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Incidence of excessive gestational weight gain among overweight and obese women

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Objective
To determine the incidence of excessive gestational weight gain (GWG) among overweight and obese pregnant women, its associated factors, and pregnancy outcomes.

Methods
A total of 355 overweight or obese singleton pregnant women who were included. Obstetric characteristics, weight gain, and pregnancy outcomes, were extracted from medical records. GWG was categorized according to the Institute of Medicine recommendation. Comparisons were made between individuals with inadequate, normal, and excessive GWG. Logistic regression analysis was performed to determine independent associated factors for excessive GWG.

Results
Majority of the women were overweight (68.7%), 38.9% were nulliparous, and mean pre-pregnancy body mass index was 28.9 kg/m^2. Excessive GWG was observed in 53% of the women. Women with excessive GWG had significantly higher weight gain in every trimester. Risk of excessive GWG increased in women ≤30 years, while gestational diabetes (GDM) significantly decreased the risk. Women with excessive GWG had a significantly higher primary cesarean section rate. Both women with normal and excessive GWG showed higher rate of having large for gestational age (LGA) infants (*P*=0.003). Maternal age of ≤30 years significantly increased the risk of excessive GWG (adjusted odds ratio [aOR], 1.91; 95% confidence interval [CI], 1.11-3.27) and GDM significantly decreased this risk (aOR, 0.40; 95% CI, 0.24-0.67).

Conclusion
The incidence of excessive GWG among overweight and obese women was 53%. Maternal age of ≤30 years significantly increased this risk while women with GDM were significantly decreased risk. Primary cesarean section and fetal LGA significantly increased in women with excessive GWG.

Keywords: Overweight; Obesity; Gestational weight gain; Risk factors

Introduction

The body weight of the global population has been increasing in recent decades due to changes in lifestyle, the global civilization, and the development of foods and facilities. The World Health Organization estimated that, in 2022, 43% of adults aged 18 years and over (43% of men and 44% of women) were overweight or obese, an increase from 25% in 1990. Being overweight and obese are considered to be serious health problems worldwide [1-3]. Over the years, an increasing trend of obesity and being overweight has been observed in both men and women in Thailand as well, resulting in an increasing rate of pregnant women who are overweight or obese [4].

Numerous studies have consistently reported that higher pre-pregnancy body mass index (BMI) and greater gestational

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weight gain above the recommended value have an adverse impact on both maternal and fetal outcomes [5-12]. Overweight and obese pregnant women are at an increased risk for adverse pregnancy outcomes such as gestational diabetes (GDM), pregnancy-induced hypertension, fetus that are small and large for gestational age (LGA), fetal growth restriction, increased cesarean section rate, shoulder dystocia, and postpartum hemorrhage [6,9,11,12]. A previous systematic review reported that gestational weight gain above the recommendations was associated with higher risk of LGA, macrosomia, and cesarean delivery [5]. Previous studies also reported that overweight or obese women who had excessive gestational weight gain had a higher risk of adverse outcomes, including preeclampsia, LGA, macrosomia, cesarean delivery, and neonatal intensive care unit admission [7,8]. Another study showed that weight gain tends to be higher in pregnant women with a higher BMI [13].

The Institute of Medicine (IOM) has issued weight gain recommendations for pregnant women in order to decrease adverse pregnancy outcomes as well as postpartum weight retention, and prevent further metabolic risk for pregnant women. This recommendation is similar to that recommended by the American College of Obstetricians and Gynecologists [14,15].

In our institute, which is a tertiary care hospital, the rate of pregnant women who are overweight or obese has increased significantly from 14.6% in 2011-2012 to 29.7% in 2018-2019 [10,16]. In terms of gestational weight gain, a previous study reported the overall adherence to weight gain recommendations to be only 40.5% [10]. A more recent study showed that 60.2% and 44% of overweight and obese women, respectively, gained weight as per recommendations [17]. Many methods have been implemented among this specific group of women to control weight gain, including early counseling of recommended weight gain, dietary advice, and weight gain monitoring during antenatal care visits. However, there is still limited information on the rate of excessive weight gain among overweight and obese pregnant women.

Therefore, the purpose of this study was to determine the incidence of excessive gestational weight gain in overweight and obese pregnant women, the factors associated with it, and their pregnancy outcomes.

