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Could Maternal Body Mass Index (BMI) Affect Neonatal Birth Weight? A Retrospective Study

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Abstract: *Background*: Obesity is one of the global health problems and maternal obesity may be associated with an increased risk for pregnancy complications and neonatal death. *Objective*: The purpose of this study is to evaluate the effect of maternal pre-pregnancy body mass index (BMI) on neonatal birth weight. *Methods*: In a retrospective study, the neonatal weight birth of all singleton term babies of nulliparous non-diabetic women who delivered in Shahid Sadoughi Hospital, Yazd, Iran, from 2018 to 2019 was evaluated. The weight and height of the mother were measured in the first visit (within the first trimester). Body mass index (BMI: weight in kilogram / height in meter squred) of the mothers were was calculated and BMI less than 18.5, 18.5–24.9, 25–29.9 and more than 30 was categorized as underweight, normal, overweight and obese, respectively. *Results*: In this study, 3154 cases were evaluated. Eighty-one (2.6 %) women were underweight, 1615 (51.2 %) were normal weight, 1218 (38.6 %) were overweight and 240 (7.6 %) were obese based on their pre-pregnancy BMI. 542 (17.2 %) and 273 (8.7%) neonates were low birth weight (< 2500gr) and macrosomia (> 4000 gr), respectively. Neonatal macrosomia was significantly higher in obese and overweight mothers. Low birth weight (LBW) was observed more in the underweight group but the difference was not statistically significant compared to other groups. *Conclusion*: Our study showed that pre-pregnancy maternal BMI affects the neonatal birth weight. High BMI increases the incidence of macrosomia and there is a strong association between macrosomia and maternal overweight.

Key words: Pre-Pregnancy Body Mass Index · Low Birth Weight · Macrosomia

INTRODUCTION

Maternal and fetal well-being are directly coupled. Optimal fetal growth is influenced by a number of factors. These factors through an intricate mechanism control fetal metabolic signaling pathways and guide "fetal programming". Maternal nutritional status is the most important among these factors as it ensures continuous nutrient supply to developing fetuses. Birth weight is one of the main indicators of growth and one of the main determinants of survival, physical growth and neural development of a child and is a reliable sign of intrauterine growth, health and maturity of the fetus [1]. Maternal health is a key determinant of fetal growth [2]. Maternal body mass index (BMI) is one of the most important predictors of the nutritional status of a pregnant women. Both nutritional intake and maternal weight are modifiable factors that can influence pregnancy outcomes [3]. Maternal malnutrition refers to deficiency, excess, or imbalance in maternal intake of energy and/or nutrients [4]. Worldwide there has been an alarming increase in the incidence of obesity and overweight, particularly in the past two to three decades [5].

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In addition, maternal obesity and overweight in pregnancy might be associated with maternal complications such as an increase in the risk of pregnancy-induced hypertension, preeclampsia, gestational diabetes and cesarean delivery. Maternal obesity causes many fetal and neonatal complications such as fetal growth abnormalities (macrosomia, intrauterine growth retardation), fetal death and other adverse neonatal outcomes. Furthermore, it has been shown that low APGAR score is more common in new born infant of obese women [6].

However, the effect of maternal underweight on the birth weight of a newborn remains still controversial. Some studies have reported an increased incidence of anemia, intrauterine growth retardation, low birth weight (LBW) babies and preterm labor [3, 7]. The purpose of this study was to evaluate the effect of maternal BMI on neonate birth weight.

MATERIALS AND METHODS

In a retrospective study, by reviewing hospital archived files, the height and weight of all singleton term non-diabetic nulliparous women who were referred for prenatal care within 12 weeks, at Shahid Sadoughi Hospital, Yazd, Iran, from 2018 to 2019 were collected and BMI was calculated as weight in kilograms divided by the square of height in meters. Multiple pregnants, pregnant women with chronic hypertension and chrpnic systemic disease were excluded. Birth weight was measured using a digital weight scale within 15 minutes and then categorized into three groups: low birth weight (< 2500 gr), normal birth weight (2500 to 4000 gr) and macrosomia (> 4000 gr) babies.

Gestational age was calculated from the first day in the last menstrual period or estimated from measurements of a dating ultrasound scan that was performed before the 20th week. We collected data on maternal age, drug abuse and smoking habit. Exclusion criteria were gestational diabetes, medical disorders (such as diabetes mellitus, chronic hypertension, cardiac or endocrine disorders) and surgical conditions during pregnancy. The women were categorized into five subgroups according to their BMI as follows:

- Underweight: BMI = 19.9 kg/m2
- Normal: BMI of 20-24.9 kg/m2
- Overweight: BMI of 25-29.9 kg/m2
- Obese: BMI of 30 -34.9 kg/m2

All data were analyzed by SPSS 20. The appropriate sample size to answer the research question of this study is 3000 given a confidence interval of 95 % and 80% power. Pearson Chi-square test was used to test the differences between the five categorized BMI groups. We used the McNemar test to find out whether the groups were independent. A p-level < 0.05 was considered to be significant.

