Original Article

Obstetric and Neonatal Outcomes of Excessive Weight Gain in Different Pre-Pregnancy Body Mass Index using BMI Criteria for Asians by World Health Organization Western Pacific Region (WPRO)

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Objective: To evaluate the relationship between gestational weight gain and pre-pregnancy body mass index (BMI) on the risk of adverse obstetric and neonatal outcomes using cut off BMI criteria by Regional Office for the Western Pacific Region of WHO (WPRO).

Materials and Methods: The present study was a retrospective cohort. Subjects of live birth singletons who had full term delivered at four tertiary care centers, teaching university hospitals between January and December 2012 were enrolled. All pregnant women with pre-pregnancy BMI 18.5 kg/m2 or over were recruited and categorized into two groups, normal BMI and high BMI. The level of BMI at 18.5 to 22.9 kg/m2 was defined as normal BMI, and level at or over 23 kg/m2 was defined as high BMI, respectively. Gestational weight gain (GWG) was grouped into two categories as recommended weight gain (RWG) and excessive weight gain (EWG) which defined as 11.5 to 16 kg and above 16 kg in normal pre-pregnancy BMI and 5 to 9 kg and above 9 kg in high pre-pregnancy BMI, respectively. The association between RWG and EWG in different pre-pregnancy BMI groups and poor adverse pregnancy outcomes were evaluated.

Results: Two thousand seven hundred and thirty-three pregnant women were recruited. Normal and high pre-pregnancy BMI women were 1,840 (67.33%) and 893 (32.67%), respectively. Of these, 2,036 cases had complete data for evaluation. In normal pre-pregnancy BMI, 737 (59.58%) were categorized as RWG (11.5 to 16 kg) and 500 (40.42%) as EWG (>16 kg), while in high pre-pregnancy BMI, 273 (34.17%) were categorized as RWG (5 to 9 kg) and 526 (65.83%) as EWG (>9 kg). The mean weight gain in the normal pre-pregnancy BMI group was 13.80±1.35 kg vs. 20.39±3.84 kg in the RWG and EWG group, respectively. While the mean weight gain in high pre-pregnancy BMI group was 7.32±1.38 kg vs. 15.24±4.46 kg in the RWG and EWG group, respectively. In multivariate logistic analysis, normal pre-pregnancy BMI group with EWG had increased risk of instrumental delivery or cesarean section (Odd ratio; with OR 1.06, 95% CI 1.03 to 1.08, p<0.001) and high pre-pregnancy BMI group with EWG, there was significant increased risk of preeclampsia with birth weight above 90th centile (OR 1.09, 95% CI 1.04 to 1.15 and OR 1.09, 95% CI 1.06 to 1.12 with p = 0.001 and <0.001, respectively).

Conclusion: For pregnant women with high pre-pregnancy BMI by WPRO criteria increased the risk of pregnancy complications and adverse pregnancy outcomes especially in excessive weight gain women. The high pre-pregnancy BMI should be a concern for pre-conception counseling. Optimal GWG ranges should develop based on pre-pregnancy BMI cut off for Asian women.

Keywords: Neonatal birth weight, Gestational weight gain, Pre-pregnancy BMI, WPRO

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Sufficiently providing food and nutrition to pregnant women is extremely important in the first thousand days of a baby's life. There is a need for more nutrients and energy during pregnancy for the intrauterine growing of the fetuses[1]. This is the cause of weight increase during pregnancy. If pregnant women receive excessive nutrients, their weight can increase more than the standard which will affect the well-being of both the mother and the fetus. The adverse effects can occur during pregnancy, childbirth and after childbirth. The report from many studies found that excessive gestational weight gain augmented the risk of

