

# Gestational Weight Gain and Pregnancy Outcomes in Relation to Body Mass Index in Asian Indian Women

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## Abstract

**Aim:** The aim of the study was to compare the weight gain during pregnancy (using Institute of Medicine guidelines) among Asian Indians across different body mass index (BMI) categories (using World Health Organization Asia Pacific BMI cut points) and to compare the pregnancy outcomes in each of the different BMI categories. **Methodology:** Retrospective records of 2728 pregnant women attending antenatal clinics and private maternity centers in Chennai, South India, from January 2011 to January 2014 were studied. Pregnancy outcomes were analyzed in relation to BMI and weight gain across different BMI categories. **Results:** Overweight and obese women who gained more weight during pregnancy were at high risk of delivering macrosomic infants (overweight - odds ratio [OR]: 2.3, 95% confidence interval [CI]: 1.1–5.2,  $P = 0.02$  and obese - OR: 1.6, 95% CI: 1.1–2.4,  $P = 0.01$ ). In addition, obese women who gained more weight were also at high risk of preterm labor (OR: 2.1, 95% CI: 1.1–3.8;  $P = 0.01$ ), cesarean section (OR: 1.9, 95% CI: 1.4–2.5;  $P < 0.001$ ), and preeclampsia (OR: 2.8, 95% CI: 1.1–7.2,  $P = 0.03$ ). Normal weight and overweight women who gained less weight had a protective effect from cesarean section and macrosomia. **Conclusions:** Overweight/obese women who gained more weight than recommended are at a high risk of developing adverse pregnancy outcomes. Normal and overweight women who gained weight less than recommended have low risk for cesarean section and macrosomia. However, they have a higher (statistically insignificant) risk for low birth weight and preterm birth. This highlights the need for gaining adequate weight during pregnancy.

**Keywords:** Asian Indians, gestational weight gain, Institute of Medicine, pregnancy outcomes, World Health Organization Asia Pacific

## INTRODUCTION

In recent years, maternal prepregnancy body mass index (BMI) has increased, reflecting the overall increase in the prevalence of obesity.<sup>[1]</sup> High prepregnancy BMI and/or excessive gestational weight gain (GWG) have negative implications on pregnancy outcomes, and this amplifies the burden of chronic diseases putting health of both mother and the infant at risk.<sup>[2]</sup>

Recent studies have reported that prepregnancy BMI is associated with birth weight of the infant.<sup>[3,4]</sup> Women who are overweight/obese are at high risk of developing preeclampsia and gestational diabetes mellitus. This in turn is found to influence the neonatal outcomes such as perinatal mortality, macrosomia, and congenital anomalies.<sup>[5,6]</sup> In addition, maternal obesity leads to higher cesarean sections and increased risk of anesthesia. The long-term impact of maternal

obesity includes maternal weight retention and exacerbation of obesity and postpartum.<sup>[7]</sup>

In 2009, the Institute of Medicine (IOM), USA, published revised GWG guidelines that are based on prepregnancy ranges for underweight, normal weight, overweight, and obese women.<sup>[8]</sup> These recommendations were, however, based on American women and therefore its generalizability to other populations is unclear as maternal anthropometry varies across different populations.<sup>[9]</sup> The IOM later published a commentary

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acknowledging that they based their recommendations primarily on the basis of primigravida mothers of high social status and those with no physical activity.<sup>[10]</sup> Some recent studies from Asia have concluded that IOM guidelines are suitable for the Asian population,<sup>[11,12]</sup> whereas others have reported that GWG among Asians is different from what has been recommended by the IOM.<sup>[13,14]</sup> There are very few studies from India that have looked at the applicability of the IOM guidelines in pregnant women.<sup>[15]</sup> This is mainly because the BMI classification for Asians<sup>[16]</sup> is different from the World Health Organization (WHO) BMI cutoffs recommended for the West. Furthermore, there are no national guidelines for weight gain during pregnancy in India. The weight gain recommendations by the IOM are in turn, based on Western WHO BMI cutoffs, making it difficult to compare, translate, or generalize their findings to Asian Indians.

