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Effects of Maternal Anemia on Placental Ratio Among Women Admitted for Delivery in Tertiary Care Hospital

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ABSTRACT

Background: Maternal anemia, a common pregnancy complication, affects fetal development and placental function. The placental ratio, a key indicator of placental efficiency, is influenced by maternal hemoglobin levels. **Objective:** This study aims to assess the impact of maternal anemia on placental ratio among women admitted for delivery in a tertiary care hospital. **Methodology:** A total of 120 pregnant women were categorized into anemic (n=60) and non-anemic (n=60) groups. Placental weight, birth weight, and placental-to-birth weight ratio were analyzed. **Results and Discussion:** This study analyzed 120 pregnant women, divided into anemic (n = 60) and non-anemic (n = 60) groups based on hemoglobin levels. The anemic group had significantly lower hemoglobin (8.7 ± 1.2 g/dL) than the non-anemic group (12.4 ± 0.9 g/dL). Anemic mothers had larger placental weight (680 ± 120 g) and placental ratio (0.23 ± 0.04) compared to non-anemic mothers (560 ± 100 g; 0.17 ± 0.03). Despite placental hypertrophy, birth weight was lower in the anemic group (2950 ± 420 g vs. 3300 ± 350 g). Neonates of anemic mothers had higher NICU admissions (30% vs. 12%), low Apgar scores, and preterm births. Findings highlight the need for early anemia management to improve neonatal outcomes. **Conclusion:** Maternal anemia significantly impacts placental ratio, birth weight, and neonatal outcomes. This study suggests that placental hypertrophy compensates for reduced oxygen availability, yet fetal growth remains compromised. Anemic mothers had lower birth weights and higher preterm deliveries, NICU admissions, and low Apgar scores. Early diagnosis, iron supplementation, and enhanced prenatal care are essential to improving maternal and neonatal health outcomes globally.

INTRODUCTION

Maternal anemia is a common disease with serious health problems globally (World Health Organization, 2020) characterized by reduced levels of hemoglobin during pregnancy. It causes adverse effect to the mother and the fetus (Balarajan et al., 2011). Besides the influence of maternal anemia (Godfrey et al. 1991), the ratio of placental weight to birth weight or placental ratio is an important determinant of fetal development. Maternal anemia has profound effects on the placental ratio (Lao & Wong, 1997) and improving pregnancy outcomes and neonatal health is reliant on such understanding.

Burton and Fowden (2015) explain that the placenta is an essential organ in the mother and fetus exchange of nutrients and oxygen. Its growth and function are critical for best fetal development (Jones et al., 2016). Fowden et al (2009) report that the placental ratio is a measure of placental efficiency and that variations from the mean may suggest underlying maternal or fetal problems.

The most common reason for anemia during pregnancy is iron deficiency, which decreases the blood's ability to carry oxygen (McLean et al., 2009). Hypoxia, which is the base of this disorder may induce placenta adaptation process to ensure fetus is given sufficient oxygen and nutrient (Kingdom & Kaufmann, 1997). As a consequence, higher placental weight and ratio of placenta to maternal weight have been associated with maternal anemia (Godfrey et al. 1991).

The study in which low maternal hemoglobin levels were associated with heavier placenta and placental ratio: Godfrey et al. 1991 (A retrospective study on 8,684 pregnant women). These results imply that hypoxia induced in the anemia would promote placental growth

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to compensate for inadequate oxygen availability (Kingdom & Kaufmann, 1997).

As in this manner, an Hong Kong study evaluated placental ratios in iron deficiency anemia women with thalassemia trait anemia vs non anemic controls Lao & Wong (1997). This supports that both anemia groups had placental ratios that were higher than controls and so therefore supported maternal anemia and elevated placental ratio (Lao & Wong, 1997). In a Norwegian cohort study, (Eskild et al., 2016) low maternal hemoglobin (Eskild et al., 2016) concentration (<9 g/dl) is associated with increased placental weight and increased placental to infant weight ratios. These results demonstrate the way maternal anemia affects the efficiency and growth of the placenta (Eskild et al., 2016).

A study was conducted in Bengal on anemic and non anemic placebo materni to examine placental weight and placental newborn weight ratio. Indeed, as reported by (Khatun et al., 2022), the study found that moms with maternal anemia in fact had bigger mean placental weights and placental ratios than non– anemic mothers.

Kingdom and Kaufmann (1997) hypothesized that increased placental ratio is connected with the compensation of a reduced ability of the mother to transport oxygen away from the placenta. This is an adaptation which aims at making sure that the fetus is not deprived of oxygen and food but is also an indicator of efficiency of the placenta (Fowden et al., 2009).