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developing diabetes during pregnancy, high blood pressure, difficult birth, cesarean section, and directly affecting the newborn birth weight and postpartum weight retention[2-4]. Therefore, maternal weight gain should increase according to the appropriate criteria for proper fetal growth. There are differences in mothers with different body mass indexes. According to the recommendation from IOM 2009, the pregnant women with the pre-pregnant body mass index (BMI) between 18.5 to 24.9 kg/m^2, the weight during pregnancy should increase 11.5 to 16 kg, the BMI between 25 and 29.9 kg/m^2, thus, the appropriate weight rising is 7 to 11.5 kg and if the BMI 30 kg/m^2 or more, the weight should increase not more than 5 to 9 kg[5]. However, this recommendation is based on information from Europe and the United State. The guidelines of body mass index to identify obesity or overweight of Asian pregnant women are using WPRO criteria: the Regional Office for the Western Pacific Region of WHO that proposed a specific classification in 2004 for obesity in the Asian population. The definitions of normal, overweight, and obesity were defined as BMI in 18.5 to 22.9, 23 to 24.9 and 25 kg/m^2 or more, respectively[6]. However, there is very little information about the impact of gestational weight gain on the obstetrical outcomes among Asian women when using different cut-off points of BMI such as WPRO definition for pre-pregnancy BMI.

Accordingly, the purpose of this study was to determine the effect of gestational weight gain on obstetrical outcomes in mothers with normal and high pre-pregnancy BMI by using WPRO definition for Asian populations.

Materials and Methods

This retrospective cohort study was conducted by selecting women aged 18 to 40 years with singleton term live birth (>37 weeks of gestation) who attended the antenatal clinic and had their babies delivered at one of four affiliated university hospitals namely Thammasat University, Rajavithi, Phramongkutklao, Srinakharin Khon Kaen Hospitals during January and December 2012. The research protocol was reviewed and approved by the ethics committee of each hospital. The medical records of pregnant women were reviewed. Incomplete records and the cases whose pre-pregnancy BMI were lower than 18.5 kg/m^2 were excluded. All cases had a minimum of four antenatal visits. The patients were then classified into two categories as normal pre-pregnancy BMI and high pre-pregnancy BMI (overweight and obesity) groups according to the pre-pregnancy BMI by WPRO definition. The normal pre-pregnancy BMI and high pre-pregnancy BMI groups were defined as BMI of 18.5 to 22.9 and >23 kg/m^2, respectively. Data on gestational weight gain were defined as the difference between the weight on the day of delivery and pre-pregnancy weight. Gestational weight was grouped into 2 categories as recommended weight gain (RWG) and excessive weight gain (EWG) which defined as 11.5 to 16 kg and above 16 kg in normal pre-pregnancy BMI and 5 to 9 kg and above 9 kg in high pre-pregnancy BMI, respectively.

Sociodemographic variables included initial visit maternal age, parity, gestational age (GA) at initial visit, number of antenatal visits, BMI at first visit, total weight gain and gestational age (GA) at delivery were recorded. Obstetrics and perinatal outcomes included gestational diabetes (GDM), preeclampsia, premature rupture of membrane, type of labor (spontaneous or induced), type of delivery (spontaneous vaginal delivery, operative vaginal delivery or cesarean section), prolonged second stage of labor (more than 1 hour for primigravida and 2 hours for multigravida), neonatal weight, macrosomia (birth weight above 90th centile at gestational age of delivery) and postpartum hemorrhage were reviewed and analyzed. Clinical variables with a *p*-value of less than 0.05 in the binary logistic model were selected for the final model. Multiple logistic regression models were used to calculate the odd ratio (OR). The risks of obstetric complications were presented as adjusted odd ratios with 95% confidence intervals. Statistical analysis was conducted using the STATA program.

Results

A total of 2,733 pregnant women were included in the study. Of these, 1,840 (67.33%) were categorized as normal pre-pregnancy BMI (BMI 18.5 to 22.9 kg/m^2) and 893 (32.67%) as high pre-pregnancy BMI (BMI >23 kg/m^2). There were missing data for 603 cases and 94 cases in normal pre-pregnancy BMI and high pre-pregnancy BMI groups, respectively. A total 1,237 with normal pre- pregnancy BMI were included; 737 (59.58%) were categorized as RWG (11.5 to 16 kg) and 500 (40.42%) as EWG (>16 kg). While a total of 799 with high pre-pregnancy BMI was included, 273 (34.17%) were categorized as RWG (5 to 9 kg) and 526 (65.83%) as EWG (>9 kg).

