 To understand the determinants of BMI and Anemia and the changes of the determinants over time.

2.1 To analyze the change in Birth Weight over time and across states.
2.2 To explore the effect of Young Mother's BMI and Anemia on Birth Weight and associated changes in Determinants over time.

DATA AND METHODOLOGY

DATA

The only 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, Birth size and Birth weights were taken from both the rounds of NFHS. Birth weight was only considered for the birth occurred within three years preceding the date of survey. Our study is carried out for only young woman lying in age groups between 15-19 and 20-24, married and having at least one child. 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, birth order, place of delivery and cesarean delivery.

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 relationship between nutritional status of the young women and children ever born to them in the past years. For birth weight, the variable was divided into two categories; less than or equal to 2.5kg denoted as low birth weight and the other one more than 2.5kg denoted as high birth weight.
The prevalence rates were calculated using crosstab methods 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. 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.

Levels and changes in young mother's BMI and Anemia levels over time and across states

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 the 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 determinants of BMI and Anemia and the changes of the determinants over time.

For this part of study we have appended the two sets of data NFHS 2 and NFHS 4 and have created pooled data set for further calculations. While appending we have created separate time variable for each data set.
The association between BMI and its determinants are calculated using the multivariate analysis 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 member of my sample. For our study we have considered Y to be the BMI of women which is continuous and X1 X2 X3… Xn 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. So 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.

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

Change in Birth Weight over time and across states.
First we have created a bi variate table similar to the chapter 3 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.
Effect of Young Mother's BMI and Anemia on Birth Weight and associated changes in Determinants over time.
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-

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

Where Yi is the dependent dichotomous (0 or 1) variable which shows the log odds of Birth Weight, β_0 represents the intercept term of the model, β_i (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

This paper attempted to analyze the impact of BMI and Anemia on birth outcomes that is birth size and birth weight. It also measures the change in association between these variables between 1998-2015. The socio, economic, and demographic variables which influence the BMI and Anemia of women in India have also been analyzed.

Change in Basic characteristics of Young Mothers overtime

Table 1.1a

The percentage of woman belonging to no education category has decreased over the years from 26.36% to 15.18% for age 15-19 and remains more or less same for age 20-24. Whereas percentage of woman having higher education have decreased over the years from 2.29% to 1.75% for age 15-19 and from 18.1% to 9.95% for age 20-24. It is even surprising to see that the percentage of poor have increased over the years from 37.66% to 53.5% for age 15-19 and 36.4% to 41.19% for age 20-24. Mothers belonging to the rich section of the society have decreased over the years from 43.16%-21.2% for age group 15-19 years and from 42.8%-34.53% for age group 20-24 years. Even we can observe that woman belonging to the urban areas has also decreased over the years from 29.01%-19.86% for 15-19years and from 41.37%-26.26% for 20-24years. This is indeed surprising to see that as compared to urban woman belonging to rural areas has increased from 70.99%-80.14% for 15-19 years and from 58.63%-73.84% for 20-24 years.

Table 1.1b

Change in Health Index of Young Mothers over time

We can observe that prevalence of Low BMI among both age groups has decreased over the years from 45.96-34.79 for age 15-19 years and 36.92-29.2 for age group 20-24 years. Whereas prevalence rate of high BMI has increased from 2.68-6.32 for age 15-19 years and from 6.55 -9.96 for age 20-24 years. Similarly for anemia we find that prevalence rate of anemic has decreased over the years from 72.24-60.55 for age 15-19 years and from 64.64-57.79 for age 20-24 years.

Change in mean BMI level by education and wealth groups

Table 1.1c

The mean BMI level increases with increase in highest level of educational qualification and increase in wealth status for both rounds of NFHS 2 and NFHS 4 and for both the categories of young mothers. For each category of highest education the mean BMI level has increased over the years. For no education it is showing an increase of 0.67kg/m2, for primary it is showing a change of 0.83kg/m2, for secondary it is showing a change of 0.32kg/m2 for young mother age 15-19 and for age 20-24 it is 0.36kg/m2 increase for no education, 0.63kg/m2 increase for primary education, 0.49kg/m2 increase for secondary education and 0.63kg/m2 increase for higher education with an exception with the higher education group for age group 15-19 group where it showed a decrease. We found that the BMI level has decreased over the years from 21.71kg/m2 to 19.97kg/m2 for Higher Education. It indicates decrease in over weight among higher educated young mothers.

