Correlation of BMI to Pregnancy Outcomes in Thai Women Delivered in Rajavithi Hospital

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***Objective**: To establish the correlation between pre-pregnancy body mass index (BMI) and pregnancy outcomes in Thai women. Cultural modernization has changed lifestyle of Thai population including eating habits, leading to higher incidence of overweight in pregnant woman. This study aims to analyze the relationship between BMI of Thai women before pregnant and pregnancy outcomes.*

***Material and Method**: The study population included 3,715 deliveries in Rajavithi Hospital, Bangkok, Thailand, between January 1, 2009 and December 31, 2009. The number of individuals in each adverse outcomes was compared with those in each BMI group. Odds ratios were calculated using normal BMI as reference.*

***Results**: The overweight and obese BMIs resulted in significant risk of cesarean section, pre-eclampsia and diabetes mellitus with [OR (95% CI)] 1.37 (1.13-1.68), 2.3 (1.4-3.7), 4.02 (2.66-6.08) for overweight and 2.11 (1.53-2.90), 5.7 (3.3-9.8), 6.02 (3.52-10.32) for obesity, respectively. The underweight BMI resulted in significant risk of preterm, very preterm, low birthweight (LBW) infant with [OR (95% CI)] 1.79 (1.48-2.16), 1.69 (1.15-2.47), 1.61 (1.27-2.03). Only obesity attributed to significant risk of macrosomia with [OR (95% CI)] 5.36 (2.73-10.52). Both overweight and obesity led to significant risk of postpartum hemorrhage and severe postpartum hemorrhage with [OR (95% CI)] 1.71 (1.21-2.44), 2.13 (1.08-4.22). No correlation was found between pre-pregnancy to stillbirth and congenital anomaly.*

***Conclusion**: Overweight and obesity could increase risk in cesarean section, pre-eclampsia, DM, PPH and severe PPH, but were protective factors of LBW. Only obesity played high risk of macrosomia. Underweight was a protective factor for cesarean section, pre-eclampsia, DM and PPH, but could cause risk in preterm, very preterm and LBW.*

***Keywords:** Pre-pregnancy BMI, Pregnancy outcomes, Pre-eclampsia, Diabetes mellitus, Rajavithi Hospital, Thai woman*

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The pre-pregnancy maternal obesity is related to an elevated risk of maternal complications[1] and adverse neonatal outcomes[2]; particularly, obese women have an increased risk of cesarean sections than those of the nonobese[3]. Several studies reported that maternal obesity was associated with increased risk of adverse pregnancy outcomes including cesarean section[3], pre-eclampsia[4], gestational diabetes[1], preterm delivery[5], macrosomia[6], postpartum hemorrhage(PPH)[7], stillbirth[8], and congenital anomaly[2]. Thailand is a changing society, Thai people have adapted to cultural modernization and western lifestyle resulting in the mix between conservative eastern and expressive western living patterns. From such changes including eating habits, the incidence of the obese population increased from 29% in 2004 to 35% in 2009[9]. Obesity is becoming a major problem in socio-economical and medical aspects of Thailand. There are several reports of adverse pregnancy outcomes in obese women and majority of them are from the United States and Europe.

The aim of this study was to evaluate the correlation between the pre-pregnancy maternal body mass index (BMI), and obstetrical and fetal outcomes in women delivered at the Department of Obstetrics and Gynecology, Rajavithi Hospital, Bangkok, Thailand.

Material and Method

The present study was approved by ethics committee of Rajavithi hospital. In this retrospective

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cohort study, all deliveries (n = 5,610) that gave birth between 1st January 2009 and 31st December 2009 at the Department of Obstetrics and Gynecology, Rajavithi Hospital were included. Data were collected from the maternal and perinatal database. All women who attend antenatal care with complete baseline maternal clinical information and pertinent outcome data were eligible for inclusion (n = 3,715). Any deliveries with incomplete database were excluded (n = 1,895).

