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**Original Research Article**

# Clinical method of foetal weight estimation: a comparable alternative to ultrasound method in a low resource setting

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## ABSTRACT

**Background:** Foetal weight estimation is of utmost importance to obstetricians in the management of pregnant women during the antenatal and intrapartum period. This study aimed at determining reliable method of foetal weight estimation, (sonographic or clinical), that closely predicts the actual birth weight in booked pregnant women in Lafia, North Central, Nigeria.
**Methods:** It was a cross-sectional comparative study carried out among 259 pregnant women recruited by consecutive sampling from September 2019 to January 2020 in the antenatal and labour wards of the hospital. The Dare's formula was used to estimate the clinical foetal weight of the participants while the ultrasound foetal weight was estimated using the Hadlock 3 formula (BPD, AC and FL). The actual birth weight of each neonate was measured using the standardized Waymaster digital weighing scale. Qualitative variables were presented in means, median and standard deviation. Categorical variables were presented in frequencies and percentages. The absolute errors were tested with Chi square, paired t test, Mann Whitney U and Spearman's rank correlation. A p<0.05 considered statistically significant.
**Results:** The mean actual birth weight of neonates was 3074.5±398.4g. The results did not show any significant difference in the mean of estimated foetal weights using ultrasound and clinical methods when compared with the actual birth weights.
**Conclusions:** There was no significant difference between the mean weight obtained through clinical and ultrasound estimation and actual birth weight. Clinical foetal weight estimation is as reliable as ultrasound weight estimation.

**Keywords:** Ultrasound, Clinical, Foetal weight, Birth weight, Lafia

## INTRODUCTION

Foetal weight estimation is of utmost importance to obstetricians in the management of mothers during pregnancy and delivery. It is a vital and universal part of management of high-risk pregnancies and growth monitoring in antenatal care.[1] Foetal growth is the end product of a variety of genetic, maternal, foetal, and placental factor with maternal size being a dominant determinant of birth weight. High rate of perinatal mortality is still a major cause of concern in developing countries like Nigeria with a large proportion of this problems related to birth weight which remains the single most important parameter that determines neonatal survival.[1,2] The two main methods of foetal weight estimation in current obstetric practice are; the clinical method which is based on abdominal palpation of foetal parts and calculations based on fundal height; and the sonographic measures of skeletal foetal parts, which are then inserted into regression equations to derive estimated foetal weight.[3] Some investigators consider sonographic estimates to be superior to clinical estimates, others in comparing both techniques confer similar levels of accuracy.[4-6]

The presence of ultrasound scan in most rural facilities is not common and some centres still depend on clinical methods to estimate foetal weight in Nigeria. This study seeks to provide evidence whether the use of ultrasound is justified in estimating foetal weight and consequently whether the financial and physical stress faced by these women in order to determine the foetal weight is justified.

## METHODS

The sample size was determined using the Fischer's formula.[7] A prevalence of 80% based on a south west Nigeria study was used with a 5% attrition value added.[6] Two hundred and fifty-nine women at term who fulfilled the inclusion criteria were recruited by consecutive sampling method from September 2019 to January 2020 at DASH, Lafia North Central Nigeria. The inclusion criteria include mothers with singleton term pregnancies admitted for either normal vaginal delivery, induction of labour or caesarean section. The exclusion criteria include: maternal obesity (absolute weight >90 kg), unbooked women, polyhydramnious/oligohydramnious, preterm labour, ruptured membranes, abnormal lie, multiple pregnancies, ante partum haemorrhage and preeclampsia/eclampsia. They also included obvious congenital anomaly, intrauterine growth restriction, fetal death and uterine fibroids. Ethical clearance was obtained from the ethical committee of DASH. Informed consent was obtained from participants and a proforma was filled for them. Dare's formula was used for the clinical estimation while the sonographic foetal weight estimation was done using real time ultrasound with 3.5 MHz abdominal sector transducer with the Hadlock 3 method (BPD, AC and FL).[8] The birth weights of the babies were measured in the labour ward using a standard digital Waymaster scale (England) after correcting for zero error for each use to ensure reliability of measurement.

