

ความแม่นยำของการประเมินน้ำหนักทารกด้วยคลื่นเสียงความถี่สูงในระยะเจ็บครรภ์คลอด ในมารดาที่เป็นเบาหวานเปรียบเทียบกับมารดาที่ไม่เป็นเบาหวาน: การศึกษาแบบย้อนหลังจากเหตุไปหาผล

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บทคัดย่อ

การประเมินน้ำหนักทารกในครรภ์ในระยะเจ็บครรภ์คลอดมีความสำคัญกับการตัดสินใจของสูติแพทย์ โดยเฉพาะในมารดาที่เป็นเบาหวาน การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อประเมินความแม่นยำของการประเมินน้ำหนักทารกด้วยคลื่นเสียงความถี่สูงในระยะเจ็บครรภ์คลอดในมารดาที่เป็นเบาหวานและปัจจัยที่มีผลต่อความแม่นยำของการวัด ทำการศึกษาแบบเหตุไปหาผลย้อนหลังในหญิงตั้งครรภ์เดี่ยวที่ได้รับการประเมินน้ำหนักทารกด้วยคลื่นเสียงความถี่สูง โดยการวัดที่มีความคลาดเคลื่อนจากน้ำหนักแรกคลอดทารกไม่เกินร้อยละ 10 จะถือเป็นกลุ่มที่วัดได้ถูกต้อง และหากมีความแตกต่างมากกว่าร้อยละ 10 จะถือเป็นกลุ่มที่วัดได้ไม่ถูกต้อง ทำการประเมินความแม่นยำเปรียบเทียบระหว่างกลุ่มที่มารดาเป็นเบาหวานและมารดาปกติ และทำการวิเคราะห์ด้วยสถิติความถดถอยโลจิสติกเชิงพหุเพื่อหาปัจจัยที่มีความสัมพันธ์กับภาวะดังกล่าว ในการศึกษานี้ได้รวบรวมข้อมูลผู้คลอดที่เข้าเกณฑ์จำนวน 454 ราย โดยเป็นกลุ่มมารดาเบาหวาน 226 รายและมารดาไม่เป็นเบาหวาน 228 ราย พบว่าร้อยละ 61.95 ของกลุ่มมารดาเบาหวานมีการประเมินน้ำหนักทารกได้ถูกต้อง ซึ่งไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติเมื่อเทียบกับร้อยละ 63.16 ในกลุ่มมารดาไม่เป็นเบาหวาน (adjusted risk ratio [ARR]: 1.00; ความเชื่อมั่นร้อยละ 95 = 0.78-1.28; $p=0.998$) โดยปัจจัยที่มีผลกับความแม่นยำของการวัด ได้แก่ น้ำหนักทารก (ARR 1.04 ต่อน้ำหนัก 100 กรัมทารกที่เพิ่มขึ้น; ความเชื่อมั่นร้อยละ 95 = 1.01-1.06; $p=0.003$) และประสบการณ์ของผู้วัด (แพทย์ประจำบ้านและอาจารย์แพทย์มีความผิดพลาดน้อยกว่ากลุ่มแพทย์ใช้ทุน (ARR: 0.74; ความเชื่อมั่นร้อยละ 95 = 0.58-0.94; $p=0.013$)) โดยสรุป ความแม่นยำของการประเมินน้ำหนักทารกด้วยคลื่นเสียงความถี่สูงในระยะเจ็บครรภ์คลอดระหว่างมารดาที่เป็นเบาหวานและไม่เป็นเบาหวานไม่แตกต่างกันอย่างมีนัยสำคัญทางสถิติ โดยปัจจัยที่มีผลกับความแม่นยำ ได้แก่ น้ำหนักทารก และประสบการณ์ของผู้วัด

คำสำคัญ: น้ำหนักทารก; คลื่นเสียงความถี่สูง; เบาหวาน; ความแม่นยำ; น้ำหนักแรกเกิด

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Accuracy of intrapartum ultrasonographic fetal weight estimation in pregnancy with diabetic mellitus compare with non-diabetic pregnancy: A retrospective cohort study

