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Frequency of Anemia and Its Type in Antenatal Women Presenting at Allied Hospital, Faisalabad

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Abstract

Background

Anemia in pregnancy remains a major public health problem in South Asia, and Pakistan carries one of the highest reported burdens among low- and middle-income countries, with facility-based estimates from Punjab showing little decline over three decades. Prevalence figures alone are an inadequate guide to management, because anemia in pregnancy is etiologically heterogeneous and morphological subtypes carry different therapeutic implications (e.g., iron versus folate/cobalamin replacement). Empirical iron supplementation without characterization risks both under-treatment of megaloblastic anemia and unnecessary iron exposure in women who are not iron deficient. This study was undertaken to determine the frequency of anemia and its morphological types among antenatal women presenting at Allied Hospital, Faisalabad.

Methodology

A hospital-based descriptive cross-sectional study was conducted in the Department of Obstetrics and Gynecology, Allied Hospital, Faisalabad, from October 15, 2019, to April 14, 2020. Women aged 18 to 40 years with a singleton pregnancy attending for a first routine antenatal checkup were enrolled by non-probability consecutive sampling. Women on iron supplementation, recently transfused, or with chronic liver or renal disease were excluded. Using Cochran's formula with 95% confidence, 6% margin of error, and an anticipated prevalence of 13.6%, the sample size was 126. Complete blood count, peripheral blood morphology, and serum ferritin were performed, and anemia was defined by trimester-specific hemoglobin cut-offs.

Results

Among 126 antenatal women, the median age was 31.0 years (interquartile range (IQR): 28.0-34.0), the mean gestational age at booking was 31.58 ± 3.64 weeks, and the mean body mass index was 28.98 ± 3.41 kg/m². Most were categorized as multiparous (n=102, 81.0%) and urban residents (n=76, 60.3%). Anemia was present in 71 women (56.3%). Among these, 41 had microcytic hypochromic anemia (57.7%), 18 had macrocytic anemia (25.4%), and 12 had normocytic normochromic anemia (16.9%). Median hemoglobin was 10.4 g/dL (IQR: 8.0-12.2), median mean corpuscular volume was 87.8 fL, median mean corpuscular hemoglobin concentration was 33.5 g/dL, and median serum ferritin was 53.5 ng/mL. Anemia was significantly more frequent at 32 weeks or less, affecting 47 women (65.3%) versus 24 women (44.4%) beyond 32 weeks, and in women with a body mass index of 30 kg/m² or less, affecting 52 women (62.7%) versus 19 women (44.2%). Median ferritin differed markedly across morphological groups, from 8.7 ng/mL in the microcytic group to 119.3 ng/mL in the macrocytic group. Age, parity, residence, education, gestational diabetes, and pregnancy-induced hypertension showed no significant association.

Conclusion

More than half of the antenatal women were anemic at first booking. Although microcytic hypochromic anemia predominated, macrocytic and normocytic normochromic forms together accounted for a substantial minority, and serum ferritin diverged sharply across these groups. Routine morphological and biochemical characterization at booking is therefore warranted so that replacement therapy is matched to the underlying deficiency rather than assumed to be iron.

Categories: Obstetrics/Gynecology
Keywords: anemia in pregnancy, antenatal care, erythrocyte indices, iron deficiency anemia, serum ferritin

Introduction

Anemia in pregnancy remains one of the most persistent nutritional and hematological problems encountered in obstetric practice, and its burden is concentrated in low- and middle-income countries,

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where analyses of pooled national survey data show that a substantial proportion of women of reproductive age are affected and that the condition clusters with poverty, low educational attainment, and limited utilization of health services [1]. South Asia carries a disproportionate share of this burden. A systematic review and meta-analysis of Pakistani data has confirmed that iron deficiency anemia is highly prevalent among pregnant women and adolescent girls throughout the country [2], while facility-based studies from Lahore [3], other urban centers [4], and Faisalabad itself [5] have consistently documented high frequencies among women attending antenatal services.

The clinical significance of the condition lies in its downstream consequences. Maternal anemia in Pakistani tertiary care settings has been associated with adverse perinatal outcomes, including preterm delivery and low birth weight [6], and comparable associations with unfavorable neonatal outcomes have been reported from Sindh [7] and from East African antenatal cohorts [8]. Identifying the women at greatest risk is therefore a public health priority, and facility-based analyses have repeatedly implicated obstetric and sociodemographic determinants such as gestational age at booking, parity, nutritional status, place of residence, and maternal education [9,10].

