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Influence of Maternal BMI on the Intra-Observer and Inter-Observer Reliability in Fetal Sonography Obtained Parameters in the Last Trimester of Gestation

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Abstract

Aim: To assess the impact of maternal BMI on the intra-and inter-observer obtained parameters in third-trimester fetal sonography.

Methodology: The current research prospective study, conducted at a tertiary center, recruited Study subjects are range from 35+0 gestational weeks and 36+6 gestational weeks of singleton gestations between 1st of January 2013, and 1st of April 2015 Fetal sonography parameters were assessed twice by a first sonographer and a third time by a second sonography. Intra-and inter-observer reliability were statistically analyzed by means of the Cronbach α reliability coefficient, and parameter reliability was compared with cases categorized by a body mass index (BMI, calculated as weight in kilograms divided by the square of height in meters) under 25 or at least 25.

Results: The research conducted involved 197 gestations (133 cases had a BMI < 25 and 64 cases had a BMI ≥25). Within gestations having a BMI under 25, the reliability coefficients calculated BPD, HC, AC, and FL indices have been 0.97, 0.95, 0.98, and 0.96, correspondingly, for intra-observer reliability, and were 0.97, 0.93, 0.98, and 0.95, correspondingly, for inter-observer reliability. Within gestations having a BMI of at least 25, these calculated indices were 0.97, 0.96, 0.98, and 0.97, correspondingly, for intra-observed reliability, and 0.97, 0.94, 0.98, and 0.96, correspondingly, for inter-observer reliability.

Conclusion: High intra-and inter-observer reliability was displayed for final trimesteric fetal sonography parameters, as well as for gestations that were overweight.

Key words: *Fetal biometric measurements; Intra- and inter-observer reliability; Obesity; Third trimester sonography*

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Introduction

Obesity is a growing issue arising globally; as regards the WHO statistics, 1 above 1.9 billion of adult population have been overweight in 2014 and, of these, above 600 million have been classified as obese. Statistical data obtained from 2011–2014 in the United States displayed that 34.4% of females having an age range of 20–39 years were categorized as obese (body mass index 'BMI', calculated as weight in kilograms divided by the square of height in meters, ≥30) [1]. Obese females during gestation are at raised hazardous risk of maternal and perinatal unfavorable issues during gestation, with the health risks rising in proportion with BMI classes. Ultrasound calculated estimated fetal weight during the last gestational weeks of the final trimester of gestation in low-risk gestations is considered the most efficient tool for clinical diagnoses restrictive fetal growth. On the other hand, there is no agreement on the requirement for everyday 3rd-trimesteric sonographic assessment for the goal to screen for intrauterine restrictive fetal growth pattern for clinically low-risk gestations, and clinical evidence did not display any obtained privilege for maternal–fetal clinically observed outcomes [2].

On the other hand, a previously performed research have demonstrated clearly that the clinical recognition rate for a SGA fetus was greater at 36 weeks of gestation in comparison to 32 weeks (sensitivity: 38.8% vs 22.5%; P = 0.006). Sonographic evaluation and assessment are challenging in performance in cases suffering obesity in comparison to cases having a normal BMI.

A small number of research studies have assessed and evaluated the precision and reliability of sonographic weight calculation in the final gestational trimester in obese females. Additionally, a number of research studies performed, have implied and concluded that the precision of sonographic parameters estimating fetal weight are not affected in significant manner by gestational body mass index while other research groups have implied and came to a conclusion that gestational obesity reduced the precision of estimated fetal weight by ultrasound [3-5].

The goal of the current research study was to assess and evaluate intra- and Inter-observer reliability of 3rd trimester sonographic fetal biometric parameters and to compare it statistically in gestations having normal BMI and those who were overweight.

Methodology

The current research cohort study was conducted at the Obstetrics and Gynecology Fetal Medicine Unit, Ain Shams Maternity University Hospital, and recruited cases for the research was between 1st of January 2013, and 1st of April 2015. Cases had previously scheduled visits at between 35+0 and 36+6 gestational weeks of a clinically low-risk singleton gestation and arranged to go through 3 sonographic assessments on the same working day were included in the research. Existence of maternal diseases or observed fetal anomalies were exclusive research criteria. The research was permitted by the Ain Shams maternity Hospital ethical committee and an informed written consent have been obtained from every study subject before recruitment.

Maternal age at time of recruitment, parity, body mass index, and waist circumference were obtained. BMI was obtained by using maternal height and weight measurements from the start of gestation; these parameters and indices were gathered from hospital clinical records. Maternal waist circumference was obtained at 35+0–36+6 gestational weeks by the nearest 1 mm by using a flexible tape for measurement. The obtained primary outcome was the reliability of measured fetal BPD, HC, AC, and FL sonographically obtained parameters (GE Voluson E8 with a 3.5-MHz Transducer; GE Healthcare, Wauwatosa, WI, USA).

