Bio-Social Determinants of Nutritional Anemia: A Review

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MASTER OF PHILOSOPHY

Pankaj Kumar Mishra

CENTRE OF SOCIAL MEDICINE AND COMMUNITY HEALTH

SCHOOL OF SOCIAL SCIENCES

JAWAHARLAL NEHRU UNIVERSITY

New Delhi-110067

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CENTRE OF SOCIAL MEDICINE AND COMMUNITY HEALTH

SCHOOL OF SOCIAL SCIENCES

JAWAHARLAL NEHRU UNIVERSITY

NEW DELHI – 110067

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DECLARATION

I declare that the dissertation entitled **"Biosocial Determinants of Nutritional Anemia: A Review"**, submitted by me for the award of the degree of **Master of Philosophy** at Jawaharlal Nehru University is my own work. The dissertation has not been submitted for any other degree of this university or any other university.

Pankaj Kumar Mishra

Reg- 210100512

CERTIFICATE

We recommend that this dissertation be placed before the examiners for evaluation.

Prof. Rajib Dasgupta	Prachinkumar Rajeshrao Ghodajkar	Prof. Rajib Dasgupta
(CHAIRPERSON)	**(CO-SUPERVISOR)**	**(SUPERVISOR)**

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Chapter 1. Introduction and Outline of the Studies

1.1 Introduction

It is necessary to study and comprehend how we conceptualize health and what we mean when we use the word health before examining and searching the literature, specifically the possible consequences and factors of nutritional anemia in pregnant women. There are several definitions of health, most of which are provided by UN agencies, and these definitions have influenced our society's fundamental notion of how the state and society would give health care services and how the health system or healthcare system will take form. To research the determinants and distributions of illness in a population, we need to have a good grasp of health and its determinants. As a result, it is precarious to understand how we conceptualize the word health, which defines health from which perspective, and how these perspectives and definitions will impact our knowledge. So, looking at health from a sociological standpoint may permit us to see well-being and health not just as a biomedical concept or understanding that focuses solely on the medical and bodily aspects of the individual but also as how social realities shape not only the functioning of a society but also the positioning of individuals within it (K R Nayar 1993). As a result, it's critical to recognize that whether a person is ill or may become unwell throughout his or her life is influenced not just by his or her biology but also by the social environment in which he or she lives. Understanding the concept of health will also aid and guide us in researching the distribution and determinants of anemia in pregnant women, not only from a biological standpoint such as hemoglobin levels and micronutrient deficiency such as iron, vitamin B12, folate, and other micronutrients, but also from a social, economic, political, and cultural standpoint that influences our health and well-being. When studying a topic like anemia or any other health-related problem or incident, it's critical to look at both the social and biological elements, as well as how they interact. So, going forward, we'll look at the biological aspects and determinants of anemia, such as iron, folate, Vitamin B12, and other micronutrient deficiency, their roles, causes, and consequences, and how we assess the level of these deficiencies in an individual, along with who had a higher incidence of anemia during pregnancy. We may analyze both biological and social factors of anemia by looking at their social traits, economic status, cultural and political place in society. So, in this research, we're attempting to include a biosocial approach, in which we look at not only just the biology but also the social components of a person, and how these two factors affect their health and well-being. Across the life span, biological, economic, cultural and social elements are generally acknowledged as key drivers of health. However, a thorough interpretation of the multidimensional biosocial paths which link society, biology, health, and socioeconomic position is yet tricky. In the social sciences, the word "biosocial" is often used but seldom defined. Its meaning may be self-evident. Although the term has been utilized in the systematic works for more than 50 years, biosocial exploration methods and applications have progressed qualitatively in the last fifteen years. Kathleen Mullan Harris and Thomas W. McDade describes the biosocial as a broad theory referring to the dynamic, bidirectional interfaces between biological events and societal interactions and circumstances which represent procedures of human being progress over the life course (Harris and McDade 2018).

1.2 Defining Anemia

Anemia is defined as a decrease in haemoglobin level concentration below a reference level in a given population under the same environmental conditions as the reference level. Anemia is defined by the World Health Organization as "the presence or absence of red blood cells, or a low haemoglobin content, which results in the blood's ability to carry oxygen throughout the body falling below a specified cutoff value, resulting in anemia. A low hb level, is a sign of malnutrition as well as bad health " (World Health Organization 2018).

1.3 Nutritional Anemia

Nutritional anemia is a kind of anemia that manifests itself as a result of insufficient mineral consumption in the diet, which does not provide an enough amount of bioavailable vital hematological elements to satisfy the body's requirements for hemoglobin and red blood cell production. It is not always the case that nutritional anemia is caused by dietary changes and a change in way of living (Underwood 2000; World Health Organization 1968)

Anemia is one of the highly severe nutritional issues facing the globe, females of reproductive age and children under five being the most at risk. Because the causes of anemia are multi-factorial, it is critical to understand the direct and indirect relationships between them and potential deciding variables. Nutritional anemia is a substantial public health issue, with a larger rate of recurrence amongst children U5 and females during pregnancy and breastfeeding than among the general population. Even though the frequency of anemia has decreased throughout the years, this fall has not been uniform. The prevalence of HIV/AIDS remains high in low- and middle-income countries, whereas it is common in high-income nations. However, even in affluent nations, this is not the case, particularly among ethnic groups and marginalized people. People living in rural areas, slums, and remote areas are more vulnerable to micronutrient deficiency and infections than people living in urban areas. It is due to a lack of education, poverty, food insecurity, inadequate livelihood environments, sanitation, limited access to healthcare facilities, and ecological conditions (Green and Lynch 2000)

1.4 Problem Statement: The High Prevalence of Anemia in India.

Anemia has been subjected to much research throughout the years. In recent years, a large number of study papers on anemia, nutritional anemia, and other kinds of anemia have been published, with the majority of these studies being undertaken in developing nations and comparable studies being conducted in rich countries. There were several differences in the information available about the prevalence of anemia for a long time. As a result, numerous organizations researched to determine the prevalence of the disease using large samples of data from various regions of the globe (World Health Organization 1968). These investigations discovered a significant prevalence of anemia, particularly amongst under-five children and women of reproductive age. The prevalence rate varies depending on the individual's age, environment, and other socioeconomic characteristics. An examination of the literature on the prevalence, etiology, causes, and programmatic response to anemia reveals that the burden of anemia continues to be significant despite significant research and advancements in treatment and diagnosis. According to the Indian Institute for Population Sciences (IIPS), in 2021, almost 1.3 million people worldwide are considered fragile, and the frequency of anemia is on the rise in both developing and industrialized nations(Kassebaum et al. 2016). A significant incidence of death and morbidity is attributed to this condition, particularly prevalent amongst children under-five and wome.

The occurrence of anemia has grown in almost all Indian states and around the world. According to Kerala's Department of Health, the prevalence of anemia has grown from

22.6 percent to 31.4 percent in the pregnant women (15-49) age range, which is better than the rest of India's states. The consumption rate of more than 100 and 180 IFA pills during pregnancy, on the other hand, has grown from 67.1 to 80 and 47 to 67 correspondingly, for the same category of IFA supplements (World Health Organization 2018). Since rounds four to five of the National Family Health Survey (NFHS), a similar pattern of increasing prevalence has been seen in practically all age groups in most Indian states and other regions globally, including the United States. Such a reversal of the trend raises severe concerns about our ability to comprehend the causes and etiologies of nutritional anemia. Many research has proved that iron insufficiency is a crucial cause of anemia; however, new data has revealed that the incidence of anemia has increased despite a decline in the frequency of iron deficiency in the population. This research confirmed iron insufficiency as a cause of anemia and showed that iron deficiency is not as widespread or severe in the anaemic population as previously believed (Cappellini, Musallam, and Taher 2020). Another set of micronutrient deficiencies, including vitamin A, vitamin B12, folate, and riboflavin (B2), contributes to the development of nutritional anemia in children (6-37 months) and nonpregnant women (B2) (Abioye and Fawzi 2020; Green and Lynch 2000; Underwood 2000; Woodruff et al. 1970).

Despite improvements in associated factors such as iron-fortified foods consumption early registration of pregnancy (Tibambuya, Ganle, and Ibrahim 2019), antenatal care services , antenatal visits (Ikeanyi and Ibrahim 2015), literacy rates, and other indicators that have a significant impact on anemia, the recent trend of increasing the prevalence of anemia in many countries and specifically in Indian states has raised many questions about the current understanding of anemia. The identification of the components that contribute to anemia has grown increasingly complex. The findings also reveal that, despite a reduction in the iron deficit, anemia has increased, even though iron deficiency is regarded as an important anemia cause. On the other hand, recent research has produced contradictory findings of the relationship between iron deficiency and a greater frequency of anemia (Cappellini et al. 2020). The available studies and reports must be reviewed from a new perspective to provide a more accurate and context-specific understanding of the causation and etiology of nutritional anemia. It is also necessary to understand why the burden of anemia has not been lessened in the past. This study will aim to analyze the current nutritional anemia materials to understand better the determinants of the high incidence of nutritional anemia in the general population. It will explicitly explore biosocial determinants rather than just bio determinants to pay attention to the social determinants of anemia that have been overlooked in previous research. Attempting to transition from biosocial to biomedical factors is necessary due to the increased frequency of nutritional anemia despite several therapies based on biological knowledge of the condition. Why is it that, despite several programmatic measures, the prevalence rate of anemia continues to rise? There seems to be an issue with classifying determinants, the comprehension of aetiology, and building programs based on the limited data provided.

1.5 Objectives

The research contains two major and two secondary goals, both descriptive and analytical, and are divided into two groups.

a) To assess the role of biological and social variables in developing nutritional anemia in pregnant and non-pregnant women.

b) To estimate the prevalence and study the trends of anemia in Pregnant and Non-Pregnant women.

c) To investigate the relationship between nutritional anemia and socioeconomic variables such as land tenure, women's empowerment, decision-making, and inter-household eating patterns.

An intersectional method was used to evaluate the characteristics of both anaemic and non-anaemic population samples from the National Family Health Survey data to investigate potential alternative explanations for the high incidence of nutritional anemia.

As part of our research to better understand the cause, aetiology, and dominating factors of nutritional anemia, we examined historical knowledge of nutritional anemia, changes in definition and cutoff, and discussion on biological determinants and social determinants. We have included the research since it is primarily concerned with nutritional anemia, including its causes, trends, and distribution throughout the population. As a result of the increasing rates of anemia despite various interventions based on the biomedical understanding of anemia, we attempted to investigate the relationship between socioeconomic determinants such as land distribution, women's empowerment, inter-household decision making, and dietary patterns. As a result of examining the National Family Health Survey data, these socioeconomic variables were mostly overlooked in the study conducted to determine the prevalence of anemia.

1.6 Methodology

The first of the study's objectives were addressed by reviewing studies and reports from various institutions: the World Health Organization (WHO), the United Nations Children's Emergency Fund (UNICEF), the Indian government, and other studies that addressed the objectives of other countries. An extensive study was conducted of articles and reports from journals such as the Journal of Haematology, the American Journal of

Clinical Nutrition, Indian Paediatrics and Nutrition, the National Nutrition Monitoring Bureau, and many other relevant publications.

Using the data from fourth rounds of the National Family Health Survey data, we determined the relationship between socioeconomic status and anemia, which was the study's second purpose. The National Nutrition Monitoring Bureau's statistics and recent results from the Comprehensive National Nutrition Survey 2016-18, the World Health Organization's report, and other assessments have been further examined.

To achieve the third objective of the study, we will use STATA software to analyze the data from the NFHS 4-2015-16 in order to determine the relationship between the prevalence of anemia and the landholding of the family, decision-making power in the household, inter-household dietary pattern, and other indicators in order to find an alternative method of determining the cause and determinants of nutritional anemia in the community.

The study analyzed data from the National Family Health Survey (NFHS-5), which was undertaken by the International Institute for Population Sciences, Mumbai in 2015-2016 under the auspices of the MoHFW. The NFHS-4 survey, which was conducted in 2015-16 as part of the global Demographic Health Survey (DHS), was a countrywide representative sample survey of 109,041 homes, with 124,385 women aged 15 to 49. In India, this is the only available large scale assessment that has gathered complete nutrition and health statistics with large and comprehensive samples from all 29 indian states, encompassing more than 99% of the country’s population (International Institute for Population Sciences 2017). It includes information on maternal and child health, fertility, mortality, and morbidity. The pregnant (n = 32428), non-pregnant or unsure (n=

667,258) and total women (n = 699,686) women samples are sufficient for the vigorous numerical evaluation.

