ORIGINAL ARTICLE

Anemia in Pregnancy: its Renal Complications and Neonatal Outcome: A Community-Level Correlation Study

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ABSTRACT

Background: Anemia during pregnancy is a prevalent condition posing public health concern, especially in resource-limited regions where the combination of poor nutrition, late commencement of antenatal visits, and chronic inequities in healthcare access sustain its prevalence. The consequences of anemia on maternal and neonatal outcomes is well documented; however, its possible effects on renal function during pregnancy remain largely overlooked. To examine the correlation between anemia and renal function in pregnant women within a community-based clinical setting, evaluating how hemoglobin levels may relate to markers of renal performance and maternal outcomes.

Methods: This cross-sectional study included 71 pregnant women attending the antenatal clinics of a teaching hospital in Peshawar over a one-year period. Participants were referred from both urban neighborhoods and rural areas, including Riorkala, Urmar Miana, Badaber, and Matani, via local Basic Health Units (BHUs) and Rural Health Centers (RHCs). Anemia severity was classified using WHO hemoglobin thresholds. Renal function was evaluated through serum creatinine, blood urea nitrogen (BUN), and estimated glomerular filtration rate (eGFR). Maternal outcomes assessed included birth weight, preterm delivery, and mode of delivery.

Results: Most participants had mild (n = 28) or moderate (n = 20) anemia; no cases of severe anemia were found. Mean eGFR was lowest among women with moderate anemia. Although renal impairment (eGFR < 90 mL/min/1.73m²) occurred in both anemic and non-anemic women, no statistically significant correlation was observed between hemoglobin and eGFR (r = 0.06, p = 0.68).Birth weights and preterm delivery rates varied modestly by anemia severity. Anemia was more prevalent in rural participants, who also exhibited lower mean hemoglobin and eGFR values.

Conclusion: Anemia in pregnancy remains a prevalent health issue and may be linked with subtle renal changes. While no direct correlation between hemoglobin levels and eGFR was demonstrated, the presence of renal impairment across all anemia categories underscores the importance of routine renal monitoring in antenatal care, especially in underserved rural populations.

Keywords: Anemia in pregnancy, renal function, eGFR, maternal outcomes, community health, hemoglobin, antenatal care

INTRODUCTION

Anemia is among the most prevalent medical complications during pregnancy, especially in developing countries with persistent nutritional deficiencies and limited healthcare access. The physiologic demands of pregnancy increase iron and other nutrients in expectant mothers' diets which makes them prone to anemia, particularly without proper supplementation or dietary intake[1-3].

On a global scale, approximately 40% of pregnant women suffer from anemia, with iron deficiency being the most common culprit. This condition often goes untreated in many populations s due to infrequent or poorly timed antenatal care visits. There is abundant evidence to support an association between anemia and adverse perinatal outcomes including low birth weight, preterm delivery, and elevated maternal morbidity. However, the impact of anemia on renal function during pregnancy remains less comprehended[4-6].

The kidneys are essential in coping with the vascular and metabolic changes of pregnancy. Such copings are increases in blood volume, decreased serum creatinine levels, and greater glomerular filtration rate (GFR) of the kidney. Any changes from this adaptive physiology can indicate renal system insult, which is important from both maternal and fetal perspective[7-9].

Anemia's role in early renal stress or dysfunction, particularly among pregnant women in malnourished, underserved, and medically isolated communities with infections and poor healthcare access, has yet to be fully explored. Determining this relationship forges pathways toward improving expectant mother screening Algorithms as well as preventative frameworks within prenatal care[10,11]

This study was designed to assess the severity of

anemia in pregnant women and examine its relationship with renal function, using common laboratory markers such as serum creatinine, blood urea nitrogen, and estimated glomerular filtration rate (eGFR). By investigating these associations in a community-level setting, the study aims to provide insights that can inform local health policies and improve antenatal care practices.

METHODOLOGY

This research was carried out as a descriptive, analytical cross-sectional study at Khyber Girls Medical College (KGMC) and its constituent hospital units. The data gathering process took place over one year, from January 2022 to January 2023, which enabled seasonal fluctuations in dietetic infection trends due to their natural occurrence. The study population represented a diverse mix of urban and rural communities from the greater Peshawar region. Participants were referred from a variety of locations in and around Peshawar. Rural participants predominantly came from villages such as Riorkala, Urmar Miana, Badaber, and Matani, via local Basic Health Units (BHUs) and Rural Health Centers (RHCs).This referral system allowed access to a broader population of pregnant women across different socioeconomic and geographic settings.Semi-urban participants belonged to peri-urban fringes of Peshawar, such as areas on the outskirts of Hayatabad and Kohat Road, which are in transition from rural to urban characteristics. Urban participants resided in central Peshawar city, with direct access to tertiary antenatal care services.

