Thai Journal of Obstetrics and Gynaecology
July 2015, Vol. 23, pp. 130-135

## OBSTETRICS

# Effect of Maternal Weight Gain on Neonatal Birth Weight and Pregnancy Outcomes in Normal Pre-pregnancy Body Mass Index

Jitlada Boondech, MD*,
Sekson Suwannapang, MD*,
Thumwadee Tangsiriwatthana, MD.*

** Department of Obstetrics and Gynecology, Khon Kaen Hospital, Khon Kaen 40000, Thailand*

**ABSTRACT**

**Objective:** To compare neonatal birth weight, incidence of large for gestational age (LGA), macrosomia and pregnancy outcomes between excessive and normal maternal weight gain in singleton pregnancies with normal pre-pregnancy body mass index (BMI).

**Materials and Methods:** A retrospective cohort study of 320 singleton pregnancies was analyzed (160 per group). Labour records of singleton pregnant women with normal pre-pregnancy BMI who delivered at Khon Kaen Hospital between 1st August and 30th November 2013 were reviewed. Neonatal birth weight, pregnancy outcomes such as shoulder dystocia, uterine atony and birth trauma between two groups were analyzed.

**Results:** The mean neonatal birth weight in the excessive weight gain group was significantly greater than in the control group (3,295 ± 468 g and 3,127 ± 375 g, $p < 0.01$). Infants with LGA in excessive weight gain group was significantly more than in control group (22.5% and 12.5%, $p = 0.02$, adjusted RR = 2.5 (95% CI 1.17 - 3.98)). The adverse maternal and neonatal outcomes such as shoulder dystocia, neonatal hypoglycemia and birth trauma were not significant different between two groups.

**Conclusion:** Excessive maternal weight gain in pregnant women with normal pre-pregnancy BMI women was associated with neonatal birth weight and influence LGA.

**Keywords:** Excessive maternal weight gain, Normal pre-pregnancy body mass index, Pregnancy outcomes

***Correspondence to:*** *Jitlada Boondech, MD., Department of Obstetrics and Gynecology, Khon Kaen Hospital, Srichan Rd., Amphur Meung, Khon Kaen 40000, Thailand*
*Tel: +66-4333-6789-3736 Fax: +66-4333-6789-3736, Email address: jitladaclinic@gmail.com*

## Introduction

Large for gestational age (LGA) infants, which is defined as infants whose birth weight greater than the 90th percentile for their gestational ages, have increase morbidity of pregnancy outcomes. For maternal outcomes, LGA infant increase the risk of prolonged

labor, cesarean delivery, shoulder dystocia, perineal trauma, uterine atony and postpartum hemorrhage[1-4]. Moreover, LGA infant increase risk of neonatal outcomes such as hypoglycemia, neonatal jaundice and birth trauma[1-3].

The risk factors for fetal overgrowth are maternal obesity, diabetes- gestational and type 2, postterm gestation, multiparity, large size of the parents, advancing maternal age, previous macrosomia, racial and ethnic factors[5]. However, the correlation between maternal weight gain and neonatal birth weight is still unclear.

The guidelines for maternal weight gain by the Institute of Medicine (IOM) in the singleton pregnancy based on body mass index (BMI) were revised in 2009[6]. The woman who has normal pre-pregnancy BMI (18.5 - 24.9 kg/m$^2$) should have a weight gain between 11.5 - 16.0 kg. The recommendation proposed that a woman who has weight gain in the normal range would have lower risks of maternal and neonatal morbidity. The 2009 IOM guidelines are based on data from western countries that might be different from Asian countries. In Thailand, there is still no consensus recommendation for optimal total weight gain during pregnancy and its effects on pregnancy outcomes. The present study intended to study the neonatal birth weight in normal pre-pregnancy BMI women which were the majority of our population. The objective was to compare neonatal birth weight, incidence of LGA, macrosomia and pregnancy outcomes between excessive and normal maternal weight gain in singleton pregnancies with normal pre-pregnancy body mass index.

## Materials and Methods

This retrospective cohort study reviewed the labour records from pregnant women and their infants who delivered at Khon Kaen Hospital between 1$^{st}$ August and 30$^{th}$ November 2013. Baseline characteristics including maternal age, parity, height, pre-pregnancy BMI, total weight gain and gestational ages at delivery were analyzed. Inclusion criteria were term singleton pregnancies (gestational age 37 - 42 weeks) with pre-pregnancy BMI between 18.5 - 24.9 kg/m$^2$, confirmed certain gestational age by last menstruation period or early ultrasound at gestational age < 14 weeks at first antenatal care (ANC). Medical complications (e.g. hypertension, diabetes mellitus (overt DM and GDM), anemia, renal diseases, hyperthyroidism, heart diseases, HIV infection and systemic diseases), preterm delivery, stillbirth, and congenital anomalies were excluded. This study was approved by Khon Kaen Hospital Institute Review Board in Human Research.