1.6.1 Outcome Variables

The effect variable in the research is the manifestation of any anemia (yes = 1; no = 0). The NFHS utilized the HemoCue blood examination to assess the hemoglobin level in grams/deciliter of blood. The anemia level of the assessed females was categorized into any anemia, severe, moderate, and mild, based on WHO standards (WHO, 2011). For pregnant and lactating women. Severe anemia was described as the hemoglobin 7.0 g/dL and 8.0 g/dL for nonpregnant women. When moderate anemia occurred, it was classified as 7.0 to 9.9 for pregnant and breast-feeding women, and 8.0 to 10.9 for nonpregnant women. If ones hemoglobin level is between 10.0 and 10.9 g/dL during pregnancy and hb level in the middle of 11.0 and 11.9 g/dL in non-pregnancy, they will be categorized as mild anemic. In pregnant and lactating women, anemia was specified as a hb level below 11.0 g/dL, while in nonpregnant women, anemia was defined as a hb level lower than 12.0 g/dL.

1.6.2. Statistical Analysis

Using appropriate sampling weights, bivariate and multivariate analyses were used to establish the occurrence of anemia in prenatal and nonpregnant women. The intersection of socioeconomic characteristics was studied using multivariate analysis. Across socioeconomic and demographic attributes, the statistical impact of bivariate and multivariate differences in anemia prevalence was examined using the chi-square test. The chi-square test and a binary logistic regression model was used to examine the net effects of several confounding factors associated with the occurrence of anemia in pregnant and nonpregnant women. Difference in the occurrence of anemia projected and an adjusted odds ratio with a 95 percent confidence interval for each predictor variable was assessed using an alpha of 0.05. STATA 17.0 was used for all of the statistical analyses in this study.

Chapter 2. History of The Evolution of Nutritional Anemia

2.1 Historical Evolution of Nutritional Anemia

Nutritional anemias are acquired issues caused by a shortage of bioavailable necessary haematological elements in the diet to satisfy the demand for haemoglobin and red blood cell formation (Ramakrishnan 2000). Environmental variables which produce disproportionate blood cost or homolysis impact need. Dietary anemias are improbable to be natural in man's life. However, they developed when age-old man's way of life shifted away from chasing mammals and hunting for wild berries, produce fruit, and dark-green leaves and toward producing cereal crops and seeding vegetables to meet strength and nutritional demands. This resulted in a shift in people's key list of options for diets with fewer bioavailable haematopoietic nutrients (vitamin B12 and Iron) or individuals that improve their utilization (vitamins C and A), as well as a modification in his cooking practises to individuals that unprotected food to lengthier heat contact, which could be harmful to certain nutrients (folates). Additionally, he developed a liking for flavors and drinks to increase eating delights, and they reduce the bioavailability of hematopoietic nutrients (iron) (Ramakrishnan 2000).

When wounded combat veterans were suffering from muscle weakness, the age-old Greeks understood the advantages of iron common salt. Those who were already feeble wished to get a little of the power of this iron by sipping water that had been rusted in the form of a sword. Colors of exhaustion and fainting ladies were often shown in sculpture, notably by the school of Dutch artists, and are also mentioned in various plays by Shakespeare and his poems to characterize females in love with someone else. The name "chlorosis" was initially used to describe the symptoms of anemia, which is a Greek word that means "green". Researchers are unknown when this diagnosis initially occurred. However, it was connected with several symptoms in the 16th century, including pallor and weariness, a poor appetite, and gastrointestinal, neurological, and menstrual disorders, which were particularly prevalent in teenage females (Robscheit-Robbins and Whipple 1927).

A 17th-century physician named Snydenham recommended the use of iron salts to treat chlorosis in children. Chlorosis was first discovered in the 18^{th} century and shown to relate to minimal iron concentrations in the blood line as well as a decreased amount of red blood cells between 1832 and 1843 according to historical records (Beard, Dawson, and Piñero 1996). At the time, Blaud was marketing his renowned Blaud pills, which were constructed of ferrous sulphate and potassium carbonate and contained 24 mg iron. Blaud's pills were demonstrated to treat chlorosis, and they were manufactured by Blaud himself. After discovering the simple micro-scope in the 17th century, these reports occurred after the beginning of modern haematology. Since the early twentieth century, scientists have debated the aetiology of chlorosis. However, tracing the advancement of nutritional anemias by signs and symptoms such as chlorosis, faintness and spoon-formed nails is clearly inadequate and qualitative for influencing the shifting worldwide occurrence of nutritional anemias.

2.1.1 Nutritional Anemia in Post Industrial Era

Modern haematology six has enabled significant advancements in our knowledge of the aetiology of anemias due to deficiency of nutrition, in the contemporary era by bringing together awareness of the chemical conformation of blood by descriptions of the morphologic characteristics of red cells in health and disease. This has resulted in considerable improvements in our interpretation of the aetiology of dietary anemias in the modern era. Hoppe-Seylers demonstrated in the nineteenth century that haemoglobin was formed of hematin, which comprised protein and iron, demonstrating that the pigment of blood was comprised of hematin and protein. When Gowers described a method of assessing its absorption in blood by colour contrast to a standard (the first hemoglobinometer) around the year 1880, it was quickly followed by an even more precise method, namely, the Sahli hemoglobinometer, which is even now being utilized today in various forms. During the 1890s, Haldane, Hüfner, and Smith proved stoichiometric correlations amongst haemoglobin and its heme concentration, between iron and oxygen, and between haemoglobin and oxygen-transport capacity, significantly advancing our knowledge of anemia (Ramakrishnan 2000).

2.1.2 Nutritional Anemia: Post Second World War

When chlorosis was discovered to be related with a reduction in the amount and magnitude of the red cell as well as a decrease of iron component in the first half of the nineteenth century, it was discovered that there remained other kind of anemias in which haemoglobin was condensed but red cell extent was not decreased. The appearance of increased red blood cells revealed that a variety of factors might cause nutritional anemia. The twentieth century has seen a slew of scientists make substantial impacts to our understanding of nutritive anemias. At the University of Rochester Dr Whipple and hisb associates maintained a consistent anemia concentration over period, permitting for the organized examination of blood redevelopment in answer to dietary aspects. Max Wintrobe of the Utah University was instrumental in bringing about standardization in haematology. Clement Finch and Moore made significant contributions to our knowledge of iron assimilation, metabolism, and the determination of the level of hemopoietic nutrients. Minot and Murphy at the Thorndike Laboratory in Boston were the first to introduce us to macrocytic anemias caused by vitamin B12 and folate deficiencies (Ramakrishnan 2000).

Post Second World War, the Food and Agriculture Organization (FAO), the World Health Organization (WHO), and other United Nations agencies collaborated on a number of nutrition-related projects with other organizations. Following the first Globe

Health Assembly, several trials and research were carried out in various locations throughout the world, with the problem of micronutrient deficiencies being raised and documented throughout the process. When the Food Balance Sheet was first developed, it was considered to be one of the most important guiding documents in the field of nutritional research because it provided information on the supply of different foods and food groups available per capita at the retail level, as well as their calorie and nutrient content (Burgess 1956).

2.1.3 Iron Deficiency Anemia: Report of a Study Group by WHO

A meeting of the World Health Organization's Study Group on IDA was held in Geneva from 29 September to 4 October 1968 to examine the state of the issue from the standpoints of causation, evolution, and prevention of the disease. The findings of numerous studies intended to govern the comparative occurrence of different types of anemia in the general population suggest that the vast majority of cases of anemia are iron-deficient, which supports the findings of therapeutic trials with iron and suggests that more studies along these lines are needed in various countries (World Health Organization 1959).

Hemoglobin surveys conducted in various regions have revealed that anemia is a significant public health problem in underdeveloped and tropical areas of the world. It has also been discovered that the high rates of maternal mortality in countries such as India and Mauritius are influenced by the prevalence of anemia. According to the findings of the Group, recent research conducted in India, Africa, Central and South America has shown that iron deficiency anemia is the most frequent kind of anemia in these nations. In Mauritius, it has been reported that some segments of the population may be impacted to the extent of 50 percent or more, with iron-deficient anemia accounting for 95 percent of the cases (World Health Organization 1959). The Study

Group also recommended that investigations be conducted into the following topics: 1) the iron absorption from diets in tropical countries, 2) dermal dead of heme in tropical regions, 3) the role of hookworm infection in anemia, 4) tissue iron stores, and 5) the role of protein deficiency in anemia in children and infants in tropical regions (World Health Organization 1959).

2.1.4 Haematological Value for Detection of Anemia in Population

The Study Group concluded that, to discover and analyze the anemia issue in a community, it was necessary to establish a standard of reference, even if it was somewhat arbitrary. It is also critical to have consistent international standards when comparing survey results from various locations throughout the globe. Using a great body of haematological statistics resulting from studies of ostensibly normal individuals conducted in the world, as well as individual thought of Group associates, hemoglobin values that can be considered as the lower edge of regular for determining the presence or absence of anemia in nutritional surveys have been determined (Table 1). For the investigator, they are meant to serve as a general point of reference for the investigation and show that lower results than these indicate anemia. Higher levels of one or more of these, on the other hand, may be associated with anemia in certain people. This is especially true in the case of megaloblastic anemia, which may be distinguished by the presence of comparatively greater hemoglobin levels at periods. They also concluded that optimal hemological levels in the tropical and temperate zones are the same. It is necessary to make the proper upward adjustment for the high altitude. The Group also acknowledges that, in the field, it is frequently impractical to establish packed cell volume and red blood cell counts, which is why they have formed this working group. Although they were hesitant to include this in the table, they consented to do so in the expectation that as time goes on, more research will include similar factors and that values will be calculated even in field surveys (World Health Organization 1959).

Figure 1 *Values of Haemoglobin the Levels Below Which Anemia is Considered to Exist, and the Corresponding Haematological Values- Accepted by Study Group.*

Years	Sex	Hb g/100 ml		RBCM/mm2	PCV %	MCH mm2	MCHC %
0.6-4		10.8		4.1	32	79	33
5-9		11.5	11.5	4.1	33	80	34
10-14		12.5		4.1	37	82	34
Adults	Male	14		4.7	42	87	34
	Female	12		4.0	35	87	34
	Pregnant Female	11		3.3	29	87	34

Source- *Iron Deficiency Anemia: Report of a Study Group by WHO, 1959*

2.1.5 WHO Scientific Group of Nutritional Anemia

In contrast to IDA, which is the extremely widespread structure of the condition, and anemia produced by iron deficiency, it was quickly discovered that there was little information available on the prevalence of megaloblastic anemia caused by a nutritional deficit. As a result of the inadequacy or unsuitability of methodologies for prevalence research, the scale of the issue caused by megaloblastic anemia remained unknown owing to a lack of clear data. The importance of recognizing the severity of the difficulties associated with nutritional anemia, particularly those characterized by megaloblastosis in 1961-62, the World Health Organization (WHO) organized a rapid survey to assess the severity of the problem of nutritional anemia. The survey concluded that the nutritional anemias of greatest concern were those caused by iron, folate, and vitamin B12 deficiency. Anemia is caused by nutrient deficiencies such as protein deficiency, which will most likely be recognized only after iron, folate, and vitamin B12 deficiency and have been ruled out as prominent causes of the condition. During the expert committee meeting, it was mentioned that there were some criteria for detecting deficiency centered on the degrees of iron, folate, and vitamin B12 in blood serum, as well as non-morphological fluctuations in white and red blood cells as found in the peripheral blood.

Nonetheless, improved criteria were required, and their usefulness for detecting deficiency states that lead to anemia necessitated further research into this area. It was suggested that investigations into the following characteristics of single blood and serum specimens be carried out. The following parameters are measured in whole blood:, packed cell volume, hemoglobin the low average count of polymorphonuclear cells, and morphological changes in red blood corpuscles; and 2) serum:,percentage saturation of iron in transferring, vitamin B12 (assayed Lactobacillus leichmannii or by Euglena gracilis), and folate (assayed by Lactobacillus leichmanii) (assayed by Lactobacillus Casei).

