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THE EFFECT OF MATERNAL OBESITY ON SONOGRAPHIC FETAL WEIGHT ESTIMATION

By

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ABSTRACT

Background: Obesity is one of the most serious public health challenges of the 21st century. Obesity has reached epidemic proportions worldwide. American College of Obstetricians and Gynecologists committee opinion, estimated that at least one- third of pregnant women are obese, and 8% are extremely obese.

Objective: To detect the possible effect of maternal obesity on the accuracy of ultrasound fetal weight estimation during the third trimester shortly before labor.

Patients and Methods: A prospective, comparative study was conducted at Om El Masryeen Hospital from August 2019 to August 2020. One hundred and fifty (150) singleton pregnant women who fulfilled the inclusion criteria were included in the study. All pregnant participants were between 37 and 42 weeks of gestation with a singleton cephalic presentation, and none of the participants had any medical or obstetrical problems. In the present work, women were classified into five BMI categories based on their current BMI each group included 30 patients. The study population was drawn from consecutive patients who underwent sonographic fetal weight estimation within 7 days of delivery and actual birth weight within thirty minutes after delivery.

Results: By comparison between groups, we found that the mean of age was 27.4 ± 6.03 years, 27.8 ± 4.9 years, 28.8 ± 4.3 years, 28.6 ± 5.2 years and 28.6 ± 4.88 years in the normal weight, overweight, class I, class II and class III groups, respectively. Estimated fetal weight by ultrasound was 2.89±0.30kg, 3.00± .28kg, 3.21 ± .35kg, 2.99 ± 0.39kg and 3.31 ± 0.55kg in the normal weight, overweight, class I, class II and class III groups, respectively. Regarding actual birth weight was 2.95 ± 0.35kg, 3.09 ± 0.30kg, 3.23±0.34kg, 2.92 ± 0.45kg and 3.13±0.55kg in the normal weight, overweight, class I, class II and class III groups, respectively. Statistically significant difference between ultrasound (US) estimated fetal weight (EFW) and birth weight versus body mass index in obesity class II and III.

Conclusion: Maternal obesity decreased the accuracy of sonographic fetal weight estimation. Clinicians should be aware of the limitations of sonographic fetal weight estimation, especially in obese patients.

Keywords: Body mass index, Fetal weight, Obesity, Ultrasonography.

INTRODUCTION

The shifting demographic of the maternal body mass index (BMI) in pregnancy over the last decades is well documented. In a review from 1956, the rate of obesity in pregnancy was 3.6% (defined as weight >190 lb). Obesity is a global health problem that is increasing in prevalence. The World Health Organization (WHO) characterizes obesity as a pandemic issue, with a higher prevalence in females than males. Thus, many pregnant patients are seen with high body mass index (BMI). At least, one third of pregnant women are obese, and 8% are extremely obese *(American College of Obstetricians and Gynecologists, 2013).*

Obesity during pregnancy is considered a high-risk state that adversely affects both mother and neonate and impairs the pregnancy outcome. The prevalence of obesity in both developed and developing countries has risen dramatically especially among women in reproductive age. Research that has specially evaluated pregnancy outcome among obese patients has allowed for a better understanding of the adverse prenatal complications the antepartum, intrapartum, intraoperative, post operatve and post-partum period times, the obese pregnant mothers is at greater risk for adverse maternal fetal outcomes. Compared with ideal body weight, mother's comorbid medical conditions that commonly are associated with pregnancy accentuate perinatal risk. All obese pregnant mothers should be counselled regarding these risks and strategies should be used to improve perinatal outcome. Obese mothers of reproductive age should be counselled before conception and advised to achieve ideal body weight before pregnancy *(Li et al., 2010)*.

The clinical significance of obesity in pregnancy is based on the associated obstetric complications. In addition to obstetric complications caused by maternal obesity, obesity may also impair the visualization of the fetal anatomy and degrade image quality, making it difficult or impossible to obtain adequate images for clinical interpretation. Obese patients with predominant subcutaneous fat will have lower quality images than non- obese patients with minimal subcutaneous fat. Ultrasound imaging of obese patients remains challenging due to the adverse effects of adipose tissue on the propagation of sound waves *(Hendler et al., 2010* and *Hendler et al., 2011).*

The prediction of estimated fetal weight (EFW) before delivery during the third trimester plays a pivotal role in obstetric practice, with a major impact on antenatal management. Many important clinical decisions depend upon a precise and accurate assessment of sonographic EFW. For example, overestimation of fetal weight before delivery can lead to unnecessary obstetric interventions. Conversely, underestimation of fetal weight can cause delays in essential obstetric interventions *(Aksoy et al., 2015).*

This study aimed to detect the possible effect of maternal obesity on the accuracy of ultrasound fetal weight estimation during the third trimester shortly before labor.

