

## **Pregnancy outcome according to body mass index in primigravidas: a prospective cohort study**

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**Keywords:** Obesity, weight gain, primigravida, diabetes, hypertension

### **Abstract**

*Objective:* The study aims to evaluate the association between Body Mass Index (BMI), gestational weight gain (GWG) and adverse obstetric outcomes among primigravidas.

*Material and methods:* This was a prospective cohort study conducted at a tertiary University Hospital between June 2015 and May 2017. The study included 480 primigravidas, with singleton pregnancies, who were divided into three groups: women with a healthy weight (BMI: 18.5–24.9 kg/m<sup>2</sup>) overweight (BMI: 25 – 29.9 kg/m<sup>2</sup>) and obese (BMI ≥ 30 kg/m<sup>2</sup>). The primary outcome of the study was the rate of GWG in the participants. Secondary outcomes included the rate of gestational diabetes mellitus (GDM), gestational hypertension, pre-eclampsia, preterm labor (PTL), postdate pregnancy, fetal macrosomia and the rate of birth by cesarean (CB).

*Results:* There were no significant differences between groups regarding the socio-demographic criteria. The rate of GWG was significantly higher in obese women versus average weight women (11.4±1.73 vs. 10.49±1.09,  $p=0.0001$ ). There was an increased incidence of GDM ( $p=0.008$ ), gestational

hypertension ( $p=0.001$ ), pre-eclampsia ( $p=0.0001$ ), PTL ( $p=0.002$ ), postdate ( $p=0.0001$ ) and macrosomia ( $p=0.0001$ ) in women who were obese compared with women with a healthy weight. Additionally, there was an increased incidence of CB with increasing body mass ( $p=0.0001$ )

*Conclusions:* Higher BMI in primigravidas is associated with increased GWG and with adverse pregnancy outcomes such as GDM, gestational hypertension, pre-eclampsia, PTL, postdate, fetal macrosomia and cesarean birth.

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### **Introduction**

Overweight and obesity are defined as abnormal or excessive percent fat accumulation that may impair health.<sup>1</sup> The WHO and the National Institute of Health define underweight as a body

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mass index (BMI) of  $\leq 18.5$ , normal weight as a BMI of 18.5–24.9, overweight as a BMI of 25–29.9, and obesity as a BMI of  $\geq 30$ . Obesity is further characterized by BMI into class I (30–34.9), class II (35–39.9), and class III ( $>40$ ).<sup>1</sup> The WHO estimates that in 2008 around 1.4 billion adults were overweight. Additionally, they stated that in 2015 nearly 2.3 billion adults were overweight and  $>700$  million were obese.<sup>2</sup>

There is no accepted definition for obesity during pregnancy due to the expected weight gain variability during pregnancy and the short interval of time. Therefore, it is strongly recommended that pregnant women have their BMI calculated at the first antenatal visit, which is usually in the first trimester, with recommendations then made for healthy gestational weight gain. Some studies use other measures to define obesity including weight at delivery and the waist to hip ratio.<sup>3</sup>

Maternal obesity is known to be associated with maternal complications including gestational diabetes mellitus (GDM), gestational hypertension and preeclampsia<sup>4-6</sup> Large-for-gestational-age infants and cesarean delivery (CB) are also more common in women who are overweight or obese.<sup>7</sup>

The purpose of the current study was to evaluate the association between BMI, gestational weight gain (GWG) and obstetric outcomes in primigravid women delivering singleton babies.

## **Materials and methods**

This study was a prospective cohort study conducted at Aswan University

Hospital, Egypt, between June 2015 and May 2017. The Institutional Ethical Review Board approved the study protocol (IRB009898). We included all singleton pregnancies greater than 20 weeks in gestational age (GA) from the Outpatient Antenatal Care Clinic.

We excluded women with a risk of preterm delivery (before 37 weeks of gestation), those with medical disorders during pregnancy (hypertension, diabetes, cardiac disease), those with a history of infertility treatment (no pregnancy for more than one year), women who received medications, and those who are participating in dietary control and exercises prior to and during pregnancy to control their body weight.