The criteria for the diagnosis of anemia were established in 1958 after the publication of the World Health Organization Study Group's report on the subject. The Scientific Group on Nutritional Anemia came to the conclusion that the values proposed by the Study Group were picked at random by the Study Group. At that time, it was not feasible to define normalcy with any precision. Based on evidence from numerous research, including a recommendation by International Committee for Standardization in Haematology, an unpublished observation by Natvig, K. in 1966 and other findings, the Scientific Group has advised that anemia be addressed in people whose hemoglobin levels are lower than the numbers recognized by scientific Group be considered. According to the committee's findings, the normal mean corpuscular hemoglobin concentration should be 34 for all ages (Larsen 1966; WHO 1968).

Figure 2 *Values of Haemoglobin The Levels Below Which Anemia is Considered to Exist-Accepted by WHO Scientific Group on Nutritional Anemia*

Years	Sex	Hb g/100ml
0.6-6		11
6-14		12
Adults	Males	13
	Females, nonpregnant	12
	Females, Pregnant	11

2.1.6 Nutritional Anemia: Study in Vellore, Andhra Pradesh

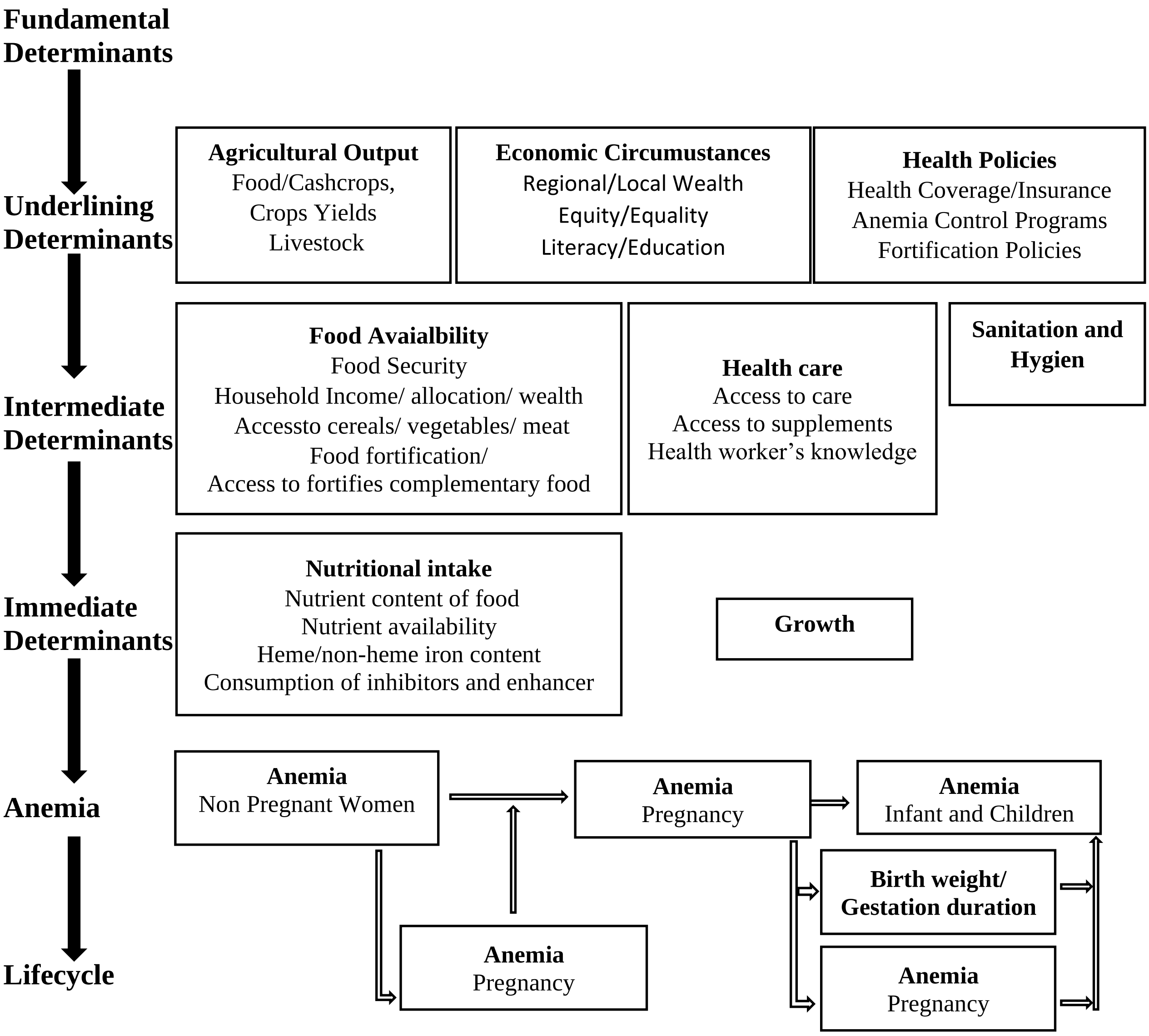
An international collaborative study on anime and pregnancy was launched in 1963 as a result of the above recommendation, and participants came from India, Israel, Mexico, Poland (now Poland), South Africa, the United Kingdom, the United States, and Venezuela. In particular, attention was to be paid to the investigation of (1) the iron stored in the tissues, (2) the absorption of food iron, (3) dermal and total losses of body iron, and (4) the role of hookworm infection in the development of anemia associated with pregnancy The World Health Organization sponsored studies using standard methods found that the prevalence of anemia in pregnant women in different parts of the world ranges from 21 percent to 80 percent. These studies were conducted up until 1967. A much higher figure is indicated by the serum iron, vitamin B12 and folate levels, for example, iron deficiency as indicated by the percentage saturation after transferring was found in 40-99 percent of the pregnant women studied and was without a doubt responsible for the vast majority of anemia cases. As previously discussed, numerous studies were carried out in various parts of the world; however, the author focuses primarily on the research carried out in India in this paper. Approximately 1000 women who were receiving antenatal care at the General Hospital Clinic Vellore participated in a survey. There was 61 percent from a very low-income group, and all of the women who participated in the study were in their last trimester of pregnancy, which is a significant finding. As controls, researchers looked at a group of 100 nonpregnant women of similar age and socioeconomic background, as well as 99 husbands of women who had been admitted for delivery (World Health Organization 1968).

Chapter 3. Biosocial Approach, Causes, Consequences, and Assessment of Nutritional Anemia

3.1 Introduction

Figure 1 builds on previous efforts to highlight the multilevel domains and pathways relevant to bio-social approaches to health and health inequality in society (Kuh and Ben-Shlomo 2004; Glass and McAtee 2006). The top boxes of the figure represent a set of nested and interconnected social contexts "outside" the body that influences an individual's developing body at all stages of life. Meanwhile, the bottom boxes represent the nested and interconnected levels of biological organization "inside" the body that responds to and shapes social worlds. From conception to death, biological can be defined as processes and arrangements within an individual that provide the growth, reproduction, and maintenance of the soma. Associations and interactions among people living in groups and within social environments (groups, neighbourhoods, schools) who contribute to the norms, organizations, and hierarchies that structure them are examples of social phenomena that are similarly complex and multidimensional. Aspects of the physical environment relevant to biology (such as contact to environmental pollutants public space for recreation) that social associations and orders control can include in the social realm.

Figure 3 Determinants of Nutritional Anemia: Based on Socio-economic, Political and Environmental Conditions



Note- Based on the approach described in UNICEF Policy Review, "Strategy for Improved Nutrition of Children and Women in Developing Countries," UNICEF, New York, 1990, 36 pages- with Modification by Author.

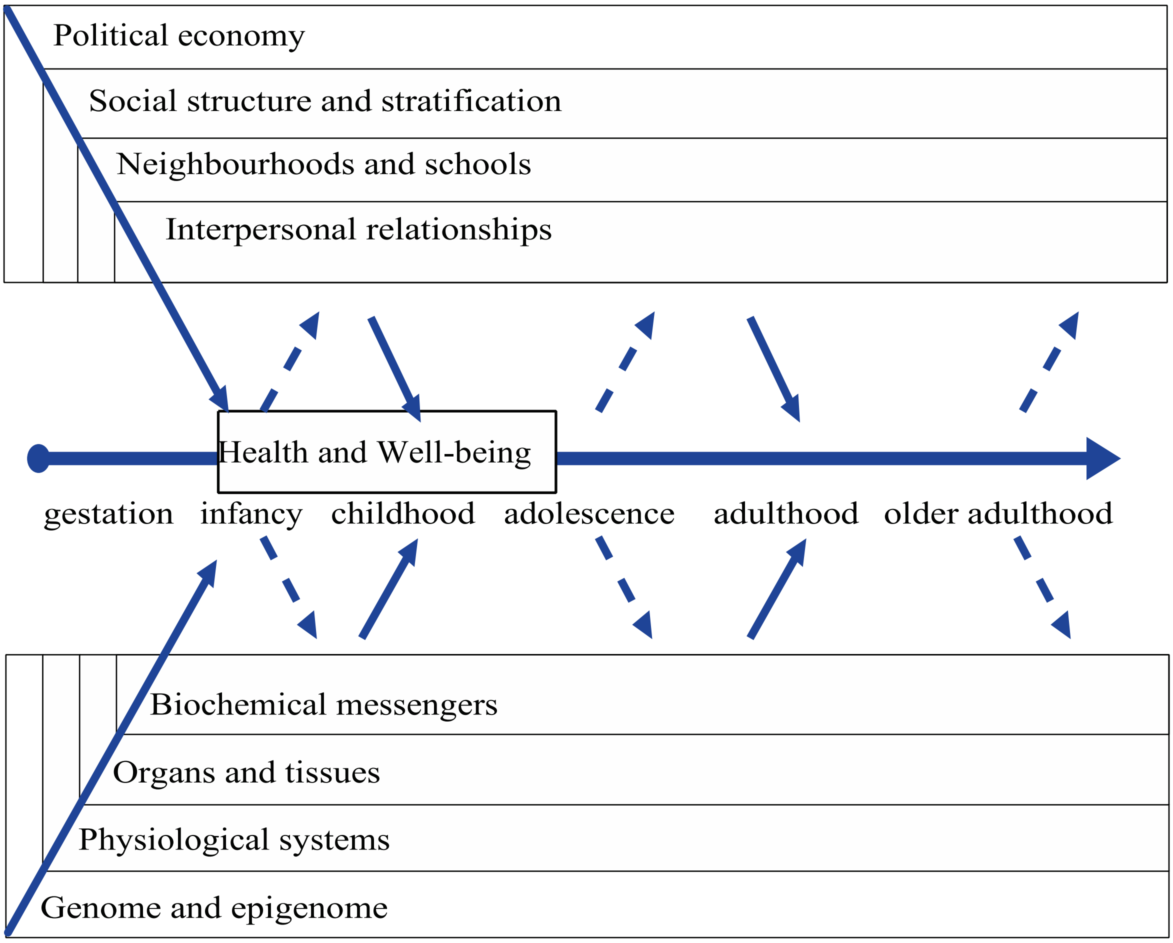
On the other hand, Biosocial perspectives use a variety of models and methods from various disciplines. The social and biological are seen as mutually constituting forces in this theory, and the line between what happens inside the body and what happens outside the body is blurred. Thus, it implies that attempts to comprehend them in isolation are faulty. An approach to human development, behaviour, and health developed and applied by scholars with anthropology, psychology, epidemiology, sociology, public health and genomics and demography is known as transdisciplinarity.

Translating social science findings into policy requires the very crucial consideration of the biosocial context. The quality of social conditions can be revealed through biological measures. This can sometimes lead to action to improve social situations to prevent disease rather than treat individuals who are already sick. It is possible to prevent the development of costly cognitive and behavioural disorders through using lead screening in children to inform housing policy.

Regular health screenings should include questions about people's social connections. Physicians should encourage their patients to ask about their relations as part of annual wellness checks. There is a reliable indication of the importance of societal relationships for biological processes affecting health(Harris and McDade 2018).

More than a 3rd of the world's population, according to the WHO, is anemic. Deficiencies in essential nutrients are the root of the problem. Iron deficiency anemia affects more than half a billion people worldwide(Cook, Skikne, and Baynes 1994) Vitamin A deficiency, folic acid deficiency, or vitamin B12 deficiency contribute to a lesser but substantial percentage of instances. Tropical regions have a high frequency of infectious infections that induce anemia, making it difficult to recognize, avoid, or remedy the condition. Malaria and hookworm are the most serious threats. Pregnant women and their infants are less likely to die due to anemia management programs, as are children's cognitive and developmental abilities and adults' productivity. On the other hand, accurate identification of causal causes is critical to successful intervention. For this reason, clear and reliable criteria for identifying the particular dietary causes of anemia and assessing the efficacy of management techniques are essential.