The maternal characteristics are shown in Table 1. The data demonstrated the maternal demographics in categories of normal pre-pregnancy BMI and high pre-pregnancy BMI with RWG and EWG in each group. In normal pre-pregnancy BMI group, the mean age, average pre-pregnancy BMI and family history of diabetes or hypertension were not significantly different between the RWG and EWG groups. However, mean gestational age (GA) at first visit and at delivery in the RWG and EWG groups were clinically comparable between two groups but there were statistically significant differences (15.86±8.01 vs. 14.87±7.83 weeks and 38.29±1.46 vs. 38.58±1.36 weeks, p = 0.03 and 0.0007, respectively). Most of the women in the EWG group were nulliparous. The mean weight gain was 13.80±1.35 kg vs. 20.39±3.84 kg in the RWG and EWG groups, respectively.

In high pre-pregnancy BMI group, the mean age, GA at delivery and family history of diabetes or hypertension were not significantly different between RWG and EWG group. However, mean GA at first visit in EWG was earlier than in recommended weight gain group with statistically significant differences (14.65±7.11 weeks vs. 19.01±9.15 weeks, p<0.001). Most of the women in both groups were nulliparous. The mean weight gain was 7.32±1.38 kg vs. 15.24±4.46 kg in the RWG and EWG groups, respectively.

Table 1. Maternal characteristics stratified by the pre-pregnancy BMI using WPRO criteria, recommended weight gain and excessive weight gain

Characteristics	Pre-pregnancy BMI					
	Normal BMI group			High BMI group		
	Recommended weight gain (n = 737)	Excessive weight gain (n = 500)	*p*-value	Recommended weight gain (n = 273)	Excessive weight gain (n = 526)	*p*-value
Age (years)	28.46±5.61	28.09±4.99	0.23	29.71±6.05	29.12±5.69	0.18
Parity (%)						
Nulliparous	57.26	66.60	0.001	55.31	54.37	0.063
Multiparous	42.74	33.40		44.69	45.63	
GA at first ANC (weeks)	15.86±8.01	14.87±7.83	0.03	19.01±9.15	14.65±7.11	<0.001
Pre-pregnancy BMI at first ANC (kg/m^2)	20.48±1.20	20.51±1.22	0.65	27.04±3.72	26.08±2.95	<0.001
Gestational weight gain (kg)	13.80±1.35	20.39±3.84	<0.001	7.32±1.38	15.24±4.46	<0.001
GA at birth (weeks)	38.29±1.46	38.58±1.36	0.0007	38.39±1.63	38.50±1.43	0.388
Family history of diabetes or hypertension	6.24	5.60	0.641	7.29	9.90	0.304

Numbers are mean ± SD, or n (%)

The impact of gestational weight gain in different pre- pregnancy BMI on the pregnancy outcomes were summarized in Table 2. The data showed the women in normal pre-pregnancy BMI group with EWG had significantly increased the incidence of instrumental delivery or cesarean section, prolonged second stage of labor, average neonatal weight and birth weight above 90th centile comparing with RWG (48.80% vs. 37.45%, 11.80% vs. 6.92%, 3,254.73 ±1,264.33 grams vs. 3,071.72±395.80 grams, 15.20% vs. 10.45% with p<0.001, 0.003, 0.002, 0.018, respectively). Nevertheless, the incidence of labor induction was higher in RWG women (10.04% vs. 5.20% with p = 0.002). The incidence of GDM, preeclampsia, premature rupture of membranes, and PPH were no significant different between two groups.

