Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

Impact of Education and Nutritional Intervention on Haemoglobin Levels Among Anaemic Pregnant Women: A Comparative Study

Laxmipriya Mishra[1,2], Utkalika Mallick[3], Tapan Kumar Pattnaik[4], Pravati Tripathy[1,*]

1SUM Nursing College, Siksha 'O' Anusandhan Deemed to be University, Kalinganagar, Bhubaneswar-751003, Odisha, India.
2Govt. ANM Training Center, Near Capital Hospital, Unit-6, Bhubaneswar-751001, Odisha, India.
3Centre for Biotechnology, Siksha 'O' Anusandhan Deemed to be University, Kalinganagar, Bhubaneswar-751003, Odisha, India.
4Department of Obstetrics and Gynaecology, IMS and SUM Hospital, Siksha 'O' Anusandhan Deemed to be University, Kalinganagar, Bhubaneswar-751003, Odisha, India.

(Received: 27 September 2025 Revised: 05 October 2025 Accepted: 10 November 2025)

KEYWORDS

Anemia, pregnancy, haemoglobin, iron supplementation, nutritional.

ABSTRACT:

Background: Anemia during pregnancy remains a major public health challenge, particularly in developing countries like India, where nutritional deficiencies, poor dietary habits, and limited access to antenatal care contribute to high prevalence rates. Anemia is associated with increased maternal and perinatal morbidity and mortality, yet remains preventable with timely and effective interventions.

Objective: To assess the impact of a structured nutritional intervention on haemoglobin levels among anemic pregnant women and to examine the socio-demographic and clinical factors influencing anemia status and intervention outcomes.

Methods: A total of 3500 pregnant women were enrolled in this observational study. Of these, 1000 were identified as anemic (haemoglobin <11g/dL) and were equally divided into a control group (n=500) and an intervention group (n=500). The intervention group received iron supplementation along with dietary and lifestyle guidance. Haemoglobin levels were recorded during the first trimester, at mid-pregnancy, and at the time of delivery. Demographic variables, BMI, dietary patterns, obstetric history, and previous anemia history were collected and analyzed.

Results: At baseline, both groups had comparable mean haemoglobin levels (control: 7.47 ± 0.87 g/dL; intervention: 7.48 ± 0.89 g/dL; p=0.8458). By mid-pregnancy, the intervention group showed a significant improvement (8.48 ± 1.0 g/dL) compared to the control group (7.70 ± 0.23 g/dL; p=0.0001). At delivery, haemoglobin further increased in the intervention group (9.48 ± 2.0 g/dL) versus the control (7.97 ± 0.50 g/dL; p=0.0001). Improvement in haemoglobin levels was also associated with higher compliance to the intervention and iron intake. Demographic analysis showed that anemia was more prevalent among women with lower education, non-vegetarian diets, and a history of previous pregnancy complications.

Conclusion: The study demonstrates that structured nutritional and iron-based interventions significantly improve haemoglobin levels among anemic pregnant women. Early detection and targeted management, along with consideration of socio-demographic factors, can help reduce the burden of anemia and its associated risks in pregnancy. These findings support the integration of such interventions into routine antenatal care programs.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

1. Introduction

Pregnancy is a critical period in a woman's life, characterized by profound physiological, hormonal, and nutritional changes. These changes increase the demand for various micronutrients, particularly iron, which plays an essential role in the synthesis of haemoglobin. Haemoglobin is vital for oxygen transport, and its deficiency leads to anemia, a condition that poses significant risks to both maternal and fetal health [1]. Anemia during pregnancy is a major public health concern globally and is especially prevalent in low- and middle-income countries, where nutritional deficiencies, poor dietary practices, limited access to healthcare, and repeated pregnancies without adequate spacing are common [2].

According to the World Health Organisation (WHO), anemia affects approximately 40% of pregnant women worldwide. Iron deficiency anemia (IDA) is the most table type and accounts for more than half of all anemia cases in pregnancy [3, 4]. In India, the prevalence of anemia among pregnant women ranges between 50% and 70% [5], indicating a severe public health problem. The high prevalence of anemia in pregnancy is associated with numerous adverse outcomes such as preterm labour, low birth weight, intrauterine growth restriction, perinatal mortality, increased risk of postpartum haemorrhage, and maternal mortality [6]. Despite various national programs like Anaemia Mukt Bharat and the Iron and Folic Acid (IFA) supplementation scheme, the problem persists due to issues related to adherence, inadequate follow-up, and socio-economic disparities (Ministry of Health and Family Welfare) [7] [8].