Prevalence estimates alone, however, provide an incomplete basis for management, because anemia in pregnancy is etiologically heterogeneous. Studies that have characterized morphological subtypes report that microcytic hypochromic anemia predominates, while macrocytic and normocytic normochromic patterns also contribute appreciably [11,12], and hemoglobinopathies such as beta-thalassemia trait may coexist with or clinically mimic iron deficiency [13]. Empirical supplementation without morphological and biochemical characterization therefore risks both under-treatment of megaloblastic anemia and unnecessary iron exposure in non-iron-deficient women, particularly in a country where supplementation coverage itself varies substantially across regions [14]. A key limitation of existing local literature is that data describing the distribution of anemia subtypes among antenatal attendees in Faisalabad remain limited. The present study was therefore undertaken to determine the frequency of anemia and its morphological types among antenatal women presenting at Allied Hospital, Faisalabad.

Materials And Methods

Study design and study setting

This was a hospital-based, descriptive cross-sectional study conducted in the Department of Obstetrics and Gynecology, Allied Hospital, Faisalabad, Punjab, Pakistan, a tertiary care teaching institution serving a large urban and peri-urban catchment population.

Study period

Data were collected over a six-month period from October 15, 2019, to April 14, 2020.

Ethics committee approval

The study protocol was reviewed and approved by the Institutional Ethical Review Committee of Faisalabad Medical University (formerly Punjab Medical College), Faisalabad (registration no. 995/2018, dated November 19, 2018), and the research synopsis was subsequently approved by the Research Evaluation Unit of the College of Physicians and Surgeons Pakistan (ref. no. CPSP/REU/OBG-2017-035-8519, dated October 15, 2019). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from every participant after explaining the study purpose, the single venous sampling involved, and the right to decline or withdraw without any effect on clinical care. Participant identifiers were replaced with serial codes, and records were stored confidentially.

Inclusion criteria

Women aged 18 to 40 years, both primiparous and multiparous, with a singleton pregnancy confirmed on ultrasonography and of any gestational age calculated from the last menstrual period, presenting for a routine antenatal checkup for the first time, were eligible.

Exclusion criteria

Women already receiving iron supplementation, those transfused within the preceding one month, and those with chronic liver disease (serum bilirubin above 2.0 mg/dL), chronic renal failure (serum creatinine above 1.5 mg/dL), or current immunosuppressive therapy were excluded on the basis of history and medical records, since these conditions independently alter hemoglobin concentration, erythrocyte indices, or ferritin interpretation.

Sample size estimation

The sample size was calculated using Cochran's formula for a single proportion.

$$n = \frac{Z^2 \times p \times (1-p)}{d^2}$$

where Z was 1.96 for a 95% confidence level, p was the anticipated prevalence, and d was the absolute margin of error, taken as 6%. The anticipated prevalence was taken as 13.6%, the pooled prevalence of iron deficiency anemia reported by Adam et al. (2018) in a systematic review and meta-analysis of 16 studies comprising 15,688 pregnant women [11]. Substitution in the formula gave a final sample of 126 antenatal women.

Sampling method

Participants were enrolled by non-probability consecutive sampling. All consecutive antenatal attendees fulfilling the eligibility criteria during the study period were approached until the calculated sample size was reached.

Data collection procedure

A structured proforma was administered to record maternal age in completed years, gestational age at booking in weeks, parity as primiparous or multiparous, place of living as rural or urban, and education level as illiterate, primary, matric, or graduate. Weight and height were measured, and body mass index was computed in kg/m². Gestational diabetes mellitus and pregnancy-induced hypertension were recorded as present or absent from clinical assessment and antenatal records. A 5 mL venous blood sample was drawn by the researcher and sent to the institutional pathology laboratory for complete blood count, peripheral blood morphology, and serum ferritin estimation, and hemoglobin, mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC) were recorded. Anemia was labeled when hemoglobin was below 11 g/dL in the first and third trimesters or below 10.5 g/dL in the second trimester. Among anemic women, the morphological type was classified as microcytic hypochromic (MCV below 80 fL with MCHC below 32.0 g/dL), macrocytic (MCV above 100 fL with MCHC above 36.0 g/dL), or normocytic normochromic (MCV 80-100 fL with MCHC 32.0-36.0 g/dL) [11,12]. Hemoglobin electrophoresis and serum vitamin B12 estimation were performed where clinically indicated to identify hemoglobinopathy or megaloblastic change [13]. All participants were managed according to standard ward protocol.

