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Effect of gestational weight gain on pregnancy outcomes in underweight pregnant women

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ABSTRACT

Objective: To determine a relationship between inadequate gestational weight gain and adverse pregnancy outcomes among Thai gravidas with underweight.

Methods: A retrospective cohort study was conducted in 306 underweight pregnant women who attended our antenatal clinic between December 2009 and August 2012. The study subjects (women who gained less than 12 kg throughout pregnancy) were matched 1:1 with the control subjects (women who gained ≥12 kg) by age group and parity. Adverse pregnancy outcomes including low birth weight (LBW), small-for-gestational age (SGA), birth asphyxia, and neonatal intensive care unit (NICU) admission were compared between the two groups.

Results: Complete data of 145 study subjects and 145 controls were analyzed. The study group had significantly lower mean neonatal birth weight than the control group: 2,939.0±338.1 grams vs. 3,037.2±336.9 grams; p=0.014. By univariable and multivariable analyses, women in the study group were not at increased risk of LBW, SGA, birth asphyxia, and NICU admission compared to control subject. However, when different thresholds for inadequate weight gain were applied, we found that gestational weight gain less than 8 kg was significantly associated with LBW, but not SGA, birth asphyxia, and NICU admission, in underweight women. The adjusted OR was 4.5 (95% confidence interval, 1.4-14.6; p=0.012).

Conclusion: There was no significant relationship between inadequate gestational weight gain (<12 kg) and adverse pregnancy outcomes among Thai gravidas with underweight. However, women who gained less than 8 kg were at significantly increased risk of delivering a LBW infant.

Keywords: gestational weight gain, pregnancy outcomes, underweight

Introduction

A large percentage of reproductive-age women in developing countries including Thailand have thin body habitus. From a global analysis by the International Food Policy Research Institute in 2000, approximately 60% of South Asian women and 40% of Southeast

Asian women had body weight less than 45 kg; 40% of which were classified as underweight[1]. The causes of underweight may be due to genetics, lack of food, or secondary to underlying disease[2]. There is evidence that individuals with underweight are at increased risk of anemia, poor immune response, and osteoporosis[3]. Focusing on the impact of thin body habitus on perinatal outcomes, a few studies reported that maternal underweight was significantly related to small-for-gestational age (SGA), low birth weight (LBW), and preterm infants[4-6]. Inadequate gestational weight gain was also found to associate with adverse neonatal outcomes[7]. However, the number of these studies is limited. Moreover, the recommended criteria for diagnosing underweight varied from body mass index (BMI) <18.5 kg/m^2 to <20 kg/m^2 [8-10]. The definition of inadequate weight gain in underweight gravidas also ranged from <12 kg to <12.7 kg throughout pregnancy[8-10].

Given that recommendations for gestational weight gain were set by expert panels from Western countries, it is not known whether these guidelines would be applied to Asian women. The aim of this study was to determine the effect of inadequate gestational weight gain (<12 kg) on adverse pregnancy outcomes among Thai gravidas who had underweight. Specifically, we focused on the adverse outcomes which are major public health problems or impose substantial costs on overall economy. These included LBW, SGA, birth asphyxia, and neonatal intensive care unit (NICU) admission. A further aim was to search for the threshold of gestational weight gain which was significantly associated with any of these four adverse outcomes in underweight women.

Materials and Methods

This retrospective cohort study was conducted by reviewing medical records of pregnant women who presented for antenatal care and delivered in our institution between December 2009 and August 2012. Eligibility criteria were term, singleton pregnant women who had their first antenatal booking at gestational age (GA) less than or equal to 13 weeks. These women must have certain GA by their last menstrual period or by early ultrasound at an initial visit. They must also have underweight, which was defined as pre-pregnancy BMI less than 20 kg/m^2. Exclusion criteria were women who had medical disorder or any condition which may affect pregnancy outcomes (e.g. pre-existing diabetes, chronic hypertension, autoimmune disease, renal disease, etc), drug abuse, smoking, alcohol drinking, severe congenital anomaly or chromosomal abnormality, incomplete data record, and non-Thai ethnicity. The study was approved by the Vajira Institutional Review Board (Registered Number 074/55).

We divided the study population into two groups: study and control groups. The study subjects were gravidas who did not achieve adequate weight gain (<12 kg) while the control subjects were women who achieved adequate weight gain (>12 kg) throughout pregnancy. Each control was selected from a woman who gave birth next to a study subject and was matched according to age group and parity.

