**SHORT COMMUNICATION**

# Prepregnancy Body Mass Index and Gestational Weight Gain and Their Association with Some Pregnancy Outcomes

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## Abstract

**Background:** Weight gain during pregnancy for women with normal Body Mass Index (BMI) before pregnancy has been reported to be 11.5–16.0 Kg/m2 by IOM and supported by several authors. This study was carried out to determine the relationship between pre-pregnancy BMI and gestational weight gain and pregnancy outcome.

**Methods:** In 476 pregnant women, BMI was categorized and weight gain was divided into less than normal and higher than normal groups based on Institute of Medicine (IOM) recommendations.

**Results:** Women with normal weight gain had better pregnancy outcomes. The incidence of low birth weight was higher among underweight women and those with low gestational weight gain. Overweight women and those with high gestational weight gain had a higher rate of cesarean delivery and postpartum hemorrhage. There was also a significant difference between the BMI early postpartum hemorrhage, method of delivery, neonatal weight, nausea, vomiting and weight gain during pregnancy. Women gained weight according to recommendations had good pregnancy outcome in relation to weight, lengths and head chest circumferences of the neonate and methods of delivery and post partum hemorrhage.

**Conclusion:** The findings presented here indicate that prenatal care providers should consider women with abnormal prepregnancy BMI and gestational weight gain at an increased risk unconditionally and that they need special care to avoid the pregnancy-associated complications forthwith.

**Keywords:** Pregnancy; Body mass index; Weight gain; BMI

## Introduction

Optimal nutrition and weight gain in pregnancy are important for securing, protecting and promoting the health of women and newborns .This is because of their relation to optimal perinatal outcome, a better health status later in life, normal adult weight and no obesity. Weight gain during pregnancy for women with normal BMI before pregnancy has been reported to be 11.5–16.0 Kg/m2 by IOM (Table 1) and supported by several authors.[1-8] In 1990, a strong association was reported between pregnancy weight gain and infant size which provided target ranges of recommended weight gains by pre-pregnancy BMI. Ten years after the IOM's report, a large body of literature addressed not only the birth weight but also other outcomes correlated to labor, delivery and maternal postpartum weight status.[9]

Obesity and high weight gain in pregnancy were correlated with many complications (e.g. hypertension, diabetes, preeclampsia, multifetal pregnancy, macrosomia, caesarean section, malpresentation, obstetric bleeding, postpartum thrombophelebitis, urinary tract infection, dysfunctional labor, shoulder dystocia and fetal asphyxia at birth).[2,10]

Complications related to underweight mothers were reported to be anemia, premature rupture of membranes (PROM), low agar score, low birth weight (LBW), preterm delivery and increase of perinatal mortality.[10]

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**Table 1:** Recommended ranges of total weight gain for pregnant women by prepregnancy Body Mass Index (BMI) for Singleton Gestation Adapted from the Institute of Medicine , 1990; as appearing in Cunningham F. Gary: Williams Obstetrics, 22nd edition: 2005; 213-214.

| Weight for height category | | Recommendation | |
|---|---|---|---|
| | BMI ($Kg/m^2$) | Weight Gain (kg) | (lb) |
| Low | <19-8 | 12.5-18 | 28-40 |
| Normal | 19.8-26 | 11.5-16 | 25-35 |
| High | 26-29 | 7-11.5 | 15.25 |
| Obese | >29 | 7 | 15 |

This study was performed in order to determine the correlation between maternal body mass index and gestational weight gain with maternal and fetal complications in patients receiving prenatal care and admitted for delivery at Beheshti, Hafez and Zeinabieh hospitals affiliated to Shiraz University of Medical Sciences in Shiraz, Southern Iran.

## Materials and Methods

In a descriptive cross-sectional study, all pregnant women with 18-40 years of age and gravidity of 1 to 5 without any history of systemic disorder influencing pregnancy outcome such as hypertension, diabetes mellitus or substance abuse referring to Hafez, Beheshti and Zeinabieh hospitals affiliated to Shiraz University of Medical Sciences were enrolled. In the initial examination in the first 3 months of gestation, information was collected on maternal age and demographic status, parity, pre-pregnancy weight, gestational weight gain, maternal height, pre-pregnancy BMI, past history of premature delivery, birth weight, length, head, chest, and mid upper arm circumferences, and both first and fifth minute Apgar scores were recorded for the neonate.

