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Original Article

Obstetrics and Gynaecology Section

Association of Pre Pregnancy Body Mass Index and Gestational Weight Gain on Pregnancy Outcomes in Women with Gestational Diabetes: A Retrospective Observational Study

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ABSTRACT

Introduction: The incidence of obesity and gestational diabetes is increasing globally. Gestational diabetes and obesity are known to be independently associated with adverse perinatal outcomes. Gaining excess weight in pregnancy, especially in obese and overweight women appears to increase the risk of maternal and neonatal complications.

Aim: To evaluate the association of maternal Body Mass Index (BMI) and Gestational Weight Gain (GWG) with pregnancy outcomes in women with Gestational Diabetes Mellitus (GDM).

Materials and Methods: The present retrospective observational study was conducted at Fernandez Hospital, Hyderabad, Telangana, India from January 2017 to December 2019. Singleton pregnancies with gestational diabetes were included. Those booked after first trimester or with pregestational diabetes or hyperthyroidism were excluded. Based on BMI, participants were categorised into lean (<18.5 kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2) and obese (>30 kg/m^2) groups. Based on recommended weight gain for each BMI category, Institute of Medicine (IOM) has laid specific ranges. GWG in each group was divided into inadequate, adequate and excessive weight gain as per these recommendations. Maternal and perinatal outcomes were compared between groups. Regression analysis was carried out and adjusted odds ratio, along with their 95% CI was presented. The p-value <0.05 was considered statistically significant. Statistical Package for the Social Sciences (SPSS) version 25 was used for analysis.

Results: Total of 2626 pregnant women were included. Obese and overweight population was 575 (21.9%) and 1095 (41.7%), respectively. Based on GWG, 1042 (39.7%) and 633 (24.1%) had inadequate and excessive weight gain respectively in the entire study population. Both obese and overweight groups had higher caesarean section rates compared to the other two groups. As per regression analysis, obese women had significant adjusted odds ratio {2.32 (95% CI 1.6-3.31)} for gestational hypertension and need for Induction of Labour (IOL) {1.48 (95% CI 1.11-1.97)}. Women with inadequate weight gain had less gestational hypertension {0.68 (95% CI 0.49-0.95)}, need for IOL {1.28 (95% CI 1.001-1.64)}, and less chance for large for gestation age babies {0.67 (95% CI 0.51-0.89)} and more preterm deliveries {1.63 (95% CI 1.20-2.20)} as compared to other groups. In excessive weight gain, odds ratio for large for gestation age babies was found to be significant (p-values <0.001), Adjusted OR {(2.01 (95% CI 1.54-2.64)}.

Conclusion: Obese women had higher rate of IOL and caesarean section rate, excess GWG group had higher incidence of large for gestation age neonate.

Keywords: Hyperglycaemia, Neonatal, Obesity, Overweight, Perinatal, Pregnant women

INTRODUCTION

The proportion of obese individuals is increasing globally and nationally. India has witnessed an alarming rise of 60% in the rate of obesity from 12.6 to 20.7% as reported in NFHS-3 and NHFS-4, respectively [1]. Overweight or obesity affects the prevalence of GDM with an adjusted odds ratio of 2.23 [2]. As per the International Diabetes Federation (IDF) latest reports, the current prevalence of GDM was found to be 14% [3]. IDF estimates that 16.8% of births were in women with hyperglycaemia in pregnancy, of which 84% were due to GDM [3]. In 2014, India had the largest number of overweight and obese pregnant women (11.1%, 4.3 million) in the world [4]. Urbanisation, increase in calorie surplus and gross national income and less of agricultural employment led to obesity [5]. GDM is often associated with adverse pregnancy, neonatal, and perinatal outcomes along with several adverse health effects in the later life of women [6]. Likewise with the obesity, that further increases the risk of these outcomes by 2-3 folds [7]. Weight gain during pregnancy (GWG) is associated with the risk of obesity thereby with the associated adverse outcomes. Excessive GWG is common in women with GDM, raising the incidence of obesity and adverse pregnancy outcomes like Large for Gestational Age (LGA) babies [8]. The complex interplay of association between obesity, GWG and GDM is less studied. However, to ensure better pregnancy care, IOM in 2009 recommended optimal weight gain in pregnancy based on pre-pregnancy BMI [9]. Maternal gestational diabetes and obesity are known to be independently associated with adverse perinatal outcomes [10]. Gaining excess weight in pregnancy, especially in obese and overweight women appears to increase the risk of maternal and neonatal complications [11].

