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Original Research Article

An investigation into the frequency of anemia and the relationship between pregnant women's educational attainment and anemia in Meerut City

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ABSTRACT

Background: Anemia during pregnancy poses serious health risks for both mothers and infants, particularly in resource-limited environments. This study examines the prevalence of anemia among pregnant women in Meerut City, India, and analyzes its correlation with educational attainment.
Methods: A cross-sectional study was conducted from April 2025 to June 2025 across 28 UPHCs in Meerut City among pregnant women attending antenatal clinics in urban and semi-urban areas of Meerut City. Hemoglobin levels were measured to assess anemia status. Socio-demographic and educational information was gathered using structured interviews. Descriptive and inferential statistical analyses, including Chi-square to examine associations.
Results: Anemia was found to be highly prevalent among the study participants. A notable negative correlation was observed between educational attainment and anemia severity ($p<0.05$). Women with higher education levels demonstrated better dietary practices, greater awareness of anemia-related health risks, and higher adherence to iron supplementation. In contrast, women with lower education levels exhibited limited nutritional awareness, reduced use of maternal healthcare services, and limited understanding of anemia prevention and management.
Conclusions: The findings underscore the vital role of education in improving maternal health outcomes. Enhancing women's educational status may significantly reduce the burden of anemia and contribute to broader public health and social development goals. The study advocates for integrated policy approaches that link education and health sectors to achieve sustainable improvements in maternal and child health.

Keywords: Anemia in pregnancy, Antenatal care, Educational attainment, India, Maternal health, Public health, Social determinants of health women's education

INTRODUCTION

Anemia in pregnancy remains a major global public health concern, particularly in low- and middle-income countries where it significantly contributes to maternal and perinatal morbidity and mortality. The World Health Organization defines anemia in pregnancy as a hemoglobin concentration of less than 11 g/dL.[1] It is associated with increased risks of preterm delivery, low birth weight, impaired immunity, maternal complications, and mortality.[2-6] Globally, more than 38% of pregnant women are affected by anemia, with the highest burden observed in South Asia and sub-Saharan Africa.[7]

India carries one of the world's highest burdens of maternal anemia. According to the National Family Health Survey (NFHS-5, 2019-21), approximately 52.2% of pregnant women in India are anemic, with the

prevalence even higher in several northern states, including Uttar Pradesh.[8-10] Despite long-standing national programs such as iron-folic acid (IFA) supplementation, intensification of antenatal care services, and nutrition awareness initiatives, anemia remains persistently high. This suggests that important social determinants, including women's education, socio-economic status, and health literacy are still inadequately addressed.[9,11,12]

Educational attainment has consistently emerged as a key factor influencing maternal health outcomes. Evidence demonstrates that educated women are more likely to adopt healthy dietary practices, utilize antenatal services, comply with IFA supplementation, and make informed decisions regarding their health and pregnancy.[13-15] Studies from South Asia and Africa also show a strong inverse association between women's education and anemia prevalence.[7] Interventions focusing on nutrition education have been found effective in improving hemoglobin levels and anemia-related knowledge among pregnant women.[13-15]

Research from India further highlights the role of socio-demographic factors, dietary habits, and regional disparities in shaping anemia prevalence among pregnant women.[9-12] Systematic reviews have consistently identified inadequate dietary diversity, irregular antenatal visits, and poor compliance with IFA supplementation as major contributors to maternal anemia.[14,15]

Given this context, it is important to examine local-level determinants of anemia to guide targeted public health interventions. Meerut City, located in western Uttar Pradesh, represents a diverse urban and semi-urban population characterized by socio-economic disparities and variations in women's educational attainment. Understanding the relationship between education and anemia in this setting is essential to designing effective, community-oriented strategies.

Therefore, the present study aims to assess the prevalence of anemia among pregnant women in Meerut City and examine its association with their educational attainment. Insights gained from this study may assist policymakers, healthcare providers, and community health programs in developing more targeted interventions focusing on educational empowerment and improved maternal nutrition.