The data demonstrated that the women in high pre-pregnancy BMI group with EWG had significantly increased the average neonatal weight (3,221.58±422.54 grams vs. 3,093.20±504.45 grams with p = 0.0004) but there was no significant different in the incidence of birth weight above 90th centile comparing with RWG. However, the incidence of GDM, induction of labor and PPH were significantly higher in RWG group (14.29% vs. 7.98%, 12.82% vs. 7.60%, 5.49% vs. 1.33% with p = 0.005, 0.017, 0.001, respectively). The incidence of preeclampsia, PROM, instrumental delivery or cesarean section and prolonged second stage of labor were similar between the two groups. Multivariate logistic analysis was applied as showed in Table 3, after adjusting the confounders then comparing obstetric and perinatal outcomes between women with RWG and EWG. In normal BMI group the data showed that the EWG had no significantly increased risk of GDM, preeclampsia, prolonged second stage of labor and neonatal with birth weight above 90th centile while it was increased risks of instrumental delivery or cesarean section (OR 1.06, 95% CI 1.03 to 1.08, p<0.001). The data from high pre-pregnancy BMI group demonstrated that there were significant increased risks of preeclampsia and birth weight above 90th centile in women who gained excessive weight compared to recommended weight groups (OR 1.09, 95% CI 1.04 to 1.15 and OR 1.09, 95% CI 1.06 to 1.12 with p = 1.1 and <0.001, respectively).

Discussion

Numerous studies have shown the obvious correlations between GWG and pre-pregnancy BMI toward adverse obstetric and neonatal outcomes[1-4]. As a general recommendation for appropriate GWG and pre-pregnancy BMI by the IOM 2009, the data was based on populations in North America and Europe[5,6]. Based on criteria from WPRO recommendation BMI for Asian population, the data from the preceding study by Somprasit et al, demonstrated that pregnant women with overweight (BMI 23 to 24.9 kg/m^2) and obesity (BMI ≥25 kg/m^2) which were defined by WPRO criteria had impact on their pregnancy outcomes such as gestational diabetes, preeclampsia, instrumental delivery or cesarean section, prolonged 2nd stage of labor, and the newborn birth weight above 90th centile and PPH[7]. Based on the recent GWG recommendations from IOM 2009, some of the studies were conducted in Asian women. Unfortunately, there was no official recommendation for this population. In the present study, the authors inspected the relationship between GWG and associated obstetric and neonatal outcomes to affirm the association of the different of pre-pregnancy BMI by using the cut-off point of BMI from WPRO recommendation.

The study revealed that women with high pre-pregnancy BMI tend to have excessive weight gain during

Table 2. Obstetrics and perinatal outcomes in the different pre-pregnancy BMI by WPRO criteria with recommended weight gain and excessive weight gain

Obstetrics and perinatal outcomes	Pre-pregnancy BMI					
	Normal BMI group			High BMI group		
	Recommended weight gain (n = 737), n (%)	Excessive weight gain (n = 500), n (%)	p-value	Recommended weight gain (n = 273), n (%)	Excessive weight gain (n = 526), n (%)	p-value
Gestational diabetes	30 (4.07)	17 (3.40)	0.545	39 (14.29)	42 (7.98)	0.005
Preeclampsia	16 (2.17)	11(2.20)	0.97	8 (2.93)	29 (5.51)	0.099
Premature rupture of membranes	67 (9.09)	38 (7.6)	0.356	35 (12.82)	49 (9.32)	0.126
Induction of labor	74 (10.04)	26 (5.2)	0.002	35 (12.82)	40 (7.6)	0.017
Instrumental delivery or cesarean section	276 (37.45)	244 (48.8)	<0.0001	111 (40.66)	231 (43.92)	0.378
Prolonged 2nd stage of labor	51 (6.92)	59 (11.8)	0.003	36 (13.19)	60 (11.41)	0.463
Average newborn birthweight (gms)	3,071.72±395.80	3,254.73±1264.33	0.002	3,093.20±504.45	3,221.58±422.54	0.0004
Birthweight above 90th centile	77 (10.45)	76 (15.20)	0.018	43 (15.75)	92 (17.49)	0.639
Postpartum hemorrhage	12 (1.63)	7 (1.4)	0.75	15 (5.49)	7 (1.33)	0.001

Numbers are mean ± SD, or n (%)

pregnancy than those women who have normal pre-pregnancy BMI. Most of them were nulliparous. Previous studies revealed the incidence of excessive weight gain during pregnancy was commonly found in high pre-pregnancy BMI women, younger women and nulliparous[4,8-10]. The study in Thailand from Siriarunrat et al, revealed that one of the important risk factors of this problem was high pre-pregnancy BMI (an odds ratio of 4.2)[8]. Accordingly, pre-conceptional education about nutrition is important and should be encouraged in all reproductive women, especially in high pre-pregnancy BMI women to promote good consumption behavior, prevent overnutrition, and overweight problems.