Studies so far have been carried out to postulate the effect of obesity on pregnancy outcomes in women without GDM [11]. Miao M et al., evaluated the influence of excess maternal weight and GWG on pregnancy outcomes among gestational diabetes women and reported that high pre-pregnancy BMI and excessive GWG were associated with higher incidences of caesarean section rate and Large for Gestational Age (LGA) babies [12]. Another study

found that caesarean section, large for gestation age fetuses and macrosomia were associated with obesity in GDM [10]. Studies on the effect of pre-pregnancy BMI and GWG on pregnancy outcome in GDM women was found to be lacking in developing countries like India and so we carried out this retrospective observational study to fill the paucity.

The aim of the study was to evaluate the association of BMI and GWG with perinatal and pregnancy outcomes including gestational hypertension, hypothyroidism, Preterm Premature Rupture of Membranes (PPROM), IOL, caesarean section, preterm birth, low APGAR score at 5 minutes, Small for Gestational Age (SGA), LGA, grow centile and birth weight among pregnant women with GDM.

MATERIALS AND METHODS

The present retrospective observational study was carried out at Fernandez Hospital, Hyderabad, Telangana, India from January 2017 to December 2019. Convenient sampling technique was used in the study as it was a retrospective analysis of data. A total of 2626 pregnant women with GDM were included in the final analysis.

Inclusion criteria: Inclusion criteria were singleton pregnant women, who were booked in the first trimester and diagnosed with GDM.

Exclusion criteria: Excluded women who were booked after first trimester, those who were diagnosed with pregestational diabetes and hyperthyroidism (independent factor that can influence weight gain), and those where data was incomplete.

Study Procedure

All the demographic details along with the perinatal and pregnancy outcome parameters were collected using a structured data collection sheet.

Each woman in antenatal clinic at the study site undergoes a standardised examination protocol of collecting details like woman's age, previous obstetric history, if any, and history of pre-existing medical conditions like hypertension, thyroid disorders and diabetes and screened for pre-existing diabetes. BMI was derived with booking weight in kilograms divided by square of the height in metres (kg/m^2). As per World Health Organisation (WHO) recommendations, the women were categorised into four groups based on BMI viz., as having lean (<18.5 kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2) and obese (>30 kg/m^2) [13]. At the time of booking visit, women were educated about diet, exercise, and the need to limit excessive weight gain to have the best pregnancy outcomes. As per hospital protocol, women with lean BMI and/or obese were offered nutrition counselling at booking for optimal weight gain in pregnancy. The IOM recommendation for weight gain in lean BMI, normal BMI, overweight and obese women is 12.5-18 kg, 11.5-16 kg, 7-11.5 kg, 5-9 kg, respectively [9]. All pregnant women were screened between 11 to 13+6 weeks to assess the risk for chromosomal abnormalities, between 19-20 weeks for foetal anomalies and foetal growth assessment based on risk factors. Women were screened for GDM using the 75 grams oral glucose tolerance test, as per International Association of Diabetes and Pregnancy Study Groups (IADPSG) guidelines. With normal range as fasting blood glucose <92 mg/dL,1st hour blood glucose as <180 mg/dL and 2nd blood glucose value as <153 mg/dL. Women with one or more values deranged were considered as GDM [14]. All the GDM-diagnosed women were managed as per the institutional protocol, based on available evidence. Based on glycaemic control, delivery was planned, and types of labour, mode of delivery and neonate details were noted.

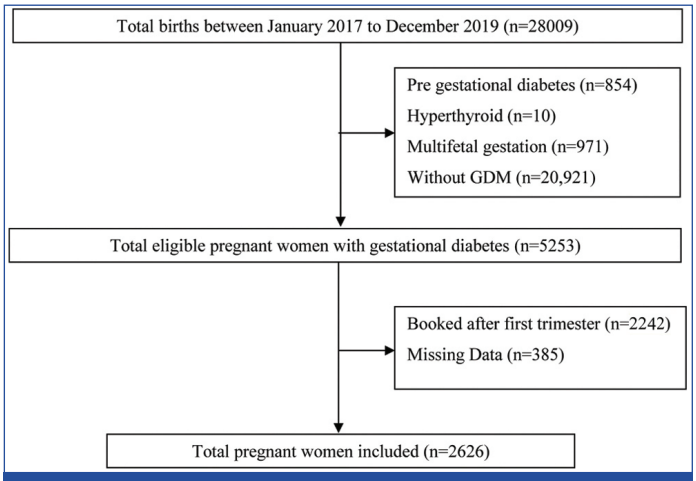
Based on the International Society for the Study of Hypertension in Pregnancy (ISSHP) guidelines, hypertension in pregnancy was diagnosed as chronic (predating pregnancy or diagnosed before 20 weeks of pregnancy) or de novo (either preeclampsia or gestational hypertension) [15]. A low Apgar score was defined as an Apgar score of <6 at five minutes of birth. Preterm birth was defined as birth before 37 completed weeks of gestation. Based on birth weight, neonates were categorised into average for gestational age, Appropriate for Gestational Age (AGA), SGA, and LGA using customised GROW charts from the Perinatal Institute, Birmingham, UK [16].