Materials and methods

A retrospective cohort study was conducted after approval from Siriraj Institutional Review Board (SIRB) (COA no. Si220/2023). The study was conducted in a university-based tertiary care hospital in Bangkok, Thailand. The hospital served mainly women living in Bangkok, with approximately 5,000 deliveries each year. Between 2021-2023, a total of 355 singleton pregnant women who started antenatal care before 20 weeks of gestation and had pre-pregnancy BMI of ≥25 kg/m^2 were included. All these women received antenatal care and delivered at Siriraj Hospital. Exclusion criteria included fetal anomalies or fetal death in utero, chronic underlying diseases such as chronic hypertension, diabetes mellitus, renal disease, autoimmune disease, eating disorders, thyroid disease, or gastrointestinal abnormality that affected weight gain. Sample size was estimated from a pilot study which showed 55% incidence of excessive gestational weight gain (GWG) in overweight and obese pregnant women. At least 347 women were required to be enrolled considering a 95% significance level, 5.5% acceptable error, and 10% drop-out rate.

As per institutional guidelines, all women were scheduled for routine antenatal care visits every 4 weeks during the first and second trimesters and every 1-2 weeks during the third trimester. The schedule varied depending on the attending physicians' discretion and whether there were any pregnancy complications.

In addition to providing routine antenatal care according to institutional guidelines, all the women were informed regarding their BMI status as well as recommended gestational weight gain. Weight gain was recorded during each visit and appropriate dietary advice was provided. Pregnant women who were diagnosed with gestational diabetes received more intensive dietary and weight gain control advice to reach optimal glycemic targets. Metformin or insulin were provided as necessary to those women with suboptimal glycemic control. All the women received labor and delivery care by attending physicians under staff supervision.

Pre-pregnancy BMI status and gestational weight gain were categorized according to the IOM recommendation [15]. Pre-pregnancy BMI was calculated from measured height and self-reported pre-pregnancy weight. Overweight was defined as having a pre-pregnancy BMI of 25-29.9 kg/m^2 and obesity was defined as having a pre-pregnancy BMI ≥30 kg/m^2, and

the recommended GWG was 7-11.5 kg and 5-9 kg for both groups, respectively. Gestational weight gain was calculated from difference between weight at delivery and pre-pregnancy weight and further classified as inadequate, normal, and excessive weight gain.

Data, including baseline and obstetric characteristics, total and trimester-specific weight gain, labor and delivery data, and pregnancy outcomes, were extracted from medical records. Small and large for gestational age was defined as birth weight of <10th and >90th percentile of birth weight for gestational age, respectively. Macrosomia was defined as having birth weight of >4 kg.

Descriptive statistics such as mean, standard deviation, number, and percentage were used to describe different variables. The incidence of excessive GWG was estimated. Comparisons between different GWG categories were performed using one-way analysis of variance with Tukey's *post hoc* comparison, Kruskal-Wallis test, or chi square test as appropriate. Logistic regression analysis was used to determine independent associated factors for excessive GWG, adjusted for potential confounders. Adjusted odds ratio (aOR) and 95% confidence interval (CI) were estimated. A *P*-value of <0.05 was considered to be statistically significant.

Table 1. Baseline characteristics among overweight and obese pregnant women (n=355)

Baseline characteristic	Value
Maternal age (yr)	31.7±5.46
BMI (kg/m^2)	28.92±3.35
GA at 1st antenatal care visit (weeks)	9.72±3.56
Nullipara	138 (38.9)
BMI category	
Overweight	244 (68.7)
Obese	111 (31.3)
GDM	88 (24.8)
GWG during pregnancy	
1st trimester (kg)	1.6 (-0.6 to 3.6)
2nd trimester (kg)	4.8 (3.2 to 6.3)
3rd trimester (kg)	5.0 (3.1 to 6.6)
Throughout pregnancy (kg)	11.3 (7.5 to 15)
GWG category	
Inadequate weight gain	64 (18.0)
Normal weight gain	103 (29.0)
Excessive weight gain	188 (53.0)

Values are presented as mean±standard deviation, median (IQR), or number (%).
BMI, body mass index; GA, gestational age; GDM, gestational diabetes; GWG, gestational diabetes; IQR, interquartile range.