Data analysis

Data were analyzed using SPSS version 25.0 (release 2017; IBM Corp., Armonk, NY, USA). Normality was assessed by the Shapiro-Wilk test. Normally distributed continuous variables are reported as mean and standard deviation, and non-normally distributed variables as median with interquartile range (IQR). Categorical variables are reported as frequency and percentage. Associations between anemia status and stratified variables were tested by the chi-square test. Groups were compared using the independent samples t-test, Mann-Whitney U test, and Kruskal-Wallis test as appropriate. A p-value below 0.05 was considered statistically significant.

Results

A total of 126 antenatal women were studied. The median age was 31.0 years (IQR: 28.0-34.0), the mean gestational age at booking was 31.58 ± 3.64 weeks, and the mean body mass index was 28.98 ± 3.41 kg/m². Of the participants, 24 were primiparous (19.0%), and 102 were multiparous (81.0%), while 50 lived in rural areas (39.7%) and 76 in urban areas (60.3%). Education was illiterate in 16 (12.7%), primary in 22 (17.5%), matric in 55 (43.7%), and graduate in 33 (26.2%). Gestational diabetes was present in 36 (28.6%) and pregnancy-induced hypertension in 34 (27.0%) (Table *1*).

Variable	Category	Value
Age (years)[a]	-	31.0 (28.0-34.0)
Gestational age at booking (weeks)[b]	-	31.58 ± 3.64
BMI (kg/m²)[b]	-	28.98 ± 3.41
Parity	Primiparous	24 (19.0%)
	Multiparous	102 (81.0%)
Place of living	Rural	50 (39.7%)
	Urban	76 (60.3%)
Education level	Illiterate	16 (12.7%)
	Primary	22 (17.5%)
	Matric	55 (43.7%)
	Graduate	33 (26.2%)
Gestational diabetes mellitus (GDM)	Yes	36 (28.6%)
	No	90 (71.4%)
Pregnancy-induced hypertension (PIH)	Yes	34 (27.0%)
	No	92 (73.0%)

TABLE 1: Baseline Demographic and Clinical Characteristics of Antenatal Women (N = 126)

Data are presented as n (%), mean ± SD, or median (IQR). Normality was assessed using the Shapiro-Wilk test.

[a]Age was non-normally distributed (Shapiro-Wilk p = 0.018) and is reported as median (IQR).

[b]Gestational age and BMI were normally distributed (Shapiro-Wilk p = 0.075 and p = 0.337) and are reported as mean ± SD.

SD: standard deviation; IQR: interquartile range; BMI: body mass index

Anemia was present in 71 women (56.3%), while 55 had hemoglobin above the trimester-specific cut-off (43.7%). Among the 71 anemic women, 41 showed a microcytic hypochromic picture (57.7%), 18 showed macrocytic anemia (25.4%), and 12 showed normocytic normochromic anemia (16.9%). For the cohort as a whole, median hemoglobin was 10.4 g/dL (IQR: 8.0-12.2), median mean corpuscular volume was 87.8 fL (76.9-96.6), median mean corpuscular hemoglobin concentration was 33.5 g/dL (31.0-35.1), and median serum ferritin was 53.5 ng/mL (12.0-102.4) (Table *2*).

Variable	Category	Value
Anemia (Hb below trimester-specific cut-off)	Present	71 (56.3%)
	Absent	55 (43.7%)
Morphological type (among anemic women, n = 71)	Microcytic hypochromic	41 (57.7%)
	Macrocytic	18 (25.4%)
	Normocytic normochromic	12 (16.9%)
Hemoglobin (g/dL)[a]	-	10.4 (8.0-12.2)
MCV (fL)[a]	-	87.8 (76.9-96.6)
MCHC (g/dL)[a]	-	33.5 (31.0-35.1)
Serum ferritin (ng/mL)[a]	-	53.5 (12.0-102.4)

TABLE 2: Frequency, Morphological Type, and Hematological Profile of Anemia Among Antenatal Women (N = 126)

Data are presented as n (%) or median (IQR).

