Exploration of predictors of anemia among pregnant women in India using the 2015-16 National Family Health Survey (NFHS-4)

Professional Publication Framework

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Yerevan, Armenia, 2021

Acknowledgement

This MPH graduate program is one of the significant milestones in my medical career. My Yerevan State Medical University seniors Dr. Lakshmi Priya, Dr. Dhamodharan, and other MPH students inspired me to pursue this course. I want to thank them all for their continuous support and motivation to pursue this course.

I especially thank my mother, Gomathi Raja, who kept me pushing over the barriers and still continuously motivating me in my career. Also, I would like to thank my father, Raja Nataraj, a backbone to support all my financial needs, and along with my mother, he never failed to motivate me to pursue MPH.

Also, I would like to thank my MPH cohort, who helped me during these two years at AUA. I especially thank Dr. Helen Heera and Dr. Vineeth Paul for helping me with the AUA works.

I thank my MPH master thesis advisors, Dr. Anahit Demirchyan and Dr. Vahe Kachadourian, who actively provided constructive feedback and helped me gain an enormous amount of knowledge in data analysis and complete my thesis paper on time.

Nevertheless, I would like to thank all my AUA SPH faculties involved in teaching the MPH program. I thank my internship preceptors Dr. Aida Giloyan and Dr. Tsovinar Harutyunyan. Because of whom I was able to get a better virtual online internship experience.

I thank our SPH dean Dr. Varduhi Petrosyan, whom I saw as an influential leader and one of the best teaching faculties to me, who showed me leadership values.

I want to thank my friends Harsha Vardhini, Aravind, Mohana Sowmiya, and Dr. Santhosh Sivan, for helping me to overcome stress and difficulties in different situations. Also, I would like to thank my MPH seniors: Dr. Yogeshwaran, Dr. Rohit Sharan, Dr. Divetiya Khanduja, Dr. Darshan Shingala, Dr. Monica Steffi, and Dr. Karthiga Vasudevan, for their constant support throughout the MPH journey.

Finally, I thank the god almighty, who helped me travel this far and giving me all good health.

Abstract

Background: Pregnant women with severe iron deficiency anemia are at high risk for rapid heart failure and neurological complications, as well as for having a preterm delivery, stillbirth, and low-birth-weight baby. World Health Organization in 2015 showed that around 32.4 million pregnant women are suffering from anemia. One out of five deaths in pregnant women are due to anemia, and it is accountable for 16% of maternal mortality in India. Low socioeconomic status, malnutrition, starvation, parasitic infections, and pregnancy are among the known risk factors for anemia.

Aim: The study aimed to identify the predictors of anemia in pregnant women living in India using the data from the National Family Health Survey-4 (2015-16) dataset.

Methods: Secondary data analysis using NFHS-4 collected data which features India's population was conducted. The woman's questionnaire dataset available in the demographics and health survey site was downloaded, opened in the SPSS software and, after applying the eligibility criterion of being pregnant at the time of the survey, a sample size of 32,428 women was obtained for data analysis, which included descriptive, univariate and multivariable logistic regression analyses and fitting a model of predictors of pregnancy anemia.

Results: The predictors of anemia among pregnant women in India were: poor wealth index (OR= 1.31, 95% CI: 1.23 – 1.40), no educational background (OR= 1.42, 95% CI: 1.34 – 1.51), scheduled caste/scheduled tribe/other backward caste category (OR= 1.15, 95% CI: 1.09 – 1.22), low BMI (OR= 1.11, 95% CI: 1.03 – 1.21), young age of pregnant women (OR= 0.99, 95% CI: 0.98 – 0.99), and low food diversity score (OR= 0.98, 95% CI: 0.97 – 0.99). The prevalence rate of anemia among pregnant women in India from the NFHS-4 survey was 50.2%.

Conclusion: The study found that pregnant women from low-socioeconomic backgrounds, with no educational experience, backward caste and having low food diversity score are vulnerable for developing pregnancy anemia. Therefore, promotional interventions are recommended, such as nutritional education, awareness campaigns, and iron and folic acid supplementation targeted at-risk categories. Also, the "National Anemia Awareness and Treatment Day" initiative could invite the attention of the women's population towards anemia and its seriousness.

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Abbreviations

ANC	Ante Natal Care
BMI	Body Mass Index
DHS	The Demographics and Health Surveys
Hb	Hemoglobin
ICMR	Indian Council of Medical Research
IDA	Iron Deficiency Anemia
IFA	Iron and Folic Acid
NFHS	National Family Health Survey
NIPI	National Iron Plus Initiative
OBC	Other Backward Caste
PHC	Primary Health Care
RBC	Red Blood Cells
RDA	Recommended Dietary Allowance
SC	Scheduled Caste
ST	Scheduled Tribe

1. Introduction

1.1. Background

"Anemia is a medical condition in which the red blood cells (RBCs) have a decreased capacity to carry oxygen and transport them into the tissues throughout the body".[1] Anemia is a multifactorial disease and could be caused by many reasons, including micronutrient (i.e., folic acid, iron, vitamin B12, and vitamin A) deficiencies,[2] inflammatory disorders,[2] infectious diseases (i.e., intestinal-parasitic infections,[3] tuberculosis, acquired immunodeficiency syndrome(AIDS), malaria)[2], blood loss, haemolysis, disturbed haematopoiesis,[4] etc. Iron deficiency anemia (IDA) is the most common type of anemia globally – approximately over half of the world population with anemia are having iron deficiency anemia.[6] "Iron deficiency anemia is characterized by a low concentration of hemoglobin in the RBCs[7] leading to hypochromic and microcytic erythrocytes on the peripheral blood smear".[8]

Anemia is especially common during pregnancy.[2] According to World Health Organization (WHO), if hemoglobin in a pregnant woman's blood is less than 110g/l, she has anemia.[5] Based on the concentration of hemoglobin (Hb) in the blood, WHO has classified anemia among pregnant women into the following categories:

a) Mild anemia (Hb level is between 90 g/l and 109 g/l),

b) Moderate anemia (Hb level is between 70 g/l and 89 g/l),

c) Severe anemia (Hb level is less than 70 g/l).[9]

The causes of anemia during pregnancy are iron and folate deficiency. Pregnant women consuming inadequate diets and, therefore, failing to receive the needed amount of iron and

folate with their diet, may develop iron-deficiency or megaloblastic anemia, respectively, unless receiving iron and folic acid supplements prenatally.[8]