RESULTS

In this study, 3154 mothers aged 29.5 ± 2.1 years old with singleton pregnancies and available pre-pregnancy BMI were evaluated. Eighty-one (2.6%) women were underweight, 1615 (51.2%) were normal weight, 1218 (38.6%) were overweight and 240 (7.6%) were obese. The maternal and neonatal characteristics for the aforementioned BMI groups are shown in Table 1.

Table 1: The maternal and neonatal characteristics based on maternal pre-pregnancy BMI

BMI	<18.5	18.5–24.9	25–29.9	>30	P-value
Maternal age in year: (mean ± SD)	28.2 ± 6.4	30.2 ± 5.5	29.1 ± 4.8	31.2 ± 6.6	0.1
Gestational age in week (mean ± SD)	38.5 ± 1.1	38.9 ± 1.3	38.7 ± 0.9	39.1 ± 1.2	0.1
Mother employment					
Yes [N (%)]	50 (61.7)	979 (60.6)	511 (42)	99 (41.3)	0.09
No [N (%)]	31 (38.3)	636 (39.4)	707 (58)	141 (58.7)	
Neonatal sex					
Girl [N (%)]	37 (45.7)	730 (45.2)	672 (55.2)	130 (54.2)	0.1
Boy [N (%)]	44 (54.3)	885 (54.8)	546 (44.8)	110 (45.8)	
Pregnancy weight gain in kg (mean ± SD)	5.5 ± 1.3	8.2 ± 1.4	7.1 ± 1.4	7.5 ± 1.9	0.2

Table 2: Comparison of neonatal weight within 15 minutes of birth on various maternal pre-pregnancy BMI groups

	BMI [kg/m^2]				
Neonatal weight	<18.5	18.5-24.9	24.9-29.9	> 29.9	P-value
Low birth weight (<2500 gr)	171 (31.5%)	310 (57.3%)	36 (6.6%)	25 (4.6%)	0.07
Normal weight (2500-4000 gr)	445 (19%)	756 (32.4%)	553 (23.6%)	585 (25%)	0.2
Macrosomia (>4000gr)	10 (3.7%)	96 (35.1%)	77 (28.2%)	90 (33%)	0.02

The statistical analyses of these data indicated that there is no significant difference among various BMI groups, in terms of the average age of mothers, gestational age, pregnancy weight gain, mother employment status and neonatal sex.

Based on collected data, 542 (17.2%) and 273(8.7%) neonates were low birth weight (< 2500gr) and macrosomia (> 4000 gr), respectively. The neonatal weight within 15 minutes of birth versus maternal pre-pregnancy BMI is presented in Table 2.

The groups of overweight and obese pregnant women show the highest number of infants weighing more than 4 kg, which was a significant difference compared to the other two groups ($P = 0.01$). Compare to the three other groups, there were more LBW infants in the group of underweight pregnant women, however, the difference was not statistically significant ($P = 0.1$).

The figures in the table show the number (percentage) of newborns in each group.

DISCUSSION

The present study has evaluated the effect of maternal pre-pregnancy BMI on infants birth weight. The study evaluated 3154 mothers with singleton pregnancies and available pre-pregnancy BMI. Out of 3154 mothers, 48.7%, 2.6 %, 38.6 % and 7.6 % were categorized as abnormal, underweight, overweight and obsess, respectively. The results of this study reveal the birth weight of a baby is significantly influenced by the mother's BMI; so that the maximum number of low birth weights was in the underweight group and the maximum number of macrosomia was in the overweight and obsess groups.

Several studies have been conducted, the results of which are similar to our study and have shown that mothers' pre-pregnancy BMI can have an effective role on the birth weight of the babies [2, 3, 8]. Similar to our study, Jan The mother's BMI and socio-economic factors influenced birth weight [9] with a direct relevance existed between maternal BMI and neonatal birth weight [2].

Also, a number of studies showed a relevance between maternal weight and adverse pregnancy and neonatal outcomes [5, 6, 9, 10] An increased risk of preterm births in obese women recommended to reduce prepregnancy body mass index" [11]. Overweight or obese was associated with an increased risk of macrosomia and admission to the neonatal intensive care unit, while underweight was associated with an increased risk of preterm birth, small for gestational age and LBW [12].

A data meta-analysis study showed that the higher maternal pre-pregnancy BMI and gestational weight gain were associated with an increased risk of childhood overweight/obesity with the strongest effects at later ages [13].

The limitation of this study was the self-reporting pre-pregnancy weight of pregnant women which may not always be accurate. An overall correlation coefficient of 0.99 was recorded between self-reported and measured pre-pregnancy weight and had concluded that self-reported weight would reflect the actual weight [14].

CONCLUSION

In conclusion, the results of this study showed that maternal pre-pregnancy overweight and obesity can increase the risk of macrosomia and newborn infants. On the other hand, the mother's underweight can also cause the low birth weight babies.

Our study examined the pre-pregnancy body mass index of the mother with the birth weight of her infant, while the studies conducted also considered the weight of the mother during pregnancy [3, 8].

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