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The Effect of Mothers' Hemoglobin Concentration During Pregnancy on the Weight and Height of Babies

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ABSTRACT

Background & Objective: Low and high hemoglobin concentration is one of the main concerns of women during pregnancy due to its high prevalence and adverse effects. The present study aimed to examine the correlation between maternal hemoglobin concentration and the baby's birth weight and height in 326 pregnant women referred to the Alwiyah hospital for obstetrics and gynecology in Baghdad, Iraq, in 2019.

Materials & Methods: In the current descriptive-analytical study, pregnant women were classified into two groups: anemia and normal; four groups of moderate to severe anemia, mild, regular, and high hemoglobin; and eight groups with intervals of 12 g/L from severe anemia to high hemoglobin. This study's variables included infants' age, number of children, education level, socioeconomic status, weight, and height. The data was analyzed using SPSS version 19, descriptive statistics, t-test, and logistic regression. In this study, the level of statistical significance was deemed to be 0.001.

Results: The results showed that the probability of low birth weight and abnormal height increases 4.96 times and 4.13 times, respectively, in mothers with high hemoglobin concentrations versus mothers with low hemoglobin concentrations; these ratios are statistically significant (P<0.001). Also, hemoglobin concentrations ranging from 104 to 115 g/L have the lowest probability. Furthermore, hemoglobin concentrations greater than 125 g/L are statistically significant (P<0.001).

Conclusion: The current study revealed that high maternal hemoglobin concentrations during pregnancy could significantly impact the baby's weight and height.

Keywords: Hemoglobin, Anemia, Pregnant women, Low birth weight

Introduction

Determining anthropometric indicators, such as weight and height, is one of the most common and straightforward ways to evaluate the development and health of children in society **(1)** These indicators have changed substantially over the centuries due to geographical, cultural, genetic, and environmental factors **(2)**. Their evaluation of infants has provided helpful information, and growth is required to diagnose nutritional status **(3)**. According to the findings of numerous studies, the physical conditions and anthropometric indicators of newborns, such as their weight and height, are the primary factors that determine the child's future physical and mental health and are reliable indicators of intrauterine growth **(4, 5)**. In developing and even developed nations, low birth weight and abnormal height significantly burden the health and treatment service system and family members **(6)**. In such a way, adverse birth conditions, such as low birth weight, lead to death and an increase in childhood disabilities and diseases **(7)**. In addition, underweight infants are more susceptible to health issues than their normal-weight counterparts **(8)**.

Numerous genetic, nutritional, and endocrine factors impact the birth weight and height of the infant **(9)**. These factors influence the fetus's structure, function, and metabolism during pregnancy, resulting in

variations in fetal size **(10)**. In this field, the amount of hemoglobin in the blood during each trimester of pregnancy is essential **(11)**. Various researchers have reported a correlation between the amount of maternal hemoglobin and anthropometric indicators of newborns, including birth weight and birth height **(12)**.

The most noticeable physiologic change during pregnancy is an increase in blood volume. During pregnancy, the blood hemoglobin level decreases due to dilution caused by the disparity between the increase in plasma volume and the number of red blood cells **(13)**. The normal range of hemoglobin levels can be determined by age and gender. Table 1 displays the normal values for blood hemoglobin. The values listed in Table 1 may vary slightly depending on the measurement technique and laboratory, so the amount of hemoglobin determined should be compared to each laboratory's reference range.

Table 1. The classification of hemoglobin levels

Classification	Hemoglobin level (g/dL)
Infants	11-18
Children	11.5-16.5
Adult men	13.5-16.5
Adult women	12-16
Pregnant women	11-16

The fastest increase in blood volume occurs between weeks 25 and 30 of pregnancy; at this time, approximately 2 g/dL of blood hemoglobin decreases, and a significant drop in hemoglobin occurs in the absence of sufficient iron reserves **(14)**. All pregnant women are advised to take iron tablets as one of the primary components of prenatal care to meet their iron requirements; however, various studies indicate that the iron requirements of individuals vary **(15)**. This drug's excessive use can increase the concentration of blood hemoglobin and its adverse effects during pregnancy **(16)**.

