Research Article

Assessment of Cord Blood Hemoglobin and Serum Ferritin Levels in Newborns of Anemic and Non Anemic Mothers in Children and Maternity Minia University Hospital

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Abstract

Background: Iron deficiency in infancy may adversely influence cognitive, emotional, motor, and neurophysiological development. Iron deficiency anemia (IDA) is a decrease in the total hemoglobin levels caused by iron deficiency, it is a major health problem affecting about 2 billions worldwide and about of 43% of infants in Egypt. Iron deficiency anemia during pregnancy is associated with preterm deliveries, low birth weights, morbidity and perinatal mortality, it was thought that maternal iron deficiency has little or no effect on the acquisition of iron by the fetus, however, in contrast other investigator have found a positive correlation between maternal and newborn iron status, thus, understanding the relationship between maternal and fetal iron status may help inform efforts to prevent ID in pregnancy and infancy and improve outcomes for mothers and infants. **Objective:** To compare the mean values for pre-delivery hemoglobin and serum ferritin concentrations of anemic and non anemic mothers with the cord blood hemoglobin and serum ferritin concentrations of their newborns. **Methods:** This is a prospective case control study which was conducted at Children and Maternity Minia University Hospital, Minia governorate, during the period from March 2014 to May 2015. The target population of this study was 200 pregnant women who were admitted to Children and Maternity Minia University Hospital at obstetric ward and their newborns. **Results:** The results revealed that non- anemic mothers (group, II) had significantly ($p<0.01$) higher blood Hb concentration and serum ferritin level compared to anemic mothers (group, I). There were no significant differences between neonates of anemic mothers and neonates of non-anemic mothers as regard gestational age, length and head circumference however, neonates of non-anemic mothers had significantly higher ($p<0.01$) body weight mean than those of anemic mothers. Neonates of anemic mothers had significantly ($p<0.01$) lower Hb concentration than neonates of non-anemic mothers, however, there was no significant difference between them as regard serum ferritin concentration. Neonates of anemic mothers had significantly ($p<0.01$) higher Hb and ferritin concentrations compared to their mothers. Also, neonates of non-anemic mothers had significantly ($p<0.01$) higher Hb and ferritin concentrations compared to their mothers. **Conclusion:** Maternal anemia is a significant risk factor for adverse neonatal birth weight and hematological parameters. Also, neonates of anemic mothers appeared to be at increased risk of developing IDA. Receiving iron supplements had a beneficial effect on iron status of pregnant women and decreasing the incidence of IDA and its adverse effects on both mothers and fetus. Iron deficiency anemia was significantly higher among low education women in comparison with well educated ones. Neonates of non-anemic mothers had good iron status compared to neonates of anemic mothers.

Keywords: Cord Blood Hemoglobin’ Serum Ferritin; Anemic Mothers

Introduction

Iron is a vital element in all aerobic organisms, and it plays critical functions in the human body (Nguyen, 2016). Iron is essential for normal human growth, it is required for many essential body functions, including oxygen transport, adenosine triphosphate (ATP) production, DNA synthesis, mitochondrial function, and protection of cells from oxidative damage (Adediran et al., 2013). Also, low iron stores at birth and iron deficiency (ID) in infancy may also adversely influence cognitive, emotional, motor, and neurophysiological development in humans (Shao et al., 2012).

Anemia in pregnancy (mostly due to ID) is a major challenge to obstetric care in developing countries where the prevalence rate varies between 33 and 75% (Adediran et al., 2013) when compared with figures from developed countries with a prevalence rate of 14% (Shill et al., 2014) since the prevalence of anemia in non-pregnant women in developing countries is also high (43%) it is possible that many of these women were already anemic at the time of conception (Abu-Ouf and Jan, 2015).

Iron deficiency anemia (IDA) is a decrease in the total hemoglobin (Hb) levels caused by iron deficiency, it is known to be the most common nutritional deficiency worldwide affecting more than 700-800 million people globally (Akhtar et al., 2013). Around of 50% of all cases of anemia worldwide are thought to be caused by iron deficiency (Abdel- Rasoul et al., 2015). IDA has reached epidemic levels in numerous developing countries and is currently the most prevalent micronutrient deficiency in the world (Alzaheb and Al-Amer, 2017). The prevalence of IDA could be affected by several factors which include socioeconomic conditions, lifestyle, and health-seeking behaviors across different communities (Chowdhury et al., 2015).