We considered LBW to be the primary outcome measure since it is common and associates with various neonatal complications. From our pilot investigation in a separate cohort of 50 gravidas with underweight, the rates of LBW were 8% and 23% in those with and without adequate weight gain, respectively. The sample size was then calculated using 5% type I error and 10% type II error. We added 25% to the number calculated in the event that any subject was excluded. This resulted in total of 153 study subjects and 153 controls needed. Data collection included maternal demographic and antenatal characteristics, delivery information, and adverse pregnancy outcomes. BMI was calculated from self-reported pre-pregnancy weight (kg) divided by square of height (m^2). Gestational weight gain during pregnancy was defined as the weight measured on the date of admission to the delivery ward minus pre-pregnancy weight. Weight measurements of all women were performed using the same weighing scales at the antenatal clinic and delivery room. Adverse pregnancy outcomes included LBW, SGA, birth asphyxia, and NICU admission. LBW referred to neonatal birth weight less than 2,500 grams[11]. A diagnosis of SGA was made when estimated fetal weight was under the 10th percentile for that particular GA[12]. Birth asphyxia was defined as 5-minute Apgar

score below 7[13]. The criteria for NICU admission in our institution were respiratory or circulatory instability, suspected sepsis, and the need for close observation as assessed by the attending neonatologist.

Statistical analysis was performed using the SPSS software package version 11.5 (SPSS Inc., Chicago, IL, USA). Continuous variables were compared by the Student t-test while categorical variables were compared by χ^2 test or Fisher exact test as appropriate. The odds ratios (ORs) with 95% confidence intervals (95% CIs) for the four outcomes studied in the study group were analyzed by multivariable analysis adjusted for potential confounders. P-value <0.05 was considered statistically significant.

Results

A total of 306 pregnant women who had underweight were enrolled. Eight women were non-Thai (five gravidas in the study group and three gravidas in the control group) and Eight women had incomplete data (three gravidas in the study group and five gravidas in the control.

Demographic and antenatal characteristics of pregnant women in the study and control groups are presented in Table 1. Both groups had similar characteristics of mean GA at first booking, number of antenatal care visits, prepregnancy BMI, hematocrit levels both at the first trimester and during first stage of labor, proportion of either nulli-or multiparas, and unemployment. The differences between both groups were that the study group had significantly lower mean age and higher rate of under Bachelor degree. The mean gestational weight gains in the study and control groups were 9.3±2.0 kg and 14.6±1.8 kg (p<0.001), respectively.

With respect to delivery outcomes, there were no significant differences of mean GA at delivery and rate of cesarean section between the two groups. Focusing on the indications for cesarean section, the rate of primary cesarean section in the study group was significantly lower than that in the control group. The study group also had significantly lower mean birth weight than the control group. Details of delivery routes and indications for cesarean section of gravidas in both groups are shown in Table 2.

From our 290 newborns studied, 17 (5.9%) had LBW, 4 (1.4%) had SGA, 9 (3.1%) had birth asphyxia, and none was admitted to the NICU. By univariable and multivariable analyses (Table 3), underweight pregnant women with inadequate weight gain (<12 kg) throughout pregnancy did not have a significantly increased risk of the four adverse outcomes of interest. We also investigated the risk of these four outcomes in our subjects using different thresholds for inadequate weight gain (e.g. <11 kg, <10 kg, <9 kg, <8 kg, etc). Upon further analysis, we found that gestational weight gain less than 8 kg was significantly associated with LBW in underweight women. The adjusted OR was 4.5 (95% CI, 1.4-14.6; p=0.012) compared to weight gain ≥8 kg. The risk appeared to be higher when gestational weight gain was less than 7 kg (13.3 folds; 95% CI, 3.4-52.3; p<0.001 compared to weight gain ≥7 kg). However, both gestational weight gain thresholds were not significantly associated with the risk of SGA, birth asphyxia, and NICU admission.

Table 1. Demographic and antenatal characteristics of the study population (n=290)