Pregnant women require higher amounts of iron to support increased maternal red cell mass, placental development, and fetal growth. When this demand is unmet through dietary intake or supplementation, it results in iron deficiency and subsequent anemia [9]. The condition may progress silently, especially in women with pre-existing low iron stores, and often goes undetected until symptoms become pronounced [10]. Symptoms of anemia in pregnancy include fatigue, weakness, dizziness, pallor, and shortness of breath, all of which can impair the quality of life and hinder daily functioning [11]. Moreover, in the context of pregnancy, these symptoms may overlap with normal pregnancy-related discomforts, making diagnosis more challenging without routine haemoglobin monitoring [12].

Anemia can occur at any stage of pregnancy, but it is most commonly diagnosed during the second and third trimesters [13]. Physiological haemodilution during pregnancy often exaggerates the drop in haemoglobin levels, even in women with adequate iron stores, but in cases where iron intake is insufficient, this dilution unmasks or aggravates true anemia [14]. Early detection and timely intervention are crucial to prevent progression to moderate or severe anemia, which significantly increases maternal and neonatal morbidity and mortality [15].

Various strategies have been employed globally and nationally to combat anemia in pregnancy. These include nutritional education, iron-rich dietary plans, prophylactic iron supplementation, and therapeutic iron therapy in moderate to severe cases. In settings where dietary habits are influenced by cultural and religious beliefs, addressing anemia requires a more tailored and culturally sensitive approach [16]. For example, vegetarian diets, common among many Indian communities, may lack adequate bioavailable iron, which necessitates a greater reliance on supplementation or fortified foods [17].

This study was designed to assess the impact of a structured intervention on haemoglobin levels among pregnant women diagnosed with anemia. A total of 3500 pregnant women were included in the study, out of which 1000 were found to be anaemic. These anaemic women were divided equally into a control group and an intervention group, with 500 participants in each. The intervention involved iron supplementation and possibly additional nutritional or lifestyle modifications, depending on the study protocol. Haemoglobin levels were monitored across three critical points during pregnancy first trimester, mid-pregnancy, and at delivery to evaluate the effectiveness of the intervention. A comprehensive demographic assessment was also carried out to explore the influence of socio-

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

demographic variables on anemia prevalence and response to treatment. These variables included age, educational status, occupation, type of family, dietary habits, and body mass index (BMI). The majority of the participants belonged to the 18 to 22-year age group, followed by

Table 1. Demographic data according to age group of all participants

Age	Total participant	Education				Occupation				Type of Family			Dietary Habits		
		No	Primary	secondary	Higher	Housewife	Daily wage workers	Private sector	Government sector	Extended	Nuclear	Joint	Mixed	vegetarian	Non-vegetarian
18 to 22	791	215	191	194	191	209	198	207	177	243	266	282	259	281	251
23 to 27	741	172	186	184	199	187	188	199	167	240	248	253	244	276	221
28 to 32	726	187	195	161	183	187	170	181	188	250	242	234	263	233	230
33 to 37	772	204	161	189	218	186	207	192	187	239	263	270	259	243	270
38 to 40	470	121	115	114	120	106	109	127	128	167	139	164	167	162	141
Total	3500	3500				3500				3500			3500		

Educational background varied from no formal education to higher education, and occupation ranged from housewives to government sector employees. Most participants came from nuclear families, with a significant portion following non-vegetarian diets. The BMI analysis revealed a worrying trend of overweight and obesity among a large segment of the participants, which can be an additional complicating factor in managing anemia during pregnancy (Table 2). A significant portion of the anaemic women had a previous history of anemia and pregnancy complications (Table 3 and Table 4).

Table 2. Demographic data according to BMI category of all participants

BMI	Total participant	Education				Occupation				Type of Family			Dietary Habits		
		No	Primary	secondary	Higher	House wife	Daily wage workers	Private sector	Government sector	Extended	Nuclear	Joint	Mixed	vegetarian	Non-vegetarian
Underweight (<18.5)	263	69	73	57	64	66	77	56	64	81	95	87	89	82	92
Normal weight (18.5 – 24.9)	1073	293	256	268	256	271	276	254	272	357	368	348	378	365	330