STATISTICAL ANALYSIS

Descriptive analysis was carried out. Analysis was done to compare the outcomes among lean, normal, overweight and obese gestational diabetic women. Based on GWG, women were categorised into inadequate, adequate and excessive weight gain, and outcomes were compared. For normally distributed quantitative parameters, the mean values were compared between study groups using one-way Analysis of Variance (ANOVA) test (>2 groups). If a statistically significant difference was found in ANOVA, an appropriate post-hoc test (LSD) was used to assess the statistical significance of pairwise comparisons. For non-normally distributed Quantitative parameters, the median values were compared between study groups using the Kruskal-Wallis test. Categorical outcomes were compared between study groups using the Chi-square test. Univariate Binary logistic regression analysis was performed to test the association between the explanatory variables and outcome variables. Variables with statistical significance in univariate analysis were used to compute into multivariate regression analysis. Adjusted odds ratio, along with their 95% CI was presented. The p-value <0.05 was considered statistically significant. Statistical analysis was performed using the SPSS version 25 [17].

RESULTS

A total of 2626 pregnant women with GDM were included in the final analysis, [Table/Fig-1] represents the population filtered at each level of screening for inclusion in the study.



[Table/Fig-1]: Study flow diagram.

Based on the pre-pregnancy BMI, 1.7%, 34.7%, 41.7%, and 21.9% of women were found to be lean, normal, overweight, and obese, respectively [Table/Fig-2]. Based on GWG, greater proportion of women (39.7%) were in the inadequate weight gain group while 36.2% had adequate weight gain in pregnancy. Significant difference was observed in the maternal age, proportion of nulliparous women and BMI between the groups with p-value 0.005 and <0.001 and <0.001, respectively [Table/Fig-3]. Except in lean BMI women, mean birth weights of neonates were significantly higher as weight gain increased in normal, overweight and obese women with p-value <0.001 [Table/Fig-4].

After adjusting with maternal age, parity, and gestational age, a comparison of normal BMI women with lean BMI reported no significant morbidities and adverse perinatal outcomes. In the adjusted analysis, overweight and obese groups were found to be associated with caesarean section compared to normal BMI group,

Parameters	BMI				
	Lean BMI	Normal BMI	Over weight	Obese	p-value
	<18.5	18.5-24.9	25-29.9	30 and more	
No. of observations (n, %)	44 (1.7%)	912 (34.7%)	1095 (41.7%)	575 (21.9%)	
Maternal age (mean±SD)	26.73±3.98	28.68±3.92	29.68±3.92	30.12±4.19	<0.001[a]
Age >=35 years	2 (4.5%)	67 (7.3%)	118 (10.8%)	88 (15.3%)	<0.001[b]
Nulliparous	31 (70.5%)	543 (59.5%)	553 (50.5%)	239 (41.6%)	<0.001[b]
Artificial reproductive conception	0 (0%)	19 (2.1%)	40 (3.7%)	18 (3.1%)	0.126[b]
Neonatal characters					
Gestational age at delivery, weeks (mean±SD)	38.25±1.37	38.04±1.53	37.89±1.66	37.76±1.66	0.005[a]
Birth weight (kg) (mean±SD)	2.92±0.48	2.95±0.46	2.99±0.5	3.01±0.53	0.099[a]
Grow centile (median (IQR))	59.3 (30.2-82.7)	55.7 (31.7-79.6)	55.9 (26.5-79.7)	51.6 (23.7-81.6)	0.597[c]
Small for Gestational Age (SGA)	5 (11.4%)	73 (8%)	87 (7.9%)	54 (9.4%)	0.493[b]
Large for Gestational Age (LGA)	8 (18.2%)	123 (13.5%)	158 (14.4%)	95 (16.5%)	

[Table/Fig-2]: Comparison of study population based on BMI categories.
[a]=One-way ANOVA test; [b]=Chi-squared test, [c]=Kruskal-Wallis test