We, therefore, aimed to compare the weight gain during pregnancy (using IOM weight gain guidelines) among Asian Indians across different BMI categories (using WHO Asia Pacific BMI cut points) and to compare the pregnancy outcomes in each of the different BMI categories.

## METHODOLOGY

A total of 4081 records of pregnant women attending three antenatal clinics and private maternity centers in Chennai, from January 2011 to January 2014 were retrieved. Of the total 4081, a total of 2728 (66.8%) records were available for data analysis after data cleansing. BMI at first booking (early pregnancy) was classified according to WHO Asia Pacific BMI cut points,<sup>[16]</sup> and weight gain during pregnancy was classified according to IOM recommendations [Table 1]. Pregnancy outcomes were analyzed in relation to BMI and GWG across different BMI categories.

## Definitions

Preterm birth or premature birth is one that occurs before the start of 37 weeks of pregnancy.<sup>[17]</sup> Macrosomia is used to describe a newborn who is significantly larger than average; a infant weighing >3.5 kg is considered macrosomic.<sup>[18]</sup>

## Statistical analysis

All analyses were done using Windows-based SPSS statistical package (version 22.0, IBM SPSS, Chicago, IL, USA). Estimates were expressed as mean ± standard deviation or proportions. To compare continuous variables, *t*-tests were

used, whereas Chi-square tests were used to test differences in proportions. *P* < 0.05 was considered statistically significant. Logistic regression was carried out to assess the association between GWG and adverse pregnancy outcomes such as preterm delivery, macrosomia, cesarean section, low birth weight, and preeclampsia. Independent variables for logistic regression were chosen based on *P* < 0.2 in univariate analysis.

## RESULTS

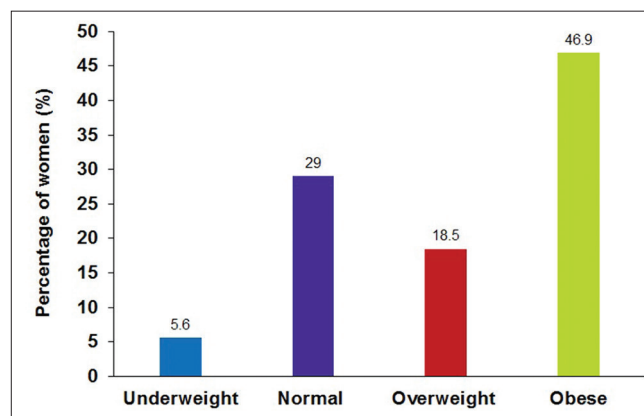
Mean age of pregnant women was 27.4 ± 4 years, mean BMI was 25.1 ± 4.8 kg/m<sup>2</sup>, and mean weight gain during pregnancy was 8.8 ± 4.8 kg. Family history of type 2 diabetes was seen in 6.6%.

As shown in Figure 1, 5.6% (*n* = 154) were underweight, 29% (*n* = 791) normal weight, 18.5% (*n* = 504) overweight, and the rest 46.9% (*n* = 1279) were obese. Table 2 shows the clinical characteristics and pregnancy outcomes of the women classified according to their BMI at first booking. Obese women were significantly older (27.9 ± 4.1 years) than overweight, normal weight, and underweight women (27.3 ± 3.8, 27.0 ± 3.9, and 25.6 ± 3.7 years, *P* < 0.0001, respectively). Weight at booking (kg) was significantly higher in obese women when compared to the other three groups. Family history of diabetes was significantly higher among obese women (8.1%) compared to the overweight, normal weight, and underweight women (5.4%, 5.5%, and 3.2%, *P* < 0.001, respectively). The mean birth weight of the infants born to normal weight, overweight, and obese women was significantly higher than birth weight of infants of underweight women (3.0 ± 0.4 kg, 3.0 ± 0.5 kg, 3.0 ± 0.5 kg, and 2.9 ± 0.4 kg; *P* = 0.007, respectively). Rates of cesarean sections (45%, 33.7%, 26.2%, and 13.6%, *P* < 0.001), macrosomia (14.2%, 12.7%, 8.9%, and 6.5%, *P* = 0.001), and preeclampsia (1.9%, 0.7%, 0.3%, and 0.6%, *P* = 0.006) were significantly higher in obese women than overweight, normal weight, and underweight women, respectively.