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

Overweight (25.0 – 29.9)	924	238	217	214	255	232	215	260	217	299	299	326	302	335	287
Obesity Class I (30.0 – 34.9)	707	173	164	170	200	171	166	196	174	235	220	252	251	230	226
Obesity Class II (35.0 – 39.9)	383	89	95	94	105	91	103	110	79	115	131	115	122	120	141
Obesity Class III (>40) (Severe)	127	29	40	33	25	39	28	24	36	47	37	43	43	53	31
Total	3500	3500				3500				3500			3500		

Table 3. Medical history of all participants according to the haemoglobin concentration

Haemoglobin concentration	**Total Participants**	**Gravida Status**		**History of Anaemia**		**Previous complication**		**Use of Iron Supplements Before Pregnancy**	
		Prim	Multigra	yes	No	yes	No	yes	No
No anemia: >11	2500	1240	1260	0	2500	0	2500	1261	1239
Mild anemia: Hb = 10.0 – 10.9 g/dL	20	13	7	10	10	11	9	9	11
Moderate anemia: Hb = 7.0 – 9.9 g/dL	658	320	338	344	314	321	337	333	325
Severe anemia: Hb = < 7.0 g/dL	322	156	166	163	159	157	165	166	156
Total	3500	3500		3500		3500		3500	

Table 4. Demographic data according to past history of anaemia

History of Anaemia	**Total Participants**	**Education**				**Occupation**				**Type of Family**			**Dietary Habits**		
		No	Primary	secondary	Higher	House wife	Daily wage worker	Private sector	Government sector	Extended	Nuclear	Joint	Mixed	vegetarian	Non-vegetarian
Anaemic ≤10.0	1000	248	267	299	256	247	249	267	237	309	323	368	334	346	320
Non- Anaemic>10.0	2500	651	581	613	655	628	623	639	610	830	835	835	858	849	793
Total	3500	3500				3500				3500			3500		

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

This underlines the chronic and recurrent nature of the problem, which may be rooted in longstanding nutritional deficiencies or repeated pregnancies without adequate correction of underlying anemia. A history of complications such as miscarriage, low birth weight, or preterm labour can be both a consequence and a predictor of anemia, making its prevention a top priority in maternal healthcare [17].

The initial haemoglobin levels in both the control and intervention groups were similar, indicating the comparability of the groups at baseline. Over the course of pregnancy, the intervention group showed a statistically significant improvement in haemoglobin levels, both at mid-pregnancy and at delivery. These findings highlight the effectiveness of timely and consistent intervention in improving maternal haemoglobin status and potentially reducing anemia-related complications (Table 5).

Table 5. Increase of haemoglobin due to intervention

Number of intervention	Total Participants	Status of haemoglobin (Mean)		Perceived Benefit of Intervention		Mode of Delivery		
		Increase in mid term	Increase in delivery	Yes	No	Assisted vaginal	Cesarean	Normal vaginal
0.	3000	0.31	0.23	ND	ND	1014	998	988
1.	110	0.98	1.04	72	38	35	41	34
2.	120	1	1	70	50	43	37	40
3.	130	1.02	0.97	86	44	33	44	53
4.	140	0.98	0.98	46	94	47	52	41

Participants also reported subjective improvements in their health and energy levels, and various modes of delivery were recorded, including normal vaginal, cesarean, and assisted deliveries. By analysing the impact of intervention on haemoglobin status and linking it to demographic, nutritional, and obstetric factors, this study provides valuable insights into the complex interplay between social determinants of health and medical outcomes. The findings underscore the need for early screening, individualized care plans, and targeted public health strategies that address not only the biological aspects of anemia but also its social and behavioural roots. In conclusion, anemia in pregnancy remains a pressing concern with significant implications for maternal and fetal health. This study seeks to contribute to the growing body of evidence supporting the implementation of structured, sustained interventions to combat anemia. By examining both clinical outcomes and the contextual factors influencing them, the research aims to inform policy and guide healthcare providers in delivering more effective and equitable maternal care.

2. Objectives

With the ultimate goal of producing evidence to support antenatal care strategies for lowering maternal anemia and improving pregnancy outcomes, the study aims to assess the impact of structured nutritional and educational interventions on hemoglobin levels among anemic pregnant women. It also looks at the impact of dietary, clinical, and sociodemographic factors on anemia status and treatment outcomes.

3. Methods

This longitudinal interventional study was conducted to assess the effect of nutritional and educational interventions on haemoglobin concentration among pregnant women diagnosed with anaemia. The study was carried out over 12 months across selected maternal health centres and antenatal clinics.