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Abstract

The intrapartum fetal weight estimation is crucial for obstetrician decision-making, especially in diabetic mothers. This study aims to assess the accuracy of intrapartum ultrasonographic fetal weight estimation among diabetic mothers and identify factors influencing its accuracy. A retrospective cohort study was conducted, including singleton pregnant women who underwent intrapartum ultrasonographic fetal weight estimation. The accurate estimation group was defined as a percentage difference of fetal weight < 10%, while cases with a > 10% difference were classified as the inaccurate estimation group. The accuracy of estimation between diabetic and non-diabetic patients and the potentially associated factors were compared using multivariable logistic regression analysis. A total of 454 eligible women were included in this study, with 226 in the diabetic group and 228 in the non-diabetic group. In the diabetic group, 61.95% had accurate ultrasonographic fetal weight estimation, while the non-diabetic group had a 63.16% accurate result, with no statistically significant difference (adjusted Risk ratio [ARR]: 1.00; 95% confidence interval [CI] = 0.78-1.28; $p=0.998$). The factors associated with the accuracy of ultrasonographic fetal weight estimation were birthweight (ARR 1.04 per each 100 g increment; 95% CI = 1.01-1.06; $p=0.003$) and the examiner's experience (residents and staff had a lower inaccurate rate than interns, with the ARR: 0.74; 95% CI = 0.58-0.94; $p=0.013$). The accuracy of intrapartum ultrasonographic fetal weight estimation between diabetic and non-diabetic mothers showed no statistically significant difference. The factors influencing accuracy were the actual birthweight and the level of experience of the examiner.

Keywords: fetal weight; ultrasound; diabetes; accuracy; birthweight

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Introduction

Diabetes mellitus (DM) is a common medical disease in pregnant women. The decrease of glucose tolerance by placental hormones may cause either gestational diabetes or deterioration in the diabetes during pregnancy. In 2009, approximately 7% of pregnant women in the United States had diabetes¹ and in 2016, the prevalence of preexisting and gestational diabetes in the US were 0.9% and 6.0%, respectively². The prevalence is 2-38% of pregnant women in other countries³. Gestational diabetes carries risks for both the mother, such as gestational hypertension, cesarean delivery, preterm delivery, cardiovascular diseases and for their child, including macrosomia, neonatal hypoglycemia, shoulder dystocia or birth injury, neonatal respiratory distress and hyperbilirubinemia⁴.

The poor control of maternal plasma glucose causes macrosomic fetus which increases the likelihood of shoulder dystocia. Those with newborns weighting > 4,500 grams are at risk of postpartum hemorrhage, injury to the delivery canal, and sepsis⁵. The ability to accurately estimate fetal weight is crucial for treatment planning to reduce the likelihood of such complications. The fetal weight assessment can be investigated in a variety of ways, including the abdominal palpation (Leopold's maneuvers), ultrasonography, and magnetic resonance imaging (MRI)⁶. The estimated weight of the fetus is mostly determined by ultrasonography with several parameters. Measurements include biparietal diameter (BPD), head circumference (HC),

abdomen circumference (AC), and femur length (FL). The American College of Obstetricians and Gynecologists (ACOG) summarized that the ultrasonographic assessment of fetal weight had a sensitivity and specificity of 56 percent and 92 percent, respectively, however the accuracy reduced if fetal weight was greater than 4,000 grams⁵. In cases of suspected macrosomic fetus (estimated infant weight greater than 4,000 grams), it was more likely to have a cesarean delivery⁷.

Maternal diabetes also affects the fat distribution of the fetus. The fetus of maternal diabetes trends to have an overgrowth pattern, involving the central deposition of subcutaneous fat in the abdominal and interscapular areas⁸. They have larger shoulders and extremity circumferences, a decreased head-to-shoulder ratio, significantly higher body fat and thicker upper-extremity skinfolds which can affect the accuracy of ultrasound estimation of fetal weight⁹. The other factor that also affects the accuracy of ultrasonographic fetal weight assessment, such as obesity, which are common among diabetic pregnant women.

Objectives

The purpose of this study is to determine the accuracy of fetal weight assessment in the diabetic mother compared with the non-diabetic group in the intrapartum assessment period.

