Original Article

Correlation of Neonatal Birth Weight with Maternal Serum Ferritin Level in PAEC General Hospital, Islamabad

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Abstract

Objective: To assess the correlation between maternal serum ferritin level and birth weight of neonate at the time of delivery.
Methodology: This cross-sectional study was conducted at Department of Obstetrics & Gynecology, PAEC General Hospital, Islamabad (six months duration from November 2022 to May 2023. A total of 95 eligible women presenting in labour room fulfilling inclusion criteria were enrolled for study. Informed consent was obtained. Demographics like name, age, BMI, parity, gestational age at delivery, antenatal care (booked / unbooked), stage at presentation was noted. Blood sample was taken by using 3cc disposable syringe and sent to the laboratory of the hospital for assessment of serum ferritin level of mother. Reports were assessed and serum ferritin level was noted. Mode of delivery was also noted. At the time of delivery, birth weight of neonate was assessed by using weighing machine.
Results: In our study of 95 cases, mean age was 29.47+3.82 years, according to gender distribution of neonates 52(54.7%) were male and 43(45.3%) females, mean gestational age at the time of delivery was 36.33+1.38 weeks, mean ferritin level was 24.37+2.38. Correlation between maternal serum ferritin level and birth weight of neonate at the time of delivery was positive, r value was 0.881. Effect modifiers influenced the strength of the correlation between birth weight and ferritin levels. The association was stronger in full-term neonates, in males, and in babies born to mothers with higher parity.
Conclusion: We concluded that there is a correlation between maternal serum ferritin level and birth weight of neonate at the time of delivery.
Keywords: Neonates, birth weight, maternal serum ferritin level

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Introduction

Iron deficiency anemia is the most common type of anemia and is a global nutritional problem but particularly more common in developing countries.[1] Iron requirement increases exponentially during pregnancy to meet the increased demands of the fetoplacental unit, to expand maternal erythrocyte mass and to compensate for iron loss at delivery. In more than 80% of countries in the world, the prevalence of anemia in pregnancy is > 20% and could be considered a major public health problem. The global prevalence of anemia in pregnancy is estimated to be approximately 41.8%.[2] It is believed that thirty percent of all females of reproductive age are anemic.[3-4]

Ferritin, the major iron storage protein, has a function in iron metabolism. High serum ferritin levels have been demonstrated in many chronic disorders and vascular inflammation.[5-6] Little attention has been focused on the assessment of neonatal iron status at birth because of the belief that sufficient iron will be accrued across gestation even in the face of mild-to-moderate maternal anaemia.[7] Fetal growth and development is highly influenced by maternal nutritional status before and during pregnancy.[8] Fetal growth is regulated by the balance between fetal nutrient demand and maternal placental nutrient supply.[9]

In most pregnant women who are otherwise healthy, a serum ferritin level is all that is needed to determine whether or not they have an iron shortage. It is sufficient to establish the diagnosis of iron shortage if levels of ferritin are low. The World Health Organization (WHO)

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currently defines iron deficiency in adults as ferritin lower than 15 µg/L, unless inflammation is coexistent, in which case iron deficiency may exist when ferritin is lower than 30 µg/L. Iron overload is considered to exist at value >150 µg/L in females.[10]

Anaemia should be defined as haemoglobin concentration <110 g/l in first trimester and <105 g/l in second and third trimesters and <100 g/l postpartum.[11] The United Kingdom has published a recommendation for 2019 that recommends early therapy and evaluation of response in two to three weeks (a therapeutic trial). [11] This has the potential benefit of eliminating the expenditures of further visits and other tests.[12] Correction of iron shortage prior to the third trimester is optimal because iron-dependent neurogenesis is at its peak during the third trimester and early newborn life[13] and iron deficiency during this time has been related with abnormalities in neurocognitive development. Infants born to iron-deficient mothers are at high risk for having iron deficiency at birth.[14]

It's a common practice that only hemoglobin level is tested during pregnancy for the confirmation of anemia while serum ferritin, the most sensitive biomarker for early-stage iron deficiency, is often overlooked. Consequences of this practice ultimately leads to low birth weight which results in several different complications. Current study was done to understand the correlation between above two factors within local community. Evidence generated from present study will ultimately help to improve the practices in this regard.