We obtained a written informed consent from all women before participation after discussing the nature of the study. First, the participating women were enrolled in the screening phase of the study. This phase included a history (personal, menstrual and obstetric) taking, including parity and gestational age. Gestational age was calculated based on a reliable first day of the last menstrual period or if unknown dating based on a first trimester ultrasound (US). We measured the weight and height of each woman and calculated the BMI in the clinic by a nurse. Additionally, a fasting blood glucose was done at inclusion to exclude Diabetes Mellitus (DM) and blood pressure measurement to exclude the presence of essential hypertension.

The eligible women were allocated to either Group I (healthy weight), Group II (over weight), and Group III (obese) according to BMI. All of the women were monitored throughout their routine

antenatal pathway until birth for assessment of any antenatal adverse outcomes. Birthing was encouraged to be within the institution birthing unit to enable final evaluation of the study outcomes as some women in our locality could give birth at home due to transfer difficulties or illiteracy.

The primary outcome of the study was the rate of GWG in the three groups. Secondary outcomes included the rate of GDM, gestational hypertension, preeclampsia, preterm labor (PTL <37 weeks of gestation), premature rupture of membranes (PROM), postdate pregnancy (pregnancy > 40 weeks gestation), fetal macrosomia (>4.5 kg),

excessive maternal weight gain (>11.5 kg), and the rate of birth by cesarean.

Data were entered and statistically analyzed using the Statistical Package for Social Sciences (SPSS) version 22. Qualitative data were described as numbers and percentages. Chi-Square test was used for comparison between groups. Quantitative data were described as mean (SD) after testing for normality by Kolmogorov-Smirnov test. One-way ANOVA test was used for comparison between groups. Student's T-test was used to compare between each 2 groups. P-value ≤0.05 was considered to be statistically significant.

**Table 1: Characteristics of the study participants at the first antenatal visit.**

Variables #	Average weight (n = 180)	Overweight (n = 180)	Obese (n = 120)	p-value
Age (year)	25.24 ± 2.2	25.24 ± 2.6	25.78 ± 2.8	0.119
Height (cm)	163.82 ± 2.58	163.94 ± 2.8	163.49 ± 2.3	0.327
Weight (kg)	60.76 ± 2.23	74.12 ± 2.56	89.0 ± 3.18	<b>0.0001*</b>
BMI (kg/m <sup>2</sup> )	22.65 ± 1.1	27.57 ± 1.02	33.28 ± 0.82	<b>0.0001*</b>
Gestational age at inclusion (weeks)	22.55 ± 1.2	22.87 ± 1.6	23.05 ± 1.3	0.245
SBP	108.58 ± 9.16	108.25 ± 5.08	108.62 ± 1.01	0.901
DBP	67.25 ± 6.44	66.58 ± 7.76	67.08 ± 6.4	0.645
FBG	76.98 ± 7	77.09 ± 4.39	77.43 ± 4.68	0.779

*BMI, Body Mass Index; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; FBG, Fasting Blood Glucose.*

*# All Variables are presented as mean ± standard deviation.*

*\* Statistical Significant Difference between all groups tested by ANOVA test.*

**Results**

Our study approached 700 eligible pregnant women to participate; 220 (31.4%) were excluded as they did not meet our inclusion criteria or did not complete antenatal care at the hospital. The remaining 480 women were divided

into three groups according to their BMI. Group I included 180 (37.5%) women with a healthy weight (22.65±1.1), group II included 180 (37.5%) women who were overweight (27.57±1.02), and group III included 120 (25%) obese women (33.28±0.82). Their

sociodemographic and baseline characteristics are shown in Table 1. Maternal age, gestational age at inclusion, systolic blood pressure, diastolic blood pressure and fasting blood sugar at first visit in our obstetric clinic showed no significant differences. No cases of passive smoking in all groups.

Gestational weight gain showed a

statistically significant difference between women with a healthy weight and those who were overweight and obese (p= 0.0001). There were increased incidence of GDM (p=0.008), gestational hypertension (p=0.001), PTL (p=0.0001), PROM (p=0.002), postdate (p=0.0001) and fetal macrosomia (p=0.0001) in women who were obese compared with women with a healthy weight.