PATIENTS AND METHODS

A prospective, comparative study was conducted at Om El Masryeen Hospital from August 2019 to August 2020. The study population was drawn from consecutive patients who underwent sonographic fetal weight estimation within 7 days of delivery One hundred and fifty (150) singleton pregnant women who fulfilled the inclusion criteria were included in the study. All pregnant participants were between 37 and 42 weeks of gestation with a singleton cephalic presentation, and none of the participants had any medical or obstetrical problems. Body mass index (BMI) was calculated as the weight in kilograms at the current admission visit divided by the height in meters squared.

Inclusion criteria: Singleton pregnancy, cephalic presentation, pregnant between 37-42 weeks, delivered within one week of fetal weight estimation, proper dating L.M.P or 1st trimester US and intact membranes.

Exclusion criteria: Oligohydramnios, anhydramnios, any medical problems (i.e. diabetic, hypertensive, heart disease), placental abnormalities (i.e. placenta previa, ablatio placenta and placental attachment abnormalities), congenital fetal anomalies, hydrops, intrauterine fetal death, utrine fibroids and obstetric emergencies, such as antepartum hemorrhage, eclampsia and acute fetal distress.

After providing informed consent, each participant completed an enrolment questionnaire that assessed medical information:

- Maternal age
- Maternal weight
- Maternal Height
- Parity

Gestational age (Gestational age was calculated based on the last menstrual period and was confirmed in all cases using crown–rump length measured during the first trimester).

Body mass index (BMI) was calculated as the weight in kilograms at the current admission visit divided by the height in meters squared.

The women were classified into five BMI categories based on their current BMI, according to the World Health Organization and National Institutes of Health guidelines: normal weight, BMI 18.5-24.9kg/m2; overweight, BMI 25.0–29.9kg/m2; obese class I, BMI 30.0–34.9kg/m2; obese class II, BMI 35.0–39.934.9kg/m2; obese class II, BMI 35.0–39.9kg/m2; and obese class III, BMI ≥ 40.0kg/m2.

Body mass index was used as a measure of relative maternal size because it correlate with decrease of adiposity in pregnant population and allow comparison of relative maternal size in a large population of women with varying heights.

On presentation to the labor and delivery unit ultrasound scans were performed by the members of the fetal medicine unit of sayed glal university hospital Ultrasound examination was performed transabdominally using MINDRAY DC-3 Ultrasound Machine, using convex abdominal probe with Center Frequency: 3.5 MHz.

The three measurements of each fetal parameters (BPD, HC, AC and FL) were performed in frozen images of subsequent scans and the means of their values were used for further analysis. The fetal BPD was measured in the standard projection of the fetal head (the maximum diameter of transverse section of the fetal skull at the parietal eminences with the following features: a short midline, the cavum septum pellucidum and the thalami) from the outer edge of the proximal parietal bone to the inner edge of the distal parietal bone. HC was measured in the same plane as BPD, with an elipse measurement tool from frontal to the occipital part of the outer contour of the skull bone, AC was measured in the standard cross- sectional plane at the level of the stomach and umbilical vein/ductus venosus complex by placing an elipse around the outer border

of the abdomen. FL measured from the proximal end of the major trochanter to the distal meatphysis.

The fetal biometrics and EFW were calculated using a formula based on the descriptions provided by Hadlock et al. EFW was calculated according to the Hadlock formula: log10weight = 1.335 - 0.0034AC × FL+ 0.0316 BPD+0.0457 AC+0.1623 FL Inall cases, the sonographic fetal biometric measurements were performed within 7 days before delivery to eliminate possible impact of duration between ultrasound examination and delivery on the accuracy of the measurements.

All neonates were weighted within 30 minutes of the delivery and infant weight was recorded to the nearest gram.

Because the primary objective was to determine how maternal BMI affect the accuracy of sonographic, the EFW was compared with the actual birth weight (ABW) and the difference between the EFW and the ABW (i.e. simple error) was recorded as the error in grams. The percentage error was defined as: (EFW – ABW) × 100/ABW.