In Egypt, the prevalence of IDA is 43% in infants of 6 to 24 months (Al Ghwass et al., 2015). In Qena governorate, it was 12% among children in the age group of 6-11 years (Mansour et al., 2004), in Al- Gharbia governorate, IDA prevalence was 47 % in mothers and in sibling was 52.25 & 54.03 % for male and female respectively. In addition, in a recent study by Tawfik et al., (2015) among 4526 households from eleven governorates, they found that IDA (low Hb and low ferritin) was recognized among 18.5% of whole sample population, with high prevalence for mothers (25.1%).

Iron deficiency anemia could be diagnosed by low blood hemoglobin concentration (which is the iron-containing protein in the blood that carries iron and oxygen to cells) and low serum ferritin (which indicates the amount of iron stored in the body) (Arcanjo et al., 2016).

Many studies have indicated that IDA during pregnancy may be associated with an increased cases of prematurity and perinatal mortality and some adverse effects on neonates (Alwan et al., 2015). However, how ID in pregnant women affects the iron metabolism and iron status of their fetuses remains to be established (Lee et al., 2014).

Thus, understanding the relationship between maternal and fetal iron status may help inform efforts to prevent ID in pregnancy and infancy and improve outcomes for mothers and infants.

This work aimed to compare the mean values for pre-delivery hemoglobin and serum ferritin concentrations of anemic and non anemic mothers with the cord blood hemoglobin and serum ferritin concentrations of their newborns.

Patients and Methods

This is a prospective case control study which was conducted at Children and Maternity Minia University Hospital, Minia governorate, during the period from March 2014 to May 2015. The target population of this study was 200 pregnant women who were admitted to Children and Maternity Minia University Hospital at obstetric ward and their newborns who were divided into two groups according to their Hb and ferretin level as follow: **Group (I): Cases:** Included 100 pregnant anemic mothers (IDA) with Hb < 11 (g/dl) and serum ferretin < 10 (ng/ml) (As defined by the WHO, anemic mothers are those with a pre-delivery Hb of < 11 g/dl)and their neonates after delivery. **Group (II): Control:** Included 100 healthy pregnant non anemic mothers with Hb ≥ 11 (g/dl) and serum ferretin > 10 (ng/ml) and their neonates.

All mothers were chosen according to the following criteria: Attending labor ward at Children and Maternity Minia University Hospital with age range from 18-43 years, going to give birth to a full term neonates (gestational age ≥37 weeks) by date and Ultrasound, and with singleton neonates.

Patients were excluded according to the following criteria: having chronic medical condition (Diabetes, hypertension, hepatitis, renal disorders, etc….), bleeding during pregnancy, preterm labor, and high risk pregnancy (e.g. history of repeated abortion, history of trauma and severe infection during pregnancy, severe hyperemesis, preeclampsia) and previous history of hemoglobinopathy.

All cases and controls were subjected to the following: Full history taking (from mothers), examinations (to mothers and newborns) including (General examination & Local and physical examinations and measurements, and determination of newborn age by ballard method); and Laboratory investigations including: Hemoglobin and Serum ferritin.

Principles of ferritin assay:
The samples and diluted anti-ferritin-HRP conjugate had been added to the wells coated with antibody to ferritin. Ferritin in the patients serum binds to anti-ferritin antibody on the well and the anti-ferritin HRP conjugate had been washed off by wash buffer. Upon the addition of the substrate, the intensity is propotiononal to the concentration of the ferritin in the samples. A standard curve had been prepared relating color intensity to the concentration of the ferritin.

Statistical analyses:
Data entry and all statistical analyses were performed using Statistical Package for Social Science (SPSS) version 21 under windows 7 operating system. Results are expressed as means ± SD for quantitative data and by No. (%) for qualitative data. Comparisons between the groups were conducted by independent sample T test for parametric data and by Mann Whitney test for Non-parametric data. Chi-Square test was used to test the significance between groups regarding qualitative data. Bivariate correlations between the study variables were carried by calculating the Pearson’s and Sperman’s correlation coefficients.

