IJBC 2014; 7(1): 19-24

The Correlation between Infants' Birth Weight and Apgar Score and Maternal Hemoglobin Concentration

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Submitted: 09-05-2014 , Accepted: 28-10-2014

Abstract

Background: Various studies have come to contradictory results regarding the relationship between maternal hemoglobin (Hb) level and adverse pregnancy outcomes. The present study aimed to investigate the birth outcomes among pregnant women who had normal hemoglobin levels in the first trimester of their pregnancy.

Patients and Methods: In this prospective study, 108 healthy pregnant women with gestational age of 10-14 weeks and Hb≥11g/dl were selected through cluster random sampling and were followed up until delivery. Mothers' Hb concentration was measured at the end of the first, second, and third trimesters. Then, the relationship between maternal Hb concentration and infants' birth weight and Apgar score was investigated.

Results: The incidence rates of anemia in the second and third trimesters were 12.8% and 27.9%, respectively. Moreover, 16.27% of the newborns had low birth weight and 17.4% had Apgar scores of less than 8. The results revealed a significant relationship between birth weight and maternal Hb level in the second (P=0.02), and the third trimester (P=0.03). Also, the rate of birth of infants with Apgar scores<8 significantly increased among women with Hb<10.5g/dl or Hb>13.2g/dl in the second trimester (P<0.001).

Conclusion: According to the present study's findings, maternal Hb level is suggested to be controlled during the second and third trimesters of pregnancy in addition to the first trimester. In this way, necessary care and treatment measures can be taken based on the women's hemodynamic status which might reduce the low birth weight and low Apgar score among infants.

Key words: Hemoglobin, birth outcomes, pregnancy.

Introduction

Maternal hypervolaemia is the most obvious physiological change during pregnancy [1]. Due to difference in the increase of plasma volume and volume of red blood cells (50% and 18%, respectively), it leads to hemodilution and reduction of hemoglobin (Hb) level. The highest rate of hypervolaemia is detected in 25-30 weeks of gestation when 2g/dl of Hb is decreased [2-3]. Consequently, in case of a lack of body iron stores, the rate of Hb is considerably decreased [4]. Therefore, consumption of iron tablets is considered as one of the main components of prenatal care for supplying the necessary iron [5]. Excessive consumption of iron might have various consequences, such as gastrointestinal complications, increase in Hb level, and adverse pregnancy outcomes [6].

Up to now, different studies have come to contradictory results regarding the relationship between Hb concentration and pregnancy outcomes. Some studies have indicated that a reduction in Hb level increases some undesirable pregnancy outcomes, such as low birth weight (LBW) and preterm delivery [7]. On the other hand, some others have revealed a U-shaped relationship

between maternal Hb concentration and adverse pregnancy outcomes. This implies that increase in Hb level (more than 13.2g/dl), similar to its reduction, is accompanied by complications, such as preterm delivery, maternal hypertension, and intra-uterine growth restriction [8]. However, some studies have shown no relationships between Hb concentration and adverse pregnancy outcomes [9].

Up to now, most previous studies have investigated the pregnancy outcomes in mothers suffering from anemia. However, the birth outcomes have not been assessed among mothers with normal Hb levels who experience abnormal Hb changes during pregnancy. Due to the fact that Hb concentration control and initial screening of the mothers regarding anemia are usually performed in the first trimester [4], the consequences of abnormal Hb changes during pregnancy have been less taken into account. Therefore, the present study aimed to investigate the birth outcomes among the mothers who had normal Hb levels in the first trimester but experienced Hb changes due to various reasons later on.

Patients and Methods

In this follow-up study, 108 healthy pregnant women with singleton pregnancy and 10-14 weeks of gestation who were non-smokers were randomly selected among the pregnant women referring to 3 main pregnancy care centers of Shiraz, Iran, (Hafez, Zeinabiyeh, and Shoushtari hospitals) and were followed up until delivery.

In the first visit, the mothers' complete history was obtained; they were precisely examined by a specialist in gynecology and obstetrics, and the results of routine pregnancy tests, including Fasting Blood Sugar (FBS), Complete Blood Count (CBC), Urinalysis (U/A), Urine Culture (U/C), and Venereal Disease Research Laboratory (VDRL), were evaluated. Then, the mothers suffering from anemia (Hb<11g/dl) or having a history of known blood disorders, chronic kidney disease, diabetes, cardio-pulmonary disorders, inflammatory bowel disease, and malignant neoplasms were excluded from the study. Afterwards, the mothers' weight was measured and their Body Mass Index (BMI) was calculated by dividing weight before pregnancy in Kg by height in meters squared. Moreover, gestational age was determined by Last Menstrual Period (LMP) and sonography report. In case the difference between these two was more than 2 weeks, sonography report was taken into account. If not, LMP was used in order to determine the gestational age [3]. The data were then entered into pre-designed forms including individual features, demographic characteristics, present pregnancy status, and history of previous deliveries.

At the end of the first visit, 2cc venous blood was taken from the participants and sent to laboratory for CBC testing. All the experiments were performed through Coulter Counter by an experienced specialist in the laboratory of Hafez hospital, Shiraz, Iran.

