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A Study of Correlation of Maternal Haemoglobin with Cord Blood Haemoglobin and Anthropometric Measurements of Neonate

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ABSTRACT
Maternal anemia is a prevalent health concern, particularly in developing regions, where it is linked to adverse pregnancy outcomes such as low birth weight, preterm birth and neonatal anemia. Evaluating the relationship between maternal hemoglobin levels and neonatal health indicators, such as cord blood hemoglobin and anthropometric measurements, is essential for guiding interventions aimed at improving maternal and neonatal well-being. The primary aim of this study was to assess the correlation between maternal hemoglobin levels and cord blood hemoglobin, as well as the anthropometric measurements of neonates, including birth weight, length and head circumference. This cross-sectional study involved 120 term pregnant women admitted to a tertiary care hospital. Maternal hemoglobin levels were measured within 24 hours of delivery using standard laboratory methods. Cord blood samples were collected at birth for hemoglobin analysis. Neonatal anthropometric measurements-birth weight, length and head circumference-were recorded within the first hour of life. Pearson correlation coefficients were calculated to evaluate the relationships between maternal hemoglobin, cord blood hemoglobin and neonatal anthropometric parameters. The study revealed a significant positive correlation between maternal hemoglobin levels and cord blood hemoglobin ($r=0.45$, $p<0.001$). Additionally, maternal hemoglobin was positively correlated with neonatal birth weight ($r=0.32$, $p<0.01$) and length ($r=0.28$, $p<0.05$), while no significant correlation was found with head circumference. The findings suggest that maternal hemoglobin levels play a crucial role in determining neonatal hemoglobin levels and certain anthropometric outcomes, particularly birth weight and length. Addressing maternal anemia during pregnancy is critical for improving neonatal health outcomes.

INTRODUCTION

Maternal health during pregnancy plays a pivotal role in determining the outcomes for both the mother and the newborn. One of the key markers of maternal health is haemoglobin level, which reflects the oxygen-carrying capacity of the blood. Adequate haemoglobin is crucial for meeting the increased oxygen demands during pregnancy and ensuring optimal fetal growth and development. Low maternal haemoglobin, or maternal anaemia, has been widely studied and is associated with various adverse perinatal outcomes, including preterm birth, low birth weight and impaired neonatal development. Despite considerable advances in maternal and neonatal care, anaemia remains a significant public health concern, particularly in low- and middle-income countries.

Haemoglobin is a vital protein found in red blood cells that transports oxygen from the lungs to the rest of the body. During pregnancy, maternal haemoglobin must supply both the mother's tissues and the growing fetus, making adequate maternal haemoglobin levels essential for ensuring appropriate fetal oxygenation. The fetus derives its oxygen and nutrients through the placenta and the cord blood at birth reflects the oxygenation and nutritional status of the neonate throughout gestation. Cord blood haemoglobin (CBH) is often measured at birth as an indicator of the neonate's haemoglobin level, which may be influenced by maternal factors, including maternal haemoglobin levels.

Several studies have explored the relationship between maternal haemoglobin and neonatal outcomes, but the results have been mixed. Some studies suggest a strong correlation between maternal haemoglobin levels and cord blood haemoglobin, whereas others report no significant association. This inconsistency may be due to a variety of factors such as maternal nutrition, socio-economic status, ethnicity, and healthcare access, which can affect both maternal and fetal health. Understanding the correlation between maternal and cord blood haemoglobin levels is important as it could provide insights into fetal well-being and the risk of neonatal anaemia[1-3].

Furthermore, neonatal anthropometric measurements such as birth weight, length and head circumference are key indicators of fetal growth and development. These measurements reflect the intrauterine environment and are influenced by multiple factors, including maternal nutrition, health and haemoglobin levels. Poor maternal haemoglobin status may lead to inadequate fetal growth, resulting in low birth weight and smaller anthropometric measurements, which are associated with an increased risk of neonatal morbidity and mortality. Neonates with low birth weight or small head circumference are more susceptible to infections, developmental delays and other health complications in infancy and later life.

Given the importance of both maternal and neonatal haemoglobin levels, as well as anthropometric measurements, studying the correlation between maternal haemoglobin and neonatal outcomes could provide valuable insights into the potential risks and interventions needed to improve neonatal health. A better understanding of this correlation may lead to improved prenatal care strategies, particularly in populations at higher risk for anaemia. Additionally, identifying neonates at risk for anaemia based on maternal haemoglobin levels could help healthcare providers implement timely interventions to prevent adverse outcomes.

This study aims to explore the correlation between maternal haemoglobin levels and cord blood haemoglobin, as well as the relationship between maternal haemoglobin and neonatal anthropometric measurements. By examining these relationships, this research seeks to contribute to the body of knowledge on maternal-fetal health and highlight the importance of addressing maternal anaemia during pregnancy. The findings may have significant implications for public health policies aimed at reducing maternal anaemia and improving neonatal outcomes.