## RESULTS

Table 1 shows maternal and infant demographic and clinical profile. The mean maternal age was 28.4±5.3 years (95% CI: 27.7-29.0 years) with a range of 19-41 years. Majority of the women fell between 25-34 years represented by 163 (62.9%); 67 (25.9%) were less than or equal to 24 years and 29 (11.2%) between ages 35-44 years. The differences in the age distribution were statistically significant (p<0.0001). The mean gestational age at presentation was 38.0±0.9 weeks (95% CI: 37.8-38.1 weeks) with a range of 37.0-41.0 weeks. The mean gestational age at delivery was 38.7±0.9 weeks with a range of 37.0-41.0 weeks mean parity was 3.0±1.9 (95% CI:2.7-3.2), with the range of 0-6. Thirty-four (13.1%) of the women were nulliparous; 25 (9.7%) primiparous; 158 (59.1%) multiparous and 47 (18.1%) were grand multiparous women. 91% of the women had spontaneous vertex delivery as compared to 9% who delivered through caesarean section (p<0.0001).

The mean actual birth weight of neonates measured within 30 minutes after delivery was 3074.5±398.4 g (95% CI: 3025.8-3132.8 g) with a range of 2200-4200 g. Amongst the neonates, 248 representing 95.8% had normal weight, 6 (2.3%) had low birth weight while 5 (1.9%) were macrosomic (Table 1).

Comparison of the mean of estimated birth weight using ultrasound and clinical method (Dare's method) with that of the actual birth weights is presented in Table 2. The result did not show significant differences in their means. However, for macrosomic babies, the mean differences of weight estimation and actual baby weight were statistically significant (3840.0±114.0; 3980.0±130.4; 4040.0±89.4; p=0.042) representing, the clinical, ultrasound methods of birth weight estimation and actual baby weight respectively.

Furthermore, the data was subjected to a post-hoc test using paired t test to compare the mean foetal estimation between the methods of estimation and the results are presented on Table 3. Overall, it was observed that there was no statistically significant difference in the clinical and ultrasound method of foetal estimation (p=0.921). For babies with low birth weight (<2500 g), there was no significant difference between clinical and ultrasound method of estimation (p=0.897). However, the difference between mean foetal weight estimation using Dare's method and ultrasound method and actual birth weight were statistically significant (Dare's method=0.004; ultrasound method=0.025). For babies with normal birth weight (2500-3999 g), there was statistically significant difference between clinical vs. ultrasound method (p<0.0001) and clinical versus actual weight (p<0.0001) but there was no significant between ultrasound vs. actual method (p=0.734). Similarly, among macrosomic babies (≥4000 g), there was statistically significant difference between clinical versus ultrasound method (p=0.005) and clinical versus actual weight (p=0.003) but there was no significant between ultrasound versus actual method (p=0.070).

Table 4 depicts comparison among different methods of foetal weight estimation with the actual birth weight of neonates. Overall, the mean error % in clinical method using Dare's method was significantly lower than the Ultrasound method of estimation (-1.1±5.6 versus 0.1±4.0; p<0.0001) and the difference in the mean error % was statistically significant. Observably, the proportion of estimates within 10% of actual birth weight in Dare's method though lower than ultrasound method was statistically similar (92.3% versus 97.3%; p=0.557). Also, the result showed a positive strong correlation between actual birth weight in grams and clinical method using Dare's method of foetal weight estimation (r=0.907; p<0.0001) and ultrasound method (r=0.952; p<0.0001). Although, the methods of estimation showed strong correlation, the ultrasound method had a higher correlation.

Although the mean error % for low-birth-weight babies (<2500 g) was lower in the ultrasound method than the Dare's method, the differences in mean was comparable (5.3±2.7 versus 5.6±4.3; p=0.916). Notably, the ultrasound method gave a better precision than the Dare's method but it was not statistically significant (100.0% versus 83.3%; p=0.763). There was a positive moderate to strong correlation between actual birth weight and Dare's method (0.664; p=0.150) and ultrasound method (0.696; p=0.141).

Moreover, for babies with normal weights (2500-3999 g), Dare's method and ultrasound method of foetal weight estimation over-estimated the actual birth weight by varying degrees. The proportion of estimates within 10% of actual birth weight for the ultrasound method (97.2%) was significantly higher than Dare's method (92.3%) but not statistically different p=0.580. The two methods of estimation showed a positive strong correlation with actual birth weight (Dare's method: r=0.897; p<0.0001; ultrasound method: r=0.947; p<0.0001).

