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Impact Of Maternal Anemia On Cord Blood Hemoglobin

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Abstract:

Background: Maternal anemia, characterized by a deficiency of iron or other essential nutrients during gestation, can yield extensive repercussions for both the prospective mother and the developing fetus. Cord blood hemoglobin, which reflects the baby's blood health at birth, is a vital indicator. Therefore, the goal of the study was to assess the impact of maternal anemia on cord blood hemoglobin.
Methods: This observational study was conducted in the Department of Pediatrics at a tertiary healthcare center on the basis of inclusion and exclusion criteria. A total of 71 pregnant women and their infants were selected. Cord blood samples were collected immediately after delivery in the labor room and preserved in EDTA (ethylenediaminetetraacetic acid) for analysis. This present study involved comparison of the mean cord blood hemoglobin of new-born born to anemic mothers with varying degrees of anemia (mild, moderate, and severe). Furthermore, we investigate the association between cord blood hemoglobin levels and maternal anemia.
Results: Out of 71 pregnant women, 33 (46.4%) had mild anemia, 31 (43.7%) had moderate anemia, and 7 (9.9%) had severe anemia. The mean maternal hemoglobin among anemic mother was 10.39 g/dl for mild anemia, 8.62 g/ for moderate anemia and 6 g/dl severe anemia. Maternal anemia severity was associated with adverse hematological outcomes in newborns, as indicated by decreasing trends in mean cord blood hemoglobin levels (8.73 g/dl for mild, 8.76 g/dl for moderate, and 7 g/dl for severe anemia), as well as declining MCV, MCH, and MCHC values respectively, with significant p-value which was 0.0001 this represents positive correlation with maternal anemia and cord blood hemoglobin.
Conclusion: A moderate positive correlation was observed between maternal anemia and the hemoglobin levels in the cord blood of neonates. Babies born to anemic mothers exhibited lower cord blood hemoglobin levels. The present study demonstrates a linear association between maternal hemoglobin levels and fetal hemoglobin levels.

Keywords: Maternal anemia, HB, cord blood, EDTA.

INTRODUCTION:

Iron deficiency (ID) is a widespread global health concern, and it stands as one of the most manageable and avoidable factors contributing to the loss of healthy, productive years in people's lives. However, a staggering 25% worldwide prevalence of ID, primarily affecting women of reproductive age and young children, highlights the obstacles hindering the effective management of this issue. [1] According to the World Health Organization (WHO), if the hemoglobin (Hb) level during pregnancy is below 11 g/dl the condition is considered maternal anemia. [2] The connection between iron deficiency and anemia varies significantly among different populations and geographic regions, making it challenging to establish universal recommendations for the treatment of ID. [3] As per the latest WHO report, it is estimated that approximately 40% of children between the ages of 6-59 months, around 37% of pregnant women, and 30% of women aged 15-49 are believed to be affected by anemia in most countries.[4]

Maternal anemia can be caused by various factors, but malnutrition is a significant contributor. It is linked to unfavorable consequences in terms of both mortality and morbidity. It can lead to serious complications for both the expectant mother and the developing fetus, thereby affecting fetal development during pregnancy. Insufficient oxygen supply to the fetus can lead to low birth weight, premature delivery, low iron store, fetal growth retardation, Intrauterine growth retardation (IUGR) and small-for-gestational age (SGA) newborns.[5] Iron deficiency in expectant mothers can lead to reduced iron levels in the umbilical cord blood. Inadequacies in iron levels during fetal and neonatal phases may lead to compromised auditory recognition memory in infants, reflecting its impact on the maturing hippocampus.

Additionally, offspring of mothers with deficient iron levels at birth might display challenges in learning and memory, with the potential for these difficulties to persist into adulthood.[6] Regardless of the mother's iron stores, the fetus receives iron through the transferrin of the mother. During the final four weeks of gestation, the placenta absorbs the mother's transferrin, extracts its iron, and actively transfers it to the developing foetus. Fetal iron reserves decline when the fetus's ability to accumulate iron is hindered by the depletion of maternal iron resources. [7] This factor have a significant impact on the baby's iron levels and increase the risk of anemia during the first year of life. A mother's inadequate nutrition during her pregnancy has an impact on the fetus's development, which in turn impacts the newborn's birth weight. [8] For diagnosis of anemia particularly in neonatal babies cord blood hemoglobin can be used. Hematology has emerged as a field of research with a specific emphasis on the analysis of umbilical cord blood and its components.[9] Anemia during pregnancy is typically evaluated using serum markers like ferritin, iron, total iron-binding capacity (TIBC), and transferrin saturation (TSAT). The Mean Corpuscular Volume (MCV) may not be a dependable indicator of iron deficiency during pregnancy. This is because the natural stimulation of erythropoiesis that occurs during gestation can cause MCV to rise, counteracting the microcytosis associated with iron deficiency. [10]
In Maharashtra, a cohort study was conducted, reported the highest incidence of neonatal anemia cases, especially in rural areas, occurred when both low BMI(Body mass Index) and anemia were present in pregnant women.[11] However, there is limited information available regarding the implications of maternal anemia on newborns. Therefore, in the present study, we evaluated the impact of maternal anemia on cord blood hemoglobin.

