Prevalence and predictors of low birth weight in India: Findings from the 2015-2016 National Family Health Survey (NFHS-4)

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ABSTRACT

Background: The main factor for the survival, growth, and development of a newborn is the birth weight. Low birth weight (LBW) infants are likely to be born with congenital heart anomalies and prone to more serious problems like sepsis, respiratory, metabolic and neuro-developmental disorders. According to the National Family Health Survey (NFHS) of India 2015-16, the prevalence of LBW is at 18.2% of all live births. There is no proper data accounted for the LBW prevalence at the national level in the form of either birth certificate or hospital discharge data forms, even though India has the highest reported rates for LBW in the world.

Aim: This paper determines the prevalence of LBW and the factors influencing it in India, as well as mapped distribution by state. The study will help understand the main factors causing LBW and contribute to developing interventions and policies to reduce the incidence of LBW.

Methods: This study consisted of secondary data analysis of the India NFHS-4 (2015-2016) data. The descriptive results were obtained through chi-square and t-test. Predictors causing LBW in India were obtained by univariate and multivariable logistic regression results. The causal diagram was drawn using Directed Acyclic graph to obtain the potential confounders of the association between maternal age at the time of delivery and LBW.

Results: Predictors causing LBW in India are mother's age at the time of delivery, female child, birth interval less than 24 months, mother's low educational level, poor wealth index, rural residence, no insurance coverage, history of infant death, mother's low BMI, being anemic, and inadequate ANC visits during pregnancy. Maternal age at the time of delivery is significantly associated with LBW after controlling for confounders. Mothers aged below 18 at the time of delivery are at higher risk of having a LBW child compared to other women (OR: 1.212, 95% CI: 1.172 - 1.303).

Contents

1. Background

Birth weight is an essential predictor of survival, growth and development of an infant.[1] "According to the World Health Organization (WHO), Low Birth Weight (LBW) is defined as a birth weight of less than 2,500 grams at the time of birth, regardless of the gestational age".[2] The infant must be weighed within the first hour of life before the physiological postnatal weight loss occurs.[3] Cases of LBW can either be caused by preterm delivery (28 to 37 weeks) or due to intrauterine growth restriction (small for gestational age babies, weighing <10th percentile at term).[4]

1.1 Burden of disease

LBW and prematurity remain a serious public health burden worldwide. Neonatal deaths account for a major fraction of deaths of children under the age of five, globally.[5] Children with LBW are at significantly higher risks of early childhood morbidity and mortality when compared with their counterparts with normal birth weights.[6]

Infants with LBW have health issues at various stages of their lives. During the neonatal period (28 days of life), LBW is a key predictor of fetal and infant mortality. Children of mothers who suffered from nutritional deprivation during pregnancy are more likely to be malnourished during early childhood; hence, they are smaller than their peers compared to mothers who did not suffer from malnutrition during pregnancy.[7–9] Infants with LBW are more likely to have congenital heart anomalies and are more prone to serious complications like sepsis (spread of infection through the blood), respiratory distress syndrome and metabolic disturbances.[10,11] Studies have shown that children with LBW may experience impaired neurodevelopmental and cognitive functions, as well as poor academic performance during their

school years.[12–15] These individuals are also at an increased risk of developing cardiovascular disease in their early adult life when compared with children with normal birth weight.[16] Possible effects on adulthood outcomes are lower earnings and productivity due to poor cognitive achievements and pre-natal under nutrition. The latter results in permanent changes in the metabolism and body structure of the individual, and henceforth adult chronic diseases.[7,8,17] According to WHO (2004), prematurity and LBW account for 18.3 million disability-adjusted life years (DALYs) in the South-East Asian Region.[18]

Advancements in medical technologies have improved the survival rates of infants with LBW. However, they have also increased the health care costs of bringing up these children.[19] For instance, WHO recommends to deliver anticipated LBW babies or preterm infants in facilities with neonatal intensive care unit (NICU). To provide supportive care to LBW babies or preterm infants, NICUs are furnished with incubators (encased plastic bassinet), ventilators to monitor the baby's vital signs, intravenous replenishing fluids, nasogastric tubes for feeding, bilirubin lights, and blood for transfusion as premature babies cannot build up their red blood cells. LBW babies or preterm infants may also require additional prescriptions such as liquid surfactants (to enable the lung to mature), aerosolized fine mist (to reinforce breathing and heart rate), antibiotics (to avoid infection), diuretics (to increase urine output, thus helping the lungs and circulation), eye drops (to stop the development of new blood vessels causing retinopathy) and drugs to help close heart deformities (patent ductus arteriosus).[20–23] The need for and use of these facilities and services can significantly drive the costs up.[8]

Factors contributing to LBW include socio-demographic characteristics and psychosocial status of the mother. Maternal factors contributing to LBW are antenatal care (ANC), reproductive behavior, birth order, mother's height and weight, maternal age, physical work,

smoking, the timing of first ANC, nutritional status, toxic exposures, access to health care services, maternal morbidity during pregnancy, anemia, and the sex of the baby.[24–27] Additionally, factors such as gestational age, premature rupture of membranes, premature birth, number of previous LBW babies, and multiple births can also impact birth weight. The leading factors contributing to LBW vary across countries.[28–33]

1.2 Situation in low middle-income countries

Around 20 million infants are born with LBW annually, which accounts for 15.5% of all live births worldwide. A majority of LBW cases (95.6%) are from low and middle-income countries (LMIC). LMIC's, with an average LBW prevalence of 16.5%, are two times more likely to have a LBW child when compared with high income countries where the prevalence of LBW is 7.0%.[2] South Asian countries such as, Bangladesh, Nepal, India and Pakistan account for half of all babies born with LBW in Asia. It is also worth noting that these Asian countries have the highest percentage of newborns (60.0%) not weighted at birth.[34] According to United Nations children's fund (2013), 16% or 22 million infants were born with LBW around the world.[1]

Many studies have investigated predictors of LBW in countries like India. About 6.5 million children with LBWs are born in LMIC annually.[7] According to WHO, in 2004, India had the highest prevalence rate of LBW (30.0% among all live births) among the South Asian countries.[9,28] In 2011, secondary data analysis of hospital records in Punjab province of Pakistan showed an LBW incidence of 24.5%, while a hospital-based cross-sectional survey in Karachi, Pakistan found an LBW incidence of 10.6% among the total live births during the study period. Findings from many studies show that LBW is a major public health problem in the LMIC's.[35,36]

1.3 Situation in India

From 2005-06 to 2015-16, the LBW prevalence decreased from 21.5% (NFHS-3) to 18.2% (NFHS-4).[37–39] The NFHS-4 (2015-16) found an infant mortality rate of 41 per 1,000 live births, and a neonatal mortality rate of 30 per 1,000 live births. Of all the infants that died in their neonatal period, 48.1% were LBW and preterm.[38]

In 2012, a community-based study in rural Karnataka revealed a LBW prevalence of 22.9%.[40] In 2017, a study conducted in provincial Maharashtra investigated live births and found that 6.1% of newborns were preterm and 13.8% had LBW.[41] Another community based cross-sectional study conducted in Assam in 2012-13 showed a LBW prevalence of 21.8%.[42] In 2005-06, the infant mortality rate in Karnataka was 28 per 1,000 live births, notably lower than the infant mortality rate of 41 per 1,000 live births observed all over India. While the postnatal mortality has been gradually declining, the decrease of neonatal mortality rates in India has been slow.[43] Most of the neonatal deaths could have been avoided with just a few changes in the ANC, delivery, and newborn care practices.[5]

In 2005, the costs of giving birth to an LBW baby in India was Rs. 5,450 (approximately USD 125) at tertiary care centers, with medication expenses and charge of NICU care per patient per day. The average total cost of medical care varies with birth weight (<1000g, 1000-1250g, 1250-1500g) and gestational age at term, ranging from Rs. 168,000 (app. USD 3,800) to Rs. 41,700 (app. USD 950).[44] In 2014, the average cost per patient per day in Neonatal Intensive Care Units (NICU) and axillary nurse personnel in tertiary care units was Rs. 4,969 (app. USD 73.8) and Rs. 2,730 (app. 40.5 USD) respectively.[45] In 2016, the mean cost of care at NICUs in

the private health care settings was Rs. 6107 (app. USD 90.7) per patient per day.[46,47] The cost of medical care is likely to increase further, affecting families who give birth to a LBW baby.[44]

1.4 Interventions addressing low birth weight

1.4.1 Janani Suraksha Yojana (JSY) (Safe motherhood intervention scheme)

The government of India funds the JSY program through the National Rural Health Mission, which was launched on April 12th, 2005, by the Prime Minister of India. The main aim of JSY is to decrease maternal and infant mortality. This program provides incentives for pregnant women who deliver in health institutions. This encourages pregnant women to choose institutional birth over home delivery. In addition, women of certain social class stratifications (caste category) receive a cash incentive of 500 INR as compensation for their post-delivery wage loss.[48] The need for and utilization of facility-based newborn care (FBNC) has increased since the introduction of JSY.[23]

1.4.2 Thayi Bhagya (Maternal & Child Health Care of all)

The Thayi Bhagya program provides free health care to pregnant women and mothers in Karnataka state, with the motive of *zero out of pocket expenditure* for all women who need maternal and child health services. It focuses on ensuring equity, as well as accessible and affordable high quality maternal and child health care services to the society. Consequently, certain caste category pregnant women and mothers are given cash incentives to motivate them to use maternal and child health services at the Government and Private Hospitals. These services are delivered to reduce maternal and infant morbidity and mortality.[49]

