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RESEARCH ARTICLE

A CROSS SECTIONAL STUDY ON PREVALENCE AND ETIOLOGY OF ANAEMIA IN PREGNANT FEMALE IN A TERTIARY CARE CENTRE

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Abstract

Background: Anemia in pregnancy is a significant public health concern, particularly in developing countries, where it contributes to maternal and neonatal morbidity and mortality. The etiology of anemia in pregnant women is multifactorial, often involving nutritional deficiencies, particularly iron, vitamin B12, and folate. Understanding the prevalence, causes, and associated factors of anemia in this population is crucial for developing effective interventions.

Aim: The study aimed to estimate the prevalence of anemia among pregnant women attending a tertiary care center and to determine its etiology and associated factors.

Material and Methods: A cross-sectional study was conducted at the Department of Obstetrics and Gynecology, Government Hospital, Kota, including 250 pregnant women. Participants underwent a detailed clinical examination, and blood samples were analyzed for hemoglobin levels and peripheral blood smear findings. The study assessed nutritional deficiencies, including iron, vitamin B12, and folate, as the primary etiologies of anemia. Data on sociodemographic factors, parity, birth spacing, and ANC booking status were also collected and analyzed for associations with anemia.

Results: The study found a high prevalence of anemia (81.2%) among the participants, with moderate anemia being the most common form (54.4%). Nutritional deficiencies were the primary causes, with iron deficiency anemia present in 48% of cases. A significant proportion of women (20.8%) had combined deficiencies of vitamin B12, folate, and iron. Anemia was significantly associated with lower socioeconomic status, multiparity, and birth spacing of less than 24 months. No significant associations were observed with age, education, occupation, residence, type of family, or ANC booking status.

Conclusion: This study underscores the high burden of anemia among pregnant women, driven predominantly by nutritional deficiencies. The findings highlight the importance of addressing socioeconomic disparities and providing targeted nutritional interventions to reduce the incidence of anemia in this population.

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Introduction:-

Anemia is one of the most common nutritional deficiency disorders affecting the pregnant women; the prevalence in developed countries is 14%, in developing countries 51%, and in India, it varies from 65% to 75%.[i] and established risk factor for intrauterine growth retardation, leading on to poor neonatal health and perinatal death.[ii]Anemia is a major cause of maternal and fetal complications including mortality [iii]. It decreases women's ability to withstand bleeding before and after delivery and makes them more prone to infections. According to the World Health Organization (WHO), the prevalence of anaemia inpregnant women globally was **36.5% (2019)** and in india is **50.1% (2019).**In India, anemia during pregnancy is a significant public health problem, with 45.7% of pregnant women in urban areas and 52.1% in rural areas having hemoglobin levels <11g/dl. According to the National Family Health Survey (NFHS-4) data, the prevalence of anemia in India is 50.3%. Rajasthan is among the 4th leading state anaemia in india. The main cause of anaemia in india is iron deficiency (WHO).The aim of the study is to evaluate the Prevalence and Etiology of anaemia in pregnant women in tertiary care center.

Methods:-

It is a cross sectional study conducted in the dept of Obstetrics and gynaecology at a tertiary health care centre over a period of 1 year. A total of 250 women were included in the study coming to our antenatal OPD.

Inclusion criteria

Pregnant women age ≥ 18 years with anemiaattending ANC clinic.

Exclusion criteria

1. Diagnosed cases of anemia on treatment and History of recent blood transfusion.
2. Women with underlying chronic diseases like chronic kidney disease and Peptic Ulcer disease.
3. Unwilling to participate.

Study population

All the pregnant women Attending ANC with anaemia (Hb < 11g %) more than 18 years of age .Approval was taken from the institutional ethics committee prior to commencement of the study.Written consent form was taken from all the patients.All eligible study subjects were visited at OPD and information will be collected using pre-structured questionnaire. The proforma was used in collection of data including the details of general information, age of the patient, details of socioeconomic determinants, age at marriage and details of health events and treatment during pregnancy. Lab reports and antenatal check-up details were referred for the haemoglobin reading.

Statistical Analysis

Continuous data was summarized in form of mean and S.D. The difference in means will be analyzed using Student's 't' test. Count data was expressed in the form of proportions ; difference in proportion was analyzed using Chi square test. P value was kept 95% for all statistical analysis.

Result:-

A cross- sectional study conducted on 250 pregnant women showed thatthe mean age was 26.092 years, median age was of 26.000 years, and a standard deviation of 4.0695 years. The ages range from a minimum of 18.0 years to a maximum of 36.0 years (table 1) . Among the participants, 19 were aged ≤ 20 years (7.6%), 97 were aged 21-25 years (38.8%), 100 were aged 26-30 years (40.0%), and 34 were aged >30 years (13.6%) (image 1).Among the participants, 211 resided in rural areas (84.4%) and 39 resided in urban areas (15.6%)(table 2).Among the participants, 74 were illiterate (29.6%), 88 had primary education (35.2%), 68 had secondary education (27.2%), and 20 had higher education (8.0%)(table 3).65 participants were from the lower socioeconomic status (26.0%), 98 were from the lower middle socioeconomic status (39.2%), 15 were from the upper socioeconomic status (6.0%), 51 were from the upper lower socioeconomic status (20.4%), and 21 were from the upper middle socioeconomic status (8.4%).