An approval was obtained from institutional ethical review committee for this study information collection before the commencement of information gathering. Each participant provided both verbal and written consent. Throughout the entire research procedure, confidentiality was upheld with no identifying personal data used in the last analysis report.

The target population included expectant females who visited the antenatal clinic during the specified duration of the

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study. Utilizing non-probability consecutive sampling, 71 women were enrolled in the study. Women were enrolled at different gestational ages and data collection was done regardless of whether it was their first or follow-up antenatal visit.

Inclusion Criteria:
- Pregnant women aged between 18 and 45 years.
- Any trimester of pregnancy.
- Willingness to participate and provide informed consent.

Exclusion Criteria:
- Known cases of chronic kidney disease (CKD) or pre-existing renal disorders.
- Patients with chronic illnesses such as diabetes mellitus, autoimmune diseases, or blood disorders (e.g., thalassemia).
- Multiple pregnancies (e.g., twins or triplets), due to their unique physiological demands.

A form for data collection was created and used during one-on-one interviews. Moreover, pertinent clinical and laboratory variables were extracted from clinical and laboratory records.

The following sections are included in the form: Demographic Information: Included contains age, gravida, parity, level of education, current occupation, socio-economic class, and residence location.

Clinical History Data: Encompassed the trimester for specific pregnancy as well as the history regarding past antenatal visits along with any complicating features related to pregnancy, if any.

Relevant Laboratory Parameters: Included hemoglobin (for categorizing anemia), creatinine serum levels, blood urea nitrogen (BUN), and estimated glomerular filtration rate (eGFR). Also relevant urinary findings such as proteinuria for assess renal involvement concerning inferiority were evaluated.

Classification Criteria:
- Anemia was defined and categorized based on WHO standards:
  o Mild: Hb 10.0–10.9 g/dL
  o Moderate: Hb 7.0–9.9 g/dL
  o Severe: Hb < 7.0 g/dL
  o Normal: Hb ≥ 11.0 g/dL
- Renal function was assessed by calculating eGFR, using serum creatinine levels and standard age-adjusted equations. An eGFR below 90 mL/min/1.73m² was considered indicative of renal impairment.

Data were analyzed using SPSS version 25. Descriptive statistics were used for continuous variables (mean ± SD or median with range) and frequencies/percentages for categorical variables. Associations between anemia severity, residential area, and renal function (eGFR) were evaluated using ANOVA and Chi- square tests, with a p-value <0.05 considered statistically significant.

RESULT

The demographic profile of the 71 pregnant women enrolled in the study reveals a mean age of 30.1 years, indicating a relatively young reproductive-age cohort. Most participants were in their second (38%) or third trimester (38%), highlighting that the majority were beyond the early stages of pregnancy at the time of evaluation. Educational status varied, with 15% having no formal education and only 25% achieving tertiary-level education. This reflects limited educational attainment among a substantial portion of the population. In terms of occupation, nearly half were homemakers (48%), followed by laborers (34%), suggesting a predominantly non-professional working class. Socioeconomic status was largely distributed between low (40%) and middle

(44%) tiers, consistent with the economic challenges faced by many pregnant women in the region.

The distribution of residence showed that 44% lived in urban areas, 35% in semi-urban areas, and 21% in rural villages. Rural participants were primarily from areas such as Riorkala, Urmar Miana, Badaber, and Matani, often referred from local rural health centers to the teaching hospital's antenatal care unit in Peshawar. The median gravida was 3 (range: 1–5), and median parity was 2 (range: 0–4), indicating a moderately high obstetric history, which may influence both maternal and fetal outcomes. These demographic characteristics provide important context for interpreting the clinical findings related to anemia and renal function in this population.

Table 1: Demographic Profile Summary (n = 71)

Variable	Details
Age (mean ± SD)	30.1 ± 6.9 years
Trimester	1st (24%), 2nd (38%), 3rd (38%)
Education	None (15%), Primary (28%), Secondary (32%), Tertiary (25%)
Occupation	Homemaker (48%), Laborer (34%), Professional (18%)
Socioeconomic Status	Low (40%), Middle (44%), High (16%)
Residence	Urban 31(44%), Semi-Urban 25(35%), Rural 15(21%)
Gravida (median)	3 (range: 1–5)
Parity (median)	2 (range: 0–4)

Among the participants, anemia was common, with no cases classified as severe. The largest proportion fell into the mild anemia group (28 women), followed by 20 women with moderate anemia. Only 23 women were found to have normal hemoglobin levels, indicating no anemia. This high prevalence of anemia, even in mild forms, underscores its public health importance in pregnant populations, especially in resource-limited settings. Since anemia in pregnancy can impact both maternal and fetal outcomes, understanding its distribution is essential before exploring renal implications.