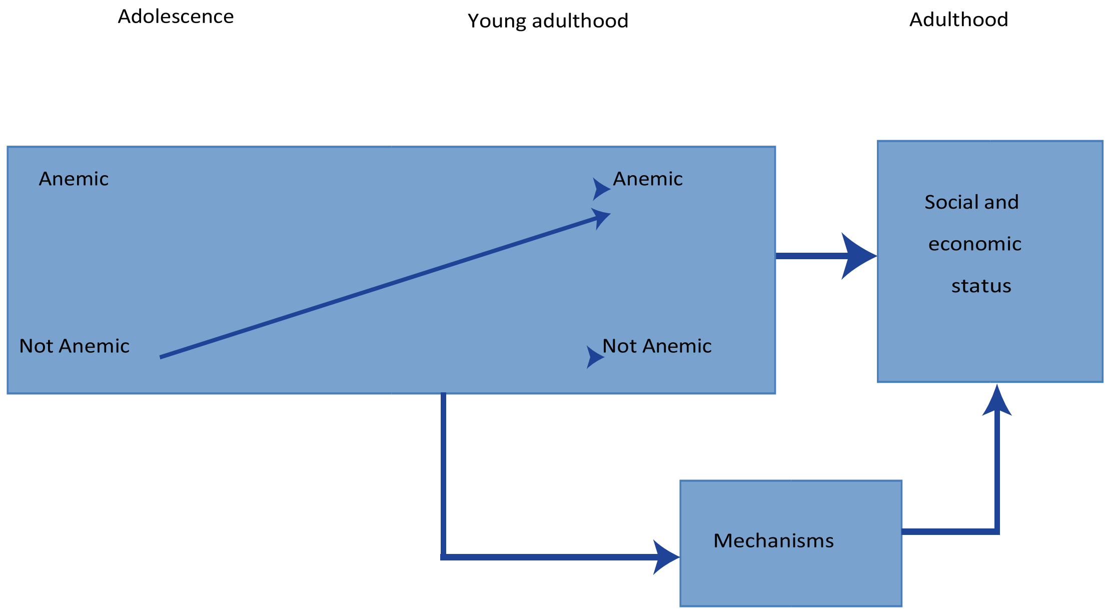
Figure 4 *Conceptual Model of Biosocial Dynamics Across the Life Course*



Source- *The Biosocial Approach to Human Development, Behavior, and Health Across the Life Course by Kathleen Mullan Harris and Thomas W. McDade*

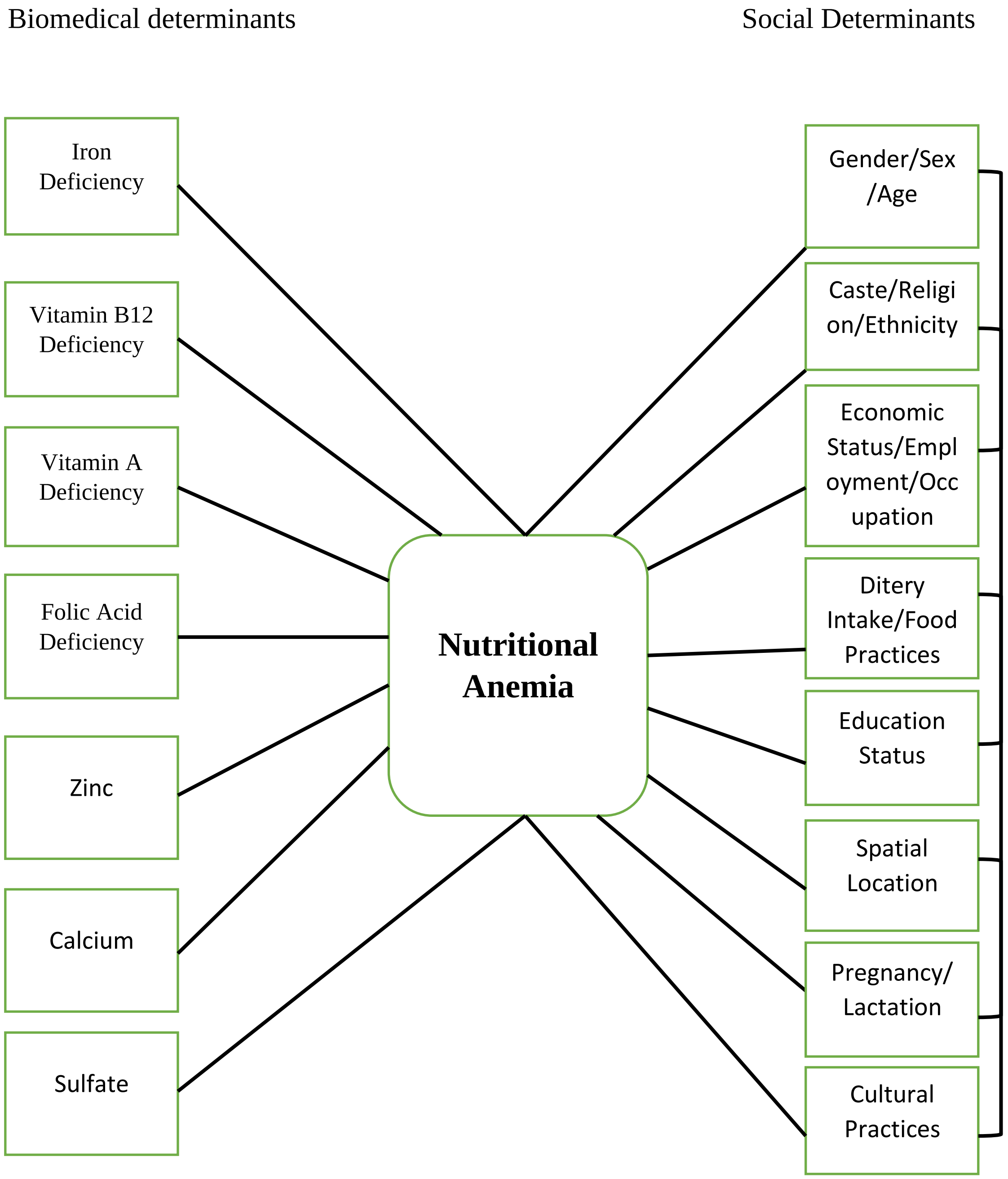
Figure 4 depicts a variety of life course models that explain how social disadvantage during specific developmental periods can lead to increased health risk in later stages of life. The top model depicts sensitive period timing effects, in which exposures during critical developmental periods have a greater impact on health outcomes than exposures at other life stages (Hayward and Gorman 2004; Gluckman et al. 2008; Cohen, Janicki-D everts et al. 2010). Social exposures during sensitive windows of development have the potential to induce structural and functional changes in the developing individual through biological programming that cannot be reversed regardless of intervening experience, according to sensitive period effects. As a result, the dark shadowed line represents a direct effect of exposure during the early stages of development, with no indirect effects and no direct effects of later social disadvantage(Harris and McDade 2018).

Figure 5 *Role of Health in Social Stratification Processes-*



Source- The Biosocial Approach to Human Development, Behavior, and Health Across the Life Course by Kathleen Mullan Harris and Thomas W. McDade

Figure 6 *Bio-social Determinants of Nutritional Anemia*



Source- *Based on the author's understanding of Biosocial determinants of health from a health system approach.*

Figure 7 *Classification of anaemia as a problem of public health significance*

Percentage (%) of serum ferritin values below threshold	Percentage (%) of transferrin receptor values above threshold	Interpretation
<20[d]	<10	Iron deficiency is not prevalent
<20[d]	≥10	Iron deficiency is prevalent; inflammation is present
≥20[e]	≥10	Iron deficiency is prevalent
≥20[e]	<10	Iron depletion is prevalent

Source-**:** World Health Organization, Centers for Disease Control and Prevention. Worldwide prevalence of anaemia 1993–2005. WHO Global Database on Anaemia. Geneva: World Health Organization; 2008F

Figure 8 *Haemoglobin levels (g/L) to diagnose anemia at sea level.*

Haemoglobin levels (g/L) to diagnose anemia at sea level				
		Anemia		
Population, age	No anemia	Mild	Moderate	Severe
Children, 6–59 months	≥110	100–109	70–99	<70
Children, 5–11 years	≥115	110–114	80–109	<80
Children, 12–14 years	≥120	110–119	80–109	<80
Nonpregnant women, 15 years and above	≥120	110–119	80–109	<80
Pregnant women	≥110	100–109	70–99	<70
Men, 15 years and above	≥130	110–129	80–109	<80

Nutritional anemia is defined by insufficient erythropoiesis and low haemoglobin content. This is related to a lack of minerals such as iron, folic acid, and vitamin B12. These nutrients are solely maternal in origin during intrauterine life, although they are received postnatally via breast milk and food. Women's anemia is a recurrent condition, notably among nonpregnant women in Northern, Central and Western Africa, Middle East and the Central Asia, and pregnant women in Southern Asia and Southern Africa (Stevens et al. 2013) The large percentage of microcytic anemia and gender differences were only seen following the time of menarche in women, suggesting that the major cause of anemia was menarche (Uria et al., 2014). The majority of studies imply that the increased incidence of anemia in women is attributable to monthly irregularities (Peuranpää et al. 2014). According to Gogoi and Prusty (2013), the more severe the anemia, the more likely the woman would give birth to a low-weight baby owing to intrauterine growth retardation (IUGR) (Gogoi, Unisa, and Prusty 2014; Shirpurkar, Shewte, and Joshi 2017). The maintenance of haemoglobin levels requires a variety of additional nutrients and cofactors. On the other hand, iron deficiency is the most common cause of nutritional anemia in the population (Kapoor 2002).

Increased risk of maternal mortality in impoverished nations may be linked to several variables, including an increased risk of infection, heart failure during labour with severe anemia, and a reduced tolerance for hemorrhagic blood loss after delivery (Elder, 2002). During pregnancy, the iron needs are significant, and meeting them alone via food is challenging. Women's iron reserves are much lower than men's, making them more susceptible to iron shortage when iron intake is reduced, or demand rises (Lai et al. 2009; Scrimshaw and Gleason 1992). It is the most common haematological condition in children, specifically in girls, and it mainly affects those women who are in the reproductive age group (Ahmed et al. 2019; Leenstra et al. 2004; Sabina Azhar, Islam, and Karim 2021). According to several research, a significant frequency of anemia among teenage girls and women has also been proven in India (Jawed et al. 2017; Sabina Azhar et al. 2021; Stevens et al. 2013). In India, females often marry and have children before their growth cycle is over, tripling the risk of anemia (Shobha and Sharada 2003).The anaemic teenage girls mature into adult women with stunted physical and mental development. These women are underweight before pregnancy and are more likely to die during delivery and give birth to underweight kids (Asrie 2017; Bhirud and Bhole 2017)

Food overcooking, parasite infection, excessive menstrual blood flow, and malaria are all factors to consider (Gupta, Hofmeyr, and Shehmar 2012). Furthermore, anemia in adolescence impacts a woman's complete life cycle since anaemic females have decreased pre-pregnancy iron levels. Women who start pregnancy anaemic are at a higher risk of giving birth to infants with low birth weight (below 2,500 grammes), delivering preterm neonates, and/or dying during giving birth because the pregnancy is too short of developing the iron reserves necessary to fulfil the demands of the growing baby. Furthermore, children born to anaemic mothers are more likely to die before reaching the age of one year and be ill, undernourished, and anemic, continuing the intergenerational cycle of maternal and child malnutrition.

Furthermore, women of reproductive age need more iron during pregnancy due to the mother's increased red cell volume and placental and foetal development (Charlton and Bothwell 1982; Worwood 1982). Compared to males, this significantly raises the risk of iron deficiency anemia in women. As a result, maternal iron reserves are crucial for maintaining iron balance throughout pregnancy(Lopez et al. 2016) . Iron supplementation of iron-deficient pregnant women enhances maternal and newborn iron reserves postpartum, according to growing data (Allen 2000a; Lopez et al. 2016; Scholl and Hediger 1994), although the functional repercussions of this improvement have not been thoroughly characterized (Grantham-McGregor and Ani 2001; Lozoff et al. 2000; Walter 2003).