Methodology

A cross-sectional study was conducted in the Department of Obstetrics & Gynecology, PAEC General Hospital, Islamabad, over a six-month period from November 2022 to May 2023. Ethical approval was obtained from the Institutional Review Board (IRB) under reference number PDHI-IRB (DME)-RCD-06-082. All pregnant women of age 20-45 years with singleton pregnancy and gestational age > 32 weeks (according to LMP) presenting in labour (>3 contractions in 10 minutes, intact membranes, Bishop >4 and cervical dilatation >4cm) were included. Women with multiple pregnancies, fetal death/still birth, fetal anomalies, IUGR due to uteroplacental insufficiency and all types of anemias except iron deficiency were excluded. Non-probability, consecutive sampling technique was used for data collection. The sample size of 95 was calculated by correlation calculator with 5% type I error, 10% type II error and value of correlation i.e. r=0.325 between maternal ferritin level birth weight. The study was done after obtaining the approval by the institutional ethical committee. Patient's confidentiality and privacy were strictly maintained throughout the study. A total of 95 eligible women presenting in labour room fulfilling inclusion criteria were enrolled for study. Informed consent was obtained. Demographics like name, age, BMI, parity, gestational age at delivery, antenatal care (booked / unbooked), stage at presentation was noted. Blood sample was taken by using 3cc disposable syringe and sent to the laboratory of the hospital for assessment of serum ferritin level of mother. Reports were assessed and serum ferritin level was noted. Mode of delivery was also noted. At the time of delivery, birth weight of neonate was assessed by using weighing machine. All this information was recorded on proforma. The data was analyzed using SPSS version 25. Quantitative variables like age, gestational age at delivery, BMI, maternal serum ferritin and neonatal birth weight were presented as mean and standard deviation / median and interquartile range. Qualitative variables like parity, mode of delivery, antenatal booking and gender of neonates were measured in frequency & percentages. Effect modifiers like age, BMI, gestational age at delivery, parity, antenatal booking, mode of delivery and gender of neonate were controlled by stratification. Post stratification, Pearson's correlation coefficient was calculated between maternal serum ferritin level and birth weight of neonate for each strata. P-value $\leq$0.05 was considered as statistically significant.

Results

A total of 95 cases fulfilling the selection criteria were enrolled to assess the correlation between maternal serum ferritin level and birth weight of neonate at the time of delivery. Maternal age distribution of mothers showed that 52(54.7%) were up to 30 years of age whereas 43(45.3%) were between 31-44 years of age, mean age was calculated as 29.47$\pm$3.82 years**.** Mean gestational age of the patients at the time of delivery was calculated as 36.33$\pm$1.38 weeks**.** Gestational age of 78(82.1%) was 32-37 weeks and 17(17.9%) have gestational age >37 weeks. Frequency of parity of patients showed that 17(17.9%) cases had parity 1, 53(55.8%) had parity 2 and 25(26.3%) had parity 3**.** Frequency of booking status of the patients showed that 42(44.2%) cases were booked and 53(55.8%) were un-booked**.** Frequency of mode of delivery of the patients showed that 8(8.4%) had spontaneous delivery, 26(27.4%) had instrumental delivery and 61(64.2%) had cesarean section**.** Mean birth weight of neonates was

2.49±0.23 kg. From 95 neonates, 43 (45.3%) were of low birth weight and 52 (54.7%) were of normal birthweight. Gender distribution of neonates showed that 52(54.7%) were male whereas 43(45.3%) were females. (Table I)

Table I: Maternal and Neonatal characteristics of the study sample.