The absolute error was defined as: absolute value of (EFW – ABW). The mean percentage error represented the sum of the positive (i.e. overestimation) and negative (i.e. underestimation) deviations from ABW.

Statistical analysis:

Data were analyzed using Statistical Package for the Social Science (SPSS) version 20.0. Quantitative data were expressed as mean± standard deviation (SD), minimum and maximum. Qualitative data were expressed as frequency and percentage. The following tests were done: Paired-samples t-test of significance one-way or ANOVA followed by post-hoc test was used when comparing between two means of the same group. Chi-square (X2) test of significance was used in order to compare proportions between two qualitative parameters. Probability (P-value) P-value <0.05 was considered significant.

RESULTS

Comparison between groups showed that the mean of age was 27.4 ± 6.03 years, 27.8 ± 4.9 years, 28.8 ± 4.3 years, 28.6 ± 5.2 years and 28.6 ± 4.88 years in the normal weight, overweight, class I, class II and class III groups, respectively **(Table 1)**.

Table (1): Comparison between groups as regard age, gestational age, and BMI

Parameters \ Groups	Control		Over weight		Obese class 1		Obese class 2		Obese class 3		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age(yrs.)	27.43	6.03	27.83	4.91	28.83	4.38	28.67	5.19	28.67	4.88	0.781
Gestational age	37.97	0.93	38.00	0.74	38.10	1.12	37.93	0.69	37.87	0.82	0.883
BMI	23.22	1.21	27.42	1.42	31.76	1.27	36.03	0.94	41.71	1.50	< 0.001

Five different groups according to BMI each group include (30) patients compare between Mode of delivery and Outcome of delivery **(Table 2)**.

Table (2): Comparison between groups according to BMI, Mode of delivery and outcome

Parameters \ Groups		Control		Over weight		obese class1		obese class2		obese class3		P value
		Count	%	Count	%	Count	%	Count	%	Count	%	
Mode of delivery	NVD	17	56.7%	11	36.7%	8	26.7%	8	26.7%	4	13.3%	0.006
	CS	13	43.3%	19	63.3%	22	73.3%	22	73.3%	26	86.7%	
Outcome	male	17	56.7%	16	53.3%	14	46.7%	17	56.7%	15	50.0%	0.923
	female	13	43.3%	14	46.7%	16	53.3%	13	43.3%	15	50.0%	

Comparison between actual weight and estimated Weight by u/s in each group included (30)patients shows Insignificant difference in Control and Obese class 1 groups but Shows Significant difference in Over weight and Obese class II and III **(Table 3)**.

Table (3): Comparison between actual weight and estimated weight in each group

Parameters \ Groups	Control		Over weight		Obese class 1		Obese class 2		Obese class 3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
EFW by U/S(kg)	2.89	0.30	3.00	0.28	3.21	0.35	2.99	0.39	3.31	0.49
Birth weight(kg)	2.95	0.35	3.09	0.30	3.23	0.34	2.92	0.45	3.13	0.55
P value	0.076		< 0.001		0.495		0.035		< 0.001	

DISCUSSION

In the present work, women were classified into five BMI categories based on their current BMI, according to the World Health Organization and National Institutes of Health guidelines: normal weight, BMI 18.5-24.9kg/m2; overweight, BMI 25.0–29.9kg/m2; obese class I, BMI 30.0–34.9kg/m2; obese class II, BMI 35.0–39.934.9kg/m2; obese class II, BMI 35.0–39.9kg/m2; and obese class III, BMI ≥ 40.0kg/m2.

The detrimental impact maternal obesity has on the accuracy of sonography for detection of anomalies has been reported *(Racusin et al., 2012). Fuchs et al. (2013)* demonstrated the adverse effects of maternal obesity on genetic sonograms during the first and second trimesters. *Goetzinger et al. (2013)* examined the sensitivity and specificity for extremes of abnormal fetal growth and found no association with the maternal BMI class. *Thornburg (2013)* reported that maternal obesity during pregnancy is associated with major limitations in the ability to evaluate fetal anatomic structures.