Study Population and Design

A total of 3,500 pregnant women were enrolled through consecutive sampling during their first antenatal visit. Screening was conducted to identify anaemic women based on WHO criteria [18], defining anaemia in pregnancy as haemoglobin concentration less than 11 g/dL. Of the total cohort, 1,000 women were diagnosed with anaemia, and these women formed the focus population for the intervention study.

The 1,000 anaemic women were randomly allocated into two equal groups:

Control group (n = 500): Received standard antenatal care, including routine IFA supplementation as per national guidelines.

Intervention group (n = 500): Received structured nutritional and educational interventions in addition to the standard care.

This group assignment allowed for a comparative analysis of the impact of targeted interventions on haemoglobin levels over the course of pregnancy.

Intervention Protocol

The intervention group was provided with the following:

Nutritional Support: A personalized iron-rich diet plan was developed for each participant based on their BMI and dietary preferences. Weekly rations of IFA tablets were provided, with compliance monitored through pill counts and follow-up logs.

Educational Sessions: Biweekly group education sessions were conducted by investigator. Topics included the importance of iron and micronutrients in pregnancy, iron absorption enhancers and inhibitors, personal hygiene, and dietary diversity. Visual aids, food models, and interactive discussions were used to enhance understanding.

The control group continued with routine antenatal check-ups and received standard iron supplementation as prescribed in government healthcare protocols, without the added nutritional or educational sessions.

Data Collection

Baseline demographic and clinical data were collected from all 1,000 participants, including age, education, income, dietary habits, BMI, and obstetric history. Haemoglobin concentration was measured using an automated hematology analyzer at three time points:

Baseline: During the first trimester (≤12 weeks of gestation)

Mid-pregnancy: Between 24–28 weeks

Late pregnancy: Between 36–38 weeks

The primary outcome measured was the change in haemoglobin concentration from baseline to late pregnancy. Secondary outcomes included improvement in anaemia status, maternal compliance with supplementation, and changes in dietary behaviour and delivery outcomes.

Statistical Analysis

Data were analyzed using SPSS software. Descriptive statistics were used to summarize demographic and baseline variables. Haemoglobin levels at different time points were compared using paired t-tests and repeated measures ANOVA within and between the groups. Categorical variables, such as anaemia status and adherence levels, were analyzed using chi-square tests. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board prior to the commencement of the study. Written informed consent was obtained from all participants. Confidentiality of participant information was maintained throughout the research process.

4. Results

A total of 3500 pregnant women were enrolled in the study. Among them, 1000 participants were diagnosed with anemia, defined as having haemoglobin levels less than 11g/dL, while the remaining 2500 had normal haemoglobin levels above 11 g/dL. The 1000 anaemic women were randomly divided into two groups, with 500 participants in the control group and 500 in the intervention group.

The demographic distribution according to age is shown in Table 1. The largest proportion of participants fell within the age group of 18 to 22 years (n=791), followed by 33 to 37 years (n=772), 23 to 27 years (n=741), and 28 to 32 years (n=726). The smallest age group was 38 to 40 years (n=470). Educational attainment varied across age groups, with some participants having no formal education, and others possessing primary, secondary, or higher education. Occupation categories included housewives, daily wage workers, private sector employees, and government employees. Family types ranged from nuclear and joint to extended and mixed families. Dietary habits also varied, with both vegetarian

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

and non-vegetarian participants represented across age groups.

Body mass index (BMI) data are presented in Table 2. A majority of participants were in the normal BMI category (n=1073), while 924 were overweight, 707 belonged to Obesity Class I, 383 to Obesity Class II, and 127 to Obesity Class III. A smaller group of participants (n=263) were underweight. These distributions indicate a high prevalence of overweight and obesity among the pregnant women studied.

Haemoglobin levels were used to classify the severity of anemia (Table 3). Among the 3500 participants, 2500 women had no anaemia (haemoglobin >11 g/dL), 20 women had mild anaemia (10.0–10.9 g/dL), 658 had moderate anaemia (7.0–9.9 g/dL), and 322 women had severe anaemia (haemoglobin <7.0 g/dL). The majority of moderate and severe anemia cases were observed among women with lower educational backgrounds and a higher proportion of non-vegetarian diets.

Medical and obstetric history data are shown in Table 4. Among the 322 women with severe anemia, 163 had a history of anemia and 157 had experienced complications in previous pregnancies. Furthermore, 1261 non-anaemic women reported using iron supplements before pregnancy, compared to a lower proportion among anaemic participants. Table 5 shows that among the 1000 women with a past history of anemia, educational levels varied, with a large number having secondary education, and occupations ranged across all listed categories. Family structures and dietary habits among this group mirrored the general population.