Anemia is described as having a lower hemoglobin (Hb) concentration or a lower hematocrit level (see definition below). Iron deficiency anemia is thought to be the most frequent nutritional deficit globally, but there is contestation among researchers over whether it is the most common. The incidence and causes of vitamin A, folic acid, riboflavin, and vitamin B12 deficiency are discussed, as are the consequences of these deficiencies. Anemia is associated with an increased risk of preterm birth ,Neo-natal and deaths, inadequate iron levels for the baby, an increased risk of postpartum illness and fatality, and reduced physical activity, mental attention, and productivity in women. (Scholl et al., 1992; Gillespie and Johnston, 1998). Despite medical advances, iron deficiency continues to remain a severe public health issue in both industrialised and developing countries, with women being particularly vulnerable. (Beck et al., 2014). The most common extra-genital condition in women of reproductive age is anemia. It lowers women's quality of life and causes pregnancy difficulties (miscarriage, placental insufficiency, etc.) and a negative impact on the baby's growth and development. Before conception, iron deficiency impairs the formation of the neural tissue (the brain), resulting in a decline in intellect, psychomotor development difficulties, and other abnormalities in the future. Organic uterine illnesses (polyps, fibroids) and functional uterine disorders (abnormal and/or excessive uterine bleeding) are common causes of iron insufficiency in women (Solovyova et al., 2018.) Infants delivered to moms with severe anemia had a greater chance of irreparable brain damage, worse school success, less physical and exercise tolerance, and a poor immunological response, according to nutritional status, physical work capacity, and mental function of school children (Agarwal et al., 1987).

3.1.1 Assessment of Iron Deficiency in Population

Hemoglobin, serum ferritin or transferrin receptor are the best methods for assessing the iron status of populations (7). WHO recommends a combination of serum ferritin and hemoglobin to track the effectiveness of interventions on anaemia at the national level (7). Table 3 shows a possible approach for evaluating transferrin and ferritin receptor values in population surveys (51). Because arterial blood is more difficult to gather and carry in the field, many nutritional status assessments are performed with arterial blood (including biomarkers for iron status) must be performed on arterial blood, which is expensive and necessitates sophisticated laboratory equipment and trained technicians, as opposed to hemoglobin. Despite this, "field-friendly" methods for assessing nutritional status are becoming more common. This is a common misconception.

3.2 Causes of Iron Deficiency Anemia:

ID is by far the most common cause of anemia around the world. According to the World Health Organization, iron supplementation may be used to successfully cure 50 percent of anemia in women and 42 percent of anemia in children throughout the world, respectively . Iron insufficiency can occur as a result of insufficient consumption of high levels of iron essential for growth, as well as inability to replenish losses during pregnancy and menstruation. Other reasons include a lack of total iron or absorbable iron, as well as high iron losses due to parasite infections (World Health Organization 2018).

Figure 9 *Classification of anaemia as a problem of public health significance*

Percentage (%) of serum ferritin values below threshold	Percentage (%) of transferrin receptor values above threshold	Interpretation
<20[d]	<10	Iron deficiency is not prevalent
<20[d]	≥10	Iron deficiency is prevalent; inflammation is present
≥20[e]	≥10	Iron deficiency is prevalent
≥20[e]	<10	Iron depletion is prevalent

Source**:** World Health Organization, Centers for Disease Control and Prevention. Worldwide prevalence of anaemia 1993–2005. WHO Global Database on Anaemia. Geneva: World Health Organization; 2008

Pasricha et al. summarised some of the most common causes of iron deficiency anemia. Iron malabsorption due to prolonged ingestion of absorption inhibitors, celiac illness, chronic gastritis, iron refractory IDA Premature newborns, early childhood, and teenage growth spurt have increased physiologic needs that are not supplied by dietary iron. During pregnancy, for example, iron status varies with gestational age, steadily decreasing from the first to the third trimester as fetal and placental iron requirements rise, menstrual blood loss, gastrointestinal or urinary tract bleeding, and helminth diseases (hookworm, schistosomiasis) (Pasricha et al. 2013).

The amount of iron an individual needs daily varies widely depending on age, gender, and other factors. In terms of daily iron requirements, infants need about one milligram per 1,000 calories; preschoolers and schoolchildren, about four milligrams; teenagers, about eight milligrams; and adult men, about three milligrams; women who are not pregnant, about six milligrams; and lactating and postmenopausal women, about four milligrams. The most vulnerable to iron deficiency are those with the highest iron needs, such as pregnant women and newborns, who may go without the iron they need if their diet does not include enough iron-rich foods or supplements. A cultural bias favouring men implies that they eat an excessive quantity of animal products in certain locations.

3.2.1 Causes of Iron Deficiency Anemia During Pregnancy

Anemia is more common among pregnant women. Nonpregnant women need 1.25 mg of iron per day, but pregnant women require around 6 mg per day owing to the transfer of iron from the fetus to the placenta and an increase in maternal hemoglobin synthesis. Physiological hemodilution occurs throughout pregnancy, peaking between 20 and 24 weeks of gestation, and Hb levels fluctuate throughout the trimesters (Goonewardene, Shehata, and Hamad 2012) In fact, it is widely known that Hb levels diminish physiologically throughout the third trimester. This physiological decline is attributable to a larger rise in plasma volume during pregnancy than a small increase in RBC mass. This physiological mechanism causes relative hemodilution of blood viscosity, which aids placental blood circulation (Chandra et al., 2012).

Figure 10 Proposed interpretation* of low serum ferritin and high transferrin receptor concentrations in population surveys.

Percentage (%) of serum ferritin values below thresholdb	Percentage (%) of transferrin receptor values above thresholdc	Interpretation
<20[d]	<10	Iron deficiency is not prevalent
<20[d]	≥10	Iron deficiency is prevalent; inflammation is present
≥20[e]	≥10	Iron deficiency is prevalent
≥20[e]	<10	Iron depletion is prevalent

Source- Assessing the iron status of populations. Second edition including literature reviews. Report of a Joint World Health Organization/Centers for Disease Control and Prevention technical consultation on the assessment of iron status at the population level, Geneva, Switzerland, 6–8 April 2004. Geneva: World Health Organization; 2007

**- This classification is based on experience measuring ferritin and transferrin receptor in research studies and requires validation in population surveys. [a] Thresholds for serum ferritin: <12 µg/L for children aged under 5 years; <5 µg/L for all other individuals. [b] Use thresholds recommended by manufacturers as there is not currently an international standard reference. [c] <30% for pregnant women. [d] ≥30% for pregnant women*

Furthermore, due to the increased iron demand during pregnancy, iron insufficiency is rather prevalent, with a mean iron need of 4.4 mg/day (Milman 2012). Women with low iron levels at the start of pregnancy, as in many underdeveloped countries, are at risk of developing anemia in the second and third trimesters of their pregnancy. They must take iron supplements due to the risk of anemia (World Health Organization 2018). Pregnant women are unlikely to meet their required iron intakes and maintain their iron reserves solely via food, particularly in wealthy countries. For example, in the United States, pregnant women are recommended to take a daily iron supplement of 30 mg, or 60 mg if anemic. Pregnant women in places where anemia is more than 40% frequent should take 60 mg iron with 400 g folic acid daily for six months. The regimen continues for three months following delivery (World Health Organization 2018). A daily dose of 120 mg is recommended for women who are very anaemic. Anemia may also be caused by the insufficient time between pregnancies, adolescent pregnancy, and multiple births. The quantity of iron a woman has saved at the conclusion of her pregnancy is an excellent predictor of her iron depletion after giving birth. While breastfeeding, a mother's iron stores are conserved. Unless the quantity of blood lost after delivery is significant, anemia is less likely in the early postpartum period (Allen 2000a). Within 2 to 3 months of giving birth, iron levels begin to deplete, causing anemia to flare up again. Breastfeeding iron needs are influenced by the mother's iron status at delivery and the duration of postpartum amenorrhea. These variables indicate the need for having enough iron before, during, and after pregnancy. Throughout their reproductive years, most women in underdeveloped countries suffer from iron deficiency anemia.

3.2.2 Consequences of Iron Deficient Anemia during Pregnancy

Although various studies have shown the advantages of iron supplementation in decreasing anemia and increasing iron reserves in pregnant women, the evidence on the fetus's possible advantages and other mother outcomes is inconclusive. This section offers a short assessment of known evidence on the functional effects of nutritional anemias, Iron Deficiency Anemia.

Lindsay H Allen investigates the consequences of maternal anemia and iron deficiency on pregnancy outcomes. The research discovered that there is still a lot to learn about the advantages of maternal iron supplementation on the health and iron status of the mother and her child throughout pregnancy and after delivery. It was also shown that iron deficiency anemia during pregnancy is a risk factor for preterm delivery, low birth weight, and perhaps poor neonatal health. The amount of data available to assess how much maternal anemia contributes to maternal mortality is insufficient (Allen 2000b).

Low birth weight or prematurity, perinatal and neonatal mortality, insufficient iron stores for the newborn, increased maternal morbidity and mortality and decreased physical activity, mental concentration, and productivity are all consequences of anemia for women (Scholl et al., 1992; Gillespie and Johnston, 1998). Iron deficiency remains a major public health concern in developed and developing countries, with women being particularly vulnerable (Beck et al., 2014). The most common extra-genital illness in women of reproductive age is anemia. It lowers women's quality of life and, during pregnancy, causes pregnancy complications (miscarriage, placental insufficiency, etc.) as well as a negative impact on the fetus's growth and development. Before conception, iron deficiency interferes with the formation of the uterus.

3.2.3. Iron Deficiency: Perinatal Complication in Women

Several large observational studies have discovered a U-shaped relationship between maternal haemoglobin levels and perinatal mortality. Garn et al. found the lowest rates of foetal death among women with Hb values of 95 to 105 g/l in whites and 85 to 95 g/l in blacks, based on data from the National Collaborative Perinatal Project included nearly 60,000 births in the United States. The Cardiff Births Survey (approximately 55,000 births) found the lowest death rate in England at maternal Hb levels of 104 to 132 g/l. In a study of 18,000 singleton births in Nigeria, Lister et al. discovered a similar U-shaped relationship between maternal hematocrit and perinatal mortality. In a study of over 4000 pregnancies in Nigeria, Onadeko et al. failed to find a link between Hb levels and stillbirths. Mola et al. recently discovered that women whose lowest Hb values during pregnancy were between 10 and 11 g/dl had the lowest stillbirth rates (14 per 1000) in a study of hospital-based deliveries in Papua New Guinea. Even after controlling for other confounding variables like age, parity, and hypertension, women with severe anemia (8 g/dl) had a higher risk of stillbirth (adjusted odds ratio = 1.6, 95 percent confidence interval: 1.3, 2.0). Malaria and hookworm infestation was endemic in this population, with a mean Hb value of 100 g/l. Although these studies suggest that anemia has only a minor impact on perinatal mortality, the causes of anemia may differ in these different settings; few intervention trials have looked into this. The iron supplemented Group in India had a significant reduction in neonatal deaths. However, the trial's biases due to the high loss to follow-up (40 percent) cannot be overlooked. In contrast, a group of Finnish women who received routine iron supplementation experienced an unexpected increase in perinatal mortality compared to those who received only selective supplementation, suggesting that providing too much iron to not deficient women can have negative consequences. These findings should be interpreted with caution, and more data from areas where anemia is common is needed.

In two large intervention trials conducted in The Gambia and Tanzania, the control groups who received routine iron-folate supplements had perinatal mortality rates that were much lower than the general population.

Chapter 4. Prevalence and Socioeconomic Determinants of Nutritional Anemia in Pregnant and Nonpregnant Women

4.1 Introduction

Globally, the most common cause of death due to malnutrition is anemia. It refers to a low haemoglobin content in the blood and a poor ability to transport oxygen. Anemia is a low haemoglobin concentration below normal levels or a low hematocrit (% of red blood cells) that causes the blood to have a poor oxygen-carrying capacity. Anemia manifests itself in a person's appearance as paleness, weakness, and a tendency to get quickly weary. Nutritional anemia is defined by a WHO Scientific Group on Nutritional Anemia as a condition in which the amount of haemoglobin in the blood falls below the cutoff owing to a deficit of one or more vital nutrients, regardless of the origin of the shortfall. Anemia manifests as paleness, sluggishness, or exhaustion. A decrease in oxygen transport to tissues occurs as anemia progresses from mild to severe.

