

Association between Gestational Weight Gain and Maternal and Neonatal Outcomes

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Abstract

Background: Gestational weight gain (GWG) during pregnancy is influenced by pre-pregnancy body mass index (BMI) and may affect both maternal and neonatal outcomes. Inadequate as well as excessive weight gain has been associated with adverse pregnancy outcomes. This study was undertaken to assess the relationship between gestational weight gain based on initial BMI and maternal and neonatal outcomes.

Materials and Methods: This observational study was conducted over 18 months from November 2022 to April 2024 in the Department of Obstetrics and Gynaecology, Government Victoria Hospital, Visakhapatnam. A total of 230 women aged 18–35 years with singleton, uncomplicated, spontaneously conceived pregnancies were included. Women with multiple gestation or medical disorders complicating pregnancy were excluded. Participants were categorized into insufficient, adequate, and excessive GWG groups according to Institute of Medicine recommendations. Maternal outcomes including gestational diabetes mellitus, gestational hypertension, oligohydramnios, PPRM, pre-eclampsia, preterm delivery, fetal growth restriction, SGA and mode of delivery were assessed. Neonatal outcomes included birth weight, APGAR score and NICU admission. Statistical analysis was performed using JMP-SAS software, with $p < 0.05$ considered statistically significant.

Results: Of the 230 women, 63 (27.4%) had insufficient, 83 (36.1%) had adequate and 84 (36.5%) had excessive GWG. Mean total weight gain was 8.26 ± 1.61 kg, 11.98 ± 2.26 kg and 15.57 ± 2.70 kg in the insufficient, adequate and excessive groups, respectively ($p < 0.00001$). Significant associations were observed between GWG and fetal growth restriction ($p = 0.024$), oligohydramnios ($p = 0.0347$), preterm delivery ($p = 0.0236$), cephalopelvic disproportion ($p = 0.0347$), and birth weight ($p = 0.015$). Mean birth weight was 2.70 ± 0.56 kg in the insufficient group, 2.96 ± 0.57 kg in the adequate group and 2.95 ± 0.60 kg in the excessive group. No significant association was observed between GWG and gestational diabetes mellitus, gestational hypertension, PPRM, pre-eclampsia, NICU admission or APGAR scores.

Conclusion: Both insufficient and excessive gestational weight gain were associated with adverse maternal and neonatal outcomes. Appropriate pre-pregnancy BMI and adequate gestational weight gain may contribute to improved pregnancy and neonatal outcomes.

Keywords: Gestational weight gain; Maternal BMI; Maternal outcomes; Neonatal outcomes.

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Introduction

Comprehending the correlation between the increase in weight during pregnancy and difficulties in both the mother and the newborn is not just a topic of curiosity but an essential need. Proper management of gestational weight gain is necessary to prevent any negative consequences for the baby. [1]

Obesity is rapidly becoming a significant health issue. According to NFHS 3, married women aged 15–49 in India were obese or overweight in 2005–2006, up from 11–15%. According to NFHS 4, this

rose to 20.6%. [2] According to NFHS4, 22.9% of women in India who are of reproductive age have a body weight that is below the recommended level. [3] The maternal and neonatal problems linked to BMI and prenatal weight gain have significant implications for public health since they contribute to the overall illness burden in women and children and lead to higher medical expenses.

Hence, comprehending the correlation between weight increase during the early stages of pregnancy, the birth weight of the newborn, and

problems experienced by the mother is crucial and time-sensitive. [4]

This research has the potential to significantly influence our comprehension of the separate and combined relationship between the increase in weight during pregnancy and the problems experienced by both the mother and the newborn. In addition, it might provide significant information on the frequency of women who fall below, fall within, or exceed the acceptable guidelines for weight gain during pregnancy as established by the Institute of Medicine (IOM), as well as the variables that affect the amount of weight gained during pregnancy.

Aim: To assess the impact of weight gain during pregnancy based on initial BMI on maternal and neonatal outcomes. **Objectives:** To establish the relationship between gestational weight gain and maternal outcomes and neonatal outcomes.