The method of delivery and gestational age were also recorded. The relationship between BMI and weight gain during pregnancy outside and within ranges based on IOM recommendation with pregnancy outcome was then determined. Before delivery, all the patients were examined, considering the initial maternal weight by subtracting initial maternal weight from new categorized regarding IOM recommendation (Table 1).

The SPSS software program was used for statistical analysis and $P<0.05$ was considered as statistically significant. The T Test and one way ANOVA were used to compare the means and the association between the two qualitative variables was assessed by Chi-Square test. This study was approved and supervised by the Ethics Committee of Shiraz University of Medical Sciences.

## Results

A total of 485 women participated in this study. Their mean age was 24.8 years (±5.1), with a range of 18 to 40 years old. Out of these cases, 1.8% had no education, 28.5% secondary school education, 28.9% had high school education, 32.4% had received a high school diploma, and 8.4% had university education. The mean pre-pregnancy weight and BMI, weight gain and gestational age at delivery were 57.3±10.1 kg, 23.4±3.9 $Kg/m^2$, 11.5±4 kg, and 275.5±11.4 days, respectively. The mean neonatal birth weight, length, head, chest and mid upper arm circumferences were 3,127.8 g, 49.1 cm, 34.05 cm, 32.2 cm, and 10.2 cm, respectively while the mean birth interval was 2.7 years. 45.4% of these cases were multiparous and 54.6% nulliparous. In the overweight group, parity was higher than that in the other groups ($P=0.001$) and pregnancy weight gain was inversely related to prepregnancy BMI ($P=0.002$).

There was also a significant relationship between the method of delivery and BMI ($P=0.009$). The induction of labor and caesarean delivery in the overweight women were higher than those in the other groups and the most common cause of caesarean section was cephalopelvic disproportion (CPD).

Neonatal birth weight, length, chest, head and mid upper arm circumferences had a significant relationship with prepregnancy BMI (Table 2). There was no correlation between BMI and gestational age but the rate of preterm delivery was higher in overweight women. There was a relationship between weight gain and BMI ($P=0.002$) and method of delivery ($P=0.001$). There was no association between caesarian section or induction of labor and weight gain, but the rate of malpresentation, cephalopelvic disproportion (CPD), and induction of labor was higher in women with more than 16 Kg gestational weight gain.

There was a significant difference between weight gain in BMI of less than 19.8 Kg/m2 according to IOM recommendation and birth weight, length, head, chest and mid upper arm circumferences (Table 3). A significant difference existed between

newborn size and gestational weight gain in BMI of 19.8-26 kg/m$^2$ according to IOM recommendation (Table 4). We also found this correlation in BMI (26.1-29 kg/m$^2$) and weight gain within and outside the IOM recommended ranges (Table 5), but we didn't find this correlation in the obese women with BMI more than 29 kg/m$^2$.

A comparison between the mean gestational age and weight gain during pregnancy base on IOM recommendation showed no significant difference. On the other hand, the minimum gestational age (230 days) was seen in the BMI of less than 19.8 kg/m$^2$ with a low gestational weight gain (<12.5 kg). Likewise, in the normal weight group (BMI of 19.8-29 kg/m$^2$), the minimum gestational age of 239 days was seen in the group with low weight gain (<11.6 Kg),

