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The Relationship between Maternal Haemoglobin and Haematocrit with Low Birth Weight and Preterm Labour

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ABSTRACT

Background & aim: Low levels of maternal haemoglobin and haematocrit in the first, second, and third trimesters are considered as possible risk factors regarding low birth weight (LBW) and preterm labour (PTL). The present study aimed to evaluate the relationship between maternal haemoglobin (Hb) and haematocrit (HCT) levels with LBW and PTL.

Methods: This cross-sectional study was conducted on 383 pregnant women who were admitted in postnatal ward and gave birth to live neonates. Maternal Hb and HCT levels in the first, second, and third trimesters were obtained from medical records. The data were analysed using chi-square test by SPSS software (version 19).

Results: A total of 383 pregnant women with the mean age of 25.5 years were participated in this study. There was a significant relationship between maternal HCT in the first, second, and third trimesters with LBW ($P<0.01$). Also a significant relationship was observed between maternal Hb in the first, second, and third trimesters with the LBW ($P<0.01$). In addition, a significant relationship was reported between maternal HCT with the PTL ($P<0.01$). There was a significant correlation between maternal Hb in the first, second, and third trimesters with the PTL ($P=0.01$).

Conclusion: Based on the findings of this study, it was suggested that maternal anaemia should be diagnosed and treated at any stage of pregnancy in order to reduce the risk of the LBW and PTL.

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Introduction

Neonatal mortality rate is among the most important health indicators in every country, which is linked to the adequacy of maternal health care and social and economic factors (1). One of the determinants of neonatal mortality is low birth weight (LBW) (1, 2). The LBW is defined as birth weight of a newborn between 1500 and 2500 g (1). Mortality rate in the neonates with LBW is reported as 40 times and in newborns with very low birth weight (VLBW), between 1000 and 1500 g, is announced as 200 times higher than that in neonates with normal birth weight (2). According to statistics, 90% of the newborns with LBW are annually born in developing countries (3). In some areas of Asia, one out of two live births is considered to be a neonate with LBW (3).

In Iran, 289 children below 5 years old daily die among which 48% are neonates mostly with LBW (3). Maternal age, occupation, and weight, as well as a history of LBW in previous pregnancies, the number of pregnancies along with addiction and pregnancy duration have been identified as predicting factors for the LBW (4-6). On the other hand, poor socio-economic condition, malnutrition, hypertension, multiple pregnancies, and low maternal haemoglobin

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(Hb) and haematocrit (HCT) levels, as well as illiteracy, maternal chronic diseases, and alcohol use were reported to be related with the LBW (7-9). It is believed that the LBW is associated with mental retardation, learning disorders, and cognitive growth retardation, as well as visual-motor disorders, and cerebral palsy (CP) (10).

Preterm labour (PTL) is defined as giving birth earlier than 37 weeks of gestation (11). Based on the differences observed in mortality and morbidity, the PTL was divided into the following categories based on the gestational age (GA), which were mild preterm (between 32 and 36 weeks of gestation), very preterm (between 28 and 31 weeks of gestation), and extremely preterm (earlier than 28 weeks of gestation) (12). The PTL may be related to cardiopulmonary disorders, brain growth retardation, and various anomalies (13). Morbidity and mortalities due to the PTL are mainly attributed to prematurity of the organs and include respiratory distress syndrome, bronchopulmonary dysplasia, pneumothorax, pneumonia, patent ductus arteriosus, intraventricular haemorrhage, periventricular leukomalacia, and the CP (13). The neonates with both LBW and PTL are at extremely high risks regarding morbidity and mortality (2, 13, 14).

