Thai Journal of Obstetrics and Gynaecology
September 2017, Vol. 25, pp.167-174

OBSTETRICS

Fetal Weight Estimation using Symphysio-fundal Height and Abdominal Girth Measurements in Different Pre-pregnancy Body Mass Indices

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ABSTRACT

Objectives: To study the accuracy of birth weight estimations obtained by multiplying the symphysio-fundal height (SFH) and abdominal circumference (AC) in different pre-pregnancy body mass index (BMI).

Materials and Methods: This cross-sectional study was conducted from April 2015 to September 2015 at two tertiary hospitals. The authors included pregnant women with singleton fetus in vertex presentation with gestational age of 24-42 weeks and intact membranes who expected to deliver within 24 hours after admission. Participants were classified into four pre-pregnancy BMI categories using the criteria for Asian populations. The trained nurses in each hospital measured fundal height starting from the upper border of the symphysis pubis to tip of the uterine fundus, and then the AC was measured at the umbilical level using a measuring tape marked in centimeters. The procedure was conducted during no uterine contraction.

Results: This study recruited 432 pregnant women. Spearman correlation coefficients between fetal weight obtained from multiplication of SFH and AC and actual birth weight in the underweight, normal weight, overweight and obese groups were 0.44, 0.54, 0.59, 0.71, respectively. There was no significant impact of pre-pregnancy BMI on the accuracy rate of birth weight estimation after adjusted for maternal age, parity, and gestational age.

Conclusion: Pre-pregnancy BMI did not significantly affect the accuracy of fetal birth weight estimations obtained by multiplying SFH and AC.

Keywords: fetal weight estimation, abdominal circumference, fundal height, pre-pregnancy body mass index

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การคาดคะเนน้ำหนักของทารกในครรภ์ โดยใช้ผลคูณระหว่างความสูงของมดลูกและเส้นรอบเอวที่ระดับสะดือในดัชนีมวลกายมารดาก่อนตั้งครรภ์ที่แตกต่างกัน

ยุวดี อิฐรัตน์, ประนอม บุพศิริ, สุทธิวรรณ โสภณวิวัฒน์

บทคัดย่อ

วัตถุประสงค์: *เพื่อศึกษาความแม่นยำในการคาดคะเนน้ำหนักของทารกในครรภ์ โดยใช้ผลคูณระหว่างความสูงของมดลูกและเส้นรอบวงของท้องที่ระดับสะดือในมารดาที่มีดัชนีมวลกายก่อนตั้งครรภ์แตกต่างกัน*

วัสดุและวิธีการ: *ทำการศึกษาเชิงพรรณาแบบตัดขวางในโรงพยาบาลตติยภูมิ 2 แห่ง ตั้งแต่เดือนเมษายน พ.ศ.2558 ถึง เดือนกันยายน พ.ศ.2558 โดยสตรีตั้งครรภ์ที่เข้าร่วมวิจัยเป็นการตั้งครรภ์เดี่ยว ส่วนนำเป็นท่าศีรษะ ถุงน้ำคร่ำยังไม่แตก อายุครรภ์ตั้งแต่ 24-42 สัปดาห์ และคาดว่าจะคลอดภายใน 24 ชั่วโมง หลังจากรับเข้ารักษาในโรงพยาบาล จัดแบ่งเป็น 4 กลุ่ม ตามดัชนีมวลกายมารดาก่อนตั้งครรภ์ โดยอ้างอิงดัชนีมวลกายของประชากรทวีปเอเชีย พยาบาลห้องคลอดในแต่ละโรงพยาบาลที่ผ่านการฝึกสอน ทำการวัดความสูงของมดลูกจากขอบบนของกระดูกหัวหน่าวไปยังยอดมดลูก และวัดเส้นรอบวงของท้องที่ระดับสะดือเป็นหน่วยเซนติเมตรในขณะที่ไม่มีการหดรัดตัวของมดลูก*