Pre-pregnancy weight was recorded by recall in kilograms; maternal height was recorded by measuring at first antenatal booking in centimeters. Pre-pregnancy BMI was calculated as pre-pregnancy weight (kg), divided by height square (m^2). The subjects were divided into 4 groups according to maternal pre-pregnancy BMI using body mass groupings recommended by WHO (underweight BMI < 18.5 kg/m^2; normal BMI 18.5-24.9 kg/m^2; overweight BMI 25-29.9 kg/m^2, and obese BMI > 30.0 kg/m^2)[10].

Information about maternal age, gravida, parity, and complications during pregnancy or delivery were obtained from records routinely filled out when the mother was admitted to and discharged from the hospital. Maternal age was defined as age in completed years at the time of delivery, gravid as the number of pregnancy and parity as the number of previous births, including stillbirths at 28 weeks of gestation or later. Complications during pregnancy and delivery were classified by a physician at the time of hospital discharge, according to the International Classification of Diseases, Ninth Revision (ICD-9).

For this analysis, the author used two groups of diagnosis that associated with pre-pregnancy BMI and the risk of adverse pregnancy outcomes. Mild pre-eclampsia, severe pre-eclampsia and eclampsia were defined as pre-eclampsia (ICD-9 codes 642A, 642E, 642F, and 642G), and insulin-dependent or non-insulin-dependent diabetes mellitus present before pregnancy or gestational diabetes were defined as diabetes mellitus (ICD-9 codes 250, 648A, and 648W). Information about the duration of gestation, and birth weight were obtained from the standardized pediatric record, routinely filled out immediately after delivery. Late fetal death was defined as stillbirth occurring at 28 or more completed weeks of gestation. Delivery at less than 37 completed weeks of gestation was classified as preterm delivery; delivery at less than 34 completed weeks was defined as very preterm. Low birthweight (LBW) infants were defined as those with birthweights less than 2,500 grams, infants with birthweight more than 4,000 grams were defined as macrosomia. Estimated gestational age was based on last menstrual period or ultrasound examinations performed routinely at no later than 18 completed weeks of gestation.

Statistical Analysis

All analyses were performed with the statistical program SPSS 17.0. The One way ANOVA was used for comparison of the mean between patient groups. Data were presented as mean $\pm$ standard deviation (SD) for continuous data and number (%) for categorical data. A p-value of < 0.05 was considered to be statistically significant. Differences in the frequencies of events between patient-groups were analyzed using a chi-square test. Odds ratio (OR) with 95% confidence intervals (95% CI) was estimated for the effect of pre-pregnancy BMI on the outcomes.

Results

The relationship between body mass index and pregnancy outcomes in Thai pregnant women was determined. The study group included pregnant women who attended antenatal care and delivered at delivery room Rajavithi Hospital from 1st January 2009 to 31st December 2009. During this period there were 3,715 deliveries with antenatal care, complete baseline maternal clinical information and pertinent outcome data. Within 3,715 cases, the normal BMI group (18.5 to 24.9 kg/m^2) accounted for 2,417 cases, representing 65 percent, the underweight group (< 18.5 kg/m^2) accounted for 656 cases, 18 percent, the overweight group (25.0 to 29.9 kg/m^2) accounted for 482 cases, representing 13 percent and the obesity group (> 30.0 kg/m^2) accounted for 160 cases, representing 4 percent. The study compared the average of age with pre-pregnancy BMI groups and found that the underweight group had youngest mean age of (standard deviation) 25.1 (5.4) years, followed by the normal BMI, the obesity group and the overweight group, with an average age of (standard deviation) 27.6 (5.7), 29.5 (5.9) and 29.9 (5.6) years, respectively. This difference was statistically significant at $p < 0.001$, and when comparing each pair we also found that the mean age difference is statistically significant for every pair ($p < 0.05$) except for the pair between the overweight group and the obesity group. The relationship of BMI to gravida and para shows statistical significance at $p < 0.001$. In addition, those who had higher BMI before pregnancy also had higher gravida and para as well (Table 1).