1.4.3 Indian Newborn Action Plan (INAP)

INAP was introduced in September 2014, with the main aim of attaining a single digit neonatal mortality rate (per 1000) by 2030. The main strategy is to cover 90.0% of the mothers to practice Kangaroo Mother Care (KMC), ANC and pre-conception care, care during labor, immediate newborn and healthy newborn care, care of small and sick newborn, and care beyond newborn survival. These are the six pillars of interventions which play a key role in reducing neonatal mortality, by the year 2030.[50]

1.5 Rationale for the study

Even though India has the highest prevalence of LBW in the world, there is no national-level source for birth weight data, neither in the birth certificate forms nor in the hospital discharge data forms.[28] The NFHS of India, equivalent to the Demographic Health Survey (DHS), in its third round (NFHS-3, conducted in 2005-06) collected data on the birth weight of infants by maternal recall, while asking mothers who had institutional deliveries to show their health cards, where the birth weight of the child is recorded.[51]

Many changes have taken place since 2005-06, thereby there is a need for a new study elaborating the present condition of the country regarding LBW. There is also a need for studies investigating potential factors contributing to the high prevalence of LBW in India. Findings from such studies can be used to improve interventions and policies targeting LBW in India.

1.6 Study aim

The primary aim of this study was to assess the maternal predictors of LBW among babies born in India, using the NFHS-4 (2015-16) data. The study findings will be useful for policymakers and public health practitioners aiming for reduction in incidence of LBW and

infant mortality. The second aim was to find an association between maternal age at the time of delivery and risk of LBW, among babies delivered at healthcare facilities in India.

1.7 Research questions

- What is the prevalence of LBW in each state and union territories of India?
- What are the maternal predictors associated with LBW among babies born at healthcare facilities in India?
- Is maternal age associated with LBW among babies born at healthcare facilities in India?

2. Conceptual Framework

To assess the factors associated with LBW in India, a conceptual framework was used to show the interrelationships between potential risk factors and unfavorable birth outcomes, such as premature birth, LBW, and cesarean section. The framework was adapted from a previous study and emphasized the potential predictors measured in NFHS. According to findings of earlier studies, LBW is related to socio-demographic characteristics, several maternal factors, service accessibility, and newborn factors.[3,6]

Socio-economic and demographic factors

Birth weight is a major predictor of neonatal health. According to a study in rural Maharashtra, the likelihood of having a baby with LBW is two times higher for women below the age of 22, compared to older women. Similarly, women below the age of 22 are three times more likely to have a preterm baby when compared with older women.[41,51] Maternal age from

35 to 49 is also associated with 70% higher risk of having LBW baby, also other studies have showed that older aged women are at a higher risk of giving birth to LBW infants.[6,52]

Women from low income household are more likely to have LBW infants. A study using the National Family Health Survey-3 data for India indicated a significant association between socio-economic status and LBW. The study assessed socio-economic status using household assets and ethnicity by using the recorded variable caste/ tribe. The study also found that mothers with no education or primary education are at a higher risk of having LBW baby when compared with mothers with higher levels of education.[32] A systematic review and meta-analysis showed that single and unmarried mothers tend to be more at risk of having a preterm birth, LBW and small for gestational age babies.[53] In 2017, a study conducted in Iran found similar results, showing significant associations between preterm birth, infant's sex, pregnancy risk factors, mother's educational level, place of residence, as well as delivery factors, such as parity number, maternal age at delivery, mode of delivery, with LBW.[54]

Reproductive behavior and service accessibility

Living in the rural area is a significant risk factor for having LBW babies. The low availability of access to services necessary for women during their pregnancy and delivery in rural areas is a major contributing factor to this increased risk. A study conducted in Cambodia, after adjusting for primigravidae women, and birth interval less than a year (women with highest birth order) identified a significant association between the place of residence and having LBW infants.[55]

Maternal health care and nutritional status

A study conducted in Indonesia assessed the impact of cultural practices on neonatal survival. Practices such as immediate bath of newborn in the name of "ritual pollution",

discarding of colostrum (first milk after delivery of the child), not practicing exclusive breastfeeding, and inadequate ANC has increased the odds of mortality of LBW babies by 129.0%. The practices of didaring (warm water padding) and KMC have positive impact on neonatal survival.[56] According to the WHO's recommendation, women must make their first ANC visit during their first trimester and have at least four ANC visits during pregnancy. A study using data from Ethiopian DHS (2011) indicates that utilization of ANC among rural women is 44% lower than urban women. The study also found that multigravida (mothers who have given birth more than one time) have 36% lower utilization rate of ANC when compared to primigravida (mothers who are giving birth for the first time). The study concluded that 66.3% women did not use ANC during their first trimester, and 22.3% had less than four visits during the pregnancy period.[57] A meta-analysis conducted using data from 57 low middle-income countries showed that ANC attendance decreases the risk of adverse birth outcomes, particularly neonatal mortality, by 32.0% (HR 0.68, 95% CI 0.61-0.75).[58]

Studies have found association between various maternal characteristics and LBW. For instance, a few studies have shown an association between short stature of the mother and LBW.[6,7,36,59] In 2015, a meta-analysis included the clinical trials conducted in LMICs on the use of multiple-micronutrient supplementation (iron and folic acid) during pregnancy, concluded that iron and folic acid significantly decreased the numbers of newborn babies born with LBW (risk ratio of 0.88) and small for normal gestational age (risk ratio of 0.92).[60] A study using data from 193 DHSs conducted in 69 low and middle-income countries found that making at least one visit to an ANC facility decreased the probability of having LBW baby by 3.8%.[25]

Biological factors

Biological factors such as sex of the child and multiple births are associated with LBW. Although there are several studies regarding the association between sex of the child and LBW, most of the studies have limited data on confounding variables and face limitations in distinguishing the causal effect of biological factors on LBW. [61–63] Empirical evidence shows that multiple births have a higher probability to have LBW and premature birth.[64,65]

3. Methodology

3.1 Data source

This study used the DHS data form India (2015-2016), also known as the NFHS-4. The DHS datasets are freely available to the public; however, researchers must enroll at the DHS official website and submit a request to access and download the data.

3.2 National Family Health Survey 2015-2016 (NFHS-4)

NFHS-4 includes information on characteristics of the population, health, and nutrition of India, by state and union territory (national and state levels). NFHS-4 also provides estimates for many essential indicators at the district level, which were not collected in the previous series. The NFHS-4 data was collected in 19 languages and included four survey questionnaires (household, men's, women's and biomarker).[66]

In NFHS-4, the sample included both rural and urban areas. Two-stage sample design was used for the selection of houses; villages were the Primary Sampling Units (PSUs) for rural areas, and Census Enumeration Blocks (CEB) were the PSUs for urban areas. In the second stage, within each PSU, 22 households were randomly selected. Later on, the households were chosen only after listing of the household and complete mapping for the units selected during the

first stage. Women aged 15-49 from the selected households were interviewed, and data were collected about them and all their children born during the five years period preceding the survey.[66] Complete information on birth weight was based on the health card, a written record, or the mother's self-reported data (recall).[38]

3.3 Target population

3.3.1 Inclusion criteria

- Youngest child born in the family, to minimize the possibility of change in various maternal factors over time.
- Babies born at health facilities in India, to eliminate the imprecision of birth weight taken at home. Of all the live births in NFHS-4, 78.9% were delivered at health facilities.
- Singleton babies, because multiple births such as twins, triplets (more than one child in one delivery) have an influence on the birth weight of the babies.

3.4 Sample selection

The survey gathered information from 699,686 women, and 112,122men.[38] The sample was limited to the youngest child in the family whose mother participated in NFHS-4. This process resulted in a sample size of 147,167 infant-mother pairs meeting the inclusion criteria.

3.5 Measures

3.5.1 Dependent variable

Children with a birth weight of less than 2500 mg were considered to have LBW.

3.5.2 Independent variables

Individual and household socio-demographic characteristics include age of the mother,

education of the mother, wealth index (categorized into 5 quintiles as recommended by DHS), marital status, religious background, and place of residence.

Reproductive characteristics of the mother included age at first birth, birth order, birth interval, the desirability of pregnancy, use of contraception, the nature of complications during pregnancy of last birth, any history of infant death, and general health behaviors such as smoking and alcohol status.

ANC status included , the timing of the first ANC visit, number of ANC visits, tetanus injection during pregnancy, place of delivery, and service accessibility.

Anthropometric measures include body mass index of the mother and the anemic status of the mother.[67, 3] Appendix 1 provides further details on dependent and independent variables of interest.