In the second visit which was carried out in 25-30 weeks of gestation, in addition to obtaining the history of the second trimester, venous blood samples were also taken for CBC testing.

In the third visit which was conducted in 37-40 weeks of gestation, in addition to obtaining the history of this trimester, CBC test was also required. According to the Center for Disease Control and Prevention, Hb levels less than 11g/dl in the first and third trimesters and less than 10.5g/dl in the second trimester were considered as anemia [4]. It should be noted that all the mothers had regularly received pregnancy care services, including ferrous sulfate tablet (50mg), since the 16th week of gestation.

The last visit was carried out immediately after the natural vaginal or cesarean delivery. In order to evaluate the infants using Apgar method, infant's heart rate, muscle strength, response to nasal catheter, and skin color were considered [10]. After complete physical and nervous examination of the infants and rejection of major congenital disorders, the infants' weight was measured using Seca scale (accuracy: 10g), and was inserted in the related forms.

During the study, 22 samples were excluded from the study due to bleeding, gestational diabetes, preeclampsia, severe anemia (Hb<8g/dl), intra-uterine death, severe infantile disorder, and unwillingness to continue participation in the study. At the end the data related to 86 patients were analyzed using the SPSS statistical software. One-way ANOVA and T-test were used to assess the relationship between infants' weight and their demographic features, maternal Hb level in all three trimesters, and infants' sex. Besides, chi-square test was used to investigate Apgar score<8

in different study groups.

Results

The mean age of the study participants was 25.6±5.69 years and their mean BMI was 23.6±3.83. According to table 1, most of the study participants were 20-35 years old, had BMI of 19.8-26 Kg/m^2, and were nulliparous. In addition, the mean weight of the newborns was 3097±480.6 g and the prevalence of LBW (birth weight<2500g) was 16.27%.

In spite of the fact that none of the study participants had anemia (Hb<11g/dl) at the beginning of the study, the incidence rate of anemia was 12.8% in the second trimester (Hb<10.5g/dl) and 27.9% in the third trimester (Hb<11g/dl).

Table 1- Maternal and neonatal characteristics of pregnant women (n=86).

Variables	Group(s)	%	Mean(SD)
Maternal Age(year)	<20	94/20	
	35-20	09/72	6/25 ± 69/5
	>35	97/6	
Parity	nuliparous	13/58	_
	multiparous	87/41	
Prepregnancy Body mass index (kg/m^2)	<8/19	28/16	
	19/26-8	97/56	23/ 6 ± 83/3
	>26	75/26	
Hb in First trimester	2/13-11	9/70	
	>2/13	1/29	69/12 ±13/1
Hb in Second trimester	<5/10	8/12	
	2/13-5/10	4/81	11/ 70 ± 06/1
	>2/13	8/5	
Hb in Third trimester	<11	9/27	
	2/13-11	1/72	36/11 ± 09/1
	>2/13	0	
Birth weight	<2500	27/16	2/3097 ±480 /6
	≥2500	73/83	
APGAR score	<8	44/17	_
	10-8	56/82	
Fetal sex	female	5/56	_
	male	5/43	

Table 2- Criteria of anemia severity during pregnancy according to Hb concentration (g/dl).

Anemia severity	Hb concentration in the first and third trimester	Hb concentration in the second trimester
Severe	<7	<5/6
Moderate	9/8-7	4/8-5/6
Mild	9/10-9	4/10-5/8
Normal	≥11	≥5/10

Table 3- Association of birth outcome and maternal factors in pregnant women (n=86).

Variables	Group(s)	Birth weight (mean &SD)	P(value)	APGAR score less than 8(%)	P(value)
Maternal age(year)	<20 35-20 >35	544±3004 473±3106 643±3265	7/0	3/33 12/ 7 0	2/0
parity	Nulliparous multiparous	485±3085 482±3113	8/0	9/17 1/11	4/0
Maternal height(cm)	<155 ≥155	330±2821 489±3208	001/0	-	-
Pre-pregnancy BMI(kg/m²)	<8/19 26-8/19 >26	396±2781 431±3155 596±3150	07/0	30 6/14 7/6	2/0
Fetal sex	Female male	442±3141 511±3120	8/0	12 2/13	7/0
Hb concentration in the first trimester(g/dl)	2/13-11 >2/13	470±3052 502±3216	2/0	5/12 2/22	2/0
Hb concentration in the second trimester(g/dl)	<5/10 2/13-5/10 >2/13	365±2692 478±3166 181±3060	02/0	4/44 3/9 3/33	01/0
Hb concentration in the third trimester(g/dl)	<11 2/13-11	547±2906 433±3174	03/0	1/42 3/4	001/0

Moreover, the highest incidence rate of anemia was detected in the third trimester and was mild and moderate in 92% of the cases. Classification of different types of anemia based on various Hb levels is presented in table 2 [12]. In the present study, 5.8% of women had Hb>13.2g/dl in the second trimester; however, none of the participants had Hb>13.2g/dl in the third trimester.