ผลการศึกษา: *มีสตรีตั้งครรภ์จำนวน 432 ราย เข้าร่วมในการศึกษา พบว่า ค่าสัมประสิทธิ์สหสัมพันธ์แบบสเปียร์แมนระหว่างการคาดคะเนน้ำหนักทารกจากผลคูณระหว่างความสูงของมดลูกและเส้นรอบวงที่ระดับสะดือและน้ำหนักทารก ในกลุ่มดัชนีมวลกายต่ำกว่าเกณฑ์ ปกติ น้ำหนักเกิน และอ้วน เป็น 0.44, 0.54, 0.59 และ 0.71 ตามลำดับ โดยดัชนีมวลกายก่อนการตั้งครรภ์ไม่เป็นปัจจัยที่มีผลต่อความแม่นยำในการคาดคะเนน้ำหนักของทารกอย่างมีนัยสำคัญทางสถิติ เมื่อควบคุมด้วยตัวแปรอายุสตรีตั้งครรภ์ จำนวนการคลอด และอายุครรภ์*

สรุป: *ดัชนีมวลกายก่อนการตั้งครรภ์ไม่มีผลต่อความแม่นยำในการคาดคะเนน้ำหนักของทารกด้วยวิธีการใช้ผลคูณ ระหว่างความสูงของมดลูกและเส้นรอบวงที่ระดับสะดือ อย่างมีนัยสำคัญทางสถิติ*

คำสำคัญ: *การคาดคะเนน้ำหนักของทารกในครรภ์, เส้นรอบเอว, ความสูงของยอดมดลูก, ดัชนีมวลกายมารดาก่อนตั้งครรภ์*

Introduction

Accurate estimation of fetal weight is crucial for obstetricians or labor attendants in order to determine route of delivery. Fetal birth weight can be estimated using either clinical or imaging techniques. Clinical estimations measure various maternal body composition parameters to calculate the fetal weight, including symphysio-fundal height length, symphysio-fundal height and abdominal circumference, and maternal self-estimation[1-7]. The imaging techniques used for fetal birth weight estimation include ultrasonography and magnetic resonance imaging[1, 8-14].

The principal advantage to use clinical information and examination to estimate fetal weight is that it is simple and does not require specialized equipment. Dare et al[5] reported that estimated fetal birth weight obtained by multiplying symphysio-fundal height (SFH) with abdominal circumference (AC) at the umbilicus level had a high correlation with actual birth weight. However, this study did not mention the impact of maternal pre-pregnancy body mass index (BMI) on the accuracy of this clinical approach. Theoretically, obesity may interfere the accuracy of prediction due to increased abdominal wall thickness. This means that fetal weight may be overestimated in pregnant women with high BMIs and underestimated in those with low BMIs[7]. However, data regarding maternal BMI affecting the accuracy of fetal weight estimation were studied mostly from non-Asian populations[7, 15, 16].

We aimed to study the accuracy of clinical estimation of fetal birth weight technique obtained by multiplying the distance of SFH and AC in varying pre-pregnancy BMIs.

Materials and Methods

This was a cross-sectional prospective study. The study was conducted from April 15, 2015 to September 30, 2015 at 2 tertiary hospitals (Srinagarind and Mahasarakham Hospital). The authors included pregnant women with singleton fetus in vertex presentation with intact membranes and gestational age of 24-42 weeks, who were expected to deliver within 24 hours after admission. The authors excluded women with pre-admission diagnoses of oligohydramnios, hydramnios, a dead fetus in utero, or fetal anomalies, as well as cases in which the weight of the fetus was unable to be determined within 30 minutes after delivery. After giving written informed consent, the pregnant women voided and laid on a bed, the labor room nurse (3 nurses were trained in a standardized fashion in each hospital) measured fundal height starting from the upper border of the symphysis pubis to tip of the uterine fundus using a measuring tape and marked in centimeters. The AC was measured at the umbilical level. The measurements were conducted three times while no uterine contractions were taking place. The means of both sets of measurements were used to calculate fetal weight. Antenatal care records were reviewed. Baseline data were collected such as maternal height, pre-pregnancy weight, total weight gain, current weight, and underlying diseases. The cases with incomplete data were excluded from the study. The infants were weighed in grams using a standardized digital scale within 30 minutes after delivery.

