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A Study of Hemoglobin and Iron Status of Term Neonates Born to Anaemic Mothers

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ABSTRACT

The present study includes the correlation between cord blood hemoglobin, serum iron and serum ferritin levels of term neonates with maternal hemoglobin levels and serum iron and serum ferritin levels of mothers, and to study the correlation between anthropometry and maternal anemia and iron status of neonates. This was a Cross-Sectional Study done on 100 singleton term neonates and their mothers fulfilling the inclusion and exclusion criteria. Maternal venous samples and Cord blood samples were collected for Hemoglobin, Serum Iron and Serum Ferritin estimation. Thorough physical examination of the neonate including anthropometry (Weight, Length, Head Circumference and Chest Circumference) was done. The data collected was analyzed using suitable statistically tests. The Present study focuses on the correlation between cord blood hemoglobin, serum iron and serum ferritin levels of term neonates with maternal hemoglobin levels. The Present study focuses on the correlation between maternal anemia and anthropometry of neonates and study the correlation between the iron status of neonates and anthropometry.

Key words: Hemoglobin, Serum iron, Schistosomiasis, Placenta, Anthropometry, IREs

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INTRODUCTION

Iron deficiency anemia is a common problem, especially in developing countries. Anaemia affects nearly half of all the pregnant women in the world, 52% in developing countries compared with 23% in the developed world [1]. The most common cause of anaemia is poor nutrition, deficiencies of iron and other micronutrients, malaria, hookworm disease, and schistosomiasis; HIV infection and hemoglobinopathies are additional factors [2]. Maternal anemia has several deleterious effects on the health of the mother and the foetus. Mounting evidence indicates that maternal iron deficiency in pregnancy reduces fetal iron stores, perhaps well into the first year of life [3]. Iron sufficiency is of paramount importance in the neonatal period. Controversy exists whether the transfer of iron to the foetus from the mother is determined by fetal demands or by maternal iron stores [4].

Iron is transferred to the foetus through the placenta against a concentration gradient, particularly during the later stages of pregnancy, with the amount of iron transported across the placenta increasing as pregnancy progresses. Several factors influence the concentration of Hb at birth, including gestational age, gender, state of maternal iron reserves, and other factors affecting the maternal-fetal iron exchange. In term pregnancies, 70 – 80% of fetal iron is present in the red cells as Hb [5]. Anaemia in new-borns is established with a cord blood Hb concentration <13.0 g/dL. The cut-off cord blood serum ferritin (CSF) indicating an iron deficiency in the Newborn is set at <35.0 mg/L at which point the iron available to meet normal brain requirements is restricted. CSF is, in addition to the direct examination of stainable iron in bone-marrow smears, the most specific indicator of body iron reserves, Iron homeostasis and iron status indicators [6].

Body iron balance are primarily determined by regulation of absorption of iron where the efficiency of absorption is inversely related to the body iron status. This efficiency may vary from as low as 1% to 2% to nearly 50%to 60% depending on the characteristics of the food source of iron and the iron status of the individual [7]. Regulation is exerted at the level of movement both into the cell through the receptor-mediated process as well as moving across the basolateral membrane into the plasma pool. This former process likely involves both the transferrin receptor and the divalent metal transporter proteins while the latter involves the cellular iron exporter, ferroprotein [8]. The amount of ferroprotein expressed on the basolateral membrane is influenced by a hepatocyte secreted signal peptide named hepcidin. As liver iron stores increase, more hepcidin is released into the plasma pool to decrease the ferroprotein mediated movement of gastrointestinal cell iron across the basolateral membrane.

Iron in the plasma pool is transported by transferrin, which has 2 identical binding sites for ferric ions [9]. This iron will be delivered to any cell that expresses the transferrin receptor; the developing red cell mass takes about 80% of this plasma iron turnover daily.

The remaining 20% is distributed to other body iron pools and the excess iron put into storage in the multi - unit protein, ferritin [10]. The amount of transferrin receptor (TfR) located on the cell surface is regulated by cellular iron status through translational regulation involving Iron Response Elements (IREs) on the non-coding regions of the mRNA and rates of recycling of the TfR on and off the membrane. As a cell becomes iron deficient, there is an upregulation of the translation of TfR-mRNA and more receptor is produced; the inverse is seen when the cells are replete with iron [11].