Results

A total of 355 overweight and obese women were included in this study. Baseline characteristics are shown in Table 1. Mean age was 31.7 years, mean BMI was 28.9 kg/m^2, mean gestational age (GA) at first antenatal care was 9.7 weeks, and 38.9% women were nulliparous. Among these women, 244 (68.7%) were overweight and 111 (31.3%) were obese. Median GWG was 1.6, 4.8, and 5.0 kg during first, second, and third trimesters, respectively. Majority of the women had excessive GWG (53.0%) and only 29.0% had GWG within recommendations. Gestational diabetes was diagnosed in 24.8% of the women.

Comparisons of characteristics between GWG groups are shown in Table 2. Women with normal GWG were significantly older than the women in other 2 groups (*P*=0.002). The risk of excessive GWG was higher in every age group with the highest risk among those who were ≤30 years of age (*P*=0.023). Risk of excessive GWG was comparable between nulli- and multiparous women, and those who were overweight and obese. GDM significantly decreased the risk of excessive GWG (59.2% vs. 34.1%; *P*<0.001). Moreover, women with GDM had higher rate of both inadequate and normal GWG than women without GDM.

Table 3 shows the comparison of trimester-specific GWG between different GWG categories. Women with excessive GWG had significantly higher weight gain in every trimester (*P*<0.001). While women with under and normal GWG gained less than 1 kg during their first trimester, those with excessive GWG gained as much as 3 kg.

Table 4 shows comparisons of pregnancy outcomes between GWG categories. Mean GA at delivery and mean birth weight were significantly lower among those with inadequate GWG. Pregnant women with excessive GWG had a significantly higher primary cesarean section rate (37.8%) than those with inadequate (23.4%) and normal GWG (25.2%) (*P*=0.015). The three groups were comparable in the rate of preeclampsia and postpartum hemorrhage. Both women with normal and excessive GWG had higher rates of LGA infants (38.8% and 43.1%; respectively) than those

Table 2. Comparison of characteristics between different GWG categories

Characteristic	Inadequate weight gain (n=64)	Normal weight gain (n=103)	Excessive weight gain (n=188)	*P*-value[a]
Age (yr)	31.9±5.5	33.1±4.8[c]	30.8±5.6	0.002[b]
Age group				0.023
≤30 years	20 (16.0)	26 (20.8)	79 (63.2)	
31-34 years	20 (18.2)	32 (29.1)	58 (52.7)	
35 years	24 (20.0)	45 (37.5)	51 (42.5)	
Parity				0.064
Nullipara	17 (12.3)	40 (29.0)	81 (58.7)	
Multipara	47 (21.7)	63 (29.0)	107 (49.3)	
BMI category				0.832
Overweight	42 (17.2)	72 (29.5)	130 (53.3)	
Obese	22 (19.8)	31 (27.9)	58 (52.3)	
GDM diagnosis				<0.001
No GDM	40 (15.0)	69 (25.8)	158 (59.2)	
GDM	24 (27.3)	34 (38.6)	30 (34.1)	

Values are presented as mean±standard deviation or number (%).
GWG, gestational diabetes; BMI, body mass index; GDM, gestational diabetes.
[a]Chi square test.
[b]Analysis of variance with Tukey's *post hoc* comparison.
[c]Significantly higher than excessive weight gain group.

Table 3. Comparison of gestational weight gain in each trimester between gestational weight gain categories

GWG per trimester	Inadequate weight gain (n=64)	Normal weight gain (n=103)	Excessive weight gain (n=188)	*P*-value[a]
1st trimester	-2.4 (-4.9 to 0.0)	0.8 (-0.5 to 2.3)	3.0 (1.3 to 4.8)	<0.001
2nd trimester	2.4 (1.3 to 4.0)	4.1 (2.9 to 5.3)	5.8 (4.3 to 7.3)	<0.001
3rd trimester	3.0 (1.5 to 4.6)	3.8 (2.8 to 5.1)	6.1 (4.6 to 8.0)	<0.001

Values are presented as median (interquartile range).
GWG, gestational weight gain.
[a]Kruskal-Wallis test, all pairwise comparisons were significantly different; *P*<0.001.

with inadequate GWG (15.6%) (*P*=0.003). Macrosomia was also slightly higher in women with normal and excessive GWG but without statistical significance.