METHODOLOGY:
An observational study was conducted in the Department of Pediatrics at a tertiary healthcare center over the period of 2 years, from December 2019 to November 2021. This study was accomplished according to ethical principles and good clinical practice guidelines. In the present study, a total of 71 patients were included as per the inclusion criteria. Similarly, the full term neonates 37 to 41 weeks, women with singleton pregnancies, prime or multi-parity and babies born to normal vaginal deliveries or caesarean sections were included. Whereas, newborns with congenital malformations, birth asphyxia, Rh incompatibility, twins, maternal risk factors like gestational diabetes mellitus and pregnancy induced hypertension were excluded. For this study, the participants who signed a written consent form were examined.
Pre-delivery maternal hemoglobin was estimated. According to Hb, mothers were distributed into two groups, namely anemic and non-anemic. The cord blood hemoglobin of their new-born baby's was collected. The umbilical cord was clamped after the delivery of the infant and prior to the expulsion of the placenta. Then, samples were drawn into an EDTA anticoagulation tube and used for biochemical measurements. The hemoglobin concentration was measured by using the Sysmex auto analyzer model KX21. The mean maternal and mean cord blood hemoglobin were compared in different groups i.e. Mild, Moderate and Severe.

STATISTICAL ANALYSIS:
Data collection used a structured proforma and Microsoft Excel for recording. Analysis employed IBM USA's SPSS version 24.0. Qualitative data was presented as proportions, while quantitative data used means and standard deviations.The Chi-square test or Fischer's exact test was employed to analyze qualitative variables, and an unpaired T test was used to compare group means and standard deviations. For each variable having a $P < 0.05$, descriptive statistics were calculated using the mean, standard deviation, and standard error of the mean.

RESULTS:

In terms of gender, the sample comprises 53.5% males and 46.5% females. Age-wise distribution reveals that 9.9% were below 20 years old, 38% fall within the 21-25 age bracket, and the majority 52.1%, were aged between 26 and 30 years. Regarding the residence, a significant 81.7% reside in rural areas, while 18.3% lived in urban settings. The socioeconomic status of the participants was divided, with 63.4% categorized as lower status and 36.6% as middle status.
In the context of pregnancy, 70.4% were classified as multi-gravida (having multiple pregnancies), whereas 29.6% were primi-gravida (experiencing their first pregnancy). The mode of delivery statistics indicates that 54.9% of the individuals underwent a lower segment Caesarean section (LSCS), while 45.1% had a normal vaginal delivery (NVD). Anemia grades in the sample population vary, with 46.4% having mild anemia, 43.7% having moderate anemia, and 9.9% suffering from severe anemia.

Table-1: Demographic distribution of patients

Gender	Frequency	Percentage
Male	38	53.5
Female	33	46.5
Total	71	100
Age group in years		
<20	7	9.9
21-25	27	38
26-30	37	52.1
Total	71	100
Place of residence		
Rural	58	81.7
Urban	13	18.3
Total	71	100
Socioeconomic status		
Lower	45	63.4
Middle	26	36.6
Total	71	100
Gravida status		
Multi	50	70.4
Primi	21	29.6
Total	71	100
Mode of delivery		
LSCS	39	54.9
NVD	32	45.1
Total	71	100
Grade of anemia		
Mild	33	46.4
Moderate	31	43.7
Severe	7	9.9
Total	71	100

In terms of maternal hemoglobin levels, the mean values for mild, moderate, and severe anemia were 10.39 g/dl, 8.62 g/dl, and 6 g/dl, respectively. These results suggest a significant reduction in maternal hemoglobin value corresponding to the severity of anemia, with severe cases exhibiting the lowest levels. This trend was statistically significant, as indicated by the p-value of 0.0001.The study also explored the effect of maternal anemia on cord blood parameters in newborns. The mean hemoglobin levels in cord blood were 8.73 g/dl for mild anemia, 8.76 g/dl for moderate anemia, and 7 g/dl for severe anemia. Similarly, newborn MCV, MCH, and MCHC showed decreasing trends corresponding to the severity of maternal anemia. These trends were statistically significant (p-value of 0.0001), showing a clear association between maternal anemia severity and adverse hematological outcomes in newborns.
Notably, the MCHC values exhibited a non-significant p-value of 0.084, suggesting a weaker correlation with the severity of maternal anemia compared to other parameters.