Figure 2 shows weight gain during pregnancy across the different BMI categories. It was seen that 30.5% of underweight, 23.4% of normal weight, 22.5% overweight,

Weight category	WHO Asia Pacific criteria - BMI (kg/m <sup>2</sup> )	IOM recommended weight gain (kg)
Underweight	<18.5	12-18
Normal weight	18.5-22.9	11.5-16
Overweight	23-24.9	7-11.5
Obese	≥25	5-9

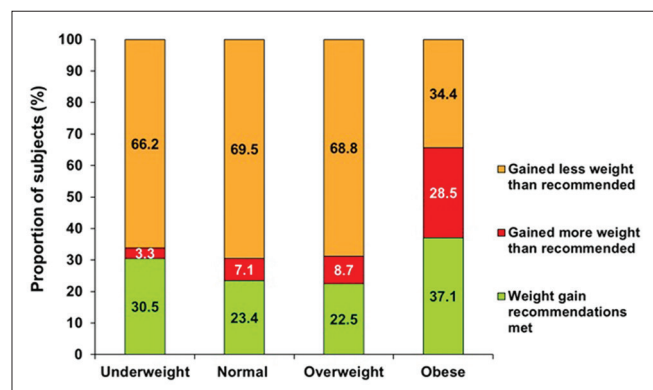
BMI: Body mass index, IOM: Institute of Medicine, WHO: World Health Organization



**Figure 1:** Classification of body mass index according to Asia Pacific guidelines

and 37.1% obese women met the recommendations for weight gain. While majority of underweight (66.2%), normal weight women (69.4%), and overweight women (68.8%) gained weight less than recommended, among obese women, 28.5% of them gained more weight and 34.4% of them gained less than the recommended weight.

Table 3 shows the association of GWG with pregnancy outcomes across the different BMI categories. Considering the pregnant women who met the weight gain recommendations as the reference group, we compared the risk of adverse outcomes in women who gained weight above [Table 3a] and below [Table 3b] the recommended weight after adjusting for



**Figure 2:** Comparison of weight gain across different body mass index categories

age, parity, and presence of gestational diabetes. Overweight and obese women who gained more weight than recommended were at a significantly higher risk of delivering macrosomic infants (overweight - odds ratio [OR]: 2.3, 95% confidence interval [CI]: 1.1–5.2;  $P = 0.02$  and obese - OR: 1.6, 95% CI: 1.1–2.4;  $P = 0.01$ ). In addition, obese women with more than the recommended weight gain were also at higher risk of preterm labor (OR: 2.1, 95% CI: 1.1–3.8,  $P = 0.01$ ), cesarean section (OR: 1.9, 95% CI: 1.4–2.5;  $P < 0.001$ ), and preeclampsia (OR: 2.8, 95% CI: 1.1–7.2;  $P = 0.03$ ). Underweight and normal weight women who gained more weight than recommended did not have any statistically significant adverse outcomes [Table 3a].

Table 3b shows the risk for adverse outcomes in women who gained less than the recommended weight after adjusting for potential confounders such as age, parity, and presence of gestational diabetes. Normal weight and overweight women who gained less weight were found to have less risk of undergoing a cesarean section (normal weight - OR: 0.5, 95% CI: 0.3–0.7,  $P < 0.001$  and overweight OR: 0.5, 95% CI: 0.3–0.8,  $P = 0.005$ ) and developing macrosomia (normal weight - OR: 0.3, 95% CI: 0.2–0.6,  $P < 0.001$  and overweight - OR: 0.5, 95% CI: 0.3–0.8,  $P = 0.02$ ) compared to those who gained adequate weight according to the recommendations. However, the risk of preterm birth and low birth weight was higher in all the groups although this did not reach statistical significance.