Other variables of interest are:

Smoking

Smoking was considered as a risk factor for low birth weight.[68–70]

Alcohol consumption

Excessive alcohol consumption is an unhealthy behavior aggravating the risk of low birth weight. Although low amount of alcohol consumption has a weak positive association with birth weight depicting healthy drinker effect, it has no relationship with preterm birth.[70–73]

Health insurance coverage

We included lack of health insurance coverage as a risk factor for LBW. Health care coverage scope can diminish budgetary obstructions, this in turn can encourage women to have frequent ANC visits and facilitate access to health facilities during pregnancy.[74]

Anemia status of the mother

During pregnancy, increased production of blood compensating the increased demand for blood supply and providing nutrients to the baby can result in physiologically anemia in the mother. To help with this condition, often additional supplements and medications are provided to women during pregnancy. In case of severe deficiency of hemoglobin, anemia can become pathological. Indeed, it is the most common hematological condition that occurs in pregnancy, leading to nutritional depreciation in intrauterine life. Such nutritional depreciation can increase the risk of poor birth outcomes and lead to preterm birth and LBW. The mean birth weight of the newborns born to mothers with anemia during the third trimester of pregnancy is lower when compared to the birth weight of newborns born to non-anemic mothers.[42,75,76]

3.5.3 Causal diagram

To identify potential confounders of the maternal age and LBW association we conducted literature review and depicted the identified relationships using the directed acyclic graph theory (see figure 2). The identified confounders and also common risk factors of LBW providing were selected and adjusted for. Those variables included use of family planning, total number of births, birth interval, number of ANC visits, marital status, anemia status, place of residence, and smoking and alcohol consumption.[42,69,71,72,77–125]

3.6 Data analysis

Descriptive data analysis was done for all the variables listed (means and standard deviations for continuous variables; frequency and proportions for categorical variables) to describe the distribution of variables in the sample. Chi-square tests for categorical variables and t-tests for continuous variables were used to compare the distribution of covariates and independent variables across children with different LBW status. The effect of predictor

variables on LBW was explored in simple and multivariable logistic regression analysis. Those variables with different proportions or means between the groups (defined by p-value < 0.05) were put into simple logistic regression to obtain a crude odds ratio for each variable. All the variables from the simple logistic regression models were subsequently entered into the multivariable logistic regression model.

For the first research question to identify the predictors, all the variables with a p-value greater than 0.05 in the multivariable logistic regression were eliminated, and all the remaining variables (significant variables) were considered as potential predictors. The final variables were screened and evaluated for practical significance on an individual basis. The multivariable logistic regression model performance was evaluated by receiver operating characteristic (ROC) curve, and we used the variance inflation factor test to check for multicollinearity.

Multivariable logistic regression analysis was used to find an association between mother's age and LBW after adjusting for the potential confounding variables selected using directed acyclic graphs (figure 2). A p-value of less than 0.05 was considered as statistically significant. All the analysis followed the DHS guidelines and applied the sampling weights .[126]

3.7 Logistical consideration

No expenses were required for the study, as the database was available at no cost.

3.8 Ethical consideration

The study protocol was reviewed and approved by the International Review Board (IRB) of the American University of Armenia (AUA). All computerized information was secured with a password, and only the research team had access to it.

3.9 Data management

Data were obtained in SPSS format and were kept on a password-protected personal computer.

4. Results

After excluding home deliveries and multiple births (twins, triplets, etc.), a total of 135,250 cases were included in the analysis after excluding the missing cases. Considering the sampling weights, the total sample included 137,544 cases. Table 1 presents the prevalence of LBW infants among live singleton births delivered in healthcare facilities in India by states and union territories. More than a third (37.3%) of all newborns had LBW. State of Uttar Pradesh had the highest prevalence of LBW infants (48.3%) while the lowest prevalence was observed in the state of Mizoram (10.8%). The highest prevalence among the union territories was in Dadar and Nagar Haveli at 52.3%, and the lowest prevalence among the union territories was in Lakshadweep, at 22.2%.

Table 2 describes the maternal and socioeconomic characteristics of mothers of the youngest singleton babies born in health facilities. About 89.6% of the mothers were 18 to 34 years old at the time of delivery, and 98.7% were married. The sample size comprised of 54.7% male infants and 45.3% female infants. Among those mothers who gave birth to normal weight babies, 17.9% had no education, 11.3% had primary level of education, 53.7% had secondary level of education, and 17.1 % had a higher level of education. Nearly 17.0% of the mothers had insurance coverage, and every mother faced at least one problem with service accessibility. Nearly half of the mothers (43.0%) were mildly anemic, 43.1% were not anemic, 13.1% were moderately anemic, and 0.8% of them suffered from severe anemia. The majority of mothers

(60.6%) attended ANC visits at least four times or more during their pregnancy. Most of the mothers were vaccinated against tetanus during pregnancy (94.1%). Just 0.5% of the mothers reported smoking habit, and 0.8% of the mothers reported alcohol consumption. The data on smoking and alcohol consumption habits were collected at the time of interview. Of the total sample, 37.3% of the babies were born with LBW, of which male babies and female babies comprised 51.5% and 48.5% respectively. Among the infants with LBW, 39.9% were firstborns, 49.9% were second and third born, and 10.2% were fourth or higher birth-order babies. More than 1 in 7 (15.5%) infants with LBW had birth interval less than 24 months. Birth interval was only relevant for those who were not the first child. Among mothers who gave birth to LBW infants, 52.4% were educated, and 22.3% were not educated. By religion, 81.6% of the infants with LBW belonged to Hindu religion, and by a caste of the household, 43.8% of infants with LBW belonged to the social stratification category named "Other Backward Class". Comparing the wealth index of the households, 18.6% cases of the poorest group and 17.0% cases of the richest group gave birth to low weight babies. Among the household of the infants with LBW, 68.0% were in rural residence. More than a quarter (26.9%) of mothers who gave birth to a child with LBW were underweight, 58.2% had normal weight, and 15.0% were overweight. Nearly, 61.2% of the mothers with a LBW infant had complications during their pregnancy. More than a quarter of mothers (28.2%) with a LBW infant took iron supplementation during their pregnancy. As Table 3 shows, among mothers with a LBW infant, on average the first ANC visit was made during the third and fourth month of pregnancy (mean 3.25, (S.D. 1.55). The chi-square and t-test results showed differences between maternal socio-economic and health characteristics between the two groups defined by the presence or absence of LBW. Age of the mother at the time of delivery, child's sex, birth order, birth interval, mother's educational level,

wealth index, religion, caste, marital status, place of residence, insurance coverage, mother's BMI, anemia status, complication during pregnancy, survival status of all births, number of ANC visits, timing of ANC visits, tetanus injection during pregnancy, desirability of child, use of family planning, and smoking status during the interview were significantly associated with LBW of infants ($P < 0.05$). Variables which were not significantly associated with LBW included iron supplementation of the mother during pregnancy, desirability of pregnancy and alcohol consumption during the interview.

For the first research question, Tables 4, and 5 summarize the results of the logistic regression of factors associated with LBW among singleton youngest children born in health facilities, based on NFHS-4 (2014-15). Table 4 shows twenty-two characteristics of interest, both categorical and continuous variables, all statistically significantly associated with LBW.

The multivariable regression, presented in table 5, demonstrates that the age of the mother at the time of delivery, child's sex, birth order of the child, birth interval, mother's educational level, wealth index, marital status, place of residence, insurance coverage, mother's BMI, anemia status of the mother, history of infant death (immediately after birth), and number of ANC visits during pregnancy were significantly associated with LBW (Table 5). Maternal age was a strong predictor of LBW in India. Mothers younger than 18 at the time of delivery had 8.4% higher odds of having LBW babies, compared to mothers aged 18 to 34. Female children had 24.1% higher odds of having an LBW compared to male children. Mothers giving birth for the first time were at 37.5% higher odds of having LBW baby compared to mothers with four or successive children. Mothers with an interval less than 24 months between two births had 10.7% higher odds of having a child with LBW than mothers with a birth interval of 24 months and above. Mothers with primary and no education had nearly 63.5% higher odds of giving birth to

an LBW infant compared to mothers with higher education. Children from households with a poor (OR= 1.086, 95% CI: 1.051 – 1.123) or middle (OR= 1.059, 95% CI: 1.025 - 1.093) wealth index had higher odds of having born with LBW compared to those from households with rich wealth index. Mothers who were never covered by insurance had 14.4% higher odds of having an LBW child than mothers who had insurance. Underweight mothers were more likely to have a child with an LBW child when compared to overweight mothers (OR= 1.624, 95% CI: 1.564 - 1.687). Mothers who are severely and moderately anemic have 26.8% and 8.8% higher odds of giving birth to an LBW child compared to mothers who are not anemic. Mothers with a history of infant death soon after birth had 26.4% higher odds of having an LBW child in their recent pregnancy compared to those with no such history. Mothers who resided in rural areas had 3.9% higher odds of having an LBW child compared to urban mothers. Mothers who made less than four ANC visits during their last pregnancy had 10.7% higher odds of having babies with LBW. The model evaluation showed the area under the ROC curve was 0.60 with p-value <0.001 and VIF test showed maximum value of 1.348, indicating no evidence of collinearity.

Table 6 describes multivariable logistic regression with LBW as the outcome and maternal age at the time of delivery as the exposure of interest, controlled for all potential confounders (use of family planning, total number of births, birth interval, number of ANC visits, marital status, anemia status, place of residence, and smoking and alcohol consumption). LBW was significantly associated for women who were younger than eighteen at the time of delivery (p-value<0.001), whereas LBW was not significant for women aged thirty-four and above (p-value = 0.118). Mothers who were younger than eighteen at the time of delivery had 25.3% higher odds of having babies with LBW, compared to mothers aged 18 to 34.

5. Discussion

The current study investigated the predictors of LBW in India and explored the effect of maternal age on the risk of LBW.