Characteristic	Overall (n = 290)	Overall (n = 290)	Control group (n = 145)	p
Age (years)	27.4 ± 5.7	27.4 ± 5.7	28.3 ± 5.4	0.011*
Occupation				0.142**
Civil servant	24 (8.3)	24 (8.3)	16 (11.1)	
Other	184 (63.4)	184 (63.4)	93 (64.1)	
Non-employee	82 (28.3)	82 (28.3)	36 (24.8)	
Education				0.015**
Under bachelor degree	203 (70.0)	203 (70.0)	92 (63.4)	
Above bachelor degree	87 (30.0)	87 (30.0)	53 (36.6)	
Parity				0.906**
Nullipara	149 (51.4)	149 (51.4)	74 (51.0)	
Multipara	141 (48.6)	141 (48.6)	71 (49.0)	
GA 1st visit (weeks)	9.8 ± 2.3	9.8 ± 2.3	9.9 ± 2.3	0.661*
Number of ANC	10.4 ± 2.4	10.4 ± 2.4	10.5 ± 2.4	0.650*
Prepregnancy BMI (kg/m^2)	18.2 ± 1.6	18.2 ± 1.6	18.1 ± 1.9	0.492*
Gestational weight gain (kg)	12.0 ± 3.3	12.0 ± 3.3	14.6 ± 1.8	< 0.001*
Hematocrit (%)				
At 1st trimester	35.4 ± 3.0	35.4 ± 3.0	35.3 ± 2.9	0.772*
At delivery room	35.2 ± 3.3	35.2 ± 3.3	35.3 ± 3.3	0.570*

Data are mean (SD) or n (%).

Abbreviation: ANC = antenatal care; BMI = body mass index; GA = gestational age; n = number; SD = standard deviation.

* Student t-test.

** χ^2 test.

Table 2. Delivery outcomes of the study population (n=290)

Outcome	All (n = 290)	Study group (n =145)	Control group (n = 145)	p
GA at delivery (weeks)	38.4 ± 1.0	38.4 ± 1.0	38.4 ± 1.0	0.726*
Route of delivery				0.898**,#
Vaginal route	203 (70.0)	101 (69.7)	102 (70.3)	
Normal delivery	195 (67.2)	99 (68.3)	96 (66.2)	
Vacuum extraction	6 (2.1)	1 (0.7)	5 (3.4)	
Forceps extraction	2 (0.7)	1 (0.7)	1 (0.7)	
Cesarean section	87 (30.0)	44 (30.3)	43 (29.7)	
Nonreassuring FHR pattern	6 (6.9)	3 (6.8)	3 (6.9)	
Others	24 (27.6)	9 (20.5)	15 (34.9)	

Table 2. Delivery outcomes of the study population (n=290) (Cont.)

Outcome	All (n = 290)	Study group (n =145)	Control group (n = 145)	p
Previous cesarean section	29 (33.3)	19 (43.2)	10 (23.3)	
Neonatal birth weight (grams)	2,988.0 ± 340.5	2,939.0 ± 338.1	3037.2 ± 336.9	0.014*

Data are mean (SD) or n (%)

Abbreviation: CPD = cephalopelvic disproportion; FHR = fetal heart rate; GA = gestational age; n = number; SD = standard deviation.

*Student t-test.

** χ^2 test.

Comparison between vaginal delivery and cesarean section.

Comparison between primary cesarean section and previous cesarean section.

Table 3. Univariable and multivariable analyses to determine the effect of gestational weight gain on neonatal outcomes in underweight pregnant women

	Study group (n =145)	Control group (n=145)	Crude OR (95% CI)	Adjusted OR* (95% CI)	p
LBW	10 (6.9%)	7 (4.8%)	1.5 (0.5-3.9)	1.2 (0.4-3.4)	0.710
SGA	2 (1.4%)	2 (1.4%)	1.0 (0.1-7.2)	0.8 (0.1-6.4)	0.854
Birth asphyxia	5 (3.4%)	4 (2.8%)	1.3 (0.3-4.8)	1.4 (0.3-5.3)	0.666
NICU admission	0 (0%)	0 (0%)	-	-	-

*Adjusted for age, occupation, education, parity, and number of antenatal care.

Abbreviation: LBW= low birth weight; n = number; NICU= neonatal intensive care unit; OR = odds ratio; SGA= small for gestational age.

Discussion

Weight gain is a basic parameter to evaluate maternal and fetal health status during the prenatal period. We focused on gestational weight gain in underweight mothers because thin body habitus is commonly found in Thailand particularly among adolescents and individuals from lower socioeconomic levels. According to recommendations by several expert panels, underweight women should gain at least 12-12.7 kg during pregnancy[8-10]. However, one limitation of these guidelines is that their databases were based primarily on Western populations. Since body size, body composition, and fat distribution are various across ethnicity[14], the general application of these guidelines is still questionable.

During the study period, the prevalence of underweight in our population was 8.8%. This prevalence was in the range of 3.8-21.6% in other population groups[15-22]. The differences among our and other studies might be due to various clinical features and backgrounds in each study. Furthermore, our study used the BMI cutoff value of 20 kg/m^2 while other studies obtained the values of 18.5 kg/m^2[21] or 19.8 kg/m^2[20] as a diagnostic criterion for underweight.