All parameters were obtained and performed by conventional methods [10,11] with fetal structures of concern occupied at minimum 30% of the sonographic monitor. Fetal BPD and HC were measured using an axial plain of the fetal brain at the trans thalamic level, with an angle of intonation as near to 90° as possible. Head measurements were performed using the trans thalamic plane; previous research and clinical evidence have revealed that, especially in late gestation, this sonographic plane is much easier to recognize and permit more reliable indices to be obtained in comparison to the trans ventricular sonographic plane.

The fetal head had to be oval in shape, symmetrical, and centrally positioned for performing the sonographic measurements. The falx cerebri had to be interrupted anteriorly, at 1/3 its length, by the cavum septum pellucidum. BPD was obtained by outer-to- Inner placement of caliper at the widest portion of the fetal skull. A reliability research study [6-8] has displayed that both outer-to- Outer and outer-to- Inner parameters are equivalent.

The outer-to- inner method was performed in the current research to prevent the creation of sonographic artifacts by the distal echo of the fetal skull. The measuring of the fetal AC was made from a cross-sectional plane of the abdomen as near as possible to circular shape, at the plane were the bifurcation of the main portal vein is revealed, and with the fetal stomach noticeable. Both HC and AC have been measured using the ellipse tool on the outer margins of the fetal skull and abdomen, correspondingly. No manual tracing sonographic tool have been used.

Femur length have been measured using a longitudinal plane of the fetal thigh as near as possible to the probe, each parameter was assessed twice by the first sonographer and a third time by a second sonographer who was masked from the first sonographer's obtained indices. There were five sonographers in the research two of them were consultants. Harmony between and among sonographers was statistically analyzed using the Pearson correlation coefficient and the Cronbach α reliability coefficient.

A statistically obtained value above 0.75 was considered to indicate reliable consensus for the coefficients. Measurements reliability was assessed using the Cronbach α coefficient. The intra-and inter-observer measurements were put in comparison within subcategories of cases depending on maternal BMI; cases were categorized using BMI values below 25 or BMI values of 25 at least, and statistical comparisons were performed between the research categories using the paired-sample t test. A P value <0.05 was considered statistically significant.

Results

Variables		Values
Maternal age		29.7+/-5.5
parity	nulliparous	121 (61.4)
multiparous		76 (38.6)
BMI at beginning of pregnancy		23.8 ± 4.5
BMI group		
Low weight (<18.5)		18 (9.1)
Normal weight (≥ 18.5 and <25)		115 (58.4)
Excess weight (≥25 and <30)		44 (22.3)
Obese (≥30)		20 (10.2)
Maternal weight gain at ultrasonography Kg		11.4 ± 4.9
Maternal waist circumference at ultrasonography, cm		104.1±8.5
Pregnancy duration at ultrasonography, wk		36

Table 1: *Abbreviation: BMI, body mass index.*

A Values are given as mean ± SD, number (percentage), or median.
B Compared with pre-pregnancy weight.

Maternal age mean +/- SD = 29.7+/-5.5yrs, BMI at beginning of pregnancy mean +/- SD = 23.8 ± 4.5, 9.1% of cases are low weight, 58.4% are normal weight, 22.3% are excess weight, 10.2% are obese.

Parameter	Intra-observer reliability		Inter-observer reliability	
	Pearson correlation coefficient (95% CI)	Cronbach α reliability coefficient	Pearson correlation coefficient (95% CI)	Cronbach α reliability coefficient
BMI <25				
BPD	0.94(0.92-0.96)	0.97	0.94(0.92-0.96)	0.97
HC	0.91(0.88-0.94)	0.95	0.87(0.82-0.90)	0.93
AC	0.96(0.95-0.97)	0.98	0.97(0.95-0.98)	0.98
FL	0.92(0.89-0.92)	0.96	0.91(0.87-0.93)	0.95
BMI ≥25				
BPD	0.94(0.91-0.97)	0.97	0.95(0.91-0.97)	0.97
HC	0.93(0.89-0.96)	0.96	0.89(0.82-0.93)	0.94
AC	0.96(0.93-0.98)	0.98	0.97(0.95-0.98)	0.98
FL	0.94(0.90-0.96)	0.97	0.92(0.87-0.95)	0.96

Table 2: *Intra-and inter-sonographer correlation and reliability of fetal sonographic parameters, stratified by early-pregnancy BMI.*

Abbreviations: BMI: Body mass index; CI: Confidence interval; BPD: Bi-parietal diameter; HC: Head circumference; AC: Abdominal Circumference; FL: Femur length

Intra observer reliability for BMI Below 25 was 0.97, 0.95, 0.98, 0.96 for BPD, HC, AC, FL consecutively and concerning inter observer reliability was 0.97, 0.93, 0.98, 0.95 for BPD, HC, AC, FL respectively.

