



Maternal BMI and Hb for the prediction of placental weight and neonatal outcome

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Abstract

Background & Aims: Anthropomorphic and parametric features of mothers are associated with placental weight (PW) changes and its function. Anthropomorphic and parametric features can affect neonatal well-being. The aim of this research was to assess the prediction role of maternal body mass index (BMI) and hemoglobin (Hb) in placental weight and neonatal outcome.

Materials & Methods: This study was a correlational descriptive-analytical study. The data were collected using a demographic-reproductive questionnaire completed by 365 parturient women referred to Valiasr Hospital in Kazeroun, Fars, Iran from May 1 to August 31, 2020. The inclusion criteria were singleton delivery at term (37–42 weeks) and mothers' consent to attend the study after recovery. The exclusion criteria were retained placenta, multiple pregnancies, and mothers' discontent to participate in the study. The data were analyzed using Pearson correlation coefficient and multiple regression analysis. All analyses were carried out with SPSS V.21. The significance level was considered less than 0.05.

Results: The findings of the study showed that maternal BMI in early pregnancy ($\beta = 0.20$, $P < 0.01$), and gestational age ($\beta = 0.24$, $P < 0.01$) were the positive predictive factors for placental weight. Also, among the maternal traits, only maternal hemoglobin ($\beta = 0.14$, $P < 0.001$) turned out to be a positive predictor for the neonate's Apgar score. Of all fetal features, only neonatal weight had a significant correlation with placental weight ($P < 0.01$).

Conclusion: Mother's BMI and Hb can predict placental weight and neonatal outcome. According to this finding, caregivers can help pregnant women with congruent education about proper nutrition to reach a safe BMI and create a positive outcome for the placenta and the newborn.

Keywords: Maternal BMI, Maternal Hb, Neonatal Outcome, Placental Weight

Received 26 June 2023; accepted for publication 11 October 2023

Introduction

Low or high body mass index (BMI) in pre-pregnancy and inadequate or excess gestational weight gain (GWG) are associated with an increased risk of adverse neonatal outcomes. Overweight and obese BMI scores and excess GWG have been linked to large-for-gestational-age (LGA) infants, preterm birth (PTB), and stillbirth; while underweight BMI and low GWG have been associated with small-for-gestational-age (SGA) infants and PTB (1). In addition, stress factors such as anemia, malnutrition, and severe physical activity play a significant role in the growth and development of the placenta and birth weight (2). Anemia is characterized by reduced blood hemoglobin (Hb) levels and reduced oxygen-carrying capacity in the blood. It is a common health complication in pregnancy, most often attributed to iron deficiency due to increased iron demands from the growing fetus and placenta and maternal blood volume expansion (3). Some studies indicated Hb changes as maternal anemia was associated with fetal growth restriction and low placental weight leading to impaired placental function (4, 5). In fact, the weight and size of the placenta could have a direct effect on placental function and fetal wellbeing (6). However, other studies have reported no effect of maternal anemia on placental weight, or even reduced placental weight with maternal anemia (7). Thus, the relationship between maternal Hb status and placental weight may be more complex and depend on additional factors such as the gestational age of anemia onset and whether the placenta and fetus maintained an appropriate level of Hb to sustain adequate oxygen delivery and growth (7). However, placental weight reflects placental functioning, but placental weight relative to birth weight (PW/BW ratio) is considered to be a more appropriate indicator of placental function than placental weight alone because placental weight is highly correlated with birth weight (6). Many studies about the relation between placental weight and birth weight have been done for more than a century. They indicated that placental weight was associated with pregnancy outcome. So that high weight of the placenta accompanied with placental hydrops, a low Apgar