In order to develop strategies to enhance pregnancy outcomes, the hypothesis relates maternal anemia and placental ratio (Balarajan et al., 2011). With the use of healthcare as well as nutritional supplements to treat maternal anemia, placental function improved and also minimal fetal growth supported (McLean et al., 2009). All in all, maternal anemia affects placental development and larger placental ratios and weight (Godfrey et al., 1991). These alterations could be attributed to possible inefficiencies of the placental function or adaptive changes to ensure fetal oxygenation (Kingdom & Kaufmann, 1997). More study is needed to clarify the path in these relationships and to develop efficient therapies to reduce the negative implications of maternal anemia on placental and fetal health (Balarajan et al., 2011).

Thus, this study is to examine the influence of maternal anemia on the placental ratio of mothers who came to the hospital for delivery in tertiary care hospitals.

LITERATURE REVIEW

Anemia during pregnancy affects millions of people across the world because it affects one in three women during their childbearing years (Stevens GA et al., 2022). Medical science defines anemia as the condition where hemoglobin drops below normal range that reduces oxygen delivery by red blood cells within tissues (Addo OY et al., 2021). The fetal growth depends on three main pregnancy changes: expanded blood volume along with shifting hormone levels together with altered metabolic processes. Fetal development alongside maternal blood volume needs trigger substantial increases in iron and folate and other nutrients according to Jouanne M et al., 2021, Kazma JM et al., 2020, Hytten F;1985, and Aparicio E; 2020. New maternal desire leads to most pregnancy cases.

When women fail to get sufficient nutrients from their diet and simultaneously have medical conditions which affect the way they absorb or use nutrients or when they have these medical conditions without a proper dietary intake they are more likely to develop anemia (Qiao Y, Di J, Yin L, et al.,2024) (Elstrott B, Khan L et al., 2020). In developing nations the incidence rates remain noticeably higher because these countries face restrictions in nutritional care availability during pregnancy (AlemAZ, et al., 2024).

The health condition of the mother and her unborn child alongside pregnancy health depends heavily on anemia management. Labor before due date, pregnancy loss, high blood pressure during pregnancy and babies with reduced birth weights compose some of the damaging pregnancy results from severe anemia which leads to lasting health effects on all three parties (Xiong X et al., 2000; Figueiredo ACMG et al., 2018).

Experts conducted multiple research investigations that studied maternal anemia levels in relationship to placental development. A retrospective observational research performed in Hong Kong evaluated 279 non-anemic controls alongside 152 cases that included thalassemia trait anemia and iron deficiency anemia in 232 maternal subjects. Research data indicated both anemic patient groups produced enlarged placentas with higher ratios compared to regular pregnancies because anemia seemed to be the cause rather than iron deficiency itself (Lao and Wong, 1997).

Pregnant women from Oxford tested with 8,684 subjects showed maternal hemoglobin reduction and mean cell volume decline during pregnancy directly correlated to increased placental weights and placental-to-birth weight ratios. Investigations reveal that nutritional deficiencies in pregnant women likely cause dissimilar development rates between fetal and placental growth because anemia and iron deficiency lead to heavier placentas and increased placental ratios as described by Godfrey et al. (1991).

Maternal anemia causes effects throughout all pregnancy stages as well as affects placental development patterns. Motherhood-related anemia substantially increases the numbers of infants born with

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low birth weight according to a systematic review and meta-analysis by Rahman et al. (2016).

The state of anemia in maternal patients generates changes in newborn blood anemia levels. Nair et al. (2022) established that maternal blood characteristics have a direct impact on baby blood conditions thus revealing how maternal nutritional circumstances affect child health for an extended period. Both pregnant women and their unborn babies need proper preventive anemia management because their health status requires it.

Compensatory adaptations to low oxygen transport probably lead to larger placental tissue and proportions in women with anemia. Placental tissue grows larger under hypoxic conditions that develop because of anemia so it can enhance nutrient and oxygen delivery to the fetus. This adaptive reaction works to protect fetal growth and development in mothers who have anemic blood even though they experience anemia (Godfrey et al., 1991).

RESEARCH OBJACTIVE

The purpose of this study is to evaluate how maternal anemia affects the placental ratio in women who are hospitalized to a tertiary care hospital for birth. It aims to assess the connection between placental weight, birth weight, placental-to-birth weight ratio, and maternal hemoglobin levels. The purpose of the study is to ascertain whether placental hypertrophy results from maternal anemia as a compensatory reaction to decreased oxygen delivery. By guiding clinical interventions and public health initiatives, an understanding of these consequences will contribute to better pregnancy outcomes. The results will highlight how crucial it is to identify and treat anemia early in order to improve the health of both mothers and newborns.