The study found several predictors of LBW, including: maternal age, gender of the child, mother's education, wealth index, religion, insurance, place of residence, BMI, anemia, history of immediate death of the infant, birth spacing, use of family planning and ANC visits. Most of the predictors were modifiable, including: maternal age at the time of delivery, education, insurance, maternal BMI, anemia, proper birth interval, and adequate ANC visits.

Findings from this study confirm previous studies that female babies are at a higher risk of LBW, when compared to males.[54] One possible explanation for this finding might be the higher levels of intolerance of mother's glucose among female fetuses impacting their birth weight.[62]

Theories suggest that nulliparous women (women who are giving birth for the first time) are at an increased risk for giving birth to a child with LBW, compared to multiparous women (women who have given birth once before) with poor birth spacing. Findings from this study fit into this theory.[127] Moreover, findings showed that mothers who had a birth interval of less than two years were more likely to have a LBW child, compared to mothers who maintained a birth spacing of two or more years. These findings were also consistent with findings from previous studies.[55,63]

The results of this study showed that educatrd mothers were less likely to give birth to a LBW infant when compared to mothers with no education. We observed the dose-response pattern where the odds of having a LBW baby decreases with increase in educational level of the mother. This was consistent with findings from previous studies in India using the NFHS-3

data.[32] Results suggest that infants born to mothers belonging to poor and middle-income households had a higher risk of being born with low weight than those from rich households. These results are similar with previous study findings.[32,42]

Our findings suggest that there was a significant association between the mothers with history of infant death and LBW. Consistent with other studies, we found that mothers with a history of an infant death were more likely to give birth to an LBW infant.[30,33]

Insurance coverage plays an important role in LBW in India. Mothers with health insurance were less likely to give birth to an LBW child when compared to those without health insurance. This was a unique finding of the study as previous studies had contradicting results. A study in Cambodia did not find an association between insurance coverage and LBW, while a study conducted in Arizona showed that absence of insurance was significantly associated with higher risks of having a LBW child. [55,74]

Rural mothers had a protective factor of having an LBW child, which is different from NFHS-3 study findings.[51] This result may be due to healthier eating habits and different practices in the care of pregnant women.[56,128]

Mothers who were underweight had a higher risk of giving birth to a child with LBW. This was similar to the findings of previous studies.[25,31,32,129] The results from the current study provided evidence that mothers who were severely or moderately anemic were more likely to give birth to LBW babies, compared to non-anemic mothers. This finding is similar to those from previous studies.[42,75,110] Some studies have found that an inadequate number of ANC visits had several effects on the course of pregnancy and also on a newborn's health. They showed that inadequate ANC visits during pregnancy was significantly associated with LBW, increasing

the risk of having such babies. [24,57,58,105,124,130] History of infant death increased the risk of LBW, hence the finding from this study fits into the theory of previous studies.[11,30,33,40]

The results from our study showed that mothers who were under eighteen at the time of delivery had a particularly higher risk of giving birth to a child with LBW, when compared to their counterparts between ages 18 to 34. This was consistent with previous studies, which found that teenage mothers are at a higher risk of having a child with an LBW.[131] This association could be attributable to the lower mental and physical maturity of mothers who are under eighteen. Additionally, young mothers have a higher likelihood to suffer from nutritional deprivation due to their growing age, which can be another factor contributing to their increased risk of having a LBW child.[32]

5.1 Strengths of the study

The study had a large sample size. The sample size was weighted to obtain valid estimates considering the complex design of the survey. Data regarding the birth weight of the infant was mainly collected based on mother's recall. To minimize impact of recall bias, the sample size was limited to the youngest child of the household. Infants born at home may not be appropriately weighed, or they may be weighed after the physiological weight loss. Limiting our sample to institutional births helped us obtain an analytical sample that included more accurate birth weight measures. Infants from multiple births such as twins, triplets were excluded from the sample, making the study sample more homogenous.

5.2 Limitations of the study

The study had many limitations to be addressed. The study had limited access to the choice of variables, many potential covariates causing LBW, such as partner's educational level,

employment status of both parents, the history of LBW, history of premature births, and illness during pregnancy were not available. Some of the variables were measured at the time of the survey, not necessarily reflecting the situation at the time of delivery or pregnancy. This was particularly important for variables such as smoking and alcohol consumption. The study analysis was limited to babies born at health facilities, and this might decrease the generalizability of the prevalence estimates, especially given that babies born at home are more likely to be born to poorer mothers or less educated ones, who are less likely to afford making the minimum recommended ANC visits. Moreover, those mothers are more likely to be unaware of the benefits of maternal health care and therefore might be at a higher risk for having an LBW child. Considering that everyone had problems with service accessibility we did not have any variation in that variable; hence we could not assess its association with LBW.

5.3 Conclusion and recommendation

This study assessed the predictors of LBW in India. Knowledge on predictors of LBW highlighted in this study can be used to identify high risk populations and also predict the LBW trends. These findings also emphasise the need for further studies to evaluate the potential causal effect of these predictors measured during pregnancy, including BMI, anemia, smoking, alcohol consumption, history of LBW, and others.

This study also investigated the association between maternal age and LBW among the infants born in India. The study showed that teenage mothers are at a higher risk of having a child with LBW. Health care personnel, health care providers, and non-governmental organizations will benefit from the study results. Findings from this study can help policymakers and public health practitioners in developing interventions targeting LBW in India.

Despite the limitations, the findings suggest that the prevalence of LBW could be reduced as most of the predictors are modifiable with a better enforcement of the INAP program. Further in-depth studies are required to find the predictors by states, since every state will have different predictors; each state differs in characteristics, such as socioeconomic status, cultural, practices, service accessibility, etc. The program should further reinforce to focus on vulnerable groups such as young mothers, economically challenged mothers, and those with low educational level. Also, find effective ways to reach out to the vulnerable groups regarding the information on the importance of ANC visits during their pregnancy and awareness about the harmful effect of anemia during their pregnancy on the development of the child.

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Figure 1

Conceptual framework for factors associated with low birth weight[132, 3]