**Table 2: Adverse perinatal outcomes by body mass index groups**

Outcomes #	Average weight (n = 180)	Overweight (n = 180)	Obese (n = 120)	p-value
GDM	5 (2.8)	9 (5)	12 (10)	<b>0.024*</b> 0.276 / <b>0.008***</b> / 0.96
Gestational hypertension	5 (2.8)	12 (6.7)	15 (12.5)	<b>0.004*</b> 0.082 / <b>0.001***</b> / 0.84
Pre-eclampsia	1 (0.6)	8 (4.4)	11 (9.2)	<b>0.001*</b> <b>0.037**</b> / <b>0.0001***</b> / 0.1
PTL	4 (2.2)	12 (6.7)	13 (10.8)	<b>0.008*</b> <b>0.041**</b> / <b>0.002***</b> / 0.201
PROM	3 (1.7)	9 (5)	14 (11.7)	<b>0.001*</b> 0.078 / <b>0.0001***</b> / 0.033****
Postdate	4 (2.2)	17 (9.4)	18 (15)	<b>0.001*</b> <b>0.003**</b> / <b>0.0001***</b> / 0.142
Macrosomia	1 (0.6)	9 (5)	14 (11.7)	<b>0.0001*</b> <b>0.01**</b> / <b>0.0001***</b> / <b>0.033****</b>

GDM, Gestational diabetes mellitus; PTL, Preterm Labor; PROM, Premature Rupture of Membranes.  
# All Variables are presented as number (percentage).

\*Statistical significant difference between all groups tested by ANOVA test.

\*\*Statistical significant difference between average weight and overweight group tested by Student's T-test.

\*\*\*Statistical significant difference between average weight and obese group tested by Student's T-test.

\*\*\*\*Statistical significant difference between overweight and obese group tested by Student's T-test

There were increased incidence of preeclampsia (p=0.037), PTL (p=0.04), postdate (p=0.003) and macrosomia (p=0.01) in overweight women than average weight women. However, no significant difference in GDM, gestational hypertension and postdate (p=0.276, p=0.082, and p=0.078

respectively).

The incidence of PROM and macrosomia were increased in obese women compared with overweight women (p=0.033). However no significant difference in GDM (p=0.96), gestational hypertension (p=0.84),

preeclampsia (p=0.1), PTL (p=0.201) and postdate (p=0.142) (Table 2) between overweight and obese women was shown in analysis.

incidence of birth by cesarean with increasing BMI (15.6 %) in women with healthy weight, (31.1%) in women who were overweight and (58.3%) obese (p=0.0001) (Table 3).

Finally, there was an increased

**Table 3: Gestational weight gain, excessive weight gain and Mode of birth in the three groups.**

Outcomes #	Average weight (n = 180)	Overweight (n = 180)	Obese (n = 120)	p-value
<b>Gestation Weight gain</b>	10.49 ± 1.09	10.86 ± 1.36	11.4 ± 1.73	<b>0.0001*</b> <b>0.0001** / 0.0001*** / 0.0001****</b>
<b>Excessive GWG outside the IOM recommendations</b>	18 (10)	47 (26)	49 (40)	<b>0.0001*</b> <b>0.0001** / 0.0001*** / 0.007****</b>
<b>Mode of Birth</b>				
- CB	28 (15.6)	56 (31.1)	70 (58.3)	<b>0.0001*</b> <b>0.0001** / 0.0001*** / 0.0001****</b>
- VD	152 (84.4)	124 (68.9)	50 (41.7)	

CB, Cesarean Delivery; VD, Vaginal Delivery.

# All Variables are presented either mean and standard deviation or number (percentage).

\*Statistical significant difference between all groups tested by ANOVA test.

\*\*Statistical significant difference between average weight and overweight group tested by Student's T-test.

\*\*\*Statistical significant difference between average weight and obese group tested by Student's T-test.

