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THE EFFECT OF MATERNAL OBESITY ON SONOGRAPHIC FETAL WEIGHT ESTIMATION

By

Yahea A. Wafa[(1)], Mohamed El Mohandes[(2)] and Hamada A. Sayed

[(1)]Department of Obstetrics and Gynaecology, Faculty of Medicine, Al-Azhar University

[(2)]Department of Obstetrician and Gynecologist, El Galaa Maternity Teaching Hospital

Correspondence: hamadaadly89@gmail.com ; **Tel.:** 01067724403

ABSTRACT

Background: Obesity is one of the most serious public health challenges of the 21st century. Obesity has reached epidemic proportions worldwide.

Objective: To detect the possible effect of maternal obesity on the accuracy of sonographically estimated fetal weight (EFW) in the third-trimester shortly before labor and to compare the accuracy of the estimation between normal weight, overweight, and class I, class II and class III obese groups.

Subjects and Methods: This was a prospective study of singleton pregnancies with sonographic fetal weight estimation prior to scheduled delivery. Women were classified according to current body mass index (BMI) into five categories: normal (BMI 18.5–24.9 kg/m2, n = 30), overweight (BMI 25.0–29.9 kg/m2, n = 30), obese class I (BMI 30.0–34.9kg/m2, n = 30), obese class II (BMI, 35.0–39.9 kg/m2, n = 30) and obese class III (BMI ≥ 40.0 kg/m2, n = 30).The EFW was compared with the actual birth weight(ABW), and the difference between them was recorded.

Results: There was a statistically significant difference between US EFW by (g) and birth weight by (g) 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.

Key words: Body mass index, fetal weight, obesity, ultrasonography.

INTRODUCTION

Obesity is one of the most serious public health challenges of the 21st century. Obesity has reached epidemic proportions worldwide *(Hurt et al., 2010).*

American College of Obstetricians and Gynecologists committee in 2013, estimated that at least one-third of pregnant women are obese, and 8% are extremely obese *(ACOG, 2015).*

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 *(Aksoy et al., 2015).*

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 *(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 between April 2019 and December 2019 at El Galaa Maternity Teaching Hospital. The study population was drawn from consecutive patients who underwent sonographic fetal weight estimation within 7 days of delivery and who fulfilled all of the following:

The study included singleton pregnancy, with cephalic presentation, early pregnancy, who delivered within one week of fetal weight estimation, proper dating last menstrual period (L.M.P) or 1st trimester US and intact membranes.

Patients with 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, obstetric emergencies, such as antepartum hemorrhage or eclampsia and acute fetal distress were excluded from the study.

One hundred and fifty (150) singleton pregnant women who fulfilled the inclusion criteria were included in the study. All pregnant participants were followed up through pregnancy and with Singleton pregnancy, cephalic presentation at 37-42 weeks of gestation. None of the participants had any medical or obstetrical problems.

After providing informed consent, each participant completed an enrolment questionnaire that assessed medical information: maternal age, maternal weight, maternal height and 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).

BMI was calculated as the weight in kilograms before pregnancy by history 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 18.5-24.9 kg/m2; overweight, BMI 25.0-29.9 kg/m2; obese class I, BMI 30.0–34.9 kg/m2; obese class II, BMI 35.0–39.934.9 kg/m2; obese class II, BMI 35.0–39.9 kg/m2; and obese class III, BMI ≥ 40.0 kg/m2.

BMI was used as a measure of relative maternal size because it correlated with decrease of adiposity in pregnant population and allowed 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 El Galaa Maternity Teaching 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 parameter (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 ellipse 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 within7 days before delivery to eliminate possible impact of duration between ultrasound examination and delivery on the accuracy of the measurements.

All neonates were weighed 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 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 Pakage for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage. The following tests were done: Independent-samples t-test of significance was used when comparing between two means. 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

This is a year-long study involving 150 singleton pregnancies of 37–42 weeks' gestation underwent sonographic (Hadlock) fetal weight estimation within 7 days of delivery. Patients were stratified into five different groups based on increasing maternal BMI: underweight (less than 19.8), normal weight (19.8–26.0), overweight (26.1–29.0), Class I obesity I (30.0 to 34.9.), Class II obesity (35.0 to 39.9) and Class III obesity (equal to or greater than 40.0). The EFW were compared with ABW.

