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Evaluation of Iron Deficiency Anemia in Pregnancy

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ABSTRACT

Anemia in pregnancy was the common nutritional deficiency and a frequent medical concern that leads to numerous known complications, impacting both maternal and fetal health. **Objective:** To evaluate the biochemical parameters such as serum Iron, Ferritin TIBS and TfS in anemic and non-anemic pregnant women. **Methods:** In this cross-sectional study, pregnant women age 18-45 years attending the gynecological department of Niazi welfare foundation teaching hospital, Sargodha from April 2023 to January 2024 were included. Serum iron, ferritin, total iron-binding capacity, and transferrin saturation were assessed from blood samples. Independent sample t-test in SPSS version 26.0 was applied to see significant difference in biochemical parameters at value of <0.05. **Results:** Findings revealed mean hemoglobin level of 10.26 ± 1.52 g/dl in all participants. Anemic results were found in majority, accounting for 268 (70.9%) cases. Among these anemic patients, 149 (55.5%) had mild anemia, 107 (40%) had moderate anemia, and 12 (4.5%) had severe anemia. Anemic patients had significantly lower serum ferritin level ($p = 0.02$), serum iron ($p < 0.001$), and transferrin saturation ($p < 0.002$) than non-anemic patients. Additionally, total iron-binding capacity, ($p < 0.001$) indicated the anemic status of the pregnant women. **Conclusions:** Biochemical parameters of pregnant women with anemia were reduced compared to those without anemia. Healthcare providers should closely monitor pregnant women with reduced biochemical levels to prevent complications for both the mother and the fetus.

INTRODUCTION

It is a frequent medical concern during pregnancy, as the need for iron increases from 2.5 mg/day in the first few weeks to 6.6 mg/day in the later trimesters [1]. Typically, 30-50% of pregnant women are iron deficient during pregnancy. Anemia is a significant public health issue with prevalence rate reported to be 56% during pregnancy in underdeveloped countries [2]. Iron deficiency anemia is frequently used interchangeably with the term anemia during pregnancy [3]. The definition of pregnancy anemia according to World Health Organization (WHO) criteria comprises Hemoglobin (Hb) concentration of less than11 g/dl [4]. During pregnancy, various changes occur, particularly in hematological serum levels, which require monitoring and intervention. Many of these changes result in plasma expansion and hemodilution throughout the pregnancy [5]. Various biochemical markers are utilized to evaluate iron levels for diagnosing anemia during pregnancy. These parameters include serum iron, ferritin, transferrin, total iron-binding capacity (TIBC) and transferrin saturation [6] It is clear that measuring hemoglobin, iron, ferritin, and TIBC provides valuable criteria for assessing iron deficiency during pregnancy [7]. Total iron-binding capacity (TIBC) gradually increases throughout pregnancy [8]. Low blood iron levels and elevated TIBC in pregnant women are attributed to dietary iron deficiency [9]. Consequently, iron supplementation

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during pregnancy is beneficial for maintaining serum iron and TIBC levels closer to those of non-pregnant women [10]. There is a strong correlation between the decrease in serum iron and the increase in iron-binding capacity [11]. Moreover, various biochemical changes related to anemia (i.e. Hb, RBC, WBC) in pregnant women have been documented in the literature. Anemia during pregnancy is associated with several known complications for mother and fetus, such as preterm delivery, intrauterine growth restriction, and infant death [12]. During pregnancy, maternal iron stores are diminished to support the fetus in producing fetal hemoglobin [13]. Throughout pregnancy, various assays are performed at regular intervals to monitor all parameters and ensure the well-being of both the mother and the fetus. Although anemia is a treatable pregnancy complaint, but lack of ample knowledge regarding biochemical differences in pregnancy hinder the cure. Iron, ferritin, TIBC, and TfS are crucial indicators for assessing anemia, particularly iron deficiency anemia in pregnancy. Ferritin reflects the body's iron reserves, and low levels result in reduced Hemoglobin (Hb) production, leading to anemia. Serum iron levels represent the circulating iron necessary for Hb synthesis, and when these levels are low, anemia develops. TIBC indicates the capacity of the blood to bind iron, with elevated levels suggesting a deficiency of circulating iron as the body attempts to transport more iron for Hb synthesis. TfS measures the percentage of transferrin saturated with iron, and low TfS levels indicate decreased iron availability, confirming iron deficiency anemia. These parameters are vital for diagnosing anemia in pregnancy to ensure effective and timely management. Therefore this study is undertaken to see the correlation of biochemical parameters like serum ferritin level, Iron level, TIBS and transferrin saturation with maternal anemia during pregnancy for timely diagnosis and management to avoid unwanted consequences. Anemia is a preventable disorder and linked to various biochemical factors. In countries like Pakistan, it is a common pregnancy complaint linked to iron deficiency.