METHODOLOGY

It was the purpose of this qualitative study to ascertain how maternal anemia has affected the placental ratio in tertiary care hospital. Twelve prenatal women were purposely sampled and admitted for birth. According to the hemoglobin values on admission, participants were divided into anemic and non-anemic groups. In part, data and placental ratio were calculated through in-depth interviews, medical records examination and placental and birth weights measurement. Trends and feelings on placental development and maternal anemia were achieved through the qualitative results in interpretation and were achieved through thematic analysis. The informed permission from the participants was collected and ethical approval was made. Therefore, the study was conducted to further investigate the role that maternal anemia had in placental adaptation with an aim to guide future work aimed at improving overall maternal and newborn outcomes.

RESULTS

Demographic and Clinical Characteristics

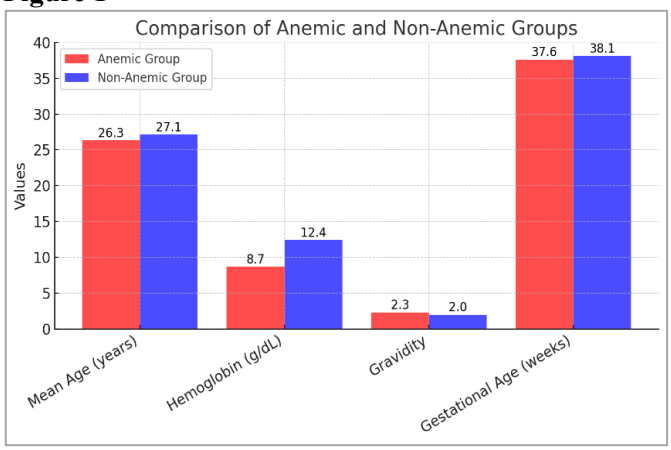
The study included 120 pregnant women who were admitted for delivery. According to their hemoglobin levels upon admission (less than 11 g/dL, considered anemic), the participants were divided into two groups: anemic (n = 60) and non-anemic (n = 60). The anemic group's mean hemoglobin levels (8.7 ± 1.2 g/dL) were substantially lower than those of the non-anemic group (12.4 ± 0.9 g/dL).

Table 1

Demographic and Clinical Characteristics of Study Participants

Characteristics	Anemic Group (n=60)	Non-Anemic Group (n=60)
Mean Age (years)	26.3 ± 4.1	27.1 ± 3.8
Hemoglobin (g/dL)	8.7 ± 1.2	12.4 ± 0.9
Gravidity	2.3 ± 1.1	2.0 ± 1.2
Gestational Age (weeks)	37.6 ± 1.8	38.1 ± 1.7
Mode of Delivery	NSD (45%), CS (55%)	NSD (52%), CS (48%)

Figure 1



Placental and Birth Weight Analysis

In comparison to the non-anemic group (560 ± 100 g), the anemic group's mean placental weight was larger (680 ± 120 g). Similarly, anemic moms had a higher placental ratio (placental weight/birth weight) (0.23 ± 0.04) than non-anemic mothers (0.17 ± 0.03).

Table 2

Placental and Birth Weight Comparisons

Parameter	Anemic Group (n=60)	Non-Anemic Group (n=60)
Placental Weight (g)	680 ± 120	560 ± 100
Birth Weight (g)	2950 ± 420	3300 ± 350
Placental Ratio	0.23 ± 0.04	0.17 ± 0.03

Maternal Anemia and Neonatal Outcomes

The groups were compared in terms of neonatal outcomes including NICU admissions and Apgar scores.

