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Original Research Article

Influence of body mass index on clinical estimation of fetal weight

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ABSTRACT

Background: Estimation of fetal weight is essential for prenatal care and delivery management. Clinical methods, such as symphysiofundal height (SFH) assessment, and ultrasound-based techniques are commonly used for this purpose. Maternal body mass index (BMI) can influence fetal weight estimation accuracy, particularly in obese patient. In periphery where ultrasound facilities are not available clinical estimation of fetal weight plays very important role in antenatal care. This study was aimed to examine the impact of maternal BMI on the accuracy of clinical fetal weight estimation.
Methods: This cross-sectional study included 800 pregnant women. Anthropometric measurements were collected, including weight, height, SFH, abdominal girth, and double abdominal fold thickness (DAFT). Fetal weight was estimated using clinical methods and compared with actual birth weight. Statistical analysis was performed using statistical package for the social sciences (SPSS) version 26.0.
Results: Participants had a mean weight of 46.4 kg, height of 154.5 cm, and body mass index of 19.4 kg/m^2. SFH×AG method yielded a mean birth weight estimation of 3.0 kg with an absolute error of 136 grams, while Johnson's formula estimated 3.3 kg with an absolute error of 478 grams. double abdominal fold thickness measurements also showed variations in fetal weight estimation accuracy across different ranges. It was observed that as body mass index increased, the absolute error also increased. It was also noted that the SFH×AG formula was more accurate compared to Johnson's formula.
Conclusions: Relying solely on clinical estimation of fetal weight, especially in mothers with high body mass index, may be limited in accuracy. The SFH×AG method outperformed Johnson's formula, particularly in cases influenced by body mass index. Complementary methods, such as ultrasound-based techniques, are recommended to enhance accuracy, especially in obese pregnant women.

Keywords: Fetal weight estimation, Symphysiofundal height, Maternal body mass index, Clinical methods, Ultrasound, Prenatal care

INTRODUCTION

Estimation of fetal weight is crucial in prenatal care, labor planning, and delivery management.[1,2] To enhance the precision of prenatal fetal weight estimations and optimize the selection of delivery mode, additional tools that complement ultrasound are required. The primary ultrasonic methods for fetal weight calculation rely on measuring the fetal abdominal circumference (AC) and estimated fetal weight (EFW) using the Hadlock et al formula which has recently demonstrated sufficient accuracy.[3-5] Experienced clinicians can provide a clinical estimation of fetal weight following Leopold's manoeuvres, incorporating symphysis-fundal height and abdominal palpation.[1] Studies have indicated that clinical estimation, particularly through the symphysiofundal height (SFH) multiplied by abdominal girth (SFH×AG) method, is comparable in accuracy to routine ultrasound estimation of average birth weight. However, ultrasound procedures necessitate sophisticated equipment, rendering them costly in low-resource settings, particularly rural areas.[6,7] In this context, the SFH×AG clinical formula holds significant value, particularly in developing countries where ultrasound availability in healthcare centers is limited. Maternal body mass index (BMI) has been identified as a factor influencing the accuracy of EFW.[8] Clinicians should be mindful of the limitations of sonographic fetal weight estimation, particularly in obese patients, as maternal BMI influences sonographic fetal weight estimation before scheduled delivery. Measurement deviation tends to be greater in pregnant women with a BMI ≥25 underscoring the importance of considering maternal BMI in pregnancy and fetal weight estimation.[9,10] Accurate estimation of fetal weight is pivotal for proficient antenatal care and labor management. In light of limited ultrasound access in certain regions, this study delves into the potential of clinical assessment and scrutinizes the effect of maternal BMI on the accuracy of fetal weight estimation. Our research aims to elucidate the critical clinical implications of maternal BMI on the clinical estimation of fetal weight.

METHODS

The study employed a cross-sectional design and was conducted at Lady Goschen Hospital, Kasturba Medical College, Mangalore over the course of one year from 01 March 2015 to 01 March 2016. The sample size comprised 800 individuals. Methodologically, data collection involved retrieving necessary information from antenatal records and conducting clinical examinations upon admission. Pre-pregnancy weight was calculated based on documented weight during the first trimester to determine BMI, while the height of the mother was measured upon admission. Subsequently, various measurements including SFH, abdominal girth, and double abdominal fold thickness (DAFT) were taken utilizing specific techniques. Estimated fetal weight was calculated using SFH multiplied by abdominal girth through Johnson's formula. Additionally, actual fetal weight was measured using an electronic weighing machine, enabling a comparison between the estimated and actual birth weight of the baby across different BMI categories.