[a]Hemoglobin, MCV, MCHC, and serum ferritin were all non-normally distributed (Shapiro-Wilk $p < 0.05$) and are reported as median (IQR).

MCV: mean corpuscular volume; MCHC: mean corpuscular hemoglobin concentration; IQR: interquartile range

Anemia was significantly more frequent among women booking at 32 weeks or earlier, affecting 47 (65.3%) compared with 24 beyond 32 weeks (44.4%) ($\chi^2 = 5.44$, $p = 0.020$), and among women with a body mass index of 30 kg/m² or less, affecting 52 (62.7%) compared with 19 in the higher category (44.2%) ($\chi^2 = 3.93$, $p = 0.048$). Age group, parity, place of living, education level, gestational diabetes, and pregnancy-induced hypertension showed no significant association, with p-values ranging from 0.112 to 0.852 (Table *3*).

Variable	Category	Anemia present n (%)	Anemia absent n (%)	χ^2	p-Value
Age group (years)	18-30	35 (60.3)	23 (39.7)	0.70	0.404
	31-40	36 (52.9)	32 (47.1)		
Gestational age (weeks)	≤32	47 (65.3)	25 (34.7)	5.44	0.020*
	>32	24 (44.4)	30 (55.6)		
Parity	Primiparous	17 (70.8)	7 (29.2)	2.53	0.112
	Multiparous	54 (52.9)	48 (47.1)		
BMI (kg/m²)	≤30	52 (62.7)	31 (37.3)	3.93	0.048*
	>30	19 (44.2)	24 (55.8)		
Place of living	Rural	30 (60.0)	20 (40.0)	0.45	0.503
	Urban	41 (53.9)	35 (46.1)		
Education level	Illiterate	9 (56.3)	7 (43.8)	0.79	0.852
	Primary	14 (63.6)	8 (36.4)		
	Matric	31 (56.4)	24 (43.6)		
	Graduate	17 (51.5)	16 (48.5)		
Gestational diabetes mellitus	Yes	17 (47.2)	19 (52.8)	1.71	0.191
	No	54 (60.0)	36 (40.0)		
Pregnancy-induced hypertension	Yes	20 (58.8)	14 (41.2)	0.12	0.734
	No	51 (55.4)	41 (44.6)		

TABLE 3: Association Between Sociodemographic and Clinical Factors and Anemia Status

Percentages are row percentages (within each category). The chi-square test (Pearson, without continuity correction) was used for all associations.

*$p < 0.05$ was considered statistically significant.

BMI: body mass index

The mean gestational age was significantly lower in anemic than in non-anemic women, at 30.90 ± 3.80 versus 32.45 ± 3.25 weeks (t = -2.47, p = 0.015). Median age did not differ significantly between the two groups, at 31.0 years (IQR: 27.0-33.5) in anemic women and 32.0 years (28.0-35.0) in non-anemic women (U = 1721.0, p = 0.255). Mean body mass index was lower in anemic women, at 28.50 ± 3.29 versus 29.60 ± 3.49 kg/m², but the difference did not reach significance (t = -1.79, p = 0.077) (Table *4*).

Variable	Anemia present (n = 71)	Anemia absent (n = 55)	Test statistic	p-Value	Test used
Age (years)[a]	31.0 (27.0-33.5)	32.0 (28.0-35.0)	U = 1721.0	0.255	Mann-Whitney U
Gestational age (weeks)[b]	30.90 ± 3.80	32.45 ± 3.25	t = -2.47	0.015*	Independent samples t-test
BMI (kg/m²)[b]	28.50 ± 3.29	29.60 ± 3.49	t = -1.79	0.077*	Independent samples t-test

TABLE 4: Comparison of Continuous Variables Between Antenatal Women With and Without Anemia

Data are presented as median (IQR) or mean ± SD.

[a]Age was non-normally distributed (Shapiro-Wilk p = 0.018); the Mann-Whitney U test was used, and U is the smaller of the two rank-sum statistics.

[b]Gestational age and BMI were normally distributed (Shapiro-Wilk p = 0.075 and p = 0.337) and were compared using the independent samples t-test (Welch approximation).

*p < 0.05 was considered statistically significant.