The primary aim of this study was to investigate the prevalence of anemia among pregnant women residing in Meerut city and to explore the potential association between anemia and the educational attainment of these women. By analyzing the frequency of anemia in this specific population, the study seeks to provide a clearer understanding of the magnitude of the problem within the urban context of Meerut. Furthermore, this research aims to examine how varying levels of education among pregnant women might influence their risk of developing anemia, thereby highlighting the role of education as a potential determinant of maternal health outcomes. The findings are intended to inform public health strategies and interventions aimed at reducing anemia prevalence and improving maternal health through targeted educational and nutritional programs. Specifically, the study focuses on two core objectives: 1) to analyze the prevalence (frequency) of anemia among pregnant women in Meerut city, and 2) to investigate the relationship between pregnant women's anemia status and their educational attainment.

METHODS

This study adopted a cross-sectional descriptive research design to assess the frequency of anemia among pregnant women in Meerut City and to examine the association between their educational attainment and anemia status.

Study area and population

The research was conducted across 28 Government Urban Primary Health Centers (UPHCs) in Meerut city, Uttar Pradesh, India. The study population consisted of pregnant women attending antenatal clinics at these health centers during the study period.

Sample size and sampling technique

A total of 210 pregnant women were selected using stratified random sampling to ensure adequate representation from all 28 UPHCs. Participants were included if they were currently pregnant, belonged to the age group of 18-45 years, were permanent residents of Meerut city, and were willing to provide informed consent for participation.

Data collection (tools and techniques)

Data was collected using a structured and pre-validated questionnaire specifically developed for this study. The questionnaire was administered digitally through Google Forms to ensure standardized, efficient, and error-free data collection. Ethical approval for the study was obtained from the Institutional Ethical Committee of Swami Vivekanand Subharti University, Meerut (U.P.), India, and informed consent was obtained from all participants before data collection.

The questionnaire covered several essential areas relevant to the research objectives. It included socio-demographic information such as age, household income, and occupation. Educational attainment was recorded and categorized as no formal education, primary, secondary, higher secondary, or graduate and above. Dietary and health-related practices were assessed through questions addressing food intake patterns, consumption of iron-rich foods, adherence to iron and folic acid supplementation, and antenatal care behaviors.

Hemoglobin (Hb) levels were obtained from recent clinical records during routine antenatal checkups. Based on WHO guidelines for pregnant women, anemia was categorized as mild when Hb levels ranged from 10.0 to 10.9 g/dL, moderate when levels were between 7.0 and 9.9 g/dL, and severe when Hb levels were below 7.0 g/dL.

Data analysis

Data that was gathered was collated and examined. Anemia's prevalence and severity were evaluated using descriptive statistics. Utilizing chi-square testing; the association between anemia prevalence and educational attainment was assessed, with a significance level of $p<0.05$.

RESULTS

The largest proportion of pregnant women (42%) belonged to the age group 26-30 years. Among women aged 21-25 years, 29% were anemic. The prevalence of anemia was highest (43%) among women aged 31-35 years.

Table 1: Anemic versus non-anemic pregnant women's socio-demographic and food habit features.

Characteristics	All pregnant women, n=210	Non anemic, n=76		Anemic women, n=134	
	No.	No.	Percent (%)	No.	Percent (%)
Age (in year)					
≤20	12	3	25.0	9	75.0
Age 21-25	77	31	40.3	46	59.7
Age 26 -30	89	33	37.1	56	62.9
Age 31 -35	26	7	26.9	19	73.1
Age >35	6	2	33.3	4	66.7
Religion					
Hindu and other	113	45	39.8	68	60.2
Muslim	97	31	32.0	66	68.0
Interest in entertainment activity (watch TV, cinema & read news paper)					
High	71	44	62.0	27	38.0
Medium	55	21	38.2	34	61.8
Low	84	11	13.1	73	86.9
Access to basic amenities (light, sanitation, TV, computer, AC & Car)					
Normal	55	37	67.3	18	32.7
Medium	96	20	20.8	76	79.2
Low	59	19	32.2	40	67.8
factors influenced your decision to attend ANC					
Advice from family/friends	68	32	47.1	36	52.9
Awareness of ANC benefits	118	39	33.1	79	66.9
None of above	24	5	20.8	19	79.2
Include iron-rich foods (e.g., meat, beans and green leafy vegetables) in your diet					
2-3 times/week	51	6	11.8	45	88.2
Daily	11	2	18.2	9	81.8
Rarely	148	68	45.9	80	54.1
Frequency of taking IFA (Iron) Tab					
Daily	55	19	34.5	36	65.5
Once in a week	29	13	44.8	16	55.2
Sometime	126	44	34.9	82	65.1
Level of awareness regarding anemia and its causes					
Normal	64	35	54.7	29	45.3
Moderate	76	18	23.7	58	76.3
Low	70	23	32.9	47	67.1

Religion-wise distribution showed that anemia prevalence was 68.8% among Muslim women, while among Hindu and other religious groups it was 60.2%.