Table 1:- Distribution of study participants according to Age.

Age group	Frequency	Percent
≤ 20 years	19	7.6
21-25 years	97	38.8
26-30 year	100	40.0

>30 years	34	13.6
Total	250	100.0

Table 2:- Distribution of study participants according to residence.

Residence	Frequency	Percent
Rural	211	84.4
Urban	39	15.6
Total	250	100.0

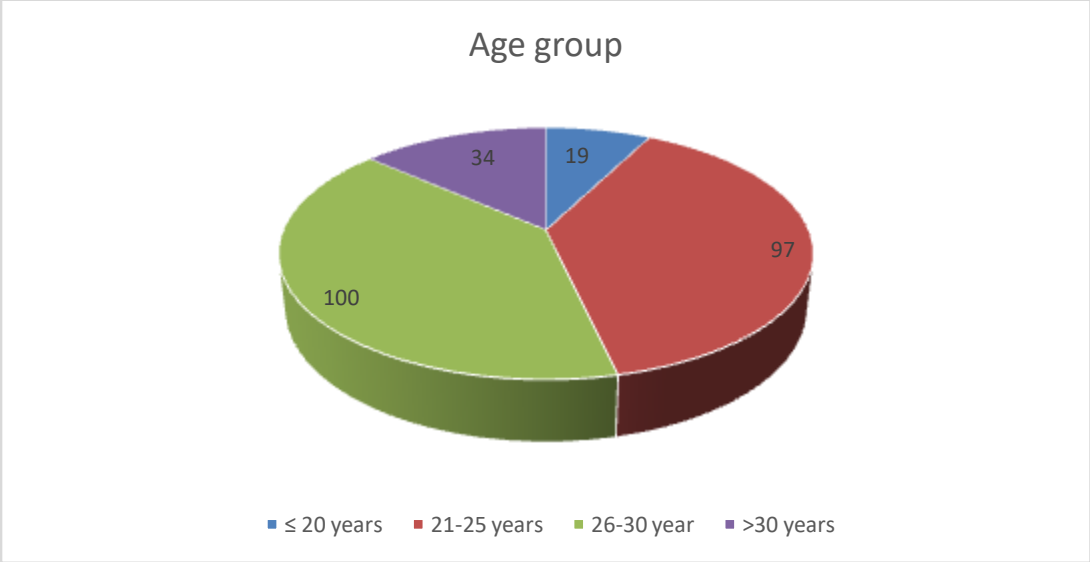


Image 1:-

Table 3:- Distribution of study participants according to education.

Education	Frequency	Percent
Illiterate	74	29.6
Primary	88	35.2
Secondary	68	27.2
Higher	20	8.0
Total	250	100.0

Among the participants, 20 were grand multipara (8.0%), 124 were multipara (49.6%), and 106 were primipara (42.4%).74 had birth spacing of less than 24 months (29.6%), 70 had birth spacing of more than 24 months (28.0%), and 106 were primigravida, making birth spacing not applicable (42.4%).

Table 4:- Distribution of CBC among the study participants:

CBC parameters	Mean	Median	SD	Minimum	Maximum
TLC	7139.812	6784	1665.44	4300	11000
Platelet count	2.6417	2.6	0.59	1.5	4.3
RBC count	4.0157	3.73	4.57971	1.73	75.6
Haemoglobin	9.3	9.5	1.7265	3.3	13.2
MCV	83.011	79.8	11.6354	58.2	115.7
MCH	25.883	26.4	3.9316	15.4	37.2
MCHC	30.478	30.8	2.0579	21.7	33.9

The table presents the distribution of CBC parameters among the study participants:

- **TLC**: Mean 7139.812 cells/µL, SD 1665.44 cells/µL
- **Platelet count**: Mean 2.6417 lakh/µL, SD 0.59 lakh/µL

- **RBC count**: Mean 4.0157 million cells/µL, SD 4.57971 million cells/µL
- **Hemoglobin**: Mean 9.3 g/dL, SD 1.7265 g/dL
- **MCV**: Mean 83.011 fL, SD 11.6354 fL
- **MCH**: Mean 25.883 pg, SD 3.9316 pg
- **MCHC**: Mean 30.478 g/dL, SD 2.0579 g/dL

Table 5:- Distribution of study participants according to severity of anaemia:

Anemia	Frequency	Percent
No anaemia	47	18.8
Mild anaemia	47	18.8
Moderate anaemia	136	54.4
Severe anaemia	20	8.0
Total	250	100.0

The table presents the distribution of study participants according to the severity of anemia. Among the participants, 47 had no anemia (18.8%), 47 had mild anemia (18.8%), 136 had moderate anemia (54.4%), and 20 had severe anemia (8.0%). In total, there were 250 participants, representing 100% of the study population.