Anemia is a known risk factor for both mother and child during pregnancy. Fetal complications include stunted growth, premature birth, intrauterine death, and infection **(17)**. Maternal complications include cardiovascular symptoms, a decrease in physical and mental strength, a decrease in immune function, fatigue, a decrease in blood reserves, and an increase in the need to receive blood during the postpartum period **(18)**. Other anemia causes include blood diseases, kidney issues, and parasitic infections. In addition to clinical evaluation, laboratory tests play an essential role in diagnosing anemia. If iron deficiency anemia is diagnosed, it is easily treatable with oral or intravenous iron supplements **(19)**.

Several studies have been conducted on the epidemiology of iron deficiency anemia in various communities and among pregnant women. According to 1998 WHO report and studies conducted in 2001 and 2002, eighty percent of pregnant women in South Asian countries suffer from iron deficiency anemia **(20-22)**. In some studies, a decrease in maternal hemoglobin concentration has increased the risk of babies being born with low birth weight and height **(23)**.

Due to the lack of research on the effect of hemoglobin concentration on pregnant mothers and the adverse effects of different amounts of hemoglobin on birth weight and height indicators, the present study is deemed necessary. Therefore, additional research and studies are required in this field. The current study aimed to examine the relationship between blood hemoglobin concentration and the incidence of adverse pregnancy outcomes, such as low birth weight and abnormal height, to identify at-risk pregnant mothers and implement the necessary interventions in the future. Among the innovations of the present research is the use of distinct groupings for the study's participants and the evaluation of its impact on the accuracy of the results.

Methods

The current research is a cross-sectional study. For this study, simple random sampling was used to select 326 participants from the 1783 individuals referred to the Alwiyah hospital of obstetrics and gynecology in Baghdad, Iraq, in 2019. Inclusion criteria included a willingness to participate in the study, blood tests, and the absence of blood-concentration-altering drugs. Among the exclusion criteria were mothers with high blood pressure and liver or kidney disease. During the study period, 29 individuals were excluded for various reasons, including bleeding before delivery, severe fetal distress, intrauterine death, severe abnormalities of the baby, a mother suffering from preeclampsia, and unwillingness. In order to comply with ethical considerations, participants were provided with a comprehensive description of the study's conduct, methodology, and objectives before its initiation. In addition, they were assured that their identities would not be revealed and that they could leave the study at any time. The authors entirely covered the research expenses. The ethics committee approved this research of the College of Medicine at the University of Baghdad.

The gestational age was determined using the mother's LMP (last menstrual period) and an ultrasound report of early pregnancy. If the difference was more significant than two weeks, the ultrasound report was used to determine the gestational age; otherwise, the LMP was used. The measurements and required information results were entered into pre-designed forms containing questions about demographic characteristics, current pregnancy status, and previous pregnancy and childbirth records.

Approximately 2 ml of venous blood was drawn for the hemoglobin test.

In the present study, anemic mothers had hemoglobin levels below 11 mg/dL in the first trimester and below 10.5 mg/dL in the second trimester. In the current study, three types of groupings were performed to increase the efficiency of investigations and compare the precision of various methods. First, pregnant women were divided into two groups: anemic (hemoglobin less than 105 g/L) and healthy (hemoglobin greater than 105 g/L). The purpose of dividing the participants into two groups was to provide a general overview of fetal complications and to make it easier to report the results to the general population of women. In addition, to increase the study's precision, the participants were divided into four groups based on their hemoglobin levels. Four groups included: moderate to severe anemia (less than 100 g/L), mild (100-119 g/L), regular (120-149 g/L), and high hemoglobin (greater than 150 g/L). By dividing the study participants into eight groups, it was possible to compare the accuracy of each division's results more effectively. Eight groups were separated by intervals of 12 g/L, ranging from severe anemia to high hemoglobin levels. This study examined the mother's age, the number of children, level of education, socioeconomic status, the weight of babies (less than 2500 grams as underweight and above 2500 to 4000 grams as standard weight), and height (46-53 cm as standard height). In Figure 1, the various methods used to divide the participants in this study are depicted graphically.