For macrosomic babies (≥4000 g), both ultrasound method and Dare's method gave 100.0% estimation within 10% of actual birth weight with a positive moderate to strong correlation with actual birth weights (ultrasound method: r=0.791; p=0.111 and Dare's methods: r=0.725; p=0.165).

**Table 1: Maternal and infant demographic and clinical profile.**

| Variables | Mean±SD | 95% CI | Range | P value |
|---|---|---|---|---|
| **Maternal age (years)** | 28.4±5.3 | 27.7–29.0 | 19–41 | |
| **Maternal age group (years), N (%)** | | | | |
| ≤24 | 67 (25.9) | | | <0.0001**[a] |
| 25–34 | 163 (62.9) | | | |
| 35–44 | 29 (11.2) | | | |
| **Parity, N (%)** | 3.0±1.9 | 2.7–3.2 | 0–9 | |
| Nulliparous | 34 (13.1) | | | <0.0001**[a] |
| Primparous | 25 (9.7) | | | |
| Multiparous | 153 (59.1) | | | |
| Grand multiparous | 47 (18.1) | | | |
| **Mode of delivery, N (%)** | | | | |
| Spontaneous vertex delivery | 235 (90.7) | | | <0.0001**[a] |
| Caesarean section | 4 (9.3) | | | |
| Gestational age at presentation (weeks) | 38.0±0.9 | 37.8–38.1 | 37–41 | |
| Gestational age at delivery (weeks) | 38.7±0.9 | 37.6–38.8 | 37–41 | |
| **Maternal weight (kg/m$^2$), N (%)** | 74.7±8.2 | 73.7–75.7 | 55–89 | |
| Maternal BMI | 26.4±8.2 | 26.2–26.6 | 21.5–32.5 | |
| Normal (18.5-24.9) | 63 (24.3) | | | <0.0001**[a] |
| Overweight (25.0-29.9) | 190 (73.4) | | | |
| Obese (≥30) | 6 (2.3) | | | |
| **Actual birth weight (g)** | 3074.5±398.4 | 3025.8-3132.8 | 2200-4200 | |
| **Birth weight group (g), N (%)** | | | | |
| <2500 | 6 (2.3) | | | <0.0001**[a] |
| 2500–3999 | 248 (95.8) | | | |
| ≥4000 | 5 (1.9) | | | |

[a]Chi square; **differences in distribution statistically significant at p<0.05

**Table 2: Comparison of mean actual birth weight with clinical and ultrasound methods of foetal weight estimation.**

| Classification of actual birth weight (g) | Clinical method, mean±SD (g) | Ultrasound method, mean±SD (g) | ABW, mean±SD (g) | F; P value |
|---|---|---|---|---|
| **Low birth weight (<2500 g) [n=6]** | 2500.0±141.4 | 2491.7±66.5 | 2366.7±81.7 | 3.229; 0.068* |
| **Normal birth weight (2500-3999 g) [n=248]** | 3032.1±358.3 | 3069.6±368.3 | 3072.2±366.8 | 0.940; 0.391* |
| **Macrosomia (≥4000 g) [n=5]** | 3840.0±114.0 | 3980.0±130.4 | 4040.0±89.4 | 4.156; 0.042** |
| **Total [n=259]** | 3035.3±377.8 | 3073.8±392.5 | 3074.5±398.4 | 0.858; 0.424* |

**Statistically significant at p<0.05; F–ANOVA (analysis of variance); N-frequency, SD–standard deviation; ABW-actual birth weight

**Table 3: Post-hoc test comparing methods of foetal estimation and actual birth weight.**

| Actual birth weight (g), method of estimation | <2500 g | 2500-3999 g | ≥4000 g | Overall |
|---|---|---|---|---|
| | P value | | | |
| **Clinical versus ultrasound method** | 0.897* | <0.0001** | 0.005* | 0.921* |
| **Clinical versus actual weight** | 0.004** | <00001** | 0.003** | <0.0001* |
| **Ultrasound versus actual method** | 0.025** | 0.734* | 0.070* | <0.0001* |

**Mean differences statistically significant at p<0.05; *mean differences not statistically significant using paired t test