1.2 The burden of the disease

Globally, IDA anemia is a significant public health problem. "Over 2 billion people in the world are estimated to have IDA with a wide range of prevalence, distribution, and a spectrum of contributing factors in different parts of the world".[5] IDA is predominantly seen in children and women of reproductive age between 15- 49 years.[5,9] "A report from WHO in 2015 shows that around 528.7 million reproductive-age women are estimated to have anemia (with 496.3 million cases among non-pregnant women and 32.4 million among pregnant women)".[2] Studies have shown that anemia is a preventable and well-controllable disease if detected and managed in a timely manner.[3] However, it is one of the main reasons for mortality and morbidity among pregnant women.[3,10] "There is a significant difference in anemia prevalence among pregnant women and lactating women between the high-income and middle-income countries".[11] It is being as low as 24.1% in high-income countries like the USA and as high as 52.0% in South East Asia.[12] Women living with severe anemia are at risk of adverse health effects such as infections, prolonged hospital admissions, and other general health problems.[13] Pregnant women with anemia may have symptoms, including headache, malaise, lethargy, paraesthesia, and signs of rapid heartbeat, increased respiratory rate, pallor, glossitis, and cheilitis.[8] Women with severe IDA are at high risk for rapid heart failure.[8] And these women can be presented with complications like placenta previa or abruptio placenta, and postpartum hemorrhage.[14] IDA causes several neurological consequences like emotional instability, behavioural changes, restless leg, depression, and stress in postpartum women.[6,15,16] IDA can also cause epithelial malfunction and frequent infections.[17,15] Pregnant women living with IDA are at high risk of having a preterm delivery, stillbirth, and low-birth-

weight baby.[7] Also, IDA leads to weakened educational performance and decreased productivity and work capacity.[18,19] A study showed that deficient iron supply to the growing fetus can undesirably impact the fetal neurodevelopment and result in underdevelopment of the psychomotor system in the newborn.[20]

1.3 Iron requirements during pregnancy

The daily iron requirement during pregnancy ranges from 0.8 mg/day in the earliest pregnancy to 10 mg/day in the last trimester of the pregnancy period.[21] Among pregnant women, the average dietary intake of iron in 12 European countries (Bosnia, Belgium, Sweden, Northern Ireland, Scotland, Wales, Serbia, the UK including England, Denmark, Switzerland, Hungary, and Italy) was between 7.6-9.9 mg/day.[22] The recommended dietary allowance (RDA) of iron in most European countries is 15 mg/day.[22] Sufficient iron stores in pregnant women are prerequisites for healthy gestation. Therefore, a body iron store of at least 300 mg is a requirement before becoming pregnant.[23] Adequate iron levels in pregnant women are essential for ensuring saturation of tissues with oxygen, synthesizing the needed amounts of hemoglobin, myoglobin, and a spectrum of iron-dependent enzymes.[24] Moreover, adequate iron store of a pregnant woman also helps in supporting the increasing demands of the developing fetus in iron.

The iron status and iron balance of an individual are dependent on the dietary iron intake and bioavailability of dietary iron.[21] "There are two forms of iron, heme and non-heme iron". The heme iron is predominantly present in food products like meat, chicken, fish. And the food products that contain ascorbic acid help to increase the bioavailability of the consumed iron.[21] These products are consumed in higher quantities by the western populations. The Southeast Asians predominantly take non-heme iron-containing food products like cereals and vegetables.[21] Therefore, pregnant women living in developing countries like India may need

more iron which could be fulfilled by iron supplements in pregnancy.[15] Nordic Nutrition Recommendation 2012 states that those pregnant women with body iron stores of less than 500 mg require iron supplements during the second and third trimesters of pregnancy as prophylaxis of anemia.[25]

1.4 Risk factors for anemia in pregnant women

Low socioeconomic status, malnutrition, starvation are risk factors for IDA in the vulnerable population groups (children and pregnant women) living in countries like India.[26] Other common causes of IDA in developing countries are parasitic infections (caused by hookworm and schistosomes)[27] and pregnancy (second and third trimester).[26]

In developed countries, IDA risk factors include vegetarian diets, vegans, mal-absorption, and chronic blood loss.[26] Drugs like non-steroidal anti-inflammatory preparations and anticoagulants can lead to blood loss. And proton-pump antagonists can decrease iron absorption.[28] All these factors can predispose to anemia.[26]

Socioeconomic status

Low-socioeconomic status is a significant risk factor for anemia during pregnancy with pregnant women at a lower socioeconomic status being more likely to have anemia .[29] A study from Venezuela assessed the anemia status among pregnant women in low-income families and found that 34% of them had anemia.[30] Likewise, a study from rural Turkey found that anemia prevalence was higher among those woman's family income was lower (<500 million TL) than the national average family income in Turkey's currency.[31]

Age

A cohort study from Karnataka showed that pregnant women who are less than 18 years old are highly likely to develop anemia.[29] Similarly, according to a study conducted in Southern Ethiopia, the younger the pregnant women (15-24 years old), the higher their chance of

developing anemia.[32] Older age was found to be a risk factor for pregnancy anemia as well. The NFHS-3 study from India showed that the prevalence of anemia was significantly higher in pregnant women who were more than 38 years of age.[33] Similarly, in Aurangabad city, India, the anemia prevalence in pregnant women 30 years of age and above was the highest - 93.7%.[34]

Place of residence (urban/rural)

Pregnant women who are living in rural areas are at increased risk of having anemia.[35] It is mainly due to the reduced access to health care services, lack of nutrition information, and low-family income.[36] The previous NFHS-3 showed a significant difference in anemia prevalence between pregnant women living in urban and rural areas.[35] A Malaysian study compared pregnant women according to their place of residence (urban/rural). It found that the anemia prevalence among pregnant women from rural sites is significantly higher compared to pregnant women living in urban sites.[15]

Diet

Anemia is most predominantly due to diet-related iron deficiency. A study in Malaysia claims that a pregnant woman's daily diet should have a minimum amount of 27 mg of iron to fulfil the daily iron requirement.[15] This study also shows that changes in dietary habits like consuming more heme-iron containing animal foods can increase iron absorption and maintain good iron status. But in this study, no significant changes were seen in dietary habits in women before and during pregnancy.[15] The diet of the majority of pregnant women in India consists of cereals, pulses, and vegetables.[37] Therefore, they mainly consume non-heme iron with low bioavailability.[38] Also, these commonly consumed food products contain more phytates that significantly reduce the absorption of iron in the intestines.[39,37] According to a study in India, pregnant women avoid non-vegetarian food as it produces heat in the body.[34] A study from Bangalore city, India, showed that the mean dietary iron intake was 9.5 mg/day among young women.[37] Anemia rates among these women were 39%, and iron deficiency

rates were 62%. If these women with iron deficiency become pregnant, they are more likely to develop IDA during pregnancy.[37]