The correlation between cesarean section and pre-pregnancy BMI was significant in all weight groups. The risk of cesarean section was high in overweight

Table1. The relationship between general characteristics of the sample with the pre-pregnancy BMI

Factors	Under weight (n = 656)	Normal weight (n = 2,417)	Over weight (n = 482)	Obesity (n = 160)	Total (n = 3,715)	p-value
Age(years)	25.1 ± 5.4	27.6 ± 5.7	29.5 ± 5.9	29.9 ± 5.6	27.5 ± 5.9	< 0.001*[a]
Gravida						< 0.001*[b]
1	344 (52.4)	1,097 (45.4)	150 (31.1)	34 (21.3)	1,625(43.7)	
2	211 (32.2)	835 (34.5)	183 (38.0)	70 (43.8)	1,299 (35.0)	
3	74 (11.3)	357 (14.8)	101 (21.0)	37 (23.1)	569 (15.3)	
4	21 (3.2)	92 (3.8)	37 (7.7)	13 (8.1)	163 (4.4)	
≥5	6 (0.9)	36 (1.5)	11 (2.3)	6 (3.8)	59 (1.6)	
Para						< 0.001*[b]
0	410 (62.5)	1,324 (54.8)	184 (38.2)	47 (29.4)	1,965 (52.9)	
1	181 (27.6)	787 (32.6)	195 (40.5)	73 (45.6)	1,236 (33.3)	
2	53 (8.1)	252 (10.4)	87 (18.0)	36 (22.5)	428 (11.5)	
3	11 (1.7)	39 (1.6)	13 (2.7)	4 (2.5)	67 (1.8)	
≥4	1 (0.2)	15 (0.6)	3 (0.6)	0 (0.0)	19 (0.5)	

Values are represented as means ± SD and n(%)
a = p-value from One-Way ANOVA, b = p-value from Chi-square test, * significant at $p < 0.05$

group (OR = 1.37, 95% CI 1.13-1.68, p = 0.002) and obese group (OR = 2.11, 95% CI 1.53-2.90, p < 0.001), while it was low in underweight women (OR = 0.49, 95% CI 0.40-0.60, p < 0.001) (Table 2). The relationship between pre-pregnancy BMI and pre-eclampsia was also statistically significant. The risk of pre-eclampsia increased in overweight (OR = 2.3, 95% CI 1.4-3.7, p < 0.001) and obese women (OR = 5.7, 95% CI 3.3-9.8, p < 0.001), while it decreased in underweight women (OR = 0.3, 95% CI 0.1-0.8, p = 0.016) (Table 2). The correlation between diabetes mellitus and pre pregnancy BMI was significant in all weight groups. The risk of diabetes mellitus was significant in overweight group (OR = 4.02, 95% CI 2.66-6.08, p < 0.001) and obese group (OR = 6.02, 95% CI 3.52-10.32, p < 0.001), while it was unrecognizable in underweight group (OR = 0.13, 95% CI 0.03-0.53, p = 0.004) (Table 2).

The risk of preterm deliveries (< 37 weeks) and very preterm deliveries (< 34weeks) increased significantly only in the underweight group (OR = 1.79, 95% CI 1.48-2.16, p = 0.518 and OR = 1.69, 95% CI 1.15-2.47, p = 0.008 respectively), but not in the overweight or obese groups (Table 2).

The correlation between LBW (< 2,500 gm) and pre-pregnancy BMI was significant in all weight groups, showing higher risk in underweight group (OR = 1.61, 95% CI 1.27-2.03, p < 0.001), and lower risk in overweight group (OR = 0.60, 95% CI 0.42-0.86, p = 0.005) and obese group (OR = 0.44, 95% CI 0.22-0.87) (Table 2).

