ISSN: 0976-3031

*Available Online at http://www.recentscientific.com*

**CODEN: IJRSFP (USA)**

*International Journal of Recent Scientific Research*
*Vol. 10, Issue, 05(C), pp. 32341-32344, May, 2019*

**International Journal of Recent Scientific Research**

**DOI: 10.24327/IJRSR**

**Research Article**

# PREPREGNANCY NUTRITIONAL STATUS AND PROPORTIONAL WEIGHT GAIN, IMPORTANT DETERMINANTS OF ADVERSE MATERNAL AND FOETAL OUTCOMES

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**DOI: http://dx.doi.org/10.24327/ijrsr.2019.1005.3449**

**ARTICLE INFO**

*Article History:*
Received 6th February, 2019
Received in revised form 15th March, 2019
Accepted 12th April, 2019
Published online 28th May, 2019

*Key Words:*

Maternal body mass index, Proportional weight gain, Pregnancy outcomes.

**ABSTRACT**

**Background:** Maternal nutritional status and gestational weight gain (GWG) may be associated with complications of pregnancy and delivery.
**Objectives:** The aim of our study was to compare the proportional weight gain during pregnancy among Asian Indians across different body mass index (BMI) categories and to compare the pregnancy outcomes in each of the different BMI categories.
**Methods:** Follow up study of 83 pregnant women attending antenatal clinics of KGMU, Lucknow, India, was done. Pregnancy outcomes were analysed in relation to initial BMI and proportional weight gain across different BMI categories.
**Results:** There was a decreasing trend in proportional weight gain with increase in nutritional status. Proportional weight gain was maximum in underweight and minimum in obese. Proportion of LSCS deliveries were significantly higher ($p<0.001$) in overweight (70.0%) and obese (86.0%) females. Similarly, proportion of preterm deliveries were significantly higher ($p<0.001$) in overweight (70.0%) and obese (97.7%) females.
**Conclusion:** Women who's initial BMI was towards higher side, gained less weight and were at a high risk of developing adverse pregnancy outcomes. Normal weight women gained more weight and had low risk for caesarean section and preterm deliveries.



## INTRODUCTION

In 2005 the World Health Organization declared obesity a "worldwide pandemic" affecting 400 million adults.[1] Studies have shown that obesity at time of pregnancy is associated with higher prevalence of gestational diabetes mellitus, pre-eclampsia, stillbirth, large for-gestational age, and offspring's long-term consequences of obesity and metabolic syndrome[2,3]. Pre-pregnancy weight and gestational weight gain (GWG) are important determinants of weight retention maintenance over the female lifespan.[4] In 2009, the Institute of Medicine (IOM)[5] updated GWG recommendations, taking into account the pre-pregnancy BMI categories defined by the World Health Organization (WHO) position and evidence from several cohort studies published since 1990.

Adipocytes, serve as a future energy source, and help to avoid the negative metabolic consequences. Adipose tissue also contains a large number of non-fat cells. Both cells synthesize and secrete numerous peptide and steroid hormones as well as cytokines, adipokines and chemokines, and such factors are known to influence local and systemic physiology.[6]

Anthropometry—The most commonly used method for the assessment of obesity, or overweight, in all age-groups (Jelliffe and Jelliffe, 1989).[12] Measurements of weight, height (or length)Waist circumference, and, less frequently, subcutaneous fat and muscle, are the usual data collected. It is a non-invasive and relatively economical to communitiesat large.

Waist circumference-- is an indicator of internal fat deposits. Visceral fat in particular appears to be associated with insulin resistance which leads to type 2 diabetes and adverse lipid profiles which predispose to cardiovascular disease. [13] Measurements of waist circumference can be useful in the assessment of abdominal obesity and disease risk.

Pre pregnancy adiposity and excess maternal weight gain are known to increase the risk of caesarean delivery. The association between pre-pregnancy body mass and caesarean delivery has been reported in population-based cohort studies. Incremental increases in gestational weight gain have also been associated with greater risk for caesarean delivery, independently of its effects on fetal growth.[18,19,20]

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However, understanding these associations is also complex, because both BMI and GWG are closely linked to lifestyle factors, diseases, and genetic traits that are also correlated with the outcome of pregnancy. In addition, pregnancy outcomes (e.g., birth weight) may be in the causal pathway between GWG and other pregnancy outcomes (e.g. caesarean delivery), which also complicates the interpretation of these relations.