MATERIALS AND METHODS

Study design

Cross-sectional study.

Study population

We studied the neonates born at Sree Balaji Medical College and Hospital and their mothers.

Sample size

100 singleton term neonates and their mothers.

Study period

One year from April 2017 to March 2018.

Study place

The study was done in the Department of Paediatrics and Department of Obstetrics and Gynecology at Sree Balaji Medical College and Hospital, Chennai.

Inclusion criteria

Singleton term neonates and their mothers.

Exclusion criteria

- Multiple gestations.
- Preterm neonates.
- Premature rupture of membranes (PROM>18 hrs).
- Maternal Fever.
- Foul-smelling liquor.
- Antepartum haemorrhage (APH).
- Pregnancy Induced Hypertension (PIH).
- Eclampsia.
- Gestational Diabetes-mellitus or overt Diabetes complicating pregnancy.
- Mothers with liver disorders, kidney disorders, and other systemic illness.
- Women who have received blood transfusion.

Study method

After obtaining informed consent from the parents, detailed maternal history was recorded in a predesigned proforma. Venous blood sample was collected from the pregnant women during labour. And cord blood sample was collected from the umbilical cord immediately after clamping without milking the cord. The maternal venous and baby's cord blood samples were collected in Vacutainer blood collection tubes with EDTAK3 as an anticoagulant for estimation of Hemoglobin levels, haematocrit and RBC indices. And in plain vacutainer tubes for estimation of Serum iron and Serum Ferritin levels. A through physical examination of the neonate including anthropometry (Weight, Length, Head Circumference, and Chest Circumference) was done.

Laboratory analysis

Hemoglobin level, haematocrit and RBC indices were calculated using an automated analyser. Serum Iron using calorimetry method and Serum Ferritin using immunohistochemistry. The data collected has been analysed using suitable statistically tests.

Study definition

Mothers with haemoglobin <11gm/dl were defined as anaemic as per WHO cut off. The gestational age of pregnancy was calculated from the last menstrual period and was confirmed by new Ballard score. Term gestation was defined as gestational age between 37 weeks 0 days to 41 weeks 6 days.

BG Prasad scale: The socio-economic classification was measured based on the BG Prasad scale. This scale was introduced in 1961 was later modified in 1982, 2001, 2013 and in 2016. The scale is updated periodically as inflation is an ongoing process. There are tools and calculations available which enables real time update of the classification to maintain the validity of the published data. The revised classification for 2016 is as follows (Table 1).

Table 1: BG Prasad scale.

Social Class	Amount (Rs. /month)
I (upper class)	6261 and above
II (upper middle class)	3099-6260
III (middle class)	1835-3098
IV (lower middle class)	949-1834
V (lower class)	<948

Statistical analysis

The statistical analysis was done using the Chi-Square test to find the association between the parity, educational status of the father and mother, occupational status with the severity of anaemia. Differences in mean parameters between the pregnant women and their new-borns in the four groups were determined using the analysis of variance. Pearson's correlation coefficient was used for the correlation analysis. A p-value of <0.05 was significant for all the tests.

RESULTS

100 mothers and their new-borns were enrolled in the study to determine the relationship between them with regard to their iron status. These 100 mothers were divided into 4 groups based on their hemoglobin levels done by automated analyser.

Group 1: Hemoglobin level≤6.9 gm/dl.

Group 2: Hemoglobin level 7g/dl -9.9g/dl.

Group 3: Hemoglobin level 10g/dl -10.9g/dl.

Group 4: Hemoglobin level ≥ 11g/dl.

No of pregnant women in each group

- Group 1 contained 9 mothers and they constituted 09% of the sample size.
- Group 2 contained 61 mothers and they constituted 61% of the sample size.
- Group 3 contained 10 mothers and they constituted 10% of the sample size.
- Group 4 contained 20 mothers and they constituted 20% of the sample size.