There are many deaths and disabilities associated with anemia. In 2017, it accounted for 3.5% of all years spent living with a handicap due to all conditions. Anemia is described as a low haemoglobin concentration below normal levels or a low hematocrit of red blood cells that causes the blood to have a poor oxygen-carrying capacity. Anemia manifests itself as paleness, weakness, and a tendency to get quickly weary.

Figure 11 *The percentage of women who are pregnant, not pregnant, or do not know based on their background characteristics in India from NFHS (2015 to 2016)*

Background characteristics	Pregnant	Nonpregnant or Unsure
Caste		
Schedule caste	19.97	18.55
Schedule tribe	19.84	18.92
OBCs	41.45	40.8
Others	18.22	21.24
don't know	0.53	0.49
Type of Place of Residence		
Urban	24.11	29.51
Rural	75.89	70.49
Education		
No education	25.13	28.24
Primary	13.2	12.59
Secondary	49.57	47.79
Higher	12.1	11.39
Religion		
Hindu	71.72	74.34
Muslim	16.19	13.39
Christian	7.83	7.43
Sikh	1.84	2.20
Age (age |in 5-year |groups)		
15-19	11.37	18.16
20-34	83.88	46.14
35+	4.75	35.7
Duration of pregnancy		
Less than 3 months	15.8	Na
3 months to 6 months	53.96	Na
More than 6 months	30.24	Na

Figure 11 The prevalence of anemia among pregnant and nonpregnant women from various

Background characteristics	**Pregnant**	**Nonpregnant or Unsure**
Partner Education		
No education	15.13	19.71
Primary	13.04	14.9
Secondary	55.75	52.12
Higher	15.72	12.93
Don't know	0.36	0.34
Supplementary Nutrition		
Yes	55.33	44.16
No	44.67	55.84
Receive Health Check-up during Pregnancy		
Yes	73.45	75.37
No	26.55	24.63
Working Status		
Yes	12.48	23.28
No	87.52	76.72

socioeconomic groups is depicted in Figure 6. We found that pregnant women from lower socioeconomic groups have a higher rate of severe anemia than women who are not pregnant or are unsure about their pregnancy status. It also shows that the prevalence of anemia in different economic groups is not uniform and pregnant women who belong to a higher income group, as determined by DHS Survey guidelines, have a lower risk of developing severe anemia during their pregnancy than those who belong to a lower income group.

When we examine the stark differences in the prevalence of severe anemia among various economic classes, we find that those in the poorest category are three times more likely to be severely anemic than those in the highest economic group.

Figure 12 *Anemia Level in Pregnant and Nonpregnant Women in India, by Background Characteristics*

	Pregnant Women				**Nonpregnant**		
Background Characteristics	**Severe**	**Moderate**	**Mild**	**Not Anemic**	**Severe**	**Moderate**	**Mild**
No of Children ever born							
0	1.31	20.88	22.76	55.04	1.04	10.74	38.47
1-2 child	1.29	25.79	24.03	48.89	0.88	11.34	39.29
more than 2	2.35	30.33	24.85	42.47	1.08	12.19	39.61
χ2	292.008***				432.9329***		
Age							
15-19 years	1.22	24.62	25.4	48.77	0.98	11.08	40.29
20-34 years	1.41	24.38	23.58	50.63	0.92	11.4	39.4
more than 35 years	2.58	26.97	20.82	49.64	1.1	11.66	38.23
χ2	30.9573***				194.1509***		
Duration of Pregnancy							
1st Trimester	1	16.34	21.52				
2nd Trimester	1.48	26.75	25.56				
3rd Trimester	1.85	29.65	23.25				
χ2	761.9565***						
Body Mass Index							
Underweight	1.55	24.45	25.3	48.7	1.52	14.26	42.38
Normal	1.54	25.26	23.84	49.36	0.93	11.12	39.2
Overweight	0.98	21.31	21.69	56.02	0.56	8.99	35.06
Obese	0.71	20.45	20.21	58.62	0.45	8.96	34.89
χ2	100.255***				5.8e+03***		
Iron Tablet/Syrup Consumption							
No	3.66	28.05	21.95	46.34	1.82	14.17	43.02
100 Days	1.62	27.55	25.65	45.18	0.93	12.46	42.37
100-180 Days	1.7	24.79	22.54	50.97	0.69	11.49	40.53
180+ days	1.03	25.93	23.56	49.49	0.66	10.43	39.68
χ2	28.447***				245.375***		
Food Consumption only on Daily Basis							
Milk/Curd	1.31	22.59	22.57	53.53	0.96	11.3	38.14
Dark Green Leafy Vegetable	1.15	22.48	23.98	52.45	0.88	10.83	38.58
Pulse or Bean	1.18	23.93	24.09	50.8	0.9	11.15	39.78
Chicken/Meat	1.38	22.04	25.07	51.52	0.65	9.02	33.82
Fruits	0.92	20.69	22.85	55.54	0.79	10.25	36.46
Fish	0.82	17.26	20.89	61.04	0.64	8.24	34.96
χ2	for all (***)				for all (***)		

Background Characteristics	Pregnant Women				Nonpregnant		
	Severe	Moderate	Mild	Not Anaemic	Severe	Moderate	Mild
Caste Group							
Schedule Caste	1.65	27.15	24.79	46.41	1.12	12.84	40.95
Schedule Tribes	1.65	25.54	22.6	50.2	1.13	11.92	38.67
OBCs	1.45	24.63	24.04	49.89	0.97	11.26	39.71
Other	0.99	20.8	22.26	55.95	0.77	9.91	37.46
$\chi 2$	132.803***				1.4e+03***		
Income Group							
Poorest	1.87	29.59	25.36	43.18	1.18	13.06	44.04
Poorer	1.74	26.88	23.91	47.47	1.09	11.75	39.8
Middle	1.46	23.04	24.27	51.23	1.04	11.57	37.84
Richer	1.17	24.47	21.88	54.48	0.96	10.96	37.08
Richest	0.61	17.17	21.75	60.48	0.68	9.79	37.07
$\chi 2$	489.267***				3.7e+03***		
Place of Residence							
Urban	1.14	21.59	22.65	54.62	0.89	10.58	37.2
Rural	1.54	25.44	23.97	49.04	1.04	11.79	39.94
$\chi 2$	81.413***				926.704***		
Education							
No Education	2.22	30.74	24.85	42.2	1.26	13.13	41.41
Primary	1.8	26.87	23	48.33	1.09	11.9	39.33
Secondary	1.14	22.5	23.95	52.42	0.91	10.87	38.44
Higher	0.71	17.22	20.67	61.4	0.58	9.05	36.9
$\chi 2$	761.9565***				2.7e+03***		
Partner's Education							
No Education	2.7	32.48	23.28	41.54	1.7	14.21	40.9
Primary	2.28	27.07	25.93	44.73	1.4	13.46	39.12
Secondary	1.37	25.97	23.9	48.76	1.19	12.38	38.34
Higher	0.97	19.47	22.49	57.07	0.76	37.31	37.31
$\chi 2$	71.9341***				285.6008***		
Religion							
Hindu	1.48	25.33	24.33	48.86	1.01	11.81	40.41
Muslim	1.66	25.74	23.1	49.49	1.03	11.3	37.96
Christian	0.8	15.5	19.91	63.78	0.62	8.03	29.2
Sikh	0.17(n=1)	20.27	21.28	58.28	0.56	10.23	41.05
$\chi 2$	280.609***				4.9e+03***		

Women who are not pregnant and belong to the poorest socioeconomic group are twice as likely to be silver anemic as those who belong to the highest socioeconomic group. As a result of this figure, we can deduce that those in better economic circumstances have a lower risk of becoming anemic during pregnancy or at reproductive age than those in other income groups.

Let's examine the prevalence of severe anemia in pregnant and nonpregnant women from a feminist standpoint. We can categorically state that pregnancy is a cause and reason for higher anemia prevalence. So, we must investigate whether the pregnancy is a biological, sociological, cultural, or even social-political aspect of a woman's reproductive age. While we may say that reproduction is an important societal responsibility of a woman, they must reproduce or go through the cycle of reproduction during their lifetime to fulfil their societal role. However, it becomes clear and pertinent when we consider that societal norms play a dominant role in how women go through the reproductive process. So, while being pregnant may be a biological cause, the number of times a woman becomes pregnant is determined by social and cultural norms. We have ample evidence to show that if a woman does not have any living male children during her reproductive age, she is obligated to produce more babies due to son preference.

The prevalence of anemia in different economic groups is not uniform. Pregnant women from lower socioeconomic groups have a higher rate of severe anemia. Women who are not pregnant and belong to the lower economic group are twice as likely to be anemic as those of the highest economic group.

***Figure 13** Prevalence of Anemia among Income group in Pregnant and Nonpregnant Women*

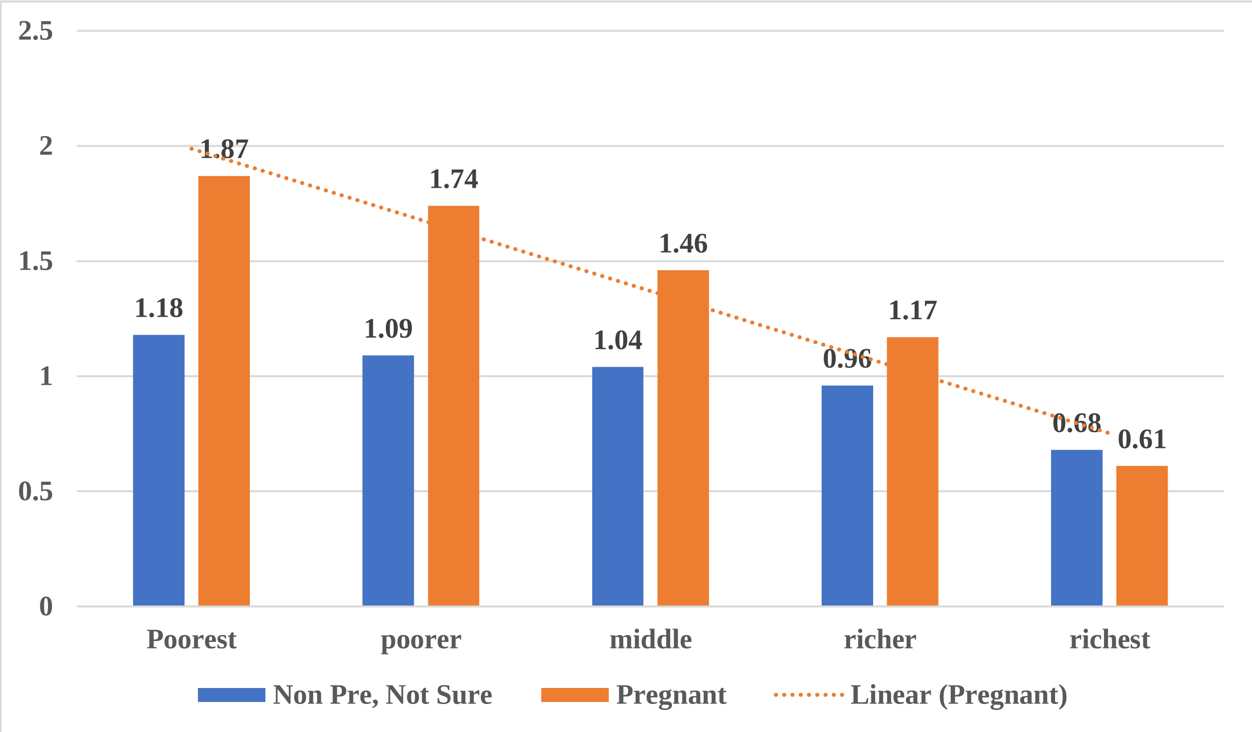


Figure 14 The prevalence of severe anemia in pregnant and nonpregnant women from various social groups during round 4 of the National Family Health Survey

