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The Impact of Body Mass Index on Pregnancy Outcome

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ABSTRACT

Background & aim: Pre-pregnancy obesity is considered as a significant predictor for neonatal and maternal morbidity and mortality. Several studies have indicated conflicting associations between body mass index (BMI) and pregnancy outcomes. This study aimed to evaluate the effects of pre-pregnancy BMI on adverse pregnancy outcomes.

Methods: This cohort study was conducted from 2010 to 2013 in Qazvin province, Iran. BMI was measured in a total of 1376 pregnant women before their 12th week of pregnancy. The subjects were followed-up until the termination of their pregnancy and childbirth. Data collection was performed through checklists prepared by the researchers, which consisted of three parts: demographic features, obstetric history, and subsequent pregnancy outcome. For data analysis, Chi-square, ANOVA and Mann-Whitney tests were performed, using SPSS version 16. In addition, adjusted odds ratio (OR) and 95% confidence interval (CI) were measured.

Results: The risk of preeclampsia (OR: 5.36, CI: 2.505-11.49), gestational diabetes mellitus (OR: 5.092, CI: 1.67-15.46), cesarean section (OR: 1.959, CI: 1.37-2.79), and large for gestational age (OR: 4.735, CI: 1.402-15.98) was higher in overweight (25≤BMI≤29.9 kg/m^2) and obese groups (BMI>30 kg/m^2), compared to women with below-normal and average weight.

Conclusion: Pre-pregnancy obesity is strongly associated with certain pregnancy complications and perinatal conditions. Therefore, these complications implicate the need for pre-pregnancy counseling and weight loss in this group of women.

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Introduction

Nowadays, obesity is considered an individual and public health issue, given its contribution to the development of several chronic diseases. The prevalence of obesity in the general population is increasing dramatically (1). In a review, Rashidi et al. (2005) estimated the rate of obesity to be between 22-40% in Iran (2).

Due to the rising prevalence of obesity within the past few decades, the rate of obesity during pregnancy has also increased. According to a 20-year cohort study, the prevalence of obesity during pregnancy increased from 15% in 1980 to 35% in 2000 (3, 4).

Maternal overweight and obesity are widely associated with adverse pregnancy outcomes, such as gestational hypertension, preeclampsia, gestational diabetes mellitus (GDM), repeated cesarean section, and birth of large-for-gestational-age (LGA) and stillbirths (4–9).

According to a number of studies, pregnancies in morbidly obese women definitely result in complications and adverse outcomes (10–12); however, the limited number of patients lowers their statistical power.

Overweight, obesity and underweight are defined differently in various reports. Earlier studies have extensively explored the relationship between maternal height, maternal weight and pregnancy complications, while Body Mass Index (BMI) is widely accepted as a better

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measurement of maternal overweight or underweight in more recent reports (13-16).

According to the guidelines of American Gynecological & Obstetrical Society on the clinical status of pregnant women, it is recommended that BMI be calculated in all these women during their first prenatal visit (5, 6).

In general, obese people are at a higher risk of wound infections, endometritis, and giving birth to children with congenital anomalies, macrosomia and morbidity due to childhood obesity (8, 9).

Several studies have been conducted on maternal BMI, weight gain during pregnancy, and pregnancy complications. For instance, a study by Liu in China (2009) claimed that pregnant women with high BMI were at an increased risk of preeclampsia, GDM, premature rupture of membranes (PROM), placental abruption and stillbirths (10).

On the other hand, Sheiner's study in the United States was indicative of no correlations between maternal obesity and cesarean delivery (11). In 2006, Yang Zhong et al. conducted a study in the U.S to evaluate the association between premature birth and PROM. According to their findings, high BMI in pregnant women was highly associated with increased PROM (12).

Another study by Laurent et al. in the U.S (2010) indicated that below-average BMI was associated with an increased risk of preterm births.

The current study aimed to determine the association between BMI, obstetric findings and perinatal outcomes.

Materials and Methods

This cohort study was conducted from 2010 to 2013 in Qazvin province, Iran. The subjects were selected by multiple cluster sampling from five health care centers in different regions of Qazvin, Abyek, BuinZahra, Alborz and Takestan.

All the pregnant women referring to these centers, who met the inclusion criteria, were enrolled in this study. The inclusion criteria were as follows: 1) willingness to participate in the study; 2) age range of 18-35 years and gestational age of less than 12 weeks.

The exclusion criteria were as follows: 1) medical conditions influencing pregnancy outcome, such as hypertension, diabetes mellitus and renal diseases; 2) migration from the selected region of study; and 3) lack of referral for prenatal care.