The prediction of EFW before delivery during the third trimester plays a pivotal role in obstetric practice, with a major impact on antenatal management. Many important clinical decisions depend upon a precise and accurate assessment of sonographic EFW. For example, overestimation of fetal weight before delivery can lead to unnecessary obstetric interventions. Conversely, underestimation of fetal weight can cause

delays in essential obstetric interventions. In our study, analysis was confined to 150 singleton pregnancies to detect the possible effect of maternal obesity on the accuracy of ultrasound fetal weight estimation during the third trimester shortly before labor *(Aksoy et al., 2015).*

In the present study, no statistically significant difference in control group and obesity class 1 group although there is statistically significant difference in class 2 and class 3 obesity. In our study 48 patient undergone normal vaginal delivery and 102 undergone cesarean with percentage 32% and 68% respectively *(Chen et al., 2010).*

By comparison between groups we found that the mean of age was 27.4 ± 6.03 years, 27.8 ± 4.9 years, 28.8 ± 4.3 years, 28.6 ± 5.2 years and 28.6 ± 4.88 years in the normal weight, overweight, class I, class II and class III groups, respectively *(Campoverde Reyes et al., 2021).*

Regarding estimated fetal weight by ultrasound was 2.89±0.30kg, 3.00± 0.28kg, 3.21 ± 0.35kg, 2.99 ± 0.39kg and 3.31 ± 0.55kg in the normal weight, overweight, class I, class II and class III groups, respectively. Actual birth weight was 2.95 ± 0.35kg, 3.09 ± 0.30kg, 3.23±.34kg, 2.92 ± 0.45kg and 3.13±.55 kg in the normal weight, overweight, class I, class II and class III groups, respectively. Maternal BMI and pregnancy weight gain mostly reflect nutritional status before and during pregnancy. Weight gain has a significant relationship with pregnancy outcomes. However, weight gain in most pregnant women is not within the ideal ranges *(Abrams et al., 2010).*

In the study done by *Aksoy et al. (2015),* the demographic and clinical characteristics did not differ between the study groups, except for maternal age, which was 25.19 ± 5.39 years, 26.56 ± 6.31 years, 25.30 ± 5.52 years, 30.42 ± 5.18 years and 30.20 ± 5.88 years in the normal weight, overweight, class I, class II and class III groups, respectively. They observed no significant differences between the groups with respect to EFW and ABW. When intra-group comparisons between EFW and ABW were made, significant differences were found in the obese classes II and III groups. Significant differences in the mean absolute error and the mean absolute percentage error were found between all five groups. A significant difference in the magnitude of the mean absolute error and the absolute percentage error was observed with increasing maternal obesity.

Wolfe et al. (2010), reported a greater risk of suboptimal visualization when BMI (kg/m2) was above the 90th percentile.Another study conducted by *Dashe et al. (2012)* showed that increasing maternal BMI limits the visualization of the fetal anatomic structures during a standard second-trimester ultrasound examination.

Field et al. (2010) and *Farrell et al. (2012)* found that the accuracy of clinical and sonographic EFW measurements is not affected by increasing maternal obesity. *Field et al. (2010)* evaluated the effect of maternal obesity on the accuracy of clinical and sonographic EFW measurements in a group of 998 singleton pregnancies with gestational age ranging from 26 to 42 weeks. *Farrell et al. (2012).* Have discrepancy in findings which may

be related to differences in sample size and gestational age, because EFW is strongly influenced by gestational age. This discrepancy may also be related to differences in the study protocols and to the existence of possible biases in the previous studies.

Dammer et al. (2013) have investigated the factors that affect sonographic EFW prediction evaluating the effect of nine different factors, including maternal BMI; presentation of the fetus; time interval between estimation and delivery; fetal gender; fetal weight; placenta location; amniotic fluid index; gestational age and degree of operator experience, on the accuracy of EFW measurements. That retrospective study, reported that of the nine evaluated factors that may affect accuracy of EFW measurements, only time interval >7 days between estimation and delivery had an adverse effect on prediction.

Caughey (2012) summarized the impact of EFW can have an effect on the mode of delivery. A study *by Kritzer et al.,* found that patients who underwent sonographic examination were 50% more likely to undergo a cesarean delivery, with an even greater impact if the EFW was greater than 3500 g. This finding lends credence to the conclusion that clinicians rely on the EFW in their management of labor and decision making regarding the mode of delivery.

Kritzer et al. (2014) quantitated the impact, of an increasing maternal BMI has on the accuracy of sonographic EFW obtained within 2 weeks of delivery. Estimation of the EFW near delivery does not appear to be similarly affected by the maternal body habitus. Sonography performed in a dedicated obstetric ultrasound unit within 2 weeks of delivery had a relatively low percentage error for estimation of fetal weight, and this error rate did not vary substantially by maternal BMI classification.