SD: standard deviation; IQR: interquartile range; BMI: body mass index

All four hematological indices differed significantly across the four groups. Median hemoglobin fell from 12.3 g/dL in non-anemic women to 8.6, 8.0, and 7.5 g/dL in the microcytic, macrocytic, and normocytic groups (H = 92.61, p < 0.001). Median mean corpuscular volume was 71.4 fL in microcytic and 106.9 fL in macrocytic anemia (H = 102.10, p < 0.001), with corresponding mean corpuscular hemoglobin concentrations of 28.8 and 37.8 g/dL (H = 101.63, p < 0.001). Median serum ferritin ranged from 8.7 ng/mL in microcytic to 119.3 ng/mL in macrocytic anemia (H = 93.27, p < 0.001) (Table 5).

Variable	Non-anemic (n = 55)	Microcytic (n = 41)	Macrocytic (n = 18)	Normocytic (n = 12)	H	p-value
Hemoglobin (g/dL)	12.3 (11.6-13.0)	8.6 (7.4-9.6)	8.0 (7.7-9.0)	7.5 (6.6-9.8)	92.61	<0.001*
MCV (fL)	90.4 (84.8-95.8)	71.4 (65.7-76.4)	106.9 (104.3-111.3)	94.9 (88.3-97.0)	102.10	<0.001*
MCHC (g/dL)	33.9 (33.2-34.9)	28.8 (26.4-30.8)	37.8 (37.2-38.2)	34.5 (33.3-35.3)	101.63	<0.001*
Serum ferritin (ng/mL)	82.1 (53.8-120.4)	8.7 (5.8-12.0)	119.3 (94.4-146.9)	48.4 (41.2-58.4)	93.27	<0.001*

TABLE 5: Comparison of Hematological Indices Across Anemia Morphological Types (Kruskal-Wallis Test)

Data are presented as median (IQR). All four hematological indices were non-normally distributed (Shapiro-Wilk p < 0.05); the Kruskal-Wallis test (df = 3) was used to compare the four anemia-type groups. "Non-anemic" refers to women with Hb above the trimester-specific cut-off.

*p < 0.05 was considered statistically significant.

MCV: mean corpuscular volume; MCHC: mean corpuscular hemoglobin concentration; IQR: interquartile range

Discussion

In this cross-sectional study of 126 antenatal women booking for the first time at Allied Hospital, Faisalabad, anemia was detected in 71 women (56.3%). Among the anemic women, a microcytic hypochromic picture was the dominant morphology in 41 women (57.7%), followed by macrocytic anemia in 18 women (25.4%) and normocytic normochromic anemia in 12 women (16.9%). Median hemoglobin was 10.4 g/dL (IQR 8.0-12.2) and median serum ferritin was 53.5 ng/mL. Only gestational age at booking and body mass index were significantly associated with anemia status.

The observed frequency sits within the range reported for Pakistani antenatal populations. Ullah et al. (2019), studying 390 pregnant women in Lahore, reported anemia in 57.7%, almost identical to ours [3]. The systematic review by Mahar et al. (2024), which synthesized 27 Pakistani studies from 2007 to 2021,

documented pregnancy anemia prevalence ranging from 46.7% to 91% [2]; our estimate falls toward the lower end, plausibly because recruitment was confined to first-visit outpatient attendees. Higher figures were reported by Baig-Ansari et al. (2008), with anemia in 90.5% of 1,369 women sampled at 20-26 weeks in Hyderabad [4], and by Hamid et al. (2022), with 74.6% among 300 pregnant women in Muzaffarabad [15]. Ashraf et al. (2024) documented anemia in 71.5% of 397 reproductive-age women at a Karachi tertiary center [16], and Asrar et al. (2025) described the burden among admitted antenatal women in Faisalabad itself [5], whereas Qadir et al. (2022) found only 25% of 216 largely non-pregnant women in urban Quetta to be anemic [17]. Owais et al. (2025) showed that anemia among Pakistani reproductive-age women fell only from 50.5% in 2011 to 42.7% in 2018, with iron status actually deteriorating [18], and Shahzad et al. (2025) demonstrated marked provincial variation in antenatal iron supplementation across four Demographic and Health Survey waves [14], which helps explain the persistence of facility-level estimates in Punjab.