Table-2: Comparison of clinical parameter with grade of anemia in mother.

Grade of Anemia in mother	Mild	Moderate	Severe	Total	p value
N	33	31	7	71	**N**
Mean maternal HB	10.39 ± 0.28	8.62 ± 0.62	6 ± 0	9.19 ± 1.43	**0.0001**
Mean cord blood HB	8.73 ± 0.48	8.76 ± 0.96	7 ± 0	8.57 ± 0.88	**0.0001**
Newborn MCV (fl)	104.22 ± 2.17	102.21 ± 2.32	100 ± 0	101.07 ± 2.34	**0.0001**
Newborn MCH (pg)	34.08 ± 0.7	34.83 ± 0.6	33.9 ± 0	34.39 ± 0.73	**0.0001**
Newborn MCHC (g/dl)	33.2 ± 0.92	33.53 ± 0.81	33.9 ± 0	33.41 ± 0.85	0.084

MCV: mean corpuscular volume, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration

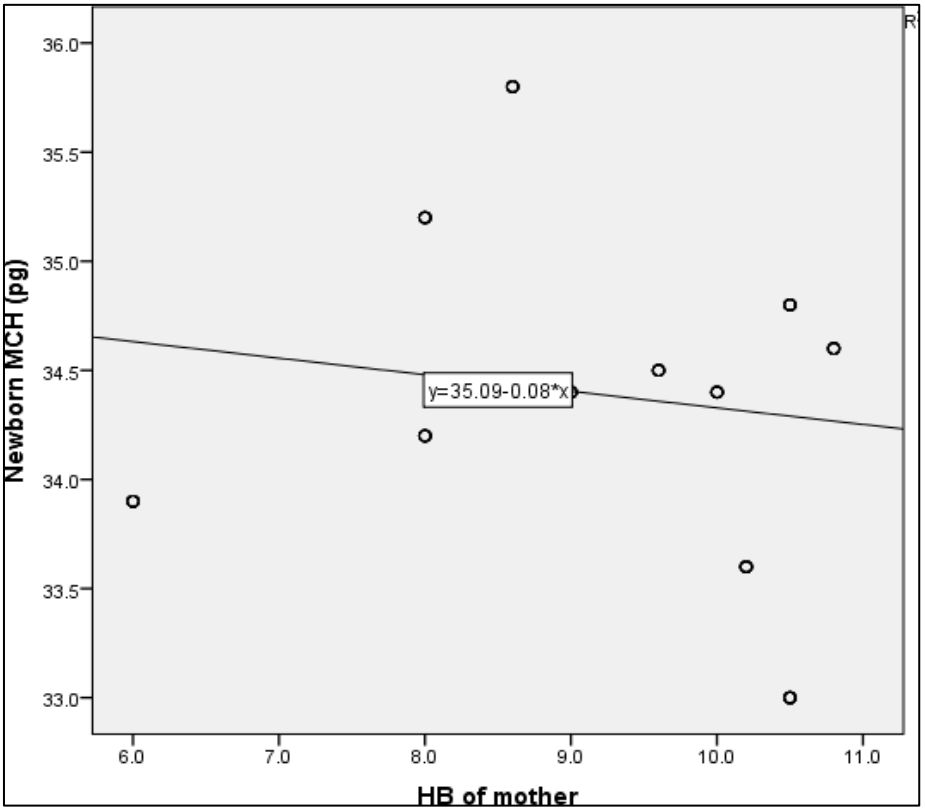


Figure: Correlation of maternal HB with newborn MCH and MCHC.