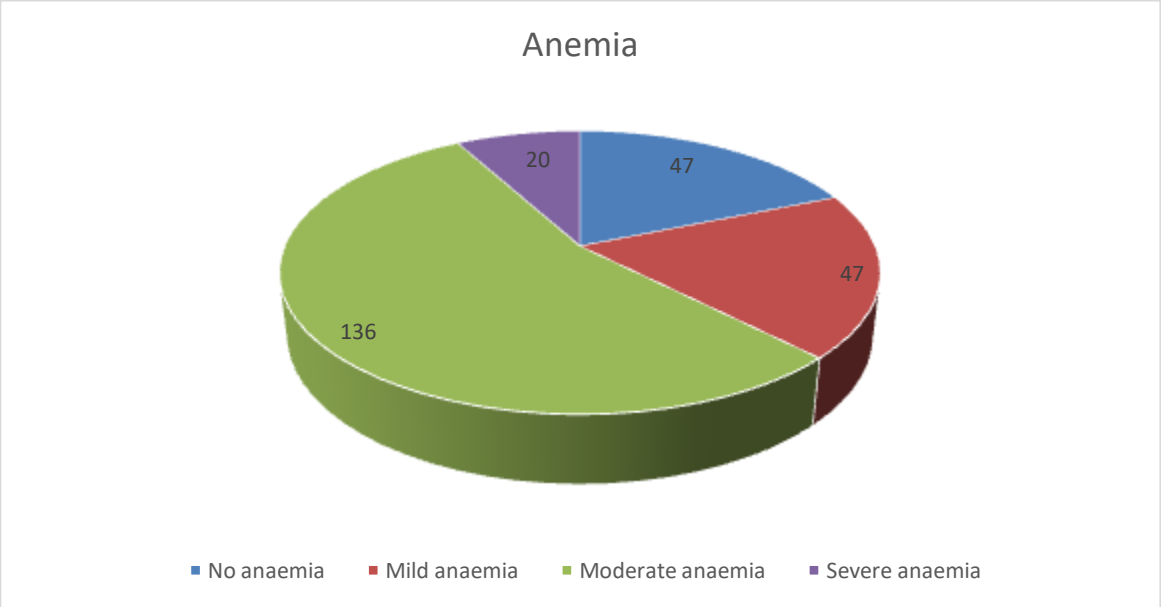


Image 2:-

Table 6:- Distribution of study participants according to peripheral blood smear findings:

PBF findings	Frequency	Percent
No anaemia	47	18.8
Dimorphic	24	9.6
Macrocytic	23	9.2
Microcytic hypochromic	117	46.8
Normocytic normochromic	35	14.0
Normocytic to microcytic	4	1.6
Total	250	100.0

The table presents the distribution of study participants according to peripheral blood smear findings. Among the participants, 47 had no anemia (18.8%), 24 had dimorphic findings (9.6%), 23 had macrocytic findings (9.2%), 117 had microcytic hypochromic findings (46.8%), 35 had normocytic normochromic findings (14.0%), and 4 had normocytic to microcytic findings (1.6%). In total, there were 250 participants, representing 100% of the study population.