Similarly for wealth index we find that the mean BMI level has increased over the years for each category of wealth quintiles -poor middle and rich income groups for both the young mother groups. We find that for age group 15-19, mean BMI has shown an increase of 0.42 kg/m2 for poor category and an increase of 0.44 kg/m2 and 1.27 kg/m2for middle and rich categories. For age 20-24 we find that mean BMI has shown a decrease of 0.21kg/m2 for poor category and an increase of 0.37kg/m2 and 1.37kg/m2 for middle and rich categories.

Change in mean Hemoglobin level by education and wealth groups

Table 1.1d

The represented table helps us to understand that 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 youth groups late as well as early.

We even found out that over the years the mean hemoglobin level has increased for each category of education and wealth. It is showing a drastic change in the mean hemoglobin level projecting the decrease in Anemia level over the years. With respect to education we can see a change of 1.2g/dl, 1.41g/dl, 1.13g/dl, and 1.73g/dl

increase in hemoglobin level for no education, primary, secondary and higher categories for age 15-19 and for the age 20-24 it is showing a increase of 1.39g/dl, 1.18 g/dl, 1.09 g/dl, and 1 g/dl for no education, primary, secondary and higher categories of education.

For wealth index we find that the hemoglobin level has decreased for the poor category over the years by 0.21g/dl. Whereas for all the other categories it has increased by 0.37g/dl, and 1.37 g/dl for middle and rich respectively for age 20-24. And for the age 15-19, it is showing an increase of 0.42 g/dl for poor category whereas hemoglobin has increased by 0.44 g/dl for middle category and by 1.27 g/dl for rich category over the years.

Changes in young mother's BMI and Anemia levels across states for age group 15-19years.

Table 1.1e

This table shows the change in prevalence rate for each state. We find that for J&K, Punjab, New Delhi, Haryana, Bihar, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Rajasthan, Goa the prevalence of Low BMI have increased over the years whereas it has decreased for all the other states.

Prevalence for Anemia has decreased over the years for J&K, New Delhi, Haryana, Arunachal Pradesh, Nagaland, Sikkim, and Goa whereas it has increased for rest of the states.

Changes in young mother's BMI and Anemia levels across states for age group 20-24 years.

Table 1.1f

Similar to the last table, this table also shows the change in prevalence rates over the years for age group 20-24 years. We find that for Low BMI prevalence it has decreased over the years for all states except that of New Delhi, Bihar, Tripura, and Assam.

Whereas we also find that prevalence rate of Anemia has only decreased for the state of Himachal Pradesh, New Delhi, West Bengal, Arunachal Pradesh, Tripura, Meghalaya, Nagaland Assam, and Kerala over the years. For overall India we can see that the prevalence rate of Anemia has only decreased over the years.

BMI and its Determinants

Table 1.2a

Table 1.2a is showing the BMI and its determinants. The impact of socio economic and behavioral characters is shown on BMI of women. It shows that the age group plays a significant role in this i.e. as compared to lower ages, for higher age BMI is also increasing by 0.57 units.

While exploring the social factors we find that the BMI decreases as compared to urban areas for rural areas it decreases by 0.44 units. Similarly as compared to SC category, OBC and General we find the BMI level to be increasing by 0.16 and 0.41 units. When the association is measured between BMI and religion we found that compared to Hindus the BMI level has increased among Muslim and Other religious groups of woman by 0.49 and 0.64 units respectively.

