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Original Article

Paediatrics Section

Effect of Haemoglobin and Iron Status of the Antenatal Mothers on their Newborns at Birth: A Cross-sectional Study

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ABSTRACT

Introduction: Iron deficiency (ID) anaemia in pregnant mothers can affect the iron reserves of their newborns and lead to anaemia later. The haematological indices and iron status of pregnant women and its correlation with their neonates is still unclear.

Aim: To assess the correlation between maternal and cord blood Hb and iron status.

Materials and Methods: The present cross-sectional study included 134 antenatal mothers, at term gestation without any significant antenatal complications. Complete haemogram, serum iron, ferritin, and iron binding capacity were assessed for these mothers before delivery and also, from the cord blood samples of their newborns at birth. Statistical difference and correlation were observed using Chi-square test and Pearson's correlation coefficient.

Results: Maternal anaemia (Hb <11 gm/dL) was observed in 62 (46.3%) mothers. The mean Hb and ferritin of the mothers were 11.06±1.02 gm/dL and 113.3±7.1 μg/L, respectively. The mean Hb and ferritin levels of the cord blood samples were 12.24±0.17 gm/dL and 214.3±20.1 μg/L, respectively. In univariate analysis, maternal Hb showed a significant correlation with cord blood Hb with Odds Ratio (OR) 0.508 and 95% Confidence Interval (CI): 0.428-0.603. The Pearson's correlation showed a moderate correlation between mother and cord blood Packed Cell Volume (PCV) (r=0.344, p<0.001) and weak correlation between other maternal and cord blood iron indices and serum ferritin (r=0.191, p-value=0.027 and r=0.203, p-value=0.019).

Conclusion: There is a significant correlation between maternal and cord blood Hb in term neonates. The study indicates that, the haematological indices of pregnant women determine the neonatal Hb in term babies.

Keywords: Anaemia, Cord blood, Maternal anaemia, Neonatal anaemia

INTRODUCTION

The ID anaemia in pregnant women is highly common in developing countries [1]. Worldwide, anaemia in pregnancy is considered to be the most common problem with the rate of occurrence ranging from 5.4% to 80% [2-7]. ID anaemia during pregnancy adversely affects the foetal growth and both maternal Hb and serum ferritin significantly affect the anthropometric indices of the newborns [8].

During pregnancy the foetal iron status is completely dependent on the mother. In utero, the main source of foetal iron is from the mother, the iron requirement of foetus entirely depends on transport of iron from the maternal side of syncytiotrophoblast to foetus. This process is mediated by the serum transferrin binding to its specific receptor i.e., transferrin receptor (TFR1), which are found in the syncytiotrophoblast. The expression of TFR1 has been reported to be up regulated in response to maternal ID [9]. For transport of iron from the mother to foetus for the foetal development and also to maintain maternal adaptation during pregnancy, there is substantial increase in maternal iron absorption and mobilisation during the pregnancy [10]. The placental transfer of iron from mother to foetus is highly regulated and it is a unidirectional active process, which is independent of maternal iron store. During maternal ID, this system becomes inadequate to maintain iron transfer to the foetus. The iron homeostasis is regulated by hormone hepcidin. It is reported that hepcidin is supressed during the second and third trimesters in order to increase the availability of iron, but the mechanism behind the hormone suppression is unknown [11]. The threshold of maternal ferritin concentration below which foetal iron accretion is affected was estimated as <12 μg/L [12]. Neonates born to mothers with ferritin less than 12 μg/L have significantly lower ferritin, as compared to their counterparts [13].

Studies on maternal and neonatal iron status have shown varying results. Shao J et al., found that despite maternal ID, iron status of foetus was adequate except in situations where maternal ID was severe [14]. Some studies have shown a direct correlation between maternal and foetal Hb levels [15-20], but few others have shown contrasting results [21-23]. More research is needed to evaluate the effects of maternal iron on the foetal iron indices to prevent the serious effects of maternal ID on the foetus. Hence, the present study was done to evaluate the relationship between maternal and cord blood Hb and iron indices in term neonates.

MATERIALS AND METHODS

This cross-sectional study was conducted at a tertiary care Institute for Maternal and Child Health, Chennai, Tamil Nadu, India from February 2020 to April 2020. Approval from Institutional Ethical Committee (IEC-MMC No. 01102019), and informed consent from the mothers were obtained.

