Original Research Article

The Impact of Gestational Weight Gain on Obstetric and Neonatal Outcomes in Pregnant Women with Lean Body Mass Index in the First Trimester

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Abstract

Optimal weight gain in pregnancy is required to meet the nutritional demand of pregnant female, changes in the physiology during pregnancy and also to meet the additional physiological and nutritional demands of the growing fetus(s). However, pre pregnancy weight gain and BMI is important determinant of maternal and fetal outcome. Institute of Medicine (IOM) has recommended weight gain in kg as per pre pregnancy BMI of the female. 100 females with BMI >18.5 were included in the study and were monitored for weight gain during pregnancy and out of the pregnancy (both maternal and fetal). It was concluded that females with BMI>18.5 and sub optimal weight gain (>12.5 kgs) had significantly lower neonatal birth weight than females with BMI>18.5 and optimal weight gain during pregnancy (12.5 -18kgs).

Keywords: Body Mass Index, Neonatal Outcomes, Obstetric Outcome, Pregnancy, Weight Gain.

Introduction

Obstetrics and neonatal outcome are significantly better in pregnant females with lean BMI in the first trimester and gestational weight gain as per the recommendation of the Institute of Medicine guidelines as compared to pregnant females with lean BMI in the first trimester and weight gain less than recommended by institute of medicine. Optimal weight gain in pregnancy is required to meet the nutritional demand of pregnant female, changes in the physiology during pregnancy and also to meet the additional physiological and nutritional demands of the growing fetus(s). During the first half of this century, weight gain guidelines during pregnancy were restrictive in the belief that obstetrical complications could thereby be avoided[1]. In 1970, the National Academy of Sciences recommended the ideal weight gain of 20 to 25 pounds in the gestation period[2].In 1983, the first edition of Guidelines for Perinatal Care[3]recommended a maternal weight gain of 22 to 27 pounds during pregnancy. In 1990, Institute of Medicine (IOM) recommended a maternal weight gain of 25 to 35 pounds for women with normal weight for height[4].The Institute of Medicine (IOM) guidelines were developed to provide recommended ranges of weight gain for optimal fetal growth and, best maternal and infant outcomes. Recently, these recommendations of IOM were revised by in accordance with the World Health Organization guidelines of overweight females (BMI 25.0 – 29.9 kg/m^2 instead of 26.0 – 29.9 kg/m^2) and obese females (>30.0 kg/m^2) which were lacking in the IOM guidelines issued in 1990[4,5]. Strict caloric restriction during pregnancy might be dangerous to the fetus, therefore many females believe that more the weight gain during pregnancy better it is for them and the fetus, which is actually not true. It has been seen that 37% of normal BMI females and 64% of overweight females (BMI =26.0 -29.9) gained more weight during the pregnancy than recommended by IOM [6,7].Weight gain during pregnancy more than the recommendations of IOM has been associated with maternal complications like preeclampsia and cesarean section deliveries, and neonatal complications like hypertension, diabetes mellitus, macrosomia (large for gestational age)[9-13]and obesity by the age of 3 years [14,15]. Gestational weight gain more that the recommendations of IOM has also been associated with maternal weight retention after pregnancy and future overweight[16-19].Therefore, to prevent postpartum obesity, it is critical to prevent excessive weight gain during pregnancy[20].Many studies have suggested that pre pregnancy weight is a significant predictor of weight changes during pregnancy. Although overweight women gain less absolute weight than normal-weighing women during pregnancy but women who are overweight before pregnancy are more likely to exceed IOM weight gain guidelines (with the 1990 IOM overweight criterion of BMI ≥26 kg/m2) as compared with normal-weight women[8,21,22]. The risks of excess gestational weight gain can be predicted with the pre-pregnancy BMI[23-26].Compared with normal BMI women, obese females when pregnant have a higher risk of first trimester pregnancy loss, recurrent miscarriages[27]and congenital anomalies like neural tube defects, heart defects, and omphaloceleetc[28-30]. Other complications related with pre-pregnancy obesity are chronic hypertension, pregnancy-induced hypertension, pregestational diabetes mellitus, gestational diabetes mellitus, postdated delivery [31-35], urinary tract infection[36] asthma, obstructive sleep apnea, and gallbladder diseases[37-38], and numerous other delivery [39], operative[40], and postpartum[41-44]complications. Maternal obesity also has a significant impact on developing fetus like higher risk of having fetal macrosomia, still birth[45,46] and childhood complications after delivery like childhood obesity[47].Available data suggest that the prevention of excessive weight gain during pregnancy does not have adverse consequences and it is in fact