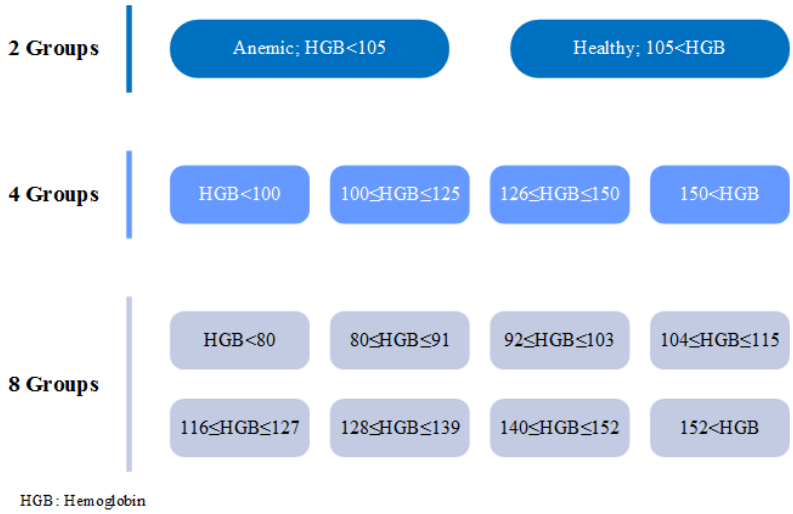

Figure 1. Types of groups investigated in the current study

The person in charge of the babies in the operating room measured their weight with a digital scale manufactured by Beurer GmbH (Germany) and their height with a meter from a distance between the head and the heel of the foot. The data analysis was performed using version 19 of the SPSS statistical software (IBM, USA). Based on descriptive statistics (frequency and percentage), chi-square tests, independent t-tests, and logistic regression were performed. In the current study, the level of statistical significance was deemed to be 0.01.

Results

The mean age of the women in this study was 30.41±5.68 years. Most pregnant women in both the anemic and healthy groups were between the ages of 25 and 35, but this correlation was not statistically significant (P=0.318). Fifty-two women (77%) in the anemic group and 209 women (81%) in the healthy group did not have children, but this difference was not statistically significant (P=0.142). Regarding the level of education, three women (4%) in the anemic women group and five women (2%) in the healthy women group were illiterate, and there was no statistically significant correlation between the two groups (P=0.274). Thirty-nine people (57%) in the anemic women group and 168 people (65%) in the healthy women group had a medium socioeconomic status, which was not statistically significant (P=0.019). The mentioned results are presented more fully in Table 2.

Table 2. Demographic characteristics of the studied pregnant mothers

Demographic characteristics	Classification	Frequency (%)		P-value
		Anemic group	Healthy group	
Age	<25	23 (34%)	83 (32%)	0.318
	25-35	31 (45%)	126 (49%)	

Demographic characteristics	Classification	Frequency (%)		P-value
		Anemic group	Healthy group	
	>35	14 (21%)	49 (19%)	
Number of children	0	52 (77%)	209 (81%)	0.142
	1	11 (16%)	35 (14%)	
	>1	5 (7%)	14 (5%)	
Level of education	literate	65 (96%)	253 (98%)	0.274
	illiterate	3 (4%)	5 (2%)	
Socioeconomic status	Very poor	5 (8%)	10 (4%)	0.019
	Poor	9 (13%)	24 (9%)	
	Medium	39 (57%)	168 (65%)	
	Good	13 (19%)	40 (16%)	
	High	2 (3%)	16 (6%)	

Table 3 displays the low birth weight and abnormal height of infants born to anemic and healthy mothers. In the division of maternal hemoglobin concentration into two anemic and healthy groups, the results showed that 7.6% of anemic mothers had babies with low birth weight and 6.4% had babies with abnormal height; however, there was no statistically significant correlation between the two variables (P>0.01). There is a statistically significant relationship between the hemoglobin concentration groups of mothers with low birth weight and babies' abnormal height in the four mothers' groups (P<0.001). All eight subgroups of mothers' hemoglobin concentration had a statistically significant correlation with low birth weight and infant height (P<0.001).