Aksoy et al. (2015) found significantly higher mean absolute error and mean absolute percentage error in the higher BMI category. Strong positive correlations were observed between BMI and the mean absolute error or the mean absolute percentage error; these correlations were statistically significant. Therefore, maternal obesity decreases the accuracy of sonographic fetal weight estimation. In our study, there was a statistically significant difference between US EFW and birth weight versus body mass index in obesity class II and II.

CONCLUSION

Maternal obesity decreased the accuracy of sonographic fetal weight estimation. Clinicians should be aware of the limitations of sonographic fetal weight estimation, especially in obese patients. Obesity brings many health hazards on obese mothers and their babies as obese mothers exposed to cesarean section delivery, adverse pregnancy outcome on their babies as preterm baby, macrosomic baby and congenital anomalies.

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تأثير سمنة الأم على دقة تحديد وزن الجنين بإستخدام الموجات الفوق صوتية

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خلفية البحث: السمنة هي واحدة من أخطر تحديات الصحة العامة في القرن الحادي والعشرين. ولقد وصلت السمنة إلى معدلات وبائية في جميع أنحاء العالم. وقد قدّر رأي لجنة الكلية الأمريكية لأطباء النساء والتوليد، والذي نُشر في عام 2013، أن ثلث النساء الحوامل على الأقل يعانون من السمنة، و 8٪ يعانون من السمنة المفرطة.

الهدف من البحث: الكشف عن التأثير المحتمل لسمنة الأمهات على دقة تقدير وزن الجنين بالموجات فوق الصوتية خلال الثلث الثالث قبل المخاض بوقت قصير.

المريضات وطرق البحث: تم إجراء دراسة مقارنة مستقبلية في مستشفى أم المصريين في الفترة من أغسطس 2019 إلى أغسطس 2020. وتم إختيار مجتمع الدراسة من المرضى المتتاليين الذين خضعوا لتقدير وزن الجنين بالموجات فوق الصوتية في غضون 7 أيام من الولادة حيث تم تضمين مائة وخمسين (150) امرأة حامل بمفردها استوفين معايير الاشتمال في الدراسة. وكانت جميع المشاركات الحوامل بين 37 و 42 أسبوعًا من الحمل مع عرض رأسي فردي، ولم يكن لدى أي من المشاركات أي مشاكل طبية أو ولادة.

نتائج البحث: بالمقارنة بين المجموعات وجدنا أن متوسط العمر كان 27.4 ± 6.03 سنة، 27.8 ± 4.9 سنة، 28.8 ± 4.3 سنة، 28.6 ± 5.2 سنة، 28.6 ± 4.88 سنة في الوزن الطبيعي، الوزن الزائد، الفئة الأولى، الفئة الثانية والفئة الثالثة على التوالي. فيما يتعلق بوزن الجنين المقدر بالموجات فوق الصوتية كان 2.89 ± 0.30 كجم، 3.00 ± 0.28 كجم، 3.21 ± 0.35 كجم، 2.99 ± 0.39 كجم و 3.31 ± 0.55 كجم في الوزن الطبيعي، والوزن الزائد، والفئة الأولى،

والفئة الثانية والفئة الثالثة، على التوالي. وكان وزن الولادة الفعلي كان 2.95 ± 0.35 كجم، 3.09 ± 0.30 كجم، 3.23 ± .34 كجم، 2.92 ± 0.45 كجم و 3.13 ± 0.55 كجم في الوزن الطبيعي، الوزن الزائد، الفئة الأولى، الفئة الثانية والفئة الثالثة على التوالي. وكانت هناك فروق ذات دلالة إحصائية بين تقدير وزن الجنين بالموجات فوق الصوتية ووزن الولادة بمقدار مؤشر كتلة الجسم في السمنة من الصنف الثاني والثالث.

الاستنتاج: السمنة لدى الأمهات تقلل من دقة تقدير وزن الجنين بالموجات فوق الصوتية. ويجب أن يكون الأطباء على دراية بالقيود المفروضة على تقدير وزن الجنين بالموجات فوق الصوتية، وخاصة في المرضى الذين يعانون من السمنة المفرطة.

الكلمات الدالة: مؤشر كتلة الجسم، وزن الجنين، السمنة، الموجات فوق الصوتية.