Antenatal care (ANC) visits

WHO recommends pregnant women to have a minimum of four ANC visits, and the 1st ANC visit is important as it helps to evaluate the mothers' health condition and to improve the outcome of the pregnancy.[40] According to the NFHS-3 report, only 47.9% of pregnant women made three or more ANC visits. Only 56.9% of pregnant women made their 1st ANC visit during the 1st four months of pregnancy.[35]

Religion and caste

The caste system in India is a significant factor that plays a substantial role in anemia prevalence. The study from Aurangabad city, India, revealed a significant association between pregnant women's religion and anemia prevalence. Approximately 94% of Hindu women were anemic compared to85% Muslim and 82% Buddhist pregnant women.[34] In the NFHS-3 study, the pregnant women from scheduled caste (SC) and scheduled tribe (ST) were more likely to live with anemia than the pregnant women from other backward and other classes.[35]

Educational status

Pregnant women having lower levels of education or illiterate are more likely to be anemic.[35] A cross-sectional study conducted in Aurangabad city, India, shows that illiterate pregnant women are at higher risk to develop anemia.[34] It shows also a negative association between pregnant women's husbands' educational status and the prevalence of anemia among women. Pregnant women living with their husband were less likely to suffer from anemia.[34]

Multigravida

The main risk factors for pregnancy anemia is the increase in iron and folic acid demand among multigravida pregnant women. The prevalence of anemia was found to be significantly higher in women with a history of four and above live births.[31]

Inter birth intervals

Birth interval is associated with anemic status of pregnant women. Women who had birth interval of two and more years are less likely to suffer from anemia.[41] A study from rural India revealed that women with lesser inter birth (<2 years) intervals are more likely to suffer from anemia compared to those women with>2 years of inter birth intervals.[42]

Body mass index (BMI)

According to a study from Westmoreland, Jamaica in the year 2010, BMI a strong predictor of anemia in pregnant women.[43] A cross-sectional study from Ethiopia showed that pregnant women with BMI of less than 18.5 are highly anemic.[44] Similarly, BMI was associated with anemia in pregnant women in countries like Egypt, and Tanzania.[44]

1.5 Situation in India

One out of five deaths in pregnant women is due to anemia, and it is accountable for 16% of maternal mortality in India.[34] From NFHS-3 (2005-06) to NFHS-4 (2015-16), the anemia prevalence among pregnant women in India decreased from 58.7% to 50.4%, respectively.[33] A meta-analysis conducted in 2002 using data from countries like India, Malaysia, and Nigeria, showed that for every 1g/dl increase in the haemoglobin (Hb) concentration, there is a 20% reduction in the risks of maternal deaths.[45] "Previous National Family Health Survey in India during 1998-1999 has proven that increase in anemia prevalence in pregnant women is causing complications like intrauterine growth restriction of the fetus and low-birth-weight".[27] According to the NFHS-3 report from India, women who were divorced, widowed, or deserted were more likely anemic. It showed decreased anemia prevalence among women having higher education and higher wealth.[46]

"Another study conducted in 16 districts in India during 2014-15 showed that anemia among pregnant women was 84.9%".[47] A study done in 2013 had the anemia prevalence among pregnant women from the rural part of Tamil Nadu of 56.6%.[48] In 2014, a community based cross-sectional study in Karnataka revealed anemia prevalence of 64% in pregnant women.[49]

From a prospective observational study in Kolar Taluk of Karnataka, the prevalence of anemia was 62.3% in pregnant women.[50] In this study, anemia rates in pregnant women were commonly found higher in women 21-30 years age (66.1%) and in SC/ST women (61.6%). Pregnant women with inter-birth interval of lesser interval were more likely to have anemia. In this observational study, many pregnant women who were anemic were observed to have several maternal and fetal complications (low birth weight, abortions, obstructed labor, postpartum haemorrhage, pre-eclampsia, still births, and birth asphyxia).[50] A mixed method study from Chandigarh city in 2009, Punjab, revealed anemia prevalence of 65% in pregnant women[51]. All the above-mentioned studies from different states of India reported higher prevalence of anemia among pregnant women than the national average value of 50.4% measured during NFHS-4 study in 2015-16.[33]

As per the NFHS-4, the iron and folic acid (IFA) supplementation program coverage was not very high among pregnant women in India. Around 77.7% of the pregnant women have taken the IFA supplements, and out of these, only 33.3% have consumed it for 100 days as recommended.[47] The NFHS-4 data suggested that the women's literacy rate and wealth index play significant roles in their IFA consumption.[47] The higher the literacy rate (46.7%), and the higher the wealth index (48.2%), the more is the IFA consumption by the women.[47] The overall program on IFA supplementation was not successful in India. Still, a few states showed decreasing trends in the prevalence of anemia among pregnant women.[52]

1.6 The rationale for the study

Few studies have been conducted in India to explore the prevalence of anemia in pregnant women and the factors associated with anemia in pregnant women. Since the NFHS-3 (2005-2006) survey, many changes have taken place in peoples' life conditions, health and healthcare, as well as the environment, etc. These changes could have changed the set of risk

factors of pregnancy anemia in India or the role of each particular risk factor. Therefore, a study using the most recent dataset from the NFHS-4 is important to identify the potential risk factors for anemia among pregnant women in India. Even though India's government has taken several steps to reduce anemia rates among vulnerable population groups, including the provision of free iron and folic acid supplements to pregnant women during the last several decades, there is no significant reduction in the anemia prevalence among pregnant women in India. Therefore, identifying significant predictors and novel findings from this study can help to improve intervention strategies and policies to fight the disease successfully in the future.

1.7 Study Aim

This study seeks to identify predictors of anemia among pregnant women in India, using the NFHS-4 (2015-2016) dataset. The study results will help policymakers and public health workers develop effective strategies to reduce the anemia prevalence among pregnant women in India.

1.8 Research questions

1. What are the predictors of anemia among pregnant women living in India?
2. What is the prevalence of anemia among pregnant women across the states and union territories of India?

2. Methodology

2.1 Data source and methods

This study used DHS data from the NFHS-4 survey that was conducted in India between 2015-2016. The dataset from DHS for India is free to the public. The student investigator got access to download the NFHS-4 dataset by registering and submitting a request to the official the demographics and health surveys (DHS) website. This is a quantitative study – secondary analysis of a cross-sectional survey data.