The present study showed significant increase in risks of instrumental delivery or cesarean section in pregnant women with EWG in normal pre-pregnancy BMI women and increased risk of preeclampsia and infant birth weight above 90th centile on pregnant women with EWG in high pre-pregnancy BMI which similar to the previous study[11,12]. However, the impact of instrumental delivery or cesarean section in normal pre-pregnancy BMI in this study might be related to nulliparous and clinician decisions which were in different study sites.

Previous studies published the impact of maternal GWG on poor adverse outcomes such as GDM, preeclampsia, prolonged 2nd stage of labor, and infant birth weight above 90th centile[2,11-13]. Whereas, these impacts had no effect on pregnant women with normal pre-pregnancy BMI in this study, and could be explained by the fact that GDM and preeclampsia are chronical process illnesses and show multifactors causing them. Their effect might have occurred before or in early pregnancy period. Therefore, the weight changing during pregnancy may not be the main factor for these adverse outcomes. As the report from Life Cycle Project-Maternal Obesity and Childhood Outcomes Study Group, determined among women with normal weight before pregnancy and found that the absolute risk for an adverse outcome was highest in the extreme of gestational weight gain above 28 kg[4].

This cohort study has shown an increased risk of preeclampsia and neonatal birth weight above the 90th centile in excessive weight gain pregnant women with high pre-pregnancy BMI. These adverse outcomes correlated with many preceding studies[14-16]. Also, the present study found that high pre-pregnancy BMI was significantly associated with pregnancy complications and obesity in their offspring. Same as the previous study suggested that maternal pre-pregnancy BMI was more strongly associated with adverse maternal and infant outcomes than gestational weight gain[4].

The present study had some limitations. Firstly, it is a retrospective study which means that uncertainty of data is commonly found. The most common pitfalls are incomplete and loss of data. Secondly, the analysis did not measure the changes in GWG with adverse outcomes by each trimester.

The strength of the present study was its collected

Table 3. Multivariate analysis comparing obstetric and perinatal outcomes between women with recommended weight and excessive weight gain in different pre-pregnancy BMI by WPRO criteria after adjusting for confounding factors

Outcomes	Pre-pregnancy BMI					
	Normal BMI group			High BMI group		
	Adjust OR	95% CI	*p*-value	Adjust OR	95% CI	*p*-value
Gestational diabetes						
Recommended weight gain	1.00			1.00		
Excessive weight gain	0.95	0.90 to 1.00	0.08	0.91	0.87 to 0.95	<0.001
Preeclampsia						
Recommended weight gain	1.00			1.00		
Excessive weight gain	1.03	0.97 to 1.11	0.32	1.09	1.04 to 1.15	0.001
Instrumental delivery or cesarean section						
Recommended weight gain	1.00			1.00		
Excessive weight gain	1.06	1.03 to 1.08	<0.001	0.98	0.96 to 1.01	0.217
Prolonged 2nd stage of labor						
Recommended weight gain	1.00			1.00		
Excessive weight gain	1.02	0.99 to 1.06	0.183	0.97	0.93 to 1.006	0.079
Birthweight above 90th centile						
Recommended weight gain	1.00			1.00		
Excessive weight gain	1.01	0.98 to 1.04	0.38	1.09	1.06 to 1.12	<0.001

OR = odds ratio

data from four health care centers from different regions that represent the majority population. Additionally, it provides data about the risk for obstetric and neonatal outcomes by using WHO's criteria for the Asian population (WPRO).