In this study, we found that newborns of underweight mothers with inadequate weight gain had significantly lower mean birth weight than newborns of underweight women with adequate weight gain. Our result was in line with the finding of Mitchell et al who reported that birth weight increased significantly with

antenatal weight gain in a group of underweight mothers[23]. The relationship between inadequate weight gain and the risk of LBW was also observed in one prior study. Hulsey et al found that underweight gravidas with gestational weight gain less than 12.7 kg had a 4.1-fold increase in the risk of delivering a moderately LBW infant and a rise in very LBW cases by 2-fold compared to mothers with normal BMI who had adequate weight gain[19]. Unlike their results, we found no significant relationship between inadequate weight gain and the risk of LBW. This might be because we assigned underweight women with weight gain ≥12 kg as the reference group and considered weight gain less than 12 kg to be inadequate weight gain which were different from the study of Hulsey et al. Nevertheless, our finding of an association between gestational weight gain less than 8 kg and a 4.5-fold increase in the risk of LBW should alert the physicians to be aware of this adverse outcome and carefully monitor the women who are at risk.

In addition to LBW, studies of Harita et al, Simas et al, and Jeric et al reported an association of inadequate weight gain in underweight pregnant women with the risk of having an SGA infant[15-17]. However, our study did not confirm this finding. Likewise, we were unable to find a relationship between inadequate weight gain and risks of birth asphyxia and NICU admission. The absence of such an association in our study might be due to a lack of statistical power since our sample size was calculated based on LBW as a primary outcome. Future research with larger sample size is needed to verify these contradictory results.

It is interesting to note that we observed a significantly lower rate of overall primary cesarean section in a group of underweight gravidas with inadequate weight gain compared to thin women with adequate weight gain. This finding was in agreement with the results of Ehrenberg et al and Saereeporncharenkul et al's studies which reported that underweight was a protective factor for cesarean section[6,20]. One possible explanation for this observation is due to a consequence of small or LBW babies as we found a lower cephalopelvic disproportion rate in a group of inadequate weight gain than the other group. This finding may serve as basic information for clinicians to use for encouraging and monitoring underweight gravidas during the intrapartum period.

Several characteristic features have been described as potential risk factors for inadequate weight gain, such as younger age, under bachelor's degree, low socioeconomic status, etc[24,25]. This was corroborated by our findings which identified higher numbers of non-employee and under Bachelor's degree in a group of inadequate weight gain than the other group. The reason for this finding might be that this particular group of women had poor nutrition or less self-care therefore they were not aware of weight gain during pregnancy. Unfortunately, we were unable to prove an association between young or teenage mothers and the risk of inadequate weight gain since the study and control subjects in this study were matched by age group. Further studies are warranted to explore this relationship.

This is the first study to explore an effect of gestational weight gain on pregnancy outcomes in a cohort of Thai populations. The strength of our study was that all pregnant women presented in early gestation at their first prenatal visit so an error on recalled pre-pregnancy weight was minimized. Likewise, data on gestational weight gain was reliable because we had certain criteria to measure the last pregnancy weight for all gravidas. Our study also included only uncomplicated and term pregnancies so potential influences of preterm delivery, maternal, and obstetric complications on adverse outcomes could be exclued. At the same time, there were some limitations of our study. As this was a retrospective study, some demographic or clinical data might not be available. In addition, it was conducted in a small population and focused mainly on neonatal outcomes so possible effect of gestational weight gain on maternal outcomes, e.g., preeclampsia, gestational diabetes, or postpartum hemorrhage, etc. were not determined. These limitations may be reduced in future prospective studied with larger sample size.

In conclusion, our results demonstrated that underweight women with gestational weight gain less than 12 kg were not at higher risk of LBW, SGA, birth

asphyxia, and NICU admission than thin women whose weight gain was ≥12 kg throughout pregnancy. However, since we found that Thai women with weight gain <8 kg were at increased risk of delivering a LBW infant, we propose that this cutoff value of gestational weight gain might be used as a criterion to monitor general health status of underweight gravidas in these particular ethnic groups.