The effect of intervention on haemoglobin levels is presented in the final comparative table and in (Table 6).

In the first trimester, mean haemoglobin levels were similar in both the control group (7.47 ± 0.87 g/dL) and the intervention group (7.48 ± 0.89 g/dL), with no statistically significant difference (p = 0.8458). However, at the mid-pregnancy checkup, the intervention group showed a significant increase in mean haemoglobin to 8.48 ± 1.0 g/dL compared to 7.70 ± 0.23 g/dL in the control group (p = 0.0001). This trend continued until delivery, where the mean haemoglobin in the intervention group reached 9.48 ± 2.0 g/dL, while the control group had a mean of 7.97 ± 0.50 g/dL (p = 0.0001), indicating the effectiveness of the intervention in improving haemoglobin levels.

Table 5 also includes data on perceived benefits and delivery methods in the intervention group. Participants receiving between 110 and 140 doses of the intervention showed varying degrees of hemoglobin improvement and reported subjective benefits. For instance, those who received 130 doses had a mean hemoglobin increase of 1.02 g/dL at mid-pregnancy and 0.97 g/dL at delivery. Perceived benefit was reported by 86 participants, and delivery methods in this subgroup included assisted vaginal (33), cesarean (44), and normal vaginal (53) deliveries.

Complications during previous pregnancies were reported by 489 participants, as outlined in (Table 7).

Table 6. Demographic data according to haemoglobin concentration of all participants

Haemoglobin concentration	**Total participant**	**Education**				**Occupation**				**Type of Family**			**Dietary Habits**		
		No	Primary	secondary	Higher	House wife	Daily wage	Private sector	Government sector	Extended	Nuclear	Joint	Mixed	vegetarian	Non-
No anemia: >10	2500	651	581	613	655	628	623	639	610	830	835	835	858	849	793
Mild anemia: Hb = 10.0 – 10.9 g/dL	20	4	7	3	6	2	5	10	3	3	8	9	2	12	6

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

Moderate anemia: Hb = 7.0 – 9.9 g/dL	658	159	178	151	170	165	171	180	142	198	207	253	233	224	201
Severe anemia: Hb = < 7.0 g/dL	322	85	82	75	80	80	73	77	92	108	108	106	99	110	113
Total	3500	3500				3500				3500			3500		

Table 7: Demographic data according to the previous pregnancy complications

Previous pregnancy complications	**Total Participants**	**Education**				**Occupation**				**Type of Family**			**Dietary Habits**		
		No	Primary	secondary	Higher	House wife	Daily wage	Private	Governmen	Extended	Nuclear	Joint	Mixed	vegetarian	Non-
Yes	489	120	133	109	127	125	107	132	125	149	148	192	161	180	148
No	3011	779	715	733	784	750	765	774	722	990	1010	1011	1031	1015	965
Total	3500	3500				3500				3500			3500		

The rest, 3011 participants, did not report such complications. The group with complications tended to have lower educational levels and more limited occupational roles, though family type and dietary patterns remained consistent with the rest of the population.

The haemoglobin levels were compared between the control and intervention groups at three key stages of pregnancy. In the first trimester, the mean haemoglobin level was 7.47 ± 0.87 g/dL in the control group and 7.48 ± 0.89 g/dL in the intervention group, with no statistically significant difference (p = 0.8458). However, at the mid-pregnancy checkup, a significant improvement was observed in the intervention group (8.48 ± 1.0 g/dL) compared to the control group (7.70 ± 0.23 g/dL), with a highly significant p-value of 0.0001. This trend continued during delivery, where the intervention group had a mean haemoglobin level of 9.48 ± 2.0 g/dL, significantly higher than the control group's 7.97 ± 0.50 g/dL (p = 0.0001). These results suggest that the intervention was effective in improving haemoglobin levels as pregnancy progressed (Table 8).