Materials and Methods

This was an Observational Study done for 18 months period from November 2022 to April 2024 in the 230 Patients admitted in the Department of Obstetrics & Gynecology, Government Victoria Hospital, and Visakhapatnam.

Inclusion Criteria: Patients between 18 to 35 years with Singleton, uncomplicated Spontaneous conception.

Exclusion criteria: Patients of Age <18 & >35 years, with multiple gestation, Hypertension, Diabetes, Thyroid disorder, Bronchial asthma and any medical illness complicating pregnancy.

Methodology: A predesigned structured study pro-forma will be used to note down demographic details, complete history taking, and physical examination will be done. Written & informed consent was taken from all the patients enrolled in the study. Pregnancy outcomes were analyzed in relation to BMI & GWG across different BMI Categories. BMI was obtained by dividing body weight in kilograms by the square of height in meters.

Women included in this study are divided into 3 groups according to their weight gain in pregnancy: Insufficient weight gain, adequate weight gain, Excess weight gain. The 2009 IOM GWG recommendation is for underweight, normal weight, overweight and obese women to gain 12 - 18 kg, 11.5 to 16 kg, 7 - 11.5 kg, 5 - 9 kg respectively.

Under Maternal outcome variables included: Pre-eclampsia, Preterm delivery, Gestational Hypertension, Gestational Diabetes Mellitus, PPROM, Oligo hydramnios, Post term pregnancy, Small for Gestational Age, Fetal growth restriction, Mode of Delivery: Normal Vaginal Delivery or Cesarean Delivery or Instrumental. Under Perinatal outcome variables included: Birth weight, APGAR score, NICU Admissions, Babies needing SNCU admissions in v/o neonatal complications will be followed, Babies will be followed up to 7 days post-delivery. All the information will be represented in the form of pie charts after analyzing.

Statistical Analysis: The data obtained were entered into a Microsoft Excel sheet, and statistical analysis was performed using JMP-SAS Software. Descriptive statistics, including means and standard deviations (S.D.), as well as counts and percentages, were computed to summarize the data. The ANOVA (Analysis of Variance) test was used to compare means among three groups, providing insights into whether there were statistically significant differences between the group means, with a p-value of <0.05 considered significant. Additionally, the Chi-square test was employed to compare categorical variables between groups, with a p-value of <0.05 indicating statistical significance. Results were presented with descriptive statistics and visual diagrams to facilitate interpretation and understanding of the data.

Results

Table 1: Age Distribution in the Study Population

Age	Frequency	Percentage
< 20	34	14.78
21-30	168	73.04
31-40	28	12.17
Total	230	100
	Mean 24.36 SD 3.94	

Table 2: Patient Characteristics in Study Population

Education	Frequency	Percentage
School	112	48.70
Intermediate	86	37.39
Degree	10	4.35
Illiterate	22	9.57
Working	69	30
Housewife	161	70
Lower	48	20.87
Lower Middle	129	56.09
Upper Lower	1	0.43
Upper Middle	52	22.61

Table 3: BMI in the Study Population

BMI	Frequency	Percentage
< 18.5	37	16.09
18.5-22.9	112	48.70
23-24.9	58	25.22
> 25	23	10.00
Total	230	100

Table 4: Weight Gain in The Study Population

BMI	Insufficient		Adequate		Excessive	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
< 18.5	12	19.05	18	21.69	7	8.33
18.5-22.9	35	55.56	38	45.78	39	46.43
23-24.9	11	17.46	20	24.10	27	32.14
> 25	5	7.94	7	8.43	11	13.10
Total	63	100	83	100	84	100
P Value	0.11023					

Table 5: Parity in the Study Population

Parity	Insufficient		Adequate		Excessive	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Nulli parous	27	42.86	49	59.04	49	58.33
Multi parous	36	57.14	34	40.96	35	41.67
Total	63	100	83	100	84	100
P Value	0.09897					