**Table 2: Clinical characteristics at first booking**

Clinical parameter	Underweight (n=154)	Normal (n=791)	Overweight (n=504)	Obese (n=1279)
Age (years)	25.6±3.7	27.0±3.9 <sup>a</sup>	27.3±3.8 <sup>a</sup>	27.9±4.1 <sup>a,b,c</sup>
Weight at booking (kg)	44.5±4.5	54.0±5.3 <sup>a</sup>	60.8±5.1 <sup>a,b</sup>	70.6±9.7 <sup>a,b,c</sup>
Weight gain during pregnancy	9.3±5.0	9.1±4.8	9.0±4.9	8.5±4.8 <sup>b,c</sup>
BMI at booking (kg/m <sup>2</sup> )	17.2±0.9	21.0±1.2 <sup>a</sup>	23.7±0.6 <sup>a,b</sup>	29.0±4.0 <sup>a,b,c</sup>
Family history of type 2 diabetes (%)	5 (3.2)	41 (5.5)	30 (5.4)	103 (8.1) <sup>a,b,c</sup>
Mean birth weight (kg)	2.9±0.4	3.0±0.4 <sup>a</sup>	3.0±0.5 <sup>a</sup>	3.0±0.5 <sup>a</sup>
Preterm deliveries (%)	9 (5.8)	45 (6.1)	38 (6.9)	94 (7.3)
Caesarean rates (%)	21 (13.6)	195 (26.2) <sup>a</sup>	186 (33.7) <sup>a,b</sup>	576 (45) <sup>a,b,c</sup>
Low birth weight (%)	21 (13.6)	83 (11.2)	55 (10) <sup>a</sup>	134 (10.5)
Macrosomia (%)	10 (6.5)	66 (8.9)	69 (12.7) <sup>a,b</sup>	182 (14.2) <sup>a,b</sup>
Preeclampsia (%)	1 (0.6)	2 (0.3)	4 (0.7)	24 (1.9) <sup>b,c</sup>

<sup>a</sup>Compared to underweight, <sup>b</sup>Compared to normal weight, <sup>c</sup>Compared to overweight. BMI: Body mass index

**Table 3a: Association of gestational weight gain with pregnancy outcomes#: In women who gained more than recommended weight**

Parameter	Underweight*		Normal*		Overweight*		Obese*	
	OR	P	OR	P	OR	P	OR	P
Preterm	-	-	0.3 (0.04-2.7)	0.3	0.3 (0.03-2.7)	0.3	2.1 (1.1-3.8)	0.01
Caesarean rates	-	-	1.4 (0.7-2.7)	0.3	1.3 (0.6-2.3)	0.7	1.9 (1.4-2.5)	<0.001
Low birth weight	2.7 (0.2-32.1)	0.42	1.4 (0.4-3.1)	0.5	0.6 (0.2-1.8)	0.3	0.9 (0.6-1.5)	0.8
Macrosomia	-	-	1.9 (0.9-4.1)	0.1	2.3 (1.1-5.2)	0.02	1.6 (1.1-2.4)	0.01
Preeclampsia	-	-	-	-	2.8 (0.3-22.1)	0.3	2.8 (1.1-7.2)	0.03

\*Reference group: Pregnant women who met weight gain recommendations as per IOM guidelines, #Adjusted for age, parity, and presence of gestational diabetes. OR: Odds ratio, IOM: Institute of Medicine

**Table 3b: Association of gestational weight gain with pregnancy outcomes#: In women who gained less than recommended weight**