Total weight gain was calculated from maternal body weight at the date of delivery minus self-reported pre-pregnancy weight recorded at the first time of ANC. According to the recommendation of weight gain in 2009 guidelines were 11.5 - 16.0 kg. Therefore, excessive weight gain group was maternal with a total weight gain more than 16.0 kg and the control group was maternal with a total weight gain between 11.5 - 16.0 kg.

The primary outcomes were neonatal birth weight, LGA and macrosomia. LGA was defined as birth weight 90th percentile or greater for gestational age[7, 8]. Macrosomia is based on weight alone that means infant with birth weight ≥ 4000 g[9]. Pregnancy outcomes including shoulder dystocia (difficulty delivering the baby's shoulder after the head has already come out), perineal trauma (injury of the vagina, anal sphincter and rectum during birth), uterine atony (failure of the myometrium contraction after delivery of the placenta), pregnancy induce hypertension (PIH; BP ≥ 140/90 mmHg in a previously normotensive pregnant woman who is ≥ 20 weeks of gestation), neonatal hypoglycemia (blood glucose < 40 mg/dL after delivery), neonatal jaundice (higher than normal level of bilirubin in the blood after delivery in 48 hr), and brachial plexus injury (brachial plexus nerve are damaged during birth) were analyzed.

Sample size was calculated based on our pilot study. The incidence of LGA infant was 7.5% in normal weight gain group and 20% in excessive weight gain group. The power of 80% and the level of confidence at 5% were applied to determine the difference between groups. The ratio between excessive and normal maternal weight gain groups was 1:1 with unmatched design. The number of participants was 160 cases per group.

The data were analyzed by SPSS version 19 (IBM). Chi-square test and Fisher's exact test were used for categorical data and student T-test was used for continuous data. Multivariate analysis was analyzed association factors of excessive maternal weight gain in LGA and macrosomia and presented as relative risk (adjusted RR) and 95% confidence interval (CI). P-values of less than 0.05 was considered statistically significant.

## Results

Three hundred and twenty singleton pregnancies women were included in this study. Using the 2009 IOM guideline, 160 pregnant women were enrolled into each group (normal and excessive weight gain group). Table 1. showed maternal baseline characteristics. The average height and total weight gain in excessive weight gain group was significantly higher than normal weight gain group. There was no statistically significant in age, pre-pregnancy BMI and gestational age of delivery between two groups.

**Table 1.** The maternal characteristics between normal weight gain (11.5 - 16 kg) and excessive weight gain (>16 kg)

| Characteristics | Excessive weight gain (n=160) | Normal weight gain (n=160) | P |
|---|---|---|---|
| Age (yrs), mean ± sd | 25.59 ± 4.96 | 27.39 ± 9.52 | 0.35 |
| Nulliparous (n), % | 98 (61.2) | 85 (53.1) | 0.17 |
| Height (cm), mean±sd | 159.3 ± 5.7 | 156.7 ± 5.6 | < 0.001 |
| Pre-pregnancy BMI (kg/m$^2$), mean ± sd | 20.1 ± 1.8 | 21.1 ± 1.8 | 0.362 |
| Total weight gain (kg), mean ± sd | 20.2 ± 3.6 | 13.5 ± 1.5 | < 0.001 |
| Gestational age (wks), mean ± sd | 38.8 ± 1.2 | 38.2 ± 1.0 | 0.88 |

Maternal outcomes were shown in Table 2. There were no statistically significant differences in shoulder dystocia, perineal trauma, uterine atony, PIH and cesarean delivery rate between two groups.