Interest in entertainment activities such as watching television, using mobile phones, reading newspapers, and other media varied between anemic and non-anemic women. Low interest in entertainment activities was more

common among anemic women (33%) compared to non-anemic women (20%).

Access to basic household amenities (toilet, water supply, sanitation, TV, computer, AC, car) also differed. Women with limited amenities had a higher prevalence of anemia (44%) compared to those with adequate amenities (35%).

Table 2: Frequency of various anemia levels in pregnant women (n=210).

Various level of anemia	Frequency	Percent
<7 g/dl (severe)	8	4
7-9.9 g/dl (moderate)	70	33
10-10.9 g/dl (mild)	56	27
11+ g/dl (normal)	76	36

Most women (74%) reported that their decision to attend antenatal care (ANC) was influenced by family members. Anemia prevalence was higher among women whose ANC attendance was dependent on family decisions. Dietary patterns revealed that 62% of pregnant women consumed iron-rich foods irregularly. The intake of green leafy vegetables, fruits, pulses, and meat was lower among anemic women than among non-anemic women. Frequency of iron and folic acid (IFA) tablet intake was inadequate among 54% of anemic women. Overall awareness regarding anemia and its causes was also lower in anemic women compared to non-anemic women.

Table 2 presents the distribution of anemia levels among the 210 pregnant women included in the study. A total of 36% of women had normal hemoglobin levels (≥11 g/dL), while 64% were anemic. Among the anemic women, 33% had moderate anemia (7.0–9.9 g/dL), 27% had mild anemia (10.0–10.9 g/dl), and 4% had severe anemia (<7 g/dl).

Table 3 presents the distribution of anemia among pregnant women across different educational levels. The findings indicate a clear inverse relationship between education and anemia prevalence. Among women with no formal schooling, anemia was extremely common, affecting 77% (23 out of 30) of participants. Those with primary or middle-level education (grades 1-8) also showed a high prevalence, with 71% (67 out of 95) being anemic. In contrast, anemia prevalence declined among women with higher schooling: 59% (37 out of 63) of those with secondary or higher secondary education were anemic. The lowest prevalence was observed among women with undergraduate or postgraduate education, where only 32% (7 out of 22) were found to be anemic.

A chi-square test demonstrated that the association between educational attainment and anemia status was statistically significant (χ^2=14.4574, p=0.00234), suggesting that higher education is strongly linked with reduced risk of anemia during pregnancy.

Table 3: The distribution of anemia across different levels of education among pregnant women.

Education level	No of PW	<11 g/dL (Anemia)	≥11 g/dL (Normal)	% of Anemic PW
No formal schooling	30	23	7	77
Primary and middle (1-8)	95	67	28	71
Secondary and higher secondary (9-12)	63	37	26	59
UG & PG	22	7	15	32
Total	210	134	76	64

The chi-square statistic is 14.4574. The p-value is .002344. The result is significant at p<0.05.

Table 4: The distribution of anemia across different levels of education among pregnant women.

Education level	Normal	Moderate	Low	% Normal	% Moderate	% Low
No formal schooling	3	15	12	10	50	40
Primary and middle (1-8)	25	34	36	26	36	38
Secondary and higher secondary (9-12)	22	22	19	35	35	30
UG & PG	14	5	3	64	23	14
Total	64	76	70	30	36	33

The chi-square statistic is 19.4719. The p-value is .003437. The result is significant at p<0.05.

Table 4 examines the association between education level and awareness regarding anemia and its causes. The results demonstrate that awareness improves substantially with rising educational attainment. Among women with no formal education, only 10% exhibited normal awareness, while 40% showed low awareness. Awareness increased progressively among women with primary, middle, and secondary schooling. The highest levels of awareness were found among undergraduate and postgraduate women, where 64% demonstrated normal awareness and only 14% had low awareness.

The chi-square test confirmed a statistically significant association between educational level and awareness about anemia (χ^2=19.47, p=0.0034), indicating that higher

education contributes to better understanding of anemia, its causes, and its prevention.