The constructed table also points that as compared to lower education level for higher education level the BMI is increasing, i.e. as compared to no education (which has been considered to be the reference category) for secondary and higher levels we find that the beta (β) coefficient is increasing. We find that BMI level is increasing by 0.34 and 0.88 units respectively for secondary and higher levels. There is also a positive association noticed between wealth index and BMI level. It is observed that from lower wealth category to higher, BMI level is increasing by 0.44 and 1.02 units for middle and rich categories respectively. We even found that BMI has increased by 1 unit during NFHS 4 when compared to NFHS 2.

To find out the regional differences, India is divided into five different regions i.e. North, South, East, West and North East. And it is found that as compared to the northern region of the country to the eastern, western and central regions, BMI is decreasing by 0.57, 0.67, 0.73 units respectively. Whereas for the southern regions we find that the BMI is increasing by 0.45 units. There is no significant difference between BMI of Northern and North Eastern regions.

Behavioral factors show that for those who drinks, BMI increases by 0.58 units as compared to non-drinkers.

Determinants of change in BMI

Table 1.2b

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 units compared to urban places and for NFHS 4 it has decreased by 0.34 units. So we can say that the association between the place of location 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 women, 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 and 1.54 units whereas it is increasing by 0.36 and 0.92 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 units. Whereas during NFHS 4 BMI has decreased by 1.31 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

Association is found between Hemoglobin level and its determining 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 show association. We can observe from the shown table that Age group of woman have significant impact on hemoglobin level. For age group 20-24, we find hemoglobin level to be increasing by 0.07 units as compared to 15-19.
For the social factors like caste we find that as compared to SC, for ST category we find hemoglobin level to be decreasing by 0.05 units and where as for the OBC and General categories we find hemoglobin is increasing by 0.11 and 0.19 units respectively. For the category of religion we find that as compared to Hindu for Muslims and Others, hemoglobin increases by 0.16 and 0.27 units respectively.
For education we find that with increase in education hemoglobin level is also increasing, i.e. as compared to no education for primary, secondary and higher education we find that the hemoglobin increases by 0.15, 0.21 and 0.35 units respectively. Similarly for wealth index we find that with comparison to poor for middle and rich category, hemoglobin level increases by 0.08 and 0.12 units. The table shows that Hemoglobin level have increased during NFHS 4 by 1.27 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(East), 0.75(North East), 0.33(West), 0.36(South), 0.27(central).
Similarly we find that for normal weight and overweight the hemoglobin level to be increasing by 0.14 and 0.25 units respectively when compared to underweight category.

Determinants of change in Hemoglobin level

Table 1.2d

First from the table we can see that association between age group and Hemoglobin level was insignificant during NFHS 2 and is significant for NFHS 4.
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 units for rural areas, whereas for NFHS 4 it is decreasing by 0.05 units.
As we consider religion we find that for the Hindu Muslim gap, association has decreased over the years. Whereas for the Hindu and Other religion gap, association seemed to be insignificant during NFHS 2 and is significant during NFHS 4.
For 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 decreased over the years. We can see that during NFHS 2 as compared to no education for secondary and higher education, Hemoglobin level has increased by 0.52 and 0.75 units. Whereas during NFHS 4 it has increased by 0.24 and 0.33 units.

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.

Change in Mean Birth Weight by BMI

Table 2.1a

From this table we can find 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 born to mothers of age group 15-19years across states.

Table 2.1b

This table shows the impact of change in prevalence rate on one other for each state.

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. For India as a whole we find that prevalence of Low Birth weight has decreased over the years.

Change in Birth Weight of infants born to mothers of age group 20-24years across states.

Table 2.1c

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.

Association of BMI, Anemia and other determinants with Birth Weight

Table 2.2a

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.

Next we find the impact of Anemia on Birth outcomes. We find 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.

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.

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 NFHS 4 than NFHS 2.

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

Table 2.2b

Impact of BMI has changed over the years on birth size and 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.
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.

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

Table 2.2c

The difference in Birth weight when observed with respect to BMI, it is 0.11 units. 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.
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.

DISCUSSION

This study indentified the determinants of BMI and Anemia, explored the change in association between the determinants of BMI and Anemia. It has been also examined the impact of low BMI and anemia on Birth weight. 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 poor are 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 have developed during NFHS 4.The 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 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.