The above table depicts Hemoglobin values of the mothers. Among 100 mothers 9(9%) mothers were in severe anaemia, 61(61%) group were in mild anaemia, 10 (10 %) were in moderate anaemia and 20(20%) mothers were normal. This data shows that 80% of the pregnant mothers were anaemic (Table 2 and Figure 1).

Table 2: Classification of pregnant women into 4 groups according to the Hemoglobin level.

Group	Frequency	Percent
≤6.9 gm/dl	9	9
7 gm/dl -9.9 gm/dl	61	61
10 gm/dl -10.9 gm/dl	10	10
≥11 gm/dl	20	20
Total	100	100

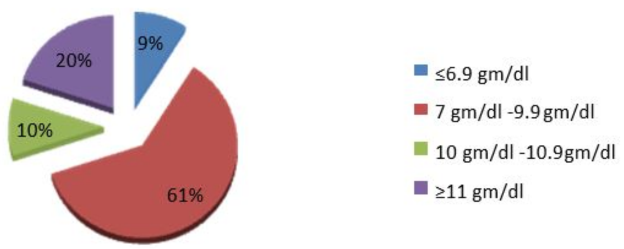

Figure 1: Distribution According to HB Group of the mother.

The above table 3 depicts age of the mothers. Among 100 mothers 43(43%) mothers were in 18 -21 age group, 22(22%) were in 22 -24 years, 23 (23 %) were in 25-28 years and only 12(12%) mothers age were 29 -32 years. This data shows that 88% of the pregnant mothers age were 18-28 years (Figure 2).

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Table 3: Age

Age group	Frequency	Percent
18-21 Years	43	43
22-24 Years	22	22
25-28 Years	23	23
29-32 Years	12	12
Total	100	100

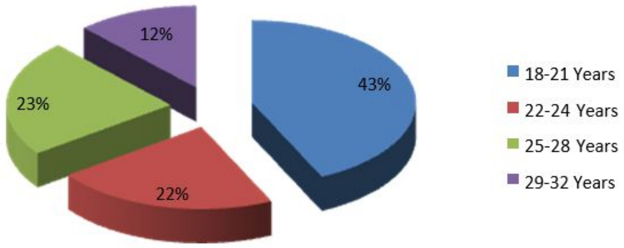

Figure 2: Distribution according to age of the mother.

Only primi and second gravida in the age group of 18 to 32 were selected to make the different study groups comparable with respect to age and parity. In the present study group, 45% were primi and they were the major group. Rest of the women were non primi and they constitute 55%. In the group of second gravida women with previous live births were 49% and the women with previous abortions were 6% (Table 4 and Figure 3).

Table 4: Parity.

Parity	Frequency	Percent
Primi	45	45
G2P1L1	49	49
G2A1	6	6
Total	100	100

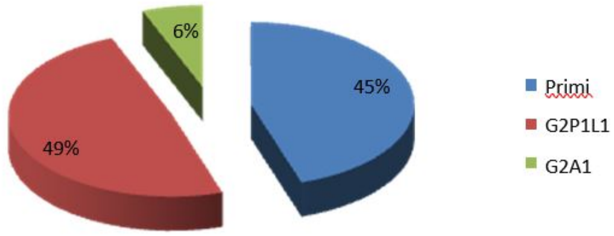

Figure 3: Distribution according to parity of the mother.

Of the 100 mothers, 7 of them were not able to read and write and 4 of them were degree holders. 33 had education up to the primary school level, 19 up to the secondary level, and 37 mothers were having higher secondary level education (Table 5 and Figure 4).

Table 5: Classification of mothers according to their educational status.

Educational status of mother	Frequency	Percent
No formal Education	7	7
Primary	33	33
Secondary	19	19
Higher Secondary	37	37
graduate Level	4	4
Total	100	100

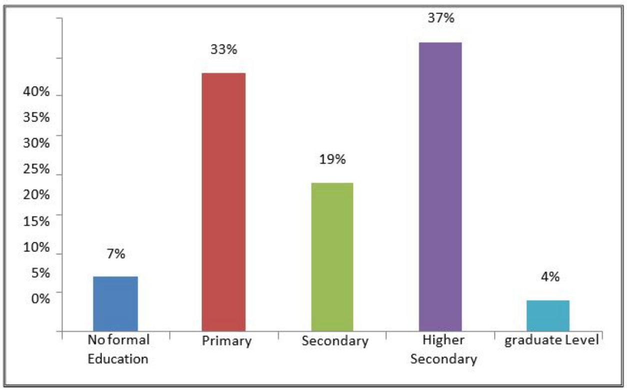

Figure 4: Distribution according to the educational status of the mother.