The primary outcome is comparison the accuracy of fetal weight estimation from ultrasound assessment. The secondary outcome aimed to assess the potential factors

including pre-delivery factors and intrapartum factor that may be affecting accuracy of ultrasound.

Materials and Methods

Study Design

This retrospective cohort study was carried out in Udon Thani Hospital, Thailand, after the study protocol was approved by the Ethical Research Committee of Udon Thani Hospital (No.23/2564). The eligible criteria for this analysis were the singleton pregnant women with gestational age ≥ 34 weeks who delivered in Udon Thani Hospital during January 2018 to December 2020. The ineligible criteria were: incomplete data, fetal anomaly, intrauterine fetal death, uterine abnormalities, the pregnant who had severe medical diseases (such as hypertension, heart disease and thyroid disease), and those who did not give birth in Udon Thani Hospital.

The sample size was calculated using the formula for two independent proportions. The estimated proportion of inaccurate ultrasonographic fetal weight estimation in the diabetic group was 0.50, and the non-diabetic group was 0.367 (from a pilot study) were used for calculating sample size. A α was 0.05 and the power was 80%. The calculated sample size per group was 217 participants. The medical records between January 2018 to December 2020 were selected for review for eligible and ineligible criteria.

Research Tools

The electronic medical records were retrospectively reviewed. The study group

(diabetic group)'s data, during the study period, were collected until the sample size number was met. The control group (non-diabetic group) was randomly selected from the non-diabetic delivered women during the study period, by using computer generated number for selection.

The baseline characteristics and study variables comprised of maternal diabetes, birth weight, and the intrapartum ultrasonographic estimation of fetal weight with parameters that include; head circumference (HC), biparietal diameter (BPD), abdominal circumference (AC), femur length (FL)¹⁰, fetal position, amniotic fluid index (AFI) and physicians who performed ultrasound was also recorded.

The ultrasonographic study was done using GE Voluson P6 ultrasound machine with a 3.5-5 MHz convex probe. All women in this study were taken only single ultrasound scan. There were 3 experienced levels that performed ultrasound; interns, residents, and obstetricians (staffs).

The fetal weight was calculated by the machine's program using Hadlock's formula (BPD, HC, AC and FL). The diabetic group was defined as the pregnant women with previous history of overt diabetes before pregnancy or having gestational diabetes which was diagnosed. As it is clinical practice in our institution, the GDM screening strategy was performed by risk-based screening and two-step approach to testing. The women with any risk were tested at 1st ANC or early pregnancy screening with 50 grams oral glucose testing after 1 hour for screening (GCT),

if GCT $\geq$ 140 mg/dL followed by the confirmatory test -100 grams glucose tolerance test (100 gm OGTT). The National Diabetes Data Group (NDDG) diagnostic criteria¹¹ was used which the positive OGTT test was defined as at least two abnormal blood glucose levels at fasting, 1, 2, and 3 hours after 100 grams glucose intake were $\geq$ 105, 190, 165, 145 mg/dL, respectively. If negative test result repeat at 24-28 weeks of gestational age. All pre-gestational DM cases were managed with insulin, and in GDM were clarified that; GDMA1 were controlled diet without hypoglycemic agent and GDMA2 were treated with oral hypoglycemic agents and/or insulin.

Neonatal birth weights were recorded after delivery and compared with the ultrasonographic fetal weight estimation. The absolute mean percent error was calculated by [(Estimated fetal weight - Birth weight)/Birth weight $\times$ 100]. The less than or equal to 10% error was classified into the accurate group while more than 10% error was classified to inaccurate group¹². Then, the accuracy of the ultrasonographic fetal weight estimation between diabetic and non-diabetic patients, and the possible associated factors were compared using bivariable and multivariable logistic regression analysis.

Statistical Analysis

The participants' characteristics were shown in term of frequency, percentage, mean and standard deviation (SD). The factors comparison between two groups was calculated by Pearson's chi square, or Student t test depended on the characteristic of

variables. Continuous variables are presented as mean (SD) and were compared by Student t test; categorical variables are presented as frequency (%) and were compared by Chi-square test. Multivariable regression analysis was used to examine the effect of confounding factors. The Adjusted Risk ratio (ARR) with 95% confidence interval (CI) were calculated using binary regression analysis and a p -value <0.05 considered statistically significant. All analyses were performed using STATA 13 (Stata Corp, College Station, TX).