score, respiratory distress syndrome, perinatal death, and finally, a poor perinatal outcome, accompanied placenta with high weight. Conversely, a low placental weight was shown to be accompanied by medical complications in the mother (7-9). Placental growth and its functional capacity are naturally estimated in normal pregnancy (10). A high PW/BW ratio, due to a disproportionately heavy placenta compared to birthweight, is associated with higher risks for adverse birth outcomes and cardiovascular diseases in adulthood. Compensatory hypertrophy of the placenta in hypoxic conditions is one of the most important underlying mechanisms by which a high PW/BW ratio develops (6). In fact, functional capacities of the placenta and fetal nutritional conditions could be shown by placental weight. In some situations such as Ramadan (an annual period of daytime fasting for Muslims) and long fasting, placental weight is decreased during the second and third trimester of pregnancy, due to the changes in maternal diet (11, 12).

Considering the significance of maternal and child health as the main axis of sustainable development in the developing countries including Iran, and due to the limited studies conducted on this topic, there is a strong need for studying the predictive role of maternal BMI and Hb in placental weight and neonatal outcome.

Materials & Methods

This cross-sectional study was conducted on women who gave birth to live newborns in Valiasr Hospital of Kazeroon, Iran from May 1 to August 31, 2020.

Study Participants:

Three hundred and sixty-five parturient women who were eligible for the present study, participated. The inclusion criteria were singleton delivery at term (37–42 weeks), normal vaginal delivery, lack of retained placenta, and mothers' consent to participate in the study after recovery.

The exclusion criteria were lack of high-risk pregnancy (anorexia nervosa, anemia, gestational diabetes, preeclampsia...), multiple pregnancies, and

incomplete questionnaire fulfillment. In addition, confounding variables were identified and omitted from this study.

Data Collection:

By using a research-made questionnaire that included demographic and reproductive characteristics (i.e., maternal age, gestational age by LMP (Last Menstrual Period) or ultrasound, parity, mother's weight and height in early pregnancy, BMI in early pregnancy, mother's Hb and HCT (Hematocrit) measured as routine antenatal care in the 28th week, placental weight (PW), neonatal weight (NW), gender of newborns, and Apgar score of the neonate) were investigated. All placentas, with their membranes and 2-3 cm cords being cut off after removing obvious blood clots, were weighed shortly after delivery using a calibrated weighing digital scale. Accordingly, the women were categorized as high placental weight (> 660 g), normal placental weight (500-650 g), and low placental weight (< 500 g) groups.

The weights of the newborn babies were recorded by a valid weighting scale and categorized as low neonatal weight (< 2500 g), normal neonatal weight (2500-4000g), and high neonatal weight (> 4000 g)

groups.

All participants provided written, signed informed consent, and if an appropriate institutional review board reviewed and approved the study protocol.

Data Analysis:

In the present study, confounding variables were controlled as much as possible and data related to incomplete questionnaires were omitted from the analysis. Then, descriptive statistics such as Mean \pm SDM were used for the description of demographic and reproductive characteristics of participants.

Data were analyzed with SPSS V.21 software. The correlations between variables were then investigated using Pearson's correlation test (r). Multiple linear regression analyses were performed to explore the predictors between the dependent variables by the independent variables. For assessing the fit of multivariable models, adjusted R² and Anova were significant, and then multiple regression was used.

Results

Three hundred and sixty-five parturient women of various demographic and reproductive characteristics were included in this study (Table 1).

Table1. Maternal, Placental, and Fetal Characteristics

Variable	%	Mean ± SDM
Maternal age		
< 20	13.2	27.53 ± 5.99
20-35	83.3	
>35	2.2	
Gestational age		
<36	21.1	38.99 ± 1.44
38-40	50.1	
>40	25.2	
Maternal BMI in early pregnancy		
< 21	21.4	21.48 ± 1.001
21-23.9	21.4	
24-28.5	21.1	
> 28.6	21.1	
Maternal Hb		

