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Original Article

Serum Ferritin Level and Total Iron Binding Capacity Relationship with Iron Deficiency Anemia during Pregnancy and Labour

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ABSTRACT

Background: Iron deficiency anemia (IDA) is a prevalent condition globally, impacting maternal and fetal health outcomes significantly. The condition is especially concerning during pregnancy, given its association with complications such as preterm labor and increased maternal and neonatal morbidity and mortality rates.

Objective: The study aimed to assess the prevalence of IDA among pregnant women and its correlation with fetal-maternal complications, as well as to evaluate the effectiveness of current healthcare interventions in managing the condition.

Methods: A cross-sectional study was conducted at Shikhzayad Women Hospital, Larkana, over six months from January 1, 2022, to July 1, 2022. Fifty pregnant women with IDA at various gestational stages were selected and evaluated for serum ferritin and total iron-binding capacity (TIBC). The severity of anemia and its correlation with feto-maternal complications were analyzed using SPSS version 25.

Results: Out of the 50 women studied, 6 had mild anemia, 37 had moderate anemia, and 7 had severe anemia. Serum ferritin levels showed that 10 participants had levels between 5-10 mg/L, 20 had levels between 10-50 mg/L, 10 had levels between 50-150 mg/L, and 10 had normal levels (150-300 mg/L). Elevated TIBC levels (400-600 ug/ml) were observed in 30 women. Feto-maternal complications included emergency cesarean sections (28 cases), postpartum hemorrhage (8 cases), disseminated intravascular coagulation (6 cases), cardiac failure (4 cases), and maternal death (4 cases). Pregnancy outcomes were reported as 5 first-trimester abortions, 2 second-trimester abortions, 4 preterm deliveries, 15 cases of intrauterine growth restriction (IUGR), 9 intrauterine deaths (IUD), and 5 neonatal deaths (NND).

Conclusion: IDA remains a significant determinant of adverse maternal and neonatal outcomes. This study underscores the urgent need for enhanced preventive strategies, including iron supplementation and dietary education. Further large-scale research is required for a comprehensive understanding of IDA's impact and the development of targeted interventions.

Keywords: Iron Deficiency Anemia, Pregnancy, Maternal Health, Feto-Maternal Complications, Serum Ferritin, Total Iron-Binding Capacity, Antenatal Care, Neonatal Outcomes.

INTRODUCTION

Iron deficiency anemia (IDA) poses a substantial public health challenge, affecting nearly one-fourth of the global population. This condition is particularly prevalent among women of reproductive age (15-50 years), where it stands as the foremost cause of anemia (1, 2). IDA is identified by its hypochromic, microcytic nature, resulting from inadequate iron, a crucial component for hemoglobin synthesis. This deficiency impedes the transport of oxygen to critical organs, leading to a spectrum of symptoms such as fatigue, dizziness, pallor, and more severe outcomes like fetal growth restrictions and increased risk of morbidity and mortality in both the fetus and the mother (2, 3).

According to the World Health Organization (WHO), anemia is defined based on a hemoglobin level that is two standard deviations below the mean for a healthy population (4). Pregnancy introduces physiological adaptations, including a 48-50% increase in plasma volume, which, while essential for enhancing placental perfusion and supporting fetal development, leads to dilutional anemia. The

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WHO sets the anemia threshold at a hemoglobin concentration below 11 g/dl during pregnancy and below 10.8 g/dl in the postpartum period (3-5). Notably, hemoglobin levels under 7 g/dl significantly escalate maternal mortality risks, with levels as low as 6 g/dl often correlating with emergency presentations and adverse fetal outcomes (6).

The role of iron extends beyond hemoglobin synthesis; it is vital for numerous physiological functions (6-8). The total iron requirement during pregnancy is estimated to be around 1240mg to cater to the needs of the fetus, placenta, and the mother's increased red cell mass. Iron is predominantly stored in the liver as ferritin, and levels ranging from 30 to 300 ng/ml are deemed normal. However, during pregnancy, reduced serum ferritin levels are indicative of IDA (7). The diagnostic utility of total iron binding capacity (TIBC), which normally ranges from 250 to 400 ug/ml, is limited in pregnancy due to physiological hemodilution affecting its accuracy (8).

Emerging research on serum hepcidin levels presents a new avenue for understanding IDA in pregnancy, highlighting the dynamic and multifaceted nature of iron metabolism and its implications for maternal and fetal health (6-8). The WHO recommends a daily intake of 100-200 mg of elemental iron during pregnancy to mitigate the risk of IDA and its associated complications (9). This comprehensive approach underscores the critical importance of addressing iron deficiency to improve pregnancy outcomes and safeguard maternal and neonatal health (9-11).