\*\*\*\*Statistical significant difference between overweight and obese group tested by Student's T-test

## Discussion

The study found a significant association between increasing maternal BMI and the risk of developing GDM, preeclampsia, gestational hypertension, PTL, PROM, postdate, fetal macrosomia and birth by cesarean. This is consistent with other research though we present a unique focus on Egyptian mothers.

Several observational studies demonstrated an association between maternal obesity and gestational

hypertension, with a reported 2.5-3.2-fold increased risk.<sup>7,8</sup> A link has also been drawn between maternal obesity and preeclampsia.<sup>9</sup> One systematic review found the risk of preeclampsia doubled with each increase of 5 to 7 kg/m<sup>2</sup> in BMI.<sup>10</sup> In another prospective cohort study, increases in BMI between the first and second pregnancies were found to also increase pre-eclampsia risk.<sup>11</sup> Our results are keeping in the same track with all previous studies; however, it is the first one among Egyptian mothers. The incidence of gestational hypertension and pre-

eclampsia was significantly higher among women who are obese than women with a healthy weight (12.5% vs 2.8% and 9.2% vs 0.6% respectively)

In our study, the incidence of GDM has been shown to be higher in obese and overweight women, with a rate of 10% and 5% respectively compared with 2.8% in average weight women. Previous studies have shown an association between maternal obesity and an increased risk of GDM.<sup>7,8</sup> A meta-analysis found that the overall risk for GDM in obese patients was 3.76 times higher than in non-obese patients (OR=3.31–4.28), with the prevalence of GDM increasing by 0.82% for every increase of 1 kg/m<sup>2</sup> in BMI.<sup>12</sup>

Maternal obesity predisposes to insulin resistance, many women who are obese will have undiagnosed preexisting type 2 diabetes mellitus before pregnancy.<sup>13</sup> Several studies have described the detrimental effect of increasing maternal obesity on perinatal outcomes in women with diabetes. Sugiyama et al., 2014, evaluated women in Japan with gestational diabetes finding increased rates of adverse pregnancy outcomes with increasing BMI.<sup>14</sup> Similarly, Marshall et al., 2014, in the United States demonstrated that increasing BMI among diabetic gravidas increased rates of preeclampsia, macrosomia, and cesarean section.<sup>15</sup>

In our study, the incidence of PTL has been shown to be higher in obese and overweight women, with a rate of 13% and 12% respectively compared with 4% in average weight women. Overall, the literature is conflicting regarding the association between preterm delivery and obesity. Although some studies

support an increased risk<sup>4</sup> others do not<sup>16</sup> particularly when controlling for confounding co-morbidities including hypertensive disorders, DM and smoking.<sup>17,18</sup>

In our study, the incidence of postdate has been shown to be higher in obese and overweight women, with a rate of 15% and 9.4% respectively compared with 2.2% in average weight women. Obesity has been associated with prolonged and post term pregnancy, with several studies demonstrating an increased risk of prolonged pregnancy beyond 41 weeks' gestation as well as post term pregnancy at or beyond 42 weeks' gestation among obese women.<sup>16,19</sup>

Fetal macrosomia was higher in obese and overweight women, with a rate of 11.7% and 5% respectively compared with 0.6% in average weight women. Obesity is a well-established risk factor for fetal macrosomia with a 2-3 fold increased risk.<sup>7,16</sup> Morbid obesity and increasing BMI have been shown to be associated with higher rates of macrosomia.<sup>9,16</sup>

In our study CB has been shown to be higher in obese and overweight women, with a rate of 58.3% and 31.1% respectively compared with 15.6% in average weight women. This is in agreement with studies that have been shown an increased risk of CB among obese women.<sup>4,8</sup>

The current study had some limitations. The ideal time to record the baseline height and weight of a pregnant woman is prior to pregnancy or in the very early antenatal period. In Egypt this is seldom a routine practice. Systems in the



hospital are not structured to provide adequate booking data. A strength is that we measured height and weight in early pregnancy before any real impact of GWG.

In conclusion, increased maternal BMI in primigravidas is associated with increased GWG and adverse pregnancy outcomes.

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