Conclusion

The high pre-pregnancy BMI should be a concern for pre-conception counseling and encourage reproductive women to adjust eating behavior before getting pregnant. These will bring less adverse obstetric and neonatal outcomes. Optimal GWG ranges should develop based on pre-pregnancy BMI cut off for Asian women.

What is already known on this topic?

Pre-pregnant body mass index and the gestational weight gain have impacts on adverse obstetric and fetal outcomes.

What this study adds?

In adds the effect of gestational weight gain on obstetrical outcomes in mothers with normal and high pre-pregnancy BMI by using WPRO definition for Asian populations. In normal pre-pregnancy BMI group, the excessive weight gain had no significantly increased risk of GDM, preeclampsia, prolonged second stage of labor and neonatal with birth weight above 90th centile while it was increased risks of instrumental delivery or cesarean section. In high pre-pregnancy BMI group, the excessive weight gain had significantly increased risk for preeclampsia and birth weight above 90th centile.

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Potential conflicts of interest

The authors declare no conflicts of interest.

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ผลของการเพิ่มน้ำหนักที่เกินเกณฑ์ในระหว่างตั้งครรภ์ต่อหญิงตั้งครรภ์และทารกแรกคลอดในกลุ่มสตรีดัชนีมวลกายก่อนตั้งครรภ์ที่แตกต่างกัน โดยใช้เกณฑ์ดัชนีมวลกายสำหรับชาวเอเชียโดยองค์การอนามัยโลกภูมิภาคแปซิฟิกตะวันตก (WPRO)

จรินทร์ทิพย์ สมประสิทธิ์, ชำนาญ แท่นประเสริฐกุล, ต้องตา นันทโกมล, นิพัทธา วินะยานุวัติคุณ, เอกชัย โควาวิสารัช, ปริศนา พานิชกุล, จุฑาวดี วุฒิวงศ์, ถวัลย์วงค์ รัตนศิริ, ปิยะมาศ ศักดิ์ศิริวุฒโฒ

วัตถุประสงค์: เพื่อศึกษาผลของน้ำหนักที่ เพิ่มขึ้นเกินเกณฑ์ขณะตั้งครรภ์ต่อหญิงตั้งครรภ์และทารกแรกคลอด โดยอิงดัชนีมวลกายก่อนตั้งครรภ์ที่แตกต่างกันตามเกณฑ์ขององค์การอนามัยโลก ภูมิภาคแปซิฟิกตะวันตก

วัสดุและวิธีการ: การศึกษาครั้งนี้เป็นการศึกษาย้อนหลังในโรงพยาบาลมหาวิทยาลัยสี่แห่ง ระหว่างเดือนมกราคมถึงเดือนธันวาคม พ.ศ. 2555 ในหญิงตั้งครรภ์ที่มีค่าดัชนีมวลกายก่อนตั้งครรภ์ 18.5 กก./ตร.ม. ขึ้นไป โดยแบ่งเป็นสองกลุ่ม คือ ค่าดัชนีมวลกายปกติ (18.5 ถึง 22.9 กก./ตร.ม.) และค่าดัชนีมวลกายสูง (เท่ากับหรือมากกว่า 23 กก./ตร.ม.) การเพิ่มน้ำหนักขณะตั้งครรภ์ แบ่งออกเป็น 2 ประเภทคือ น้ำหนักเพิ่มตามคำแนะนำ และน้ำหนักเพิ่มเกินเกณฑ์ ซึ่งกำหนดไว้ที่ 11.5 ถึง 16 กก. และสูงกว่า 16 กก. ในกลุ่มหญิงตั้งครรภ์ที่มีค่าดัชนีมวลกายก่อนตั้งครรภ์ปกติ ในกลุ่มหญิงตั้งครรภ์ที่มีค่าดัชนีมวลกายก่อนตั้งครรภ์สูง กำหนดที่ 5 ถึง 9 กิโลกรัมและสูงกว่า 9 กิโลกรัม ตามลำดับ ประเมินหาความสัมพันธ์ระหว่างน้ำหนักที่เพิ่มขณะตั้งครรภ์ในดัชนีมวลกายก่อนตั้งครรภ์ที่แตกต่างกันกับผลลัพธ์การตั้งครรภ์ที่ไม่พึงประสงค์ในหญิงตั้งครรภ์และทารกแรกคลอด