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beneficial for the developing fetus and the mother. In a randomized trial by Asbee et al[48], it was seen that the intervention to limit the gestational weight gain significantly reduced the number of cesarean deliveries due to "failure to progress" compared with standard care (25% vs 58.3%). In another trial by Wolff et al[49], dietary counselling and gestational weight gain restriction did not had any adverse effects on fetal growth, and reported fewer incidences of pregnancy and birth complications when compared with the control group. Similarly, Claesson et al[50] found no significant differences between restricted weight gain group in obese female group and control group regarding mode of delivery and neonatal outcomes. Gray-Donald et al[51], Polley et al[52] and Olson et al[53] did not found any significant difference in the birth weight between the intervention and control group. However, results of these studies require further investigation in larger randomized controlled trials. Although there are certain contraindications for exercise during pregnancy (like pregnancy-induced hypertension and cervical incompetence) but research has shown that moderate aerobic exercise does not have any ill effect on the developing fetus[54,55]. In a study by Kulpa et al[54] it was found that moderate aerobic exercise was very effective to prevent the excessive weight gain in the gestational period with no adverse effects on the gestational age, birth weight, APGAR score or obstetric complications.The 2009 Institute of Medicine (IOM) recommendations for total weight gain ranges for pregnant women is as in the table below:

BMI	Recommended Weight Gain in Kgs
<18.5	12.5-18
18.5-24.9	11.5-16
25-29	7-11.5
≥30	5-9

This study aims to determine the weight gain among pregnant females which had low BMI (<18.5) in the first trimester and the fetal and maternal outcomes of these pregnancy.

Materials and Methods

This retrospective, observational study was conducted over a period of 1 year, in the Department of Obstetrics &Gynaecology at Fernandez Hospital at Bogulkunta, Hyderguda and Jubilee Hills, all located in Hyderabad. Participants for the study will be recruited from the antenatal clinics of Fernandez Hospital at Bogulkunta, Hyderguda and Jubilee Hills.

Inclusion Criterion

1. Pregnant women booked for antenatal care in the first trimester.
2. Exact date of LMP (Last Menstrual Period) known.
3. Singleton fetus
4. Lean BMI at baseline (BMI<18.5)

Exclusion Criterion

1. Multiple pregnancies
2. Fetal abnormalities
3. Did not consent to participate

There are three groups of interest:

1. Pregnant women who gain optimal weight during pregnancy
2. Pregnant women who gain less than optimal weight during pregnancy
3. Pregnant women who gain more than optimal weight during pregnancy

All pregnant women in the study undergo an individualized nutritional counseling program with follow up.

Variables Studied: Maternal demographics- age, socioeconomic status, urban/rural, education status, past and current medical and obstetric history, personal risk behaviors, gestational age, height, weight, BMI, fetal growth parameters, fetal abnormalities, pregnancy induced hypertension, gestational diabetes, maternal anemia, mode of delivery, gestational age at delivery, birth weight, neonatal growth classification, fetal distress, neonatal morbidity/mortality, intrauterine fetal death, miscarriages and still birth. Standard clinical measures will be used to ascertain variables.A potential source of bias is the more intense monitoring that will be offered for pregnant women who do not gain optimal weight. This intense monitoring may reduce the incidence or severity of adverse events. Maternal age, past and current medical and obstetric history, personal risk behaviors and socio-demographic characteristics are potential confounders. These will be compared at baseline and adjusted as necessary in the multivariate model.