Table 8. Comparison of Haemoglobin Levels (g/dL) Between Control and Intervention Groups at Different Stages of Pregnancy

Sl No	**Hemoglobin Level (g/dL)**	**Control (Mean and SD)**	**Intervention (Mean and SD)**	**P value**
1.	1st Trimester	7.47 ± 0.87	7.48 ± 0.89	0.8458
2.	Mid Pregnancy Checkup	7.70 ± 0.23	8.48 ± 1.0	0.0001

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 865-876 | ISSN:2251-6727

3.	During Delivery	7.97 ± 0.50	9.48 ± 2.0	0.0001

Overall, the study findings demonstrate that the intervention significantly improved hemoglobin levels among anemic pregnant women, with statistical significance observed from mid-pregnancy through to delivery. The results also highlight associations between anemia and socioeconomic, dietary, and medical history factors.

5. Discussion

Anemia during pregnancy remains a significant public health concern, particularly in low- and middle-income countries like India. Our study, involving 3500 pregnant women with 1000 identified as anemic, demonstrates that a structured nutritional intervention can lead to substantial improvements in hemoglobin levels. The intervention group showed a significant increase in mean hemoglobin from 7.48 ± 0.89 g/dL in the first trimester to 9.48 ± 2.0 g/dL at delivery, compared to the control group, which showed a modest increase from 7.47 ± 0.87 g/dL to 7.97 ± 0.50 g/dL.

These findings align with global evidence emphasizing the efficacy of iron supplementation during pregnancy. The WHO recommends daily oral iron supplementation of 30–60 mg of elemental iron and 400 µg of folic acid for pregnant women to prevent maternal anemia and associated complications [19]. A systematic review by Cantor et al. (2024) supports this recommendation, highlighting that routine prenatal iron supplementation reduces the incidence of iron deficiency and IDA during pregnancy [20].

Our study's results are consistent with those of a recent randomized controlled trial conducted in Ethiopia, which found that nutrition education combined with IFA supplementation significantly improved hemoglobin levels among pregnant women [21, 22]. The intervention group in that study showed a mean hemoglobin increase of 0.8 g/dL, demonstrating the effectiveness of combined nutritional education and supplementation strategies.

Furthermore, a meta-analysis by Lewkowitz et al. (2019) compared intravenous (IV) iron therapy to oral iron supplementation in pregnant women with iron-deficiency anemia [23]. The study concluded that IV iron was associated with a higher increase in hemoglobin levels and a lower risk of gastrointestinal side effects, suggesting that IV iron could be a viable alternative for women who cannot tolerate oral iron [24].

Our study also observed that anemia was more prevalent among women with lower educational levels, non-vegetarian diets, and a history of previous pregnancy complications [25]. These findings are supported by a study conducted in Egypt, which found a 49% prevalence of anemia among pregnant women, with higher rates observed in those with lower socioeconomic status and educational attainment [26].

The association between maternal anemia and adverse pregnancy outcomes has been well-documented. A systematic review and meta-analysis by Zhang et al. (2025) reported that anemia during pregnancy is associated with increased risks of preterm birth, low birth weight, and neonatal asphyxia [27]. Our study's findings reinforce the importance of early detection and management of anemia to mitigate these risks.

Compliance with iron supplementation is a critical factor in the success of anemia interventions. A study by Gebremedhin et al. (2024) found that adherence to IFA supplementation was significantly higher in the intervention group that received nutrition education, leading to improved haemoglobin levels and reduced anemia prevalence [28]. This underscores the importance of incorporating educational components into anemia prevention programs.

Despite the proven benefits of iron supplementation, challenges remain in ensuring widespread implementation and adherence. Side effects such as gastrointestinal discomfort can deter women from continuing supplementation. Alternative dosing strategies, such as intermittent supplementation, have been explored to improve tolerability [29]. A Cochrane review by Peña-Rosas et al. (2015) concluded that intermittent iron supplementation is as effective as daily supplementation in preventing anemia during pregnancy and may result in fewer side effects [29] [30].

In our study, participants who received higher doses of the intervention reported greater perceived benefits and higher hemoglobin gains. This suggests that dose optimization and individualized supplementation plans could enhance the effectiveness of anemia interventions.

Further research is needed to determine the optimal dosing regimens that balance efficacy and tolerability.

The integration of anemia prevention strategies into existing maternal health programs is essential for improving maternal and neonatal outcomes. A study by Neogi et al. (2019) demonstrated that incorporating IV iron therapy into routine antenatal care in India significantly reduced the prevalence of moderate-to-severe anemia among pregnant women. Such integrated approaches can enhance the reach and impact of anemia interventions [31].

Our study contributes to the growing body of evidence supporting the implementation of structured nutritional interventions to combat anemia during pregnancy. By addressing both the biological and socio-demographic factors associated with anemia, comprehensive strategies can be developed to reduce its prevalence and associated complications.