Results

Demographic Characteristics and Neonatal Outcomes

A total of eligible 454 medical records of pregnant women, who delivered at Udon Thani Hospital and received the intrapartum ultrasonographic fetal weight estimation were included in this study. The samples in each group were selected by inclusion criteria for 230 women per group. There were 3 women in diabetic group no reported in criteria diagnosis of diabetes and one woman had been found uterine anomaly intraoperative cesarean section, those were excluded for analysis. There were 2 cases in non-diabetic group no reported who performed ultrasound and excluded for analysis.

There were 439 cases (96.7%) that delivered within 24 hours after ultrasonographic estimation, 8 cases that delivered in 48 hours, and 2 cases that delivered in 72 hours, and 5 cases were preterm birth who failed to inhibit labor and delivered at 4-6 days after ultrasound examination. Of these, 226 women were

diabetic group; 19 (8.4%) were pre-gestational diabetes, 207 (91.6%) were gestational diabetes and 228 were non-diabetic group.

The baseline characteristics of both diabetic and non-diabetic group are presented in Table 1. The diabetic group was significantly older, more parity, higher prepregnancy weight and body mass index than non-diabetic group. The gestational weight gain and admission body weight were also higher in diabetic group.

Preterm birth and cesarean delivery rate were significantly higher in diabetic group. Maternal complications in both groups were significantly different, whereas neonatal outcomes (except fetal macrosomia) showed no differences. Fetal macrosomia (birth weight > 4,000 grams) was found in 10.6% of the diabetic group and 0.9% in the non-diabetic group with significant difference, p -value<0.001.

Table 1 Demographic characteristics and neonatal outcomes (n=454)

Variables	Frequency (%)		<i>p</i> -value
	DM n=226	Non-DM n=228	
Age (year old)*	32.1 (6.1)	26.4 (6.3)	<0.001
Nullipara	69 (30.7%)	99 (43.4%)	0.005
Occupations			<0.001
Housewife	119 (52.7%)	144 (63.2%)	
Employee	69 (30.6%)	73 (32.0%)	
Merchant	9 (3.9%)	0 (0.0%)	
Government worker	8 (3.5%)	5 (2.2%)	
Farmer	16 (7.1%)	5 (2.2%)	
Personal business	5 (2.2%)	1 (0.4%)	
Pre-pregnancy BMI (kg/m ²)	25.8 (5.4)	22.4 (4.8)	<0.001
Under (<18.5)	17 (7.6%)	41 (18.0%)	
Normal (18.5-22.9)	57 (25.2%)	110 (48.3%)	
Overweight (23-27.4)	70 (30.9%)	48 (21.1%)	
Obesity (≥27.5)	82 (36.3%)	29 (12.7%)	
Body weight at admission (kg)	76.3 (14.7)	68.8 (12.7)	<0.001
Pregnancy weight gain (kg)	12.0 (5.6)	13.3 (5.2)	0.012
Gestational age at delivery (week)	37.9 (1.5)	38.5 (1.4)	<0.001
Preterm birth	34 (15.0%)	16 (7.0%)	0.019
Cesarean delivery	146 (64.6%)	82 (36.0%)	<0.001

Table 1 Continued

Variables	Frequency (%)		p-value
	DM n=226	Non-DM n=228	
Cesarean section indications			<0.001
Cephalopelvic disproportion	49 (33.6%)	16 (19.5%)	
Previous C/S	38 (26.0%)	17 (20.7%)	
Fetal malpresentation	9 (6.2%)	9 (10.9%)	
Failure of labor induction	15 (10.2%)	14 (17.1%)	
Severe preeclampsia with unfavorable cervix	16 (11.0%)	5 (6.2%)	
Others	19 (13.0%)	21 (25.6%)	
Maternal complications			0.040
PIH	9 (3.9%)	2 (0.9%)	
PROM	3 (1.3%)	0 (0.0%)	
PPH	1 (0.4%)	3 (1.3%)	
Abruptio placenta	1 (0.4%)	0 (0.0%)	
Birth weight (g)	3,297.2 (580.4)	3,099.0 (403.9)	<0.001
Neonatal outcomes			
Birth asphyxia (Apgar score at 1 min $\leq$ 7)	6 (2.7%)	9 (3.9%)	0.441
Low birth weight (birthweight < 2,500 g)	17 (7.5%)	14 (6.1%)	0.559
Fetal macrosomia (> 4,000 g)	24 (10.6%)	2 (0.9%)	<0.001
Birthweight $\geq$ 3,500 g	77 (34.1%)	36 (15.8%)	<0.001
NICU admission	2 (0.9%)	1 (0.4%)	0.557