Anaemia in pregnancy is defined as the HCT level below 33% or the Hb level below 11g/dl in the first and third trimester and the Hb below 10.5 g/dl in the second trimester (15, 16). Anaemia in pregnancy can lead to the PTL, intrauterine growth retardation, reduced physical activity capacity, immune response disorders, and heart failure in mother; however, it can result in the LBW, PTL, low Apgar score, and perinatal mortality in newborns (17, 18). It was previously reported that anaemia in the first half of pregnancy is related to increased risk of the PTL (19). Therefore, maternal anaemia is among the preventable causes of the PTL and LBW. On the other hand, the higher values of the HCT are related to maternal and neonatal adverse outcomes (19). The present study was carried out in order to evaluate the maternal factors, which contribute to the neonatal LBW and PTL in women that gave birth to live neonates and were admitted in the obstetric ward of Mobini Hospital, Sabzevar, Iran.

Materials and Methods

This cross-sectional study was conducted on women that gave birth to live newborns in Mobini Hospital, Sabzevar, Iran in 2016 (MedsabRec.93.76). The inclusion criteria were giving birth to live infant and having complete medical records. The exclusion criteria were multiple pregnancies, history of diabetes, thalassemia or sickle cell anaemia in mother, and infants with gross congenital abnormalities, as well as pre-eclampsia and the obstetric causes of the PTL, including placenta abruption or premature rupture of membranes.

All the participants were interviewed by the author and asked to provide information regarding their age, infant gender, place of residence, educational level, the number of pregnancies, number of health care visits during pregnancy, and neonatal outcomes. Birth weight was obtained from medical records of the newborns and GA was obtained from the medical records based on ultrasounds. The Hb and HCT levels in the first, second, and third trimester were obtained from medical records of the subjects. The HB and HCT were measured by Technicon H-1 blood counter after taking peripheral venous blood in Ethylenediaminetetraacetic acid tubes. The HCT was divided into three groups, which were low (<34%), normal (34%-40%), and high (>40%), while the Hb was grouped into low (<10.5g/dl), normal (10.5-13g/dl), and high (>13 g/dl) based on the WHO criteria.

The data were analysed using SPSS (version 19). The Continuous data were checked for normality by Kolmogorov-Smirnov test. The mean and standard deviation were utilized to describe quantitative variables. The Qualitative variables were presented as frequency and percentage. The Chi-square test was used to evaluate the relation between categorical variables. P-values lower than 0.05 were statistically considered significant.

Results

A total of 383 pregnant women were recruited in this study. The mean age of the subjects was 25.5 years. The body mass index mean of the subjects was 22.6 kg/m^2. Table 1 tabulates the demographic characteristics of the

women. The mean birth weight of the newborns was 3180 g (birth weight range: 2100-4700g). The LBW was observed in 21 (5.5%) of the neonates, while the birth weight was reported between 2500-4000 g in 353 (92.2%) newborns; furthermore, 9 (2.3%) cases had the birth weight of more than 4000 g.

Table 1. Demographic characteristics of subjects

Variable		Frequency	Percentage
Number of pregnancies	1	180	47.0%
	2	94	24.5%
	3	98	25.6
	≥4	11	2.9%
Place of residence	Urban	277	72.3%
	Rural	106	27.7%
Level of education	Primary school	49	12.8%
	Junior high school	181	47.3%
	High school	133	34.7%
	Graduate	20	5.2%
Economic status	Good	55	14.4%
	Moderate	303	79.1%
	Poor	25	6.5%
Height category	≤150cm	99	25.8%
	>150cm	284	74.%
Body Mass Index category	≤20kg/m^2	41	10.7%
	>21kg/m^2	342	89.3%
Newborn gender	Male	193	50.4%
	Female	190	49.6%

cm: centimetre; kg: kilogram; m: meter

The mean GA of the subjects was 38 weeks (minimum GA: 33 weeks, maximum GA: 42 weeks). The PTL, term, and post-term pregnancies were observed in 38 (9.9%), 296 (77.3%), and 49 (12.8%) subjects, respectively. The HCT of the subjects in the first trimester was reported as 38% (minimum HCT: 30%, maximum HCT: 47%), while the HCT in the second and third trimesters were 35.5% (minimum HCT: 26%, maximum HCT: 45.5%) and 34.5% (minimum HCT: 28%, maximum HCT: 41.8%). The HCT categories of the subjects are shown in Table 2. The Mean Hb of the subjects in the first trimester was 12.8 g/dl (minimum Hb: 9 g/dl, maximum Hb: 16 g/dl), while the mean Hb in the second and third trimesters were 12.07 g/dl (minimum Hb: 9.5 g/dl, maximum Hb: 14.2 g/dl) and 11.5 g/dl (minimum Hb: 8.6 g/dl, maximum Hb: 14 g/dl). Table 2 presents the HCT categories of the cases.