The authors classified the participants into four BMI categories according to the World Health Organization (WHO) recommendations for Asian and Pacific women[17] Definitions of each BMI group are as follows: underweight, ≤ 18.5 kg/m^2; normal weight, BMI = 18.5-23 kg/m^2; overweight, BMI = 23-27.5 kg/m^2 and obese, BMI ≥ 27.5 kg/m^2.

The estimation of fetal weight (in grams) was calculated by using the distance from the symphysis pubis to the uterine fundus multiplied by AC at the umbilical level measured in centimeters. Estimated fetal weight was considered accurate if it fell within ± 10% of actual fetal weight[7, 8, 16].

All statistical analysis was performed using STATA software version 10.1. Descriptive statistics were used for demographic baseline characteristics. The correlation between estimated fetal weight obtained from SFH multiplying with AC and actual weight was determined using Spearman Correlation

stratified by BMI category. The impact of pre-pregnancy BMI on the accuracy of birth weight estimation was assessed using logistic regression analysis adjusted for maternal age, parity status, and gestational age. Adjusted odds ratios with a 95% confidence interval (CI), which did not include unity were considered statistically significant and which had a $p < 0.05$ were considered statistically significant.

This study was approved by Human Research Ethics Committee of Khon Kaen University (HE571420).

Results

A total of 437 pregnant women were invited to participate in this study. Of those, five cases were excluded due to incomplete data, leaving 432 pregnant women included in the final analysis (307 pregnant women from Srinagarind hospital and 125 pregnant women from Mahasarakham hospital). Half of the pregnant women (217 in 432) were in the normal BMI group and 6.48% (28 in 432) were classified as obese (Fig. 1).

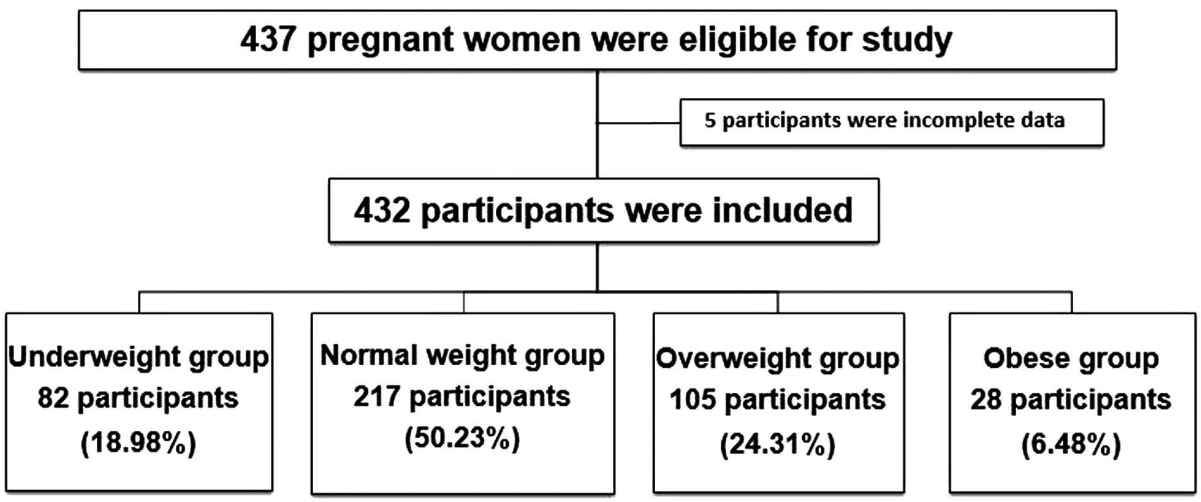

Fig. 1. Category of participants

The baseline characteristics of the participants are shown in Table 1. Most of the participants were 20-34 years old, primigravida and were at term pregnancy. Mean total weight gain in the underweight, normal weight, overweight and obese groups were 14.37±4.74, 15.38±5.23, 16.4±5.67, 10.71±5.13 kg, respectively.