The correlation between macrosomia (> 4,000gm) and pre-pregnancy BMI was significant in the obese group only (OR = 5.36, 95% CI 2.73-10.52, p < 0.001). The risk of macrosomia increased in overweight group but not significant (OR = 1.69, 95% CI 0.87-3.27, p = 0.120. The correlation was not significant in underweight group as well (OR = 0.41, 95% CI 0.14-1.14, p = 0.088) (Table 2).

The correlation of postpartum hemorrhage (PPH, > 500 ml) and pre-pregnancy BMI were significant in all weight groups. The overweight and the obese group had higher risk of PPH (> 500 ml) (OR = 1.41, 95% CI 1.12-1.77, p = 0.003) and (OR = 1.71, 95% CI 1.21-2.44, p = 0.003), respectively. In contrast, the underweight group showed lower risk of PPH (OR = 0.56, 95% CI 0.44-0.73, p < 0.001) (Table 2). The correlation between severe postpartum hemorrhage (> 1,000 ml) and pre-pregnancy BMI was significant in overweight and obese groups only. The risk of severe PPH in overweight group (OR = 1.70, 95% CI 1.06-2.73, p = 0.028) and obese group (OR = 2.13, 95% CI 1.08-4.22, p = 0.029) was pronounced, while it was not a protective factor in the underweight group (OR = 0.70, 95% CI 0.39-1.25, p = 0.225) (Table 2).

The author could not find any correlation between stillbirth and pre-pregnancy BMI as shown in Table 2 and could not identify any correlations between congenital anomaly and pre-pregnancy BMI or the

Table 2. The proportion (percent), the results of logistic regression analyses [odds ratio (95% confidence interval)] and p value are tabulated for each characters according to BMI

Characters	Proportion (%) Odds ratio (95% CI) p-value			
	Normal weight (n = 2,417)	Under weight (n = 656)	Over weight (n = 482)	Obesity (n = 160)
Cesarean Section	34.4	20.4	41.9	52.5
	1	0.49 (0.40-0.60)*	1.37 (1.13-1.68)*	2.11 (1.53-2.90)*
		p < 0.001	p = 0.002	p < 0.001
Pre-eclampsia	2.3	0.8	5.2	11.9
	1	0.3 (0.1-0.8)*	2.3 (1.4-3.7)*	5.7 (3.3-9.8)*
		p = 0.016	p < 0.001	p < 0.001
Diabetes millitus	2.3	0.3	8.7	12.5
	1	0.13 (0.03-0.53)*	4.02 (2.66-6.08)*	6.02 (3.52-10.32)*
		p = 0.004	p < 0.001	p < 0.001
Preterm (< 37 wk)	22.2	33.9	23.6	21.3
	1	1.79 (1.48-2.16)*	1.08 (0.86-1.36)	0.94 (0.64-1.39)
		p < 0.001	p = 0.518	p = 0.770
Very preterm (< 34 wk)	3.7	6.1	2.5	2.5
	1	1.69 (1.15-2.47)*	0.66 (0.36-1.22)	0.66 (0.24-1.82)
		p = 0.008	p = 0.186	p = 0.424
Low birthweigh (< 2,500 gm)	11.9	17.8	7.5	5.6
	1	1.61 (1.27-2.03)*	0.60 (0.42-0.86)*	0.44 (0.22-0.87) *
		p < 0.001	p = 0.005	p = 0.019
Macrosomia (> 4,000 gm)	1.5	0.6	2.5	7.5
	1	0.41 (0.14-1.14)	1.69 (0.87-3.27)	5.36 (2.73-10.52)*
		p = 0.088	p = 0.120	p < 0.001
Postpartum hemorrhage	20.0	12.4	26.1	30.0
(≥ 500 ml)	1	0.56 (0.44-0.73)*	1.41 (1.12-1.77)*	1.71 (1.21-2.44)*
		p < 0.001	p = 0.003	p = 0.003
Severe Postpartum	3.0	2.1	5.0	10
hemorrhage (≥ 1,000 ml)	1	0.70 (0.39-1.25)	1.70 (1.06-2.73)*	2.13 (1.08-4.22)*
		p = 0.225	p = 0.028	p = 0.029
Stillbirth	0.4	1.1	0.0	0.6
	1	2.60 (0.98-6.85)	c	d
		p = 0.540		
Congenital anomaly	2.8	2.2	1.4	2.1
	1	0.47 (0.44-1.47)	0.49 (0.21-1.15)	0.74 (0.23-2.39)
		p = 0.471	p = 0.102	p = 0.616