Inclusion criteria encompassed all live births, fresh stillbirths, and cephalic presentations beyond 28 weeks, while exclusion criteria included factors such as abnormal lie, multiple gestation, and various conditions affecting pregnancy.

Fetal weight estimation by clinical methods

SFH×AG estimated fetal weight can be obtained by measuring syphysiofundal height×abdominal girth.[11,12]

Sonographic estimation: fetal weight can be deduced by taking average of fetal parameters BPD AC FL HC.[13]

Palpation method/tactile techniques: oldest method of assessment of fetal dimensions by palpation the maternal abdomen.[14-16]

Using Down formula, fetal weight was calculated in grams, where DAFT is greater than or equal to 3 cm maternal weight <50kg with cephalic presentation, L: fundal height, and T: maximum trans diameter of gravid uterus below the fundus measured abdominally by polarimeter.[17,18]

$$Fetal\ weight\ in\ grams = L \times (T/2)^2 \times 144$$

Using Johnson’s formula, EFW was calculated, where X – presenting part not engaged 13, X- presenting part at zero SF 12, and X- presenting part at zero +1.[19,20]

$$EFW = (SF\ X - X) \times 155$$

Statistical analysis

The data obtained from the study underwent statistical analysis using statistical package for the social sciences (SPSS) version 26.0, with significance level set at p value=0.05. Continuous variables were presented as mean±standard deviation, while categorical variables were expressed as frequencies. The analysis of continuous data involved employing both analysis of variance (ANOVA) tests, followed by post-hoc tests for multiple group comparisons, as well as student's t-tests for pairwise comparisons.

RESULTS

In the present study, we enrolled 800 pregnant women, and their anthropometric measurements encompassed various physical characteristics. On average, participants weighed 46.4 kilograms and stood at a height of 154.5 centimeters. The calculated mean BMI was 19.4 kg per square meter, reflecting the overall body composition of the participants. SFH, a crucial obstetric measurement, averaged at 33.5 cm, providing insights into fetal growth. Additionally, the mean AG measured 89 cm, while the DAFT averaged 2.3 cm, offering further information on subcutaneous fat distribution (Table 1).

Table 1: Anthropometric parameters of study population (n=800).

Anthropometrics	Mean
Weight (kg)	46.4
Height (cm)	154.5
Body mass index (kg/m)	19.4
Sympysiofundal height (cm)	33.5
Abdominal girth (cm)	89
Double abdominal fold thickness (cm)	2.3

The majority of the women were primigravida (63.70%), followed by multigravida (36.30%) (Figure 1). When comparing clinical methods for fetal weight estimation, discrepancies were observed. The SFH×AG method yielded a mean birth weight estimation of 3.0 kg, with an absolute error of 136 gm and an absolute percent error of 5.20%. Conversely, Johnson's formula estimated a mean birth weight of 3.3 kg, exhibiting a larger absolute error of 478 gm and a higher absolute percent error of 13.90%. Notably, the actual birth weight, serving as the gold standard, was 2.8 kg, highlighting the importance of accurate estimation techniques in prenatal care (Table 2).

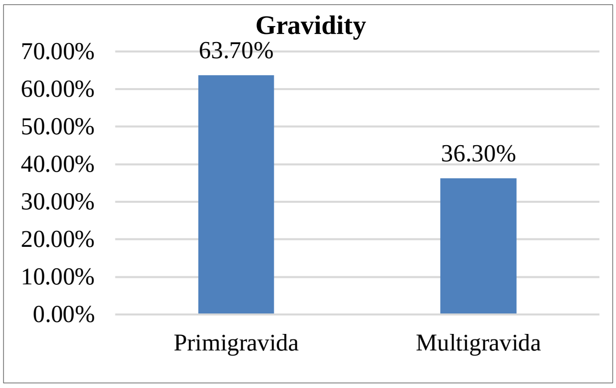

Figure 1: Gravidity distribution among study population.

Table 2: Comparison of clinical methods for fetal weight estimation.