It was also observed that only 18.18% of the difference in Birth Weight is affected by Mothers BMI and only 35.71% of the difference is affected by anemia.

RECOMMENDATION

In order to remain healthy, or to get rid of these diseases, we should try our best to stop pregnancy at early age especially between ages 15-19 years. It is the major factor that increases the risk of having Anemia. Education and standard of living are also major influencing factors. Proper policies and interventions must be made to increase education. Though there are several ongoing health policies which had immense impact. These must be continued and must be spread to a greater level to decrease the risk. Undernourishment must be controlled and iron tablets must be given to the pregnant woman with proper medical checkup.

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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
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

Table 1.1e Changes in young mother's BMI and Anemia levels across states for age group 15-19years

STATES	YOUNG MOTHERS (15-19)			
	Low BMI		Anemia	
	Change	Yearly Change	Change	Yearly Change
NORTHERN STATES				
J&K	30.61	1.80	58.44	3.44
Himachal Pradesh	-3.38	-0.20	-2.71	-0.16
Punjab	8.49	0.50	26.72	1.57
New Delhi	49.76	2.93	-65.81	-3.87
Haryana	8.74	0.51	14.76	0.87
Uttar Pradesh	-18.82	-1.11	-40.34	-2.37
EASTERN STATES				
Bihar	24.65	1.45	-0.49	-0.03
Orissa	-21.49	-1.26	-26.87	-1.58
West Bengal	-30.04	-1.77	-8.31	-0.49
NORTH EAST				
Arunachal Pradesh	15.78	0.93	9.47	0.56
Tripura	-36.58	-2.15	-9.52	-0.56
Manipur	12.57	0.74	-22.69	-1.33
Meghalaya	9.98	0.59	-3.84	-0.23
Mizoram	0.09	0.01	-22.2	-1.31
Nagaland	29.51	1.74	23.14	1.36
Sikkim	-13.52	-0.80	15.5	0.91
Assam	24.83	1.46	-2.22	-0.13
WESTERN STATES				
Rajasthan	6.38	0.38	-25	-1.47
Maharashtra	-22.21	-1.31	-28.44	-1.67
Goa	12.94	0.76	24.27	1.43
Gujarat	-5.68	-0.33	-5.72	-0.34
SOUTHERN STATES				
Andhra Pradesh	-20.75	-1.22	-14.82	-0.87
Karnataka	-9.59	-0.56	-19.08	-1.12
Kerala	-14.25	-0.84	-31.94	-1.88
Tamil Nadu	-4.08	-0.24	-1.6	-0.09
CENTRAL STATES				
Madhya Pradesh	-10.09	-0.59	-4.09	-0.24
India	-11.17	-0.66	-11.69	-0.69

Table 1.1f Changes in young mother's BMI and Anemia levels across states for age group 20-24 years

STATES	YOUNG MOTHERS (20-24)			
	Low BMI		Anemia	
	Change	Yearly Change	Change	Yearly Change
NORTHERN STATES				
J&K	-21.91	-1.29	-16.93	-1.00
Himachal Pradesh	-9.24	-0.54	3.9	0.23
Punjab	-0.42	-0.02	-16.08	-0.95
New Delhi	6.46	0.38	6.55	0.39
Haryana	-20.34	-1.20	-1.21	-0.07
Uttar Pradesh	-3.83	-0.23	-0.77	-0.05
EASTERN STATES				
Bihar	4.43	0.26	-4.66	-0.27
Orissa	-14.71	-0.87	-16.94	-1.00
West Bengal	-13.92	-0.82	3.85	0.23
NORTH EAST				
Arunachal Pradesh	-1.25	-0.07	1.91	0.11
Tripura	8.12	0.48	2.84	0.17
Manipur	-7.87	-0.46	-11.25	-0.66
Meghalaya	-15.48	-0.91	20.8	1.22
Mizoram	-10.16	-0.60	-29.08	-1.71
Nagaland	-13.09	-0.77	1.09	0.06
Sikkim	-1.2	-0.07	-20.45	-1.20
Assam	4.85	0.29	2.48	0.15
WESTERN STATES				
Rajasthan	-8.52	-0.50	-25	-1.47
Maharashtra	-8.3	-0.49	-15.25	-0.90
Goa	-24.18	-1.42	-31.74	-1.87
Gujarat	-3.98	-0.23	-10.35	-0.61
SOUTHERN STATES				
Andhra Pradesh	-14.54	-0.86	-13.75	-0.81
Karnataka	-14.43	-0.85	-12.6	-0.74
Kerala	-13.42	-0.79	0.08	0.00
Tamil Nadu	-13.44	-0.79	-8.61	-0.51
CENTRAL STATES				
Madhya Pradesh	-6.17	-0.36	-12.44	-0.73
India	-7.72	-0.45	-6.86	-0.40