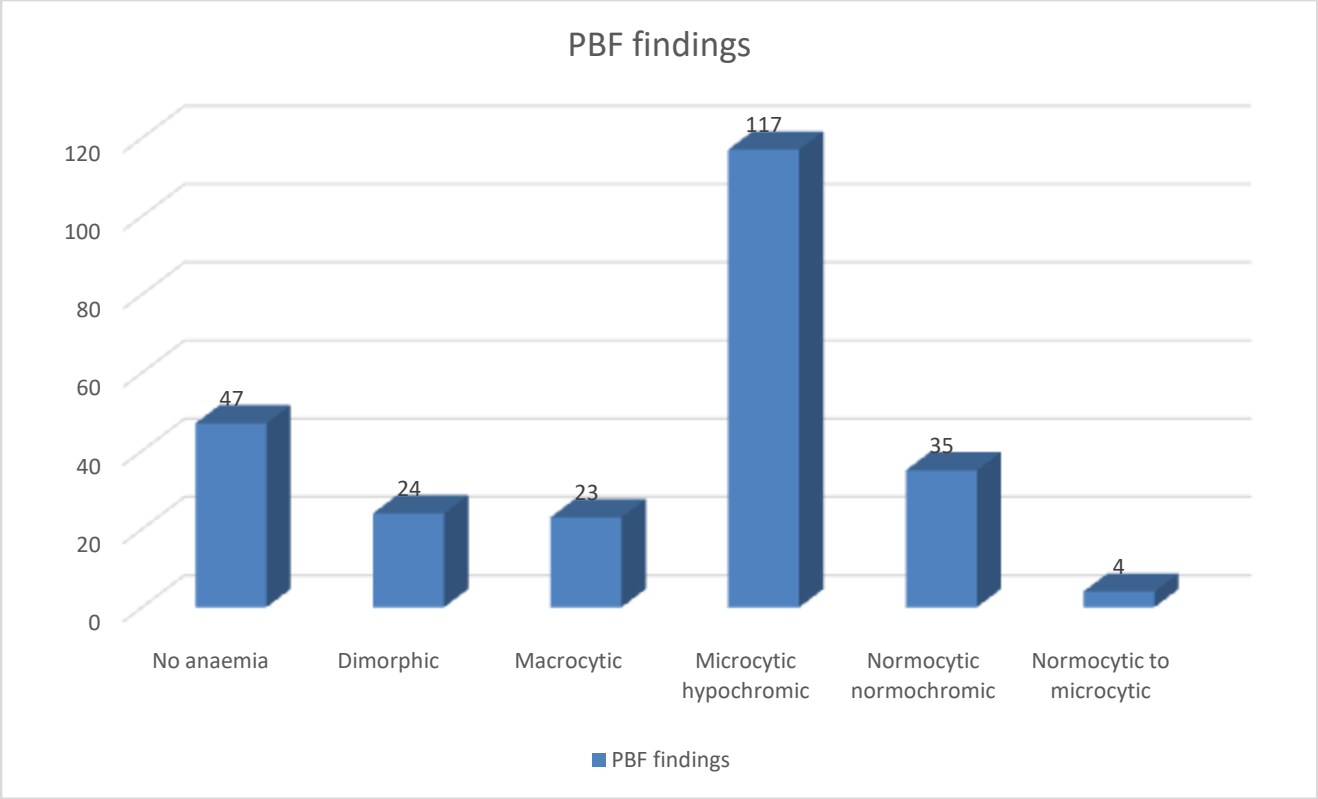


Table 7:- Distribution of other laboratory investigation among the study participants:

Parameters	Mean	Median	SD	Minimum	Maximum
s. Iron	34.552	22.900	35.5628	3.2	221.2
%Transferrin	14.9897	6.4000	40.45025	1.00	351.90
s. transferrin	268.249	251.500	119.6072	49.7	599.7
TIBC	383.1087	368.1000	155.21327	27.40	803.40
Vit B12	165.95	133.00	135.006	108	719
Folate studies	1.126	1.000	.1939	.9	1.5

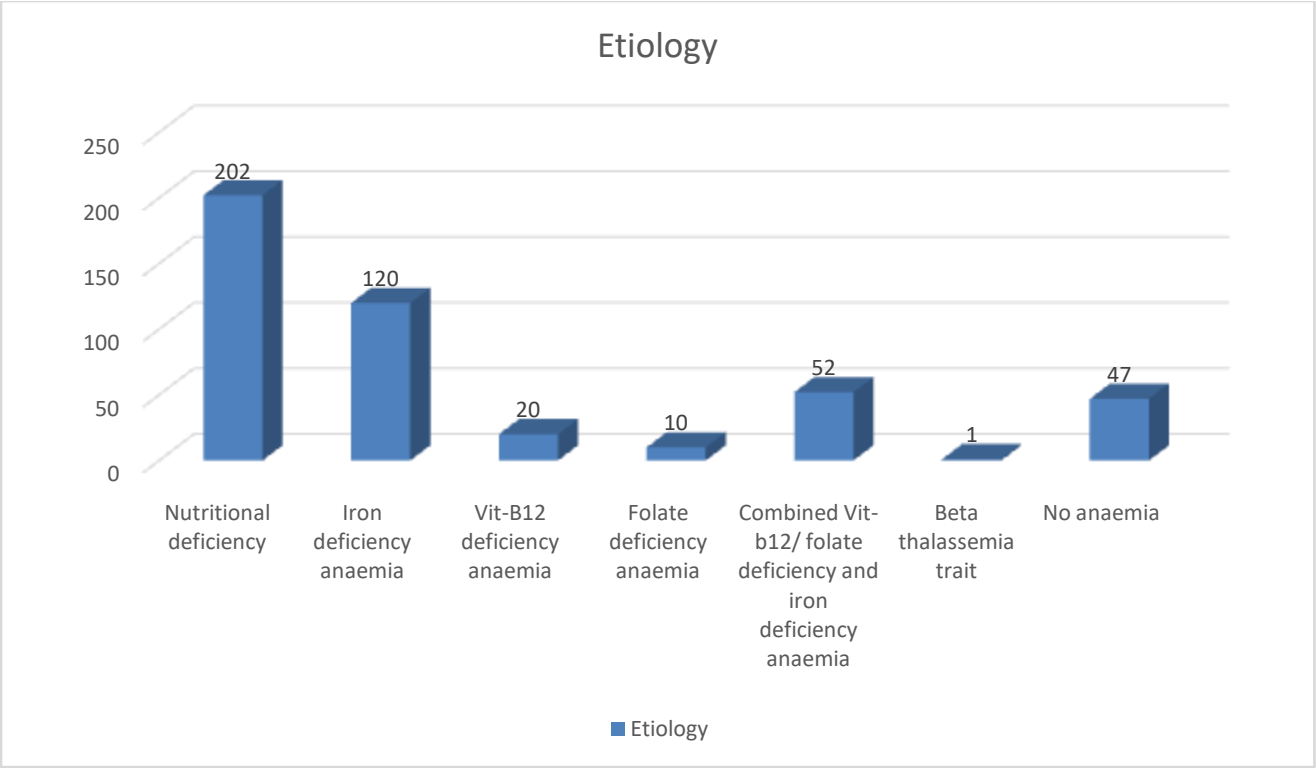
The table presents the distribution of other laboratory investigation parameters among the study participants:

- **Serum Iron**: Mean 34.552 µg/dL, SD 35.5628 µg/dL
- **% Transferrin Saturation**: Mean 14.9897%, SD 40.45025%
- **Serum Transferrin**: Mean 268.249 mg/dL, SD 119.6072 mg/dL
- **Total Iron Binding Capacity (TIBC)**: Mean 383.1087 µg/dL, SD 155.21327 µg/dL
- **Vitamin B12**: Mean 165.95 pg/mL, SD 135.006 pg/mL
- **Folate Studies**: Mean 1.126 ng/mL, SD 0.1939 ng/mL

Table 8:- Distribution of study participants according to etiology:

Etiology	Frequency	Percent
Nutritional deficiency	**202**	**80.8**
Iron deficiency anaemia	120	48.0
Vit-B12 deficiency anaemia	20	8.0
Folate deficiency anaemia	10	4.0
Combined Vit-b12/ folate deficiency and iron deficiency anaemia	52	20.8
Beta thalassemia trait	1	.4
No anaemia	47	18.8

The table presents the distribution of study participants according to the etiology of their condition. Among the participants, 202 had a nutritional deficiency (80.8%), 120 had iron deficiency anemia (48.0%), 20 had vitamin B12 deficiency anemia (8.0%), 10 had folate deficiency anemia (4.0%), and 52 had combined vitamin B12/folate deficiency and iron deficiency anemia (20.8%). Additionally, 1 participant had beta thalassemia trait (0.4%), and 47 participants had no anemia (18.8%).



Discussion:-

Anemia during pregnancy is a significant public health concern, particularly in developing countries, due to its potential adverse effects on maternal and fetal outcomes. This study aimed to provide a comprehensive analysis of the prevalence, etiology, and associated factors of anemia among pregnant women in a tertiary care setting. By examining various demographic, socioeconomic, and clinical parameters, this research offers valuable insights into the complex nature of anemia in pregnancy and its potential implications for maternal and fetal health.

Age Distribution:

In our study, the mean age of participants was 26.092 years, with a standard deviation of 4.0695 years, ranging from 18 to 36 years. The majority of participants (78.8%) were between 21 and 30 years old, with 38.8% in the 21-25 year age group and 40.0% in the 26-30 year age group. Only 7.6% were aged 20 years or younger, and 13.6% were over 30 years old.

This age distribution is similar to that reported by several other studies in the literature. For instance, Monika Malhotra et al2[4]. (2002) reported a mean age of 27 ± 4.25 years in their study population, which is close to our findings. Similarly, Raheela Rani et al[41]. (2021) reported a mean maternal age of 26.83 ± 4.13 years, which is remarkably consistent with our results.

However, our age distribution differs somewhat from some other studies. For example, Rehana Rashid et al[42]. (2021) reported a higher mean age of 30.63 ± 4.97 years in their anemic group. This difference could be attributed to variations in study populations, regional differences, or changes in demographic trends over time.

The predominance of women in the 21-30 year age group in our study is consistent with the typical reproductive age range and reflects the common age of pregnancy in many populations. The relatively low proportion of women aged

20 years or younger (7.6%) is a positive finding, as very young maternal age is often associated with increased risks during pregnancy.

Parity:
Our study revealed that among the participants, 8.0% were grand multipara, 49.6% were multipara, and 42.4% were primipara. This distribution provides important insights into the reproductive history of our study population and its potential relationship with anemia in pregnancy.

The high proportion of multipara women (49.6%) in our study is noteworthy and aligns with findings from several other studies in the literature. For instance, Devi NB et al[29]. (2015) reported that 65.24% of their study participants with severe anemia were multigravidas. Similarly, Shalini Singh et al[36]. (2018) found that 57.6% of severely anemic women in their study were multigravidas.

However, our findings contrast with some other studies. For example, Kumar KJ et al[27]. (2013) found that more than 50% of anemic mothers in their study were primigravidas. This difference could be attributed to variations in study populations, regional differences in fertility patterns, or differences in anemia prevalence among primi- and multigravidas in different settings.

The relatively high proportion of primipara women (42.4%) in our study is also significant. This group may face unique challenges related to first-time pregnancy and may have different nutritional needs and risk factors for anemia compared to multiparous women.

The presence of 8.0% grand multipara women in our study population is important to note, as this group may be at higher risk for various pregnancy complications, including anemia. Monika Malhotra et al[24]. (2002) observed that the number of women with parity more than 3 was highest in the severe anemia group, which underscores the potential relationship between high parity and anemia risk.