Table 6: Weight Gain in the Trimesters

Weight gain 1 st Trimester	Insufficient	Adequate	Excessive	P value
Mean	1.10	1.00	1.44	
SD	0.47	0.43	0.39	
Weight gain 2 nd Trimester				
Mean	2.88	4.30	5.70	< .00001
SD	0.77	1.26	1.44	
Weight gain 3 rd Trimester				
Mean	4.28	6.83	8.43	< .00001
SD	1.05	1.46	1.51	
Total Weight gain				
Mean	8.26	11.98	15.57	< .00001
SD	1.61	2.26	2.70	
Weight before delivery				
Mean	64.57	65.14	69.76	0.016628
SD	12.62	12.02	12.26	

Table 7: Maternal Complications in the Study Population

Maternal Complications	Insufficient		Adequate		Excessive		P Value
	N	%	N	%	N	%	
FGR	9	14.29	6	7.23	2	2.38	0.024 *
GDM	8	12.70	20	24.10	16	19.05	0.2222
GHTN	4	6.3	5	6.02	3	3.5	0.6932
Oligohydramnios	2	3.17	5	6.02	12	14.29	0.0347*
PPROM	5	7.94	2	2.4	2	2.38	0.3492
Pre-Eclampsia	1	1.58	2	2.4	3	3.5	0.7489
Preterm	13	20.63	5	6.02	9	10.71	0.02336*
SGA	11	17.46	7	8.43	9	10.71	0.2287
CPD	2	3.17	5	6.02	12	14.29	0.034701*
Total	63	100	83	100	84	100	

Table 8: Mode of Delivery in the Study Population

Mode of delivery	Insufficient		Adequate		Excessive	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
NVD	30	47.62	42	50.60	30	35.71
LSCS	33	52.38	41	49.40	54	64.28
Total	63	100	83	100	84	100
P Value	0.78547					

Table 9: Birth Weight of the Babies in the Study Population

Birth weight of baby	Insufficient	Adequate	Excessive
MEAN	2.70	2.96	2.95
SD	0.56	0.57	0.60
P VALUE	0.015129 S		

Table 10: Nicu Admission in the Babies in the Study Population

NICU admission	Insufficient		Adequate		Excessive	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	14	22.22	14	16.87	15	17.86
No	49	77.78	69	83.13	69	82.14
P Value 0.69183						
APGAR score 1min						
<7	4	6.3	4	4.8	2	2.38
>7	59	93.65	79	95.18	82	97.61
P value=0.48857						
APGAR score 5min						
<7	4	6.3	2	2.4	1	1.1
>7	59	93.65	81	97.59	83	98.9
P value=0.18054						

Discussion:

In the current study, 230 singleton pregnant women admitted in a tertiary healthy care center during a period of 1 year and 6 months were studied to find out the association between gestational weight gain and maternal and fetal complications.

Sociodemographic characteristics: In the literature, studies have shown that maternal gestational weight gain is associated with socioeconomic characteristics like socioeconomic status, education level and also maternal characteristics like age, parity, weight before gestation.

In the current study, the majority (73%) of the patients belonged of the 21-30 years age group. 14

% belonged to <20 years of age and 12% of the patients were relatively aged belonging to 31-40 years age group. The mean age of the patients in our study was 24.36 years. These findings were consistent with a study conducted by Rijvis et al [5] where the mean age of the patients was 25 years.

The majority (48.7%) of the patients perceived education up to the school, followed by intermediate college education (37.39%). 9.57% of the patients were illiterate and only 4.35 % perceived a degree in education. Education level is important because a limited education hampers the knowledge of nutrition, importance of antenatal care, importance of supplements. Majority of the patients (70%) were housewife whereas the

working women attributed to 30% of the study population in the current study.