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

NFHS-4 collected data on features of India's population, including their health and nutrition, on national, state, and union territory levels. During the survey, the NFHS-4 data was obtained in 19 different languages. The study instrument comprises five survey questionnaires (household, men's, women's, birth records, and biomarker). Since the prior, NFHS-3 survey, many new variables were added to the NFHS-4 instrument. "NFHS-4 used a two-stage sampling design and included rural and urban areas. Houses in the villages were selected as the Primary Sampling Units (PSUs) in rural areas, and Census Enumeration Blocks (CEBs) were used in urban areas." Selected PSUs were segmented into 100-150 households, and, in the second stage, for a selected cluster (rural/urban), 22 households were randomly selected. The woman's questionnaire for the age category of 15-49 years included topics related to woman's background characteristics; woman's reproductive behaviour; maternal and child health; contacts with community health workers; and others.[33]

2.3 Target population

2.3.1 Inclusion criteria

- Being a pregnant woman aged 15-49 years.

2.4 Sample selection

"The NFHS-4 survey selected a total of 628,900 households for the sample and 601,509 were interviewed with a response rate of 98%". From this interviewed households, a total of 699,686 women in 15-49 age category, and 112,122 men were interviewed. This study sample was limited to the pregnant women who participated in the NFHS-4 survey. A sample size of 32,428 eligible women was obtained from the NFHS-4 dataset using the inclusion criteria.

2.5 Measures

2.5.1 Dependent variable

Anemia status of a pregnant woman (binary: with/without anemia). Anemia among pregnant women is defined as having blood haemoglobin level less than 110 g/l, and pregnant women having haemoglobin of 110g/l or above are considered to be not anemic.

2.5.2 Independent variables

Following variables were included in the analysis as potential predictors of anemia:

- Wealth index, categorized into poor, middle, and rich.[53]
- Age of the respondent at 1st birth of the child, categorized into less than 18, 18-34, and 35-49 years.[53]
- Media exposure from newspaper, radio and television, a binary variable categorized into not exposed and exposed.
- Woman's religion, categorized into Hindu, Muslim, and others.[53] Others include the religions (Christian, Sikh, Buddhist, Jain, Jewish, Parsi, no religion, and others) that are in minority.[53]
- Caste, categorized either to scheduled caste (SC) or scheduled tribe (ST) or other backward caste (OBC), and others.[53]
- Number of children born to pregnant women as continuous variable.
- Woman's educational status categorized into no educational background, primary educational level, and secondary or higher educational level.[53]
- Husband's educational status with the same categories.
- Marital status, categorized into currently married, and widowed/divorced/separated/deserted/never married.[53]

- Inter-birth interval prior to the current pregnancy, categorized into less than two years and more than two years.[53]
- Timing of the first antenatal care during pregnancy in months, categorized into starting receiving ANC within the first 3 months of the pregnancy and after the 3rd month of the pregnancy.[54]
- Use of IFA supplements during pregnancy, a binary variable categorized into pregnant women consuming IFA tablets/syrups and pregnant women not consuming IFA tablets/syrups.[55]
- BMI categorized to underweight (<18.5 kg/m^2), normal or healthy weight (18.5 – 24.4 kg/m2), and overweight (>=24.5 kg/m2).[53]
- Drugs for intestinal worms during pregnancy, a binary variable categorized into pregnant women who have taken drugs for intestinal parasites and pregnant women who haven't taken drugs for intestinal parasites.
- Current smoking status/tobacco use, categorized as yes or no.[53]
- Food diversity score, based on pregnant woman's consumption of the following six essential food types that contain iron or substances increasing bioavailability of dietary iron: pulses or beans; dark green leafy vegetables; fruits; eggs; fish; and chicken or meat, with daily consumption of each given the score of 3, weekly consumption given a score of 2, occasional consumption – a score of 1, and never consumed given the score of 0. Hence, the total score range is 0 to 18 (continuous variable).

2.6 Data analysis

The data analysis was done using SPSS version 26 software. Descriptive statistics were obtained for all the variables (means and SDs for continuous variables and proportions for categorical variables). Statistical significance of the difference in each characteristic between

groups of pregnant women with and without anemia was measured using student t-test for continuous variables and chi-square test for categorical variables. As the outcome variable in the study was binary, the data was analysed using logistic regression. Continuous and dichotomous variables were entered into logistic regression analysis as such, and dummy variables were created for those variables having more than 2 categories. Those variables with the level of significance of $p<0.25$ in the chi-square or t-test (for categorical and continuous variables, respectively) were first entered into the univariate-logistic regression analysis, and then into the multivariable-logistic regression analysis with the outcome of anemia status.

To identify the predictors of anemia in pregnant women, all the insignificant variables (p-value greater than 0.05) in the multivariable logistic regression analysis were removed one by one, and the remaining variables with significant p-values (< 0.05) were considered as the predictors of anemia. The multivariable logistic regression model fit was assessed using the Hosmer and Lemeshow test statistics. Also, the Cox and Snell R-square and Nagelkerke R-square test was used to choose the best model. To check for the co-linearity between the variables in the final model, variance inflation factor (VIF) values were used.

For my second research question, the rates of anemia among pregnant women were calculated across the states of India and the states were ranked in descending order based on the rate of anemia.

2.7 Ethical considerations

This is a secondary data analysis study using de-identified dataset and cannot be linked to the surveyed subjects. Therefore, this study was considered as meeting the eligibility criteria for IRB review exemption by the American University of Armenia's Institutional Review Board.

3. Results

After applying the exclusion criteria to the dataset, the total sample size constituted 31,848 pregnant women. Table 1 presents the prevalence of anemia among pregnant women living in India by states and union territories. Around half of pregnant women (50.2%) had anemia across India. State of Jharkhand had the highest prevalence of anemia (66.0%) while the lowest prevalence was observed in the state of Sikkim (23.1%). Among the union territories, Chandigarh had the highest prevalence of anemia (76.5%) and Lakshadweep had the lowest prevalence of anemia among pregnant women (40.5%).

Table 2 presents descriptive comparisons between anemic and non-anemic pregnant women by socio-demographic, general health, and reproductive health characteristics. The mean age of pregnant women included in the sample was 24.7 years (SD 4.87). The vast majority of women (99.4%) were married, and over three-fourths (76.2%) resided in rural areas. Almost half of the total sample (47.5%) were poor and over 70.0% followed Hindu religion. One-fourth of the surveyed women had no education, and over 80% were from backward castes. As demonstrated in Table 2, the proportion of anemic women was significantly higher among the poorest, rural residents, those with no educational background, those belonging to backward castes, and following Hindu religion. Anemia was more prevalent among women with no access/exposure to media, among those who were younger than 18 years old at their first delivery, and those with a shorter than 24 months birth interval prior to current pregnancy. Overweight women had a lower prevalence of anemia when compared to those with normal or low BMI. The proportion of anemia was slightly but significantly lower among pregnant women who received IAF supplements and who took drugs for intestinal parasites. Woman's current smoking status and their marital status were not associated with anemia among them. In crude comparisons, those having anemia were younger, had a higher number of children, and higher food diversity score (table 3).