As table 3 depicts, a significant relationship was found between birth weight and maternal Hb concentration in the second (P=0.02) and third trimester (P=0.03). Moreover, the highest birth weight was related to mothers with Hb between 10.5 and 13.2g/dl in the second trimester and between 11 and 13.2g/dl in the third one. On the other hand, the lowest birth weight was related to the infants whose mothers suffered from anemia during pregnancy. Furthermore, the mothers with heights above 155cm had given birth to heavier infants (P<0.001). Also, the mothers with BMI between 19.8 and 26 Kg/m² had heavier infants compared to others; however, the difference was not statistically significant. Nonetheless, no significant relationship was observed between birth weight and mothers' age, Hb level in the first trimester, number of deliveries, and infants' sex.

The findings of the present study showed that 17.4% of the infants had Apgar scores<8 in the first minute after birth. This measure was significantly higher among the mothers with Hb<10.5g/dl or Hb>13.2g/dl in the second trimester (P<0.01) and those with Hb<11g/dl in the third trimester (P<0.001). As table 3 shows, no significant relationship was found between Apgar score at birth and mothers' age, BMI, and number of deliveries, and infants' birth weight and sex.

Discussion

Different studies have come to contradictory results regarding the relationship between maternal Hb level and adverse pregnancy outcomes. In this study, 12.8% and 27.9% of the participants experienced anemia in the second and the third trimester, respectively. Anemia was mild and moderate in most of the cases. Moreover, the highest incidence rate of anemia was related

to the third trimester and no cases with Hb>13.2g/dl were found in this period. Generally, anemia is one of the most important nutritional problems around the world, particularly in developing countries. In addition, pregnant women are one of the most vulnerable groups regarding anemia [11]. The prevalence of anemia among women has been reported to be 55.9% around the world [12] and 22.7-51% in the Persian Gulf littoral states [13]. The prevalence of anemia in the third trimester in the present study was consistent with the results of a study by Kadivar et al. reporting its prevalence as 28.5% [14]. It should be noted that some participants of the current study experienced anemia in spite of routine consumption of iron supplements. Hb level during pregnancy reflects iron reception, need, and excretion in this period [3]. Yet, there is still debate on the amount of iron supplement required during pregnancy [15]. Studies have indicated that mothers' age [2], BMI before pregnancy, smoking [2,9], race [16], number of deliveries [7], level of education [17], interval between pregnancies [18], and amount of weight gain during the first trimester [6], are important in determination of Hb concentration during pregnancy.

In the present study, the prevalence of LBW was 16.27% which is in agreement with its global prevalence. Overall, 15.5% of the infants around the world suffer from LBW, 95% of them being born in developing countries [19]. Moreover, a significant relationship was observed between infants' weight and Hb level in the second and third trimesters, and the lowest birth weight was related to mothers with anemia. The findings of a study by Ronnenberg et al. confirmed that maternal Hb concentration before pregnancy affected the pregnancy outcomes. In that study, the risk of LBW increased by 6.5 folds among the mothers with Hb<9.5g/dl [20]. Similarly, Levy et al. demonstrated that the risk of preterm delivery and LBW was higher among the mothers suffering from anemia [7,12]. Furthermore, Chang et al. revealed a U-shaped relationship between Hb concentration and adverse pregnancy outcomes, such as LBW, and emphasized that, similar to its decrease, an increase in Hb level was accompanied by undesirable complications [8]. Since none of the participants of the present study had Hb>13.2g/dl in the third trimester, the relationship between high Hb concentration and its undesirable outcomes could not be assessed. This might be due to the fact that most of our study subjects were within the low-risk age range, had normal BMI, and did not smoke. In general, higher ages, smoking, obesity, and living at high altitudes are considered as the risk factors of increase in Hb concentration [21]. It should be noted that high Hb concentration which can be detected in a normal pregnancy might result from lack of proper increase in the volume of plasma [22].

The findings of the current study demonstrated no significant relationship between birth weight and mothers' age, BMI before pregnancy, and infants' sex. Lavin has reported that the risk of LBW is higher among the short mothers with BMI<19.8Kg/m^2 [23]. Similarly in the present study, LBW was significantly associated with mothers' height, but not with BMI before pregnancy.

In this study, the infants' low Apgar scores were significantly more prevalent among the mothers with abnormal Hb levels in the second and third trimesters of pregnancy. This is in agreement with the findings of the study by Malhotra et al., indicating insufficient oxygenation as one of the main causes of fetal distress resulting from mothers' anemia [24].

Conclusion

According to the present study's findings, maternal Hb level is suggested to be controlled during the second and third trimesters in addition to the first trimester. In this way, necessary care and treatment measures can be taken based on the women's hemodynamic status which might reduce the low birth weight and low Apgar score among newborns.

Acknowledgment

The research vice-chancellor of the Islamic Azad University of Ardabil, Iran, is appreciated for financially supporting the study. We are also grateful for Research Improvement Center of Shiraz University of Medical Sciences and Ms. A. Keivanshekouh for improving the use of English in the manuscript.

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