The table 6 depicts educational status of the fathers, among 100 study participants, 4 of the fathers were not able to read and write and 7 of them were degree holders. 26 had education up to the primary school level, 45 up to the secondary level, and 18 fathers were having higher secondary level education (Figure 5).

Table 6: Classification of fathers according to the educational status.

Educational status of Father	Frequency	Percent
No formal Education	4	4
Primary	26	26

Secondary	45	45
Higher Secondary	18	18
graduate Level	7	7
Total	100	100

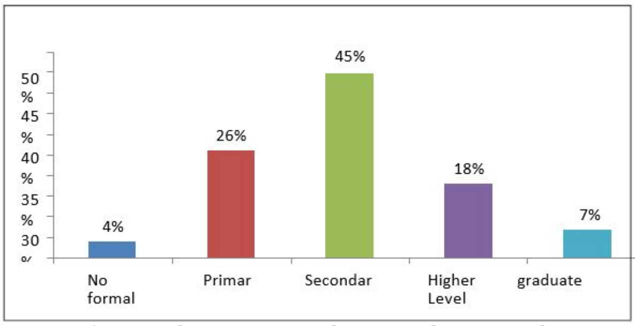

Figure 5: Distribution according to educational status of the fathers.

The above table depicts occupation status of the mothers, among 100 study participants, 83 of them were working and remaining 17 % were not working (Table 7 and Figure 6).

Table 7: The occupational status.

Working	83	83
Not Working	17	17
Total	100	100

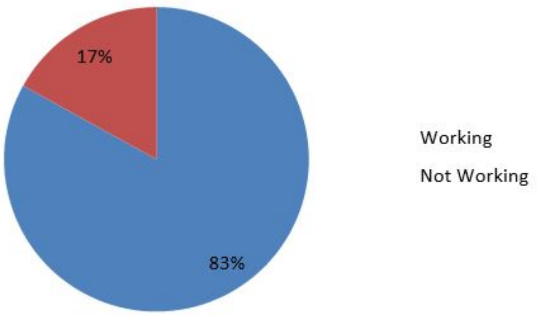

Figure 6: Distribution according to occupational status of the mothers.

The above table depicts socio economic status of the study participants classified by B.G.Prasad scale, among 100 , majority 58% of them belonged to lower status, 28% were belonged to lower middle class status and remaining 10% ,4% belonged to upper middle class and upper class respectively (Table 8 and Figure 7). Out of the 100 mothers studied, 97 had at least 3 antenatal visits and they are booked cases. Only three women were unbooked (Table 9 and Figure 8).

Table 8: Classification of pregnant women according to the socio-economic status.

Socio economic status	Frequency	Percent
Lower	58	58
Lower Middle	28	28
Upper Middle Class	10	10
Upper class	4	4
Total	100	100

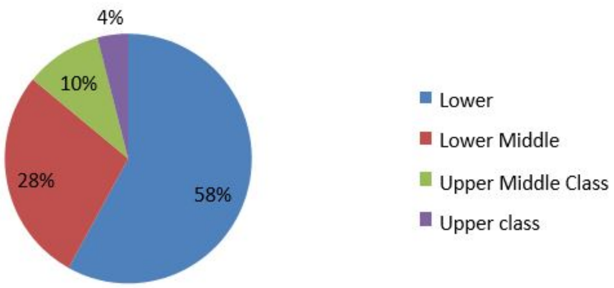

Figure 7: Distribution according to socio economic status of the mother.

Table 9: Classification of pregnant women according to booked or unbooked.