The Spearman correlation coefficient between estimated fetal weight and actual birth weight in the underweight, normal weight, overweight and obese groups were 0.44, 0.54, 0.59, 0.71, respectively (Fig. 2), and all groups were statistically significance ($p<0.001$)

The percentage of accurate estimations (within ±10% of actual weight) was highest (65.9%) in the normal BMI group and lowest (57.1%) in the obese group (Table 2). Impact of levels of pre-pregnancy BMI on the accuracy of birth weight estimation was shown in Table 3. The normal pre-pregnancy BMI group appeared to have more accurate of birth weight predictions than other groups. However, it did not reach statistical significance when adjusted by maternal age, parity, and gestational age.

Table 1. Baseline characteristics of 432 participants.

Variables	Underweight n=82	Normal n=217	Overweight n=105	Obesity n=28
Maternal age (yr, %)				
< 20	10 (12.20)	13 (5.99)	4 (3.81)	0
20-34	65 (79.27)	171 (78.80)	74 (70.48)	24 (85.71)
≥ 35	7 (8.54)	33 (15.21)	27 (25.71)	4 (14.29)
Gravida				
1	49 (59.76)	92 (42.40)	36 (34.29)	13 (46.43)
2	29 (35.37)	88 (40.55)	41 (39.05)	6 (21.43)
3	2 (2.44)	27 (12.44)	20 (19.05)	8 (28.57)
> 3	2 (2.44)	10 (4.61)	8 (7.62)	1 (3.57)
Gestational age (wks)				
$28\text{-}33^{+6}$	1 (1.22)	3 (1.38)	2 (1.90)	1 (3.57)
$34\text{-}36^{+6}$	3 (3.66)	16 (7.37)	5 (4.76)	0
$37\text{-}40^{+6}$	75 (91.46)	187 (86.18)	95 (90.48)	25 (89.29)
≥ 41	3 (3.66)	11 (5.07)	3 (2.86)	2 (7.14)
Pre-pregnancy weight (kg)	43.72±3.74	51.73±4.20	62.28±5.89	76.54±8.80
Weight on admission (kg)	58.09±6.90	67.10±7.36	78.68±8.61	87.25±10.31
Total weight gain (kg)	14.37±4.74	15.38±5.23	16.4±5.67	10.71±5.13
Pre-pregnancy BMI (kg/m^2)	17.39±0.91	20.65±1.30	24.56±1.23	30.72±2.70
Maternal complications				
Gestational diabetes mellitus	1 (1.22)	5 (2.30)	7 (6.66)	6 (21.4)
Pre-eclampsia	1 (1.22)	6 (2.76)	3 (2.85)	2 (7.14)
Heart disease	0	1 (0.46)	2 (1.90)	0
Maternal anemia	0	2 (0.92)	2 (1.90)	0
Thyroid disease	0	3 (1.38)	0	0

* Values are given as number (percentage) or mean ± SD

Table 2. Accuracy rate of birth weight prediction from symphysio-fundal height and abdominal girth measurement stratified by level of pre-pregnancy BMI.