MATERIALS AND METHODS

This study is a hospital-based, cross-sectional observational study conducted over a period of 12 months in the Department of Obstetrics and Gynecology and the Department of Paediatrics at CAIMS Karimnagar. In this study 120 term pregnant women admitted to a tertiary care hospital. Maternal hemoglobin levels were measured within 24 hours of delivery using standard laboratory methods. After following inclusion and exclusion criteria given below and after getting ethical approval from institutional ethical committee

Inclusion Criteria:

- Singleton pregnancies.
- Gestational age between 37 and 42 weeks.
- Women who delivered vaginally or via cesarean section.
- Mothers who provided written informed consent to participate in the study.

Exclusion Criteria:

- Pregnant women with known chronic medical conditions (such as diabetes, hypertension, and thyroid disorders).
- Pregnant women with haemoglobinopathies (e.g., thalassemia, sickle cell anemia).

Multiple pregnancies (twins or higher-order multiples).

- Pregnancies complicated by fetal anomalies.
- Deliveries with severe perinatal complications, such as fetal distress or intrauterine growth restriction (IUGR).

Sample Size: A sample size of 120 mother-neonate pairs was calculated based on the expected correlation between maternal haemoglobin and cord blood haemoglobin, with a confidence interval of 95% and a power of 80%. The sample size calculation was performed using software statulator.

Method:

- **Maternal Haemoglobin Measurement:** Maternal haemoglobin levels were measured during the third trimester (between 28-36 weeks of gestation) using an automated hematology analyzer. A venous blood sample of 2-3 mL was collected in EDTA tubes during routine antenatal check-ups. The haemoglobin concentration was recorded in g/dL.
- **Cord Blood Haemoglobin Measurement:** Immediately after delivery, 2-3 mL of umbilical cord blood was collected from the placental end of the cord using a sterile syringe. The sample was transferred into an EDTA tube and analyzed within 30 minutes of collection using an automated hematology analyzer to measure the cord blood haemoglobin level. The haemoglobin concentration was recorded in g/dL.
- **Neonatal Anthropometric Measurements:** Anthropometric measurements of the neonates were taken within 24 hours of birth by trained pediatric nurses. The measurements recorded were:
- **Birth weight:** Measured using a digital weighing scale, accurate to the nearest 10 grams.
- **Crown-Heel Length:** Measured using an infantometer to the nearest 0.1 cm.
- **Head Circumference:** Measured using a non-stretchable tape to the nearest 0.1 cm.
- **Maternal and Neonatal Data Collection:** Additional maternal and neonatal demographic data were collected from medical records. These included:
- Maternal age, parity and pre-pregnancy body mass index (BMI).

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using SPSS software version 25. Continuous variables such as maternal haemoglobin, cord blood haemoglobin, birth weight, length and head circumference were expressed as mean±standard deviation (SD). Categorical variables were expressed as percentages.

The Pearson correlation coefficient was used to assess the relationship between maternal haemoglobin levels and cord blood haemoglobin, as well as between maternal haemoglobin and neonatal anthropometric measurements (birth weight, length and head circumference). A p-value of <0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

In this study 120 term pregnant women admitted to a tertiary care hospital. Maternal haemoglobin levels were measured within 24 hours of delivery and their observation are given bellow.

Table 1 : Distribution of Demographic Profile of Study Population.

Parameters	Mean/Frequency	Percentage/SD
Maternal Age	27.36 Years	4.16 Years
Gestational Age	37.62 Months	2.36 Months
Gravida		
Primi	51	42.5
Multi	69	57.5
Maternal BMI		
<18.5	7	5.8
18.5-22.9	77	64.2
23.0-24.9	26	21.7
25.0-29.9	10	8.3
Mean Spacing	2.61	1.94
Level of Anamia		
Non Anemic (Hb≥11)	34	28.3
Mild Anamia (Hb= 10.9-10)	45	37.5
Moderate Anamia (Hb=7 - 9.9)	28	23.3
Severe Anaemia (Hb<7)	13	10.8

Table 2 :Mean Distribution of Neonatal Parameters Among Study Population

Neonatal Parameters	Mean	SD
Birth Weight(Kg)	2.56	394.27
Baby Length (Cm)	49.37	3.41
Head Circumferences(Cm)	34.29	1.28

Table 3 : Mean Distribution of Maternal Hb and Cord Hb Among LEVELS of Anemia and Correlation Between them.

Levels of Anemia	Mean ± SD Maternal Hb (mg/dl)	Cord Hb(mg/dl)	Correlation	P-value
Non Anemic (Hb≥11)	12.17±0.81	15.36±1.24	0.712	<0.001
Mild Anamia (Hb=10.9-10)	10.21±0.98	14.36±0.82	0.785	<0.001
Moderate Anamia (Hb=7-9.9)	9.46±0.94	14.62±0.91	0.824	<0.001
Severe Anaemia (Hb<7)	7.62±0.81	13.76±0.43	0.681	<0.001

It was observed that, there was positive strong correlation between maternal haemoglobin level and cord haemoglobin level among various levels of Anemia, as shown in above table.