In our study, majority of the patients (56.09%) were of the lower middle-class status followed by upper middle class (22.61%). 20.87% of the patients belonged to lower class whereas only 1 patient (0.43) belonged to upper lower class. Socioeconomic status also plays a vital role in weight gain during pregnancy in terms of optimal care during pregnancy and better intake of nutritional supplements.

At the first prenatal visit, BMI of the study patients was obtained and were categorized into 4 groups. The four categories were underweight (BMI <18.5), normal (BMI-18.5-22.9), overweight (BMI-23-24.9) and obese (BMI >25). We found that the majority of the patients (48.7%) were normal weight. 25.22% of the patients were overweight, 10 % were obese and 16% were underweight. Significant associations between maternal BMI at first visit to birth weight was found in various studies conducted by Singh s et al. [6], J. E Brown et al [7]

Women were categorized into 3 groups' bases upon the total weight gain in the pregnancy and as per IOM guidelines. The IOM recommends underweight, normal, overweight and obese women to gain 12-18 kgs, 11.5 -16 kgs, 7-11.5 kgs and 5-7 kgs respectively. In the current study, amongst the total study population, 63 women were found to have insufficient weight gain, 83 women had adequate weight gain and 84 women had excessive weight gain. In the insufficient category, majority (35) women were having normal BMI before pregnancy, 12 women were underweight, 11 women were overweight, and 5 women were obese. In the adequate category, majority (38) women were having normal BMI before pregnancy, 18 women were underweight, 20 women were overweight, and 7 women were obese. In the excessive category, majority (39) of the women was having normal BMI before pregnancy, 7 women were underweight, 27 women were overweight, and 11 women were obese. Yayla Abide et al [10] in their study suggested that in obese women, the excessive weight gain is higher.

In the current study, in the insufficient category, 57.14% women were multiparous and 42.86% were nulliparous. In the adequate weight gain category, around 41% of women were multiparous and 59 % were nulliparous. In the excessive weight gain category, 41.67% women were multiparous, and 58.33% women were nulliparous.

In the current study, the mean weight gain in the first trimester was more in the excessive category (1.44). It was 1kg in the adequate category and 1.1kg in the insufficient category. The mean weight

gain in the 2nd trimester was more in the excessive category (5.7 kg). It was 4.3 kg in the adequate category and 2.88 kg in the insufficient category. Anai et al [9] in their study found that maternal weight gain in the 2nd trimester plays a vital role in determining the birth weight. The mean weight gain in the third trimester was more in the excessive category (8.43). It was 6.83 kg in the adequate category and 4.28 kg in the insufficient category. Weight gain in 2nd and 3rd trimesters is important in determining the birth weight (J M Musaya et al). [8] In the current study, the mean total weight gain was more in the excessive category (15.57) as anticipated. It was 11.98 in the adequate category and 8.26 kg in the insufficient category. In the current study, the mean weight before delivery was higher (69.76 kg) in the excessive category. It was 65.14 kg in the adequate category and it was lower (64.57 kg) in the insufficient category. These findings are in parallel to other studies which stated that lean women gained less weight in pregnancy

Gestational Diabetes Mellitus (GDM): 12.7 % of the women in the insufficient category, 24.1% in the adequate category and 19.05% in the excessive category were found to have gestational diabetes. No significant correlation was found between gestational weight gain and GDM. (p value= 0.222). Similarly, in a study conducted by Yayla Abide et al [10] 14.1 % of the women in the insufficient category, 9.3% in the adequate category and 8.8% in the excessive category were found to have gestational diabetes mellitus. Also, there was no significant association found between the two (p value=0.08). In a study conducted by Kabiruw et al increase in BMI was associated with higher rates of gestational diabetes.

Gestational Hypertension: 6.3 % of the women in the insufficient category, 6.02 % in the adequate category and 3.5 % in the excessive category were found to have gestational hypertension. The prevalence was comparable in the all the three groups and no significant association were found between gestational hypertension and maternal weight gain. (p value=0.6932). Similarly, in a study conducted by Yayla Abide et al [10] 3.6 % of the women in the insufficient category, 3.3% in the adequate category and 4.4% in the excessive category were found to have gestational hypertension. Also, there was no significant association found between the two (p value=0.743).