DISCUSSION

The present study examined the prevalence of anemia among pregnant women in Meerut city and analyzed its association with socio-demographic characteristics, dietary habits, antenatal care practices, and educational attainment. The findings indicate that anemia continues to be a major public health concern in this population.

The socio-demographic analysis (Table 1) showed that anemia affected women across all age groups, with higher prevalence observed among those in economically and socially vulnerable segments. Limited access to household amenities, lower media exposure, and reduced engagement in information-related or recreational activities were more common among anemic women. Similar patterns have been documented in previous studies, suggesting that poor living conditions and restricted health information access may negatively influence dietary behavior, awareness, and overall health practices of pregnant women.[16-19]

Table 1 also showed that dietary diversity played an important role. Women with infrequent intake of iron-rich foods such as green leafy vegetables, meat, fruits, and pulses had higher anemia prevalence. Previous studies have established that inadequate dietary iron intake and poor nutritional diversity are major contributors to anemia in pregnancy.[20-24] These findings are consistent with our study and reinforce the importance of dietary counseling during antenatal visits.

Antenatal care practices further influenced anemia status. Women whose ANC visits were not self-decided but influenced by family members indicating lower autonomy showed higher anemia prevalence. Earlier studies have also highlighted that women's autonomy and decision-making capacity affect antenatal care utilization, IFA adherence, and diet-related behaviors.[17-19,24] Inadequate compliance with iron-folic acid supplementation, as seen among anemic women in this study, supports this pattern.

Table 2 shows that a considerable proportion of women were moderately anemic, highlighting gaps in supplementation, dietary intake, and awareness. The WHO reports that moderate anemia contributes substantially to maternal morbidity and poor birth outcomes in low-income settings.[3] The distribution of anemia severity in this study aligns with findings from national and regional surveys showing persistent moderate the anemia across several states in India.[26-28]

The relationship between education and anemia (Table 3A) showed a clear inverse trend, where anemia prevalence progressively declined with rising educational attainment. This association was statistically significant. Numerous studies across India and globally have reported similar findings, demonstrating that education enhances women's ability to understand nutritional requirements, recognize early symptoms, and follow preventive practices, thereby reducing anemia risk.[29-33] Our results reinforce education as a critical determinant of maternal health.

Similarly, Table 3B highlighted a strong positive association between education level and awareness about anemia and its causes. Higher-educated women demonstrated substantially greater awareness compared to those with no or limited schooling. Prior research indicates that improved education enhances health literacy, increases utilization of ANC services, and promotes better adherence to IFA supplementation and dietary recommendations.[30-34] The significant association in this study supports the understanding that health knowledge and behavior improve with educational attainment.

Overall, the combined findings from all tables demonstrate that anemia among pregnant women in Meerut City is influenced by interlinked socio-demographic, dietary, behavioral, and educational factors. The results indicate that improving maternal education, strengthening ANC counseling, enhancing dietary diversity, and increasing awareness through community and media-based interventions are essential to reducing the burden of anemia.

The present study has certain limitations. As a cross-sectional investigation confined to selected urban areas of Meerut City, the results may not fully represent all pregnant women in the wider district or other regions. The sample size, although sufficient for analysis, was relatively modest and limited to women attending health facilities, which could introduce selection bias. Information regarding dietary habits, awareness levels, and health practices was self-reported and may be influenced by recall bias or social desirability bias. Moreover, the study focused on hemoglobin-based classification and did not incorporate biochemical indicators such as serum ferritin or folate levels, which would have strengthened the assessment of anemia etiology. Despite these constraints, the study offers meaningful insights into the frequency of anemia and its association with educational attainment among pregnant women in this urban context.

CONCLUSION

The study highlights that anemia among pregnant women in Meerut City remains a significant public health concern, influenced by a combination of socio-demographic factors, dietary practices, antenatal care utilization, and educational attainment. Women with limited education, poor dietary diversity, and lower autonomy in healthcare decision-making were found to be more vulnerable to anemia. Higher education was strongly associated with lower anemia prevalence and

better awareness regarding anemia and its causes. These findings demonstrate that improving women's education, enhancing nutritional counselling during ANC visits, strengthening IFA compliance, and expanding targeted health awareness interventions can substantially reduce the burden of anemia. The study contributes valuable local evidence to inform more focused maternal health strategies that integrate education, nutrition, and community-based health promotion to address anemia effectively.

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