Variable	%	Mean \pm SDM
< 12	28.2	12.7 \pm 94
≥ 12.1	65.5	
Parity		
1-2	65.4	2.2 \pm 1.18
≥ 3	34.6	
Neonatal weight		
< 2500	5.2	3260 \pm 4.43
2500-4000	91.4	
> 4000	3.3	
Apgar score		
< 8	3	9.8 \pm 50
8-10	97	
Gender		
Male	48.4	1.5 \pm 0.5
Female	51.6	
Placental weight		
< 500	32.9	583 \pm 1.27
500-650	34.3	
> 660	32.9	

Table 2. Correlation between Maternal Characteristics with Placental Weight and Neonatal Features

Variables	Maternal age	Gestational age	BMI	Hb	HCT	Neonatal weight	Apgar	Placental weight
Maternal age	1							
Gestational age	-0.007	1						
BMI	0.22**	0.05	1					
Hb	-0.05	0.003	0.08	1				
HCT	0.05	0.004	0.07	0.93**	1			
Neonatal weight	0.12*	0.42**	0.20**	-0.02	-0.006	1		
Apgar	0.05	0.05	0.09	0.14**	0.12*	0.06	1	
Placental weight	0.07	0.20*	0.25	0.05	0.05	0.52**	0.06	1
P < 0.05*	P < 0.01**							

Out of all maternal characteristics, only BMI in early pregnancy and gestational age were correlated with PW. The correlations between maternal features and fetal traits indicated that maternal age, gestational

age, and BMI have significant relationships with NW. Out of all maternal features, only Hb and HCT have significant correlations with the Apgar score of the neonate. In addition, it was revealed that among all

fetal features, only NW was correlated with PW (Table 2).

Considering the main objective of the present study, the researchers used the enter method for multiple regression analysis. As shown in Table 3, the results

indicate that maternal BMI in early pregnancy ($\beta = 0.20$, $P < 0.01$) and gestational age ($\beta = 0.24$, $P < 0.01$) were positive predictive factors for placental weight. These variables explain 10% of the total variation score of the placental weight (Table 3).

Table 3. Multiple Regression Coefficients, β , of the Maternal BMI and Gestational Age as Predictors of Placental Weight

Variables	β	P-value	CI		Adjusted R ²
	(STANDARDIZED COEFFICIENT)		Lower	Upper	
BMI	0.2	0.001	0.369	3.267	0.10
Gestational age	0.24	0.001	8.95	28.84	

The results shown in Table 4 indicated that out of the maternal traits (such as maternal age, gestational age, parity, BMI, Hb, and HCT), only maternal hemoglobin ($\beta = 0.14$, $P < 0.001$) was a positive predictor factor for the Apgar score of the neonate in

this model. These variables explain 16% of the total variation of Apgar score in general. Because of the multicollinearity effect between HCT and Hb, this variable is not considered in the prediction of the Apgar score (Table 4).

Table 4. Multiple Regression Coefficients, β , of the Maternal Hb as Predictors of Apgar Score

Variables	β	P-value	CI		Adjusted R ²
	(STANDARDIZED COEFFICIENT)		Lower	Upper	
Apgar score	0.14	0.0001	0.014	0.137	0.016

Discussion

The aim of this study was to determine the predictive role of maternal traits in placental weight and neonatal outcome. The results of the study indicated that, out of the maternal traits, only BMI in early pregnancy and gestational age correlated with PW and NW. We believe that high BMI or obese pregnant women have larger placentas and higher placental weight, and that the length of gestation is closely related to placental weight. It appeared that mother's weight gain in early pregnancy led to hormonal increase in plasma and fat reserve, which was the cause of correlation between GA and PW. In agreement with the current study, results of the study done by Ratnasiri et al. revealed a significant

relationship between BMI in early pregnancy and gestational age with PW and NW (1). Roland MC et al. showed an increase in a unit of BMI resulted in an increase of 0.79gm of placental weight in a study done on more than 1000 Scandinavian women (13). Conversely, Macdonald et al. reported that a PWR (placental weight ratio calculated as placental weight divided by birth weight) level less than 10th percentile is associated with an increase in maternal height, overweight, and obese body mass indexes, as well as with smoking and gestational diabetes (14).