		N	%
Maternal age (Mean± S.D)		29.47	3.82
Age	up to 30 years	52	54.7%
	31-44 years	43	45.3%
Gestational Age		36.33	1.38
Parity	1	17	17.9%
	2	53	55.8%
	3	25	26.3%
Booking status	Booked	42	44.2%
	Un booked	53	55.8%
Neonatal Gender	Male	52	54.7%
	Female	43	45.3%
Neonatal Weight		2.49	0.23
Weight	low birth weight	43	45.3%
	normal weigh	52	54.7%

Mean ferritin level of the patient was calculated as 24.37±2.38 kg. Mean serum ferritin level in neonates with LBW was 22.26±0.88kg and in neonates with normal birth weight was 26.12±1.72. Ferritin levels were significantly higher in normal birth weight neonates. There was a statistically significant difference in serum ferritin levels between LBW and normal birth weight neonates. There was a strong correlation between maternal serum ferritin levels and birth weight of neonates at the time of delivery which was calculated and r value was 0.881. (Table II)

Table II: Comparison of Mean Serum Ferritin Levels Between Low and Normal Birth Weight Neonates.

	LBW		Normal		P Value	r
	Mean	SD	Mean	SD		
Ferratin Level	22.26	0.88	26.12	1.72	0.001	0.881

Effect modifiers like age, BMI, gestational age at delivery, parity, antenatal booking, mode of delivery and gender of neonate were controlled by stratification. Post stratification, Pearson's correlation coefficient was calculated between maternal serum ferritin level and birth weight of neonate for each stratum. P-value ≤0.05 was considered as statistically significant. Table III

Discussion

Iron (Fe) is essential for physiological functions, including hemoglobin (Hb) synthesis, cell growth and development. Iron deficiency results from depletion of stored iron. Increased iron demand during pregnancy can worsen this, resulting in iron-deficient erythropoiesis and eventually iron deficiency anemia. If the body iron store is deficient at conception, it is unlikely that dietary iron would be able to match the pregnancy-induced increase in demand. Therefore, assessment of body iron status during pregnancy is crucial. While ferritin is the most commonly used indicator, providers often rely on hemoglobin levels to assess iron deficiency at the population level.

According to the United States Preventive Services Task Force (USPSTF), the use of serum ferritin during late pregnancy may be limited due to the fact that its concentration frequently decreases with advancing gestational age. This is because maternal iron stores are used to supply iron to the placental and foetal circulations. However, using haemoglobin or hematocrit measurement alone to determine iron deficiency status is indirect and imprecise.[15]

World Health Organization (WHO) has defined LBW as the weight of a neonate below 2500 g at birth, irrespective of the gestational age of the neonate.[16] Birth weight is affected by nutritional factors such as the mother's pre-gestational weight as well as the amount of weight gained throughout pregnancy. Therefore, insufficient maternal caloric intake which may be the consequence of a diet that is deficient in nutrients leads to decreased absorption of important foetal development micronutrients such as vitamin B12 and iron.

Although the factors that contribute to low and insufficient birth weight are very similar to one another, the process that establishes the connection between maternal anemia and inadequate birth weight is not completely understood. The connection between maternal anemia and low birth weight has only been investigated in a limited number of prospective cohort studies.[17] Indeed, following an exhaustive review of existing research on the subject, only two retrospective

Table III: Correlation Between Ferritin Levels and Gestational Age, Parity and Gender.

		Ferratin Level (Mean ± S.D)	R (Correlation Coefficient)	P Value
Gestational Age	32–37 week	23.65±1.94	0.823	0.000
	>37 weeks	27.65±1.17	0.940	0.000
Parity	1–2	24.18±1.70	0.877	0.000
	>2 birth	24.43±2.54	0.896	0.000
Gender	Male	25.44±2.42	0.916	0.000
	Female	23.07±1.56	0.725	0.000

cohort studies, one from Colombia and the other from Finland that examined the association between dietary intake and inadequate birth weight were found. The results of study conducted in Finland highlighted maternal anemia as a risk factor for low/insufficient birth weight[18] whereas study conducted in Colombia showed no association between maternal anemia and low birth weight.[19]