Tables 4 summarizes the results of the univariate logistic regression analyses of the factors associated with anemia status of pregnant women in India, based on NFHS-4 (2014-15) data. Table 4 shows around thirteen factors, both categorical and continuous variables, all statistically significantly associated with anemia in pregnant women. The potential risk factors for anemia included having poor or middle wealth index as compared to rich, residing in rural area, having inter-birth interval of less than two years, following Hindu or Muslim religion as compared to other religions, having no or primary education, being from backward castes (SC/ST/OBC), having low or normal BMI as compared to having high BMI, having a higher number of children and higher food diversity score. The potential protective factors for anemia included age, being over 18 years old at the time of the first delivery, being primigravidae, taking IAF supplements during pregnancy, and being exposed to media.

Table 5 presents the fitted logistic regression model of predictors of pregnancy anemia. It demonstrates that wealth index, educational status of pregnant women, caste, body mass index (BMI), age, and food diversity score are independent predictors of anemia among pregnant women in India. Pregnant women from the poorest category were found to have 31% (OR= 1.31, 95% CI: 1.23 – 1.40) higher odds of having anemia, and those from the middle category 22% (OR= 1.22, 95% CI: 1.15 – 1.29) higher odds of having anemia compared to those from the richest category. Pregnant women with no educational background tended to have 42% (OR= 1.42, 95% CI: 1.34 – 1.51) higher odds and those with primary education 14% (OR= 1.14, 95% CI: 1.06 – 1.22) higher odds of having anemia compared to those pregnant women having secondary or higher educational status. Pregnant women belonging to the SC/ST/OBC caste had 15% (OR= 1.15, 95% CI: 1.09 – 1.22) higher odds of developing anemia compared to those from the other castes. Pregnant women, whose BMI indicated underweight (OR= 1.11, 95% CI: 1.03 – 1.21) or normal nutritional status (OR= 1.16, 95% CI: 1.10 – 1.23), each had 11% and 16% higher odds of having anemia compared to those pregnant women who were

overweight respectively. For every year increase in the age of pregnant women, there was a decrease in odds of having anemia by 1% (OR= 0.99, 95% CI: 0.98 – 0.99). And for the food diversity score, for each unit increase in that score, the odds of having anemia decreased by 2% (OR= 0.98, 95% CI: 0.97 – 0.99). The model was checked for co-linearity and all the VIF statistics values were less than 2.0, therefore, this model didn't have co-linearity issues. The Hosmer and Lemeshow goodness-of-fit test statistics for this model was insignificant (p=0.147), indicating acceptable model fit.

4. Discussion

According to the results of this study, anemia remains a significant public health problem in India. The prevalence of anemia among pregnant women in India was 50.2% which is significantly higher than in other countries including China (23.5%)[56], Ethiopia (31.7%)[57], and Malaysia (40%).[15] Still, this rate is lower compared to the rate in Pakistan (57.7%).[58]

The anemia prevalence among women in Jharkhand, West-Bengal, Bihar, Madhya Pradesh, Gujarat, Andhra Pradesh, and Tripura was more than 55%. And in states of Nagaland, Mizoram, and Manipur, this prevalence was less than 30%. This differences in prevalence rates between these states could be explained by the diversity of the population lifestyle, dietary habits, and the degree of socio-economic development between different states.[59]

This study investigated the predictors of anemia among pregnant women in India. The study found a set of six independent predictors of anemia among pregnant women, including wealth index, education, caste, body mass index (BMI), age, and food diversity score. Among these variables, there were several modifiable factors, including age at pregnancy, BMI, educational status of pregnant women, and food diversity score of pregnant women.

Findings from this study were similar to previous studies showing that pregnant women from families with low-socioeconomic status are at higher risk of anemia.[29,30] One of the reasons for this could be that women with low socioeconomic status may be getting inadequate nutrition.[31]

Pregnant women from this study who didn't have educational background were at higher risk for developing anemia, and this finding was consistent with the previous studies.[34,35] A possible explanation for this is that pregnant women having educational background were more bound to a healthy lifestyle.[60]

Similar to the previous NFHS-3 results, this study also indicates that pregnant women who are from backward castes (SC/ST/OBC) are at an increased risk for developing anemia.[35] This result was also similar to the previous studies from India.[34] This may be due to the effect of poverty and reduced access to proper nutrition and healthcare services for these castes.[49]

Pregnant women with lower BMI were more likely to have anemia. Again, this finding is consistent with the findings of previous studies.[43,44] This could be due to higher nutritional requirements during pregnancy because of the growing fetus that cannot be satisfied if the woman is underweight.[61]

For the age of pregnant women, younger age at pregnancy was predictive for having anemia. This result is also consistent with previous studies.[29,32]

For the diet as a risk factor for anemia in pregnant women, the more is the food diversity score, the lesser is the chance for pregnant women to develop anemia. This finding is similar and consistent with other studies.[15,62,63,64] Indian population is very diverse in their eating habits. However, the majority of pregnant women in this study sample were Hindus and they consume primarily vegetables (cereals, vegetables, fruits, etc) and only very few consume animal products (meat, chicken, eggs, etc). Therefore, the higher will be the food diversity score, the better will be their nutrition supply and lesser will be the risk of developing anemia. For pregnant women who are vegetarians, the recommendation is to consume iron-fortified cereals or foods to prevent them from developing IDA during pregnancy.[65]

The other factors that were found to be related to pregnancy anemia in other studies, like number of children born to pregnant women[31], place of residence[46,36], inter-birth interval[41,42],

religion[34], and iron and folic acid (IFA) supplements[25] taken by pregnant women were not found to be independent predictors of pregnant women's anemia status in this study.

4.1 Strengths of the study

This study had a large sample size of 31,848 pregnant women. This study only included those participants who were pregnant during the time of the data collection, minimizing potential recall bias. The anemia status of the women was recorded by blood samples collected from the pregnant women during the time of data collection, which assures the accuracy of the results.

4.2 limitations of the study

Several factors that could have influenced the anemia status of pregnant women, such as history of premature births and low birth weight babies[66], antenatal care visits[40], compliance to IFA supplementation[67], and diseases during pregnancy, were not available from the NFHS-4 dataset[68]. Neither, there was information about anemia status in late pregnancy for women enrolled in the study at the earlier terms of their pregnancy. This study was not adjusted for altitude, this could have affected the study results. Since this was a cross-sectional study and lacked longitudinal data, we cannot establish a true temporal relationship.