Primary Outcome Variable

Gestational age specific Gestational weight gain.

Secondary Outcome Variables

Pregnancy induced hypertension, gestational diabetes mellitus, anemia, preterm delivery, still births, intrauterine fetal deaths, complications of delivery, fetal distress, birth weight, fetal growth and neonatal growth, neonatal mortality and morbidity.

Statistical Analysis

Frequency distributions and 95% confidence intervals around point estimates will be determined for the variables of interest. Parametric or non-parametric tests (depending on the normality of data) will be used to compare continuous and categorical data. An adjusted multivariate logistic regression model will be fitted to determine associations of gestational weight gain with adverse outcomes. We will also use tests for diagnostic effectiveness to explore the effectiveness of weight gain as a diagnostic measure for adverse events in pregnancy.

Results

A total of 1700 pregnant women who visited antenatal clinic were documented in our study, out of them 100 pregnant women who were underweight (BMI<18.5) were enrolled in the present study. The relationship of maternal and fetal outcome with respect to maternal weight gain was assessed and determined. Study population was divided into 2 groups: Group A (Wt gain <12.5 kg) and group B (Wt. gain 12.5 kgs-18 kgs). Study subjects who did not achieve adequate weight gain(<12.5kgs) were 61% while the subjects who achieved adequate weight gain (>12.5-18kgs) throughout pregnancy were 34%. Amongst them none of women gained more than 18 kgs during the pregnancy.

The mean and SD of age of the two groups (Group A and Group B) was found to be was 25.279±3.41yrs. and 24.788±3.51yrs respectively. The mean of BMI in Group A and Group B was 16.525±1.25 and 16.524±1.27 respectively. (Table 1)

With respect to delivery outcome, there was no significant difference in the mean gestational age at delivery (P value = 0.196) and rate of cesarean sections (P value = 0.037) between two groups (Table 2). Group A had significantly lower mean birth weight than the group B. Number of preterm babies in the group A and group B were 15 and 3 respectively, while the number of very preterm (<34 weeks) babies were 03 in group A and 01 in group B. (Table 3)

The number of females having pre-eclampsia, diabetes mellitus and anemia were 1.66%, 5% and 25 % in group A and 5.88%, 5.88% and 26.47% in group B.

In this study, 99 newborns were born in group A and group B. Low birth weight (LBW) was observed in19.19% newborns in group A and 9.09% newborns in group B, while 55.55% and 42.10% newborns were small for gestational age in group A and group B respectively. (Table 4)

The mean neonatal birth weight in group A and group B were found to be 2.9±0.001 and 3.202±0.36 respectively (Table 5). When mean

neonatal birth weights were compared with t test, the difference was found to be significant (P value=0.045). (Table 5)

Table 1: Comparison between Age, BMI and Gestational weight gain during pregnancy in Group A and Group B.

Parameters	GROUP A (<12.5)	GROUP B (>12.5-18)
Age	25.279 ± 3.41	24.788 ± 3.51
BMI	16.525 ± 1.25	16.524 ± 1.27
Gestational Weight Gain	9.34 ± 2.29	14.48 ± 1.46

Table 2: Comparison between outcome of gestational age at delivery, outcome of pregnancy and route of delivery in Group A and Group B.

Parameters	Group A (<12.5)	Group B (>12.5-18)	P-value*
GA At Delivery	37.46± 5.24	38.68 ± 1.62	0.196
Route of delivery			
Vaginal delivery: Normal	48	22	-
Forceps extraction	8	7	-
Vaccum extraction	3	2	-
C-section	3	6	0.037
Miscarriage	1	0	-

*Student t-test was applied.