Results

Table (1) shows the comparison between groups regarding demographic data. The results showed that there were no significant difference between groups regarding age, length, gestational age and gravidity. However, group (1) of anemic mothers had significantly lower weight, BMI, university education and economic status compared to group (11) of non anemic mothers.

Table (1): Comparison between groups regarding demographic data.

Variables	Group (I) Cases (Anemic Mothers) (n=100)	Group (II) Control (Non- anemic Mothers) (n=100)	P value
Age (years) Mean ± SD Range	 30.2 ± 7.3 (18-41)	 28.7 ± 7.9 (18-43)	0.16^{NS}
Weight (Kg) Mean ± SD Range	 64.9 ± 5.6 (52-85)	 72.3 ± 6.9 (58-88)	**<0.01****
Length (Cm) Mean ± SD Range	 155.4 ± 4.03 (148-166)	 153.9 ± 6.5 (137-171)	0.06^{NS}
BMI (kg/m^2) Mean ± SD Range	 26.9 ± 2.6 (21.6-38.8)	 30.6 ± 3.3 (23.7-38.0)	**<0.01****
(wks.) Gestational age Mean ± SD Range	 38.1 ± 0.8 (37-40)	 38.2 ± 0.8 (37-41)	0.38^{NS}
Gravidity Mean ± SD Range	 5.02 ± 1.8 (1-9)	 4.7 ± 2.4 (1-11)	0.29^{NS}
Education University n(%) Secondary n(%) Basic n(%) Illiterate n(%)	 20 (20.0%) 62 (62.0%) 0 18 (18.0%)	 40 (40.0%) 49 (49.0%) 3 (3.0%) 8 (8.0%)	**<0.01****
Economic status High Moderate Low	 0 20 (20.0%) 80 (80.8%)	 32 (32.0%) 0 68 (68.0%)	**<0.01****

Qualitative data was presented as No. (%).
Independent sample T- test was used for quantitative data between the two groups. Chi square test for qualitative data between the two groups.
NS: Not significant   **Significant (p<0.01).**

Table (2): Comparison between groups regarding Hb g/dl and ferritin concentrations ng/ml

Variables	Group (I) Cases (Anemic Mothers) (n=100)	Group (II) Control (Non- anemic Mothers) (n=100)	P value
Hemoglobin (g/dl) Mean ± SD Range	 9.04 ± 1.7 (5.8-11)	 13.03 ± 0.4 (11-13.9)	**<0.01****
S. Ferritin (ng/ml) Mean ± SD Range	 7.2 ± 1.8 (4.0-10.1)	 19.9 ± 4.4 (11.5-29.0)	**<0.01****

Independent sample T- test was used   **** Significant (p<0.01).**

Results of table (2) revealed that anemic mothers (group, I) had significantly (p<0.01) lower blood Hb concentration and serum ferritin level compared to non- anemic mothers (group II).

Table (3): Comparison between neonates of anemic and non anemic mothers regarding gestational age and anthropometric measurements.

Variables	Group (I) Neonates of anemic mothers (n=100)	Group (II) Neonates of Non-anemic mothers (n=100)	P value
Gestational age (wks.)*			0.31[NS]
Mean ± SD	38.1 ± 0.7	38.2 ± 0.7	
Range	(37-39)	(37-39)	
Weight (kg)			**<0.**01**
Mean ± SD	3.07 ± 0.2	3.20 ± 0.2	
Range	(2.4-3.4)	(2.5-3.8)	
Length (cm)			0.15[NS]
Mean ± SD	50.6 ± 1.5	50.9 ± 1.4	
Range	(48-54)	(47-54)	
Head circumference (cm)			0.54[NS]
Mean ± SD	36.8 ± 0.6	36.9 ± 1.05	
Range	(31-37)	(29-38)	

***Gestational age was calculated by ballard score ** Significant (p<0.01).**

Table (3) showed that there were no significant differences between neonates of anemic mothers and neonates of non-anemic mothers as regards to gestational age, length and head circumference however, neonates of anemic mothers had significantly (p<0.01) lower mean body weight than those of non-anemic mothers.