Table 2: Anemia Severity Distribution

Anemia Severity	Number of Patients
Severe	0
Moderate	20
Mild	28
None	23

When stratified by residential area, notable community-level differences were observed. The prevalence of anemia was highest among pregnant women residing in rural areas (87%), followed by those in semi-urban (76%) and urban settings (61%). Mean hemoglobin levels showed a corresponding gradient, with the lowest levels recorded in rural participants (9.4 ± 1.0 g/dL), compared to semi-urban (9.8 ± 0.9 g/dL) and urban women (10.3 ± 1.1 g/dL). Renal function, as measured by eGFR, followed a similar trend: rural women had the lowest mean eGFR (92 ± 15 mL/min/1.73m²), suggesting a subtle decline in kidney performance with increasing anemia prevalence. Preterm delivery rates were also elevated in the rural group (26%) compared to semi-urban (20%) and urban (16%) groups. These findings highlight a potential community-level disparity in maternal health outcomes, underlining the influence of socioeconomic and geographic factors on anemia-related renal and obstetric outcomes.

Table 3: Community-Level Correlation between Anemia and Renal Outcomes among Pregnant Women

Community Area	Total Women (n)	Anemia Prevalence (%)	Mean Hb (g/dL)	Mean eGFR (mL/min/1.73m²)	Preterm Delivery Rate (%)
Urban (n = 31)	31	61%	10.3 ± 1.1	102 ± 14	16%
Semi-Urban (n = 25)	25	76%	9.8 ± 0.9	97 ± 13	20%
Rural (n = 15)	15	87%	9.4 ± 1.0	92 ± 15	26%

Table 4: Renal Markers by Anemia Severity

Anemia Severity	Serum Creatinine (mg/dL)	BUN (mg/dL)	eGFR (mL/min/1.73m²)	r-value (Hb vs eGFR)	p-value (Hb vs eGFR)
Severe	–	–	–	0.06	0.68
Moderate	0.95	12.19	86.30		
Mild	0.92	11.54	89.14		
None	0.94	10.76	88.50		

Table 4 presents a comparative view of renal function parameters serum creatinine, blood urea nitrogen (BUN), and estimated glomerular filtration rate (eGFR) across varying degrees of anemia in pregnant women. Notably, no data were recorded under the severe anemia category, as no participants fell into this group. Among those with moderate anemia, the mean eGFR was 86.3 mL/min/1.73m², which is slightly lower than that observed in mild (89.14) and non-anemic participants (88.5). While these fluctuations suggest a possible downward trend in kidney function with worsening anemia, the differences were not statistically meaningful.

This is supported by the Pearson correlation analysis between hemoglobin levels and eGFR, which yielded an r-value of 0.06 and a p-value of 0.68. The r-value indicates a very weak positive relationship, while the high p-value confirms that the association lacks statistical significance. In essence, the findings imply that anemia in this population was not significantly correlated with reduced kidney filtration capacity, at least not in a linear fashion. However, the absence of severe anemia cases may have limited the ability to observe stronger trends or associations.

The study also explored birth-related outcomes in relation to anemia. It was observed that women with no anemia had the highest average birth weight (3.05 kg), while those with moderate anemia delivered infants with lower average weights (2.65 kg). Preterm birth rates were higher among those with moderate anemia (50%) compared to women with no anemia (34.8%). Similarly, the frequency of C-section deliveries was higher in the anemic groups. These trends suggest that even mild to moderate anemia may increase risks for both mother and baby, possibly linked to reduced oxygen delivery and altered metabolic conditions in pregnancy.

Table 5: Maternal Outcomes by Anemia Severity

Anemia Severity	Mean Birth Weight (kg)	Preterm Births (%)	C-Section Deliveries (%)
Severe	–	–	–
Moderate	2.65	50.0%	40.0%
Mild	2.80	46.4%	35.7%
None	3.05	34.8%	30.4%

To better quantify the impact of anemia on kidney health, the study looked at the proportion of women with renal impairment (defined as eGFR < 90). Surprisingly, renal impairment was present in 55% of the moderate anemia group and in over 50% of the non-anemic group as well. This lack of clear linearity may be due to other unmeasured confounding factors like pre-existing hypertension, diet, or hydration status. It does suggest, however, that renal stress may be present irrespective of hemoglobin levels, reinforcing the need for routine renal monitoring in all pregnancies.