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ผลของการตั้งครรภ์จากน้ำหนักที่เพิ่มขึ้นในสตรีตั้งครรภ์ที่มีน้ำหนักตัวน้อย

สุทธนารัตน์ อภิวันทนา, รัชดาวรรณ สุขลิ้ม, สุมนมาลย์ มนัสศิริวิทยา, ชาดากานต์ ผโลประการ

วัตถุประสงค์ *: เพื่อประเมินความสัมพันธ์ระหว่างน้ำหนักตัวที่ขึ้นน้อยกว่าเกณฑ์ตลอดการตั้งครรภ์ และผลลัพธ์ที่ไม่พึงประสงค์ของการตั้งครรภ์ในสตรีน้ำหนักตัวน้อยชาวไทย*

วิธีดำเนินการวิจัย *: ทำการศึกษาแบบ retrospective cohort ในสตรีตั้งครรภ์น้ำหนักตัวน้อยจำนวน 306 ราย ที่มาฝากครรภ์และคลอดที่คณะแพทยศาสตร์วชิรพยาบาลระหว่างเดือนธันวาคม พ.ศ. 2552 ถึงเดือนสิงหาคม พ.ศ. 2555 โดยการคัดเลือกกลุ่มศึกษาหรือกลุ่มที่มีน้ำหนักขึ้นน้อยกว่าเกณฑ์ขณะตั้งครรภ์ (น้อยกว่า 12 กิโลกรัม) ด้วยวิธีการจับคู่ในอัตรา 1:1 กับกลุ่มควบคุมหรือกลุ่มที่มีน้ำหนักขึ้นตามเกณฑ์ (มากกว่าหรือเท่ากับ 12 กิโลกรัม) ตามกลุ่มอายุและจำนวนการตั้งครรภ์ ทำการเปรียบเทียบผลลัพธ์ที่ไม่พึงประสงค์ของการตั้งครรภ์ได้แก่ ภาวะทารกแรกคลอดน้ำหนักตัวน้อย (< 2,500 กรัม) ภาวะทารกแรกคลอดน้ำหนักตัวน้อยกว่าเกณฑ์ของอายุครรภ์นั้นๆ ภาวะขาดออกซิเจนของทารกแรกคลอด และการรักษาตัวในหออภิบาลทารกแรกเกิดขั้นวิกฤติ*

ผลการวิจัย *: สตรีตั้งครรภ์น้ำหนักตัวน้อยที่มีน้ำหนักขึ้นน้อยกว่าเกณฑ์ 145 ราย และกลุ่มที่มีน้ำหนักขึ้นตามเกณฑ์ 145 ราย มีข้อมูลในเวชระเบียนสมบูรณ์และถูกนำมาวิเคราะห์ทางสถิติ พบว่ากลุ่มที่มีน้ำหนักตัวขึ้นน้อยกว่าเกณฑ์มีน้ำหนักทารกแรกคลอดน้อยกว่ากลุ่มที่มีน้ำหนักขึ้นตามเกณฑ์อย่างมีนัยสำคัญ (2,939.0 ± 338.1 กรัม เทียบกับ 3,037.2 ± 336.9 กรัม; p = 0.014) แต่ไม่ได้เพิ่มความเสี่ยงในการเกิดทารกแรกคลอดน้ำหนักตัวน้อย ภาวะทารกน้ำหนักตัวน้อยกว่าเกณฑ์ของอายุครรภ์นั้นๆ ภาวะขาดออกซิเจนของทารกแรกคลอด และการเข้ารักษาตัวในหออภิบาลทารกแรกเกิดขั้นวิกฤต อย่างไรก็ตามจากการวิเคราะห์ข้อมูลเพิ่มเติมพบว่าหากสตรีตั้งครรภ์น้ำหนักตัวน้อยมีน้ำหนักเพิ่มขึ้นน้อยกว่า 8 กิโลกรัมตลอดการตั้งครรภ์ จะเพิ่มความเสี่ยงต่อภาวะทารกแรกคลอดน้ำหนักตัวน้อยถึง 4.5 เท่า (95% confidence interval, 1.4-14.6; P = 0.012) แต่ไม่เพิ่มความเสี่ยงต่อภาวะแทรกซ้อนอื่นๆ ของทารก*

สรุป *: สตรีตั้งครรภ์น้ำหนักตัวน้อยที่มีน้ำหนักเพิ่มขึ้นตลอดการตั้งครรภ์น้อยกว่า 12 กิโลกรัม ไม่มีความสัมพันธ์อย่างมีนัยสำคัญต่อการเกิดภาวะแทรกซ้อนที่ไม่พึงประสงค์ของการตั้งครรภ์ แต่ทั้งนี้หากมารดามีน้ำหนักเพิ่มน้อยกว่า 8 กิโลกรัม จะเพิ่มความเสี่ยงต่อภาวะทารกแรกคลอดน้ำหนักตัวน้อย*