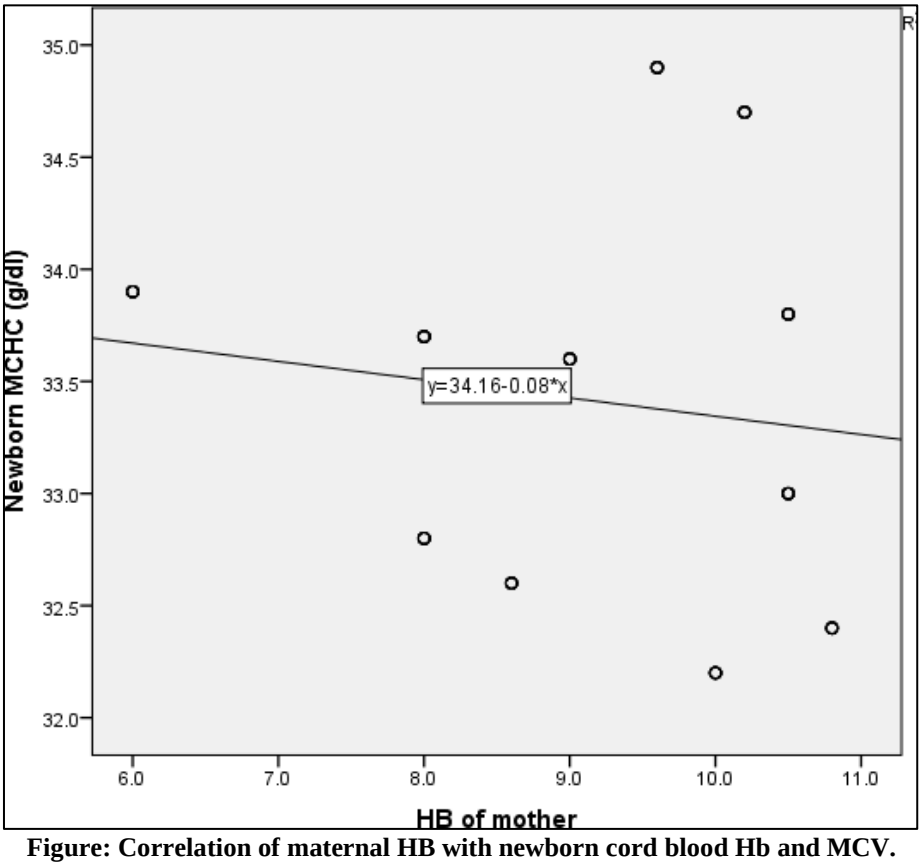
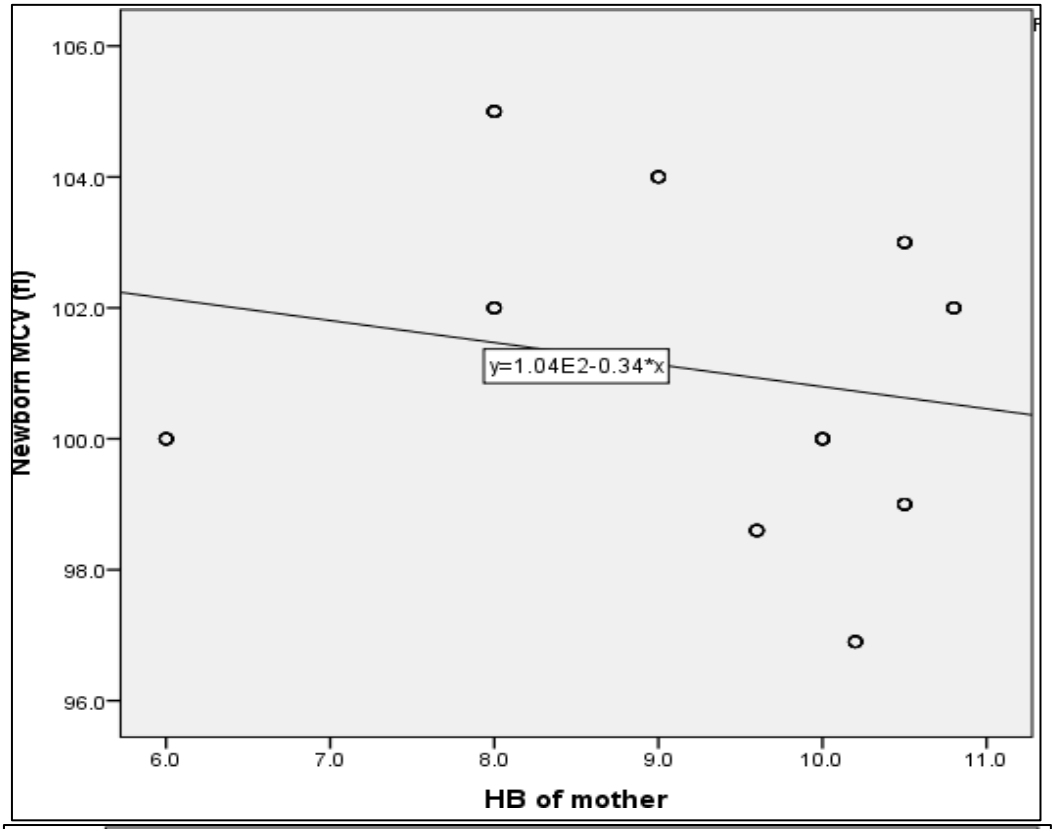
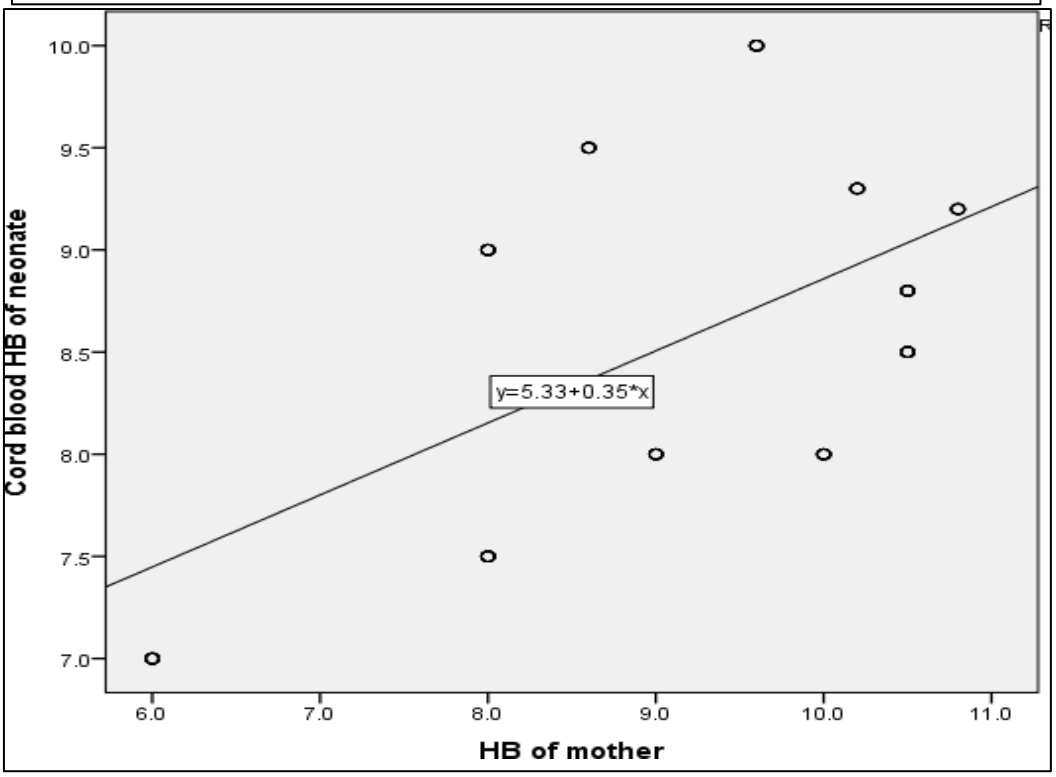