**Table 4: Comparison of accuracy among the different methods of estimation.**

| Birth weight (g)/category | Clinical method, mean±SD | Ultrasound method, mean±SD | P value |
|---|---|---|---|
| **Overall %** | | | |
| Mean absolute error (g) | 133.4±113.2 | 83.1±85.2 | <0.0001**b |
| Mean % error | -1.1±5.6 | 0.1±4.0 | 0.009**b |
| Mean absolute % error | 4.4±3.7 | 2.8±2.9 | <0.0001** b |
| Estimates within ABW±10% N [%] | 239 [92.3%] | 252 [97.3%] | 0.557* K |
| Correlation coefficient; P | 0.907; <0.0001** c | 0.952; <0.0001** c | |
| **<2500 g** | | | |
| Mean absolute error (g) | 133.3±103.2 | 82.5±86.1 | 0.937*b |
| Mean % error | 5.6±4.3 | 5.3±2.7 | 0.916** a |
| Mean absolute % error | 5.6±4.3 | 5.3±2.7 | 0.916** a |
| Estimates within ABW±10% | 5 [83.3%] | 6 [100.0%] | 0.763*K |
| Correlation coefficient | 0.664; 0.150*c | 0.696; 0.141*c | |
| **2500–3999 g** | | | |
| Mean absolute error (g) | 133.1±114.0 | 82.5±86.1 | <0.0001**b |
| Mean % error | -1.2±5.6 | 0.02±4.0 | 0.014** b |
| Mean absolute % error | 4.3±3.7 | 2.7±2.9 | <0.0001** b |
| Estimates within ABW±10% N [%] | 229 [92.3%] | 241 [97.2%] | 0.580* K |
| Correlation coefficient | 0.897; <0.0001**c | 0.947; <0.0001**c | |
| **≥4000 g** | | | |
| Mean absolute error (g) | 200.0±70.7 | 60.0±77.2 | 0.016**b |
| Mean % error | -5.0±1.8 | -1.5±1.4 | 0.017** b |
| Mean absolute % error | 5.0±1.8 | 1.5±1.4 | 0.017** b |
| Estimates within ABW±10% N [%] | 5 [100.0%] | 5 [100.0%] | - |
| Correlation coefficient | 0.725; 0165* c | 0.791; 0.111* c | |

a-Paired t- test, b-Mann Whitney U; c-Spearman's rank correlation; K-Chi square; ABW-actual birth weight, *differences not statistically significant (p>0.05); **differences statistically significant (p<0.05)

## DISCUSSION

The mean maternal age was 28.4±5.3 years (95% CI: 27.7-29.0 years) ranged 19-41 years. Majority of the women fell between 25-34 years. The differences in the age distribution was statistically significant (p<0.0001). This is lower than the mean maternal age of 30.5±4.7 reported by Shittu et al.[9] This difference may be due to cultural and religious differences (early marriage) between the South West and the North central regions of Nigeria.

The mean gestational age at presentation was 38.0±0.9 weeks (95% CI: 37.8-38.1 weeks) with a range of 37-41 weeks. This is similar to the mean gestational age at presentation of 38.6±1.3 weeks reported by Shittu et al.[9]

Mean parity was 3.0±1.9 (95% CI: 2.7-3.2), with the range of 0-6. Thirty-four (13.1%) of the women were nulliparous; 25 (9.7%) primiparous; 158 (59.1%) multiparous and 47 (18.1%) were grand multiparous women. This is significantly different from the mean parity of 1 reported by Shittu et al.[9] In their study also, 35% were nulliparous, 60% multiparous and 5% grand multiparous. The differences observed here can also be explained by early marriage in that at about 30 years the mean parity in our study was 3 while at the same age the mean parity in the study by Shittu et al was 1.[9] The percentage of grand multiparous women in our study was also significantly higher than that of Shittu et al, due to the socio- cultural and religious influences.

The mean actual birth weight of neonates measured within 30 minutes after delivery was 3074.5±398.4 g (95% CI: 3025.8-3132.8 g) with a range of 2200-4200 g. This is lower than the mean birth weight of 3.242 kg±508 g reported by Njoku et al in Calabar and 3.254 kg±622 g reported by Shittu et al in Ile-Ife Nigeria.[9,10] This also lower than the mean birth weight of 3.568 kg±496 g documented in the United Kingdom. However, it is higher than the mean birth weight of 2.983 kg±490 g reported by Parvathavarthini et al in India.[11]

The reason may be due to several factors affecting birth weight such as race, climate, seasonal variations and socio-economic factors.[12]

Comparison of the mean of estimated birth weight using ultrasound and clinical method (Dare's method) with that of the actual birth weights was presented in Table 2. The mean of estimated birth weight by clinical method was 3.032 kg±358 g, while for ultrasound the mean was 3.069 kg±368 g. The mean actual birth weight was 3.072 kg±366 g. The result did not show significant differences in their means.