MATERIAL AND METHODS

This study aimed to investigate the prevalence and implications of iron deficiency anemia (IDA) among pregnant women during various stages of pregnancy, labor, and the postnatal period. Conducted at Shikhzayad Women Hospital in Larkana, the research spanned six months, from January 1, 2022, to July 1, 2022. A cohort of 50 participants was meticulously selected based on the diagnosis of iron deficiency anemia, encompassing various gestational ages across all trimesters and stages of labor, including both outpatient department (OPD) visits and emergency admissions. The sample included both primigravida and multigravida women, ensuring a comprehensive understanding of IDA's impact across different pregnancy experiences.

Prior to participation, informed consent was obtained from all subjects, aligning with ethical standards and respecting the autonomy of the participants. This process was guided by the principles outlined in the Declaration of Helsinki, ensuring that all ethical considerations, including the rights, safety, and wellbeing of the participants, were prioritarily addressed (12, 13).

The collection of biographical data was a critical initial step, encompassing essential details such as name, age, residency, gravida status, parity, booking status, present complaints, gestational age, and any relevant medical or surgical history, including previous blood transfusions and the mode of delivery, whether spontaneous vaginal delivery (SVD) or cesarean section (c/s). These data points provided a foundational understanding of the participant's health background and potential risk factors associated with IDA. (14)

For the purpose of this study, blood samples were meticulously collected following the acquisition of informed consent. A total of 2cc of blood was drawn for hemoglobin level analysis and absolute values determination, while an additional 4cc was obtained for the assessment of serum ferritin levels and Total Iron Binding Capacity (TIBC). This approach allowed for a comprehensive evaluation of the iron status and the degree of anemia among the participants (15, 16).

Data analysis was performed using SPSS version 25, a statistical software renowned for its capability to handle complex data analysis in medical research. This step involved the application of appropriate statistical methods to assess the prevalence of IDA, its correlation with various gestational and labor stages, and its potential impact on maternal and neonatal outcomes. The use of SPSS facilitated the objective evaluation of the data, ensuring the reliability and validity of the study's findings.

RESULTS

In the investigation of iron deficiency anemia (IDA) among pregnant women, the study demonstrated a noteworthy distribution of anemia severity. Mild anemia was observed in a minority of 6 individuals, while moderate anemia was predominant, affecting 37 participants. Severe anemia was identified in 7 individuals, indicating a critical need for medical intervention in these cases.

Focusing on serum ferritin levels, which play a crucial role in diagnosing IDA, the data revealed that 10 individuals had ferritin levels significantly below the normal range, between 5-10 mg/L. A substantial portion, 20 participants, displayed ferritin levels ranging from 10-50 mg/L, underscoring a state of deficiency. Ferritin levels were found to be within the lower spectrum of normal (50-150 mg/L) in another group of 10 individuals, whereas an equal number of participants had levels within the optimal range (150-300 mg/L), reflecting adequate iron stores.