Figure: Correlation of maternal HB with newborn cord blood Hb and MCV.

There was a slight negative correlation (Pearson correlation coefficient = -0.137) between newborns' MCHC and their mothers' hemoglobin levels. However, this correlation was not significant (p-value = 0.254), suggesting it may be due to chance. Similarly, a weak negative correlation (Pearson correlation coefficient = -0.149) between newborns' mean corpuscular hemoglobin (MCH) and their mothers' attributes was observed, but it also lacks statistical significance(P-value =0.215)





Certainly, there was a moderately strong positive correlation (Pearson correlation coefficient = 0.574) between

newborns' cord blood hemoglobin levels and their mothers'. This correlation was extremely significant with a p-value of 0.0001, indicating a robust relationship. Additionally, there exists a weak negative correlation (Pearson correlation coefficient = -0.206) between newborns' mean corpuscular volume (MCV) and their mothers' hemoglobin levels, although this correlation is not statistically significant (p-value = 0.085).

DISCUSSION:

Pregnancy-related anemia can have various adverse effects on the health of expectant mothers. It may also influence the iron reserves of their newborns, potentially leading to anemia in the infants. In the present study, we investigate a specific aspect of maternal anemia by examining its impact on newborn infants, focusing on the analysis of hemoglobin levels in cord blood.