Sociodemographic Profile:
Our study provided a comprehensive sociodemographic profile of the participants, revealing important insights into the characteristics of the anemic pregnant population in our setting.

Residence:
A striking 84.4% of participants resided in rural areas, while only 15.6% were from urban areas. This high proportion of rural participants is significant and may have important implications for anemia prevalence and management. This finding aligns with several other studies in the literature. For instance, Devi NB et al[29]. (2015) reported that 53.55% of severely anemic women in their study were from rural areas. Similarly, Shalini Singh et al[36]. (2018) found that 72.4% of severely anemic women were from rural areas.

Education:
Our study revealed that 29.6% of participants were illiterate, 35.2% had primary education, 27.2% had secondary education, and only 8.0% had higher education. This educational profile is concerning, with a significant proportion of women having low levels of formal education.

These findings are somewhat consistent with other studies in the literature. For example, Seema BN et al[37]. (2017) reported that 28.9% of their study participants were illiterate, which is very close to our finding. However, our study shows a higher proportion of women with at least some level of education compared to some other studies.

Socioeconomic Status:
Our study found a diverse distribution of socioeconomic status among participants: 26.0% were from lower socioeconomic status, 39.2% from lower middle, 20.4% from upper lower, 8.4% from upper middle, and 6.0% from upper socioeconomic status.

This distribution reveals that a significant proportion of our study population (85.6%) belongs to lower or middle socioeconomic strata. This finding is consistent with several other studies in the literature. For example, Devi NB et al[29]. (2015) reported that 88.65% of severely anemic women in their study were from poor socioeconomic

backgrounds. Similarly, Shalini Singh et al[36]. (2018) found that 87.6% of severely anemic women belonged to low socioeconomic categories.

Birth Spacing:
Our study found that among the participants, 29.6% had birth spacing of less than 24 months, 28.0% had birth spacing of more than 24 months, and 42.4% were primigravida, for whom birth spacing was not applicable.

This distribution of birth spacing provides important insights into reproductive patterns and potential risk factors for anemia in our study population. The significant proportion of women with birth spacing less than 24 months (29.6%) is particularly noteworthy and may have important implications for maternal health and anemia risk.

These findings are somewhat consistent with other studies in the literature, although direct comparisons are challenging due to variations in how birth spacing is reported. For instance, Rehana Rashid et al[42]. (2021) found that 31.4% of anemic patients had an inter-pregnancy interval of less than 2 years, which is very close to our finding of 29.6%.

The association between short birth intervals and anemia risk is supported by several studies. For example, Patel A et al[36]. (2018) found that the risk of adverse pregnancy outcomes, including anemia, was higher in women with short birth intervals.

The proportion of women with birth spacing more than 24 months (28.0%) is encouraging, as it suggests that a significant portion of our multiparous participants are achieving recommended birth intervals. However, this group still represents less than a third of the total study population, indicating room for improvement in birth spacing practices.

Severity and Prevalence of Anemia:
Our study revealed a high prevalence of anemia among the participants, with 81.2% of women being anemic. Specifically, 18.8% had mild anemia, 54.4% had moderate anemia, and 8.0% had severe anemia. Only 18.8% of participants had no anemia.

These findings indicate a significant burden of anemia in our study population, with moderate anemia being the most common category. The high overall prevalence of anemia (81.2%) is concerning and higher than global estimates, but not uncommon in studies from similar settings.

Seema BN et al[37]. (2017) reported an even higher prevalence of anemia (96.5%) in their study of pregnant women in rural Karnataka, with 22.47% having mild anemia, 56.30% moderate anemia, and 14.98% severe anemia. Our findings show a slightly lower overall prevalence but a similar pattern of moderate anemia being most common.

Pereira E et al[38]. (2019) found a 64% prevalence of anemia among pregnant women in their first trimester, with 50% having mild anemia, 48.4% moderate anemia, and 1.6% severe anemia. Our study shows a higher overall prevalence and a higher proportion of moderate and severe cases, possibly due to including women at all stages of pregnancy.

Himabindu P et al[45]. (2022) reported that 74.5% of antenatal women in their study were anemic, with 24.9% having mild anemia, 49.6% moderate anemia, and 10% severe anemia. These figures are quite similar to our findings, particularly in the proportion of moderate anemia cases.

The high prevalence of moderate anemia (54.4%) in our study is particularly noteworthy. Moderate anemia in pregnancy is associated with increased risks of adverse maternal and fetal outcomes, as highlighted by several studies. For instance, Parks S et al. (2019) found that moderate maternal anemia was associated with increased risks of stillbirth and neonatal mortality.

The proportion of severe anemia (8.0%) in our study, while lower than moderate anemia, is still significant and concerning. Severe anemia in pregnancy is associated with even greater risks. Shi H et al[43]. (2022) found that severe anemia during pregnancy was associated with increased risks of placental abruption, preterm birth, severe postpartum hemorrhage, and fetal malformation.

The relatively low proportion of mild anemia (18.8%) compared to moderate anemia in our study is interesting and may suggest that many women are entering pregnancy with already depleted iron stores, progressing quickly to moderate anemia. This highlights the importance of preconception care and nutrition in preventing anemia in pregnancy.