Parameter	Underweight*		Normal*		Overweight*		Obese*	
	OR	P	OR	P	OR	P	OR	P
Preterm	1.87 (0.35-10.0)	0.46	1.3 (0.6-2.7)	0.5	1.1 (0.5-2.6)	0.7	2.0 (0.9-4.3)	0.06
Caesarean rates	0.73 (0.25-2.1)	0.56	0.5 (0.3-0.7)	<0.001	0.5 (0.3-0.8)	0.005	0.8 (0.6-1.1)	0.17
Low birth weight	2.4 (0.72-8.1)	0.15	1.5 (0.8-2.7)	0.2	0.7 (0.3-1.3)	0.2	1.3 (0.9-2.1)	0.1
Macrosomia	0.64 (0.15-2.6)	0.53	0.3 (0.2-0.6)	<0.001	0.5 (0.3-0.8)	0.02	0.7 (0.5-1.1)	0.15
Preeclampsia	-	-	0.3 (0.01-5.3)	0.4	-	-	0.4 (0.1-1.7)	0.23

\*Reference group: Pregnant women who met weight gain recommendations as per IOM guidelines, #Adjusted for age, parity, and presence of gestational diabetes. OR: Odds ratio, IOM: Institute of Medicine

## DISCUSSION

Our study shows the following findings:

1. Only 30% of women gained weight as per the recommendations
2. Obese women who gained more weight were at a higher risk of preterm delivery, cesarean section, macrosomia, and preeclampsia. Overweight women who gained more weight had high risk of macrosomia
3. Normal weight and overweight women who gained less weight than recommended had less risk of a cesarean section and macrosomia. However, there is a small albeit statistically insignificant risk of low birth weight and preterm birth.

The initial guidelines by the IOM in 1930 recommended that pregnant women should gain 6.8 kg irrespective of weight status.<sup>[19]</sup> Subsequently, with increasing prevalence of obesity and an increasing trend in birth of macrosomic infants, these guidelines were revised in 1990 and 2009.<sup>[9,20]</sup> With overweight and obesity significantly contributing to the growing prevalence of large for gestational age infants and increasing the risk of pregnancy-related complications,<sup>[21]</sup> the IOM published new guidelines in 2009.<sup>[9]</sup> This new recommendation was based on WHO BMI categories and included a more restrictive range for weight gain for obese women. These guidelines took into account the risk of small for gestational age infants and preterm birth with inadequate GWG and increased risk for large for gestational age infants and cesarean section. Following the 2009 IOM publication, several studies were published supporting less weight gain, especially in overweight and obese women.<sup>[22-25]</sup> Studies from less developed Asian countries validating these guidelines are emerging,<sup>[13]</sup> with very few studies from India.<sup>[19]</sup>

However, the WHO BMI categories that have been used to classify Europeans may not be appropriate for Asia Pacific population.<sup>[16]</sup> This is because while in the Asian population, the prevalence of obesity may be lower than in Europe; the health risks associated with obesity occur at a lower BMI in Asians than compared to the West, thereby making WHO BMI categorization, less relevant to the Asian population. Hence, in 2000, the Regional Office for the Western Pacific of WHO, the International Association for the Study of Obesity, and

the International Obesity Task Force together released, the Asia-Pacific Perspective for redefining obesity suggesting diagnostic criteria to identify overweight and obesity in the Asian population.<sup>[16]</sup> Hence, in this paper, we have employed the WHO Asia Pacific BMI criteria to classify pregnant women in our study. However, in the absence of national guidelines for weight gain recommendations during pregnancy, we have assessed the usefulness of the IOM weight gain recommendations for our population by studying the adverse pregnancy outcomes in women who gained weight above and below the recommended guidelines.