Parameters	Inadequate	Adequate	Excessive	p-value
No. of observations n (%)	1042 (39.7%)	951 (36.2%)	633 (24.1%)	
Mean maternal age	29.65±4.06	29.35±4.09	28.98±3.88	**0.005[a]**
Age >=35 years	123 (11.8%)	95 (10%)	57 (9%)	0.160[b]
Nulliparous	474 (45.5%)	505 (53.1%)	387 (61.1%)	**<0.001[b]**
Artificial reproductive conception	31 (3%)	29 (3%)	17 (2.7%)	0.910[b]
BMI (mean±SD)	25.49±4.31	27.06±4.48	28.82±4.33	**<0.001[a]**
Neonatal characters				
Gestational age at delivery, weeks (mean±SD)	37.73±1.7	38±1.56	38.12±1.52	**<0.001[a]**
Birth weight (kg) (mean±SD)	2.88±0.48	2.99±0.47	3.13±0.51	**<0.001[a]**
Grow centile (median (IQR))	49.5 (25.1-75.7)	53.8 (27-78.9)	63.8 (32.3-88.9)	**<0.001[c]**
Small for Gestational Age (SGA)	103 (9.9%)	78 (8.2%)	38 (6%)	**<0.001[b]**
Large for Gestational Age (LGA)	107 (10.3%)	130 (13.7%)	147 (23.2%)	

[Table/Fig-3]: Comparison of study population based of GWG categories.
[a]=One-way ANOVA test; [b]=Chi-squared test, [c]=Kruskal-Wallis test

BMI	GWG	No. (%)	Weight gain in pregnancy (Mean±SD)	p-value	Birth weight (Mean±SD)	p-value
Lean	Inadequate	22 (50%)	8.64±1.93	**<0.001[a]**	2.83±0.48	0.398a
	Adequate	19 (43.2%)	15.12±1.47		2.99±0.5	
	Excessive	3 (6.8%)	20.0±1.0		3.16±0.18	
Normal	Inadequate	574 (62.9%)	7.79±2.54	**<0.001[a]**	2.86±0.45	**<0.001[a]**
	Adequate	268 (29.4%)	13.63±1.36		3.08±0.44	
	Excessive	70 (7.7%)	19.68±3.89		3.16±0.45	
Overweight	Inadequate	321 (29.3%)	4.53±1.63	**<0.001[a]**	2.9±0.52	**<0.001[a]**
	Adequate	449 (41%)	9.08±1.35		2.94±0.48	
	Excessive	325 (29.7%)	14.73±3.11		3.13±0.49	
Obese	Inadequate	125 (21.7%)	2.7±1.5	**<0.001[a]**	2.9±0.52	**<0.001[a]**
	Adequate	215 (37.4%)	7.11±1.26		2.95±0.48	
	Excessive	235 (40.9%)	12.94±3.17		3.12±0.55	

[Table/Fig-4]: Comparison of birth weights among BMI groups as per Gestational Weight Gain (GWG).
[a]=One-way ANOVA test

p-value <0.001. Along with caesarean section, obesity was found to be associated with gestational hypertension, hypothyroidism, need for labour induction, as well with p-values of <0.001, 0.047 and 0.007. respectively. Except for gestational hypertension in the obese group, no other outcome showed 2-fold increased rate of incidence, as per adjusted OR [Table/Fig-5].

Outcome	Lean BMI (N=44)			Normal (N=912)	Overweight (N=1095)			Obese (N=575)		
	n (%)	AOR (95% CI)	p-value	n (%)	n (%)	AOR (95% CI)	p-value	n (%)	AOR (95% CI)	p-value
Gest HTN[a]	5 (11.4%)	1.77 (0.67-4.70)	0.251	66 (7.2%)	99 (9%)	1.28 (0.92-1.78)	0.150	83 (14.4%)	2.32 (1.63-3.31)	**<0.001**
Thyroid[a]	7 (15.9%)	0.51 (0.22-1.16)	0.108	258 (28.3%)	340 (31.1%)	1.12 (0.92-1.36)	0.273	194 (33.7%)	1.26 (1.004-1.59)	**0.047**
PPROM[a]	1 (2.3%)	2.45 (0.3-20.04)	0.402	13 (1.4%)	27 (2.5%)	1.68 (0.81-3.49)	0.165	8 (1.4%)	0.68 (0.24-1.96)	0.475
IOL[a]	7 (15.9%)	0.88 (0.38-2.04)	0.761	154 (16.9%)	194 (17.7%)	1.16 (0.91-1.47)	0.237	110 (19.1%)	1.48 (1.11-1.97)	**0.007**