* = Significant at p < 0.05, c = No stillbirth in this group, d = Only 1 case in this group.

correlations of major and minor anomaly in any group of pre-pregnancy BMI (Table 2).

Discussion

Since the past century, Thailand is one of the developing countries that gradually absorb modernization/westernization to its population, both technology and culture. The lifestyle of some Thai people has changed from eastern to western way, including food like less vegetable and herb and more meat and fat. According to this fact, it accounts for the obese population to increase from 29% in 2004 to 35% in 2009[9]. This could be implied that there is more chance to find obese women come to the delivery room. There is no report on the effect of overweight or obesity on pregnancy outcomes in Thailand. This study aims to correlate the adverse outcomes with pre-pregnancy BMI in Thai women.

The author found the significant increase in cesarean section in overweight and obese groups (OR 1.37 (95% CI 1.13-1.68) and OR 2.11 (95% CI 1.53-2.90), respectively). High rate of cesarean section in these groups may be due to confounding variables such as abnormal presentation of the fetus or increased planned elective cesarean section for predicted macrosomia. Moreover, additional factors might be as followings: the increasing rate of large for gestational age infants, leading to disproportion during labor; possible that uterine contractility may be suboptimal in these women; increase in fat deposition in the soft tissues of the pelvis; and medical complications of pregnancy. High incidence in cesarean section in these groups was clinically relevant because it may increase risk of associated complications, such as infectious morbidity[1,3].

Previous research reported a strong correlation between increasing BMI and induced hypertension during pregnancy[1,4,5]. A meta-analysis of the risk of pre-eclampsia associated with maternal BMI[11] showed that the risk of pre-eclampsia doubled with each 5-7 Kg/m2 increase in pre pregnancy BMI. The author found risks of pre-eclampsia to be 2.3 times higher in overweight group and 5.7 times higher in obese group when compared with normal weight. The author also found a significantly lower risk of pre-eclampsia in underweight women OR 0.3 (95% CI 0.1-0.8). These findings were in agreeable with those work of Sebire et al[1] and Driul et al[6].

Sebire et al[1] reported risk of gestational diabetes to be OR 1.68 (99% CI 1.53-1.84) and OR 3.6 (99% CI 3.25-3.98) in obese pregnant women who had BMI 25-30 and > 30, respectively. Similar to their report, our findings show that these two groups had risk of diabetes to be OR 4.02 (95% CI 2.66-6.08) and OR 6.02 (95% CI 3.52-10.3, respectively. Interestingly, the underweight group was a significant protective factor against diabetes, with OR 1.13 (95% CI 0.03-0.53).

When compared with the other reports, our study had different result of correlation between pregnancy maternal obesity and incidence of preterm birth. Lumme et al[12] did not find a correlation between pre-pregnancy BMI and risk of preterm birth. Driul et al[6] found overweight and obese women had an increased risk of preterm birth but only statistically significant for obese patients. On the contrary, we did not find any correlation in overweight and obese groups, but found that the underweight had an increased risk for preterm birth, in both < 37and < 34 weeks, as 1.79 times (95% CI 1.48-2.6) and 1.69 times (95% CI 1.15-2.47) higher than that of the normal weight group.