**Table 2:** Comparative mean between prepregnancy BMI and neonatal index

| Neonatal Index Prepregnancy BMI (Kg/m$^2$) | Birth weight (g) Mean±SD | Height (cm) Mean±SD | Head circumference (cm) Mean±SD | Chest circumference (cm) Mean±SD | Upper arm circumference (cm) Mean±SD | First minute apar score Mean±SD | Fifth minute apgar score Mean±SD |
|---|---|---|---|---|---|---|---|
| <19.8 No=118 | 3000.8±459.8 | 48.8±1.8 | 33.7±1.5 | 31.8±1.7 | 10.1±0.7 | 8.4±1.6 | 9.8± 0.7 |
| 19.8-26 No=270 | 3155.2±445.6 | 49.1± 1.9 | 34.1±1.4 | 32..2±1.7 | 10.3±0.9 | 8.5±0.8 | 9.9± 0.8 |
| 26.1-29 No=63 | 3135.2±84.8 | 49.1±2.1 | 34.2±1.5 | 32.5±1.4 | 10.2±0.8 | 8.4± 0.1 | 9.9± 0..5 |
| >29 No=25 | 3412.4±576.3 | 50.3± 2.1 | 35.2±1.5 | 33.7±1.7 | 10.6±0.8 | 8.4±0.8 | 9.9± 0.3 |
| F P (=) | 6.46 0.003 | 4.19 0.006 | 8.07 0.001 | 9.66 0.001 | 5.5±0.001 | 0.52 0.668 | 0.56 0.641 |

**Table 3:** Comparative mean between neonatal health parameters and weight gain in BMI less than 19.8 kg/m$^2$

| Neonatal Indices Wt. gain (kg) | Weight (gm) Mean±SD | Length (cm) Mean±SD | Head circumference (cm) Mean±SD | Chest circumference (cm) Mean±SD | Arm circumference (cm) Mean±SD | First minute Apgar Mean±SD | Fifth minute Apgar Mean±SD |
|---|---|---|---|---|---|---|---|
| Low <12.5 (No=64) | 2842.3±424.9 | 48.4±1.8 | 33.2±1.4 | 31.3±1.6 | 10±0.8 | 8.6± 0.8 | 9.9 0.4 |
| Optimal 12.5-18 (No=46) | 3194.5±305.8 | 49.3±1.6 | 34.3±1.6 | 32.4±1.7 | 10.30.6 | 8.3±1.1 | 9.70.8 |
| Excess >18 (No=8) | 3155.7±631.8 | 50.1± 1.7 | 338±1.5 | 32.5± 1.1 | 10.3 0.6 | 7.6± 1.9 | 9.30.6 |
| P-value | 0.001 | 0.003 | 0.002 | 0.001 | 0. 002 | 0.05 | 0.2 |

**Table 4:** Comparative mean between neonatal health parameters and weight gain in BMI 19.8–26 kg/m$^2$

| Neonatal Indices Wt. gain (kg) | Weight (gm) Mean±SD | Length (cm) Mean±SD | Head circumference (cm) Mean±SD | Chest circumference (cm) Mean±SD | Arm circumference (cm) Mean±SD | First minute Apgar Mean±SD | Fifth minute Apgar Mean±SD |
|---|---|---|---|---|---|---|---|
| Low <11.6 (No=143) | 3067.4±410.5 | 48.9±2.0 | 33.8±1.4 | 32.02± 1.6 | 10.1±0.8 | 8.6±0.8 | 9.9±0.1 |
| Optimal 11.6-16 (No=95) | 3234.5±418.6 | 49.2±1.9 | 34.2±1.5 | 32.4±1.6 | 10.4± 0.8 | 8.5±0.8 | 9.9±0.4 |
| Excess >16 (No=32) | 3311.6±467.4 | 49.8±1.8 | 34.5±1.7 | 32.9±2 | 10.5±10.9 | 8.4±0.8 | 9.9± 0.5 |
| P-value | 0.002 | 0.005 | 0.011 | 0.008 | 0.002 | 0.41 | 0.79 |

**Table 5:** Comparative mean between neonatal health parameters and weight gain in BMI 26.1–29 kg/m$^2$

| Neonatal Indices | Weight (gm) | Length (cm) | Head circum-ference (cm) | Chest circum-ference (cm) | Arm circum-ference (cm) | First minute Apgar | Fifth minute Apgar |
|---|---|---|---|---|---|---|---|
| Wt. gain (kg) | Mean±SD | Mean±SD | Mean±SD | Mean±SD | Mean±SD | Mean±SD | Mean±SD |
| Low <6.8 (n=16) | 2871.3±423.5 | 48.8±2.1 | 34.3±1.1 | 32.3±1.1 | 10.1±0.7 | 8.6±0.6 | 9.9±0.1 |
| Optimal 6.8-1.5 (n=28) | 3115.4±467.5 | 48.4±1.9 | 33.6±1.5 | 32.1±1.5 | 10.0±0.8 | 8.2±1.3 | 9.9±0.4 |
| Excess >11.5 (n=19) | 3368±45.6. | 50.21±1.8 | 34.9±1.2 | 32.2±1.4 | 10.5±0.8 | 8.4±0.75 | 9.9±0.5 |
| P-value | 0.0054 | 0.001 | 0.001 | 0.035 | 0.1 | 0.2 | 0.2 |

while in the overweight and obese women, a minimum gestational age was seen in those with a higher gestational weight gain (>6.8 Kg).