Levels of pre-pregnancy BMI	Accuracy rate*	95% CI
Underweight	64.6%	53.5%-74.9%
Normal	65.9%	59.2%-72.2%
Overweight	64.7%	54.8%-73.8%
Obese	57.1%	37.2%-75.5%

Abbreviation: BMI, body mass index, *Within ±10% of actual birth weight (grams)

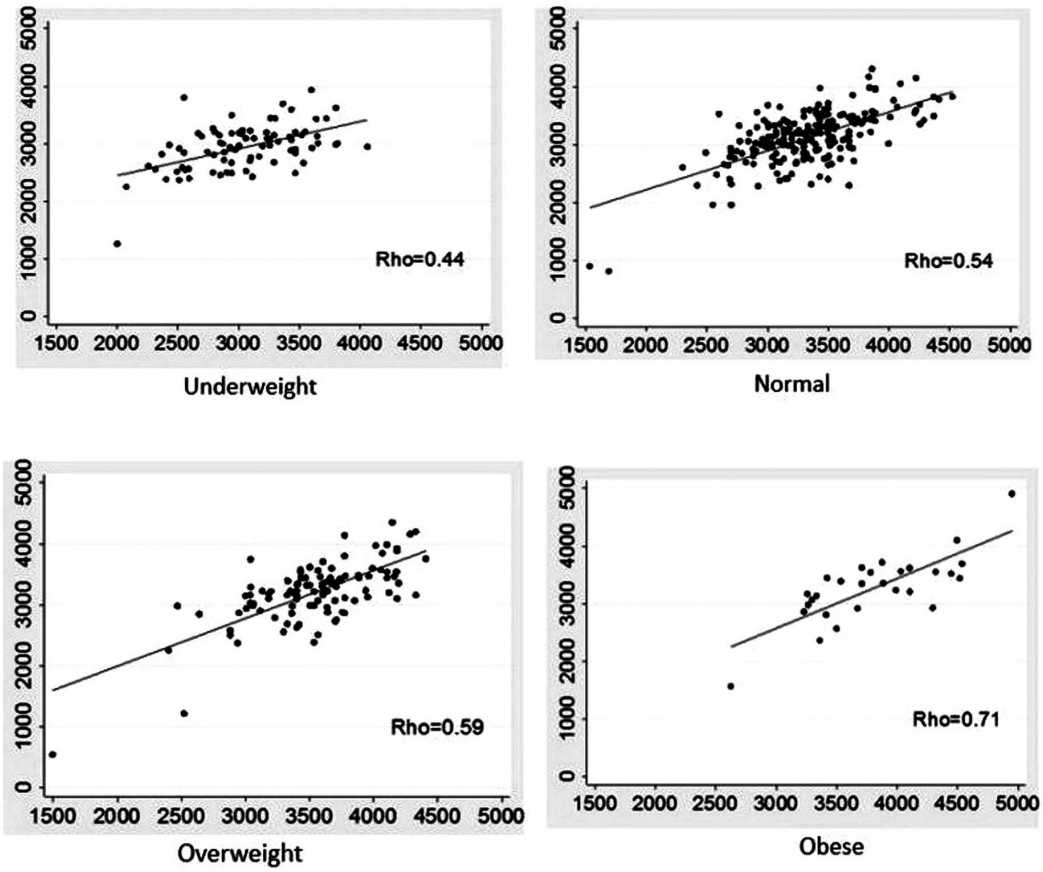

Fig. 2. The spearman correlation of calculated weight multiply SFH by AC in grams (X axis) and true infant weight in grams (Y axis)

Table 3. Impact of pre-pregnancy BMI on the accurate estimation of birth weight.

Levels of pre-pregnancy BMI	Adjusted OR*	95% CI
Normal	Reference level	Reference level
Underweight	0.88	0.52-1.49
Overweight	0.89	0.55-1.45
Obese	0.50	0.22-1.14

Abbreviation: BMI, body mass index; OR, odds ratio; CI, confidence interval
*Adjusted by maternal age (years), parity number, and gestational age (days)

Discussion

The accuracy of fetal weight estimation using symhysio-fundal height multiplied abdominal circumference at the umbilical level was moderate in all different BMI groups. The prediction rate was the highest in normal pre-pregnancy BMI. Approximately two-thirds of these estimations were within ±10% of the actual weight. Although fetal weight prediction seemed to be less accurate in the obese group, differences in pre-pregnancy BMI category had no

statistically significant impact on the accuracy of fetal birth weight estimation.