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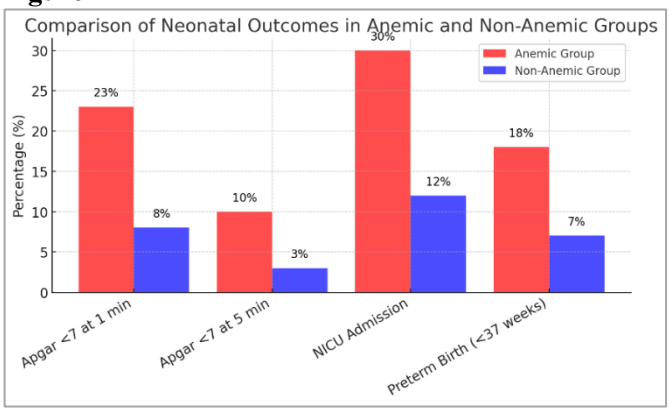
Table 3

Neonatal Outcomes in Anemic and Non-Anemic Mothers

Outcome	Anemic Group (n=60)	Non-Anemic Group (n=60)
Apgar Score <7 at 1 min	14 (23%)	5 (8%)
Apgar Score <7 at 5 min	6 (10%)	**2 (3%)**
NICU Admission	18 (30%)	7 (12%)
Preterm Birth (<37 weeks)	11 (18%)	4 (7%)

Figure 2



DISCUSSION OF RESULTS

This study results indicate that maternal anemia has a substantial impact on placental ratio, birth weight and neonatal outcome of women who are hospitalized in tertiary care hospital for delivery. Results obtained as they demonstrate mother anemia-associated placental weight and placental ratio with unfavorable newborn outcomes are consistent with the hypothesis that anemia-induced hypoxia elicits placental adaptations to maintain fetal oxygenation.

The study participants' demographic and clinical data showed similarity between both groups in the regard of age, gravidity, gestational age at birth. However, hemoglobin level (8.7 ± 1.2 g/dL) in the anemic group was significantly lower than the non-anemic group (12.4 ± 0.9 g/dL). The results also are consistent with earlier studies that have shown maternal anemia, especially iron deficiency anemia, is a common illness during pregnancy and that metabolism of oxygen is impaired.

Another main conclusion of the study is that the substantial difference placental weight between moms that are anemic vs those that are not. Placental weight of anemic mothers was 680 ± 120 g, significantly higher than non-anemic counterpart (560 ± 100 g). Placental weight increase observed there agrees well with other studies which showed that maternal anemia induces a compensatory placental hypertrophy to a decreased oxygen supply. Being an essential organ that aids the passage of nutrients and oxygen between mother and fetus, the placenta adapts to combat the hypoxia that comes with the tendency to develop anemia.

Furthermore, anemic mothers also had a significantly higher placental ratio (0.23 ± 0.04) than non-anemic mothers (0.17 ± 0.03). The finding therefore confirms the hypothesis that maternal anemia causes placental growth to outstrip fetal growth. Similar previous studies report increased placental ratio as a compensatory mechanism up regulating placental efficiency under suboptimal maternal conditions.

The placental weight increase was seen, however birth weight market in anemic group (2950 ± 420 g) was less than in non-anemic group (3300 ± 350 g). Due to this, placental hypertrophy should be considered an adaptive response to anemia, but fetal growth suppression in response to a limited oxygen and nutrient supply will not be compensated by such hypertrophy. This agrees with previous studies that anemia affects maternal size and birth weight (lower birth weight is often the consequence of maternal anemia as a result of ineffective placental function even if larger size).

Most importantly, maternal anemia had large effects on neonatal outcomes. This suggests that the newborns suffered more (low Apgar scores at 1 (23 percent vs. 8 percent) and 5 minutes (10 percent vs. 3 percent)) as more of the neonates born to anemic mothers were born. Further, the former was even more NICU admissions (30%) in the anemic group as compared to the non-anemic group (12%). In addition, anemia was also associated with a preterm birth (18 percent vs. 7 percent), as with other research that relates maternal anemia to the likelihood of a preterm birth.

CONCLUSION

Maternal anemia has a great impact on placental ratio, birth weight and neonatal outcome, reminds this study. Maternal anemia possibly predisposes placental weight enlargement and, more specifically, at increased placental ratio as an equiprimordially compensatory mechanism for decreased oxygen availability is suggested by the results. But even with these changes, the birth weights of anemic mothers were lower and the newborns had worse outcomes, including higher rates of preterm deliveries, NICU admissions, and Lown babies. These findings reinforce the point of what we need to do at an early stage in recognizing and treating maternal anemia to improve pregnancy outcomes. Maternal anemia can be treated with nutrition interventions, iron supplementation and its enhanced prenatal care, and this can diminish its effect on placental function and fetal development. Further investigation should be made into placental adaptation in the context of anemic pregnancy, focused interventions to improve health in the mother as well as the newborn.

Improvement of maternal anemia, and general healthcare, as healthcare professionals, can be achieved by increasing awareness and implementation of efficient

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techniques of anemia prevention. The study emphasizes that this is an international health problem that can be addressed by total public health efforts aimed at improving outcomes of mothers and their babies.

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