Logistic regression analysis was performed to determine independent risk factors for excessive GWG and the results are shown in Table 5. When all women were included, an age ≤30 years significantly increased the risk of excessive GWG with aOR, 1.91 (95% CI, 1.11-3.27; *P*=0.018) while GDM significantly reduced the risk with aOR, 0.40 (95% CI, 0.24-0.67; *P*<0.001). Further subgroup analysis was performed according to the GDM status. For those without GDM, only age ≤30 years significantly increased the risk of excessive GWG with aOR, 1.89 (95% CI, 1.02-3.49; *P*=0.042). On the other hand, among those with GDM, no significant risk factor was found to be associated with excessive GWG.

Discussion

High pre-pregnancy BMI and excessive gestational weight gain have been consistently reported to adversely affect pregnancy outcomes [5-12]. Gaining weight greater than what is recommended could put overweight and obese women at higher risk for obstetric complications. The results of this

Table 4. Comparison of pregnancy outcomes between different gestational weight gain categories

Pregnancy outcome	Inadequate weight gain (n=64)	Normal weight gain (n=103)	Excessive weight gain (n=188)	*P*-value[a]
GA at delivery (weeks)	37.7±2.2[c]	38.1±1.7	38.4±1.4	0.012[b]
Birth weight (g)	2,927.5±481.0[d]	3,168.9±517.5	3,238.1±477.2	<0.001[b]
Route of delivery				0.015
Vaginal delivery	28 (43.8)	58 (56.3)	78 (41.5)	
Primary cesarean section	15 (23.4)	26 (25.2)	71 (37.8)	
Repeat cesarean section	21 (32.8)	19 (18.4)	39 (20.7)	
Preterm delivery	7 (10.9)	10 (9.7)	12 (6.4)	0.411
Preeclampsia	9 (14.1)	14 (13.6)	19 (10.1)	0.563
Postpartum hemorrhage	1 (1.6)	10 (9.7)	18 (9.6)	0.103
Birth weight for GA				0.003
SGA	5 (7.8)	4 (3.9)	10 (5.3)	
AGA	49 (76.6)	59 (57.3)	97 (51.6)	
LGA	10 (15.6)	40 (38.8)	81 (43.1)	
Macrosomia	1 (1.6)	5 (4.9)	8 (4.3)	0.540
Apgar score at 1 minute <7	4 (6.3)	1 (1.0)	4 (2.1)	0.094
Phototherapy	12 (18.8)	18 (17.5)	35 (18.6)	0.967
Neonatal hypoglycemia	6 (9.4)	5 (4.9)	10 (5.3)	0.426
NICU admission	3 (4.7)	3 (2.9)	6 (3.2)	0.809

Values are presented as mean±standard deviation or number (%).
GA, gestational age; SGA, small for gestational age; AGA, appropriate for gestational age; LGA, large for gestational age; NICU, neonatal intensive care unit.
[a]Chi square test.
[b]Analysis of variance with Tukey's *post hoc* comparison.
[c]Significantly lower than excessive weight gain group; *P*=0.009.
[d]Significantly lower than normal and excessive weight gain group, *P*=0.006 and <0.001; respectively.

Table 5. Logistic regression analysis to determine independent factors for excessive gestational weight gain in all women and according to GDM status

	All cases		No GDM		GDM	
	Adjusted odds ratio (95% CI)	*P*-value	Adjusted odds ratio (95% CI)	*P*-value	Adjusted odds ratio (95% CI)	*P*-value
Age						
≤30 years	1.91 (1.11-3.27)	0.018	1.89 (1.02-3.49)	0.042	1.64 (0.51-5.28)	0.409
31-34 years	1.35 (0.79-2.13)	0.265	1.16 (0.62-2.15)	0.644	2.22 (0.77-6.4)	0.141
≥35 years	1.0		1.0		1.0	0.326
Nullipara	1.27 (0.81-2.0)	0.296	0.83 (0.49-1.38)	0.465	0.73 (0.28-1.9)	0.512
Obesity (BMI ≥30 kg/m^2)	0.93 (0.58-1.48)	0.761	0.81 (0.48-1.38)	0.443	1.52 (0.58-3.97)	0.394
GDM	0.40 (0.24-0.67)	<0.001				

Adjusted for age, parity, BMI category, GDM, and GA at delivery.
GDM, gestational diabetes; CI, confidence interval; BMI, body mass index; GA, gestational age.

study showed that as many as 53% of overweight and obese women had excessive GWG. Only 29% gained weight within the recommended range, while 18% had inadequate GWG. These rates were comparable between overweight and obese women. A previous systematic review reported the overall rate of excessive GWG to be 47% while 23% had GWG below prescribed guidelines. Further subgroup analysis among obese women showed that the rates of GWG below, within, and above recommendations were 19%, 25%, and 57%, respectively [5], which is consistent with the results of the current study.