**Table 2.** Maternal outcomes between normal weight gain (11.5 - 16 kg) and excessive weight gain (> 16 kg)

| Maternal outcomes (n), % | Excessive weight gain (n=160) | Normal weight gain (n=160) | Unadjusted RRs (95%CI) | P |
|---|---|---|---|---|
| Shoulder dystocia | 3 (1.9) | 1 (0.6) | 1.44 (0.08 to 26.22) | 0.37 |
| Perineal trauma | 4 (2.5) | 1 (0.6) | 1.04 (0.03 to 34.36) | 0.17 |
| Uterine atony | 5 (3.1) | 1 (0.6) | 1.79 (0.25 to 12.86) | 0.09 |
| PIH | 5 (3.1) | 5 (3.1) | 1.00 (0.01 to 9.24) | 1.00 |
| Cesarean delivery | 89 (55.7) | 79 (49.5) | 1.29 (0.83 to 1.99) | 0.26 |

Neonatal outcomes between two groups were shown in Table 3. Mean neonatal birth weight in the excessive weight gain group was significantly greater than in the normal weight gain group (3,295 ± 468 and 3,127 ± 375 grams, p < 0.001). When we compared LGA infant and fetal macrosomia, there was more LGA infants in women with excessive weight gain group than in the normal weight gain group (22.5% and 20%,

p = 0.02) and macrosomia in women with excessive weight gain group was also higher than in the normal weight gain group (8.1% and 1.2%, p = 0.01). After adjusted by maternal age and parity we found that excessive maternal weight gain had higher risk for LGA and macrosomia than normal maternal weight gain (adjusted RR = 2.52 (95% CI 1.17 - 3.98) and 8.03 (95% CI 1.71 - 37.62), respectively). There was no significant difference in neonatal gender, number of neonates with low APGAR scores (< 7) at 1, 5 minutes, neonatal hypoglycemia (p = 0.99), neonatal jaundice and birth trauma e.g. brachial plexus injury among two groups.

**Table 3.** The neonatal outcomes between normal weight gain (11.5 - 16 kg) and excessive weight gain (> 16 kg)

| Neonatal outcomes | Excessive weight gain (n=160) | Normal weight gain (n=160) | Unadjusted RRs (95%CI) | P |
|---|---|---|---|---|
| Gender (n), % | | | 1.23 (0.77 to 1.97) | 0.82 |
| Male | 80 (50) | 82 (52.3) | - | - |
| Female | 80 (50) | 78 (48.7) | - | - |
| Birth weight (g), mean ± sd | 3295 ± 468 | 3127 ± 375 | 1.01 (1.00 to 1.002) | < 0.001 |
| LGA (n), % | 36 (22.5) | 20 (12.5) | 2.03 (1.12 to 3.69) | 0.02 |
| Macrosomia (n), % | 13 (8.1) | 2 (1.2) | 6.99 (1.55 to 31.49) | 0.01 |
| APGAR < 7 (n), % | | | | |
| 1 min | 18 (11.2) | 12 (7.5) | 1.70 (0.65 to 4.43) | 0.33 |
| 5 min | 4 (2.5) | 4 (2.5) | 1.00 (0.25 to 4.07) | 1.00 |
| Neonatal jaundice (n), % | 21 (13.1) | 15 (9.3) | 1.46 (0.72 to 2.95) | 0.29 |
| Brachial plexus injury (n), % | 2 (1.3) | 1 (0.6) | 2.01 (0.18 to 22.4) | 0.57 |

## Discussion

The present study showed significant differences in average neonatal birth weight between the excessive weight gain and the normal weight gain group. LGA infants and fetal macrosomia in excessive maternal weight gain group was also higher than normal weight gain group. This finding was similar to the previous studies which found that excessive gestational weight gain influence neonatal birth weight[10-15]. Nowadays, there is no definite recommendation or guideline of Thai women for appropriate weight gain, therefore we used IOM 2009 guideline for recommendation of total weight gain in normal pre-pregnancy BMI, which was developed from western countries. The outcomes of interest in this study were incidence of LGA and fetal macrosomia, after multivariate analysis, we found excessive maternal weight gain had 2.5 and 8 times higher in LGA and macrosomia than in normal weight gain group, respectively which consistent with Kim, et al [16]. They found that overweight, obesity, excessive gestational weight gain and GDM were associated with LGA. Of all these risks, excessive gestational weight gain had greatest potential effect to LGA.

Excessive maternal weight gain was not only affected the neonatal birth weight or occurrence of LGA but also affected both maternal and neonatal outcomes. For maternal outcomes, there are many complications such as PIH, GDM, shoulder dystocia, birth trauma.

We found no significant difference in maternal complications between two groups. Li, et al[17], studied about maternal pre-pregnancy BMI and gestational weight gain on pregnancy outcomes and they found that pre-pregnancy BMI had more effects on maternal outcomes than gestational weight gain. The present study focused on maternal weight gain and our results were compatible with them. The cesarean delivery rate in both groups was not significant difference. In contrast, Li, et al[17], reported that excessive maternal weight gain increased risk of cesarean delivery. The cesarean section rate in our study was compatible with

Tanprasertkul, et al[11], who reported no significant difference in cesarean section rate between normal and excessive maternal weight gain group. The higher cesarean section rate in our study (49.5 and 55.7% in normal and excessive weight group, respectively) might be due to previous cesarean section and private cases were included. The maternal outcomes were not significant between two groups may be due to the sample size was too small.