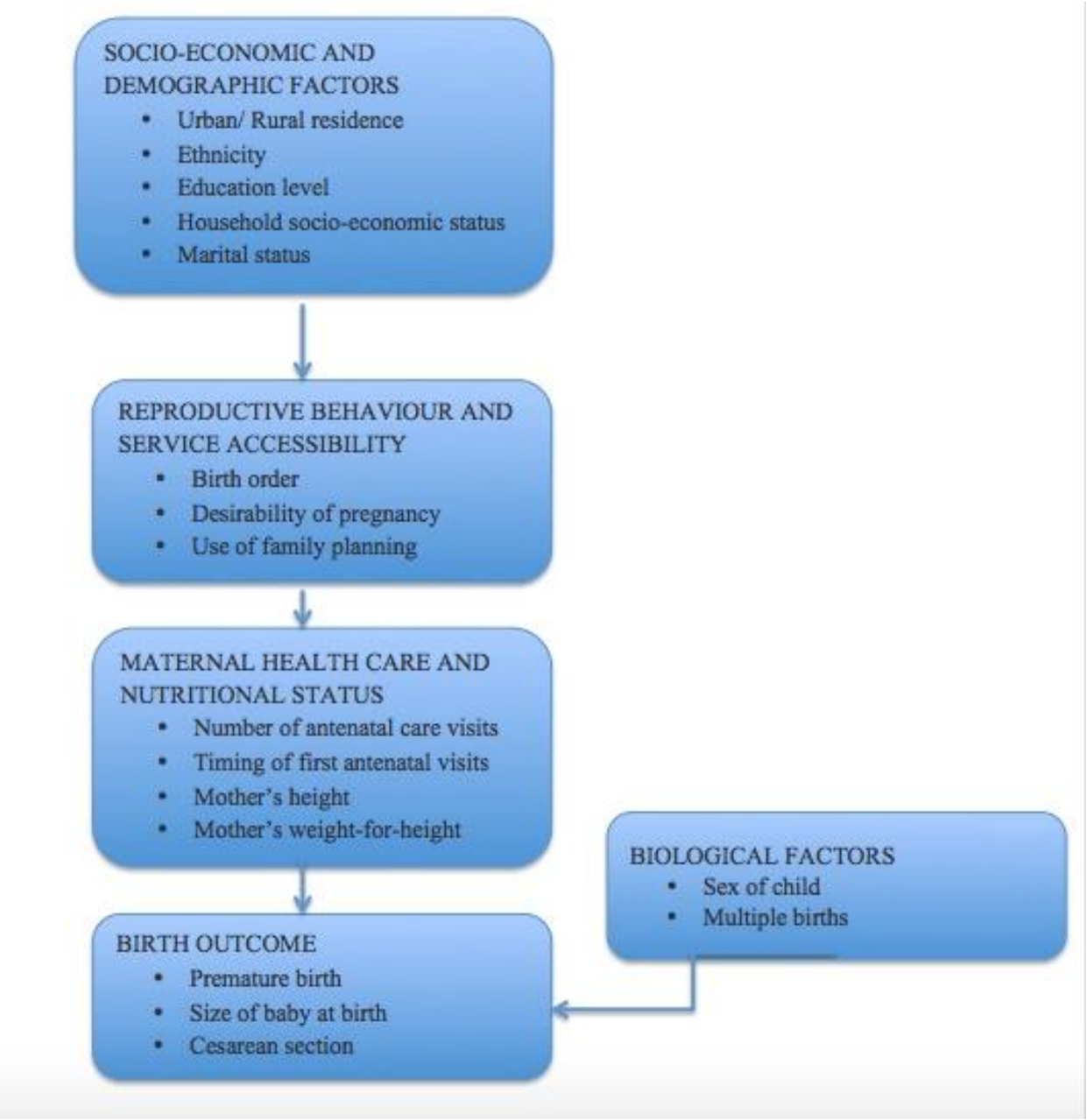
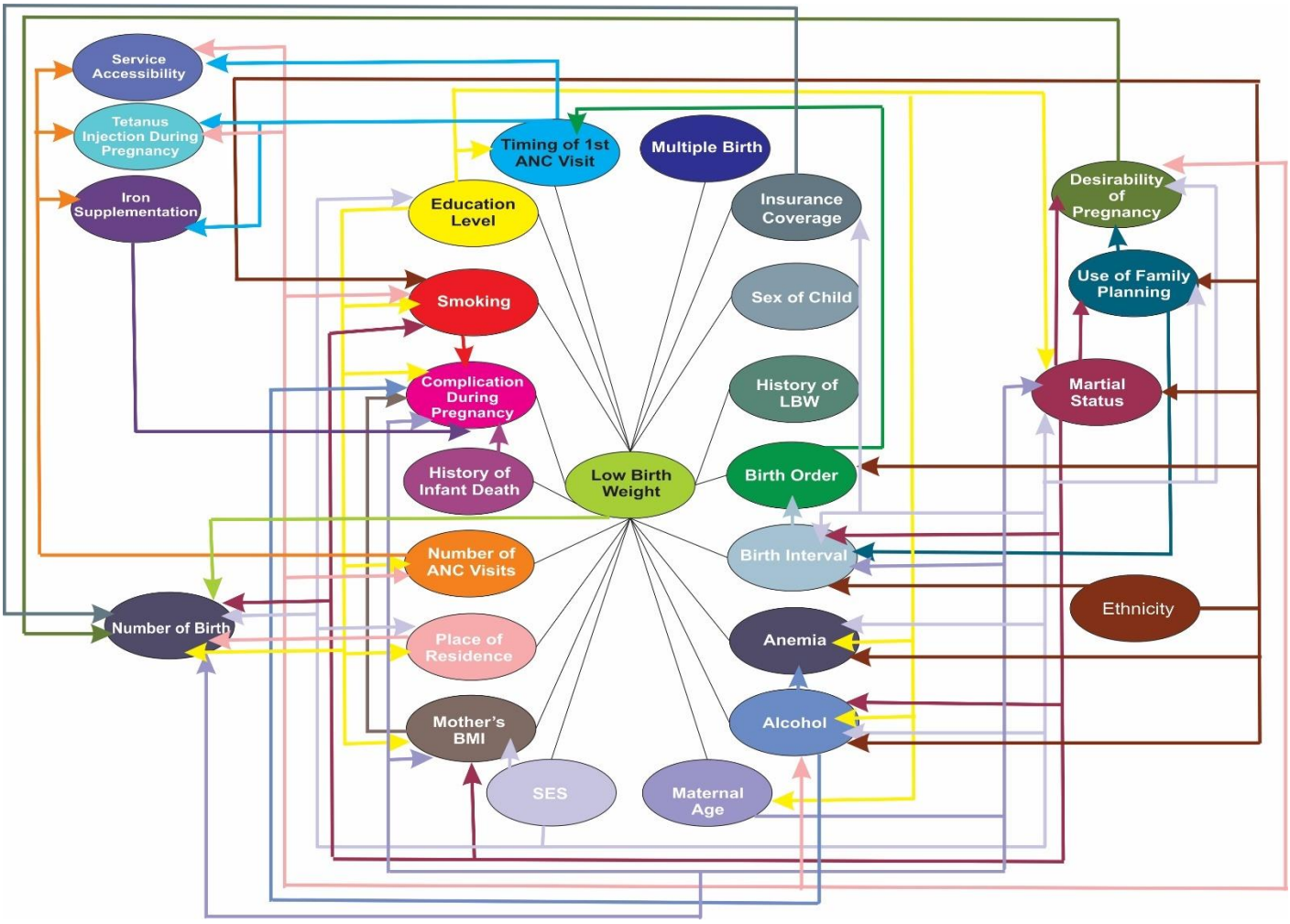


Figure 2

Causal diagram using directed acyclic graphs (DAG) to identify confounders for estimating factors causing LBW[1, 2, 3*]



[1] SES: Socioeconomic status
[2] BMI: Body Mass Index
[3] ANC: Antenatal care

Tables

Table 1: Distribution of low birth weight by state and union territory of India, among the youngest singleton babies born in health facilities of India, National Family Health Survey 2015-2016 (NFHS-4)

State	Birth weight <2500gms n =51276		Birth weight ≥2500gms n =86266		Total sample N = 137542	
	Number	Percentage	Number	Percentage	Number	Percentage
North						
Chhattisgarh	1135	36.1	2006	63.9	3141	2.3
Haryana	1253	37.9	2053	62.1	3306	2.4
Himachal Pradesh	290	44.3	365	55.7	655	0.5
Jammu and Kashmir	444	37.4	743	62.6	1187	0.9
Madhya Pradesh	4317	46.5	4976	53.5	9293	6.8
Punjab	1225	42.1	1686	57.9	2911	2.1
Rajasthan	3869	47.6	4263	52.4	8132	5.9
Uttar Pradesh	6845	48.3	9347	57.7	16192	11.8
Uttarakhand	403	44.2	509	55.8	912	0.7
East						
Assam	1093	31.3	2404	68.7	3497	2.5
Arunachal Pradesh	13	15.5	71	84.5	84	0.1
Bihar	4036	34.7	7610	865.3	11646	8.5
Jharkhand	1141	34.4	2174	65.6	3315	2.4
Manipur	40	14.7	233	85.3	273	0.2
Meghalaya	65	23.2	215	76.8	280	0.2
Mizoram	14	10.8	116	89.2	130	0.1
Nagaland	10	13.5	64	86.5	74	0.1
Odisha	1971	35.3	3617	64.7	5588	4.1
Sikkim	8	16.0	42	84.0	50	0.0
Tripura	153	36.7	264	63.3	417	0.3
West Bengal	3451	32.3	7220	67.7	10671	7.8
West						
Goa	64	37.4	107	62.6	171	0.1
Gujrat	2629	37.2	4445	62.8	7074	5.1
Maharashtra	5848	41.4	8289	58.6	14137	10.3
South						
Andhra Pradesh	2116	36.1	3745	63.9	5861	4.3
Karnataka	2520	35.3	4620	64.7	7140	5.2
Kerala	775	21.4	2844	78.6	3619	2.6
Tamil Nadu	2989	27.9	7716	72.1	10705	7.8

Telangana	1656	34.5	3149	65.5	4805	3.5
Union territories						
Andaman and Nicobar Islands	13	31.7	28	68.3	41	0.0
Chandigarh	41	39.8	62	60.2	103	0.1
Dadra and Nagar haveli	23	52.3	21	47.7	44	0.0
Daman and Diu	6	33.3	12	66.7	18	0.0
Delhi	779	41.1	1115	58.9	1894	1.4
Lakshadweep	2	22.2	7	77.8	9	0.0
Puducherry	39	23.4	128	76.6	167	0.1

Table 2: Descriptive analysis of the selected categorical characteristics by birth weight <2500gms among the youngest singleton babies born in health facilities of India, National Family Health Survey 2015-2016 (NFHS-4)

Characteristic	Birth weight <2500gms		Birth weight ≥2500gms		P value*	Total sample	
	Number	Percentage	Number	Percentage		Number	Percentage
Age of the mother at the time of delivery							
Under 18	1659	3.2	2205	2.6		3864	2.8
18-34	45616	89.0	77649	90.0		123265	89.6
35 and over	4002	7.8	6414	7.4		10416	7.6
Sex of the child					<0.001		
Male	26428	51.5	48818	56.6		75246	54.7
Female	24848	48.5	37450	43.4		62298	45.3
Birth order					<0.001		
First child	20438	39.9	33135	38.4		53573	39.0
Second and third child	25611	49.9	44741	51.9		70352	51.1
Fourth and successive child	5227	10.2	8391	9.7		13618	9.9
Birth interval					<0.001		
< 24months	7968	15.5	12392	14.4		20360	14.8
≥ 24 months	43309	84.5	73875	85.6		117184	85.2
Number of children					<0.001		
One child	20438	39.9	33135	38.4		53673	39.0
Two- three children	25611	49.9	44741	51.9		70352	51.1
Four and more children	5227	10.2	8391	9.7		13618	9.9
Highest educational level of mother					<0.001		
No education	11433	22.3	15412	17.9		26845	19.5
Primary education	7087	13.8	9767	11.3		16854	12.3
Secondary education	26874	52.4	46303	53.7		73177	53.2
Higher education	5882	11.5	14786	17.1		20668	15.0
Wealth index					<0.001		
Poorest	9537	18.6	12540	14.5		22077	16.1
Poorer	10738	20.9	16095	18.7		26833	19.5
Middle	11271	22.0	18326	21.2		29597	21.5
Richer	11000	21.5	19671	22.8		30671	22.3
Richest	8730	17.0	19636	22.8		28366	20.6
Religion					<0.001		
Hindu	41855	81.6	68699	79.6		110554	80.4
Muslim	6775	13.2	12699	14.7		19474	14.2
Christian	898	1.8	2175	2.5		3073	2.2
Others	1749	3.4	2694	3.1		4443	3.2