Oligohydramnios: 3.17 % of the women in the insufficient category, 6.02% in the adequate category and 14.29 % in the excessive category were found to have oligohydramnios. The prevalence was higher in the excessive category. Also, there was a significant association found between weight gain and oligohydramnios (p value= 0.0347). Similarly, in a study conducted by

Yayla Abide et al [10] 5.2 % of the women in the insufficient category, 11.9% in the adequate category and 8% in the excessive category were found to have oligohydramnios. Also, there was a significant association found between the two (p value=0.028).

Preterm Premature Rupture of Membranes: 7.94 % of the women in the insufficient category, 2.4 % in the adequate category and 2.38 % in the excessive category were found to have PPRM. Women in the insufficient weight gain category were found to have higher proportion of PPRM. However, no significant association was found between PPRM and maternal weight gain. (p value= 0.3492). Similarly, in a study conducted by Yayla Abide et al [10] 4.4 % of the women in the insufficient category, 2.6% in the adequate category and 1% in the excessive category were found to have PPRM. Also, there was a significant association found between the two (p value=0.026). According to Dayal S et al. the major risk factors for PPRM include short cervical length, previous history of PPRM, 2nd or 3rd trimester vaginal bleeding, nutrient deficiencies of copper, low BMI and low socioeconomic status.

Pre-eclampsia: 1.5 % of the women in the insufficient category, 2.4 % in the adequate category and 3.5% in the excessive category were found to have pre-eclampsia. In the current study, we found a slightly higher proportion of pre-eclampsia cases in excessive weight gain group. But there was no significant association found between weight gain and eclampsia (p value= 0.7489). Similarly, in a study conducted by Yayla Abide et al [10] 0.7% of the women in the insufficient category, 2.8% in the adequate category and 5.7% in the excessive category were found to have preeclampsia. Also, there was a significant association found between the two (p value=0.042).

Pre-Term Delivery: 20.63 % of the women in the insufficient category, 6.02 % in the adequate category and 10.71% in the excessive category were found to have preterm babies. The incidence was higher in the insufficient weight gain category. Also, there was a significant association found between weight gain and preterm delivery (p value= 0.0236). Similarly, in a study conducted by Yayla Abide et al [10] 19.3% of the women in the insufficient category, 14.2% in the adequate category and 10.1% in the excessive category were found to have preterm delivery. Also, there was a significant association found between the two (p value=0.005). Low gestational weight gain was associated with preterm birth in a study conducted by Ying hu et al who aimed to investigate association between maternal gestational weight gain and preterm birth.

Small For Gestational Age (SGA): 17.46 % of the women in the insufficient category, 8.43% in the adequate category and 10.71% in the excessive category were found to be SGA. In the current study, a higher number of SGA babies were found in the mothers of insufficient weight gain category. There was no significant association found between the two (p value=0.2287). Similarly, in a study conducted by Yayla Abide et al [10] 8.4% of the women in the insufficient category, 4% in the adequate category and 2.3% in the excessive category were found to have SGA babies. Also, there was a significant association found between the two (p value=0.001).

Cephalopelvic Disproportion: 3.17 % of the women in the insufficient category, 6.02 % in the adequate category and 14.29 % in the excessive category were found to have cephalopelvic disproportion. In the present study, women in the excessive weight gain category were found to have higher percentages of cephalopelvic disproportion. Also, there was a significant association found between weight gain and CPD (p value=0.03471). In a study conducted by Yayla Abide et al [10], 2.2% of the women in the insufficient category, 7.8% in the adequate category and 10.4% in the excessive category were found to have cephalopelvic disproportion. Also, there was a significant association found between the two (p value=0.016). Macrosomia is a major cause of cephalopelvic disproportion. The association between excessive weight gain and macrosomia was demonstrated by Costa et al which is in concordance to our study. Devader et al demonstrated increased maternal complications including CPD in the patients who developed excessive weight gain.