4.3 Conclusion and recommendations

Anemia in pregnant women continues to be a major public health problem in India. From the results of this study, factors like educational status, higher BMI, and food diversity were found to be modifiable protective factors for pregnancy anemia. India already has a National Iron Plus Initiative (NIPI) program which provides required IAF supplementation to pregnant women nation-wide to prevent them from anemia, but now it looks like vigorous promotion by organizing several awareness camps, healthcare provider and patients group discussions, and usage of social media in spreading information related to anemia in pregnancy, and about the importance of diet diversification is required in order to prevent pregnant women from developing anemia.[69] The NIPI program should be revised and its interventions should be

focused more on at-higher-risk categories of pregnant women including younger pregnant women, under the poorest category, and belonging to the backward castes (SC/ST/OBC).

The results of this study could help public health workers, policy makers and other health care related officials to take necessary actions by providing a larger scale educational awareness on nutrition to at-risk groups including pregnant women across India to combat anemia. Also, the findings could help policy makers in further implementing any interventions focusing on nutrition education, diet diversification, and IFA supplementation not only for pregnant women but also for all women under vulnerable categories in India.[70] A "National Anemia Awareness and Treatment Day", by targeting the vulnerable and young women population, could invite the attention of the population towards anemia and it's seriousness.[69] Moreover, there is a need for in-depth studies about other factors like social and cultural issues influencing anemia among pregnant women in India.

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Table 1:

Prevalence of anemia in pregnant women aged 15-49 years by states and union territories of India using NFHS-4 (2015-2016)

State		Pregnant women with anemia		Total sample	
		n	%	N	% from total sample
1.	Chandigarh (UT)	13	76.5	17	0.1
2.	Andaman and Nicobar (UT)	44	68.8	64	0.2
3.	Dadra and Nagar haveli (UT)	23	67.6	34	0.1
4.	Jharkhand	855	66.0	1296	4.1
5.	Bihar	2011	60.3	3334	10.5
6.	Haryana	708	59.2	1196	3.8
7.	West Bengal	378	59.2	638	2.0
8.	Madhya Pradesh	1754	57.4	3054	9.6
9.	Gujarat	487	57.2	852	2.7
10.	Andhra Pradesh	182	56.5	322	1.0
11.	Tripura	91	56.2	162	0.5
12.	Telangana	127	54.0	235	0.7
13.	Uttar Pradesh	2956	53.7	5507	17.3
14.	Maharashtra	582	52.4	1110	3.5
15.	Odisha	606	52.1	1163	3.7
16.	Rajasthan	1020	50.0	2041	6.4
17.	Tamil Nadu	445	49.4	901	2.8
18.	Karnataka	453	48.9	927	2.9
19.	Meghalaya	313	47.7	656	2.1
20.	Uttarakhand	316	47.3	668	2.1
21.	Assam	513	46.8	1097	3.4
22.	Chhattisgarh	536	46.6	1151	3.6
23.	Punjab	325	44.5	730	2.3
24.	Daman and Diu (UT)	10	43.5	23	0.1
25.	Himachal Pradesh	130	42.2	308	1.0
26.	Delhi (UT)	66	42.0	157	0.5
27.	Lakshadweep (UT)	17	40.5	42	0.1
28.	Jammu and Kashmir (UT)	411	39.0	1053	3.3
29.	Puducherry (UT)	49	35.0	140	0.4
30.	Nagaland	150	31.2	481	1.5

State	Pregnant women with anemia		Total sample	
	n	%	N	% from total sample
31. Mizoram	157	30.9	508	1.6
32. Arunachal Pradesh	218	29.9	728	2.3
33. Goa	10	28.6	35	0.1
34. Manipur	193	28.1	687	2.2
35. Kerala	92	24.8	371	1.2
36. Sikkim	37	23.1	160	0.5
Total India	16278	100.0	31848	100.0

n, number of pregnant women with anemia; N, Total number of surveyed pregnant women; UT, Union territory

Table 2:

Descriptive analysis of selected categorical characteristics by anemia status among pregnant women in India, NFHS-4 survey 2015-16

Characteristics	Pregnant women with anemia		Pregnant women without anemia		P-value	Total sample	
	Number	Percentage	Number	Percentage		Number	Percentage
Socio-demographic characteristics							
Wealth Index					**<0.001**		
Poorest	8505	52.2	6609	42.4		15114	47.5
Middle	3210	19.7	3280	21.1		6490	20.4
Richest	4563	28.0	5681	36.5		10244	32.2
Place of residence					**<0.001**		
Urban	3565	21.9	4011	25.8		7576	23.8
Rural	12713	78.1	11559	74.2		24272	76.2
Religion					**<0.001**		
Hindus	11700	74.0	11179	69.7		22879	71.8
Muslims	2580	16.3	2528	15.8		5108	16.0
Other (Christians, Parsi, Sikh, etc)	1526	9.7	2335	14.6		3861	12.1
Education					**<0.001**		
No education	4746	29.2	3287	21.1		8033	25.2
Primary education	2262	13.9	1965	12.6		4227	13.3
Secondary or higher education	9270	56.9	10318	66.3		19588	61.5
Marital status					**0.459**		
Currently married	16180	99.4	15466	99.3		31646	99.4
Widowed /separated/divorced	98	0.6	104	0.7		202	0.6
Caste					**<0.001**		
SC/ST/OBC	13133	83.9	11859	79.8		24992	81.9
Others	2524	16.1	3010	20.2		5697	18.1
Exposure to media					**<0.001**		
No	4762	29.3	3504	22.5		8266	26.0
Yes	11516	70.7	12066	77.5		23582	74.0
General Health Status							
Drugs taken for intestinal parasites					**0.018**		
No	7902	87.4	6593	86.6		14495	87.3
Yes	1095	12.2	1020	13.4		2115	12.7
Current smoking					**0.939**		
No	15160	93.1	14504	93.2		29664	93.1
Yes	1118	6.9	1066	6.8		2184	6.9

Characteristics	Pregnant women with anemia		Pregnant women without anemia		P-value	Total sample	
	Number	Percentage	Number	Percentage		Number	Percentage
Body Mass Index					**<0.001**		
Underweight (<18.5)	2272	14.0	1961	12.6		4233	13.3
Normal (18.5-24.5)	11727	72.2	10825	69.6		22552	70.9
Overweight (>=24.5)	2249	13.8	2769	17.8		5018	15.8
Reproductive health							
Age of women at 1st delivery					**<0.001**		
<18	3361	20.6	2751	17.7		6112	19.2
>=18	12917	79.4	12819	82.3		25736	80.8
IFA supplements taken					**0.019**		
No	2674	29.0	2006	27.3		4680	28.3
Yes	6551	71.0	5331	72.7		11882	71.7
Birth interval					**<0.001**		
Primigravidae	10883	66.9	11366	73.0		22249	69.9
<24 months	2206	13.6	1628	10.5		3834	12.0
>=24 months	3189	16.5	2576	19.6		5765	18.1