Table 3: Comparison of various co-morbidities and complications during pregnancy in Group A and Group B

Parameters	Group A (<12.5)	Group B (>12.5-18)	P-Value
Pre-Eclampsia	1	2	-
Diabetes Mellitus	0	2	-
Preterm (<37wks)	15	3	0.077
Very Preterm(<34wks)	3	1	-
Macrosomia(>4.5kgs)	0	1	-
Anemia	15	9	0.507

Table 4: Comparison of neonatal birth weight in Group A and Group B

Fetal Outcome	Group A (<12.5)	Group B (>12.5-18)	P-Value
Neonatal Birth Wt.	2.9 ± 0.001	3.202 ± 0.36	0.045

Table 5: Comparison of neonatal complications observed at the delivery in Group A and Group B

Parameters	Group A (<12.5)	Group B (>12.5-18)
LBW	19	9
SGA	25	8
Birth Asphyxia	1	2

Discussion

The prevalence of underweight in our population was 6%, which was in the range of 3.8-21.6% in other population groups[62-70].Our study depicted the relationship of gestational weight gain in females with BMI > 18.5 and maternal and neonatal outcome. Mean BMI with SD in group A and group B was 16.525 +1.25 and 16.524 +1.27 respectively. Pre-pregnancy body mass index and gestational weight gain are both considered to be the predictors of the maternal nutritional status and have shown to influence the pregnancy outcome. There is evidence that suboptimal and excessive weight gain, both are associated with adverse pregnancy outcome. Nan li et al found that lean women with poor weight gain during pregnancy were found to be at greater risk of low birth weight of the newborn. A minimum weight gain of 8.6 kg is needed to prevent low birth weight. Li et al and Inoue et al reported similar findings in the Indonesian population[61,71]. However, Ronnenberg et al. found no association between maternal BMI and preterm birth in the group of women[72].It was also found that in group A 15 babies were born preterm and 03 were born very pre term (<34 weeks), while in group B only 03 babies were born preterm and 01 baby was born very preterm (<34 weeks). In comparison between the group A and group B, it was seen that there was a significantly lower mean birth weight for group A than group B. However, no significant difference was observed in group A and group B with respect to delivery outcomes, mean gestational age at delivery and rate of cesarean sections.Apiwantana Suttanaratt et al conducted a study, in which they found that newborns of underweight mothers with inadequate weight gain had significantly lower mean birth weight than newborns of underweight women with adequate weight gain[62]. Their result was in line with the finding of Mitchell et al who reported that birth weight increased significantly with antenatal weight gain in a group of underweight mothers[73]. The relationship between inadequate weight gain and the risk of LBW was also observed in study by Hulsey et al, in which they found that underweight females with gestational weight gain less than 12.7 kg had a 4.1-fold increase in the risk of delivering a moderately LBW infant while increase in very LBW cases was by 2-fold compared to mothers with normal BMI who had adequate weight gain[74]. Unlike their results, we found no significant relationship between inadequate weight gain and the risk of LBW. This might be because we assigned underweight women with weight gain ≥12 kg as the reference group and considered weight gain less than 12 kg to be inadequate weight gain which were different from the study of Hulsey et al. Nevertheless, our finding of an association between gestational weight gain less than 8 kg and a 4.5-fold increase in the risk of LBW should alert the physicians to be aware of this adverse outcome and carefully monitor the women who are at risk. In addition to LBW, studies of Harita et al, Simas et al, and Jeric et al reported an association of inadequate weight gain in underweight pregnant women with the risk of having an SGA infant[63-65].Likewise, they were unable to find a relationship between inadequate weight gain and risks of birth asphyxia and NICU admission.