Table 1.2a BMI and its Determinants, by Multivariariate 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

BI-VARIATE ANALYSIS SHOWING CHANGE IN MEAN BIRTH WEIGHT FOR DIFFERENT CATEGORIES OF BMI		
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)		
VARIABLES	**MEAN BIRTH WEIGHT**	
BMI	**1998-99**	**2015-16**
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 and Birth Size of infants born to young mothers across states for age 15-19 years

STATES	YOUNG MOTHERS (15-19) Low Birth Weight	
	Change	Yearly Change
NORTHERN STATES		
J&K	-87.76	-5.16
Himachal Pradesh	7.95	0.47
Punjab	-38.93	-2.29
New Delhi	-56.29	-3.31
Haryana	5.18	0.30
Uttar Pradesh	-29.44	-1.73
EASTERN STATES		
Bihar	-24.13	-1.42
Orissa	16.58	0.98
West Bengal	-13.49	-0.79
NORTH EAST		
Arunachal Pradesh	-20.49	-1.21
Tripura	-28.55	-1.68
Manipur	-0.38	-0.02
Meghalaya	26.23	1.54
Mizoram	-12.73	-0.75
Nagaland	17.67	1.04
Sikkim	4.99	0.29
Assam	-13.96	-0.82
WESTERN STATES		
Rajasthan	1.65	0.10
Maharashtra	-13.87	-0.82
Goa	13.44	0.79
Gujarat	-1.91	-0.11
SOUTHERN STATES		
Andhra Pradesh	0.8	0.05
Karnataka	4.97	0.29
Kerala	-3.89	-0.23
Tamil Nadu	-5.95	-0.35
CENTRAL STATES		
Madhya Pradesh	-4.74	-0.28
India	-5.71	-0.34

Table 2.1c Change in Birth Weight and Birth Size of infants born to young mothers across states for age 20-24 years

STATES	YOUNG MOTHERS (20-24) Low Birth Weight	
	Change	Yearly Change
NORTHERN STATES		
J&K	-20.31	-1.19
Himachal Pradesh	-20.73	-1.22
Punjab	-0.21	-0.01
New Delhi	2.57	0.15
Haryana	-2.54	-0.15
Uttar Pradesh	-1.02	-0.06
EASTERN STATES		
Bihar	-13.52	-0.80
Orissa	-0.04	0.00
West Bengal	-6.38	-0.38
NORTH EAST		
Arunachal Pradesh	-20.19	-1.19
Tripura	-5.69	-0.33
Manipur	-0.56	-0.03
Meghalaya	10.92	0.64
Mizoram	-3.63	-0.21
Nagaland	-1.68	-0.10
Sikkim	-16.86	-0.99
Assam	-10.07	-0.59
WESTERN STATES		
Rajasthan	-13.1	-0.77
Maharashtra	-4.64	-0.27
Goa	0.54	0.03
Gujarat	-3.76	-0.22
SOUTHERN STATES		
Andhra Pradesh	-3.95	-0.23
Karnataka	-5.09	-0.30
Kerala	-8.29	-0.49
Tamil Nadu	-2	-0.12
CENTRAL STATES		
Madhya Pradesh	-15.28	-0.90
India	-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