Fetal Growth Restriction: 14.29 % of the women in the insufficient category, 7.23% in the adequate category and 2.38% in the excessive category were found to have fetal growth restriction in our study. We found a significant association between fetal growth restriction and weight gain in our study. (p value=0.024).

Mode of delivery: In the current study, the proportion of LSCS cases was higher in the excessive weight gain category (64.28%). It was 52.38 % in the insufficient category and 49.4% in the adequate category. There was no significant association found between the caesarean delivery and weight gain (p value=0.07854). The cause may be attributed to increased number of CPD cases, macrosomia and preeclampsia in the excessive weight gain category. In a study conducted by Yayla Abide et al [10] 55% of the women in the insufficient category, 46.7% in the adequate category and 54.7% in the excessive category were found to have cephalopelvic disproportion. There was no significant association found between the

caesarean delivery and weight gain (p value=0.067).

Neonatal Outcome: Birth Weight: In the current study, the mean birth weight was slightly lower in the insufficient category group (2.7 kg). It was comparable in the adequate category (2.96 kg) and excessive weight gain category group (2.95 kg). Also, there was a significant association found between the birth weight and maternal weight gain (p value=0.015). These findings are parallel to a study conducted by Yayla Abide et al [10]. LBW infants were increased in pregnant women with insufficient weight gain in their study. Viswanathan et al reported a strong relationship between BMI and newborn weight which was in concordance to our study.

NICU Admission: In the current study, the proportion of NICU admission was comparatively higher in the insufficient category (22.22%). It was 16.87 % in the adequate category and 17.8% in the excessive category. There was no significant association found between the NICU admission and maternal weight gain (p value=0.69183). In a study conducted by Yayla Abide et al [10] 10% of the neonates of the women in the insufficient category, 7.6% of the neonates of women in the adequate category and 4.9% of the neonates of the women in the excessive category were found to be admitted to NICU.

In their study, there was a significant association found between the NICU admission and weight gain (p value=0.047).

APGAR scores (1 minute): In the group with insufficient weight gain in pregnancy, higher number of APGAR scores <7 at 1 minute were found (6.3%). It was 4.8% in the adequate weight gain category and 2.38 % in the excessive weight gain category.

Lower APGAR scores at 1 minute were comparatively more in inadequate weight gain category. However, there was no significant association found between the APGAR score at 1 minute and maternal weight gain (p value=0.4857). In a study conducted by Yayla Abide et al [10] ., 5.2% of the neonates of the women in the insufficient category, 4.3% of the neonates of women in the adequate category and 4.9% of the neonates of the women in the excessive category were found to have low APGAR scores at 1 minute.

In their study, there was no significant association found between the APGAR score at 1 minute and maternal weight gain (p value=0.873) APGAR scores (5 minute): In the group with insufficient weight gain in pregnancy, higher number of APGAR scores <7 at 5 minute were found (6.3%). It was 2.4% in the adequate weight gain category

and 1.1 % in the excessive weight gain category. Lower APGAR scores at 5 minutes were comparatively more in inadequate weight gain category. Cause can be attributed to more number of preterm cases in inadequate weight category. There was no significant association found between the APGAR score at 5 minute and weight gain (p value=0.1854).

In a study conducted by Yayla Abide et al [10] ., 5.2% of the neonates of the women in the insufficient category, 1.3% of the neonates of women in the adequate category and 0.5% of the neonates of the women in the excessive category were found to have low APGAR scores at 1 minute. In their study, there was a significant association found between the APGAR score at 5 minute and maternal weight gain (p value=0.001).

Conclusion

Gestational excessive and inadequate weight gain is associated with various complications during pregnancy. We can conclude from our study that by keeping the BMI before pregnancy in the normal range and gaining adequate weight gain in pregnancy, one can prevent various poorer outcomes of pregnancy and also reduce the poorer outcome which a neonate will encounter.

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