Maternal obesity is a risk factor for several pregnancy-related complications which may have adverse effects on both the mother and her infant. Obese women have an increased risk of miscarriage early in pregnancy.<sup>[26]</sup> A prospective multicenter study of more than 16,000 pregnancy women showed that obese women were 2.5 times and 1.6 times more likely to develop gestational hypertension and preeclampsia, respectively.<sup>[27]</sup> In addition to these obstetric problems, obese women are also at an increased risk of undergoing cesarean sections.<sup>[28]</sup> Fetal overgrowth also is another major concern in obese women. In Denmark, the percentage of macrosomic infants increased from 16.7% to 20.9% in 10 years, and increasing maternal BMI has been implicated to be one major factor.<sup>[29]</sup> Several other studies have also shown an association between increasing BMI, cesarean section, and macrosomia.<sup>[30,31]</sup> Moreover, the risk for macrosomic infants was found to be consistently higher in obese women who gained more weight, whereas the risk decreased when weight gain was below the recommended values.<sup>[25]</sup> Results from our study corroborate these findings.

Cesarean section is usually influenced by several factors, such as practice behavior of the obstetrician or other pregnancy complications in obese women, may necessitate the need for cesarean section. Nevertheless, results from our study show that obese women who gained more weight were at a significantly higher risk of cesarean delivery. In contrary, Edwards *et al.*<sup>[32]</sup> and Graham *et al.*<sup>[33]</sup> found that when stratified by maternal weight gain, there was no significant association between obesity and cesarean section. However, some others have reported that greater weight gain among obese women during pregnancy was particularly associated with higher risk of cesarean sections.<sup>[34]</sup> Our results also show that obese women

who gain more than the recommended weight were at a high risk of preterm labor and macrosomia. Not many studies have reported on weight gain in obese women and its association to preterm labor. However, a few studies that have shown association between obese women and preterm labor lacked statistical significance.<sup>[35]</sup> Some studies have also reported a negative association between obesity and preterm labor.<sup>[36]</sup> These differences may be due to inconsistency in the definition of preterm birth and effect of other confounding variables.<sup>[37]</sup>

Underweight women are known to deliver preterm infants.<sup>[38]</sup> In addition, underweight women gaining less weight than recommended were shown to be at two-fold risk of delivering low birth weight infants than those who met the recommendations.<sup>[39]</sup> Our results showed that though the risk for low birth weight in underweight women was high, it was not statistically significant. This could be because the number of underweight women studied is less. Nevertheless, the percentage of low birth weight infants in our entire cohort was 10.7%. Although previous studies have reported a higher percentage (26%) of low birth weight infants,<sup>[40]</sup> the scenario seems to be fast changing owing to the quality of antenatal care available to pregnant women in the recent past.

The other important finding in this study is that though a major proportion of normal weight and overweight women gained less weight than recommended, the less weight gain had a less risk for cesarean sections and macrosomia which is in contrast with previous studies which showed that these women had increased risk for such complications.<sup>[23,41]</sup> This difference could be attributed mainly due to the different BMI criteria used.

One of the main strengths of the study is the large sample size. Second, the applicability of IOM guidelines among pregnant women in India has not been explored much, and this is one of the first studies from India to study pregnancy outcomes in relation to BMI.

However, few limitations need to be highlighted. Ideally, BMI classification should be based on prepregnancy weight. However, as seen in several other studies that data are seldom available in routine antenatal records. Some studies rely on the woman's recall of prepregnancy weight, the dependability of which may sometimes be uncertain. In our study, we have used weight recorded in the antenatal records in early pregnancy which was the only feasible option for obtaining reliable information. Second, owing to the retrospective nature of the study, there was a substantial amount of missing data which has reduced the size and power of the study. Finally, the data are collected from urban antenatal centers and hence its generalizability to rural or to the whole of India must be done with caution.

## CONCLUSIONS

Excess as well as less weight gain during pregnancy could lead to adverse pregnancy outcomes. These results highlight

the need for gaining adequate weight during pregnancy. Preconception counseling, especially for overweight and obese women, emphasizing the importance of proper physical activity and healthy eating to avoid excess weight gain and its adverse effects, could have beneficial outcomes in Asian Indian women.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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