Notes *mean (SD)

Abbreviation: DM- diabetes mellitus, SD- standard deviation, BMI- body mass index, PIH- pregnancy induced hypertension, PROM- prelabor ruptured of membrane, PPH- postpartum hemorrhage. NICU- neonatal intensive care unit.

The Accuracy of the Ultrasonographic Fetal Weight Estimation in Diabetic versus Non-diabetic Pregnancy

The comparison of the accuracy of the ultrasonographic fetal weight estimation in both study and control group is presented in Table 2. The birthweight of the diabetic group was higher than in the non-diabetic group. The means absolute difference between ultrasonographic estimation and real birthweight were higher in the diabetic group

without statistically significant 303.73 (SD 246.5) grams in diabetic group and 262.6 (SD 204.27) grams in non-diabetic group, (p -value=0.054). The accuracy (within 10% error) of both groups was 61.9% (diabetic group) and 63.2% (non-diabetic group) without significant difference. The non-accurate was mostly underestimation in both groups, however, overestimations were found in 7.1% of the diabetic group and 4.4% in the non-diabetic group.

Table 2 Comparison of the accuracy of the ultrasonographic fetal weight estimation in diabetic and non-diabetic pregnancy

Results	Frequency (%)		p-value
	DM n=226	Non-DM n=228	
Gestational age at last ultrasonography (week)*	37.8 (1.4)	38.5 (1.4)	<0.001
Scan-delivery time (day)*	1.1 (0.7)	1.0 (0.1)	0.004
Birth weight (g)*	3,297.2 (580.4)	3,098.9 (403.9)	<0.001
AFI (cm)*	11.1 (4.9)	9.2 (3.7)	<0.001
Δ FW (g)*	303.7 (246.5)	262.7 (204.3)	0.054
Absolute % error			
Within 10% of birth weight	140 (62.0%)	144 (63.2%)	0.790
Underestimated >10% of birth weight	70 (30.9%)	74 (32.5%)	0.734
Overestimated >10% of birth weight	16 (7.1%)	10 (4.4%)	0.217

Notes *mean (SD)

Abbreviation: DM- diabetes mellitus

Continuous variables are presented as mean (SD) and were compared by Student t test; categorical variables are presented as frequency (%) and compared by Chi-square test.

Factors Associated the Accuracy of Intrapartum Sonographic Estimated Fetal Weight

The possible associated factors of the accuracy of the ultrasonographic fetal weight estimation were shown in Table 3. Diabetes mellitus had no significant effect to the ultrasonic fetal weight estimation with the

ARR: 1.00; 95% CI: 0.78, 1.28; *p*-value=0.79. The factors, that had the association with the accuracy of intrapartum estimated fetal weight by ultrasonography, was the birthweight ARR 1.04 for each 100 gram increment (95% CI: 1.01, 1.06; *p*-value=0.003) and the examiner experience ARR 0.74; 95% CI: 0.58, 0.94; *p*-value=0.013.