Clinical methods	Mean birth weight (kg)	Absolute error (gm)	Absolute percent error (%)
SFH×AG	3.0	136	5.20
Johnson's formula	3.3	478	13.90
Actual birth weight	2.8	-	-

Absolute percent error of Johnson's formula in fetal weight estimation was recorded higher in obese participants (25.30%) (Figure 2). The distribution of BMI categories within the study population revealed varying frequencies across different weight ranges (Table 3). Among participants classified as underweight, comprising 330 individuals, the SFH×AG method demonstrated average absolute error less than Johnson's formula. These findings underscore the importance of considering BMI in fetal weight estimation, as it significantly influences the accuracy of different clinical methods (Table 4). Further analysis of DAFT categories in relation to fetal weight estimation methods illustrated noteworthy variations in mean birth weight and Johnson's formula estimates across different DAFT ranges (Table 5). Absolute error was depicted in Figures 3 and 4, highlighting the importance of considering DAFT measurements in fetal weight estimation, as they significantly influence the accuracy of predictive formulas. Lastly, the correlation between BMI categories and DAFT ranges revealed distinct patterns within the study population, suggesting potential correlations between adiposity levels and abdominal fold thickness. These findings provide valuable insights into the factors influencing fetal weight estimation accuracy and underscore the importance of comprehensive assessments in prenatal care (Table 6).

Table 3: Distribution of BMI categories and corresponding DAFT values in the study population.

BMI (kg/m^2)	Frequency	DAFT value (cm)
Underweight (<18.5)	330	2.0
Normal (18.5-24.9)	435	2.4
Overweight (25-29.9)	32	3.4
Obese (>30)	3	4.3

Table 4: Comparison of absolute errors in fetal weight estimation methods across BMI categories.

BMI	Frequency	Absolute error (gm)	
		SFH×AG	Johnson's formula
Underweight	330	74	509
Normal	435	154	449
Overweight	32	441	526
Obese	3	736	820

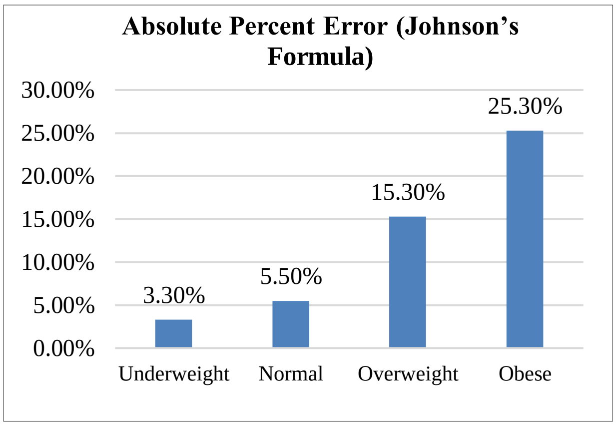

Figure 2: Absolute percent error of Johnson's formula in fetal weight estimation across BMI categories.

Table 5: Absolute error of Johnson's formula and SFH×AG in fetal weight estimation across DAFT categories.

DAFT	Frequency	Percent	Mean birth weight (gm)	SFH×AG	Johnsons formula
<2.5	591	74	2799	2927	3291
2.5-3.5	161	20.20	2799	3159	3457
>3.5	48	5.80	2800	3398	3565

Table 6: Correlation between BMI and daft categories among study participants.

BMI	DAFT (%)			
	<2.5	2.5-3.5	>3.5	Total
Underweight	286 (48.4)	4 (25.5)	3 (6.3)	330 (41.3)
Normal	300 (50.8)	106 (65.8)	29 (60.4)	435 (54.4)
Overweight	8 (0.8)	13 (8.1)	14 (29.2)	32 (4.0)
Obese	0 (0.0)	1 (6)	2 (4.2)	3 (0.3)
Total	591 (100)	161 (100)	48 (100)	800 (100)

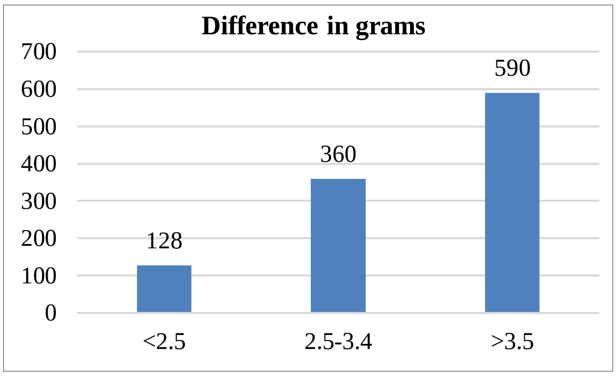

Figure 3: Distribution of error (gm) with respect to DAFT (SFH×AG).

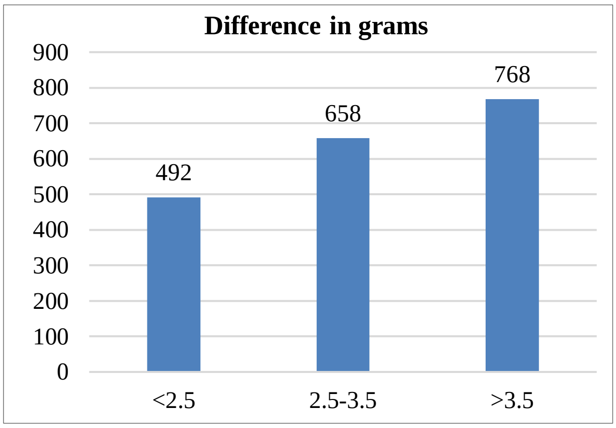

Figure 4: Distribution of error (gm) with respect to DAFT (Johnson's formula).