Peripheral Blood Smear Findings:
Our study provided detailed peripheral blood smear findings, offering insights into the morphological types of anemia present in our study population. The results showed that among the participants, 46.8% had microcytic hypochromic findings, 9.2% had macrocytic findings, 9.6% had dimorphic findings, 14.0% had normocytic normochromic findings, and 1.6% had normocytic to microcytic findings. Additionally, 18.8% had no anemia.

Pereira E et al[38]. (2019) found microcytic hypochromic anemia to be the most common morphological type (59.4%), followed by dimorphic anemia (23.4%) in their study. While our study also found microcytic hypochromic anemia to be most common, we observed a lower proportion of dimorphic anemia.

Kaushal S et al[44]. (2022) reported that all nutrient deficiencies (ferritin, folate, and vitamin B12) were found in all morphological types of anemia, highlighting the complex and often overlapping nature of nutritional deficiencies. Our findings of significant proportions of both microcytic and macrocytic anemia support this observation.

The high prevalence of microcytic hypochromic anemia in our study is consistent with iron deficiency being the predominant cause of anemia. This aligns with global patterns and underscores the importance of iron supplementation in antenatal care. However, the significant proportions of macrocytic and dimorphic anemia suggest that other nutritional deficiencies, particularly folate and vitamin B12, also play important roles in our population.

Aetiology:
Our study provided a detailed breakdown of the etiology of anemia among the participants. The findings revealed that nutritional deficiency was the predominant cause, affecting 80.8% of the participants. Specifically, 48.0% had iron deficiency anemia, 8.0% had vitamin B12 deficiency anemia, 4.0% had folate deficiency anemia, and 20.8% had combined vitamin B12/folate deficiency and iron deficiency anemia. Additionally, 0.4% of participants had beta thalassemia trait, and 18.8% had no anemia.

Kaushal S et al[44]. (2022) found that 50% of women had iron deficiency, 48.8% had vitamin B12 deficiency, and 33.72% had folate deficiency. While our study shows a similar predominance of iron deficiency, we found lower rates of B12 and folate deficiencies. This difference could be due to variations in dietary patterns or supplementation practices between the study populations.

Pereira E et al[38]. (2019) reported iron deficiency anemia as the commonest cause of anemia in pregnancy, which aligns with our findings. However, they did not provide specific percentages for other nutritional deficiencies.

Seema BN et al. (2017) did not provide a detailed etiology breakdown but reported a very high overall prevalence of anemia (96.5%), which is higher than our finding of 81.2% anemic participants.

The high prevalence of nutritional deficiency anemia in our study, particularly iron deficiency, is consistent with patterns observed in many developing countries. However, the significant proportion of participants with vitamin B12 and folate deficiencies, either alone or in combination with iron deficiency, is noteworthy and suggests a need for a more comprehensive approach to anemia prevention and treatment.

Associated Factors with Anemia:
Our study examined various factors potentially associated with anemia in pregnancy. Interestingly, we found no statistically significant association between anemia and several factors that are often considered important, including maternal age, education, occupation, residence, type of family, and ANC booked status.

We observed a statistically significant association between parity and anemia ($p=0.019$). Among grand multipara participants, none had no anemia, while 6.9% had anemia. Among multipara participants, 48.9% had no anemia and 49.8% had anemia. Among primipara participants, 51.1% had no anemia and 43.3% had anemia. A statistically

significant association was found between socioeconomic status and anemia. Anemia was found to be statistically significantly higher among the lower socioeconomic status, followed by middle class, with the lowest prevalence in the upper class.

The association between higher parity and increased anemia risk is consistent with several other studies in the literature. For instance, Devi NB et al. (2015) reported that 65.24% of severely anemic women in their study were multigravidas. The increased risk with higher parity could be due to repeated pregnancies depleting maternal iron stores, especially if birth spacing is short.

The higher prevalence of anemia among lower socioeconomic groups aligns with findings from many other studies. For example, Shalini Singh et al[36]. (2018) reported that 87.6% of severely anemic women belonged to low socioeconomic categories. This association likely reflects the impact of socioeconomic factors on nutrition, healthcare access, and overall living conditions.

Conclusion:-

Current study was a cross sectional study, conducted at the Department of Obstetrics and Gynaecology, government hospital, Kota. This study aimed to estimate the prevalence of anemia among pregnant women and to determine its etiology in pregnant female. A total 250 pregnant female were included in the study. Summary of the findings are follow-