There was no statistically significant difference between body mass index according to demographic and clinical characteristics in the normal weight, overweight, class I, class II and class III groups **(Table 1)**.

Table (1): Demographic and clinical characteristics of study group

Groups / Parameters	Normal (n = 30)	Overweight (n = 30)	Obesity class I (n = 30)	Obesity class II (n = 30)	Obesity class III (n = 30)	p-value
Age						
Mean±SD	23.57±4.16	24.33±4.06	25.77±5.06	25.53±3.30	25.93±4.91	>0.05
Range	18-35	19-34	18-36	20-33	18-36	
G.A (wks)						
Mean±SD	39.17±1.64	38.63±1.38	38.80±1.47	38.63±1.40	38.83±1.46	>0.05
Range	37-42	37-42	37-42	37-42	37-42	
Parity						
PG	4(13.3%)	6(20.0%)	3(10.0%)	3(10.0%)	1(3.3%)	>0.05
Multipara	26(86.7%)	24(80.0%)	27(90.0%)	27(90.0%)	29(96.7%)	

The difference between Us EFW and ABW is not significant; 0.116, 0.234, 0.15 in normal, overweight and obese class I respectively. Meanwhile it's highly significant 0.034, 0.021 and best shown in obesity class II and III **(Table 2)**.

Table (2): US EFW by (g) and birth weight by (g) versus body mass index

BMI Category	Us EFW by (g)	Birth Weight by (g)	p-value
Normal (n=30)	**3448.17±416.91**	**3478.67±387.66**	**> 0.05**
Overweight (30)	**3542.37±271.43**	**3576.50±232.92**	**> 0.05**
Obesity class I (30)	**3711.47±295.12**	**3747.27±288.97**	**> 0.05**
Obesity class II (30)	**3863.73±218.36**	**3920.40±219.07**	**< 0.05**
Obesity class III (30)	**4015.57±269.15**	**4131.10±255.38**	**< 0.05**

There was a statistically significant difference between US EFW by (g) and birth weight by (g); with increased body mass index. Also there was a significant value increased BMI and increased cesarian section (CS) mode of delivery **(Table 3)**.

Table (3): Relation between BMI , ESFW by US , ABW and mode of delivery

Groups / Parameters	Normal (n = 30)	Overweight (n = 30)	Obesity class I (n = 30)	Obesity class II (n = 30)	Obesity class III (n = 30)	p-value
Us EFW by (g)						
Mean±SD	3448.17±416.91	3542.37±271.43	3711.47±295.12	3863.73±218.36	4015.57±269.15	<0.001
Range	2750-4300	2980-4050	2890-4120	3410-4349	3410-4690	
Birth Weight by (g)						
Mean±SD	3478.67±387.66	3576.50±232.92	3747.27±288.97	3920.40±219.07	4131.10±255.38	<0.001
Range	2830-4220	3040-3980	2890-4090	3457-4400	3470-4600	
CS	9 (30.0%)	10 (33.3%)	13 (43.3%)	17(56.7%)	18(60.0%)	<0.05
NVD	21 (70.0%)	20(66.7%)	17(56.7%)	13(43.3%)	12(40.0%)	
Total	30 (100.0%)	30(100.0%)	30(100.0%)	30(100.0%)	30(100.0%)	

In addition, an increased number of macrosomic infants is observed with increased BMI in obesity class II and III when EFBW by Us was compared to ABW **(Table 4)**.

Table (4): Macrosomia in US EFW by (g) and birth weight by (g) versus body mass index

BMI Category	Us EFW by (g)	Birth Weight by (g)	p-value
Normal (n=30)	1 (3.3%)	1 (3.3%)	> 0.05
Overweight (n=30)	3 (10.0%)	4 (13.3%)	> 0.05
Obesity class I (n=30)	6 (20.0%)	8 (26.7%)	> 0.05
Obesity class II (n=30)	9 (30.0%)	19 (63.3%)	**< 0.05**
Obesity class III (n=30)	13 (43.3%)	24 (80.0%)	**< 0.05**

DISCUSSION

Accurate prenatal estimation of fetal weight (EFW) in late pregnancy and labor is extremely useful in the management of labor and delivery, permitting obstetricians to make decisions about instrumental vaginal delivery, trial of labor after cesarean delivery and elective caesarean section for patients suspected of having a macrocosmic fetus

There have been differing results about the effect of maternal obesity on accuracy of US estimation of fetal weight. Our study showed significant differences between EFW prior to delivery and ABW after delivery in Class II and Class III obesity respectively. We found an increased rate of cesarean section delivery with increased BMI as well.