Out of 1600 eligible subjects, 224 women were excluded due to systematic disorders, incomplete care, and migration. Finally, 1376 pregnant women were enrolled in the study. Data collection was performed through checklists including three parts of demographic features, obstetric history, and pregnancy outcome' and all the participants were followed-up until the termination of their pregnancy.

Maternal height and maternal weight were measured during the first prenatal visit, and the BMI of the subjects was calculated. Afterwards, the women were classified into the following five groups based on their BMI: 1) Underweight: BMI≤19.9 kg/m^2; 2) Normal weight: 20≤BMI≤24.9 kg/m^2; 3) Overweight: 25≤BMI≤29.9 kg/m^2; 4) Obese: 30≤BMI≤34.9 kg/m^2; and 5) morbidly obese: BMI≥35 kg/m^2 (16). The group with the normal range of BMI (20≤BMI≤24.9 kg/m^2) was selected as the reference group.

Obstetric outcomes included the following: 1) preeclampsia; 2) gestational hypertension and antepartum haemorrhage due to placenta previa or abruptio placenta; 3) type of labor (spontaneous versus induced); 4) mode of delivery (spontaneous vaginal, instrumental vaginal or Caesarean section); and 5) preterm delivery (between 34-37 weeks).

Perinatal outcomes included the rate of stillbirths and birth weight, and the total number of Caesarean sections and emergency C-sections were calculated by subtracting the second number from the first one. In addition, gestational age (GA) was recorded according to the last menstrual period of the subjects using the database, and was confirmed by ultrasound.

This study was approved by the Ethics Committee of Qazvin University of Medical Sciences, and permission was obtained from the authorities. The subjects were given participant information sheets, and written informed consents were obtained from all the respondents prior to the study. The collected data remained confidential and additional charges were imposed on the participants.

Statistical analysis of the data was conducted by SPSS version 16. For continuous variables, univariate analysis was performed using ANOVA or Mann-Whitney test, and Chi-square test was

used for categorical variables. A P-value of less than 0.05 was regarded as statistically significant, and potential confounders were controlled for logistic regression. The risk of obstetric complications was presented as crude and adjusted odds ratio (OR) with 95% confidence intervals (CI) was measured.

Results

In this study, the mean age of the subjects was 25.6 years (±5.58), with a range of 18-35 years. With regard to the subjects' educational status, 58.8% had high school education, 34.3% were high school graduates, and 6.9% had a university degree. In addition, 72.8% of the subjects were nulliparous while 27.2% were multiparous. Furthermore, 6.3% (N=87) of the studied subjects were underweight, 49.4% (N=696) had normal BMI, 30.7% (N=422) were overweight, and 13.6% (N=165) were obese.

Table 1. Demographic characteristics and maternal BMI during early pregnancy

BMI	<18.5kg/m² n=87	18.5-24.9 kg/m2 n=696	29.9Kg/m²-25 n=422	≥30 n=165	P-value
Age	22.77±4.47	24.59±5.25	26.88±5.80	28.45±5.06	>0.006
Education					
Under diploma	56.3(49%)	397(57.2%)	251(59.9%)	106(64.2%)	
Diploma	31(35.6%)	248(35.5%)	146(34.4%)	47(28.5%)	>0.12
University	7(8%)	51(7.3%)	25(5.9%)	12(7.3%)	
Parity					
G1*	75(86.2%)	525(75.1%)	303(71.1%)	100(60.6%)	>0.00
MG**	12(13.8%)	174(24.9%)	123(28.9%)	65(39.4%)	

The comparison of the socio-demographic characteristics of studied women in the five BMI groups is presented in Table 1. The subjects in the underweight group were significantly younger (mean age: 22.7, SD: 4.4) in comparison to the morbidly obese group (mean age: 28.4, SD: 5.6), who were significantly older than women with normal BMI (mean age: 24.5, SD: 5.2). In addition, a significant correlation was found between parity and pre-pregnancy BMI.

The incidence of pregnancy, labor and delivery complications of the women in the four BMI groups is depicted in Table 2.