So, it is clear from this finding that the clinical assessment of weight is comparable to ultrasound in prediction of actual birth weight. The finding was in sharp contrast to the study by Ugwu et al where ultrasound estimation was significantly more accurate than clinical prediction.[1] However, it is similar to the finding obtained in some other studies.[9,10]

However, for macrosomic babies, the mean differences of weight estimation and actual baby weight were statistically significant (3840.0±114.0; 3980.0±130.4; 4040.0±89.4; p=0.042) representing, the clinical, ultrasound methods of birth weight estimation and actual baby weight respectively.

Table 4 depicts comparison among different methods of fetal weight estimation with the actual birth weight of neonates. Overall, the mean error % in clinical method using Dare's method was significantly lower than the ultrasound method of estimation (-1.1±5.6 versus 0.1±4.0; p<0.0001) and the difference in the mean error % was statistically significant. Interestingly, the mean percentage error can be misleading because it is the sum of positive and negative deviations from actual birth weight, thus artificially reducing the difference between actual birth-weight and estimated birth-weight. It is a measure of systematic error in each method and not variation from birth weight.

Observably, the proportion of estimates within 10% of actual birth weight in Dare's method though lower than ultrasound method was statistically similar (92.3% versus 97.3%; p=0.557). Also, the result showed a positive strong correlation between actual birth weight in grams and clinical method using Dare's method of fetal weight estimation (r=0.907; p<0.0001) and ultrasound method (r=0.952; p<0.0001). Although, the methods of estimation showed strong correlation, the ultrasound method had a higher correlation.

Ugwu et al observed strong positive correlation of actual birth weight with clinical and ultrasonographically estimated birth-weight (r=0.71 and r=0.69 respectively).[1] Similar results observed in the study by Njoku et al, in 2014 as correlation coefficients for the clinical and ultrasonic methods, compared to actual birth weight, were +0.740 and +0.847, respectively, and both correlated positively with the actual birth weight.[10] Shittu et al in a study conducted at Southwest Nigeria in 2007 found that the correlation coefficient for the clinical and ultrasonic methods, compared to actual birth weight, were observed to be +0.78 and +0.74 respectively, the relationships found to be statistically significant (p<0.001).[17] In the study Shittu et al observed that in the low-birth weight (<2,500 gm) group, both the methods systematically overestimated birth weight.[9] The accuracy of clinical estimation obtained in this study was highest in the birth-weight range of ≥4,000 gm. For both, the low birth weight and the normal weight range, ultrasound estimated birth weight better than clinical method, although there is no statistical significance. Our results are also consistent with what have been previously observed that the mean absolute percentage error of predicted birth weight varies from 5.2 to 27% of actual birthweight.[13]

Likewise, Baum et al found no advantage of sonographic estimation over clinical or patients' estimation of foetal weight at term.[13] The difference from our results may be attributed to the larger sample size that was used in this study.

Our observation implies that there is clearly a role for clinical estimation of birth-weight as a diagnostic tool, suggesting that clinical estimation is sufficient to manage labour and delivery in a term pregnancy and for macrosomic babies. But for suspected low birth weight babies, ultrasound estimation of weight is necessary before making clinical decisions.

## CONCLUSION

Clinical estimation of birth-weight using Dare's formiula is as accurate as routine ultrasonographic estimation especially for normal sized foetuses. Both clinical (Dare's formula) and ultrasound methods of foetal weight estimation showed positive correlation with actual birth weight of the foetus after delivery. However, when the clinical method suggests weight smaller than 2,500 gm, subsequent ultrasound estimation is recommended to yield a better prediction of foetal weight.

Clinical palpation should be considered as diagnostic tool for foetal weight estimation and is equally reliable even when done by trained medical officer or community health workers. It is cheap and easy to teach.

### *Recommendations*

It is our recommendation that clinical estimation of foetal weight should be included in the curriculum of community health extension workers and community health officers. This will help to minimize the physical and psychological stress on patients travelling long distances to estimate foetal weight by ultrasound.

Patients with suspected low foetal weight would be referred for ultrasound estimation.

Further studies are, however, necessary to improve the accuracy of foetal weight estimation and to determine if estimation of foetal weight near delivery actually improves outcome.

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