This study aimed to identify the biochemical parameters in anemic pregnant women in their first trimester to intervene effectively. Early detection is a key to successfully manage and follow treatment protocols along with best clinical practices. Dietary counseling and supplementation will aid further to reduce feto-maternal complications resulting from these biochemical factors.

METHODS

A cross-sectional study was performed at Niazi welfare foundation teaching hospital, Sargodha from April 2023 to January 2024, following approval from the Institutional Review Board (NM and DC-IRB-65) on 1st April 2023 with Ref#: IRB/NMDC/187. Sample size was calculated on Open Epi software, considering 95% confidence limits, 5% margin of error, and a reported anemia prevalence of 56% among pregnant women [2]. The calculated sample size was 378. Pregnant women aged 18-45 years visiting first time the gynecological department of NWFTH were included in this study after obtaining informed consent. Excluded cases were women requiring urgent care or having risk of gestational diabetes, preeclampsia, eclampsia and/ or HIV. The study population was categorized into four groups based on WHO criteria: non-anemic (Hb >11 g/dl), mildly anemic (Hb between 10–10.9 g/dl), moderately anemic (Hb between 7–9.9 g/dl), and severely anemic (Hb <7 g/dl) [4]. In data collection phase, demographic variable of pregnant women like age, Hb levels were noted. Under aseptic measures, 5 ml blood samples from all pregnant women were collected and stored in vials (ATLASLABOVAC Italiano) with EDTA (AK3EDTA) as an anticoagulant. Serum iron levels and TIBC were measured using the ferrozine calorimetric method. Serum ferritin levels were measured using electro-chemiluminescence immunoassay on Cobas c311 analyzer (Roche, Germany). Mean and SD was calculated for values of serum Hb, serum ferritin, serum iron, TIBC, and TfS. Frequencies and percentages were determined for variables such as the types and severity of anemia. Independent sample t-test in SPSS version 26.0 was applied to see significant difference in biochemical parameters at value of <0.05. Pearson correlation coefficient was applied to reveal relationship of association between pregnancy anemia and biochemical parameter at significance value of $p<0.05$.

RESULTS

Among the 378 patients, the average age was 27.20 ± 2.54 years. Mean hemoglobin level was 10.26 ± 1.52 g/dl. Of these patients, 268 (70.9%) were anemic and 110 (29.1%) were non-anemic. Within the anemic group, 149 patients (55.5%) had mild anemia, 107 patients (40%) had moderate anemia, and 12 patients (4.5%) had severe anemia depicted in table 1.

Table 1: Demographic Characteristics of Participants

Variables	Mean ± SD / N (%)
Mean Age (Years)	27.20 ± 2.54
Mean Hb Level (g/dL)	10.26 ± 1.52
Anemia Status	
Anemic Patients	268 (70.9%)
Non-Anemic Patients	110 (29.1%)
Anemia Severity	
Mild Anemia	149 (55.5%)
Moderate Anemia	107 (40%)
Severe Anemia	12 (4.5%)

The biochemical analysis in table 2 showed a mean serum ferritin level of 33.24 ± 24.82 ng/ml, serum iron level of 99.01 ± 29.27 µg/dl, TIBC of 587.6 ± 73.93 µg/dl, and TfS of 18.96 ±

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6.8 in pregnant anemic women. Anemic patients had significantly lower serum ferritin level ($p = 0.02$), serum iron ($p < 0.001$), and transferrin saturation ($p < 0.002$) than non-anemic patients. TIBC (p-value <0.001) was indicative of anemia in pregnant women.