Characteristic	Birth weight <2500gms		Birth weight ≥2500gms		P	Total sample	
	Number	Percentage	Number	Percentage	value*	Number	Percentage
Caste of household					<0.001		
Scheduled caste	11674	23.8	17216	20.9		28890	22.0
Scheduled tribe	5112	10.4	7207	8.8		12319	9.4
Other backward class	21548	43.8	37962	46.1		59510	45.3
Others	10810	22.0	19933	24.2		30743	23.4
Marital Status					0.005		
Never married	45	0.1	80	0.1		125	0.1
Currently married	50561	98.6	35228	98.8		135789	98.7
Widowed/divorced/ separated/deserted	670	1.3	959	1.1		1629	1.2
Place of residence							
Rural	34850	68.0	55597	64.4	<0.001	90447	65.8
Urban	16427	32.0	30671	35.6		47098	34.2
Insurance coverage					<0.001		
No	43190	84.2	70635	81.9		113825	82.8
Yes	8057	15.8	15632	18.1		23719	17.2
Service accessibility							
No barrier							
≥ One barrier (distance/ money/waiting time)	24364	100.0	39667	100.0		64031	100.0
BMI of the mother					<0.001		
Underweight	13491	26.9	16375	19.3		29866	22.1
Normal	29220	58.2	50962	60.2		80182	59.4
Overweight	7526	15.0	17326	20.5		24852	18.4
Anemia status of the mother					<0.001		
Severe	467	0.9	585	0.7		1052	0.8
Moderate	6980	14.0	10594	12.6		17574	13.1
Mild	21770	43.6	35863	42.7		57633	43.0
Not anemic	20735	41.5	37008	44.0		57743	43.1
Complication during pregnancy					0.001		
Yes	19854	38.8	52000	60.3		83381	60.7
No	31381	61.2	34202	39.7		54056	39.3
History of infant death					<0.001		
Yes	6785	7.9	5118	10.0		11903	8.7
No	46159	90.0	79483	92.1		125642	91.3

* P-value is by chi-square test

Characteristic	Birth weight <2500gms		Birth weight ≥2500gms		P value*	Total sample	
	Number	Percentage	Number	Percentage		Number	Percentage
Number of ANC visits					0.001		
Less than four visits	21628	42.5	32128	37.6		53756	39.4
Four and more visits	29210	57.5	53339	62.4		82549	60.6
Iron supplementation of mother during pregnancy					0.698		
Yes	14037	28.2	24010	28.3			28.3
No	35666	71.8	60710	71.7		96376	71.7
Tetanus injection of the mother during pregnancy					<0.001		
Yes	47847	93.9	80847	94.3		128694	94.1
No	3086	6.1	4923	5.7		8009	5.9
Desirability of the child					<0.890		
Wanted the child	47312	92.3	79615	92.3		126927	92.3
Did not want the child	6653	7.7	3965	7.7		10618	7.7
Use of family planning							
Yes	30046	58.6	53124	61.6	<0.001	83170	60.5
No	21230	41.4	33143	38.4		54373	39.5
Smoking status					0.013		
Yes	307	0.6	429	0.5		736	0.5
No	50969	99.4	85838	99.5		136807	99.5
Alcohol consumption					0.648		
Yes	405	0.8	701	0.8		1106	0.8
No	50872	99.2	85567	99.2		136439	99.2
Frequency of alcohol consumption							
About everyday	73	18.0	123	17.5	0.056	196	17.7
About once a week	145	35.8	206	29.4		351	31.7
Less than once a week	187	46.2	372	53.1		559	50.5

* P-value is by chi-square test

Table 3: Descriptive analysis of timing of first antenatal care visit by birth weight <2500gms among the youngest singleton babies born in health facilities of India, National Family Health Survey 2015-2016 (NFHS-4)

Characteristic	Birth weight <2500gms		Birth weight ≥2500gms		P value*	Total		
	Mean	Standard deviation	Mean	Standard deviation		Number	Mean	Standard Deviation
Timing of first antenatal care visit (months)	3.25	1.548	3.18	1.575	<0.001	121017	3.20	1.565

* P-value is by t-test

Table 4: Univariate logistic regression of the selected characteristics with birth weight <2500gms as outcome among the youngest singleton babies born in health facilities of India (from NFHS-4 data)

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Age of mother at the time of delivery				
Under 18	1.281	1.201	1.367	<0.001
35 and over	1.062	1.019	1.107	0.004
18-34	1.000	Reference		
Sex of the child	1.226	1.199	1.253	<0.001
Female	1.226	1.199	1.253	<0.001
Male	1.000	Reference		
Birth order				
First child	0.990	0.953	1.029	0.613
Second and third child	0.919	0.885	0.954	<0.001
Fourth and consecutive child	1.000	Reference		
Birth interval				
Less than 24 months	1.097	1.064	1.131	<0.001
Greater than or equal to 24 months	1.000	Reference		
Number of births				
One child	0.990	0.953	1.029	0.613
Two to three children	0.919	0.885	0.954	<0.001
Four and more children	1.000	Reference		
Highest educational level of the mother				
No education	1.865	1.794	1.938	<0.001
Primary education	1.824	1.747	1.904	<0.001
Secondary education	1.459	1.411	1.509	<0.001
Higher education	1.000	Reference		
Wealth Index				
Poor	1.411	1.376	1.446	<0.001
Middle	1.225	1.190	1.261	<0.001
Rich	1.000	Reference		
Religion				
Hindu	0.939	0.883	0.998	0.043
Muslim	0.822	0.769	0.879	<0.001
Christian	0.636	0.577	0.702	<0.001
Other	1.000	Reference		
Type of caste or tribe of the household				
Scheduled Caste, Scheduled Tribe, Other Backward Class	1.133	1.103	1.164	<0.001
Any other class	1.000	Reference		
Marital status				
Never married	0.808	0.554	0.178	0.268
Currently married	0.849	0.769	0.938	0.001
Widowed/divorced/separated/deserted	1.000	Reference		

Characteristic	Odds Ratio	Confidence Interval		P value
		Lower	Upper	
Place of residence				
Rural	1.170	1.144	1.198	<0.001
Urban	1.000	Reference		
Insurance coverage				
No	1.182	1.148	1.217	<0.001
Yes	1.000	Reference		
Service accessibility				
≥ One barrier (distance/ money/waiting time)	1.086	1.042	1.131	<0.001
No barrier	1.000	Reference		
BMI of the mother				
Underweight	1.897	1.831	1.965	<0.001
Normal	1.320	1.280	1.361	<0.001
Overweight	1.000	Reference		
Anemia status of the mother				
Severe	1.427	1.262	1.613	<0.001
Moderate	1.176	1.136	1.217	<0.001
Mild	1.083	1.058	1.110	<0.001
Not anemic	1.000	Reference		
Complications during pregnancy				
Yes	0.962	0.941	0.984	0.001
No	1.000	Reference		
History of infant death				
Yes	1.299	1.250	1.349	<0.001
No	1.000	Reference		
Number of ANC visits				
Less than four visits	1.229	1.202	1.257	<0.001
Four and more visits	1.000	Reference		
Timing of first ANC visit (months)	1.031	1.024	1.038	<0.001
Tetanus injection taken during pregnancy				
Yes	0.994	0.901	0.989	0.016
No	1.000	Reference		
Use of family planning				
Yes	0.883	0.863	0.903	<0.001
No	1.000	Reference		
Smoking status				
Yes	1.206	1.041	1.397	0.012
No	1.000	Reference		

Table 5: Multivariable logistic regression of the selected characteristics with birth weight <2500gms as outcome among the youngest singleton babies born in health facilities of India (from NFHS-4 data) *

Characteristic	Odds Ratio	Confidence Interval (95%)		P-value
		Lower	Upper	
Age of mother at the time of delivery				
Under 18	1.084	1.013	1.160	0.020
18-34	1.000	Reference		
35 and over	1.023	0.980	1.068	0.298
Sex of the child				
Female	1.241	1.213	1.269	<0.001
Male	1.000	Reference		
Birth order				
First child	1.375	1.313	1.440	<0.001
Second and third child	1.160	1.112	1.211	<0.001
Fourth and consecutive child	1.000	Reference		
Birth interval				
Less than 24months	1.095	1.059	1.132	<0.001
More than 24 months	1.000	Reference		
Highest educational level of the mother				
No education	1.635	1.560	1.713	<0.001
Primary education	1.636	1.559	1.716	<0.001
Secondary education	1.371	1.322	1.422	<0.001
Higher education	1.000	Reference		
Wealth Index				
Poor	1.086	1.051	1.123	<0.001
Middle	1.059	1.025	1.093	0.001
Rich	1.000	Reference		
Place of residence				
Rural	0.959	0.933	0.986	<0.001
Urban	1.000	Reference		
Insurance coverage				
No	1.144	1.109	1.179	<0.001
Yes	1.000	Reference		
BMI of the mother				
Underweight	1.624	1.564	1.687	<0.001
Normal	1.199	1.161	1.238	<0.001
Overweight	1.000	Reference		
Anemia status of the mother				
Severe	1.268	1.119	1.438	<0.001
Moderate	1.088	1.050	1.127	<0.001
Mild	1.034	1.009	1.059	0.016
Not anemic	1.000	Reference		