ผลการศึกษา: ได้คัดเลือกหญิงตั้งครรภ์ 2,730 ราย โดยเป็นหญิงตั้งครรภ์ที่ค่าดัชนีมวลกายปกติและสูงจำนวน 1,840 ราย (67.33%) และ 893 ราย (32.67%) ตามลำดับ ในจำนวนนี้ มีข้อมูลครบถ้วน 2,036 ราย ในหญิงตั้งครรภ์ที่ค่าดัชนีมวลกายปกติ 737 ราย (59.58%) เป็นกลุ่มที่น้ำหนักเพิ่มตามคำแนะนำ และ 500 ราย (40.42%) เป็นกลุ่มที่น้ำหนักเพิ่มเกินเกณฑ์ ขณะที่หญิงตั้งครรภ์ที่ดัชนีมวลกายสูงพบว่า 273 ราย (34.17%) เป็นกลุ่มน้ำหนักเพิ่มตามคำแนะนำและ 526 ราย (65.83%) เป็นกลุ่มที่น้ำหนักเพิ่มเกินเกณฑ์ค่าเฉลี่ยน้ำหนักที่เพิ่มขึ้นในหญิงตั้งครรภ์ดัชนีมวลกายปกติคือ 13.80±1.35 กิโลกรัม และ 20.39±3.84 กก. ในกลุ่มน้ำหนักเพิ่มตามคำแนะนำและน้ำหนักเพิ่มเกินเกณฑ์ตามลำดับ ในขณะที่ค่าเฉลี่ยน้ำหนักที่เพิ่มขึ้นในหญิงตั้งครรภ์ดัชนีมวลกายสูงคือ 7.32±1.38 กิโลกรัม และ 15.24±4.46 กก. ในกลุ่มน้ำหนักเพิ่มตามคำแนะนำและน้ำหนักเพิ่มเกินเกณฑ์ตามลำดับ ในการวิเคราะห์แบบพหุปัจจัยถึงผลของน้ำหนักเพิ่มเกินเกณฑ์ พบว่าในหญิงตั้งครรภ์ดัชนีมวลกายปกติก่อนตั้งครรภ์ ความเสี่ยงสัมพัทธ์ของการใช้เครื่องมือช่วยคลอด หรือการผ่าตัดคลอดเพิ่มขึ้น 1.06 เท่า (ช่วงความเชื่อมั่น ร้อยละ 95 ที่ 1.03 ถึง 1.08, p<0.001) และในหญิงตั้งครรภ์ดัชนีมวลกายสูง ความเสี่ยงสัมพัทธ์ต่อภาวะครรภ์เป็นพิษ และน้ำหนักทารกแรกเกิดที่สูงกว่าร้อยละ 90 เพิ่มขึ้น 1.09 เท่า (ช่วงความเชื่อมั่น ร้อยละ 95 ที่ 1.06 ถึง 1.12) โดยมี p = 0.001 และ <0.001 ตามลำดับ

สรุป: หญิงตั้งครรภ์ที่มีค่าดัชนีมวลกายสูงก่อนตั้งครรภ์เพิ่มความเสี่ยงของภาวะแทรกซ้อนการตั้งครรภ์ และผลการตั้งครรภ์ที่ไม่พึงประสงค์ โดยเฉพาะในกลุ่มที่น้ำหนักเพิ่มเกินเกณฑ์ ค่าดัชนีมวลกายก่อนตั้งครรภ์ที่สูงควรใช้เป็นความเสี่ยงสำหรับการให้คำปรึกษาก่อนการตั้งครรภ์ ถึงน้ำหนักที่ควรจะขึ้นอย่างเหมาะสม โดยใช้เกณฑ์ค่าดัชนีมวลกายก่อนตั้งครรภ์สำหรับ ผู้หญิงชาวเอเชีย