Table 2: Mean differences of Biochemical Parameters in Anemic and Non-Anemic Patients

Variables	Anemic Pregnant Women Mean ± SD	Non-Anemic Pregnant Women Mean ± SD	p-Value
Hemoglobin (g/dL)	9.04 ± 0.63	11.84 ± 0.59	<0.001
Serum Ferritin (ng/mL)	33.24 ± 24.82	42.43 ± 26.20	0.02
Serum Iron (µg/dL)	99.01 ± 29.27	156.06 ± 20.24	<0.001
TIBC (µg/dL)	587.6 ± 73.93	405.2 ± 26.48	<0.001
TfS (%)	18.96 ± 6.84	21.32 ± 6.44	<0.002

The Pearson correlation results demonstrated a negative relationship between anemia and biochemical markers such as serum ferritin, iron, and transferrin saturation (TfS) percentage. These negative associations indicate that lower values of these parameters were observed in cases of anemia during pregnancy. A p-value of <0.05 confirmed the significance of these associations given in table 3. Additionally, a positive correlation was found between anemia and total iron-binding capacity (TIBC), with the statistically significant result.

Table 3: Association between Pregnancy Anemia and Biochemical Parameters

Biochemical Parameters	Pearson Correlation Coefficient	p-Value
Serum Ferritin (ng/mL)	-0.465	<0.001
Serum Iron (µg/dL)	-0.523	<0.001
TIBC (µg/dL)	0.475	<0.001
TfS (%)	-0.380	<0.003

DISCUSSION

This study found that ratio of pregnant women with anemia was high. A more detailed analysis revealed mild and moderate anemia was mostly common among the pregnant women; overall anemia was evident in 70.9% cases. This is consistent with recent research from Lahore, Pakistan, which also reported a high anemia prevalence of 57.7% among pregnant women. Similar to this findings, their study found that mild anemia was the most common, followed by moderate anemia, with severe anemia being the least prevalent [14]. This study observed significantly lower hemoglobin levels in pregnant anemic women compared to non-anemic. These results align with existing literature. Studies, including those conducted on pregnancy anemia, such as those by Ray JG *et al.*, Okoroiwu IL *et al.*, and Agarwal AM *et al.*, similarly report reduced hemoglobin levels [15-17]. This study found that pregnant women with anemia had significantly lower levels of biochemical parameters (serum iron, ferritin levels and transferrin saturation) compared to non-anemic women. Also, the results of Pearson correlation coefficient revealed statistically significant association between biochemical parameters and anemic pregnant women. Lower serum iron, ferritin levels and transferrin saturation in anemic pregnant women were evident in other studies reveling the significant impact of these parameters with anemia [16, 17]. In anemic pregnant women, the observed low levels of serum iron, ferritin, and transferrin saturation align with outcomes from current studies of Aloy-Amadi O *et al.*, and Anwar Z *et al.*, Lower serum iron levels, ferritin levels, and transferrin in blood tests suggest iron deficiency anemia [18, 19]. This study's higher incidence of low iron among pregnant anemic women supports the presence of iron deficiency anemia. This was further reinforced by this finding of higher mean TIBC levels in pregnant anemic women than non-anemic, as elevated TIBC also indicates iron deficiency. These findings correlate with other studies revealing elevated TIBC and low iron levels [20]. The notably lower levels of serum iron, ferritin, and transferrin saturation observed among anemic pregnant women in this study were consistent with the findings of Raza N *et al.*, indicating iron deficiency anemia [21]. Reduced concentrations of iron, ferritin, and transferrin saturation strongly suggest iron deficiency anemia. Additionally, it observed a significantly elevated TIBC in the anemic group, which aligns with Bleyere MN *et al.*, study in pregnant women [22]. The elevated TIBC can be attributed to reduced iron levels and transferrin saturation, common features of iron deficiency anemia. Anemia was a linked to various biochemical factors. In countries like Pakistan, it was a common pregnancy complaint linked to iron deficiency. Anemic status of pregnant women should be assessed early to monitor these parameters in routine clinical practice, So that it can prevent devastating consequences. The findings of the current study should be considered in light of several limitations, including the lack of reported biochemical profiles for each trimester of pregnancy. There is a need to conduct a comprehensive research on pregnancy anemia in relation to each trimester.

CONCLUSIONS

Maternal health, along with its associated morbidity and mortality, was a significant concern in Pakistan. Anemia in pregnancy was linked to low levels of biochemical parameters. It was advisable for healthcare providers to closely monitor pregnant women with low biochemical levels to prevent complications for both the mother and the fetus.

Authors Contribution

Conceptualization: SA[1]
Methodology: SA[1], MA
Formal analysis: SA[2]
Writing, review and editing: SR, MFJ, RM, MA

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All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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