## Discussion

In a population where overweight and obesity is common in the obstetric population,[11] it was found that increase in BMI is associated with increase in the rates of hypertensive disorders of pregnancy, gestational diabetes and caesarian section, as well as longer maternal hospital stay, higher birth weight Z scores, increased neonatal ICU admission, birth defects and prematurity. The increased parity of women in higher BMI categories, which was also noted in our study, might be related to the tendency to gain weight with each pregnancy.[11,12] As with other studies that indicate overweight and gestational Diabetes have a greater influence on maternal and neonatal outcomes,[11] our study, which included only pregnant women without any such clinical disease, confirmed this in our population..

In contrast with previous observational research, some authors believe that weight gain should continuously be monitored, to provide the ease of measuring weight gain, and the consistent findings in diverse populations that women who gain above or below the recommended amount have worse pregnancy outcomes.[11,13] We also believe that prepregnancy or early maternal BMI should be recorded on perinatal data collection sheets, as overweight and obesity have been mentioned as important public health issues with important implications for the cost of heath care delivery.[10]

In a study on women with a normal prepregnancy BMI,[14] it was found that excessive weight gain did not directly correlate with and was not an important factor in increased rates of caesarian section.[15] The high caesarean section rate might be influenced by prepregnancy BMI more than weight gain during pregnancy.[16] In a study,[15] excessive weight gain did not have any effect on the length of labor in the first or second stages of labor, as well as in the total length of labor. In another study comparing the morbidly obese with normal weight women, Cedegren[18] found that they had increased risk of preclampsia, antepartum still birth, caesarian and instrumental delivery, shoulder dystocia, and large for gestational age neonates. A report[19] concluded that pregestational obesity and greater weight gain independently increased the risk of caesarean delivery, as well as several other outcomes with vaginal delivery.

An important reason why weight gain in pregnancy should be monitored is the relation of weight gain in pregnancy and pre-pregnancy BMI with pregnancy outcomes, especially its effect on birth weight, being shown in studies in different countries.[3,7,10,19-23] Maternal BMI and pregnancy weight gain reflect one's nutritional status before and during pregnancy. Some reports indicate that weight gain has a significant relationship with poor pregnancy outcomes.[19,21,23]

The results of this research indicate that some pregnancy outcomes such as neonatal size, weight, length, head, chest and mid upper-arm circumferences, method of delivery, and weight gain have a significant association with prepregnancy BMI. It was also observed that some complications such as low

gestational age and LBW in underweight women and in those with low weight gain were observed more than in the other groups, the results being similar to those in other studies.[19-23] In this research, the overweight women had a higher parity, and the weight gain during pregnancy in this group was less as compared to the normal group as was found in several other studies.[19] Several studies showed that adverse outcomes were less common in women with a normal pregravid BMI and gestational weight gain within IOM recommendation based on prepregnancy BMI.[18-22] On the other hand, women with abnormal prepregnancy BMI and abnormal gestational weight gain have been shown to be at an elevated risk for adverse prenatal outcomes such as prematurity and intrauterine growth restriction (IUGR).[10,20-23]

Considering the findings of this research, interventional strategies must be developed to reach pregravid normal weight conditions and monitor women's weight gain throughout their pregnancy. Pregnancy in women with abnormal weight should be considered as a high risk factor. The subsequent complications could be prevented by special prenatal care. Every pregnant woman has her specific individual health history and needs. Therefore, future controlled randomized trials must aim at formulating guidelines for health care providers to encourage pregnant women to "stay in the range" of the weight gain recommended by the IOM, which is best for both infants and their mothers.

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