Inclusion criteria: One hundred and sixty antenatal mothers at term, singleton gestation without any significant antenatal complications were recruited consecutively, from February 2020 to April 2020.

Exclusion criteria: Mothers with history of antepartum haemorrhage, any chronic medical illness and babies, who needed neonatal intensive care unit admissions or with congenital anomalies were excluded from the study.

Study Procedure

The maternal blood samples were collected prior to delivery. After the delivery of the baby, 5 mL of cord blood was collected to estimate the haematological profile and iron status like serum iron, iron binding capacity, and ferritin, and C-reactive Protein (CRP). The complete blood count was recorded using five-part blood analyser and the serum ferritin was estimated by fully automated bidirectional chemilumniscent immunoassay. Serum iron was done by ferrozine method without deproteinisation. Serum Total Iron Binding Capacity (TIBC) was done by spectrophotometric assay. Maternal Hb was subcategorised as <11 gm/dL and ≥11 gm/dL, as per the World Health Organisation (WHO) definition of anaemia in pregnancy [24]. Among the 160 samples, 19 maternal samples and seven cord blood samples were excluded, since their CRP value were high and the remaining 134 sample pairs were analysed.

STATISTICAL ANALYSIS

The statistical analysis was done using SPSS Version 20.0. Descriptive statistics were used for baseline variables and expressed in frequency and percentage. Chi-square test were used to compare the data between the groups. Univariate odds were done to analyse the risk factor. Correlation between maternal and neonatal blood indices was analysed using Pearson's correlation coefficient. Statistical significance was set as p-value <0.05. Correlation coefficients significant at the 0.05 level were identified with a single asterisk and those significant at 0.01 level were identified with two asterisks.

RESULTS

The study included a total of 134 sample pairs (mother and newborn), of the total participants the mean age of the mothers were 25.9±0.26 years. Among the mothers, 59 (44%) were primiparous and 75 (56%) were multiparous [Table/Fig-1]. The mean birth weight of the neonates was 2.97±0.2 kg. The mean maternal and cord blood Hb was 11.06±1.02 gm/dL and 12.24±0.17 gm/dL, respectively. The mean maternal and cord blood ferritin was 113.3 mcg/L and 214.3 mcg/L, respectively. Maternal anaemia (Hb <11 gm/dL) was observed in 62 (46.3%) mothers [Table/Fig-2].

Variables	Mean±SD (range)
Maternal parameters	
Age (years)	25.93±0.26 (20-34)
Weight (kg)	57.04±0.79 (40-85)
Maternal Hb (gm/dL)	11.06±1.029 (9-14)
Maternal CRP (mg/L)	10.19±1.70 (2.0-152)
Maternal serum ferritin (μg/L)	113.3±7.1 (0-365)
Maternal serum iron (μg/dL)	86.07±5.0 (1-289)
Maternal serum iron binding capacity (μg/dL)	334.94±16.4 (13.5-1070.6)
Maternal RBC (million/μL)	3.75±0.09 (1.3-11.4)
Maternal PCV (%)	31.83±0.5 (3.8-47.0)
Neonatal parameters	
Baby birth weight (kg)	2.97±0.02 (2.3-3.8)
Cord blood Hb (gm/dL)	12.24±0.17 (6.0-17.8)
Cord blood CRP (mg/L)	4.33±0.34 (0.5-30.5)
Cord blood serum ferritin (mcg/L)	214.38±20.1 (33.5-2110)
Cord blood serum iron (mcg/dL)	146.9±9.2 (3.5-957.0)
Cord blood serum iron binding capacity (mcg/dL)	215.21±19.5 (22-1067)
Cord blood RBC (million/μL)	4.01±0.13 (1.7-12.7)
Cord blood PCV (%)	34.48±0.76 (3.3-56)

[Table/Fig-1]: Mean values of the maternal and foetal clinical parameters.
Hb: Haemoglobin; CRP: C-reactive protein; RBC: Red blood cell; PCV: Packed cell volume; SD: Standard deviation