Maciejkanadyswiesław conducted a study which has demonstrated that some adverse outcomes of pregnancy are associated with low pre pregnancy weight. They found that underweight women showed increased risk for SGA, and low birth weight infants in comparison to normal weight patients. Whereas, ApiwantanaSuttanaratt et alconcluded, that underweight women with gestational weight gain less than 12 kg were not at higher risk of LBW, SGA, birth asphyxia, and NICU admission than thin women whose weight gain was ≥12 kg throughout pregnancy.Apiwantana Suttanaratt, Sooklim Ratchadawan et al observed a significantly lower rate of overall primary cesarean section in a group of underweight gravidas with inadequate weight gain compared to thin women with adequate weight gain. This finding was in correlation with the results of Ehrenberg et al and Saereeporncharenkul et al in their study reported that underweight was a protective factor for cesarean section[68,75].

Our study subjects having pre-eclampsia, diabetes mellitus and anemia in group A had incidence of 1.66% ,5% and 25% respectively. While women in group B had occurrence rate of 5.88%, 5.88% and 26.47% respectively (p-value 0.507).Nan li et al found that only women with pre pregnancy underweight and adequate GWG had decreased risks of pregnancy-induced hypertension and caesarean section compared with women with normal pre pregnancy weight and adequate GWG with respect to delivery outcomes in our study there were no significant differences of mean gestational age at delivery and rate of cesarean sections between two groups, with p-value 0.196 of gestational age at delivery. Study group also had significantly lower mean birth weight than the control group[61]. Maciejkanadyswiesław concluded that low maternal weight was associated with increased prevalence of preterm delivery and low birthweight. In this study it was noticed that in this group of women there was low incidence of GDM, PIH, and neonates with large birthweight. This study showed increase in the frequency of spontaneous preterm delivery in underweight group, but this was not statistically significant[68,76-82].Nan li et al[61]documented that maternal prepregnancy underweight was associated with increased risks of infant SGA and low birth weight, and maternal inadequate GWG and was associated with increased risks of infant preterm delivery and SGA.Ross et al. found that women with underweight had a smaller plasma volume, lower cardiac output, increases in peripheral vascular resistance, and lower rennin-aldosterone response in pregnancy compared with normal-weight women. Inadequate maternal hemodynamics is associated with uteroplacental insufficiency and the increased prevalence of small for gestational age babies[83,84].Research indicates that activity of placental transport mechanisms is directly modulated by maternal nutrition[85].

There were some limitations of our study.

1. This study was retrospective in nature, due to which some of the socio-demographic details which were not recorded previously could not be added.
2. Our study was conducted in a small population and focused mainly on neonatal outcomes.
3. Weight at the time of first contact was taken as pre-pregnancy weight. It is one of the limitations of this study.
4. Only those patients were considered who were registered in their first trimester of pregnancy as the expected weight gain in first trimester was very low.

Conclusion

Pregnancy has been identified as a key time to target a weight control or weight loss strategy to help curb the rapidly growing epidemic [(59)].A new paradigm for prevention, which evolved from the notion that environmental factors in utero may influence lifelong health, has emerged in recent years. A large number of epidemiological studies have demonstrated a direct relationship between birth weight and BMI attained in later life. Although the data are limited by lack of information on potential confounders, these associations seem robust. Possible mechanisms include lasting changes in proportions of fat and lean body mass, central nervous system appetite control, and pancreatic structure and function. Additionally, lower birth weight seems to be associated with later risk for central obesity, which also confers increased cardiovascular risk. This association may be mediated through changes in the hypothalamic pituitary axis, insulin secretion and sensing, and vascular responsiveness. The combination of lower birth weight and higher attained BMI is most strongly associated with later disease risk. We are faced with the seeming paradox of increased adiposity at both ends of the birth weight spectrum— higher BMI with higher birth weight and increased central obesity with lower birth weight[47].The 1990 IOM guidelines for weight gain during pregnancy were based on the strong association between gestational weight gain and infant size at birth. Although the association between gestational weight gain and preterm birth is strong, it is complex and biological plausibility for a causal relationship is questionable. In contrast, moderately strong evidence links gestational weight gain to infant mortality [(60)]. The new guidelines envisioned a model of care that considered all women of childbearing age to have the potential to become pregnant.

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