The results also show that overweight and obese women with excessive GWG had significantly higher weight gain in every trimester. Women with excessive GWG started to gain weight since their first trimester, probably because they were less affected by morning sickness. However, second and third trimester weight gain contributed most of the GWG with approximately 6 kg being gained in each trimester. This underlines the importance of monitoring weight gain during second and third trimesters as recommended. The IOM recommends only 0.28 kg and 0.22 kg per week be gained in overweight and obese women during the second and third trimesters, respectively [15].

Although dietary advice was given and weight gain was monitored during every antenatal care visit, many women still gained excessive weight. This might be partly due to socio-cultural factors and cultural beliefs which relate weight gain during pregnancy to the infant's health and this may have made women gain greater than the recommended weight. In addition, working and living lifestyle and eating habits might also play a role since most of the women could not maintain and comply with the healthy diet as advised.

The results showed that GDM significantly decreased the risk of excessive GWG by 60%. This finding was not unexpected. In our institution, when GDM was diagnosed early in pregnancy, the women were counselled and monitored closely regarding their weight gain in addition to the intensive nutritional and behavioral interventions provided. Similar findings of lower mean GWG and rate of excessive GWG among women with GDM have been reported from the same institution [16]. The results might differ between institution as GDM screening and management varies [18].

Among women with GDM, no significant clinical factor was associated with GWG. This could be attributed to the GWG likely being affected by the intensive multidisciplinary care provided. The results partially supported the effectiveness of care provided by the institution to women with GDM. However, each component of care could not be measured and evaluated in this study.

Overall, maternal age of ≤30 years significantly increased the risk of excessive GWG by 1.9 times and the association persisted among those without GDM. A previous study reported that an age range of 30-35 years significantly decreased the risk of adequate GWG, compared to that of 20-25 years [11]. Socio-cultural factors could possibly partly explain the observed excessive GWG among younger women. This might include consumption of an unhealthy diet and lifestyle, misconception about GWG and infant's health, lower self-awareness about appropriate GWG, or other cultural beliefs. However, these issues need further investigation.

In terms of pregnancy outcomes, those with excessive GWG had higher fetal birth weight, but without clinical significance. LGA was significantly less common among those with inadequate GWG compared to those with normal and excessive GWG. These results are consistent with many previous studies [5-12]. Increased risk of LGA, macrosomia, and cesarean delivery among women with excessive GWG have been reported in a previous systematic review [5]. Overweight or obese women with excessive GWG have been reported to be at higher risk for adverse outcomes, including preeclampsia, macrosomia, cesarean delivery, and neonatal intensive care unit admission [7,8].

The strength of this study lies in the fact that the study focused specifically on overweight and obese women who were at higher risk for excessive GWG and adverse pregnancy outcomes with relatively large samples. Limitations might include the retrospective nature of data collection which could lead to inaccurate and incomplete information. However, all the medical records were reviewed carefully and hence the inaccuracies should be minimal. The sample size was limited to evaluate the relationship between GWG categories and pregnancy outcomes. Some possible determinants of GWG could not be determined, such as socio-cultural factors and the effects of nutritional counseling during antenatal care. Generalization of the results to other populations with different characteristics, settings, and cultural contexts could therefore be limited.

Nonetheless, the results of this study provide deeper understanding about the important issue of GWG among high-risk pregnant women. The importance of keeping pre-pregnancy

BMI in the normal range and appropriate GWG should be provided during both the pre-conception period and early in pregnancy. As GWG is modifiable, appropriate interventions should be developed and implemented to improve the rate of adequate GWG and to minimize related adverse outcomes. Further investigations should be conducted to gain a deeper understanding of this important health issue.

In conclusion, the incidence of excessive GWG among overweight and obese women was 53%. Maternal age of ≤30 years significantly increased the risk while women with GDM had a significantly decreased risk of developing excessive GWG. The rates of primary cesarean section and fetal LGA significantly increased in women with excessive GWG.

Conflict of interest

The authors declare no conflicts of interest.

Ethical approval

This study was approved by Siriraj Insutitutional Review Board (COA no. Si220/2023).

Patient consent

Not applicable.

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