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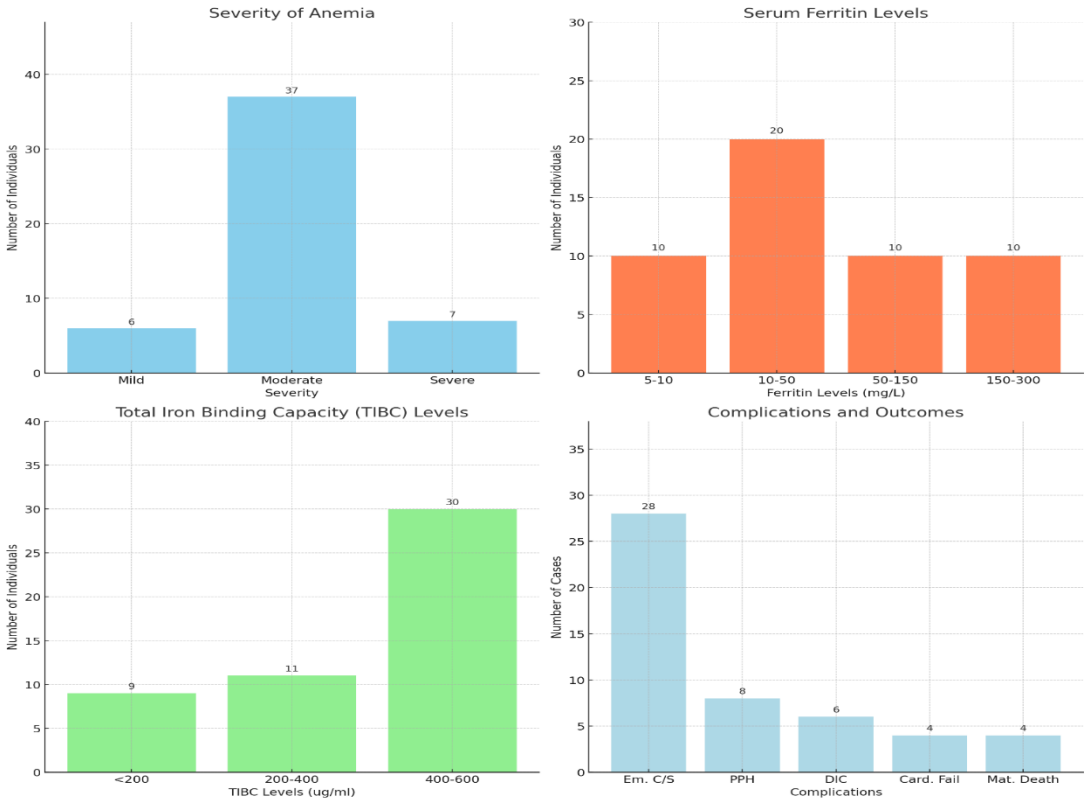

Figure 2 Study Characteristics

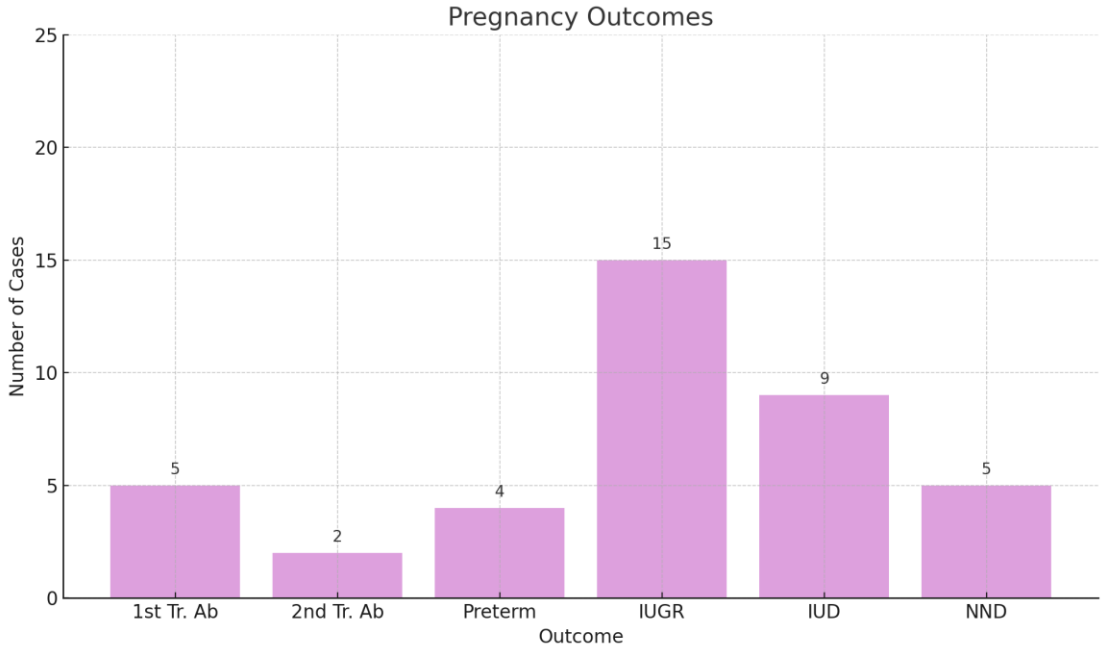

Figure 1 Outcome Characteristics

The Total Iron Binding Capacity (TIBC) levels further elucidated the iron status within the cohort. A segment of 9 individuals presented with TIBC levels below 200 ug/ml, which typically suggests a non-iron deficient state or possible inflammation. In contrast, 11 individuals had TIBC levels that fell within the 200-400 ug/ml range, reflecting a borderline normal to potentially deficient state. Notably, the majority of the study population, 30 participants, showed elevated TIBC levels (400-600 ug/ml), a clear marker of iron deficiency as the body increases TIBC in an attempt to capture more iron when stores are low.