In recent years, maternal prepregnancy BMI has increased, reflecting the overall increase in the prevalence of obesity.[41] 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. [42, 43]

***Recommended Weight Gain During Pregnancy***

**Table 1: Institute of Medicine weight gain recommendations for pregnancy**

| Weight category | WHO Asia Pacific criteria - BMI (kg/m$^2$) | 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

There are very few studies from India that have looked at the applicability of the IOM guidelines in pregnant women.[44] This is mainly because the BMI classification for Asians[45] is different from the World Health Organization (WHO) BMI cut-offs recommended for the West. Furthermore, there are no national guidelines for weight gain during pregnancy in India.

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.

***Experimental Section***

## MATERIAL AND METHODS

The study was carried out atdepartment of Physiology, antenatal clinic of the department of Obstetrics and Gynecology, King George's Medical University, Lucknow. This was a prospective observational study that involved pregnant women in the first trimester of pregnancy with singleton gestation as confirmed by ultrasound.

Ethical clearance was taken from ethical community of university.

The sample size was determined using a statistical formula that is $n=z^2p*q/d^2$[z = value of 95% confidence interval, p = prevalence of low birth weight in India, (World Health Organization. Global targets 2025)= 20%= 0.20, q = 1-p = 1-0.20=0.80, d = allowable margin of error,10%][15]

Calculated sample size was 62. However to increase the power of the study, the maximum sample size was increased by 83. Total 120 women with singleton gestation were recruited in this study. The women were counseled and written, consent was obtained. A structured questionnaire was filled for all the participants, to obtain information on age, educational status, parity, occupation, ethnic group, gestational age, and cell phone numbers. The height and baseline weight were measured for each woman, and BMI (kg/m2) was calculated at booking, and at subsequent visits. The weight was measured using a portable scale with minimal clothing. The height was measured with the rigid stadiometer.

The women were categorized into four sub-groups according to their 1st trimester BMI as described in Table: 1.The group with normal BMI (18.5-23.0 kg/m2) was used as the reference group for the analysis. The patients were followed up to delivery, and the BW of the babies was recorded.

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 21.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD.

## RESULTS

Of the 120 women who were booked for antenatal care during the study period, 83 met the eligibility criteria and were recruited into the study. At the time of enrollment in the study, all the females were in the reproductive age group (range 20-40 years) and mean age was 28.27±4.82 year Range of height, weight and BMI of the females enrolled in the study ranged from 139-165 cms, 40-80 kgs, 16.65-36.73 kg/m$^2$ respectively while mean values of above anthropometric variables were 149.07±5.64 cms, 55.46±8.29 kg and 25.11±4.35 kg/m$^2$. (Table 1)

**Table 1** Demographic Profile of Mothers present in the study (n=83)

| SN | Characteristics | Mean ±SD;(range) |
|---|---|---|
| 1. | Mean Age ± SD,(Range) in years | 28.27±4.82 ;(20-40) |
| 2. | Mean Height ±SD, (range) (cm) | 149.07±5.64 ;(139-165) |
| 3. | Mean Weight ±SD, (range) (kg) | 55.46±8.29; (40-80) |
| 4. | Mean BMI ±SD, (range) (kg/m$^2$) | 25.11±4.35 ;(16.65-36.73) |

Majority of the females enrolled in the study were Obese & overweight (43+10) i.e. (63.8%), as per criteria for Asian population. Only 4 (4.8%) females were Underweight and rest 26 (31.3%) were normal weight.

Mean maternal weight of pregnant females at enrolment was 55.46±8.29 kg which on second visit increased to 58.58±7.92 kg and on third visit to 62.18±7.60 kg. (Table; 2)

**Table 2** Maternal Weight at enrolment and different follow-up intervals during pregnancy

| SN | Time interval | Mean±SD | Range |
|---|---|---|---|
| | Maternal Weight (kg) | | |
| 1. | At enrolment | 55.46±8.29 | 40-80 |
| 2. | At second visit | 58.58±7.92 | 43-82 |
| 3. | At third visit | 62.18±7.60 | 47-85 |

Total proportional weight gain by the pregnant females from enrolment to third visit was 12.61±4.14%, contribution of proportional weight gain during enrolment to second visit was 5.86±2.23 kg and that during second to third visit was 6.35±2.07 kg.( table;3)