Table 2. Descriptive statistics for HCT categories in each trimester among subjects

Variable		First-trimester Frequency (%)	Second-trimester Frequency (%)	Third-trimester Frequency (%)
HCT (%)	<33	24 (6.3%)	75 (19.6%)	138 (36%)
	33-40	270 (70.5%)	297 (77.5%)	239 (62.4%)
	>40	89 (23.2%)	11 (2.9%)	6 (1.6%)
Hb (g/dl)	<10.5g/dl	12 (3.1%)	23 (6.0%)	66 (17.2%)
	10.5-13g/dl	195 (50.9%)	337 (88.0%)	302 (78.9%)
	>13g/dl	176 (46%)	23 (6.0%)	15 (3.9%)

HCT: haematocrit; Hb: Haemoglobin; g: gram; dl: decilitre

Table 3. Relation between birth weight categories and HCT and Hb categories in each trimester

			Birth weight		
			<2500g	**2500-4000g**	**>4000g**
1st trimester	HCT	<33%	3(12.5%)[a]	21(87.5%)	0(0.0%)
		33%-40%	16(5.9%)	251(93.0%)	3(1.1%)
		>40%	2(2.2%)	81(91.0%)	6(6.7%)
	Hb	<10.5g/dl	3(25.0%)[d]	9(75.0%)	0(0.0%)
		10.5-13g/dl	13(6.7%)	179(91.8%)	3(1.5%)
		>13g/dl	5(2.8%)	165(93.8%)	6(3.4%)
2nd trimester	HCT	<33%	10(13.3%)[b]	65(86.7%)	0(0.0%)
		33%-40%	11(3.7%)	277(93.3%)	9(3.0%)
		>40%	0(0.0%)	11(100.0%)	0(0.0%)
	Hb	<10.5g/dl	5(21.7%)[e]	18(78.3%)	0(0.0%)
		10.5-13g/dl	16(4.7%)	312(92.6%)	9(2.7%)
		>13g/dl	0(0.0%)	23(100.0%)	0(0.0%)
3rd trimester	HCT	<33%	3(12.5%)[c]	21(87.5%)	0(0.0%)
		33%-40%	16(5.9%)	251(93.0%)	3(1.1%)
		>40%	2(2.2%)	81(91.0%)	6(6.7%)
	Hb	<10.5g/dl	14(21.2%)[f]	52(100.0%)	0(0.0%)
		10.5-13g/dl	7(2.3%)	286(94.7%)	9(3.0%)
		>13g/dl	0(0.0%)	15(100.0%)	0(0.0%)

Table 4. Relation between gestational age at birth categories and HCT and Hb categories in each trimester