Complications and outcomes during the perinatal period presented a compelling aspect of the study. The most frequent complication was the need for emergency cesarean sections, occurring in 28 cases. This was followed by postpartum hemorrhage (PPH), with 8 instances recorded. Disseminated intravascular coagulation (DIC), a serious condition leading to simultaneous bleeding

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and clotting, was reported in 6 cases. Cardiac failure and maternal death each were observed in 4 cases, highlighting the severe risks associated with IDA in pregnancy.

Furthermore, the study scrutinized the pregnancy outcomes, revealing 5 instances of 1st trimester abortions and 2 instances of 2nd trimester abortions. Preterm delivery was observed in 4 cases, while a more significant number of pregnancies, 15 in total, resulted in intrauterine growth restriction (IUGR)—a condition often associated with inadequate placental blood flow, which can be a consequence of maternal anemia. Intrauterine death (IUD) was recorded in 9 cases, and neonatal death (NND) occurred in 5 cases, underscoring the critical impact of maternal iron levels on fetal and neonatal survival.

DISCUSSION

Iron deficiency anemia (IDA) stands out as a pervasive public health issue, with significant maternal and fetal repercussions observed across both developing and developed nations. This study has contributed to the understanding that iron storage in women relies heavily on ferritin availability within the reticuloendothelial system, including the liver, spleen, and bone marrow. Among the cohort, a mere 20% of the pregnant women demonstrated normal ferritin storage levels, while a staggering 80% presented with diminished levels, indicating a strong association between low serum ferritin and elevated Total Iron Binding Capacity (TIBC) (17, 18).

Feto-maternal complications were predominantly associated with cases of moderate to severe anemia, whereas mild anemia showed a lesser likelihood of leading to such complications. It is evident from this study and corroborated by previous research that IDA, though a serious condition, can be effectively managed and even cured through vigilant antenatal care and appropriate iron supplementation throughout pregnancy and extending into the postpartum period (19, 20). Such interventions have shown a considerable impact on reducing both fetal and maternal complications (19, 20).

Early diagnosis of anemia in pregnancy emerged as a critical factor, with associations between early diagnosis and increased risks of early pregnancy loss, second-trimester abortion, and as pregnancy progresses, a cascade of issues including preterm labor, intrauterine growth restriction, and ultimately, a spectrum of labor complications such as antepartum hemorrhage, postpartum hemorrhage, disseminated intravascular coagulation, and in severe cases, maternal mortality (11). The importance of a balanced diet rich in iron cannot be overstated, particularly given the findings that poor iron storage, a diet lacking in meat, and general undernourishment are all prominent in the development of IDA among pregnant women with low socioeconomic status. Conversely, higher body mass index (BMI) and greater iron intake were associated with a reduced risk of anemia (17, 21).

The World Health Organization's recommendation of 120 mg/day of elemental iron and 2.8 mg/week of folic acid for pregnant women regardless of the gestational period is a testament to the recognized need for universal measures to prevent IDA (10). Despite this, the study acknowledges its limitations, including the small sample size, which inhibits the extrapolation of these findings to a broader population. Thus, there is a call for larger-scale studies with adequate funding and robust protocols to further investigate IDA among pregnant women (4, 6, 10, 12, 22).

The research also underscores the necessity for improved health facilities and resource availability in developing countries, where the unavailability of medicines and other resources at government institutions remains a significant barrier. To truly grasp the extent of the problem and to guide public health policy, there is a pressing need for well-designed prospective control studies. These studies should aim to delve into the long-term effects of IDA on offspring, examining parameters such as proerythrocyte excretion and developmental milestones.(17, 18, 21)

In conclusion, this study adds to the growing body of literature emphasizing the profound impact of IDA on feto-maternal health. It calls for heightened research efforts, enhanced healthcare protocols, and sustained supplementation strategies as pivotal steps towards mitigating the risks associated with this preventable yet prevalent condition.

CONCLUSION

This study reinforces the critical public health implication that iron deficiency anemia during pregnancy carries substantial risks for both mother and child, necessitating concerted healthcare efforts for early diagnosis and management. It highlights the importance of widespread access to antenatal care, iron supplementation, and improved dietary practices, supported by policy and healthcare infrastructure. Addressing these needs could significantly reduce the incidence of IDA-related complications and improve outcomes in maternal and neonatal health.

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