Table 3 Factors associated the accuracy of intrapartum sonographic estimated fetal weight

Factors	Accurate group (n = 284)	Non-accurate group (n = 170)	Crude RR (95%CI)	p-value	ARR (95%CI)	p-value
DM	140 (49.3%)	86 (50.6%)	1.03 (0.81, 1.31)	0.790	1.00 (0.78, 1.28)	0.998
Gestational age (week)*	38.2 (1.4)	38.1 (1.5)	0.97 (0.90, 1.06)	0.518	NA	NA
Preterm birth	32 (11.27%)	18 (10.59%)	0.96 (0.65, 1.41)	0.823	NA	NA
Birthweight (g)*	3,283.2 (499.8)	3,146.1 (508.2)	1.03 (1.01, 1.05) (/100 g)	0.008	1.04 (1.01, 1.06) (/100 g)	0.003

Table 3 Continued

Factors	Accurate group (n = 284)	Non-accurate group (n = 170)	Crude RR (95%CI)	p-value	ARR (95%CI)	p-value
Low birthweight	19 (6.7%)	12 (7.1%)	1.04 (0.65, 1.64)	0.879	NA	NA
Birthweight 3,000-3,499 g	73 (25.7%)	108 (63.5%)	1.54 (1.12, 2.10)	0.007	NA	NA
Birthweight $\geq$ 3,500 g	58 (20.42%)	55 (32.4%)	1.44 (1.13, 1.84)	0.003	NA	NA
Macrosomia	17 (5.99%)	9 (5.3%)	0.88 (0.51, 1.53)	0.659	NA	NA
Scan-delivery time (day)*	1.1 (0.6)	1.1 (0.2)	0.67 (0.36, 1.22)	0.185	NA	NA
Examiner						
Intern	119 (41.9%)	88 (51.76%)	1	NA	1	NA
Resident & staff	165 (58.1%)	82 (48.24%)	0.78 (0.62, 0.99)	0.041	0.74 (0.58, 0.94)	0.013
Non vertex presentation of fetus	24 (8.5%)	11 (6.47%)	0.83 (0.50, 1.38)	0.473	NA	NA
Amniotic fluid (AFI) (cm)	10.1 (4.6)	10.09 (4.2)	1.00 (0.97, 1.03)	0.917	NA	NA
Active phase of labor ($\geq$ 5 cm)	20 (7.0%)	12 (7.1 %)	1.00 (0.63, 1.59)	0.995	NA	NA
Maternal BMI on u/s date (kg/m ²)*	29.1 (5.3)	29.4 (5.2)	1.01 (0.98, 1.03)	0.598	NA	NA
Obese	167 (58.8%)	98 (57.7%)	0.97 (0.76, 1.23)	0.809	NA	NA
Maternal weight gain (kg)*	12.5 (5.6)	12.8 (5.1)	1.01 (0.98, 1.03)	0.636	NA	NA

Notes *mean (SD)

Abbreviation: DM- diabetes mellitus, CI- confidence interval, AFI- amniotic fluid index.

-All percentages were column percent.

* Factors, that crude risk ratio had their *p*-value less than 0.1, were included in the adjusted model with DM which is a primary outcome of this research except birthweight $\geq$ 3,500 g was not included in the model due to multicollinearity effect with birthweight.

Discussion

Intrapartum fetal weight estimation of diabetic mothers is a worrisome problem for the health care team. Ultrasonic estimation is a valuable tool, especially in obese abdomen or hydramnios. However, the accuracy is questionable in diabetic case. The difference

in accuracy estimated weight of diabetic and non-diabetic fetus has been described to anthropometric and body composition differences. Fetuses with diabetic women, especially uncontrolled diabetic pregnancies, characterized by larger shoulder and extremity circumferences, decreased head-to-shoulder

ratio, significantly higher body fat, and thicker upper extremity skinfolds compared with non-diabetic¹³. However, data from this study showed that the diabetes only was not the risk factor of inaccurate ultrasonographic estimated fetal weight with the ARR 1.00; 95% CI: 0.78, 1.28. This information is similar to some previous studies which reported the ultrasonographic fetal weight estimation was similar among diabetic and non-diabetic women^{14,15} but was different from Combs CA, et al study, which reported fetal weight prediction had poor accuracy and the delivery decision based on sonographic estimated fetal weight will often be in error¹⁶.