Our study showed the same results as those of a study conducted by Field et al[15], which concluded that pre-pregnancy BMI did not affect the accuracy of clinically estimated fetal weight. However, they used a different technique (abdominal palpation) to estimate fetal weight. Farrell et al[7] also reported that pre-delivery BMI had no effect on the accuracy of clinical estimation of fetal weight using abdominal palpation. In contrast, Fox et al[16] found in a study of American women that maternal pre-delivery body mass index affected the accuracy of clinical estimation of fetal weight (obtained using abdominal palpitation). Possible explanations for the difference between these findings and those of our study may be 1) the higher prevalence of obesity in Caucasian women than in their Thai counterparts (19, 20) and/or 2) excessive weight gain during pregnancy may change the classification of BMI. Hence, appropriate weight gain during pregnancy in different pre-pregnancy BMI is recommended[21] in modern antenatal care in order to reduce maternal and fetal complications, such as gestational diabetes mellitus, pregnancy-induced hypertension, and macrosomic baby during pregnancy and the postpartum period. All pregnant women who attended an antenatal care clinic were informed about methods of food consumption to limit excessive weight gain. This can minimize changes to BMI during the pregnancy. The advantage of using pre-pregnancy BMI to estimate fetal birth weight over pre-delivery BMI are that it gives the caregiver the opportunity to recommend lifestyle modifications early on in the pregnancy.

The accuracy (within ±10% of actual birth weight) of fetal weight estimation using formula calculation based on data from ultrasonography varies from 58.3-74%[7, 13, 15, 22]. The accuracy observed in our study was within the same range. However, the prediction method used in our study was less accurate than the MRI technique, which has been shown to be 99% accurate [13].

Data regarding the accuracy of fetal weight prediction are inconsistent. Many studies[8-10, 23] claim better results in cases in which the patient underwent ultrasonography. However, other studies[1, 11, 12, 24] have shown no statistical difference in the accuracy of fetal weight predicted using clinical estimation and that of fetal weight predicted using ultrasonography. In addition, ultrasonography is costly, time consuming, and requires special instruments and skills. Magnetic resonance imaging (MRI) can be used to increase the accuracy of fetal weight prediction[13, 14]. Although the results are more accurate than those of ultrasonography or clinical estimation, this method is restricted by its extremely high cost, the lack of trained personnel, and the limited availability of necessary equipment.

Estimating fetal weight using symphysio-fundal height multiplied by abdominal circumference at the umbilical level is easy, comes at virtually no cost, and is able to predict fetal weight in most cases. All labor attendants were able to use this technique in order to get additional information to help guide decisions regarding further management of pre-delivery women.

This study was a preliminary report on estimating fetal weight obtained by symphysio-fudal height and abdominal circumference measurements in pregnant Thai women with different BMI classifications (according to the recommendations regarding BMI for Asian populations). This study was limited in that the authors could not exclude all oligohydramnios or hydramnios cases if there were no pre-labor ultrasonography reports. Further study to compare the accuracy of various clinical methods, such as abdominal palpation only, symphysio-fundal distance measurement and symphysio-fundal distance multiplied by abdominal girth, should be considered.

Conclusion

The accuracy of fetal birth weight prediction using symphysio-fundal height multiplied by abdominal circumference at the umbilical level was moderate in all categories of pre-pregnancy BMI. Pre-pregnancy BMI did not significantly affect the accuracy of fetal

weight estimation obtained from the multiplication of the SFH and AC.

Acknowledgement

The authors would like to thank Mr.Dylan Southard at Khon Khaen University Faculty of Medicine for English consultation. This research was supported by the Faculty of Medicine, Khon Kaen University (Khon Kaen,Thailand) (Grant number: IN58116).

Potential conflicts of interest

The authors declare no conflict of interest.

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