Internationally, our figure is closely comparable to the pooled Sudanese estimate of 53.0% (95% CI 45.9-60.1) derived by Adam et al. (2018) from 16 studies involving 15,688 pregnant women [11], and to Indian series: Sharma et al. (2024) reported 48.8% among 430 women in Delhi [10], Mehrotra et al. (2018) 50.9% among 786 women in Port Blair [19], Suryanarayana et al. (2017) 62.3% in a community cohort of 446 women in Kolar [20], and Kumari et al. (2025) 70.7% among 300 women in north-western India [21]. It is substantially higher than 18.0% among 529 women in northern Tanzania (Stephen et al., 2018) [8], 25.2% among 206 women in northwest Ethiopia (Asrie, 2017) [22], 27.1% among 823 women in Malatya, Turkey (Karaoglu et al., 2010) [23], and the 25.7% iron deficiency anemia prevalence among 300 first-trimester women in Palestine (Srour et al., 2018) [24]. Alem et al. (2023), analyzing Demographic and Health Survey data from 46 low- and middle-income countries, cited a Pakistani prevalence of 76.7% against a global figure of 29.9% for women of reproductive age [1].

The morphological distribution was the second objective of the study. Our finding that microcytic hypochromic anemia accounted for 41 of 71 cases (57.7%) accords with Bhatt et al. (2025), who found a hypochromic microcytic smear in 65.7% of 1,000 antenatal women [12], and with Lamba and Saroch (2023) in North India [25]. It contrasts sharply, however, with Shah et al. (2022), who reported normocytic normochromic anemia as the leading pattern in 52.4% of anemic women delivering in Hyderabad, Sindh, with microcytic hypochromic anemia in only 19.4% [7], and with Karaoglu et al. (2010), in whom 56.5% of anemias were normocytic normochromic and 34.5% of anemic women were vitamin B12 deficient and 71.7% folate deficient [23]. Confirmed iron deficiency also accounts for less anemia than morphology suggests: Adam et al. (2018) derived a pooled iron deficiency anemia prevalence of only 13.6% (95% CI 8.9-18.2) [11], and Nawaz et al. (2025) confirmed iron deficiency in just 27.7% of 130 anemic pregnant women in Swat, with thalassemia minor in 6.2% [13]. Our macrocytic proportion of 18 women (25.4%) therefore points to a substantial non-iron component, most plausibly vitamin B12 or folate deficiency, alongside the beta-thalassemia trait and iron deficiency described by Batool et al. (2023) in Pakistani pregnant women [26].

Biochemical stratification supported this interpretation. Median serum ferritin differed sharply across morphological groups ($H = 93.27$, $p < 0.001$), falling to 8.7 ng/mL in the microcytic group while remaining 119.3 ng/mL in the macrocytic and 48.4 ng/mL in the normocytic group. This dissociation confirms that only the microcytic subgroup was truly iron-depleted and echoes Babah et al. (2024), who found serum ferritin below 30 ng/mL in only 41.2% (95% CI 37.9-44.5) of 872 Nigerian women with moderate or severe anemia [27]. Galani et al. (2023) illustrate the converse problem, defining iron deficiency anemia by hemoglobin alone in an Indian prescribing audit, a practice our ferritin data suggest would misclassify a quarter of anemic women [28].

Among the stratified variables, anemia was significantly more frequent in women booking at or before 32 weeks, affecting 47 women (65.3%) compared with 24 women (44.4%) beyond 32 weeks (chi-square = 5.44, $p = 0.020$), and mean gestational age was lower in anemic women (30.90 ± 3.80 versus 32.45 ± 3.25 weeks, $t = -2.47$, $p = 0.015$). This inverse relationship contradicts the third-trimester excess reported by Balcha et al. (2023) (AOR: 3.21, 95% CI: 1.25-8.25) [9], Karaoglu et al. (2010) (OR: 2.3) [23], and Ahenkorah et al. (2016) among 400 first-visit attendees in Ghana [29], but mirrors Mehrotra et al. (2018), who also observed prevalence declining with advancing gestation [19]; a booking artifact, whereby later presenters had greater opportunity for incidental supplementation, is the most plausible explanation. Anemia was also more frequent in women with BMI at or below 30 kg/m², involving 52 women (62.7%) versus 19 women (44.2%) in the obese group (chi-square = 3.93, $p = 0.048$), consistent with Baig-Ansari et al. (2008), in whom non-anemic women were significantly heavier [4], and with the undernutrition association of Balcha et al. (2023) [9]. Age, residence, education, parity, gestational diabetes, and pregnancy-induced hypertension showed no significant association, diverging from Ullah et al. (2019) and Kumari et al. (2025), who found education, income, and residence or parity significant [3,21]; limited power is the likelier explanation.