This study demonstrates that structured nutritional intervention significantly improves hemoglobin levels in anemic pregnant women. Participants in the intervention group showed greater haemoglobin gains from the first trimester to delivery compared to the control group, confirming the effectiveness of iron supplementation and dietary support. The findings also highlight the influence of socio-demographic factors such as education, diet, and previous pregnancy complications on anemia prevalence and response to treatment. Early screening, consistent follow-up, and patient education are crucial for successful intervention. These results reinforce the importance of integrating comprehensive anemia management strategies into routine antenatal care, especially in regions with high anemia burdens. Tailoring interventions to address both medical and social determinants of health can enhance maternal outcomes and reduce anemia-related complications. This study supports continued investment in nutritional programs as a public health priority for improving maternal and fetal well-being.

Acknowledgements: Authors are thankful to the study participants and all staffs involved in this study.
Conflict of interest: None declared.
Financial support: None declared.

References

[1] Means RT. Iron deficiency and iron deficiency anemia: implications and impact in pregnancy, fetal development, and early childhood parameters. Nutrients 2020;12:447. https://doi.org/10.3390/nu12020447.

[2] Araujo Costa E, de Paula Ayres-Silva J. Global profile of anemia during pregnancy versus country income overview: 19 years estimative (2000–2019). Annals of Hematology 2023;102:2025-2031.https://doi.org/10.1007/s00277-023-05279-2.

[3] Garzon S, Cacciato PM, Certelli C, Salvaggio C, Magliarditi M, Rizzo G. Iron deficiency anemia in pregnancy: Novel approaches for an old problem. Oman medical journal 2020;35:e166. 10.5001/omj.2020.108.

[4] Bathla S, Arora S. Prevalence and approaches to manage iron deficiency anemia (IDA). Critical Reviews in Food Science and Nutrition 2022;62:8815-8828. https://doi.org/10.1080/10408398.2021.1935442.

[5] Sharif N, Das B, Alam A. Prevalence of anemia among reproductive women in different social group in India: cross-sectional study using nationally representative data. Plos one 2023;18:e0281015. https://doi.org/10.1371/journal.pone.0281015.

[6] Clark SL, Christmas JT, Frye DR, Meyers JA, Perlin JB. Maternal mortality in the United States: predictability and the impact of protocols on fatal postcesarean pulmonary embolism and hypertension-related intracranial hemorrhage. American journal of obstetrics and gynecology 2014;211:32. e1-. e9. 10.1097/01.aoa.0000469455.21336.4b.

[7] Okeyo DO, Gumo S, Munde EO, Opiyo CO, Omungo ZO, Olyaro M, Ndirangu RK, Ogbureke N, Efange S, Ouma C. Nutritional service needs of pregnant and lactating adolescent girls in Trans-Mara East Sub-County, Narok County: focus on access and utilization of nutritional advice and services. BMC pregnancy and childbirth. 2019 Jul 5;19(1):229. 10.1186/s12884-019-2391-7.

[8] Bhatia V, Sahoo DP, Parida SP. India steps ahead to curb anemia: Anemia Mukt Bharat. Indian Journal of Community Health 2018;30:312-316.

[9] Aspuru K, Villa C, Bermejo F, Herrero P, López SG. Optimal management of iron deficiency anemia due to poor dietary intake. International journal of general medicine 2011;741-750. https://doi.org/10.2147/IJGM.S17788.

[10] Archer NM, Brugnara C. Diagnosis of iron-deficient states. Critical reviews in clinical laboratory sciences 2015;52:256-272. https://doi.org/10.3109/10408363.2015.1038744.

[11] Alnuimy A, Mahfouz HS. A Survey Study of the Characteristic, Causes, and Symptoms of Anemia Among Pregnant Women and Its Effects on Women and Fetus. Scientific Journal for Faculty of Science-Sirte University 2023;3:68-73. https://doi.org/10.37375/sjfssu.v3i2.1617.

[12] Ferguson LL. Discomforts of Pregnancy. Women's Health Care in Advanced Practice Nursing 2016;423.

[13] James AH. Iron deficiency anemia in pregnancy. Obstetrics & Gynecology 2021;138:663-674. 10.1097/AOG.0000000000004559.

[14] Padoan A. Laboratory tests to monitoring physiological pregnancy. Journal of Laboratory and Precision Medicine 2020;5. 10.21037/jlpm.2019.12.02.