Caesarean[a]	16 (36.4%)	1.09 (0.57-2.08)	0.792	357 (39.1%)	589 (53.8%)	1.66 (1.38-1.99)	<0.001	339 (59%)	1.93 (1.55-2.41)	**<0.001**
Preterm[b]	4 (9.1%)	1.11 (0.39-3.19)	0.849	77 (8.4%)	114 (10.4%)	1.22 (0.90-1.66)	0.200	56 (9.7%)	1.09 (0.75-1.57)	0.664
Low APGAR[a]	2 (4.5%)	1.40 (0.32-6.15)	0.655	30 (3.3%)	26 (2.4%)	0.73 (0.43-1.27)	0.267	19 (3.3%)	1.08 (0.59-1.98)	0.801
SGA[a]	5 (11.4%)	1.73 (0.64-4.70)	0.279	73 (8%)	87 (7.9%)	0.96 (0.68-1.36)	0.831	54 (9.4%)	1.23 (0.83-1.83)	0.302
LGA[a]	8 (18.2%)	1.55 (0.69-3.47)	0.287	123 (13.5%)	158 (14.4%)	1.05 (0.81-1.36)	0.696	95 (16.5%)	1.24 (0.92-1.68)	0.158

[Table/Fig-5]: Effects of pre-pregnancy BMI on pregnancy outcomes.
AOR: Adjusted odds ratio; BMI: Body mass index; CI: Confidence interval; HTN: Hypertension in pregnancy; PPROM: Preterm premature rupture of membranes; IOL: Induction of labour; SGA: Small for gestational age; LGA: Large for gestational age
AORs are presented relative to normal BMI group. [a]adjusted for maternal age, parity and gestational age; [b]adjusted for maternal age and parity

After adjusting for maternal age, BMI, parity and gestational age, compared to women with adequate weight gain, women with inadequate weight gain had less gestational hypertension, less chance of IOL, more preterm delivery, and less incidence of LGA neonates. In the excessive weight gain group, the incidence of LGA was more compared with the adequate GWG group but other pregnancy morbidities and neonatal outcomes were similar [Table/Fig-6]. As there were only four stillborn and one neonatal death in the study population, these outcomes were not analysed in the study.

	Inadequate (N=1042)			Adequate (N=951)	Excessive (N=633)		
Outcome	n (%)	AOR (95% CI)	p-value	n (%)	n (%)	AOR (95% CI)	p-value
Gest HTN[a]	78 (7.5%)	0.68 (0.49-0.95)	**0.022**	101 (10.6%)	74 (11.7%)	1.02 (0.73-1.41)	0.929
Hypothyroid[a]	324 (31.1%)	1.11 (0.91-1.35)	0.291	277 (29.1%)	198 (31.3%)	1.08 (0.86-1.35)	0.510
PPROM[a]	24 (2.3%)	0.99 (0.48-2.04)	0.972	17 (1.8%)	8 (1.3%)	0.77 (0.30-1.96)	0.581
IOL[a]	182 (17.5%)	1.28 (1.001-1.64)	**0.049**	162 (17%)	121 (19.1%)	0.95 (0.72-1.25)	0.730
Caesarean[a]	478 (45.9%)	0.84 (0.70-1.01)	0.068	474 (49.8%)	349 (55.1%)	1.22 (0.99-1.51)	0.067
Preterm[b]	128 (12.3%)	1.63 (1.20-2.20)	**0.002**	77 (8.1%)	46 (7.3%)	0.87 (0.60-1.29)	0.495
Low APGAR[a]	30 (2.9%)	0.93 (0.56-1.56)	0.784	32 (3.4%)	15 (2.4%)	0.63 (0.33-1.18)	0.147
SGA[a]	103 (9.9%)	1.10 (0.79-1.53)	0.584	78 (8.2%)	38 (6%)	0.78 (0.51-1.19)	0.243
LGA[a]	107 (10.3%)	0.67 (0.51-0.89)	**0.005**	130 (13.7%)	147 (23.2%)	2.01 (1.54-2.64)	**<0.001**

[Table/Fig-6]: Effects of GWG on pregnancy outcomes.
AOR: Adjusted odds ratio; BMI: Body mass index; CI: Confidence interval; GWG: Gestational weight gain; HTN: Hypertension in pregnancy; PPROM: Preterm premature rupture of membranes; IOL: Induction of labour; SGA: Small for gestational age; LGA: Large for gestational age
AORs are presented relative to adequate weight gain group. [a]adjusted for maternal age, BMI, parity and gestational age; [b]adjusted for maternal age, BMI and parity