Variables	Categories	Frequency (%)
Age (years)	<25	44 (32.8)
	25-30	72 (53.7)
	>30	18 (13.4)
Parity	Primi	59 (44)
	Multi	75 (56)
Maternal Hb (gm/dL)	<11	62 (46.3)
	≥11	72 (53.7)
Mode of delivery	LSCS	97 (72.4)
	Vaginal	37 (27.6)
Maternal serum ferritin (mcg/L)	<15	7 (5.2)
	≥15	127 (94.8)
Maternal serum iron (mcg/dL)	<65	55 (41.0)
	≥65	79 (59.0)
Maternal serum iron binding capacity (mcg/dL)	<300	54 (40.3)
	≥300	80 (59.7)
Maternal RBC (million/μL)	<4	95 (70.9)
	≥4	39 (29.1)
Maternal PCV (%)	<32	50 (37.3)
	≥32	84 (62.7)
Birth weight (kg)	<2.7	20 (14.9)
	≥2.7	114 (85.1)
Cord blood Hb (gm/dL)	<15	126 (94.0)
	≥15	8 (6.0)
Cord blood ferritin (μg/L)	<40	4 (3.0)
	≥40	130 (97.0)
Cord blood iron (mcg/dL)	<22	6 (4.5)
	≥22	128 (95.5)
Cord blood iron binding capacity (mcg/dL)	<100	40 (29.9)
	≥100	94 (70.1)
Cord blood RBC (million/μL)	<4	88 (65.7)
	≥4	46 (34.3)
Cord blood PCV (%)	<32	32 (23.9)
	≥32	102 (76.1)

[Table/Fig-2]: Maternal and foetal variables in the study population.
Hb: Haemoglobin; LSCS: Lower segment caesarian section; RBC: Red blood cell; PCV: Packed cell volume

Univariate analysis showed significant correlation between maternal Hb and cord blood Hb with Crude Odds Ratio (OR) of 0.508 and 95% CI of 0.428-0.603 [Table/Fig-3]. The correlation was analysed between various maternal iron indices and neonatal iron indices using Pearsons's correlation coefficient. There was a moderate correlation between mother and cord blood PCV and weak correlation between other maternal and cord blood serum ferritin [Table/Fig-4].

DISCUSSION

In the present study, maternal anaemia was observed in 62 (46.3%) of the mothers. According to the WHO World Health Statistics 2016, 40.1% of pregnant women worldwide were anaemic. In south-east Asian countries, about half of the maternal deaths are due to

Variables		Maternal Hb		p-value	Odds ratio (95% CI)
		Anaemic (<11 gm/dL)	Non anaemic (≥11 gm/dL)		
Cord blood Hb	<15 (gm/dL)	62 (100%)	64 (88.9%)	0.007	0.508 (0.428-0.603)
	≥15 gm/dL	0	8 (11.1%)		
Cord blood ferritin	<40 (mcg/L)	4 (6.5%)	0	0.43	2.241 (1.851-2.715)
	≥40 (mcg/L)	58 (93.5%)	72 (100%)		
Cord blood iron	<22 (mcg/dL)	1 (1.6%)	5 (6.9%)	0.21	0.220 (0.025-1.933)
	≥22 (mcg/dL)	61 (98.4%)	67 (93.1)		
Iron binding capacity	<100 (mcg/dL)	16 (25.8%)	24 (33.3%)	0.449	0.696 (0.328-1.474)
	≥100 (mcg/dL)	46 (74.2%)	48 (66.7%)		
Cord blood RBC	<4 (million/µL)	48 (77.4%)	40 (55.6%)	0.010	2.743 (1.289-5.838)
	≥4 (million/µL)	14 (22.6%)	32 (22.6%)		
Cord blood PCV	<32 (%)	17 (27.4%)	15 (20.8%)	0.420	1.436 (0.647-3.185)
	≥32 (%)	45 (72.6%)	57 (79.2%)		
Birth weight	<2.7 kg	12 (19.4)	8 (11.1%)	0.2	1.920 (0.729-5.055)
	≥2.7 kg	50 (80.6%)	64 (88.9%)		

[Table/Fig-3]: Comparative analysis of anaemic and non anaemic mothers with cord blood parameters.
Hb: Haemoglobin; RBC: Red blood cell; PCV: Packed cell volume; Chi-square test and odds ratio for maternal Hb and cord blood parameters has been compared; p-value <0.05 is considered as statistically significant; Crude odds ratios (OR) and 95% confidence intervals (CI) associated with different exposures was calculated