Table 2. Complications of pregnancy and their relationship with BMI during early pregnancy (adjusted for Demographic variables)

BMI	<18.5 kg/m² n=87	18.5-24.9 kg/m² n=696	25-29.9 kg/m² n=422	≥30 kg/m² n=165	P-value
GDM	1 (1.1%) 0.826 (0.082-8.324)	7 (1%) 1	14 (3.3%) 3.82 (1.44-10.13)	9 (5.5%) 5.092 (1.67-15.46)	<0.001
Preeclampsia	4 (4.6%) 0.477 (0.152-1.492)	15 (2.1%) 1	18 (4.2%) 1.78 (0.852-3.75)	16 (%9/7) 5.36 (2.505-11.49)	0.001
Preterm labor	12 (13.8%) 0.644 (0.319-1.298)	65 (9.3%) 1	44 (10.3%) 1.066 (0.67-1.68)	11 (%6/7) 0.75 (0.359-1.58)	0.75
Macrosomia	1 (1.1%) 0.56 (0.054-5.849)	5 (0.7%) 1	10 (2.3%) 2.283 (0.72-7.23)	8 (4.8%) 4.735 (1.402-15.98)	0.001
Cesarean Section	27 (31%) 1.44 (0.883-2.349)	278 (40.7%) 1	197 (46.2%) 1.35 (1.05-1.73)	94 (%57/3) 1.959 (1.37-2.79)	<0.001

Furthermore, the independent risk of each complication or intervention in the abnormal BMI groups was compared with the reference group, which indicated that the incidence of GDM, preeclampsia, macrosomia and C-section was higher in the overweight and obese women compared to other groups.

The distribution of birth weight and BMI of the four groups are separately depicted in Table 3. According to these findings, a significant difference was observed between the newborn size and pre-pregnancy BMI. Moreover, macrosomia (birth weight>4000g) was observed to be more prevalent among overweight and obese women compared to the reference group, with OR of 1.9 (CI: 95%, 1.6-2.2) and 2.1 (CI: 95%, 1.3-3.2), respectively.

Table 3. Separated distribution of birth weight and BMI

BMI Birth weight	<18.5 kg/m² n=87	18.5-24.9 kg/m² n=696	29.9 -25 kg/m² n=422	≥30 kg/m² n=165
<2.5 kg	3 (3.4%)	34 (4.9%)	41 (9.6%)	6 (3.6%)
2.5-4 kg	83 (93%)	649 (93%)	368 (86.4%)	147 (89.1%)
>4 kg	1 (1.1%)	15 (2.1%)	17 (4%)	12 (7.3%)

Discussion

A growing body of evidence suggests that obesity, measured by BMI, predisposes women to complicated pregnancies and increased obstetric interventions. In the current study, a linear relationship was found between increasing BMI and the risk of preeclampsia, GDM, and caesarean section.

According to the literature, there is a strong association between increasing BMI and pregnancy-induced hypertension. Obesity is another risk factor for preeclampsia (7–11, 13–15), the mechanisms of which are still unknown. Moreover, the risk of preeclampsia rises dramatically with an increase in pre-pregnancy BMI. The risk of preeclampsia doubles in women with a BMI of 21 kg/m², compared to those with a BMI of 26 kg/m² (OR: 2.1). The risk triples in women with a BMI of 30 kg/m² (OR: 2.9) and increases even further in morbidly obese women (OR: 3.5) (13).

Obesity and preeclampsia share many common features. For instance, obesity is associated with oxidative stress (17, 18), as well as circulating inflammation markers. On the other hand, plasma level of C-reactive protein, which is another significant marker of inflammation, is elevated in obese individuals, as are plasma levels of inflammatory cytokines, tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), and interleukin-8 (IL-8) (18, 19). Similarly, preeclampsia is associated with oxidative stress (15) and circulating markers of inflammation (21, 22).

Several studies investigating the relationship between maternal obesity and fetal growth have indicated that obese women have an 18-26% increased risk of delivering LGA infants, even after GDM management (23-25). It is also suggested that rapid fetal growth, induced by maternal hyperinsulinaemia, along with placental insufficiency, may result in antepartum fetal death in obese pregnant women; this hypothesis has been corroborated by several epidemiological studies (10, 11).

In another study, Krishnamoorthy (27) recommended that all pregnancies in obese women be regarded as high-risk and be managed according to strict guidelines. The management of such pregnancies should consist of pre-pregnancy counseling for weight loss and antenatal care for the management of possible complications. Recently, there is mounting evidence confirming obesity as a significant complication of pregnancy. Thus, further research is required to incorporate evidence-based practice.

A meta-analysis on the risk of preeclampsia, associated with maternal BMI (21), indicated that the risk of preeclampsia doubled with each 5-7 kg/m² increase in pre-pregnancy BMI. Furthermore, the risk of preeclampsia during pregnancy doubled in overweight women (25≤BMI≤29.9 kg/m²), while it was 4.5 times higher in obese women (30≤BMI≤39.9 kg/m²).