Time	**Variable**		Gestational age at birth		
			<37 weeks	**37-40 weeks**	**>40 weeks**
1st trimester	HCT	<33%	6(25.0%)[a]	12(50.0%)	6(25.0%)
		33%-40%	24(8.9%)	218(80.7%)	28(10.4%)
		>40%	8(9.0%)	66(74.2%)	15(16.9%)
	Hb	<10.5g/dl	3(25.0%)[d]	9(75%)	0(0.0%)
		10.5-13g/dl	27(13.8%)	146(74.9%)	22(11.3%)
		>13g/dl	8(4.5%)	141(80.1%)	27(15.3%)
2nd trimester	HCT	<33%	20(26.7%)[b]	41(54.7%)	14(18.6%)
		33%-40%	16(5.4%)	246(82.8%)	35(11.8%)
		>40%	2(18.2%)	9(81.8%)	0(0.0%)
	Hb	<10.5g/dl	8(34.8%)[e]	12(52.2%)	3(13.0%)
		10.5-13g/dl	28(8.3%)	263(78.0%)	46(13.6%)
		>13g/dl	2(8.7%)	21(91.3%)	0(0.0%)
3rd trimester	HCT	<33%	29(21.0%)[c]	84(60.9%)	25(18.1%)
		33%-40%	9(3.8%)	206(86.2%)	24(10.0%)
		>40%	0(0.0%)	6(100.0%)	0(0.0%)
	Hb	<10.5g/dl	22(33.3%)	33(50.0%)	11(16.7%)
		10.5-13g/dl	16(5.3%)	248(82.1%)	38(12.6%)
		>13g/dl	0(0.0%)	15(100.0%)	0(0.0%)

The results of the chi-square test revealed a significant relation between birth weight with the HCT and Hb levels in the first, second, and third trimesters (P<0.001). The association between the GA at birth with the HCT and Hb levels in pregnancy were significant based on the results of chi-square test (P<0.01) (Table 4). The relationship between birth weight and gestational age, along with other study parameters, including maternal age, maternal height, the number of pregnancies, maternal education level, and neonate gender, as well as

place of residence, and economic status are shown in Table 5. There was a significant relationship between the number of pregnancies and maternal educational level (P<0.05) based on the results of chi-squared test (Table 5).

Table 5. Relation between other study parameters, birth weight, and gestational age categories

Variable		Gestational age at birth				Birth weight			
		<37 weeks	37-40 weeks	>40 weeks	P-value	<2500g	2500-4000g	>4000g	P-value
Maternal age	<20 years	6(7.9%)	56(73.3%)	14(18.4%)	0.28	3(3.9%)	70(92.1%)	3(3.9%)	0.08
	20-34 years	24(9.6%)	196(78.1%)	31(12.4%)		11(4.4%)	234(93.2%)	6(2.4%)	
	>35 years	8(14.3%)	44(78.6%)	4(7.1%)		7(12.5%)	49(87.5%)	0(0.0%)	
Maternal height	<150 cm	11(11.1%)	72(72.7%)	16(16.2%)	0.42	4(4.0%)	93(93.9%)	2(2.0%)	0.73
	<151 cm	27(9.5%)	224(78.9%)	33(11.6%)		17(6.0%)	260(91.5%)	7(2.5*)	
Number of pregnancies	1st	15(8.3%)	140(77.8%)	25(13.9%)	0.02*	6(3.3%)	169(93.9%)	5(2.8%)	0.04*
	2nd	8(8.5%)	71(75.5%)	15(16.0%)		6(6.4%)	87(92.6%)	1(1.1%)	
	3rd	12(12.2%)	77(78.6%)	9(9.2%)		6(6.1%)	89(90.8%)	3(3.1%)	
	≥4th	3(27.3%)	8(72.7%)	0(0.0%)		3(27.3%)	8(72.7%)	0(0.0%)	
Maternal education	Primary school	6(12.2%)	36(73.5%)	7(14.3%)	0.001*	3(6.1%)	46(93.9%)	0(0.0%)	0.03*
	Junior high school	18(9.9%)	142(78.5%)	21(11.6%)		9(5.0%)	169(93.4%)	3(1.7%)	
	High school	12(9.0%)	109(82.0%)	12(9.0%)		9(6.8%)	118(88.7%)	6(4.5%)	
	Graduate	2(10.0%)	9(45.0%)q	9(45.0%)		0(0.0%)	20(100.0%)	0(0.0%)	
Economic status	Good	8(14.5%)	38(69.1%)	9(16.4%)	0.53	6(10.9%)	49(89.1%)	0(0.0%)	0.07
	Moderate	27(8.9%)	238(78.5%)	38(12.5%)		12(4.0%)	282(93.1%)	9(3.0%)	
	Poor	3(12.0%)	20(80.0%)	2(8.0%)		3(12.0%)	22(80.0%)	0(0.0%)	
Place of residence	Urban	28(10.1%)	210(75.8%)	39(14.1%)	0.44	14(5.1%)	257(92.8%)	6(2.2%)	0.77
	Rural	10(9.4%)	86(81.1%)	10(9.4%)		7(6.6%)	96(90.6%)	3(2.8%)	
New born gender	Male	18(9.3%)	157(81.3%)	18(9.3%)	0.07	13(6.7%)	171(88.6%)	9(4.7%)	0.99
	Female	20(10.5%)	139(73.2%)	31(16.3%)		8(4.2%)	182(95.8%)	0(0.0%)	