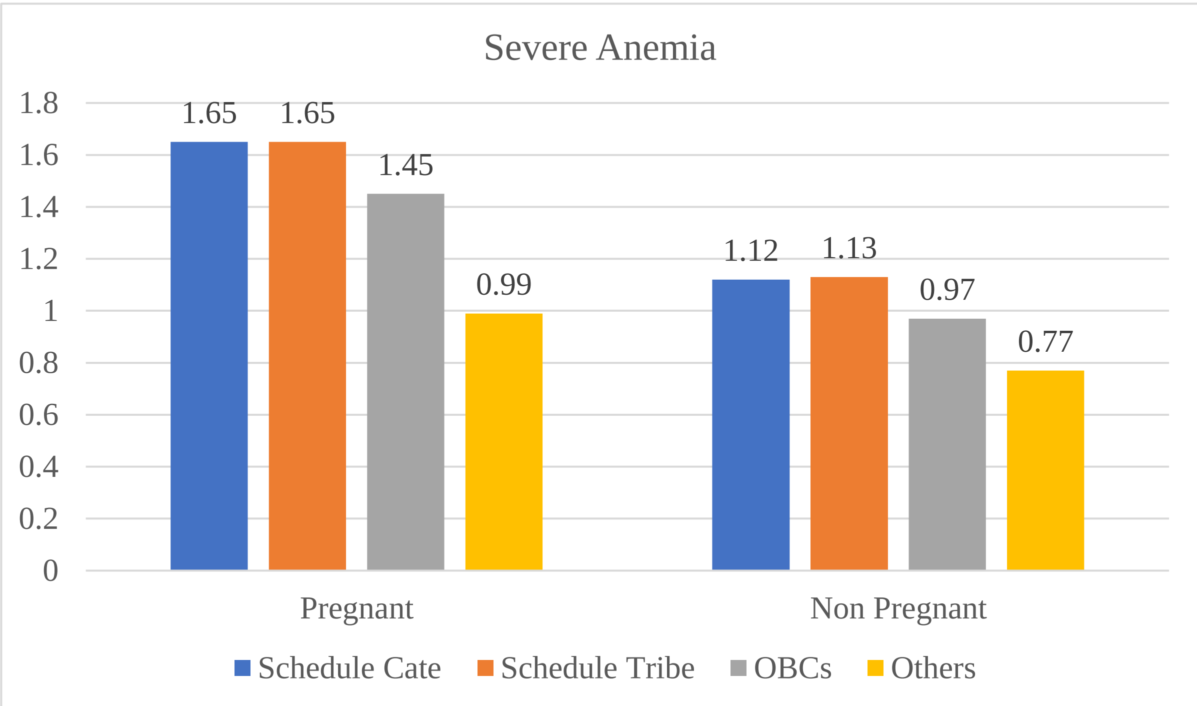
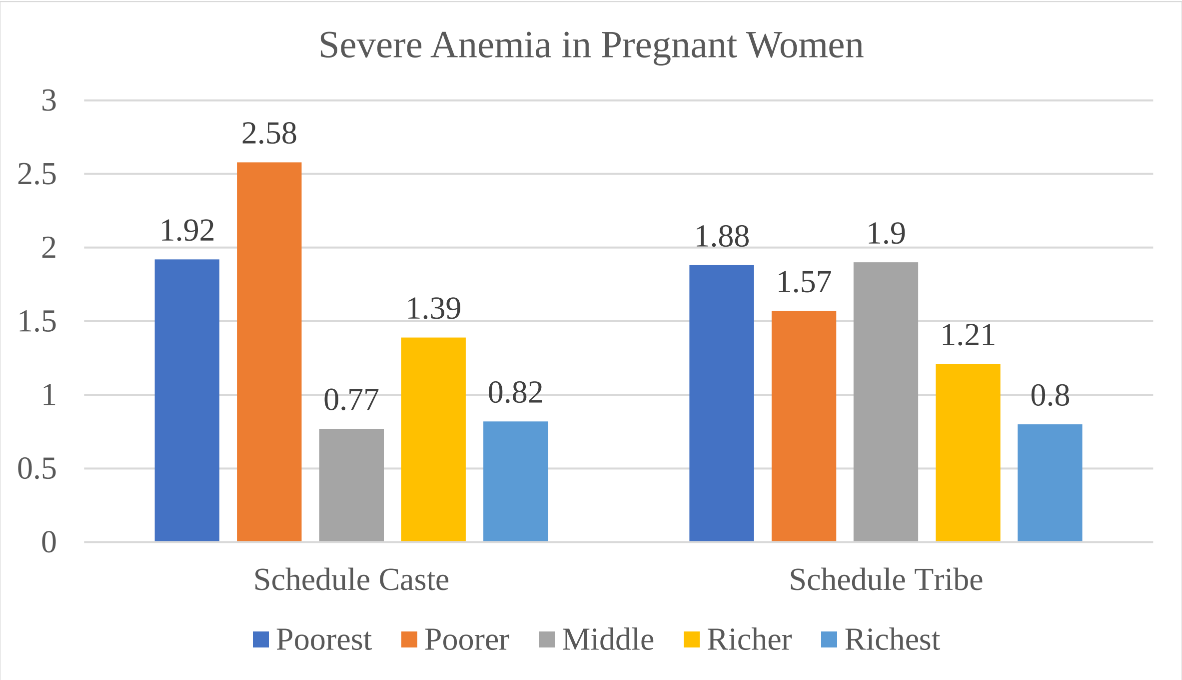


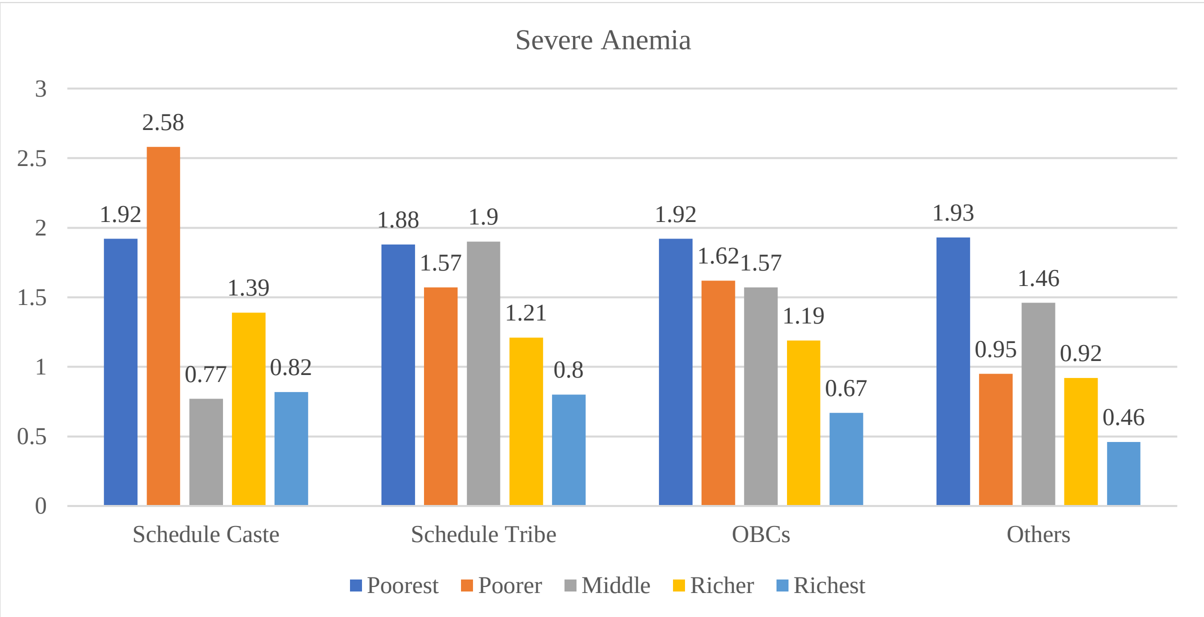
Table 8 shows the prevalence of severe anemia in pregnant and nonpregnant women from various social groups during round 4 of the National Family Health Survey. Though the prevalence of severe anemia in pregnant women is the same in both schedule cast and schedule tribe, there is a slight difference between pregnant women from schedule dry or schedule caste and those from upper caste. Only 1% of upper-caste women are severely anemic, whereas severe anemia affects 1.45 and 1.65 percent of pregnant women from other backward classes in Schedule Caste and Schedule Tribes. In the nonpregnant women category, the prevalence of severe anemia is significantly higher in women from lower socioeconomic groups than in women from higher socioeconomic groups. As a result, the data in the figure corroborate other studies and surveys that have found a high rate of severe anemia in women from lower socioeconomic strata during pregnancy or throughout their lives. As a result of analyzing the data in the figure, we can deduce that a woman's social position significantly impacts the prevalence of anemia.

Figure 15 *Caste and Income Based Distribution of Severe Anemia in SC and ST, NFHS-4*



On the other hand, as shown in Figure 7, nearly 1.65 percent of half-women from schedule cast and schedule tribes are severely anemic. They have a higher risk of being anemic than those who belong to any other social category, particularly women from higher castes. Nonetheless, we should avoid treating women as a homogeneous group because treating them as a homogeneous population or homogeneous group will be incorrect. We may end up ignoring the heterogeneity that exists among them due to this. Looking at the data in Figure 8, we can see that severe anemia is more common among pregnant women from scheduled castes and tribes than among women from other socioeconomic groups. As depicted in this figure, the intersection of caste and income demonstrates how the intersection of caste and income has disadvantaged some people and why there is a difference in the prevalence of severe anemia among women from scheduled tribes and women from scheduled castes. According to the findings, women from the scheduled group members of the higher income group have more than twice the risk of being severely anemic as women from the poorest category in the same social group. It is also important to note that there is a significant difference in the prevalence of anemia among women who belong to the poorer socioeconomic group and those who belong to the poorest socioeconomic group. According to the data, the prevalence rate of severe anemia in the poorest category is 1.92 percent, whereas it is 2.58 percent in those who are not from the poorest category. Those belonging to scheduled tribes have a significantly higher prevalence of severe anemia than those belonging to scheduled castes, despite having a significantly lower income. According to the World Health Organization, women from higher income groups, particularly those from the richest category, have a lower risk of being severely anaemic than women from any other economic category within the same social group. Only 0.8 per cent of women in the richest category or those suffering from severe anemia are affected by silver anemia. However, the prevalence rates of severe anemia in women in the poorest and poorest categories are 1.52 percent and 1.88 percent, respectively. When we used the chi-square test to determine whether or not these differences were statistically significant, we discovered that the value was statistically significant. As we have already discussed and discovered, one's health and well-being play an essential role in shaping one's future, and belonging to a higher income group gives one an advantage over those who belong to a lower income group. However, in the case of the poorer and poorest categories, the differences raise questions such as why those from the poorest category have a lower risk of being severely anemic than those from the poorer category and vice versa. At this point, we have discovered that it is difficult to determine the reasons for such differences, and we do not have any long-term evidence to support this claim. As a result, we are deferring further investigation. In the future, we will need to investigate the reasons for these differences, which will not be possible in this study due to the limitations of the data and which may be very different and complex at this level.

Figure 16 *Intersection of Caste and Income and Distribution of Severe Anemia, NFHS-4*



We have discussed caste and class differences in the prevalence of silver anemia in pregnant and nonpregnant women of reproductive age in tables six, seven, and eight. In table nine, the author observed a significant difference between these socioeconomic groups. It is evident that one's social and income category can put them in an advantageous or disadvantageous position. So, while one's social identity may put them in a favourable position, one's positioning in other areas may put them in a disadvantageous position as well. Women from the upper caste are less likely to suffer from severe anemia than those from the lower castes, as their social position in a society largely divided along the scale of caste hierarchy has put them in a better position. However, when we look at the prevalence rate of severe anemia in the same category, women from any of the four categories of the wealthiest income group have a lower chance of being severely anemic than women from the upper caste. Women in the poorest and poorest socioeconomic groups have a higher risk of developing anemia during pregnancy or at reproductive age than women in other socioeconomic groups. However, when we look at the prevalence rate of severe anemia in women from higher castes who belong to higher income groups, we find that the rate is only 0.46 per cent, which is roughly more than 4 times lower than any socioeconomic group belonging to the poorest category. We also discovered that women from the highest income group among other backward castes have roughly two times the risk of being severely anemic than women from any other caste group, even the lowest income group.

While women from the upper caste are less likely to suffer from severe anemia than those from the lower castes, their social position in a society largely divided along the scale of caste hierarchy has put them in a better position. Nevertheless, when we look at the prevalence rate of severe anemia in the same category, women from any of the four categories from the wealthiest income group have a lower chance of being severely anemic than woman from the upper caste. Women in the poorest and poorest socioeconomic groups have a higher risk of developing anemia during pregnancy or reproductive age than women in other socioeconomic groups. However, when we look at the prevalence rate of severe anemia in women from higher castes who belong to higher income groups, we find that the rate is only 0.46 percent, which is roughly more than four times lower than any socioeconomic group belonging to the poorest category. We also discovered that women from the highest income group among other backward castes have roughly two times the risk of being severely anemic than women from any other caste group from the lowest income group.