Booked or not	Frequency	Percent
Booked	97	97
Un Booked	3	3
Total	100	100

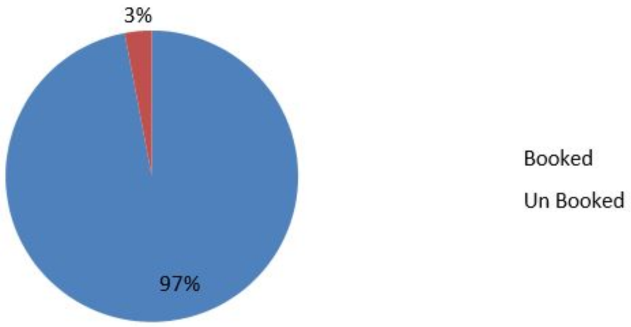

Figure 8: Distribution according to booked status of mother.

DISCUSSION

Iron deficiency anemia is the most common nutritional deficiency disorder affecting the pregnant women in our country with a significant impact on maternal and fetal mortality and morbidity. In the present study, 100 pregnant women were selected based on the inclusion criteria. These 100 mothers were divided into 4 groups:

Group 1: Hemoglobinlevel≤6.9gm/dl.

Group 2: Hemoglobin level 7g/dl -9.9g/dl.

Group 3; Hemoglobin level 10g/dl -10.9g/dl Group 4: Hemoglobin level ≥ 11g/dl.

Number of pregnant women in each group

Group 1 contained 9 mothers and they constituted 09% of the sample size. Group 2 contained 61 mothers and they constituted 61% of the sample size. Group 3 contained 10 mothers and they constituted 10% of the sample size. Group 4 contained mothers and they constituted 20% of the sample size. Among 100 mothers 9(9%) mothers were in severe anemia, 61(61%) were in mild anemia, 10 (10 %) were in moderate anemia and 20(20%) mothers were normal [12-17]. This data shows that 80% of the pregnant mothers were anemic. baby weight of the study participants among 9 severe anemia (<6.9 mg/ dl) mothers 7(78%) had 2.00 -2.5 kilograms baby and remaining 2(22%) were had 2.00 to 2.5 kilograms. Among 61 moderate anemic (<7 -9.9 mg/dl) mothers 10(16%) had 2.00 -2.5 kilograms baby, 30(49%) were had 2.00 to 2.5 kilograms and 21(34%) had above 3.0 kilograms baby. Among 10 mild anemic (<10 -10.9 mg/dl) mothers only 2(20%) had 2.00 -2.5 kilograms baby, 4(40%) were had 2.00 to 2.5 kilograms and 4(40%) had above 3.0 kilograms baby. Among 20 normal (≥11 mg/dl) mothers only 2(10%) had 2.00 -2.5 kilograms baby, 9(45%) were had 2.00 to 2.5 kilograms and 9(45%) had above 3.0 kilograms baby [18-21]. The chi-square value was 20.8 which was statistically highly significant $p<0.001$ which describe that baby wei ght was higher when mothers Hb was higher [1].

Values of Hemoglobin, serum iron and serum Ferritin in maternal and cord blood

In general, the iron-related parameters are higher in the cord blood, compared to the maternal blood. The present study also corroborates this finding in some of the parameters (22-25). The values of hemoglobin, serum iron and serum ferritin in the cord blood were higher than the maternal blood. Similar results were obtained in the studies conducted by Siddappa A. M et al. The mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration were higher in the cord blood compared to the maternal blood [22-25].

CONCLUSION

The serum iron and serum ferritin values of the neonates correlate with the maternal hemoglobin levels and serum ferritin is exceptionally low in the neonates of the mothers with severe anemia. Compared with the babies of the mothers with normal hemoglobin levels, the babies of the mothers with severe anemia show a low birth weight. The neonates of both anemic and non-anemic women may be born with a hemoglobin in the normal range but the iron stores of the neonate depend on the maternal iron status. The lower iron and ferritin values of the neonate were not reflected by the neonatal RBC indices; hence they should not be used as an indicator for assessing the iron status. The low iron stores of the neonates may be depleted easily when the demands are high in early infancy. Iron deficiency in early life may have long term adverse effects on the cognitive development and may also impair cellular immunity.

FUNDING

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ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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