Four neonates in the excessive weight gain group had hypoglycemia whereas the normal weight gain group had not. However, this finding was not significant difference between two groups. The relative risk of neonatal hypoglycemia could not be determined because of small sample size. Our finding was inconsistent with Hedderson, et al[18], which reported significant higher incidence of neonatal hypoglycemia in the excessive weight gain group. Birth asphyxia, neonatal jaundice and birth trauma, e.g., brachial plexus injury, were not significant difference between two groups. This finding was similar to the studies of Bianco and colleague[19].

The limitations of our study were firstly, LGA and macrosomia classification were different among institutes, therefore the incidence of LGA and fetal macrosomia might different. Secondly previous macrosomia, paternal BMI, racial and ethnicity might play the role in neonatal birth weight which should be taken into account in the further study.

In conclusion, excessive maternal weight gain in normal pre-pregnancy BMI women was associated with neonatal birth weight and influence LGA infant and fetal macrosomia.

## Acknowledgement

We would like to thanks Staffs of Department of Obstetrics and Gynecology Khon Kaen Hospital for their kindly advices.

## Potential conflicts of interest

None

## References

1. Boyd ME, Usher RH, McLean FH. Fetal macrosomia: prediction, risks, proposed management. Obstet Gynecol 1983;61:715–22.
2. Meshari AA, De Silva S, Rahman I. Fetal macrosomia–maternal risks and fetal outcome. Int J Gynaecol Obstet 1990;32:215–22.
3. Oral E, Cagdas A, Gezer A, Kaleli S, Aydinli K, Ocer F. Perinatal and maternal outcomes of fetal macrosomia. Eur J Obstet Gynecol Reprod Biol 2001;99:167–71.
4. Fuchs F, Bouyer J, Rozenberg P, Senat MV. Adverse maternal outcomes associated with fetal macrosomia: what are the risk factors beyond birth weight? BMC Pregnancy and Childbirth 2013;13:90.
5. Cunningham FG, Leveno KJ, Bloom SL, Spong CY, Dashe JS, Hoffman BL. Fetal- growth disorders. Williams obstetrics. 24rded. New York: McGraw Hill 2014:872-90.
6. Institute of Medicine. Weight gain during pregnancy: reexamining the guidelines. Washington, DC: The National Academies Press 2009.
7. Battaglia FC, Lubchenco LO. A practical classification of newborn infants by weight and gestational age. J Pediatr 1967;71:159-63.
8. Lubchenco LO, Hansman C, Boyd E. Intrauterine growth in length and head circumference as estimated from live births at gestational ages from 26 to 42 weeks. Pediatrics 1966;37:403-8.
9. Beckmann C, Ling WF, Herbert W, Laube WD, Smith PR, Casanova R. Fetal growth abnormalities: intrauterine growth restriction and macrosomia. Obstetrics and gynecology. 7th ed. Philadeiphia: Lippincott Williams & Wilkins 2014:151-6.
10. Lertbunnaphong T, Talungjit P, Titapant V. Does gestational weight gain in normal pre-pregnancy BMI pregnant woman reflect fetal weight gain? J Med Assoc Thai 2012;95:853-8.
11. Tanprasertkul C, Somprasit C. Effect of high gestational weight gain on birth weight and cesarean section rate in pregnant woman with a normal prepregnant body mass index. J Med Assoc Thai 2004;87:S24-8.
12. Frederick IO, Williams MA, Sales AE, Martin DP, Kilien M. Pre-pregnancy body mass index, gestational weight gain, and other maternal characteristics in relation to infant birth weight. Matern Child Health J 2008;12:557-67.
13. Butte NF, Ellis KJ, Wong WW, Hopkinson JM, Smith EO. Composition of gestational weight gain impacts maternal fat retention and infant birth weight. Am J Obstet Gynecol 2003;189:1423-32.
14. Johnson JW, Longmate JA, Frentzen B. Excessive maternal weight and pregnancy outcome. Am J Obstet Gynecol 1992;167:353-70.
15. Choi SK, Park IY, Shin JC. The effects of pre-pregnancy body mass index and gestational weight gain on perinatal outcomes in Korean women: a retrospective cohort study. Reprod Biol Endocrinol 2011;9:1-7.
16. Kim SY, Sharma AJ, Sappenfield W, Hoyt G. Wilson HG, Salihu HM. Association of maternal body mass index, excessive weight gain, and gestational diabetes mellitus