Parameters		Maternal Hb	Maternal serum ferritin	Maternal serum iron	Maternal serum iron binding capacity	Mother RBC	Mother PCV
CB-Hb	Pearson	0.191(*)	0.063	0.154	-0.180(*)	-0.071	0.208(*)
	p-value	0.027	0.469	0.076	0.038	0.417	0.016
CB ferritin	Pearson	0.020	0.203(*)	-0.073	-0.061	0.040	0.087
	p-value	0.819	0.019	0.403	0.486	0.648	0.315
CB iron	Pearson	-0.019	-0.001	-0.013	0.010	-0.035	-0.066
	p-value	0.825	0.992	0.879	0.908	0.691	0.449
CB iron binding capacity	Pearson	0.011	-0.016	0.181(*)	0.215(*)	0.051	0.087
	p-value	0.896	0.853	0.036	0.013	0.561	0.315
CB RBC	Pearson	-0.019	-0.073	0.038	0.061	0.217(*)	-0.111
	p-value	0.825	0.402	0.663	0.485	0.012	0.203
CB PCV	Pearson	0.142	0.161	0.172(*)	-0.162	-0.143	0.344 (**)
	p-value	0.101	0.063	0.047	0.062	0.100	0.001

[Table/Fig-4]: Correlation analysis between mother and cord blood parameters.
CB: Cord blood; Hb: Haemoglobin; CRP: C-reactive protein; RBC: Red blood cell; PCV: Packed cell volume; The bivariate correlations procedure computes Pearson's correlation coefficient (r-value) with their significance levels (p-value); Correlation coefficients significant at the 0.05 level were identified with a single asterisk, and those significant at the 0.01 level were identified with two asterisks

anaemia, and India contributes about 80% of maternal deaths in South Asia [24-29].

The results of the present study reveal a significant association between maternal and cord blood Hb. Debbarma R et al., studied 100 mother-infant pairs and reported that neonates of non anaemic mothers had a significantly higher level of Hb concentration than neonates of anaemic mothers [30] and the same trend has been seen by Dapper DV and Didia BC in Nigeria, McElroy PD et al., in Kenya and Alizadah L et al., in Iran [31-33].

Results of the present study show that though maternal Hb correlates to cord Hb, it does not correlate well with cord iron and ferritin. Also, there is only a weak correlation between maternal and cord blood serum ferritin. This may be because of several factors involved in iron homeostasis. Studies reported that hepcidin plays a major role in iron homeostasis [34]. A significant association was found between maternal and neonatal Hb and iron stores in a study done by Kohli UA et al., which concluded that, neonates of anaemic mothers had lower mean cord blood ferritin as compared with those with adequate stores [35].

A study conducted in China by Shao J et al., with 3000 mother and newborn pairs shows that, the newborns born to mothers with ID and mild ID anaemia were not anaemic and had elevated ferritin levels, thereby concluding that, there exists a weak correlation between maternal and newborn iron parameters, similar to the present study [14]. Choi JW et al., found that newborns born to anaemic mothers had significantly lower serum iron and ferritin levels. But, when the serum iron and ferritin values of the newborns born to iron deficient and non iron deficient mothers were compared, the difference was not statistically significant [36].

The present study reveals a significant association between maternal and cord blood Hb. From another study conducted in India, Sareen A et al., concluded that the cord blood Hb shows a linear relationship with maternal Hb, with cord Hb being less in newborns born to anaemic mothers [37].

Limitation(s)

The blood samples were only collected at the time of delivery. Follow-up for the subsequent changes in the haematological and iron parameters in the newborn babies was not carried out. Another limitation of the present study is the small sample size. However, the results certainly points that, cord blood Hb is reduced in neonates born to anaemic mothers which is indicative of insufficient iron reserves in the neonates at birth.

CONCLUSION(S)

There is a significant correlation between maternal and cord blood Hb in term neonates. The study indicates that, the haematological indices of pregnant women determines the neonatal Hb in term babies. Term newborns born to anaemic mothers may be deficient in iron stores. Such infants may benefit from follow-up and addition of iron supplements, before the recommended guidelines of six months. Need for the estimation of cord blood Hb and follow-up of the term neonates born to anaemic mothers for the development of ID anaemia and early iron supplementation is to be emphasised.

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