*p-value calculated using Chi-square test

Table 3:

Descriptive analysis of selected continuous variables by anemia status among pregnant women in India, NFHS-4 survey 2015-16

Characteristics	Pregnant women with anemia		Pregnant women without anemia		P-value	Total sample	
	Mean	SD	Mean	SD		Mean	SD
Age (years)	24.6	4.88	24.9	4.86	**<0.001**	24.7	4.87
Number of children	2.0	1.37	1.9	1.24	**<0.001**	1.9	1.31
Food diversity score (0-18)	10.7	3.86	10.6	3.80	**<0.001**	10.7	3.83

*p-value calculated using t-test

Table 4:

Univariate logistic regression of the selected variables by anemia status among pregnant women in India, NFHS-4 survey 2015-16

Characteristics	Odds Ratio (OR)	Confidence interval		P-value
		Lower	Upper	
Wealth index				
Poorest	1.60	1.52	1.69	**<0.001**
Middle	1.22	1.15	1.30	**<0.001**
Richest	1	Reference		
Place of residence				
Urban	1.24	1.18	1.30	**<0.001**
Rural	1	Reference		
Birth interval				
Primigravidae	0.77	0.73	0.82	**<0.001**
<2 years interval	1.10	1.01	1.19	**0.043**
>=2 years	1	Reference		
Religion				
Hindu	1.86	1.73	2.00	**<0.001**
Muslim	1.67	1.53	1.82	**<0.001**
Other	1	Reference		
Educational status of the woman				
No education	1.61	1.53	1.69	**<0.001**
Primary education	1.28	1.20	1.37	**<0.001**
Secondary or higher education	1	Reference		
IFA supplements taken				
No	1.20	1.10	1.31	**<0.001**
Yes	1	Reference		
Age of women at 1st delivery				
>=18	0.83	0.78	0.87	**<0.001**
<18	1	Reference		
Caste				
SC/ST/OBC	1.32	1.25	1.40	**<0.001**
Others	1	Reference		
Body Mass Index				
Underweight	1.43	1.31	1.55	**<0.001**
Healthy	1.33	1.25	1.42	**<0.001**
Overweight	1	Reference		
Exposure to media				
No	1.40	1.33	1.47	**<0.001**
Yes	1	Reference		
Current age (years)	0.99	0.98	0.99	**<0.001**
Number of children	1.09	1.07	1.12	**<0.001**

Characteristics	Odds Ratio (OR)	Confidence interval		P-value
		Lower	Upper	
Food diversity score (0-18)	1.01	1.01	1.02	**<0.001**

Table 5:

Multivariable logistic regression model of predictors of anemia among pregnant women in India, NFHS-4 survey 2015-16

Characteristics	Odds Ratio (OR)	Confidence interval		P-value
		Lower	Upper	
Wealth index				
Poorest	1.31	1.23	1.40	**<0.001**
Middle	1.22	1.15	1.29	**0.001**
Richest	1	Reference		
Educational status				
No education	1.42	1.34	1.51	**<0.001**
Primary education	1.14	1.06	1.22	**<0.001**
Secondary or higher education	1	Reference		
Caste				
SC/ST/OBC	1.15	1.09	1.22	**<0.001**
Others	1	Reference		
BMI				
Underweight	1.11	1.03	1.21	**0.012**
Healthy	1.16	1.10	1.23	**<0.001**
Overweight	1	Reference		
Age	0.99	0.98	0.99	**<0.001**
Food diversity score	0.98	0.97	0.99	**<0.001**

Hosmer and Lemeshow test value is 0.147. Totally, 18411 cases were included in the analysis.

Appendix-1

Table 1:

Dependent variable

Variable	Type	Measure
Anemia in pregnant women	**Binary (dichotomous)**	**1 = Yes** **0 = No**

Table 2:

Independent variables

Variable	Type	Measure
Wealth index	**Ordinal (categorical)**	**1 = Poorest** **2 = Middle** **3 = Richest**
Age	**Continuous**	**Years**
Place of residence	**Nominal (categorical)**	**1 = Urban** **0 = Rural**
Mass media exposure (newspaper, radio, tv)	**Ordinal (categorical)**	**0 = Very often exposed** **1 = Not and rarely exposed**
Educational status	**Ordinal (categorical)**	**1 = No education** **2 = Primary education** **3 = Secondary or higher education**
Husband's educational status	**Ordinal (categorical)**	**1 = No education** **2 = Primary education** **3 = Secondary or higher education**
Religion	**Nominal (categorical)**	**1 = Hindu** **2 = Muslim** **3 = Others (Christians, Sikhs, Parsi, etc)**
Caste	**Nominal (categorical)**	**1 = SC/ST/OBC** **0 = Others**
Number of children	**continuous**	**Units**
Body mass index (BMI)	**Ordinal (categorical)**	**1 = Underweight (<18.5 kg/m^2)** **2 = Normal or healthy weight (18.5 – 24.5 kg/m^2)** **3 = overweight (>=25 kg/m^2)**

Variable	Type	Measure
Marital status	**Nominal (categorical)**	**0 = Widowed/ divorced/separated/deserted/never married** **1 = Currently married**
Age at 1st birth	**Ordinal (categorical)**	**0 = < 18** **1 = >=18**
Birth interval	**Nominal (categorical)**	**1 = primigravidae** **2 = less than 2 years** **3 = more than 2 years**
IFA supplements during pregnancy	**Nominal (categorical)**	**0 = Yes** **1 = No**
Drugs for intestinal worms during pregnancy	**Nominal (categorical)**	**0 = Yes** **1 = No**
Smoking status	**Nominal (categorical)**	**10 = Yes** **1 = No**
Food diversity score	**Continuous**	**0 to 18**

Appendix 2:

WOMAN'S QUESTIONNAIRE

Age of women

102. In what month and year were you born?

MONTH . . . . . .

DON'T KNOW MONTH 98

YEAR . . . . . .

DON'T KNOW YEAR 9998

103. How old were you at your last birthday?

AGE IN COMPLETED YEARS . . . . . .

Educational status

105. Have you ever attended school?

YES 1

NO 2

105. Have you ever attended school?

YES 1

NO 2

106. What is the highest standard you completed?

STANDARD . . . . . .

Place of residence

104. How long have you been living continuously in (CURRENT PLACE OF RESIDENCE)?

YEARS . . . . . .