Finally Intra observer reliability for BMI above or equal 25 was 0.97, 0.96, 0.98, 0.97 for BPD, HC, AC, FL consecutively and concerning inter observer reliability for BMI above or equal 25 was 0.97, 0.94, 0.98,0.96 for BPD, HC AC, FL subsequently.

Parameters	Intra –observer reliability		Inter-observer reliability	
	Pearson correlation coefficient (95% CI)	Cronbach α reliability coefficient	Pearson correlation coefficient (95% CI)	Cronbach α reliability coefficient
Maternal waist circumference <104 cm				
BPD	0.94(0.91-0.96)	0.97	0.93(0.90-0.95)	0.96
HC	0.89(0.84-0.93)	0.94	0.88(0.82-0.92)	0.93
AC	0.94(0.92-0.96)	0.97	0.95(0.93-0.97)	0.98
FL	0.93(0.90-0.95)	0.97	0.90(0.86-0.94)	0.95
Maternal waist circumference ≥104 cm				
BPD	0.94(0.91-0.96)	0.97	0.95(0.92-0.96)	0.97
HC	0.93(0.90-0.95)	0.97	0.85(0.78-0.90)	0.92
AC	0.97(0.95-0.98)	0.98	0.97(0.96-0.98)	0.99
FL	0.92(0.89-0.95)	0.97	0.92(0.88-0.94)	0.96

Table 3: *Intra-and inter-sonographer correlation and reliability of fetal sonographic parameters, categorized by maternal waist circumference at time of sonography.*

Abbreviations: CI: Confidence interval; BPD: Bi-parietal diameter; HC: Head circumference; AC: Abdominal circumference; FL: Femur length

Intra observer reliability for maternal waist circumference below 104 cm for BPD, HC, AC, FL was 0.97, 0.94, 0.97, 0.97 consecutively, and for waist circumference above or equal 104 cm concerning fetal biometric parameters BPD, HC, AC, FL was 0.97, 0.97, 0.98, 0.97 consecutively.

Inter observer reliability for maternal waist circumference below 104 cm for fetal bio metric parameters BPD, HC, AC, FL was 0.96, 0.93,0.98 ,0.95. Finally inter observer reliability for maternal waist circumference above or equal 104 cm for fetal biometric parameters BPD, HC, AC, FL was 0.97, 0.92, 0.99, 0.96.

Comparison Groups	Comparison of mean differences (P value) a			
	BPD	HC	AC	FL
Intra-observer difference for patients with BMI <25	0.10	0.23	0.89	0.11
Intra-observer difference for patients with BMI ≥25	0.82	0.96	0.48	0.65
Inter-observer difference for patients with BMI <25	0.21	0.21	0.33	0.33
Inter-observer difference for patients with BMI ≥25	0.72	0.59	0.26	0.48
Intra-observer difference for patients with MWC <104 cm	0.16	0.13	0.75	0.17
Intra-observer difference for patients with MWC ≥104 cm	0.45	0.81	0.28	0.38
Inter-observer difference for patients with MWC <104 cm	0.25	0.77	0.37	0.12
Inter-observer difference for patients with MWC ≥104 cm	0.96	0.45	0.47	0.86

Table 4: *Differences in mean regarding intra-sonographer and inter-sonographer fetal parametric indices.*

Abbreviations: BMI: Body mass index; BPD: Bi-parietal diameter; HC: Head circumference; AC: Abdominal circumference; FL: Femur length; MWC: Maternal waist circumference; A: Paired-ample t test.

There was no statistical significant differences intra observer differences for BMI below 25 (p values = 0.10, 0.23, 0.89, 0.11 concerning BPD, HC, AC, FL Consecutively) and BMI above and equal to 25 (p values = 0.82, 0.96, 0.48, 0.65) as regards BPD, HC, AC, FL Consecutively).

Additionally there was no statistically significant differences inter observer difference for cases BMI below 25 (p values = 0.21, 0.21, 0.33, 0.33) and BMI above or equal 25 (p values = 0.72, 0.59, 0.26, 0.48). On the other hand there was no statistically significant difference as regards intra observer difference in patients having maternal waist circumference below 104 cm (p values = 0.16, 0.13, 0.75, 0.17 for BPD, HC, AC, FL Consecutively) and maternal waist circumference above or equal 104 cm (p values = 0.45, 0.81, 0.28, 0.38 for BPD, HC, AC, FL Consecutively).