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.

In general, the US fetal visualization is affected by maternal obesity. Excess abdominal (subcutaneous or intra-abdominal) fat results in an increased number of interfaces and marked attenuation of the signal due to absorption, reflection, reverberation, and scatter of the US waves *(Weichert et al., 2011).*

Although most studies focused primarily on fetal anomaly scans, one of the continued risks of maternal obesity is the challenge of accurately assessing EFW during the third trimester especially just before the delivery. Poor detection of fetal anomalies using US examination is reported in obese pregnant females compared to normal body weight pregnant females *(Aagaard-Tillery et al., 2010).*

Even the duration of US fetal examination was different between normal and obese pregnant females. It was found to be 8.9 min to 13.5 min longer in pregnant women with BMI ≥ 40 and ≥ 50 respectively *(Vivek et al., 2019).*

Regarding US estimated FBW and ABW; *Alksoy et al. (2015)* recorded significant differences in the obese classes II and obese III. Moreover, significant difference in the magnitude of the mean absolute error and the absolute percentage error was observed with increasing maternal BMI.

Kilani et al. (2019) compared the EFW and ABW for normal weight, overweight, obesity class I, II and III showing no significant difference in the first two groups and a significant difference a in class II obesity and 00.30 in class III obesity. The difference between EFW and AFW across the different BMI groups was more than 244 g.

On the contrary, there was no significant difference in ultrasound accuracy across various obesity classes. In a study, the overall mean absolute percentage error (MAPE) was 8% *(Al-Obaidly et al., 2019).*

This may have resulted of comparing obese pregnant females Class I and II to class III. This means the significant differences would only appear when comparing normal body weight pregnant women and obese pregnant women.

Manzanares et al. (2019) also concluded that maternal obesity is unrelated to the accuracy of sonographic EFW. There was an insignificant MAPE (<10%) which may be due to biased study design with unequal number of compared groups.

The limitation of this study was its dependence on history taking to know the BMI before conception. This inability to measure BMI of individuals before conception affected the estimation of weight gain along the pregnancy period. The strength of this study was the reasonable number of the study population, the equality of number between compared groups, limiting the gestational age, exclusion of diseases affecting fetal weight such IUGR or diabetes and the prospective nature of the study.

CONCLUSION

Increasing maternal obesity decreased the accuracy of sonographic EFW measurement. Clinicians should be aware of the limitations of sonographic EFW prediction, especially in obese patients class II, class III.

Our study has shown that obesity affected the mode of delivery; cesarean section delivery increases significantly with increase in body mass index.

REFERENCES

1. **Aagaard-Tillery KM, Flint Porter T, Malone FD, Nyberg DA, Collins J, Comstock CH, Hankins G, Eddleman K, Dugoff L, Wolfe HM and D'Alton ME. (2010):** Influence of maternal BMI on genetic sonography in the faster trial. Prenatal Diagnosis, 30(1):14–22.

2. **ACOG Practice Bulletin No 156: Obesity, In: Pregnancy. Obstet Gynecol (2015; 126:e112. Practice Committee of the American Society for Reproductive Medicine. (2015):** Obesity and reproduction: a committee opinion. Fertility and sterility, 104(5), 1116-1126.

3. **Aksoy H, Aksoy Ü, Karadağ Öİ, Yücel B, Aydın T and Babayiğit MA. (2015):** Influence of maternal body mass index on sonographic fetal weight estimation prior to scheduled delivery. Journal of Obstetrics and Gynaecology Research; 41(10):1556-61.

4. **Al-Obaidly, S., Al-Ibrahim, A., Saleh, N., Al-Belushi, M., Al-Mansouri, Z., and Khenyab, N. (2019):** Third trimester ultrasound accuracy and delivery outcome in obese and morbid obese pregnant women. The Journal of Maternal-Fetal & Neonatal Medicine, 32(8): 1275-1279.