***Area under the ROC curve = 0.60**

Characteristic	Odds Ratio	Confidence Interval (95%)		P-value
		Lower	Upper	
History of infant death				
Yes	1.264	1.212	1.318	<0.001
No	1.000	Reference		
Number of ANC visits				
Less than four visits	1.107	1.081	1.134	<0.001
Four and more visits	1.000	Reference		

***Area under the ROC curve = 0.60**

Table 6: Association between maternal age at the time of delivery with birth weight <2500gms controlled for identified confounders among the youngest singleton babies born in health facilities of India (from NFHS-4 data) *

Characteristic	Odds Ratio	Confidence Interval		P-value
		Lower	Upper	
Age of mother at the time of delivery				
Under 18	1.212	1.172	1.303	<0.001
18-34	1.000	Reference		
35 and over	0.969	0.927	1.008	0.109

***After adjusting for potential confounders such as use of family planning, total number of births, birth interval, number of ANC visits, marital status, anemia status, place of residence, and smoking and alcohol consumption**

Appendix 1

Table 1: Dependent variable

Variable	Type	Measure
Birth weight	Ordinal (categorical)	1 = <2500 grams 2 = >2500 grams

Table 2: Independent variable

Variable	Type	Measure
Age of the mother	Ordinal (categorical)	1 = <18 2 = 18-34 3 = 35-49
Education of the mother	Ordinal (categorical)	1 = No schooling 2 = Primary school 3 = Secondary and higher
Wealth index	Ordinal (categorical)	1 = Highest 2 = Fourth 3 = Middle 4 = Second 5 = Lowest
Marital status	Nominal (categorical)	1 = Never married 2 = Currently married 3 = Widowed/divorced/ separated/deserted
Residence of the household	Nominal (categorical)	1 = Urban 2 = Rural
Type of employment	Nominal (categorical)	1 = No job/ not working; 2 = Self-employed; professional/ technical/ sales jobs; 3 = other types of jobs (agricultural jobs/ services/ household work/ manual labor and unskilled jobs)
Religion	Nominal (categorical)	1 = Hindu 2 = Muslim 3 = Christian 4 = Others
Caste of the household	Nominal (categorical)	1 = Scheduled caste/ Scheduled tribe/ Other backward class 2 = others
Age at first intercourse	Numeric (continuous)	Year
Use of family planning	Binary (dichotomous)	1 = Yes 0 = No

Birth order	Ordinal (categorical)	1 = First child 2 = Second and third child 3 = Fourth+ child
Birth interval	Ordinal (categorical)	1 = <24 months 0 = ≥24 months
Desirability for A Child	Nominal (categorical)	1 = Have Another Child 0 = No More
Nature of complications during pregnancy of last birth	Binary (dichotomous)	1 = Yes 0 = No
History of infant death	Binary (dichotomous)	1 = Yes 0 = No
History of LBW	Binary (dichotomous)	1 = Yes 0 = No
Smoking status	Nominal (categorical)	1 = Yes 0 = No
Tobacco use	Nominal (categorical)	1 = Yes 0 = No
Timing of first antenatal care visit	Numeric (discrete)	Months
Number of antenatal care visits	Numeric (discrete)	1 = Mothers who made fewer than four visits 0 = Mothers who made four or more visits
Tetanus injection during pregnancy	Nominal (categorical)	1 = Yes 0 = No
Use of Iron supplementation	Nominal (categorical)	1 = Yes 0 = No
Place of delivery	Nominal (categorical)	1= Institutional delivery 2 = Home delivery
Service accessibility	Nominal (categorical)	0 = If the mother reported no perceived barrier 1 = If the mother reported 1 or more barriers (distance, money, and waiting time)
Mother's BMI	Nominal (categorical)	1 = Underweight (<18.5kg/m2) 2 = Normal or healthy weight (18.5-24.9 kg/m2) 3 = Overweight (≥25 kg/m2)
Hemoglobin level of the mother	Nominal (categorical)	1 = Severe (0-69g/dl) 2 = Moderate (70-99g/dl) 3 = Mild (100-119g/dl) 4 = Not anemic (>120g/dl)
Gender of the child	Nominal (categorical)	1 = Male 2 = Female

Appendix 2

HOUSEHOLD QUESTIONNAIRE

HOUSEHOLD SCHEDULE (4,5,6,7,8)

SEX

4. Is (NAME) male or female?

RESIDENCE

5. Does (NAME) usually live here?

6. Did (NAME) stay here last night?

AGE

7. How old is (NAME)?

MARITAL STATUS

8. What is (NAME)'s current marital status?

1 = MARRIED CIRCLE

2 = DIVORCED/ OF ALL

3 = WIDOWED AGE

4 = NEVER MARRIED AND NEVER LIVED TOGETHER

WOMAN'S QUESTIONNAIRE

SECTION 1. RESPONDENT'S BACKGROUND

RESIDENCE

102. How long have you been living continuously in (NAME OF CURRENT CITY, TOWN OR VILLAGE OF RESIDENCE)?

YEARS . . . . . .

ALWAYS 95

VISITOR 96

103. Just before you moved here, did you live in a city, in a town, or in a rural area?

CITY 1

TOWN 2

RURAL AREA 3

AGE OF WOMEN

105. In what month and year were you born?

MONTH . . . . . .

DON'T KNOW MONTH 98

YEAR . . . . . .

DON'T KNOW YEAR 9. 998

106. How old were you at your last birthday?

AGE IN COMPLETED YEARS . . . . . .

EDUCATION STATUS

107. Have you ever attended school?

YES 1

NO 2 111

108. What is the highest level of school you attended: primary, secondary, or higher?

PRIMARY 1

SECONDARY 2

HIGHER 3

109. What is the highest [GRADE/FORM/YEAR] you completed at that level?

SECTION 2. REPRODUCTION

BIRTH HISTORY

201. Now I would like to ask about all the births you have had during your life. Have you ever given birth?

YES 1

NO 2

PREVIOUS INFANT HISTORY

206. Have you ever given birth to a boy or girl who was born alive but later died? IF NO, PROBE: Any baby who cried, who made any movement, sound, or effort to breathe, or who showed any other signs of life even if for a very short time?

YES 1

NO 2

230. Have you ever had a pregnancy that miscarried, was aborted, or ended in a stillbirth?

YES 1

NO 2

NUMBER OF BIRTHS

208. SUM ANSWERS TO 203, 205, AND 207, AND ENTER TOTAL. IF NONE, RECORD '00'. TOTAL BIRTHS . . . . . .

SEX OF INFANT

213. Is (NAME) a boy or a girl?

TWINS

214. Were any of these births twins?

BIRTH HISTORY

222. Have you had any live births since the birth of (NAME OF LAST BIRTH)?

223. WITH NUMBER OF BIRTHS IN BIRTH HISTORY, NUMBERS ARE

ARE SAME ……..NUMBERS ARE DIFFERENT…….. (PROBE AND RECONCILE)

NUMBER OF BIRTHS

224. CHECK 215: ENTER THE NUMBER OF BIRTHS IN 2010-2015

NUMBER OF BIRTHS . . . . . .

NONE 0

DESIRABILITY FOR CHILD

226. Are you pregnant now?

YES 1

NO 2

UNSURE 8

228. When you got pregnant, did you want to get pregnant at that time?

YES 1

NO 2

SECTION 3. CONTRACEPTION

PRACTICE OF USE OF FAMILY PLANNING

303. Are you or your partner currently doing something or using any method to delay or avoid getting pregnant?

YES 1

NO 2

304. Which method are you using?

FEMALE STERILIZATION . . . . . A

(4) MALE STERILIZATION . . . . . B

IUD C

INJECTABLES . . . . . D

IMPLANTS . . . . . E

PILL . . . . . F

CONDOM . . . . . G

FEMALE CONDOM . . . . . H

EMERGENCY CONTRACEPTION I

STANDARD DAYS METHOD . . . . . J

LACTATIONAL AMENORRHEA METHOD. . . . . K

RHYTHM METHOD L

WITHDRAWAL . . . . . M

OTHER MODERN METHOD X

OTHER TRADITIONAL METHOD . . . . . Y

SECTION 4. PREGNANCY AND POSTNATAL CARE

BIRTH HISTORY

403. BIRTH HISTORY NUMBER FROM 212 IN BIRTH HISTORY.

LAST BIRTH	NEXT-TO-LAST BIRTH
BIRTH	BIRTH
HISTORY	HISTORY
NUMBER ……..	NUMBER ……..

DESIRABILITY FOR CHILD

405. When you got pregnant with (NAME), did you want to get pregnant at that time?

YES 1

NO 2

406. ONLY ONE BIRTH

Did you want to have a baby later on, or did you not want any children?

LATER 1

NO MORE/NONE 2

MORE THAN ONE BIRTH

Did you want to have a baby later on, or did you not want anymore children?

LATER 1

NO MORE/NONE 2

BIRTH INTERVAL

407. How much longer did you want to wait?

MONTHS 1

YEARS 2

DON'T KNOW 998

ANTENATAL CARE ONLY FOR LAST BIRTH

408. Did you see anyone for antenatal care for this pregnancy?

YES 1

NO . . . . . 2 (SKIP TO 414)

FIRST ANTENATAL VISIT

411. How many months pregnant were you when you first received antenatal care for this pregnancy?

MONTHS . . . . . .