DISCUSSION

In the current study, 41% were overweight and 39% gained inadequate weight in pregnancy. Though women of >35 years were more in obese group (15%) only 9% had excess GWG, maybe women of advanced age were more likely to comply with lifestyle recommendations during pregnancy. Among the lean and normal-weight participants, more women were nulliparous and were delivered at higher mean gestation age compared with overweight and obese women. Women with inadequate GWG had more preterm births, and less LGA compared to normal GWG in the present study.

Total GWG decreased as pre-pregnancy BMI increased, which was similar to the study by Miao M et al., [12]. Nutrition counselling in first trimester played a role in GWG in pregnancy. Interestingly, different BMI groups had different GWG, with a higher percentage of inadequate GWG in lean and normal BMI, adequate GWG in overweight and excess GWG in obese. This was in contrast with earlier studies where lean BMI had 50% adequate weight gain and 24% excess weight gain, and normal weight women had 43.7% adequate GWG and 31% excessive weight gain, while 53% of the overweight and 45% of the obese had excessive GWG [12]. Though it is difficult to explain the difference, the counselling about GWG might be reinforced seriously by the health care provider. However, the proportion of women with excessive GWG increased as BMI increased in both the studies.

The proportion of overweight and obese women are more in our study compared to a similar study by Miao M et al., [12]. The same study reported no significant difference between the four BMI groups in terms of maternal age, parity, and gestational weeks at delivery which is in disagreement with the current study findings. This could be due to the differences in the sociocultural habits, lifestyle and food habits of the study population. Birth weight was significantly higher in overweight or obese women than in underweight women in a study by Miao M et al., in contrast to our study where no difference was observed in birth weight [12].

Diabetes and obesity independently increase the risk of caesarean section, and hence the raise in caesarean section rate globally [18]. The caesarean section rate was more in overweight and obese women compared to normal BMI group [12]. The caesarean section rate was not different based on GWG in our study (45.9% in inadequate weight gain group, 49.85% in adequate weight gain group and 55% in excessive weight gain group); a similar observation by Egan AM et al., (39.45% in excessive weight gain group and 43.2% in no excessive weight gain group [19]. Higher odds for caesarean were observed in excess GWG group in a study by Miao M et al., (50.3% in inadequate weight gain group 48.3% in adequate weight gain group whereas 60.4% in excessive weight gain group [12]. Another study had 40.6% caesarean section in inadequate weight gain group, 48.9% in adequate weight gain group and 52.8% in excessive weight gain [20]. Obese women are at risk of developing raised blood pressure in the present study, which is in line with the other study findings of association between increased BMI and high GWG and hypertension in pregnancy [21-23]. LGA were more in excessive GWG and less in inadequate GWG group, similar observations were noted in other studies [20,24]. SGA were not high in lean BMI and inadequate GWG group. No difference was observed about the timing of delivery and birth weight at delivery based on pre-pregnancy BMI groups in the present study, which is similar to the other study that reported no association between BMI and neonatal birth weight [22].

The current study backs the existing evidence to further strengthen that the pre-pregnancy BMI and GWG influence the perinatal outcome among GDM women; hence counseling at the pre pregnancy period and/or in the first trimester about healthy lifestyle changes is important. Holding the fact that the chances of delivering

an LGA baby increases with the increasing GWG in the case of women with GDM, and GDM women with lower BMI or lower weight gain had less chance of LGA, it is high time for the IOM to postulate the specific guidelines for optimal weight gain for GDM women.

Limitation(s)

The limitation of the current study was that it is a retrospective study of a single centre. Convenient sampling method was used. These factors cannot rule out selection bias and the enrolled cohort may not represent the general population. Exercise and use of oral hypoglycaemic agents and insulin may have influenced the association between GWG and perinatal outcomes.

CONCLUSION(S)

After adjusting the potential confounder obesity was found to be associated with caesarean section, gestational hypertension, hypothyroidism, need for labour induction. In case of GWG, excessive weight gain was found to be associated with LGA babies. Women with inadequate weight gain had less gestational hypertension, need for IOL, more preterm delivery, and less incidence of LGA neonates. Further research is required to identify ideal BMI and optimal GWG to reduce adverse perinatal outcomes in Asian population where there is high prevalence of gestational diabetes.

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