In this study, the correlation of LBW (birth weight less than 2,500 g) and pre-pregnancy BMI were significant in all weight groups but only the obese group showed a significant risk for macrosomia. Several studies investigating the relationship of maternal obesity and fetal growth have shown that obese women had an increased chance of delivering large infants[1,4,5]. The present study showed that the risk of LBW in underweight was 1.61 (95% CI 1.27-2.03) and the risk of macrosomia in overweight and obese groups were 1.69 (95% CI 0.87-3.27) and 5.36 (95% CI 2.73-10.52), respectively. The original Pedersen hypothesis suggested that increased glucose concentrations in the diabetic mother led to fetal hyperglycemia and hyperinsulinemia causing higher incidence of fetal growth[13].

Some work had also previously demonstrated a strong link between postpartum blood loss and BMI[1,14]. Other studies have reported conflicting results. While Sebire et al[1] observed a 70% increase in postpartum hemorrhage, Bianco et al[14] found no such difference in the incidence. As measurement of blood loss was subjective and the definition of postpartum hemorrhage varied, it is difficult to make comparison across studies. This present study showed that the risk for > 500 ml. PPH in the overweight and obese groups were 1.41 (95% CI 1.12-1.77) and 1.71 (95% CI 1.21-2.44), respectively, while the risk for > 1,000 ml PPH in the overweight and obese groups were 1.70 (95% CI 1.06-2.73) and 2.13 (95% CI 1.08-4.22), respectively. It appears that women with higher body mass index should bleed more due to higher incidence of induced labor, operative deliveries. Moreover, the relatively larger area of implantation of the placenta usually associates with a large for gestational age fetus in these women.

Kristensen et al[8] reported that maternal obesity was associated with risk of stillbirth for more than two-folds (odds ratio 2.8, 95% CI 1.5-5.3). Sebire et al[1] reported the risk of intrauterine death 1.10 (95% CI 0.94-1.28) which was not significant. In this study, the author could not find any significant correlation of stillbirth to the pre-pregnancy BMI.

Stothard et al[2] reviewed 1,944 potential articles; of these, 39 were included in the systematic review and 18 in the meta-analysis. They concluded that maternal obesity was associated with an increased risk of a range of structural anomalies, although the absolute increase is likely to be small. The present study,

the author could not find any relation of congenital anomaly to pre-pregnancy BMI. The present study population (3,715) might not be big enough to reveal a low incidence of anomalies.

Cedergren[15] found that the optimal gestational weight gain in women by pre-pregnancy BMI was 4-10 kg for BMI less than 20 kg/m^2; 2-10 kg for BMI 20-24.9 kg/m^2; less than 9 kg for BMI 25-29.9 kg/m^2; and less than 6 kg for BMI of 30 kg/m^2 or more. He indicated that decreased risk of adverse obstetric and neonatal outcomes was associated with lower gestational weight gain limits than was earlier recommended, especially among obese women. Stotland et al[16] suggested that the patients with high pre-pregnancy BMI (BMI of 26.1-29.0 kg/m^2) was a stronger predictor of inappropriate target weight gain during pregnancy and advised avoidance of excessive weight gain in this group than women who had very high or obese pre pregnancy BMI (BMI > 29.0 kg/m^2). They also suggested that clinicians were likely to inform the patients to reduce their weight gain goals when there is obvious obesity, nevertheless, more moderate degrees of overweight may be overlooked.

Conclusion

This present study showed that the overweight and obese groups significantly had increased risk in cesarean section, pre-eclampsia, diabetes mellitus and postpartum hemorrhage. Underweight was a significant protective factor for these problems. However, the underweight had significant risk in preterm delivery and low birth weight. The overweight and obese were protective factors for low birth weight. Macrosomia significantly increased in the obese group only. No correlation between stillbirth and congenital anomaly and BMI was found.

Potential conflicts of interest

None.