On the other hand there was no statistically significant difference as regards inter observer difference for cases with maternal waist circumference below 104 cm (p values = 0.25, 0.77, 0.37, 0.12 for fetal parameters BPD, HC, AC, FL subsequently) and for maternal waist circumference equal or above 104 cm (p values = 0.96, 0.45, 0.47, 0.86 for fetal biometric parameters BPD, HC, AC, FL consecutively).

Discussion

The current research study is performed in a prospective observational manner assessing the reliability of fetal sonographic parameters within gestations at 35+0 to 36+6 weeks of gestational age. The 4 mainly performed fetal Parameters (Bi-parietal diameter, head circumference, abdominal circumference, and femur length) displayed outstanding intra-and inter-sonographer concurrence, even those gestations that were overweight. Evidence from previous research and meta-analyses performed.

Did not display that practice third-trimesteric screening for intra uterine growth restriction within low-risk gestations improve maternal and fetal clinical outcomes in comparison with clinical assessment alone? It could be debated that the conclusions of these research studies have limited up to date power due to the application of old-fashioned protocols for fetal growth assessment, and old sonographic machines, where clinical diagnosis of intra uterine fetal growth restriction did not influence in case management [9-11].

On the other hand, nonperformance of a final-trimester sonographic assessment, undiagnosed intra uterine growth restriction could cause a fetus having placental insufficiency not to survive gestation up to 41 gestational weeks and the requirements of delivery at this gestational age, raising the hazardous risk of unfavorable clinical obstetric outcomes [12,13].

Additionally, conversely to early clinical-onset of intra uterine fetal growth restriction, where the major issue is management protocol, the chief clinical challenge for late onset intra uterine fetal growth restriction is proper diagnosis since a mature fetus has a decreased capacity to tolerate hypoxic issues and a very brief zone of time for clinical identification of this issue [13]. Given these opposing clinical issues, more studies and comprehensive research on the value and precision of a regular third-trimesteric sonography in low-risk gestations is required.

In harmony with updated research data signifying that the discovery of intrauterine fetal growth restriction was more at 36 weeks of gestation in comparison with 32 gestational weeks [4], the current research study performed evaluated the intra-and inter-sonographer reliability of fetal parametric indices at 35+0 to 36+6 gestational weeks [1-3]. Additionally, there is also debate concerning the precision of sonographic fetal weight estimation in the final trimester of gestation in cases with high body mass index in comparison with those with lower body mass index; in the current research, the reliability of sonographic indices was evaluated within gestations of various BMI categories in an approach to confirm third-trimesteric sonographic evaluation in this cohort of recruited cases.

Although various research groups assessed the mean error amongst fetal weight estimation from third trimesteric sonography, the currently performed research was, one of the best according to our knowledge, one the first to assess the reliability of third-trimesteric fetal parameters by sonographic measurements within cases with high body mass index in comparison with gestations having normal body mass index [4,6].

A prior research performed assessed the reliability of sonographic parameters in a group of gestations with a broad range of gestational durations. Preceding research performed have mentioned and concluded that the accurateness of sonographic assessment reduces progressively as gestational period increases, and that this decline in accuracy is greater at raised body mass index. The currently performed research study had the privilege of focusing the research analyses to a short gestational-time interval.

At 35+0 to 36+6 gestational weeks of pregnancy, high intra-and inter-sonographer reliability and precision was displayed, with statistical correlation coefficients above 0.9 for almost all fetal biometric parameters, independent of gestational weight and abdominal

circumference of recruited case [7,9]. It has been implied that a thicker maternal abdominal wall is correlated with reduced possibility of finishing a sonographic assessment in a pregnant female who is suffering obesity, and with low quality sonographic image.

The absorption of ultrasound waves by subcutaneous tissue makes sonography more complex. Maternal gestational waist circumference could be a clinical tool of greater abdominal wall fat content and consequently thickness. Lately, it was concluded that maternal waist circumference measurement could be predictability parameter of sonographic fetal weight estimation failure, and 105 cm was mentioned in previous research studies as an efficient cut-off measurement having 70% statistical sensitivity and 61% statistical specificity.

However, it is concluded by our research group that fetal biometric parameters were highly reliable in both research case categories with higher and lower maternal abdominal waist circumferences. In harmony with other research studies that have concluded high-quality precision with sonography performed by obstetric residents and inexperienced sonographers, was high as regards fetal measured parameters was displayed in the current research performed by non-experienced sonographers [10-13].

Our research group came to a conclusion, the current research displayed high intra-and inter- sonographer reliability of third-trimester fetal sonographic parametric indices, involving within cases that are overweight.

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