Clinical significance

More than half of first-visit antenatal women were anemic, and a quarter of these had a macrocytic rather than an iron-deficient profile, so reflex iron supplementation would have left a substantial minority untreated. The stakes are considerable: Lone et al. (2004) found that anemic women in a Karachi cohort of 629 had a fourfold risk of preterm delivery and a 1.9-fold risk of low birth weight [6], and Shah et al. (2022) reported low birth weight in 47.5% of infants of anemic mothers versus 15.4% of non-anemic mothers in

Sindh [7]. A complete blood count with red cell indices, supplemented by serum ferritin, is inexpensive and sufficient to separate the three morphological groups at booking, permitting targeted iron, cobalamin, or folate replacement and prompting hemoglobinopathy screening where indices are discordant. Midwife-led continuity models such as that of Naz et al. (2024), in which 114 anemic women received intravenous iron, offer a practical delivery platform [30].

Strengths of the study

The study addressed both frequency and morphological type in a single consecutive series, which few local reports have done. Blood sampling was performed by a single investigator and processed in one institutional laboratory, limiting measurement variability. Trimester-specific hemoglobin thresholds were applied rather than a uniform cut-off, and serum ferritin was measured in every participant, allowing biochemical corroboration of morphology. Distributional assumptions were formally tested with the Shapiro-Wilk test, and non-parametric methods were applied wherever normality was violated, which strengthens the validity of the reported group comparisons.

Limitations

The single-center design and non-probability consecutive sampling restrict generalizability beyond first-visit attendees at one tertiary hospital in Faisalabad, and women who never reach institutional antenatal care, who are plausibly at higher risk, are unrepresented. The sample size was calculated against an anticipated prevalence of 13.6%, whereas the observed frequency was 56.3%; the resulting precision around subgroup estimates, particularly the 12 women with normocytic normochromic anemia, is therefore wide. The cross-sectional design permits no causal inference about the associations with gestational age and body mass index. Serum ferritin is an acute-phase reactant and was not accompanied by C-reactive protein, so iron deficiency may have been underestimated in women with subclinical inflammation.

Furthermore, morphological classification alone cannot establish the specific etiology of anemia without further diagnostic evaluation; therefore, the findings of this study should be interpreted as indicative of underlying patterns rather than definitive diagnoses. Dietary intake, birth spacing, household income, socioeconomic status, and helminth burden were not captured, and post-stratification chi-square testing without multivariable adjustment leaves residual confounding unaddressed. Consequently, subgroup associations should be interpreted cautiously and viewed as exploratory rather than definitive.

Recommendations

Reflex red cell indices and serum ferritin should accompany every booking hemoglobin, with vitamin B12, folate, and hemoglobin electrophoresis performed whenever indices are discordant or microcytosis coexists with normal ferritin. Multicenter studies with probability sampling, inflammation-adjusted iron markers, and multivariable modelling are needed to confirm the morphological distribution and clarify the inverse gestational age and body mass index associations observed here. Etiology-specific supplementation protocols, delivered within existing midwife-led antenatal services, should then be evaluated prospectively against maternal and perinatal outcomes.

Conclusions

Anemia was present in more than half of the antenatal women booking for the first time at Allied Hospital, Faisalabad, confirming that the condition remains a substantial public health problem in this population. Although a microcytic hypochromic picture predominated, a clinically important proportion of anemic women showed macrocytic or normocytic normochromic morphology, and the marked divergence in serum ferritin across these groups indicates that iron deficiency accounts for only part of the burden. Anemia was more frequent among women booking earlier in gestation and among those who were not obese, while age, parity, residence, education, gestational diabetes, and pregnancy-induced hypertension showed no significant association.

These findings suggest that reflex iron supplementation may not be an appropriate universal response to a low booking hemoglobin. Instead, they indicate the potential value of routine morphological and biochemical characterization at the first antenatal contact in this population, so that replacement therapy is matched to the underlying deficiency rather than assumed at the outset.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

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