This study enrolled 71 expectant mothers with anemia and their respective newborns, of which the majority were from rural areas, and the age-wise distribution revealed that 52.1% were aged between 26 to 30 years. Similar study done by **Agrawal et al.,** [12] shows that, the mean age of study participants which was 26.72±1.34 years and from rural area. Also, one other study conducted by **Timilsina S. et al.,**[13] reported that, mean age of study participants was 26.04 ± 3.47 who were age between 21–30 years.

In the present study, data showed 46.4% had mild anemia, 43.7% had moderate anemia and 9.9% suffered from severe anemia. The mean maternal hemoglobin level in mother with mild, moderate and severe were 10.39 g/dl, 8.62 g/dl, and 6 g/dl, respectively. This trend is extremely significant, with the p-value of 0.0001. These observation was related with

Dhanasekarn R. et al.,[14] shows 48.9% of them had mild anemia (Hb level:10-10.9 gm/dl), 42.8% of them had moderate anemia (9.9-7gm/dl) and 8.3% of them had severe. Similarly, **Aegbeleye,JO. et al.,**[15] reported that, moderate anemia was observed in 17.42% women followed by mild anemia (15.48) % and severe anemia (1.29%) respectively. Hence, we suggested that, maternal hemoglobin concentration decrease with severity of anemia.

In addition, our study findings shows that, the mean hemoglobin levels in cord blood were 8.73 g/dl for mild anemia, 8.76 g/dl for moderate anemia, and 7 g/dl for severe anemia. In newborn; MCV, MCH, and MCHC showed decreasing trends corresponding to the severity of maternal anemia. These findings were align with study performed by **Timilsina S. et. al.,** [13] indicated that 5.7% of the fetuses had a reduced hemoglobin concentration, 23.94% showed diminished MCV, and 18.24% demonstrated lower levels of MCH. Interestingly, none of the fetuses exhibited reduced MCHC. In light of these results, our report proposes a positive linear correlation between maternal hemoglobin levels and umbilical cord blood. In our study, we find a slight negative correlation between newborns MCHC and their mother's hemoglobin levels. Also there exists a weak negative correlation between newborns' mean corpuscular volume (MCV) and their mothers' hemoglobin additionally; there was strong positive correlation between new born cord blood hemoglobin level and their mothers with extremely significant p-value 0.0001. These shows a direct correlation between a mother's hemoglobin levels and the hemoglobin levels in the umbilical cord blood. The outcomes of these study was similar with study done by, **Al-Hilli NM et al.,** [16] They reported that, mean cord blood HB in mild, moderate and severe maternal anemia was 14.79 ± 1.36, 13.89 ± 0.9 and 12.1 ± 1.04 respectively, the difference was found to be extremely significant with $p<0.05$ which was consistent with our study findings. Similarly, our finding comparable to **Rumi D. et al**.,[17] reported that, mean cord blood HB in mild, moderate and severe maternal anemia was 14.79 ± 1.36, 13.89 ± 0.9 and 12.1 ± 1.04 respectively with statistically significant ($p<0.05$).

Upon comparing cord hemoglobin with maternal hemoglobin and analyzing the outcomes, we reported that, there was a direct correlation between above mentioned parameters. In other words, as maternal hemoglobin levels decrease, there is a corresponding decrease in cord hemoglobin. The present study also illustrates that hemoglobin levels are lower in anemic mothers, resulting in a decrease in cord hemoglobin. Furthermore, our study demonstrates that, the decreasing in cord blood heamoglobin is directly proportional to the severity of anemia in mother. This implies that, the placental iron transport mechanism may be less effective when maternal anemia is more severe, leading to a reduction in cord hemoglobin. These findings was consistent with studies by Najeeba CM. et al [18] demonstrated a direct correlation between maternal hemoglobin value and the hemoglobin value in the umbilical cord blood of neonates.

CONCULSION:

This study led us to the conclusion that newborns' cord hemoglobin is impacted by maternal anemia. A direct and linear relationship was observed between the hemoglobin levels of mothers and their newborns. Furthermore, the study also shows a favorable link between MCV and MCH, as well as between maternal and fetal hemoglobin. It has been noted that babies born to anemic mothers typically have lower hemoglobin levels. Therefore, it is essential to prioritize the prevention of maternal anemia and the maintenance of adequate iron reserves during gravidness through appropriate dietary measures, iron supplementation, and ensuring optimal spacing between pregnancies, particularly in our specific geographic region.

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