Figures six, seven, and eight show severe anemia prevalence in pregnant and nonpregnant women of reproductive age. Women from the upper caste are less likely to suffer from severe anemia than those from the lower caste. Figure nine shows that women from wealthier income groups have a lower chance of being severely anemic. Women in the poorest and poorest socioeconomic groups have a higher risk of developing anemia during pregnancy or in reproductive age.

Figure 17 *Distribution of Severe Anemia based on Education level of Pregnant Woman and her Partner*

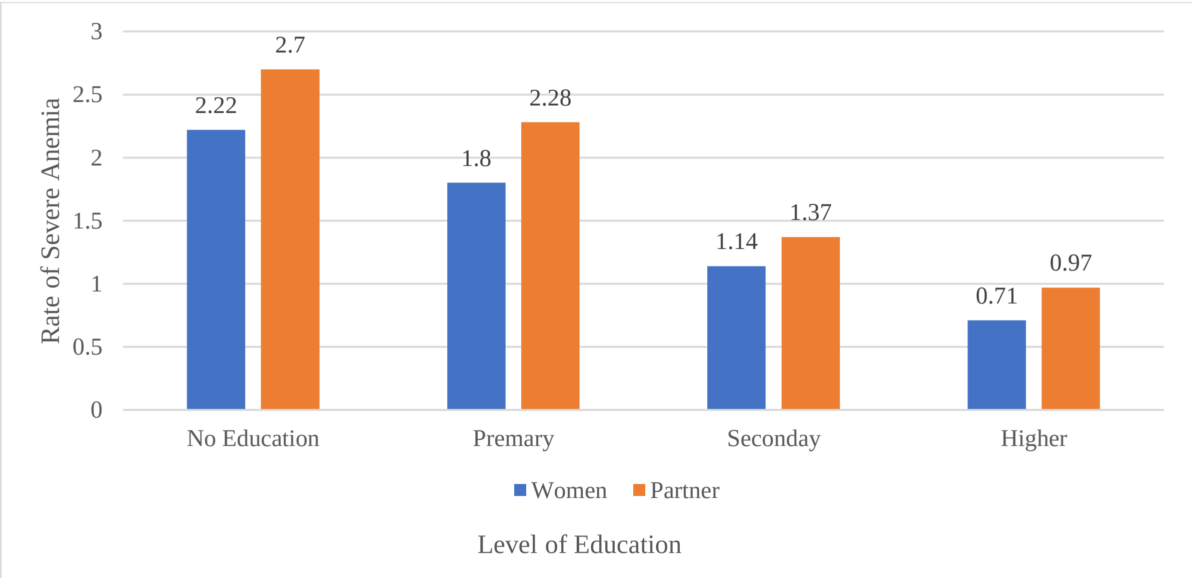


Figure 18 *Distribution of Moderate Anemia in Pregnant and Non-Pregnant Women, NFHS-4*

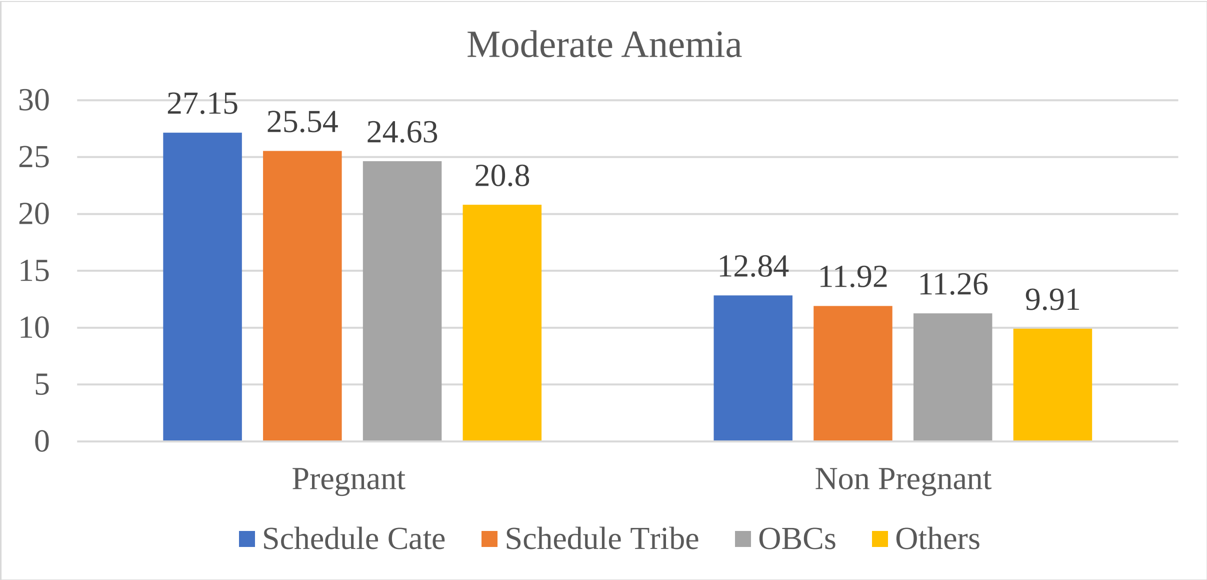


Figure 19 *Logistic Regression Estimates: Factors Associated with Anemia Among Pregnant, Lactating, and Nonpregnant-Nonlactating Women in India, 2015-2016.*

	Pregnant Women			Nonpregnant		
	95% confidence interval			95% confidence interval		
Background Characteristic	Odds Ratio	Lower Limit	Upper Limit	Odds Ratio	Lower Limit	Upper Limit
Duration of Pregnancy						
1st Trimester@						
2nd Trimester	1.83***	1.734	1.932			
3rd Trimester	1.903***	1.796	2.016			
Age						
15-19@						
20-34	0.928***	0.865	0.995	.974***	0.961	0.987
35+	.965#	0.856	1.089	.946***	0.933	0.96
Income						
Poorest@						
Poorer	0.8417***	0.788	0.898	.795***	0.783	0.807
Middle	0.7237***	0.676	0.773	.728***	0.717	0.74
Richer	0.6357***	0.598	0.681	.687***	0.679	0.698
Richest	0.4967***	0.461	0.534	.648***	0.638	0.658
Education						
No Education@						
Primary	.780***	0.724	0.841	.879***	0.865	0.894
Secondary	.662***	0.627	0.699	.808***	0.799	0.817
Higher	.458***	0.424	0.496	.697***	0.685	0.709
Partner' Education						
No Education@						
Primary	.878#	0.716	1.07	.891***	0.851	0.933
Secondary	.746***	0.638	0.873	.820***	0.791	0.85
Higher	.534***	0.439	0.65	.711***	0.677	0.747
Working Status						
Not Working@						
Working	1.046#	0.893	1.226	1.025#	0.997	1.053

Figure 20 *Logistic Regression Estimates: Factors Associated with Anemia Among Pregnant, Lactating, and Nonpregnant-Nonlactating Women in India, 2015-2016.*

	Pregnant Women			Nonpregnant		
	95% confidence interval			95% confidence interval		
Background Characteristic	Odds Ratio	Lower Limit	Upper Limit	Odds Ratio	Lower Limit	Upper Limit
Scheduled Caste@						
Scheduled Tribes	.859***	0.8	0.922	.879***	0.865	0.894
OBCs	.870***	0.818	0.924	.887***	0.875	0.9
Others	.682***	0.634	0.733	.762***	0.75	0.774
Religion						
Hindu@						
Muslim	.975#	0.917	1.036	.888***	0.876	0.901
Christian	.542***	0.498	0.591	.535***	0.524	0.545
Sikh	.684***	0.579	0.807	.945***	0.915	0.977
Place of Residence						
Urban@						
Rural	1.25***	1.187	1.316	1.178***	1.165	1.19
Food Consumption						
Fruits Never@						
Daily	.621***	0.531	0.726	.721***	0.697	0.747
Chicken Never@						
Daily	0.955#	0.774	1.178	.705***	0.647	0.738
Fish Never@						
Daily	.637***	0.561	0.723	.711***	0.693	0.729
Milk/Curd Never@						
Daily	.711***	0.653	0.775	.910***	0.894	0.927
dark green leafy Never@						
Daily	.543***	0.359	0.823	.912***	0.837	0.993
Pulse/Beans Never@						
Daily	1.192#	0.889	1.599	.967#	0.905	1.033
Note-	****** p<0.05***			**#- p> 0.05**		

4.2 Adjusted Odds Ratio of Anemia Prevalence and Its Determinants

Figure 20 presents the results of logistic regression analysis of anemia prevalence among pregnant, and non pregnant women while controlling for background characteristics. The adjusted odds of anemia prevalence was found to be higher among 3rd trimester pregnant women (odds ratio [OR] = 1.9, $p < .01$) than in 1st trimester pregnant women (OR = 1). The odds of women having anemia were not higher among pregnant women who were employed (OR = 1.04, $p < .01$) compared with their unemployed counterparts (OR = 1). However, with reference to the women whose husbands were not educated, pregnant and lactating women with edu-cated partners were less likely to be anemic. The possibility f having anemia was less among pregnant women in the richest households (OR = 0.65, $p < .05$), richer households (OR = 0.70, $p < .05$), and poorer households (OR = 0.75, $p < .05$) compared with poorest households (OR = 1). Likewise, the results also show that pregnant (OR = .46, $p < .01$) and non pregnant (OR = .648, $p < .01$) women who are from higher income group a compared with those women are from poorest category(OR = 1). Similarly, the results also showed that pregnant women who had take fruits as nutrition from on daily bases were less likely to be anemic (OR = .91, $p < .01$) compared with those women who had never taken fruits as nutrition products during pregnancy (OR = 1).

Chapter 5. Conclusion and Recmondation

Nutritional anemia is a serious public health issue that affects the health and well-being of millions of people throughout the globe. Much progress has been made in our knowledge of the origins and effects of this disease, but prevention and control still need to be improved. Advances in nutritional anemia evaluation, particularly the use of simple methods such as the Hemocue for haemoglobin estimate and blood spot techniques for iron and folate status indicators, have greatly improved our capacity to record the degree and depth of this problem (Green and Lynch 2000.) Nutritional anemia affects a wide range of people and has varying degrees and magnitudes of functional repercussions across the life span. Severe anemia is a serious danger to women's and children's health and well-being, even though the precise nature of these negative repercussions remains a subject of scientific discussion, particularly for mild and moderate types of anemia (Ramakrishnan 2000).

We found that pregnant women from lower socioeconomic groups have a higher rate of severe anemia than women who are not pregnant or unsure about their pregnancy status. It also shows that the prevalence of anemia in different economic groups is not uniform. While being pregnant may be a biological cause, the number of times a woman becomes pregnant is determined by social and cultural norms. Pregnant women from lower socioeconomic groups have a higher rate of severe anemia. Only 1% of upper-caste women are severely anemic; severe anemia affects 1.45 and 1.65 percent of pregnant women from other backward classes in Schedule Caste and Schedule Tribes.

The intersection of caste and income has shown how one may be advantageous in one axis but may be disadvantaged on other axis. According to the World Health Organization, women from higher income groups have a lower risk of being severely anaemic than women from any other economic category within the same social group. According to the data, the prevalence rate of severe anemia in the poorest category is 1.92 percent, whereas it is 2.58

percent in those who belong to the poorest socioeconomic group. Women from the upper castes are less likely to suffer from anemia than those from the lower castes, as their social position in a society largely divided along the scale of caste hierarchy has put them in a better position. Women in the poorest and poorest socioeconomic groups have a higher risk of developing anemia during pregnancy or at reproductive age.

When we look at the prevalence rate of anemia in women from higher castes who belong to higher income groups, we find that the rate is only 0.46 per cent. Women in the poorest and poorest socioeconomic groups have a higher risk of developing anemia during pregnancy or at reproductive age than women in other socioeconomic groups. However, when we look at the prevalence rate of severe anemia in women from higher castes who belong to higher income groups, we find that the rate is only 0.46 per cent, which is roughly more than 4 times lower than any socioeconomic group belonging to the poorest category. Figures six, seven, and eight show severe anemia prevalence in pregnant and non-pregnant women of reproductive age. Women in the poorest and poorest socioeconomic groups have a higher risk of developing anemia during pregnancy or reproductive age than women in other socioeconomic groups. Women from the upper caste are less likely to suffer from severe anemic than those from the lower caste.

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