- **Age**: The age distribution of the mothers had a mean age of 26.092 years, a median age of 26.000 years, and a standard deviation of 4.0695 years. Ages ranged from a minimum of 18.0 years to a maximum of 36.0 years. Among the participants, 19 were aged ≤ 20 years (7.6%), 97 were aged 21-25 years (38.8%), 100 were aged 26-30 years (40.0%), and 34 were aged >30 years (13.6%).
- **Parity**: Among the participants, 20 were grand multipara (8.0%), 124 were multipara (49.6%), and 106 were primipara (42.4%).
- **Sociodemographic Profile**: Among the participants, 211 resided in rural areas (84.4%) and 39 resided in urban areas (15.6%). Regarding education, 74 were illiterate (29.6%), 88 had primary education (35.2%), 68 had secondary education (27.2%), and 20 had higher education (8.0%). For occupation, 145 were daily wage laborers (58.0%), 86 were homemakers (34.4%), and 19 had private jobs (7.6%). In terms of family type, 113 were from joint families (45.2%) and 137 were from nuclear families (54.8%). Regarding socioeconomic status, 65 were from the lower socioeconomic status (26.0%), 98 were from the lower middle socioeconomic status (39.2%), 15 were from the upper socioeconomic status (6.0%), 51 were from the upper lower socioeconomic status (20.4%), and 21 were from the upper middle socioeconomic status (8.4%).
- **Birth Spacing**: Among the participants, 74 had birth spacing of less than 24 months (29.6%), 70 had birth spacing of more than 24 months (28.0%), and 106 were primigravida, making birth spacing not applicable (42.4%).
- **Severity and Prevalence of Anemia**: Among the participants, 47 had no anemia (18.8%), 47 had mild anemia (18.8%), 136 had moderate anemia (54.4%), and 20 had severe anemia (8.0%). In total, there were 250 participants, representing 100% of the study population.
- **Peripheral Blood Smear Findings**: Among the participants, 47 had no anemia (18.8%), 24 had dimorphic findings (9.6%), 23 had macrocytic findings (9.2%), 117 had microcytic hypochromic findings (46.8%), 35 had normocytic normochromic findings (14.0%), and 4 had normocytic to microcytic findings (1.6%). In total, there were 250 participants, representing 100% of the study population.
- **Etiology**: Among the participants, 202 had a nutritional deficiency (80.8%), 120 had iron deficiency anemia (48.0%), 20 had vitamin B12 deficiency anemia (8.0%), 10 had folate deficiency anemia (4.0%), and 52 had combined vitamin B12/folate deficiency and iron deficiency anemia (20.8%). Additionally, 1 participant had beta thalassemia trait (0.4%), and 47 participants had no anemia (18.8%).
- **Associated Factors with Anemia**: In the present study, no statistically significant association was found between mothers' age, education, occupation, residence, type of family, and ANC booked status with anemia.
- A statistically significant association was found between socioeconomic status, parity, birth spacing and anemia, with anemia being significantly higher among mothers with lower socioeconomic status, multiparity and had less than 24 months birth spacing.

This cross-sectional study on the prevalence and etiology of anemia in pregnant women at a tertiary care center has provided crucial insights into the burden, causes, and associated factors of anemia in our setting. The study revealed

a high prevalence of anemia (81.2%) among pregnant women, with moderate anemia being the most common (54.4%). Nutritional deficiencies, particularly iron deficiency, emerged as the predominant cause of anemia, but significant contributions from vitamin B12 and folate deficiencies were also noted.

The study highlighted the complex etiology of anemia in pregnancy, with a substantial proportion of women having multiple micronutrient deficiencies. Socioeconomic status and parity were identified as significant factors associated with anemia, underscoring the interplay of social, economic, and biological factors in determining anemia risk.

Strengths:

1. Comprehensive approach: The study examined a wide range of factors including etiology, severity, and associated factors, providing a holistic view of anemia in pregnancy.
2. Detailed laboratory investigations: The inclusion of comprehensive CBC parameters, peripheral blood smear findings, and specific nutritional markers (iron, vitamin B12, folate) allowed for a thorough assessment of anemiaetiology.
3. Large sample size: With 250 participants, the study had sufficient power to detect significant associations and trends.

Limitation

1. Cross-sectional design: The study's cross-sectional nature limits the ability to establish causal relationships between identified factors and anemia.
2. Single-center study: As the study was conducted in one tertiary care center, the findings may not be fully generalizable to other settings or the general population.
3. Lack of control group: The absence of a non-anemic control group limits some comparative analyses.

Recommendation:-

1. Implement comprehensive anemia screening and management protocols in antenatal care, addressing multiple micronutrient deficiencies simultaneously.
2. Develop targeted interventions for high-risk groups, particularly multiparous women and those from lower socioeconomic backgrounds.
3. Integrate socioeconomic empowerment and family planning programs with anemia prevention strategies to address broader determinants of anemia risk.
4. Enhance nutritional education and counseling as part of antenatal care, focusing on iron-rich foods and other important micronutrients.
5. Consider universal multi-micronutrient supplementation for pregnant women in this setting, given the high prevalence of multiple deficiencies.
6. Conduct further research to evaluate the effectiveness of current anemia prevention strategies and explore novel approaches.
7. Implement long-term follow-up studies to assess the impact of anemia and its management on maternal and child health outcomes.
8. Develop and evaluate community-based interventions to improve nutritional status and reduce anemia risk before and during pregnancy.
9. Conduct similar studies in diverse settings to build a more comprehensive understanding of anemia patterns and risk factors across different populations.

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