5. **Dammer U, Goecke TW, Voigt F, Schmid M, Mayr A, Schild RL, Beckmann MW and Faschingbauer F. (2013):** Sonographic weight estimation in fetuses with breech presentation. Archives of Gynecology and Obstetrics; 287(5):851-8.

6. **Hurt RT, Kulisek C, Buchanan LA and McClave SA. (2010):** The obesity epidemic: challenges, health initiatives, and implications for gastroenterologists. Gastroenterology and Hepatology:6(12):780-792.

7. **Kilani R, Al Eyadeh W, Qasrawi H and Abu Atileh L. (2019):** The accuracy of estimating fetal weight using ultrasound in women with high body mass index Jordan Medical Journal, 53(4), 0446-9283.

8. **Manzanares, S., Gonzalez-Escudero, A., Gonzalez-Peran, E., López-Criado, M., and Pineda, A. (2019):** Influence of maternal obesity on the accuracy of ultrasonography birth weight prediction. The Journal of Maternal-Fetal & Neonatal Medicine,1-6.

9. **Vivek KG, Jacquelyn HA, Timothy HJ, Iruretagoyena I, Kara KH and Kathleen MA. (2019):** Detailed Fetal Anatomic Ultrasound Examination Duration and Association With Body Mass Index. Obstetrics & Gynecology, 134(4): 774-780.

10. **Weichert, J. and Hartge, D. R. (2011):** Obstetrical sonography in obese women: a review. Journal of Clinical Ultrasound, 39(4): 209-216.

تأثير سمنة الأم على تقدير وزن الجنين باستخدام الموجات فوق الصوتية

يحيى عبد السلام وفا، محمد المهندس*، حمادة سيد

قسم التوليد وأمراض النساء، كلية الطب، جامعة الأزهر

قسم التوليد وأمراض النساء، مستشفى الجلاء التعليمى*

خلفية البحث: تعتبر السمنة واحدةً من أخطر تحديات الصحة العامة في القرن الحادي والعشرين. وقد وصلت السمنة إلى مستويات وبائية في جميع أنحاء العالم.

الهدف من البحث: الكشف عن التأثير المحتمل للسمنة لدى الأمهات على دقة وزن الجنين المقدّر من خلال الفحص بالموجات فوق الصوتية في الثلث الأخير من الحمل بفترة قصيرة قبل المخاض ومقارنة دقة التقدير بين الوزن الطبيعي والوزن الزائد والفئة الأولى والثانية من الدرجة الثانية و الفئة الثالثة ممن يعانون من السمنة المفرطة.

الأشخاص و طرق البحث: تم دراسة حالات من السيدات الحوامل فى جنين واحد مع تقدير وزن الجنين بالموجات فوق الصوتية قبل الولادة المخطط لها. وقد تم تصنيف النساء وفقًا لمؤشر كتلة الجسم الحالي إلى خمس فئات: طبيعية (مؤشر كتلة الجسم 18.5-24.9 كجم / م 2، ن = 30)، وزيادة الوزن (مؤشر كتلة الجسم 25.0 - 29.9 كجم / م 2، وعددهن =30)، وفئة السمنة الأولى (مؤشر كتلة الجسم 30.0-34.9 كجم / م 2، وعددهن = 30)، وفئة السمنة 2 (مؤشر كتلة الجسم، 35.0-39.9 كجم / م 2، و عددهن = 30) وفئة السمنة الثالثة الأكبر من 40 كجم/م2، وعددهن= 30). وقد تمت مقارنة الجنين المقدر بالوزن الفعلي للولادة، وتم تسجيل الفرق بينهما.

نتـــائج البحـــث: وجـد فـروق ذات دلالـة إحصـائية بـين الـوزن المقـدر للجنـين عنـد الـولادة بالموجـات فـوق الصـوتية ووزن الـولادة مقابـل مؤشـر كتلـة الجسـم فـي فئة السمنة II وIII.

الاســتنتاج: تقلـل السـمنة لـدى الأمهـات مـن دقـة تقـدير وزن الجنـين بالموجـات فـوق الصـوتية. ويجـب أن يكـون الأطبـاء علـى درايـة بـالقيود المفروضـة علـى تقـدير وزن الجنـين بالموجـات فـوق الصـوتية ، وخاصـة لـدى المريضـات اللاتـي تعانين من السمنة المفرطة.