cm: centimetre

Discussion

Anaemia in pregnancy can result in the PTL, low birth weight, intrauterine growth retardation, increased risk of neonatal mortality, low physical activity capacity, immunodeficiency, and heart failure in mother (20, 21). Various mechanisms have been suggested regarding the effects of anaemia on pregnancy outcomes (17, 18). Among these mechanisms, two of them are of greater importance, including 1) the consequences of fetal low oxygenation due to low levels of haemoglobin, which result in intrauterine growth restriction, and 2) reduced size and surface of the placenta that causes low birth weight, as well as the presence of accompanying nutritional deficiencies in addition to anaemia (17, 18).

This study revealed a significant relation between Hb with low birth weight and the PTL in all three trimesters. In the present study, the relationship between maternal Hb and HCT levels with pregnancy outcomes were more prominent in the first trimester. These findings were in line with the findings of the previously mentioned studies (20, 22-24). In a study carried on 903 Iranian pregnant women, low Hb and HCT levels were identified as predictors for low birth weight and the PTL (16). In a study carried out by Scholl et al. (2002), the optimum maternal HCT level related with the least possibility of the PTL was reported as 41%-44% (25).

The results of this study revealed no significant relation between high maternal Hb and HCT levels with pregnancy complications. It was in line with the findings of a previous study conducted on 609 pregnant women in Babol, Iran, which identified no relationship between maternal HCT level more than 40% and neonatal outcomes (26). Similarly, other studies have identified no significant relationship between high maternal HCT levels and

pregnancy outcomes (27-29). In contrast, previous studies identified a significant relation between high maternal HCT levels and neonatal complications (23, 27).

High maternal HCT is known to be related to the high volume of red blood cells and non-proportional increase in plasma volume, which is necessary for normal intrauterine growth; therefore, high HCT levels may result in negative pregnancy outcomes (30, 31). Moreover, according to the results of the present study, it was revealed that among the other parameters, only low maternal educational level and higher number of pregnancies were significantly associated with both the LBW and PTL. It was in line with the findings of the previous studies, which reported poor socioeconomic status, multiple pregnancy, and low maternal literacy as predictors of the LBW and PTL (7-9).

Conclusion

In this study, a possible reason for the lack of relationship between high maternal HCT level and pregnancy outcomes might be due to the limited number of the subjects with high HCT level, which can be considered as a limitation of this study. It is recommended that further studies should be performed on larger number of pregnant women with high HCT levels in order to evaluate the relationship between high maternal HCT levels and pregnancy outcomes.

The large sample size, which could represent the general population of pregnant women, can be considered as strength for this study. Furthermore, the present study included various confounders as neonatal weight and preterm labour in the analysis. On the other hand, since the aim of the study was to evaluate the relationship between maternal HB and HCT levels with neonatal weight and preterm labour, there could be no control over the number of women in each group. Further studies are required to assess this relationship among equal groups of the HCT and Hb levels using cluster sampling method.

The present study was approved by the ethical committee of Sabzevar University of Medical Sciences and all the subjects signed informed consent forms prior to participation in the study.

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Conflicts of interest

The authors declare no conflicts of interest.

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