Table (4): Comparison between neonates of anemic mothers and of non- anemic mothers regarding Hb (g/dl) and serum ferritin concentrations (ng/ml).

Variables	Group (I) Neonates of anemic mothers (n=100)	Group (II) Neonates of Non-anemic mothers (n=100)	P value
Hemoglobin (g/dl)			**<0.01****
Mean ± SD	15.07 ± 0.83	16.31 ± 1.20	
Range	(13.1-17.5)	(13.2-18.6)	
Cord S. Ferritin (ng/ml)			
Mean ± SD	70.79 ± 7.82	72.24 ± 7.31	0.17[NS]
Range	(60.2-90.1)	(60.1-91.1)	

Independent sample T- test was used

****Significant (p<0.01). NS Not significant.**

Table (4) showed that neonates of anemic mothers had significantly (p<0.01) lower Hb concentration than neonates of non-anemic mothers, however, there was no significant difference between them as regards to serum ferritin concentration.

Discussion

The present study is a prospective case control study which was conducted on a total of 200 pregnant women (with age range 18:43 years) who were admitted to Children and Maternity Minia University Hospital at obstetric ward. These women were classified into two groups according to their Hb and Serum-ferritin into anemic and non anemic: Included 100 pregnant women with iron deficiency anemia and their neonates after delivery. Group (II): Control: Included 100 healthy pregnant non anemic women and their neonates. The objectives of to our study were to estimate the mean values for pre-delivery hemoglobin and serum ferritin concentrations of anemic and non-anemic mothers and to compare these values with their neonate cord blood hemoglobin and ferritin levels.

Starting with demographic data we found that results revealed that non anemic mothers had significantly higher weight and BMI compared to anemic mothers (Table 1). These results agreed with Kaur et al., (2015).

Who studied the relationship between maternal anaemia and neonatal birth weight in a sample of low-middle income group urban mothers. They found that non anemic mothers had significantly higher weight and BMI compared to anemic mothers. Also, similar results were found by Lelic et al., (2014) & Kumar et al., (2013). Similarly, Hadipour et al., (2010) found that maternal HB level showed significant ($p<0.001$) positive correlation with neonatal birth weight. This result may be explained by that anemia cause growth impairment and some physiological dysfunctions and consequently caused weight reduction as it was reported by Alquaiz et al., (2013).

In the present study, non anemic group of mothers had higher educational level as compared to anemic group. These results agreed with Souganidis et al., (2012) who investigated the relationship of maternal knowledge of anemia with maternal and child anemia and health-related behaviors targeted at anemia and found that higher educated pregnant women had low anemia prevalence. Also, Abu-Ouf et al., (2015) reported that maternal education levels and iron-fortified foods have been associated with improved iron status of mothers.

It has been reported that a reduction in serum ferritin below 30 ng/ml shows ID with high diagnostic accuracy because a strong correlation exists between serum ferritin and the body's total iron storage (Hadipour et al., 2010). Also, it is generally assumed that for each 1 ng/ml of serum ferritin, 10 mg of iron are stored in tissues and organs. Serum ferritin appears to be iron-pool and mainly derived from macrophages (Nairz et al., 2015)

Serum ferritin is the most convenient laboratory test to estimate iron stores, it reflects total body iron stores, the most useful single laboratory value for the diagnosis of iron deficiency may be plasma ferritin (Abdel-Rasoul et al., 2015). Serum ferritin is the most clinically applicable in pregnancy (Pavord et al., 2012). Low serum ferritin concentrations are seen only in iron deficiency (Daru et al., 2017).

Our study found that non-anemic mothers had significantly higher blood Hb concentration and serum ferritin level compared to anemic ones (Table, 3). These results are in agreement with Adediran et al., (2013) who established pre-delivery hemoglobin and serum ferritin concentrations of anemic and non- anemic mothers and to compare these values with the cord blood hemoglobin and serum ferritin concentrations of their newborns. Who found that mean Hb concentration of the anemic women was 9.5 ± 1.01 g/dl, while it was 12.15 ±g/dl in non-anemic women. Also, they found that anemic mothers had low ferritin (<10 μg/l) while 3 of 77 (0.04%) non-anemic mothers had low ferritin. Also, these findings agreed with those of Hadipour et al., (2010), Kumar et al., (2013) & Kaur et al., (2015) who reported a higher Hb and ferritin concentrations in non anemic women compared to anemic ones.