In this study, we didn't find any correlation between maternal age and PW, although some studies have reported a direct association between these variables (15). They argued these relationships are due

to an increase in the placental barrier, a decrease in the vascularization of the terminal villi, or an increase in stroma and fibrin deposition in the placenta of mothers over 35 years old compared to the normal group (15, 16). However, the findings of this study revealed that maternal age is correlated with neonatal weight. This finding was similar to that of a study by Patimah conducted in Mother and Child Hospital Siti Fatimah Makassar in Indonesia (17).

Our findings indicated that placental weight significantly correlated with birth weight. This was consistent with the studies carried out by Thame et al., Salafia et al., and Alwasel et al. (13, 18, 19). Also, Palaskar et al. believed that placental weight has a significant role in the growth of the fetus and its function diversely supports the growth of the fetus. It transfers nutrients from the mother to the fetus and effects metabolic and endocrine function through regulation of metabolism in the mother and fetus. Therefore, it has an important role as a major regulator of fetal-placental metabolism (20).

Finally, our findings showed that maternal hemoglobin was a positive predictor for the Apgar score of the neonate. Consistent with this result, other studies mentioned that maternal anemia was associated with a low Apgar score, fetal growth restriction, and low placental weight because of low ferritin concentration (21, 22). Some findings suggest that low or elevated hemoglobin concentration may lead to placental compensatory hypertrophy and fetal growth restriction. However, these studies used different cutoffs for maternal hemoglobin concentration or unclear definitions or classifications of anemia, potentially affecting the association found between maternal anemia and placental weight. Mitsuda et al. (2020) found that there were a sex-dependent differences in placental function (6). Besides, they found out that Hb concentration in the mother has no relation with NW or PW, but it has been reported in some studies, especially systematic reviews, that both low and elevated maternal serum hemoglobin concentrations during pregnancy are associated with an increased PW/BW ratio (6). It is

also reported in some other studies that Hb levels at "mid- or late- pregnancy" are inversely associated with birth weight/length and placental weight (23-25). Maybe there are intermediate factors interfering with this result which entails further studies.

Limitations of this study included lack of reliable data on pre-pregnancy regarding the BMI and difference in lifestyle, e.g., vegetarian women that affect their BMI and placental weight. To avoid recall bias, we calculated BMI based on measured height and weight at the first visit. Our findings would have been more reliable if we measured MCV, MCHC, MCH, and Ferritin of maternal serum, not taken into account in the study firstly due to budget constraint and secondly because they are not measured routinely in late pregnancy. Also, placental function cannot be accurately modeled by measuring weight alone. Other factors, such as placental vascularization, barrier thickness, volume, and hemodynamics are important considerations.

Conclusions

Our data support the hypothesis that some maternal traits predict placental weight and neonatal outcome. The differential effect of maternal factors on placental weight showed the relation between mother's BMI and Hb on the placental weight and neonatal outcome. This means that caregivers can help pregnant women with congruent and necessary education about proper nutrition to reach the appropriate BMI and create a positive outcome for the placenta and newborn.

Acknowledgements

We show our gratitude to all midwives in Valiasr Hospital of Kazeroon and assistant researcher at the delivery ward for participating in data collection, in particular for weighing the placentas and the newborns.

Conflict of Interest

The authors have no conflict of interest in this study.

Funding/Support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on a reasonable request.

Ethical Statement

Institutional review board approval and patient consent were not required.

Authors' Contributions:

P Y and Sh N and Gh M aided in the conceptualization, design, and critical revision of the final manuscript, P Y and F.P. aided in design, preparation of manuscript and critical revision of the final manuscript. P Y and K H aided in data analysis and critical revision of the final manuscript. All authors read and approved the final manuscript.

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