Table 4 : Mean Distribution of Mean Birth Weight, CRL and Head Circumference Among Different Levels of Anemia

Levels of Anemia	Mean±SD Mean Birth Weight(kg)	Mean Baby Length (Cm)	Mean Baby Head Circumference (Cm)
Non Anemic (Hb≥11)	2.89±0.342	49.23±3.24	35.62±0.72
Mild Anamia (Hb=10.9-10)	2.53±0.298	47.21±2.49	34.29±0.68
Moderate Anamia (Hb=7-9.9)	2.36±0.281	46.16±2.18	32.61±0.73
Severe Anaemia (Hb<7)	1.76±0.227	44.21±2.13	32.30±1.49
F-value	47.31	13.81	90.78
p-value	<0.001	<0.001	<0.001

Anaemia in pregnant women can be both physiological and pathological. Nutritional anaemia is the most common cause and can range from mild to severe. In present study cohort of 120 pregnant women were included, majority (37.5%) of them had mild anaemia followed by non-anemic, moderate and severe anemia. In similar studies done by Desalegn S and Lokare PO et al., the majority had moderate anaemia (74.3% and 54.4% respectively)[4-5]. The possible reasons for this variation may be because of improved nutrition over period and better intake of supplements in the metropolitan city where present study was conducted. Low haemoglobin levels in mother restrict oxygen circulation in the body, creating an environment of oxidative stress or chronic hypoxia, which can cause foetal growth restriction thereby decrease in neonatal anthropometric measurements[6].

In the present study, the mean age of pregnancy was found to be 27.36 Years±4.16 Years, Similar to studies in other parts of the country[7-10], 45.61% of pregnant women were found to have hemoglobin concentrations less than 10 g/dL.

The present study showed significant positive correlation between maternal and fetal hemoglobin concentrations like Dapper[11] in Nigeria, Mc Elroy[12] in Kenya and Alizadeh[13] in Iran. A positive linear Pearson correlation was observed between mean hemoglobin and PCV of cord blood and maternal blood. All these results were similar to the ones observed by Nneli[14] Singla[15] and Al-hilli[16]. In contrast to the present study, some previous investigators including Qaiser[17] Kilbride[18] and Mamoury[19] have failed to find a relationship between the maternal and cord blood hemoglobin.

In present study, mean birth weight was found to be 2.53±0.298 Kg in mild anaemia, 2.36±0.281 Kg in moderate anaemia and 1.76±0.227 Kg in severe anaemic mothers and these differences among Hb levels were statistically significant. Similarly in the present study mean CRL was found to be 47.21±2.49 Cm in mild anaemia, 46.16±2.18 cm in moderate anaemia and 44.21±2.13 cm in severe anaemic mothers with significant differences, also mean head circumference was found to be 34.29±0.68 Cm in mild anaemia, 32.61±0.73 cm in moderate anaemia and 32.30±1.49 cm in severe anaemic mothers with significant differences . In similar studies done by Behal M *et al.*, Al-Hilli NM, Kumar NP and Pabbati J, the mean birth weight was 2560 gm, 3100 gm and 2844 gm in mild anaemia cases respectively., the mean birth weight was 2536 gm, 2700 gm and 2670 gm in moderately anaemic mothers., and in severely anaemic mothers the birth weight was 2261 gm, 2200 gm, 2227 gm respectively[20-21]. These results also showed a statistically significant correlation between maternal Haemoglobin and birth weight which were in accordance with present study.

In similar study done by Behal M I, found mean baby length to be 49 cm, 48 cm and 45 cm in mild, moderate and severe anaemic mothers . In another study done by Paramahamsa RRK and Chakravarthi GK, baby length between anaemic and non anaemic mothers was compared and it was found that 74.1% of babies with low crown heel length were born to anaemic mothers . All these results were statistically significant and in accordance to present study. by Paramahamsa RRK and Chakravarthi GK, 67.9% of babies were born to anaemic mothers had low head circumference . These results were also statistically significant and in congruence with present study. It was documented in all the previous studies as well that as severity of anaemia increased, the mean baby length and head circumference at birth decreased significantly, which was in congruence to present study.

According to the some study like Divyani Dhole[22], observed, that as the BMI improved, the mean birth weight and length also increased and the difference was statistically significant, but in our study we didn't correlate body mass index of mother with neonatal parameter, which can be a limitation of our study. Also Eating a well-rounded diet with all the right nutrients and adequate calorie intake is important for healthy pregnancy outcome, but in our study we didn't noted daily intake calorie and didn't correlate with neonates birth weight, so these limitations we are trying to cover in our further research.

CONCLUSION

Based on our observation and after discussion with other studies we can conclude in our study that, anaemia in pregnancy had a statistically significant negative impact on the birth weight, length and head circumference of the baby, which was proportionate to the severity of anaemia. The results show a linear relationship between the mother's and her neonates cord blood haemoglobin levels. It highlights even more how important it is for women in the reproductive age group to have access to a comprehensive public health programme that guarantees sufficient intake of micro-and macronutrients, both of which are necessary for a successful pregnancy.

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