Several previous studies have shown that ultrasonographic fetal weight estimation is an appropriate diagnostic tool. When the 10% difference of the actual birthweight is used as an accurate group, the accuracy rate of 65-70% has been reported¹⁷⁻²⁰. This was close to the accuracy rate of this study which was 61.9% in diabetes and 63.2% in non-diabetes groups. In this study, the fetal macrosomia ($\geq 4,000$ grams), which is commonly associated with poor control diabetes, was found in 10.62% and the neonatal birthweight of $\geq 3,500$ grams was found in 34.07% of diabetic mothers which was close to the Su R, et al study that reported rate of birthweight $\geq 3,500$ grams was 28% and fetal macrosomia was 8% in diabetic mothers²¹. The actual birthweight was positively associated with estimated fetal weight accuracy (ARR: 1.04; 95% CI: 1.01, 1.06) for each 100 gram increment of fetal weight which was similar to Meyer R, et al studies which reported fetal weight was

positively associated with estimated fetal weight accuracy (AOR 1.25; 95% CI: 1.21, 1.30) for each 500 gram increment and the fetal weight estimation in diabetic women were inaccurate in those with actual birthweights more than 3,500 grams¹².

The ultrasonographic measurement of fetal weight is overestimated when compared to actual weight in most reports²²⁻²⁵. In contrast, a retrospective study finding that among diabetic pregnant women with macrosomic fetuses, there was a trend to underestimate the birthweight, with the mean birthweight being underestimated,²⁶ which was similar to this study, that 30.97% of fetal weight were underestimated. The low experience of operator was also a significant risk of inaccurate estimation which was similar to Siemer J, et al and Milner J, et al studies^{27,28} that reported the source of inaccurate EFW may rise from operator dependent variable.

Currently, there is no guideline that suggests or includes using ultrasound for fetal weight estimation as part of intrapartum management. Fetal weight assessments have to concern in some conditions that maybe alter fetal growth such as maternal obesity, maternal diabetes, hypertensive disorder etc. However, it depends on availability and feasibility of health care center, clinical estimates by physical examination may be choice of fetal weight prediction. In our institution universally use ultrasound to estimate fetal weight in women, who visit labor room, therefore, there was no bias in selective case for ultrasound scan.

The ultrasonography was performed both latent and active phase of first stage of labor, but most in latent phase. However, in active phase when the presenting part progress descent, it may be made a low quality of image and make an error of calculation. This could be the confounder of the study.

The clinical implications from this study are the ultrasonographic fetal weight estimation in laboring diabetic women should be performed by an experienced operator, a regular and intense training is important strategy. In addition, the non-accuracy of estimation in large diabetic fetuses should be considered. The combination of the clinical manual estimation by experienced health care providers with the ultrasonographic estimation should be considered and incorporated into the decision-making process. The over-or underestimation of the fetal weight can affect the treatment decision. The overestimation by ultrasonography can increase the risk of cesarean delivery. Little S, et al. reported that the ultrasonographic estimation of fetal weight was associated with an increased risk for cesarean delivery with OR: 1.44; 95% CI: 1.1, 1.9²⁹ and Stubert J, et al. reported the increasing risk for cesarean delivery with AOR: 2.80; 95% CI: 1.2, 6.5³⁰. Moreover, the prompt emergency rescue for complications, such as shoulder dystocia, should be prepared for the unexpected fetal weight underestimation.

Furthermore, we should focus on the antepartum factors that affect the accuracy of ultrasound such as maternal obesity, hydramnios, fetal growth restriction or fetal

macrosomia that study may be the large samples. In this study discuss the accuracy of ultrasonography detecting fetal macrosomia compared between two groups but these may have small number to evaluate. Therefore, in the future study should be focus on detecting large for gestational age (LGA) and small for gestational age (SGA), the difference of pregestational and gestational DM, the effect of well and poor controlled DM on the accuracy of fetal weight estimation.

The limitations of this study are; first, its retrospective nature therefore some information was missed, and some cases were excluded due to incomplete data, which might cause the bias and many confounders, such as the standardized of procedure in multilevel of examiners, were not controlled. Second, although we used the randomization number for the non-DM mothers' selection, the different of patient characteristics were also presented. Third, some subgroup factors, such as pregestational or gestational DM, well or poor controlled DM, might be the significant factors but this study had inadequate data for subgroup analysis.

Conclusion

The study concluded that the accuracy of intrapartum ultrasonographic fetal weight estimation between diabetic and non-diabetic women was not significantly different. The factors affecting the accuracy were increasing actual birthweight and the experience of examiner.

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