Table 6: Renal Impairment by Anemia Severity

Anemia Severity	Renal Impairment (% eGFR < 90)
Severe	–
Moderate	55.0%
Mild	46.4%
None	52.2%

This bar chart illustrates the relationship between anemia severity and three key clinical outcomes: mean estimated glomerular filtration rate (eGFR), mean birth weight (kg), and percentage of renal impairment (eGFR < 90 mL/min/1.73m²). Data is grouped by anemia classification (Moderate, Mild, and None). Although mild anemia showed slightly better renal function and birth weight outcomes compared to moderate anemia, renal

impairment remained notable across all categories. The findings highlight the subtle yet potentially impactful influence of anemia on both maternal and renal health, even in its less severe forms.
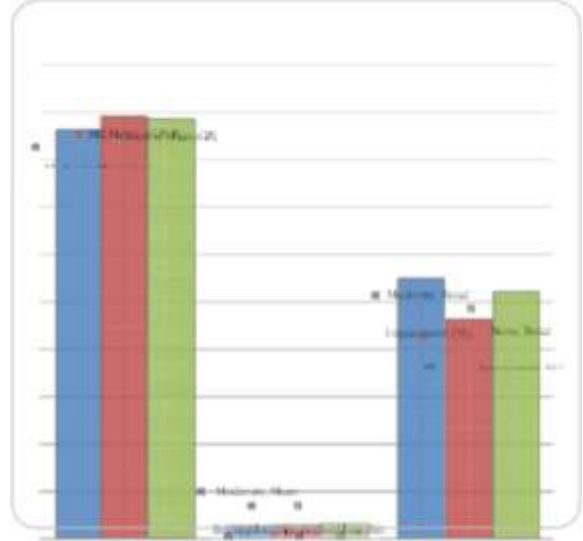

Figure 1: Clinical Outcomes by Anemia Severity in Pregnant Women

DISCUSSION

The findings of this study reaffirm that anemia remains a prevalent and pressing concern among pregnant women, particularly in low- and middle-income settings. With more than two-thirds of the participants falling into the mild or moderate anemia categories, the data clearly reflect that anemia during pregnancy is not an isolated issue but one tied closely to community-level factors like nutrition, education, occupation, and access to antenatal care[12,13].

While it is well-documented that anemia in pregnancy can lead to adverse fetal and maternal outcomes, the renal implications of this condition are less frequently explored (14-16). In our study, renal function markers such as serum creatinine, BUN, and eGFR varied modestly across anemia categories. Women with moderate anemia exhibited a lower average eGFR compared to their mildly anemic and non-anemic peers, which may suggest a degree of renal compromise. However, the Pearson correlation analysis between hemoglobin and eGFR yielded no statistically significant relationship ($r = 0.06$, $p = 0.68$), indicating that anemia severity in this sample was not strongly linked to measurable changes in renal filtration capacity.

Interestingly, even in the absence of severe anemia, renal impairment (defined as eGFR < 90) was observed in more than half of the women with moderate anemia, and also in a significant portion of those without anemia. This somewhat unexpected distribution implies that renal strain in pregnancy may not be solely a consequence of low hemoglobin levels. Other possible contributors gestational hypertension, dietary factors, hydration status, and undiagnosed subclinical conditions may be playing a role. This finding was consistent with previous literature suggesting that kidney function during pregnancy is influenced by multiple intersecting physiological and environmental factors[17-19].

Maternal outcomes such as birth weight, preterm delivery, and mode of delivery also revealed important trends. Women without anemia gave birth to infants with higher average birth weights and had lower rates of preterm delivery and cesarean sections compared to those with moderate anemia. This aligns

with research linking anemia to uteroplacental insufficiency and poor fetal growth outcomes[20]. However, it is worth noting that the differences, while clinically relevant, were not steep, and the absence of severe anemia in the study population might have muted more dramatic contrasts.

The study's strength lies in its community-level approach, capturing a range of socioeconomic and demographic variables that enrich our understanding of how anemia and renal health intersect. Nonetheless, the cross-sectional design limits causal interpretation, and the relatively small sample size particularly the lack of severe anemia cases may reduce the statistical power to detect certain associations.

CONCLUSION

This study highlights the persistent burden of anemia in pregnancy and its potential, albeit statistically non-significant, association with renal dysfunction. Although no strong correlation was observed between hemoglobin levels and renal filtration markers, the presence of renal impairment across both anemic and non-anemic groups underscores the need for broader renal screening during antenatal care. These findings reinforce the importance of early detection and management of anemia to improve both maternal and fetal outcomes. Integrating routine renal function assessment into antenatal care alongside strengthened community-level health education and improved nutritional access may offer a comprehensive approach to safeguarding maternal health in resource-limited settings.

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