with large-for-gestational age births. Obstet Gynecol 2014;123:737-44.
17. Li N, Liu E, Guo J, Pan L, Li B, Wang P, et al. Maternal prepregnancy body mass index and gestational weight gain on pregnancy outcomes. PLoS One 2013;8:1-7.
18. Hedderson MM, Weiss NS, Sacks DA, Pettitt DJ, Selby JV, Quesenberry CP, et al. Pregnancy weight gain and risk neonatal complications: Macrosomia, hypoglycemia, and hyperbilirubinemia. Obstet Gynecol 2006;108:1153-61.
19. Bianco AT, Smilen SW, Davis Y, Lopez S, Lapinski R, Lockwood CJ. Pregnancy outcome and weight gain recommendations for the morbidly obese woman. Obstet Gynecol 1998;91:97-102.

## *ผลของน้ำหนักตัวมารดาที่เพิ่มในระหว่างการตั้งครรภ์ต่อน้ำหนักทารกแรกคลอดและต่อมารดาในสตรีที่มีดัชนีมวลกายปกติก่อนตั้งครรภ์*

***จิตรลดา บุญเดช, เสกสรร สุวรรณแพง, ทุมวดี ตั้งศิริวัฒนา***

***วัตถุประสงค์:*** *เพื่อศึกษาผลของน้ำหนักตัวมารดาที่เพิ่มในระหว่างการตั้งครรภ์ต่อน้ำหนักทารกแรกคลอด และผลต่อมารดาในสตรีที่มีดัชนีมวลกายปกติก่อนตั้งครรภ์*

***วัสดุและวิธีการ:*** *เป็นการศึกษาย้อนหลังแบบ retrospective cohort study ได้รวบรวมข้อมูลจากเวชระเบียนของสตรีตั้งครรภ์เดี่ยวที่มาคลอดในโรงพยาบาลขอนแก่น ระหว่างวันที่ 1 สิงหาคม พ.ศ.2556 – 30 พฤศจิกายน พ.ศ.2556 โดยมีดัชนีมวลกายก่อนตั้งครรภ์ปกติและมีอายุครรภ์ครบกำหนดจำนวนทั้งสิ้น 320 คน โดยแบ่งเป็นกลุ่มที่มีระดับน้ำหนักตัวเพิ่มขึ้นตามเกณฑ์มาตรฐาน และกลุ่มที่มีน้ำหนักตัวเพิ่มขึ้นเกินเกณฑ์มาตรฐาน โดยมีประชากรกลุ่มละ 160 คน นำมาเปรียบเทียบน้ำหนักทารกแรกคลอดและผลของการตั้งครรภ์*

***ผลการศึกษา:*** *น้ำหนักเฉลี่ยของทารกแรกคลอดในสตรีกลุ่มที่มีน้ำหนักเพิ่มระหว่างตั้งครรภ์เกินเกณฑ์มาตรฐานสูงกว่าในกลุ่มที่มีน้ำหนักเพิ่มระหว่างตั้งครรภ์ตามเกณฑ์มาตรฐานอย่างมีนัยสำคัญ (3,295 ± 468 กรัม และ 3,127 ± 375 กรัม p < 0.01) และพบว่าสตรีกลุ่มที่มีน้ำหนักเพิ่มระหว่างตั้งครรภ์เกินเกณฑ์มาตรฐานคลอดทารกที่ตัวโตกว่าอายุครรภ์ (LGA) มากกว่าในกลุ่มที่มีน้ำหนักเพิ่มระหว่างตั้งครรภ์ปกติอย่างมีนัยสำคัญ (22.5% และ 12.5% p = 0.02, adjusted RR = 2.5 (95% CI 1.17 - 3.98)) สำหรับภาวะแทรกซ้อนของการตั้งครรภ์อย่างอื่นเช่น คลอดติดไหล่ ภาวะการบาดเจ็บจากการคลอดทั้งสองกลุ่มนั้นไม่แตกต่างกัน*

***สรุป*** *: สตรีตั้งครรภ์เดี่ยวที่มีดัชนีมวลกายก่อนตั้งครรภ์ปกติและมีน้ำหนักเพิ่มระหว่างตั้งครรภ์เกินเกณฑ์มาตรฐานมีผลต่อน้ำหนักตัวทารกและสัมพันธ์กับความชุกของทารกที่ตัวโตกว่าอายุครรภ์*