Table 3. Birth rate in hemoglobin concentration groups of pregnant mothers

Grouping type	Grouping based on hemoglobin	Number of mothers	Low birth weight babies			Abnormal height of babies		
			Frequency	Percent	P-value	Frequency	Percent	P-value
2 Groups	Anemic	68	9	13.24	0.308	7	10.29	0.114
	Healthy	258	29	11.24		26	10.08	
4 Groups	<100	51	6	11.76	<0.001	5	9.80	<0.001
	100-125	147	13	8.84		11	7.48	
	126-150	121	17	14.05		15	12.40	
	>150	7	2	28.57		2	28.57	
8 Groups	<80	2	-	-	<0.001	-	-	<0.001
	80-91	9	2	22.22		2	22.22	
	92-103	46	6	13.04		4	8.70	
	104-115	62	5	8.06		3	4.84	
	116-127	87	8	9.20		6	6.90	
	128-139	79	8	10.13		9	11.39	
	140-152	36	7	19.44		8	22.22	
	>152	5	2	40		1	20	

According to Table 3, mothers with low and high hemoglobin concentrations have a more significant proportion of infants with low birth weight and abnormal height than other mothers. Low birth weight and abnormal height are less common in babies born to mothers with a hemoglobin concentration between 100 and 140 g/L compared to other mothers. Therefore, it can be concluded that dividing the investigation into multiple groups based on the hemoglobin

concentration of the mothers' blood yields more precise results.

Table 4 displays the odds ratio for low birth weight and abnormal height in babies born to mothers with different hemoglobin concentrations. The results of this logistic regression model indicate that the likelihood of low birth weight and abnormal height increases 4.96 times and 4.13 times, respectively, in mothers with high hemoglobin concentration compared to mothers with lower hemoglobin concentration; these ratios are statistically significant (P<0.001).

Table 4. Odds ratio of birth in hemoglobin concentration groups of pregnant mothers

Grouping type	Grouping based on hemoglobin	Low birth weight babies			Abnormal height of babies		
		Odds ratio	confidence interval	P-value	Odds ratio	confidence interval	P-value
2 Groups	Anemic	1.18	0.84-1.57	0.107	1.02	0.87-1.23	0.832
	Healthy	1	-	-	1	-	-
4 Groups	<100	1.33	0.89-1.78	0.094	1.31	0.93-1.67	0.146
	100-125	1	-	-	1	-	-
	126-150	1.59	1.24-1.98	<0.001	1.66	1.29-2.13	<0.001
	>150	3.23	2.64-3.88	<0.001	3.82	2.93-4.77	<0.001
8 Groups	<80	-	-	-	-	-	-
	80-91	2.76	2.16-3.39	0.242	4.59	3.18-6.02	0.419
	92-103	1.62	1.18-2.12	0.317	1.80	1.34-2.30	0.073
	104-115	1	-	-	1	-	-
	116-127	1.14	0.86-1.46	<0.001	1.43	1.06-1.83	0.056
	128-139	1.26	0.91-1.65	<0.001	2.35	1.67-3.09	0.114
	140-152	2.41	1.72-3.16	<0.001	4.59	3.28-6.12	<0.001
	>152	4.96	3.42-6.54	<0.001	4.13	3.11-5.17	<0.001

According to Table 4, the odds ratio of babies with low weight and abnormal height is higher in low hemoglobin concentrations, but the difference is not statistically significant (P>0.01). It is well known that increasing the number of groups improves the accuracy of the results so that hemoglobin concentration values between 104 and 115 g/L have the lowest probability. Additionally, values of hemoglobin concentration greater than 125 g/L are statistically significant (P<0.001).