**Table 3** Total proportional weight gain of pregnant females

| SN | Variable | Under weight BMI (≤18.5 kg/m$^2$) (n =4) | | Normal weight BMI (18.5-23.0 kg/m$^2$) (n=26) | | Over-weight BM[ (23,0-25.0 kg/m$^2$) (n=10) | | Obese BMI (>25 kg/m$^2$) (n=43) | | Statistical significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD | Mean | SD | 'F' | 'p' |
| 1 | Enrol. to II visit | 9.21 | 2.36 | 7.13 | 2.14 | 5.63 | 1.53 | 4.85 | 1.72 | 12.48 | <0.001 |
| 2. | Enrol to III visit | 19.03 | 2.41 | 15.60 | 3.67 | 11.98 | 2.26 | 10.36 | 3.02 | 20.77 | <0.001 |
| 3. | Difference between II-III visit | 8.99 | 0.26 | 7.89 | 1.89 | 6.01 | 1.62 | 5.25 | 1.51 | 18.10 | <0.001 |

**Table 4** Perinatal Outcome

| | Mode of delivery | n=4UWt. | % | n=26 NWt. | % | n=10 OWt. | % | n= 43 Obese | % | $\chi^2$ | 'p' |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | LSCS | 1 | 25.0 | 6 | 23.1 | 7 | 70.0 | 37 | 86.0 | 29.69 | <0.001 |
| | NVD | 3 | 75.0 | 20 | 76.9 | 3 | 30.0 | 6 | 14.0 | | |
| 2. | Term | | | | | | | | | | |
| | Preterm | 1 | 25.0 | 8 | 30.8 | 7 | 70.0 | 42 | 97.7 | 38.51 | <0.001 |
| | Term | 3 | 75.0 | 18 | 69.2 | 3 | 30 | 1 | 2.3 | | |

In majority of the cases mode of delivery was LSCS (61.4%) which includes 1 underweight, 6 normal weight, 7 overweight and 37 obese females. Preterm (69.9%) which includes 1 underweight, 8 normal weight, 7 overweight, 42 obese females. (Table 4)

Mean birth weight of babies delivered to the pregnant females enrolled in the study was 2.50±0.57 kg. Birth weight of majority of the babies was ≤2.50 kg (n=51; 61.5%). Proportion of neonates with birth weight >2.5 kg was significantly higher among normal weight females (76.9%) as compared to Underweight (25.0%), Overweight (0.0%) and Obese (25.6%).[Table-5]

**Table 5** association of BMI with birth weight

| Variable | Under weight (n=4) | | Normal weight (n=26) | | Over-weight (n=10) | | Obese (n=43) | | Statistical significance | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | 'F' | 'p' |
| Birth weight(kg) | | | | | | | | | | |
| <2 | 0 | 0.0 | 3 | 11.5 | 2 | 20.0 | 13 | 30.2 | | |
| 2.01-2.5 | 3 | 75.0 | 3 | 11.5 | 8 | 80.0 | 19 | 44.2 | 30.5 | <0.001 |
| 2.51-3.5 | 1 | 25.0 | 17 | 65.4 | 0 | 0.0 | 10 | 23.3 | | |
| >3.5 | 0 | 0.0 | 3 | 11.5 | 0 | 0.0 | 1 | 2.3 | | |

There was significant association (P<0.001) found between high maternal first trimester BMI and the delivery of LBW neonates (<2.50kg). Furthermore, average weight mothers delivered significantly larger neonates compared to mothers of higher weight as shown in table-6. This was found to be statistically significant withAnalysis of Variance F value 30.56, P < 0.001.

## DISCUSSION

The mean BMI of the pregnant women 25.11±4.35 kg/m$^2$ suggests a tendency towards obesity. Mean birth weight of babies delivered to the pregnant females enrolled in the study was 2.50±0.57 kg. Birth weight of majority of the babies was ≤2.50 kg (n=51; 61.5%). Proportion of neonates with birth weight >2.5 kg was significantly higher among normal weight females (76.9%) as compared to Underweight (25.0%), Overweight (0.0%) and Obese (25.6%). There was a significant association between high 1st trimester maternal BMI and the delivery of LBW neonates (P < 0.001). Furthermore, the incidence of LBW neonates (LBW i.e., <2.50kg) was higher in overweight and obese subjects than the average weight women. A study performed by Diane Coffey (2014)[84]corroborate with our study and states that, Pre-pregnancy body mass and weight gain during pregnancy are useful measures of maternal nutrition. These factors interact to determine birth weight: on average, women with lower pre-pregnancy body mass need to gain more weight during pregnancy to deliver infants of the same birth weight as women who start pregnancy with higher body mass.