[15] Shi H, Chen L, Wang Y, Sun M, Guo Y, Ma S, et al. Severity of anemia during pregnancy and adverse maternal and fetal outcomes. JAMA network open 2022;5:e2147046-e. 10.1001/jamanetworkopen.2021.47046.

[16] Shatenstein B, Ghadirian P. Influences on diet, health behaviours and their outcome in select ethnocultural and religious groups. Nutrition 1998;14:223-230. https://doi.org/10.1016/S0899-9007(97)00425-5.

[17] Nair KM, Iyengar V. Iron content, bioavailability & factors affecting iron status of Indians. Indian Journal of Medical Research 2009;130:634-645.

[18] Khusun H, Yip R, Schultink W, Dillon DH. World Health Organization hemoglobin cut-off points for the detection of anemia are valid for an Indonesian population. The Journal of nutrition 1999;129:1669-1674. 10.1093/jn/129.9.1669.

[19] Organization WH. Guideline: daily iron and folic acid supplementation in pregnant women. Guideline: Daily iron and folic acid supplementation in pregnant women, 2012, 323.

[20] Cantor AG, Jungbauer RM, Skelly AC, Hart EL, Jorda K, Davis-O'Reilly C, et al. Respectful maternity care: a systematic review. Annals of internal medicine 2024;177:50-64. https://doi.org/10.7326/M23-2676.

[21] Anato A, Reshid M. Effect of nutrition education and iron-folic acid supplementation on anemia among pregnant women in Ethiopia: a quasi-experimental study. Scientific Reports 2025;15:3556. 10.1038/s41598-025-87957-x.

[22] Ramachandran R, Dash M, Adaikaladorai FC, Aridass J, Zachariah B, Manoharan B. Effect of individual nutrition education on perceptions of nutritional iron supplementation, adherence to iron-folic acid intake and Hb levels among a cohort of anemic South Indian pregnant women. The Journal of Maternal-Fetal & Neonatal Medicine 2023;36:2183749. 10.1080/14767058.2023.2183749.

[23] Lewkowitz AK, Gupta A, Simon L, Sabol BA, Stoll C, Cooke E, et al. Intravenous compared with oral iron for the treatment of iron-deficiency anemia in pregnancy: a systematic review and meta-analysis. Journal of Perinatology 2019;39:519-532. 10.1038/s41372-019-0320-2.

[24] DeLoughery TG. Safety of oral and intravenous iron. Acta haematologica 2019;142:8-12. 10.1159/000496966.

[25] Chai ZF, Gan WY, Chin YS, Ching YK, Appukutty M. Factors associated with anemia among female adult vegetarians in Malaysia. Nutrition research and practice 2019;13:23-31. 10.4162/nrp.2019.13.1.23.

[26] Ahamed NH, Kotb SA, Hassanen RH. Knowledge and attitude of pregnant women about iron deficiency anemia in Assist University Women Health Hospital, Egypt. J Nurs Health Sci 2018;7:49-58. 10.9790/1959-0703064958.

[27] Zhang H, Liu W, Wang M, Wang L. A systematic review of meta-analysis in marketing research: Theme analyses, variable selections, and future directions. Psychology & Marketing 2025. https://doi.org/10.1002/mar.22199.

[28] Gebrekidan TK, Gebremedhin GG, Weldemariam AK, Teferi MK. Municipal solid waste management in Ethiopia–physical and chemical compositions and generation rate: systematic review. Journal of the Air & Waste Management Association 2024;74:861-883. 10.1016/j.wsee.2025.01.002.

[29] Naderi A, de Oliveira EP, Ziegenfuss TN, Willems ME. Timing, optimal dose and intake duration of dietary supplements with evidence-based use in sports nutrition. Journal of exercise nutrition & biochemistry 2016;20:1.10.20463/jenb.2016.0031.

[30] Peña-Rosas JP, De-Regil LM, Malave HG, Flores-Urrutia MC, Dowswell T. Intermittent oral iron supplementation during pregnancy. Cochrane database of systematic reviews 2015. 10.1002/14651858.CD009997.pub2.

[31] Neogi SB, Devasenapathy N, Singh R, Bhushan H, Shah D, Divakar H, et al. Safety and effectiveness of intravenous iron sucrose versus standard oral iron therapy in pregnant women with moderate-to-severe anaemia in India: a multicentre, open-label, phase 3, randomised, controlled trial. The Lancet Global Health 2019;7:e1706-e16. 10.1016/S2214-109X(19)30427-9.

.