DISCUSSION

Ultimate aim in obstetric practice is delivery of a healthy infant with least amount of maternal morbidity. Survival of infant in outside world would then depend on factors such as gestational age and birth weight, Birth weight can be estimated antenatally. In our study it was found that product SFH×AG gives us fairly accurate estimation when compared to Johnson's formula. since the present study deals with influence of BMI on clinical estimated fetal weight, it may be possible to assess influence of BMI on various formulas and thereby pave the path for identifying a correction factor, if possible, in the formula in order to reduce the error in estimation of fetal weight.[14] Our study group included 800 parturient and included both primigravida 63.7% and multis 36.3% mean actual birth weight 2.8 kg. The mean error was over estimation of birth weight by 136 gm and 478 gm by SFH×AG and Johnsons respectively. As seen with average mean error, percentage error was lower in our study compared to previous studies. Dahiya et al conducted a study in our hospital on 200 primigravida with cephalic presentation compared estimation of fetal weight using Dawns, SFH×AG and ultrasonography (USG). They estimated a mean error of 224 grams According to SFH×AG.[18] According to Watchree Numprasert, mean error was overestimation by 227 grams.[20] According to Carranza et al, mean error was 289.4 gm.[21] Our interest in over or underestimation of birth weight stemmed from the fact that there is divided view in literature regarding this. It was universally seen that clinical estimation based on maternal abdominal measurements had a tendency mostly to overestimate the infants birth weight. Our study confirms this and this is one of the drawbacks of the study as overestimation was seen in 100% of study group, but however overestimation of fetal weight has been suggested to be an advantage as it nudges the obstetrician to be more cautious but it may be a disadvantage in lower birth weight groups, where we may be mistaken in forecasting the prognosis in the neonatal period. In our study we found that as BMI increases the error associated with the formula increases. however, SFH×AG was found to be more accurate than Johnson's formula.[17] Absolute error and absolute percent error being 136 gm, 5.2% and 478 gm, 13.9% with SFH×AG and Johnsons respectively. Through this study we also tried to find out if there is any relation between DAFT and the formulas used for clinical estimation of fetal weight. It was seen that as DAFT increases the error associated with formula also increases the error is more with Johnsons when compared to SFH×AG. But DAFT has no influence on true birth weight. i.e., increase in DAFT is not associated with increase in true birth weight.[18] Further the study was extended to see if there is any relationship between DAFT and BMI some mothers who were underweight had DAFT >2.5 cm with some overweight and obese had normal BMI and DAFT <2.5 cm. As the correlation between BMI and DAFT was 46% we could not arrive at a common correction factor so as to minimize the error with the formula. As the purpose of this study was to know the influence of BMI on clinically estimated fetal weight, both the formulas overestimated the birth weight hence by subtracting the error for the corresponding BMI we can minimize the error.

Limitations

Estimating fetal weight is very important in obese women due to the increased risk of diabetes, macrosomia, shoulder dystocia, and perioperative complications from caesarean delivery. Although This study did not address the relative accuracy of clinical estimated fetal weight compared with ultrasound-estimated fetal weight in obese women, our study did demonstrate that the clinical estimated fetal weight accuracy is reduced in obese women. Since prior studies have demonstrated no reduced ultrasound estimated fetal weight accuracy in obese women, it may be reasonable to obtain an ultrasound-estimated fetal weight on all obese women at term, to better inform them of the relative risks of vaginal and caesarean delivery.[20] If feasible, this should be done within one week of delivery.[18] It's important to note that this study is single-centric, which may limit the generalizability of the findings to broader populations. Therefore, future research should consider multi-center studies to validate these findings across diverse demographic and geographic settings, thus strengthening the evidence base for clinical decision-making in antenatal care.

CONCLUSION

The findings from this study emphasize the limitations of relying solely on clinical estimation of fetal weight, particularly in pregnant mothers with high BMI, who constitute a significant percentage of the study cohort. Despite its widespread use, clinical estimation alone may not provide completely reliable results, especially in populations with higher adiposity levels. This underscores the need for complementary methods, such as ultrasound-based techniques, to enhance accuracy in fetal weight estimation, particularly in obese pregnant women.

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