In another study, Liu estimated the risk of GDM in overweight and obese mothers to be 2.5 (CI: 1.8-3.4) and 6.4 (CI: 3-6.3), respectively (CI: 95%). On the other hand, the incidence of GDM reduced among women with below-average BMI. In our study, the risk of GDM in overweight and obese women was 3.82 (CI: 1.44-10.13) and 5.092 (CI: 1.67-15.46), respectively (CI: 95%). In addition, the incidence of GDM in the normal BMI group significantly reduced to 0.826 (CI: 0.082-8.324) (10).

Similarly, studies by Doherty (2006), Ducarme (2007), Athukorala (2010), and Benedetto (2011) demonstrated that weight gain

and obesity are likely to increase the risk of diabetes, significantly (5, 12, 14, 27).

According to several studies, below-average BMI is also considered a risk factor for preterm labor (1). In 2011, Young claimed that the risk of preterm birth is significantly higher in women with below-average BMI (29). In addition, a meta-analysis conducted in 2011 indicated that women with lower BMI are more likely to have preterm labors (30).

In the current study, the incidence of preterm birth increased to 10.8% among women with lighter weights. However, the difference was not considered statistically significant (P=0.75), and the risk of preterm birth in women with normal body weight was estimated to be 1.4 (CI: 1.0-2.0), (CI≤95%) (12).

According to the study by Ducarme, the risk of preterm birth may increase in obese women and those with below-average BMI, considering the probable occurrence of comorbidities (13). A meta-analysis performed during 1996-2007 indicated that the rate of cesarean section was higher in overweight and obese women. Moreover, the risk of emergency cesarean section was higher than elective cesarean section in these women (31).

In our study, the rate of cesarean section was significantly higher in the overweight and obese groups, compared to the reference group (P=0.000). The relative risk in the overweight and obese groups was estimated to be 1.35 (CI: 1.05-1.73) and 1.96 (CI: 1.37-2.79), respectively (CI: 95%).

According to the literature, the high rate of cesarean section in obese women is associated with frequent pregnancy complications, such as preeclampsia and macrosomia. According to another study (13), in addition to macrosomia, increased soft tissues may lead to the constriction of the pelvic outlet, which has adverse effects on the pelvic floor and abdominal muscles, causing difficulty in fetal positioning (32).

Maternal obesity and subsequent maternal and neonatal complications have a high prevalence in America (5-15). According to a report by Kabaly, the risk of fetal macrosomia noticeably increased with maternal pre-pregnancy overweight and weight gain during pregnancy (33). Another investigation on pregnancy complications conducted in 2010 indicated the development of macrosomia in women with above-average BMI (18).

On the other hand, Liu estimated the risk of macrosomia in overweight and obese women to be 27.1 (CI: 86.1-87.0) and 21.1 (CI: 41.2-61.0), respectively. In the current study, the risk of macrosomia in overweight and obese women was 1.49 (CI: 1.02-2.08) and 1.91 (CI: 1.17-3.10), respectively. Therefore, it could be inferred that increasing BMI during early pregnancy is associated with an increased risk of macrosomia (10); this finding is consistent with the studies by Kabaly and Liu.

In another study, a strong association was found between birth weight and maternal weight gain (34). Similarly, a meta-analysis in 2013 indicated that mothers with below-average BMI were at a higher risk of having low-birth-weight infants. In addition, the risk of macrosomia was significantly higher in overweight and obese mothers (35).

According to the results of the current study, high BMI at the onset of pregnancy could cause the birth weight of the newborns to increase. On the other hand, the rate of low birth weight increased in women with below-average weight, while it decreased in the overweight group. The highest neonatal weight in the overweight and obese groups was ≥4 kg, which was a significant difference in comparison with the other two groups (P=0.001). This difference might be due to the higher age range and the multiparity of overweight and obese subjects in our study.

One of the limitations of the current study was the long-term follow-up of subjects which led to the attrition of some cases. The strength of this study was the inclusion of a large sample size of pregnant women from all the regions of Qazvin province.

Conclusion

According to the results of the present study, the prevalence of overweight and obesity in women at reproductive age is relatively high in Qazvin province. Furthermore, pregnancy complications such as gestational diabetes, preeclampsia, preterm labor, cesarean delivery, and macrosomia might occur frequently with increasing maternal BMI. In addition, below-average weight was found to have a protective

effect against these complications. It is also noteworthy that obese women should not lose weight during pregnancy due to the risk of ketosis. Regarding the increased maternal and neonatal risks in women with above-average BMI prior to pregnancy, appropriate nutrition and weight control should be advised for expecting mothers.

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Conflicts of interest

Authors declared no conflicts of interest.

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