DON'T KNOW 98

NUMBER OF ANTENATAL VISITS

412. How many times did you receive antenatal care during this pregnancy?

NUMBER OF TIMES . . . . .

DON'T KNOW 98

TETANUS STATUS

414. During this pregnancy, were you given an injection in the arm to prevent the baby from getting tetanus, that is, convulsions after birth?

YES 1

NO . . . . . 2 (SKIP TO 417)

DON'T KNOW . . . . . 8 (SKIP TO 417)

415. During this pregnancy, how many times did you get a tetanus injection?

TIMES . . . . . .

DON'T KNOW 8

IRON SUPPLEMENTATION

420. During this pregnancy, were you given or did you buy any iron tablets or iron syrup?

SHOW TABLETS/SYRUP.

YES 1

NO . . . . . 2 (SKIP TO 422)

DON'T KNOW . . . . . 8 (SKIP TO 422)

421. During the whole pregnancy, for how many days did you take the tablets or syrup? IF ANSWER IS NOT NUMERIC, PROBE FOR APPROXIMATE NUMBER OF DAYS.

DAYS . . . . .

DON'T KNOW 998

BIRTH WEIGHT OF PREVIOUS BIRTH

427. Was (NAME) weighed at birth?

YES 1

NO . . . . . 2 (SKIP TO 429)

DON'T KNOW . . . . . 8 (SKIP TO 429)

428. How much did (NAME) weigh? RECORD WEIGHT IN KILOGRAMS FROM HEALTH CARD, IF AVAILABLE.

KG FROM CARD

1.

KG FROM RECALL

2.

DON'T KNOW 99998

INSTITUTIONAL BIRTHS

430. Where did you give birth to (NAME)?

PROBE TO IDENTIFY THE TYPE OF SOURCE. IF UNABLE TO DETERMINE IF PUBLIC OR PRIVATE SECTOR, WRITE THE NAME OF THE PLACE.

(NAME OF PLACE)

HOME

HER HOME . . . . . 11 (SKIP TO 434)

OTHER HOME 12

PUBLIC SECTOR

GOVERNMENT HOSPITAL . . 21

GOVERNMENT HEALTH

CENTER 22

GOVERNMENT HEALTH

POST 23

OTHER PUBLIC SECTOR …….26

PRIVATE MEDICAL SECTOR

PRIVATE HOSPITAL/ CLINIC 31

OTHER PRIVATE MEDICAL SECTOR ……36

OTHER ……..96

SECTION 7. MARRIAGE AND SEXUAL ACTIVITY

MARITAL STATUS

703. What is your marital status now: are you widowed, divorced, or separated?

WIDOWED . . . . . 1 (skip to 709)

DIVORCED . . . . . 2 (skip to 709)

SEPARATED . . . . . 3 (skip to 709)

704. Is your (husband/partner) living with you now or is he staying elsewhere?

LIVING WITH HER 1

STAYING ELSEWHERE 2

SECTION 8. FERTILITY PREFERENCES

DESIRABILITY FOR CHLD

802. Check 226, if pregnant skip to 803

803. Now I have some questions about the future. After the child you are expecting now, would you like to have another child, or would you prefer not to have any more children?

HAVE ANOTHER CHILD 1 805

NO MORE 2

UNDECIDED/DON'T KNOW 8

804. Now I have some questions about the future. Would you like to have (a/another) child, or would you prefer not to have any (more) children?

HAVE (A/ANOTHER) CHILD 1

NO MORE/NONE . . . . . 2 (Skip to 807)

SAYS SHE CAN'T GET PREGNANT . . . . . 3 (skip to 813)

UNDECIDED/DON'T KNOW . . . . . 8 (skip to 811)

812. Do you think you will use a contraceptive method to delay or avoid pregnancy at any time in the future?

YES 1

NO 2

DON'T KNOW 8

814. HAS LIVING NO LIVING

If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?

NO LIVING CHILDREN

If you could choose exactly the number of children to have in your whole life, how many would that be?

NONE . . . . . 00 (skip to 815)

NUMBER . . . . . .

OTHER 96 (Please specify)

SECTION 9. HUSBAND'S BACKGROUND AND WOMAN'S WORK

HUSBAND'S AGE

902. How old was your (husband/partner) on his last birthday?

AGE IN COMPLETED YEARS . . . . . .

HUSBAND's EDUCATION STATUS

903. Did your (husband/partner) ever attend school?

YES 1

NO . . . . . 2 (skip to 906)

904. What was the highest level of school he attended: primary, secondary, or higher?

PRIMARY 1

SECONDARY 2

HIGHER 3

DON'T KNOW . . . . . 8 (skip to 906)

905. What was the highest [GRADE/FORM/YEAR] he completed at that level? IF

COMPLETED LESS THAN ONE YEAR AT THAT LEVEL, RECORD '00'

[GRADE/FORM/YEAR] . . . .

DON'T KNOW 98

HUSBAND'S AND WOMEN'S EMPLOYMENT STATUS

908. What is your (husbands'/partner's) occupation? That is, what kind of work does he mainly do?

_____

_____ ☐

_____

909.Aside from your own housework, have you done any work in the last seven days?

a) Yes ……. 1 (skip to 913)

b) No ……. 2

910. As you know, some women take up jobs for which they are paid in cash or kind. Others sell things, have a small business or work on the family farm or in the family business. In the last seven days, have you done any of these things or any other work?

a) YES …….1 (skip to 913)

b) NO ……....2

911. Although you did not work in the last seven days, do you have any job or business from which you were absent for leave, illness, vacation, maternity leave, or any other such reason?

a) YES …….1(skip to 913)

b) NO……2

912. Have you done any work in the last 12 months?

a) YES…….1

b) NO……2(skip to 917)

913. What is your occupation? that is, what kind of work do you mainly do?

_____

_____ ☐

SECTION 11. OTHER HEALTH ISSUES

SMOKING STATUS

1104. Do you currently smoke cigarettes every day, some days, or not at all?

a) EVERYDAY …….1

b) SOME DAYS…….2 SKIP TO 1106

c)NOT AT ALL …….3

1105. On average, how many cigarettes do you currently smoke each day?

NUMBER OF CIGARETTES…… [ ]

1106. Do you currently smoke or use any other type of tobacco every day, some days, or not at all?

a) EVERYDAY…….1

b) SOME DAYS ……2

c) NOT AT ALL ……3(SKIP TO 1108)

1107. What other type of tobacco do you currently smoke or use? *RECORD ALLMENTIONED*

a) KRETEKS……. A

b) PIPES FULL OF TOBACCO……B

c) CIGARS, CHEROOTS OR CIGARILLOS……C

d)WATER PIPE……D

e) SNUFF BY MOUTH……E

f) SNUFF BY NOSE……...F

g) CHEWING TOBACCO……. G

h) BETEL QUID WITH TOBACCO…….H

i) OTHER X (SPECIFY)

ACCESSIBILITY TO FACILITY

1108. Many different factors can prevent women from getting medical advice or treatment for themselves. When you are sick and want to get medical advice or treatment, is each of the following a big problem or not a big problem:

a) Getting permission to go to the doctor?

GETTING PERMISSION TO GO

BIG PROBLEM…….1

NOT A BIG PROBLEM ……2

b) Getting money needed for advice or treatment?

GETTING MONEY

NIG PROBLEM …….1

NOT A BIG PROBLEM…….2

c)The distance to the health facility?

DISTANCE

BIG PROBLEM…….1

NOT BIG PROBLEM……2

d) Not wanting to go alone?

GO ALONE

BIG PROBLEM……1

NOT A BIG PROBLEM ……2

BIOMARKER QUESTIONNAIRE

WEIGHT, HEIGHT AND HEMOGLOBIN MEASUREMENT FOR CHILDREN AGE 0-5

103. If mother interviewed:

Copy CHILD'S date of birth (day, month, and year) from birth history.

If mother not interviewed ask:

What is (NAME)'s date of birth?

DAY…….MONTH ……YEAR ……

104. Check 103: Child born in 2010-2015?

YES…….1

NO……2 (SKIP TO 114)

105. Weight in kilograms.

KG ……

NOT PRESENT……9994

REFUSED ……9995

OTHER ……9996

106. Height in centimeters

CM…….

NOT PRESENT……..9994

REFUSED…….9995

OTHER ……..9996 (SKIP TO 108)

ANEMIA STATUS

113. Record hemoglobin level here and in the anemia pamphlet

G/DL…….

REFUSED…….995

OTHER …….996

WEIGHT, HEIGHT, HEMOGLOBIN MEASUREMENT AND HIV TESTING FOR WOMENAGE 15-49

205. HEIGHT IN KILOGRAMS

KG ……

NOT PRESENT …….99994

REFUSED …….99995

OTHER …….99996

206. HEIGHT IN CENTIMETERS

CM …….

NOT PRESENT …….99994

REFUSED …….99995

OTHER …….99996

207. MEASURER: ENTER YOUR FIELD WORKER NUMBER

FIELD WORKER NUMBER

208. CHECK 203: AGE

15-17YEARS …….1

18-49YEARS …….2(SKIP TO 210)

209. CHECK 204: MARITAL STATUS

CODE 4 (NEVER IN UNION) ……1(SKIP TO 216)

OTHER …….2