The present results revealed that neonates of non-anemic mothers had significantly higher means for body weight than those of anemic mothers (Table 4). These results are in line with those of Akaberi, 2010, Adediran et al., 2013, Ekta and Shah, (2014) who assessed the hematological profile and physical growth of neonates born to anemic mothers at birth and 3.5 months of age. Thy found that birth weight, head circumference and length were significantly compromised at birth in neonates born to anemic mothers ($p<0.01$) compared to others born to non-anemic ones. Also, same findings were reported by Akaberi, (2010), Adediran et al., (2013) & Kaur et al., (2015).

Earlier reports spanning almost last two decades indicate persistence in this relationship between maternal anemia and low birth weight (Gomber et al., 2002 & Haider et al., 2013). A meta-analysis summarizing 48 randomized controlled trials and 44 cohort (up till 2012) found that, for each 1 g/L increase in maternal haemoglobin, neonatal birth weight increased by 14.0 (6.8 to 21.8) g (Haider et al., 2013). Furthermore, there are data demonstrating long-term impairments in cognitive development and growth in babies exposed to IDA in utero (Congdon et al., 2012). In addition, it is known that severe anemia, present from early gestation along with concomitant maternal malnutrition, may be associated

with reduced placental weight and structural abnormalities of the placenta (Terefe et al., 2015).
On the other hand, Kumar et al., (2013) found that the higher hemoglobin level of mothers did not show any effect on either birth weight, in addition, we could also say that newborns weight is controlled by many other factors like mother nutritional status or iron status.

In the present study neonates of anemic mothers had significantly lower Hb concentration than neonates of non-anemic mothers. However, no statistical significant regarding serum ferritin between both groups in neonates of anemic mothers than control (Table, 10). These results are in agreement with Adediran et al., (2013) who found that neonates of anemic mothers had significantly lower Hb concentration and also ferritin concentration.

In agreement with our finding were Adediran et al. 2013 and Terefe et al., 2015 as they found that lower Hb and ferritin concentration in neonates of anemic mothers lower than Hb and ferritin concentration of neonates of non-anemic mothers

Also, these results agreed with Kaur et al., (2015). Also, as a partly agreed with our results Terefe et al., (2015) found that neonates of anemic mothers had lower iron storage (ferritin was 85 ng/ml compared to 93 ng/ml in babies of non anemic mothers). Also, cord blood hemoglobin and newborns weight were lower in anemic women compared to that of non-anemic women (Debbarma et al., 2015).

Moreover, Adediran et al., (2013) reported that the prevalence of foetal anemia in the anemic women was higher than that in the non-anemic group, this observation indicates that maternal anaemia may affect foetal Hb status. Also, this agreed with Reihaneh et al, (2010) who found significant differences between neonatal hemoglobin levels of newborns from normal and anemic mothers and also, this agreed by Al-Hilli, (2010) who also found a positive correlation between maternal hamoglobin and cord blood hemoglobin. Similarly, Özdemir et al., (2013) reported that anemia during perinatal period may be a risk factor for development of IDA in infancy.

Furthermore, Akaberi, (2010) studied hemoglobin and serum ferritin levels in newborn babies born to anemic Iranian women, he found significant differences in neonatal hemoglobin levels between neonates of normal women and neonates of anemic women. This may further confirm that whatever the cause, anemia in pregnancy may affect foetal hemoglobin concentration. In addition, the risk of developing anemia for neonates followed during their first year was increased 6.57 fold for those infants whose mothers had anemia, defined by low hemoglobin with low ferritin (<12 ng/ml) at delivery (Morton et al., 2014).

Conclusion

Maternal anemia is a significant risk factor for adverse neonatal birth weight and hematological parameters. Also, neonates of anemic mothers appeared to be at increased risk of developing IDA. Receiving iron supplements had a beneficial effect on iron status of pregnant women and decreasing the incidence of IDA and its adverse effects on both mothers and fetus. Iron deficiency anemia was significantly higher among low education women in comparison with well educated ones. Neonates of non-anemic mothers had good iron status compared to neonates of anemic mothers.

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