Discussion

The current study aimed to examine the association between the blood hemoglobin concentration of pregnant mothers and the low birth weight and abnormal height of newborns among 326 referrals to Alwiyah hospital of obstetrics and gynecology in Baghdad, Iraq, in 2019. In the present study, there was no statistically significant difference between the groups of anemic and healthy mothers regarding age, number of children, level of education, and socioeconomic status, which is consistent with the results of other studies **(24, 25)**. The present study revealed that mothers with a high hemoglobin concentration have a greater chance of giving birth to a baby with a low birth weight and abnormal height. In addition, mothers with a hemoglobin concentration of fewer than 80 grams per liter (severe anemia) are more likely to give birth to the babies mentioned above **(26)**.

Several hypotheses have been proposed regarding the cause of fetal growth retardation due to low or high maternal hemoglobin concentration. Thus, altering angiogenesis in early pregnancy affects the placental structure **(27)**. It has also been suggested that anemia and iron deficiency can increase pregnant women's stress levels and CRH production. Increased CRH is a significant risk factor for pregnancy-induced hypertension (PIH), preeclampsia, and preterm birth. It can cause an increase in fetal blood cortisol and inhibition of fetal longitudinal growth **(28)**.

Pregnancy is one of the natural and essential phenomena in any society; therefore, paying attention to the health of mothers during this period can have a lasting impact on the health of the mother and her family members. Most women during pregnancy are at an age when their iron reserves are low, and pregnancy increases the body's natural need for iron. As a result, the need for iron is not met by the regular diet, and supplementation is advised during this time **(29)**.

Different study results may be due to variations in blood hemoglobin levels during different weeks of pregnancy, as the volume of plasma and red blood cells

increases during pregnancy. In the second trimester of pregnancy, plasma volume increases faster than red blood cells, diluting the blood. In the third trimester, the plasma volume should decrease as the red blood cell volume rises, followed by an increase in hemoglobin concentration. Therefore, if maternal anemia is diagnosed regardless of the week of pregnancy, the study data will yield different results **(30)**. In contrast, the reduction of disproportionate plasma volumes causes fetal stress. In some studies, the relationship between maternal blood hemoglobin and newborn-related variables has been depicted as a U-shaped curve. In other words, babies born to mothers with iron anemia or elevated hemoglobin levels have low birth weights and shorter heights **(31)**. In the current study, infants born to mothers with normal hemoglobin had more significant weight and height than infants born to mothers with high or low hemoglobin. A U-shaped pattern was observed between the weight and height of infants and their mothers' hemoglobin levels.

Regarding the effect of iron deficiency anemia on fetal growth (including weight and height), it appears that careful follow-up of mothers from early pregnancy onwards, as well as timely diagnosis and treatment, are relatively easy and inexpensive; this is essential. In this study and others, it has been shown that high hemoglobin in the mother also causes a decrease in the baby's height and weight. Therefore, it is necessary to pay attention to high hemoglobin, typically less noticed, and eliminate possible influencing factors.

Limitations of this Study

Among the limitations of this study is that some pregnant women living in affluent areas are unwilling to visit comprehensive health service centers. As a result, the findings of these studies should not be generalized to the entire population, and the blood tests of some mothers who refer to service centers are not included in their files. Another limitation of the current study is that it was conducted in a medical center and city. Considering that numerous factors, such as diet, lifestyle, etc., which may affect blood hemoglobin concentration, the results of the current study cannot be generalized to other cities or countries. Also, examining only the weight and height of infants may be a limitation; therefore, it is suggested to investigate the relationship between other newborn parameters and the hemoglobin concentration of pregnant mothers.

Conclusion

In general, the results of the present study indicated that a high concentration of maternal hemoglobin during pregnancy could harm the weight and height of infants, which is significant and has received less attention in previous research. As a result, monitoring mothers from the beginning of their pregnancies, diagnosing their problems, and treating them can have a significant impact on the health of the mother and the baby, as well as reduce family expenses and, to a large extent, government expenditures.

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Conflict of Interest

The authors have no conflict of interest.

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