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ความสัมพันธ์ของดัชนีมวลกายต่อผลของการตั้งครรภ์ของหญิงไทยที่มาคลอดที่โรงพยาบาลราชวิถี

เกษม เสรีพรเจริญกุล

วัตถุประสงค์*: วัฒนธรรมสมัยใหม่ได้มีการเปลี่ยนแปลง ส่งผลต่อวิถีการดำรงชีวิตของคนไทย ซึ่งรวมถึงนิสัยการรับประทานอาหาร นำไปสู่การเพิ่มขึ้นของอุบัติการณ์ของหญิงตั้งครรภ์ที่มีน้ำหนักเกิน การศึกษานี้จึงมีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ของดัชนีมวลกายก่อนตั้งครรภ์ต่อการตั้งครรภ์ การคลอด และภาวะแทรกซ้อนหลังคลอดของหญิงไทย*

วัสดุและวิธีการ*: ศึกษาในหญิงไทย 3,715 รายที่มาคลอดที่โรงพยาบาลราชวิถีระหว่างวันที่ 1 มกราคม พ.ศ. 2552 ถึง 31 ธันวาคม พ.ศ. 2552 ผลของการตั้งครรภ์ การคลอด และภาวะแทรกซ้อนของผู้คลอดแต่ละรายจะถูกบันทึกและรวบรวมแยกกลุ่มตามดัชนีมวลกายก่อนการตั้งครรภ์ แล้วเปรียบเทียบตามความแตกต่างของแต่ละกลุ่ม คำนวณหา odds ratio โดยมีกลุ่มที่มีดัชนีมวลกายปกติเป็นฐาน*

ผลการศึกษา*: หญิงที่มีดัชนีมวลกาย overweight และ obese จะมีความเสี่ยงต่อการผ่าตัดคลอด, ภาวะ pre-eclampsia และเบาหวานเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ OR (95% CI) = 1.37 (1.13-1.68), 2.3 (1.4-3.7), 4.02 (2.66-6.08) ในกลุ่ม overweight และ 2.11 (1.53-2.90), 5.7 (3.3-9.8), 6.02 (3.52-10.32) ในกลุ่ม obese ส่วนผู้ที่มีดัชนีมวลกาย underweight จะมีความเสี่ยงต่อ preterm, very preterm, ทารกที่มีน้ำหนักแรกเกิดน้อยกว่า 2,500 กรัม เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ OR (95% CI) = 1.79 (1.48-2.16), 1.69 (1.15-2.47), 1.61 (1.27-2.03) ตามลำดับ เฉพาะกลุ่ม obese เท่านั้นที่มีความเสี่ยงต่อ macrosomia อย่างมีนัยสำคัญ OR (95% CI) 5.36 (2.73-10.52) ทั้งกลุ่ม overweight และ obese มีความเสี่ยงอย่างมีนัยสำคัญต่อภาวะตกเลือดหลังคลอดและตกเลือดหลังคลอดรุนแรง OR (95% CI) 1.71 (1.21-2.44), 2.13 (1.08-4.22) ในขณะที่ไม่พบความสัมพันธ์ของดัชนีมวลกายต่อ stillbirth และ congenital anomaly*

สรุป*: ภาวะ overweight และ obesity จะทำให้เพิ่มภาวะเสี่ยงต่อการผ่าตัดคลอด, pre-eclampsia, เบาหวาน, ตกเลือดหลังคลอด แต่ลดความเสี่ยงต่อทารกที่มีน้ำหนักแรกเกิดน้อยกว่า 2,500 กรัม เฉพาะกลุ่ม obesity เท่านั้นที่เพิ่มความเสี่ยงต่อ macrosomia ในขณะที่ underweight เป็นปัจจัยป้องกันต่อการผ่าตัดคลอด, pre-eclampsia, เบาหวาน, ตกเลือดหลังคลอด แต่ก็เป็นปัจจัยเสี่ยงต่อ preterm, very preterm และทารกที่มีน้ำหนักแรกเกิดน้อยกว่า 2,500 กรัม*