Our study was to determine the frequency of low birth weight in neonates and its correlation with maternal serum ferritin levels. In our study of 95 cases, mean age was calculated as 29.47±3.82 years, according to gender distribution of neonates 52(54.7%) were male whereas 43(45.3%) were females. Mean birth weight of neonates was 2.49±0.23 kg. From 95 neonates, 43 (45.3%) were of low birth weight and 52 (54.7%) were of normal birthweight. Low birth weight (LBW), associated with depleted iron reserves at or after 37 weeks of pregnancy, is a Signiant risk determinant for childhood anemia. Additionally, infants with low birth weight (LBW)are at an increased risk of developing insulin resistance and related health issues later in life.[20]

Mean gestational age of the patients at the time of delivery was calculated as 36.33±1.38 weeks, mean ferritin level of the patients was calculated as 24.37±2.38. A strong positive correlation was found between maternal serum ferritin levels and neonatal birth weight ($r = 0.881$, $p = 0.000$). This indicates that higher maternal ferritin is significantly associated with greater birth weight.

Vazirinejad et al., conducted a cohort study and observed that there was significantly but weak positive correlation between maternal serum ferritin level and neonatal birth weight i.e. r=0.434 (p-value <0.05).[21] While Fakher et al., also observed that this relationship was very weak, but positive between maternal serum ferritin level and neonatal birth weight i.e. r=0.325(p>0.05).[22] But Rehman SM et al conducted another study and found that a neutral correlation exist between maternal serum ferritin level and neonatal birth weight i.e. r=0.526 (p<0.01).[23] In our study, we found a strong correlation. The stronger correlation observed in our study compared to Vazirinejad et al. and Fakher et al. may be due to differences in sample size, population characteristics. Additionally, variations in study design and timing of ferritin measurement could have influenced the strength of the association.

In another retrospective cohort research, Mohamed Abdelaziz Youssry and his colleagues[24] evaluated the influence of the severity of anaemia on maternal and perinatal outcome. The study was carried out at the Department of Obstetrics and Gynaecology of Ibn Sina College Hospital using hospital records.The study population consisted of all pregnant women who gave birth after twenty weeks of gestation. When maternal hemoglobin level was correlated with other parameters, there was a significant positive correlation between maternal hemoglobin level and low birth weight ($r = 0.325$, $p = 0.016$), low Apgar score ($r = 0.333$, $p = 0.009$), and neonatal hemoglobin level ($r = 0.421$, $p = 0.001$).

According to the findings of their research, anaemia, and especially mild anaemia, is rather common among pregnant women. In the management of maternal anaemia, early diagnosis and therapy from the beginning of the first trimester play a vital role and this function reflects directly on the perinatal outcome. The most frequent maternal and neonatal problems include prematurity, low birth weight babies, and postpartum haemorrhage.

In summary, we recorded the correlation between the two factors within our local community. This evidence generated from present study is helpful to improve the practices in this regard. The findings highlight the importance of monitoring maternal serum ferritin levels as part of routine prenatal care to reduce the risk of low birth weight. Early identification and timely iron supplementation in pregnant women with low ferritin levels could improve fetal growth outcomes and reduce neonatal complications. Future research should explore the causal relationship between maternal ferritin levels and neonatal birth weight through longitudinal or interventional studies. Multicenter studies with larger, more diverse populations are also needed to generalize findings and assess the impact of iron supplementation timing and dosage during pregnancy.

Conclusion

We concluded that there is a correlation between maternal serum ferritin level and birth weight of neonate at the time of delivery.

LIMITATIONS: This study has a few limitations. First, the sample size was relatively small and being a single-center study, which may limit the generalizability of the findings. Also, potential confounding factors such as maternal dietary intake, iron supplementation compliance, chronic illnesses, and socioeconomic status were not controlled or adjusted for, which could have influenced both serum ferritin levels and neonatal birth weight.

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