Study performed by YS Han *et al*.(2011)[85]also corroborates with our study and explained that, Stress levels are significantly associated with BMI.They found that weight gain during pregnancy in the overweight and obese groups was significantly lower than in the underweight and normal groups, due to increase level of stress.

Study which is also in concordance with the present study by, Balaji Bhavadharini *et al*.(2017)[16]found that underweight women gaining less weight than recommended were shown to be at two-fold risk of delivering low birth weight infants. Their results showed that though the risk for low birth weight in underweight women was high, it was not statistically significant. Due to increased systemic inflammation and placental insufficiency there is low weight gain in case of overweight and obese women.

We did not get statistically significant association of Waist hip ratio (WHR) with abdominal obesity, the reason may be that most of obese were overall obese but very few had abdominal deposition of adipose tissue.

A study conducted by Anjali Gupta *et al*.(2015)[33]is not in favor of our findings. The author found that abdominal adiposity, measured by waist circumference, is a good marker of fat distribution, can be easily self-measured and has been considered as a better indicator of obesity related health risks than BMI. Women with waist circumference ≥ 80 cm had increased risk of complications. Few studies have reported the role of waist circumference in predicting preeclampsia, gestational Diabetes Mellitus, macrosomia. Preeclampsia was the major contributor to the maternal and perinatal morbidity.

Their study observed that the rate of caesarean delivery was more in the women with waist circumference ≥ 80 cm and this was found in concordance with that of Verma and Shrimaili,[40] waist circumference threshold (80 cm) for abdominal obesity has been found to be associated with various maternal and neonatal complications. Waist circumference can be used to assess the pregnancy risks associated with overweight and obesity.

Assessment of waist circumference in early pregnancy (before 8 weeks) provides a simple and practical anthropometric parameter for predicting pregnancy related adverse outcomes. It is suggested that all pregnancies in centrally obese women shall be acknowledged as high risk. Preconception counselling and interventions to reduce weight should be targeted at women who have waist circumference ≥ 80 cm.

Goldenberg and Culhane *et al*.(2007),[92]in a corroborative study have suggested that preterm birth is mediated by increased systemic inflammation due to a wide range of prepregnancy risk factors. Weight gain during pregnancy reflects increase in maternal tissue, especially fat stores and accumulated fluid, but also the growth of the products of conception. Besides being a marker for nutritional status, weight gain may reflect abnormal physiology leading to preterm birth. They found low weight

gain to be an independent and much stronger risk factor of early preterm birth than obesity.

Due to increased systemic inflammation and placental insufficiency there is low weight gain and early detachment of placenta from uterus, resulting into early preterm birth.

Proportional weight gain was significantly higher among NVD (normal vaginal delivery) delivered as compared to LSCS (lower segment caesarean section) at Enrolment to second visit (6.75±2.38 vs. 5.31±1.96%), second to third visit (7.34±2.13 vs. 5.73±1.79%) and Enrolment to third visit (14.62±4.30 vs. 11.36±3.52%).

Proportional weight gain was significantly higher among Term delivered as compared to Preterm at Enrolment to second visit (7.35±2.30 vs. 5.23±1.89%), second to third visit (7.80±1.71 vs. 5.72±1.90%) and Enrolment to third visit (15.74±3.71vs. 11.27±3.56%).

## CONCLUSION

- ✓ Proportional weight gain was maximum in Underweight females. These associations were found to be statistically significant (0.001).
- ✓ Increasing BMI is associated with greater risk of pregnancy complications like induction of labour and cesarean delivery.
- ✓ Similarly, proportion of preterm deliveries were significantly higher in Overweight (70.0%) and Obese (97.7%) females.
- ✓ Obese women had the highest rate whereas Underweight and normal weight women had the lowest rate of low-birth-weight and LSCS.
- ✓ We found proportional weight gain to be a more sensitive indicator of risk for LSCS, particularly among overweight women and obese women.
- ✓ Explanations for the increased risks of cesarean delivery in obese women are unclear. There may be a threshold for maternal weight gain beyond which uterine tone is attenuated.

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