DON'T KNOW YEAR 9998

Mass media exposure

110. Do you read a newspaper or magazine almost every day, at least once a week, less than once a week or not at all?

ALMOST EVERY DAY 1

AT LEAST ONCE A WEEK 2

LESS THAN ONCE A WEEK 3

NOT AT ALL 4

111. Do you listen to the radio almost every day, at least once a week, less than once a week or not at all?

ALMOST EVERY DAY 1

AT LEAST ONCE A WEEK 2

LESS THAN ONCE A WEEK 3

NOT AT ALL 4

112. Do you watch television almost every day, at least once a week, less than once a week or not at all?

ALMOST EVERY DAY 1

AT LEAST ONCE A WEEK 2

LESS THAN ONCE A WEEK 3

NOT AT ALL 4

Religion and caste

114. What is your religion?

HINDU 01

MUSLIM 02

CHRISTIAN 03

SIKH 04

BUDDHIST/NEO-BUDDHIST 05

JAIN 06

JEWISH 07

PARSI/ZOROASTRIAN 08

NO RELIGION 09

OTHER _____ 96

115. What is your caste or tribe?

CASTE _____ 991 (SPECIFY)

TRIBE _____ 992 (SPECIFY)

NO CASTE/TRIBE 993

DON'T KNOW 99

116. Do you belong to a scheduled caste, a scheduled tribe, other backward class, or none of these?

SCHEDULED CASTE 1

SCHEDULED TRIBE. 2

OBC 3

NONE OF THEM 4

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

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

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

YES 1

NO 2

223. WITH NUMBER OF BIRTHS IN BIRTH HISTORY, NUMBERS ARE SAME ……..NUMBERS ARE DIFFERENT…….. (PROBE AND RECONCILE) NUMBER OF BIRTHS

YES 1

NO 2

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

NUMBER OF BIRTHS . . . . . .

NONE 0

Current pregnancy

226. Are you pregnant now?

YES 1

NO 2

UNSURE 8

227. How many months pregnant are you?

MONTHS . . . . . .

SECTION 3A. MARRIAGE AND COHABITATION

Marital status

301. What is your current marital status?

CURRENTLY MARRIED 1

MARRIED, GAUNA NOT PERFORMED 2

WIDOWED 3

DIVORCED 4 SEPARATED 5

DESERTED 6

NEVER MARRIED 7

302. Is your husband living with you now, or is he staying elsewhere?

LIVING WITH HER 1

STAYING ELSEWHERE 2

309. How old were you when you (first) got married?

AGE . . . . . .

Section 3C contacts with community health workers

360. During (this contact/all these contacts) with (PERSONS MENTIONED IN 354 AND 357) in the last three months, what were the different services provided and matters talked about? Anything else?

FAMILY PLANNING . . . . . A

IMMUNIZATION . . . . . B

ANTENATAL CARE C

DELIVERY CARE . . . . . D

BIRTH PREPAREDNESS . . . . . E

COMPLICATION READINESS . . . . . F

POSTNATAL CARE . . . . . G

DISEASE PREVENTION . . . . . H

MEDICAL TREATMENT FOR SELF . . . I

TREATMENT FOR SICK CHILD . . . . . J

TREATMENT FOR OTHER PERSON . K

MALARIA CONTROL L

SUPPLEMENTARY FOOD . . . . . M

GROWTH MONITORING OF CHILD . N

EARLY CHILDHOOD CARE . . . . . O

PRE-SCHOOL EDUCATION . . . . . P

NUTRITION/HEALTH EDUCATION . . . Q

FAMILY LIFE EDUCATION . . . . . R

MENSTRUAL HYGIENE . . . . . S

OTHER X

363. In the last three months, have you visited a health facility or camp for any reason for yourself (or for your children)?

YES 1

NO 2

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

Pregnancy

407. How much longer did you want to wait?

MONTHS 1

YEARS 2

DON'T KNOW 998

408. How many months pregnant were you when you came to know about the pregnancy?

MONTHS . . .

DON’T REMEMBER ……. 98

409. Was this pregnancy registered?

YES 1

NO 2

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

YES 1

NO 2

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

MONTHS . . .

DON'T KNOW 98

Antenatal care visits during pregnancy

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

NUM. OF TIMES . . .

DON'T KNOW 98

418. As part of your antenatal care during this pregnancy, were any of the following done at least once?

d. Was a sample of your blood taken for testing?

BLOOD (YES). . . 1

(NO). . . 2

IFA supplementation

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

YES 1

NO 2

DON'T KNOW 8

429. During the whole pregnancy, for how many days did you take the tablets or syrup?

NUM. OF DAYS

DON'T KNOW 998

Tablets for intestinal parasites

430. During this pregnancy, did you take any drug for intestinal worms?

YES 1

NO 2

DON'T KNOW 8

Supplementary nutrition

434. Did you receive any supplementary nutrition from the anganwadi centre during this pregnancy?

YES 1

NO 2

SECTION 7. OTHER HEALTH ISSUES

Financial obstacles

701. Now I would like to ask you some questions about medical care for you yourself. 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, a small problem, or no problem?

c. Getting money needed for treatment?

GETTING MONEY . . . . . 1 (BIGPROBLEM)

. . . . . 2 (SMALLPROBLEM)

. . . . . 3 (NOPROBLEM)

Current smoking habits

705. Do you currently smoke cigarettes?

YES 1

NO 2

706. In the last 24 hours, how many cigarettes did you smoke?

CIGARETTES . . . . . .

Dietary habits

726. How often do you yourself eat the following food items: daily, weekly, occasionally, or never?

b. Pulses or beans?

DAILY. 1

WEEKLY. . . . 2

OCC. . . . 3

NEVER 4

c. Dark green leafy vegetables?

DAILY. 1

WEEKLY. . . . 2

OCC. . . . 3

NEVER 4

e. Eggs?

DAILY. 1

WEEKLY. . . . 2

OCC. . . . 3

NEVER 4

f. fish?

DAILY. 1

WEEKLY. . . . 2

OCC. . . . 3

NEVER 4

g. Chicken or meat?

DAILY. 1

WEEKLY. . . . 2

OCC. . . . 3

NEVER 4

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

Husbands' educational status

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

YES 1

NO 2

BIOMARKER QUESTIONNAIRE

Hemoglobin measurement

HAEMOGLOBIN MEASUREMENT FOR WOMEN AGE 15-49

305. AGE

15-17 YEARS 1

18-49 YEARS 2

306. MARITAL STATUS

NEVER MARRIED 1

OTHER 2

368. RECORD HAEMOGLOBIN LEVEL

G/DL . . . . . .

REFUSED 995

OTHER 996

NOT TESTED 998