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# COMPARATIVE ACCURACY OF SONOGRAPHIC AND CLINICAL METHODS FOR ESTIMATING FETAL WEIGHT AT TERM IN A TERTIARY NIGERIAN HOSPITAL

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**ABSTRACT**

**Background:** Background: Accurate estimation of fetal weight at term is critical in obstetric decision-making and preventing feto-maternal complications.
Objective: To compare the accuracy of clinical (Dare's formula) and sonographic (Hadlock-4) methods with actual birth weight in term pregnancies.
**Methods**: In a prospective cross-sectional study, 60 women with singleton term pregnancies were evaluated. Fetal weight was estimated clinically and sonographically within 0–7 days before delivery. Estimates were compared to actual birth weight using paired t-tests and correlation analysis.
**Results**: Mean actual birth weight was 3240.83 ± 483.85 g. Sonographic estimates had a mean absolute percentage error (MAPE) of 7.97% ± 6.28 and predicted 75% of weights within ±10% of actual birth weight. Clinical estimates had a MAPE of 17.02% ± 13.97 with 36.67% within ±10%. Sonographic estimates showed stronger correlation ($r = 0.711$; $p < 0.001$) than clinical estimates ($r = 0.531$; $p < 0.001$).
**Conclusion**: The sonographic method was significantly more accurate in predicting fetal weight and should be preferred in clinical settings.
**Keywords**: Fetal weight estimation, Sonography, Clinical methods, Accuracy, Nigeria

## Introduction

Accurate fetal weight estimation (EFW) at term is critical for optimizing delivery planning and reducing perinatal morbidity, particularly in high-risk pregnancies where macrosomia or low birth weight is suspected (Malhotra & Jain, 2016). In Nigeria, perinatal mortality rates (39–130 per 1,000 births) remain alarmingly high, with birth weight consistently recognized as the strongest predictor of neonatal survival (Shittu et al., 2007). Inaccurate EFW contributes to preventable complications including obstructed labor, uterine rupture, neonatal injury, inappropriate route of delivery, and perinatal death (Wanjaria & Kamau, 2017).

In clinical practice, two main approaches are used for fetal weight estimation: clinical methods such as symphysial-fundal height and abdominal palpation, and sonographic measurements using biometric parameters. Clinical methods are widely used in resource-limited settings due to their accessibility and affordability, yet their accuracy is compromised by factors such as maternal obesity, polyhydramnios, multiple gestation, and fetal malposition (Kumara & Perera, 2009). Sonography is theoretically more accurate, employing standardized algorithms for 3D volume-based fetal measurements (Anderson et al., 2007), but its reliability varies across different fetal weight categories. While some studies show sonography performing better in detecting low birth weight (<2,500 g), others find it less reliable in identifying macrosomia (>4,000 g), where clinical estimations sometimes yield more accurate predictions (Titapant et al., 2001).

Despite the growing body of literature, existing evidence remains contradictory and largely context-dependent. Several studies have reported inconsistent results regarding the comparative accuracy of sonographic and clinical methods, with some favoring clinical estimation and others supporting sonographic superiority (Ugwu et al., 2014; Mbu et al., 2014; El Helali et al., 2018). These inconsistencies may be influenced by racial, environmental, nutritional, or methodological variations, limiting the generalizability of findings across different populations. Importantly, there is a paucity of high-quality, comparative studies on this subject in Nigeria where unique demographic characteristics, variable operator expertise, and infrastructural limitations may significantly influence the accuracy of both methods. Without local validation, reliance on international data may result in misinformed obstetric decisions and suboptimal maternal-fetal outcomes.

This study therefore aims to address this critical knowledge gap by conducting a prospective, head-to-head comparison of sonographic and clinical EFW methods at term in a Nigerian tertiary hospital. By evaluating their accuracy against actual birth weight and stratifying by weight categories, the study seeks to provide evidence-based, context-specific guidance that can improve intrapartum decision-making and maternal-neonatal outcomes in similar low-resource settings.

**Methods:**

This was a prospective cross-sectional study conducted at the antenatal clinic and labor ward of Aminu Kano Teaching Hospital, Kano, Nigeria, from August 15 to October 5, 2018. The study targeted all booked pregnant women at term (≥37 completed weeks of gestation) attending routine antenatal care during the study period. Participants were consecutively recruited using a non-probability sampling technique until a sample size of 60 was attained.

**Inclusion and Exclusion Criteria**

Eligible participants were those with singleton, full-term pregnancies and intact membranes. Exclusion criteria included multiple gestations, intrauterine fetal demise, ruptured membranes, oligohydramnios or polyhydramnios, and any gross fetal anomaly.

**Data Collection and Measurements**

After obtaining informed consent, demographic and obstetric information (age, parity, gravidity) was collected using a standardized data capture form. Maternal weight and height were measured by the primary investigator using a calibrated mobile weighing scale and stadiometer, respectively.

Fetal weight estimation was performed first by a trained and experienced sonographer using the Hadlock-4 formula, which incorporates femoral length, abdominal circumference, head circumference, and biparietal diameter. This was followed by clinical fetal weight estimation conducted by a consultant obstetrician using Dare's formula:

Estimated fetal weight (g) = Symphysio-fundal height (cm) × Abdominal girth (cm)

Fundal height was measured from the uterine fundus to the midpoint of the symphysis pubis, while abdominal girth was measured at the umbilicus using the reverse side of a graduated tape to avoid observational bias. The obstetrician was blinded to the sonographic findings. After delivery, the actual birth weight (ABW) of each neonate was extracted from the case notes and delivery records and entered into the same data capture form.

Statistical Analysis

All data were analyzed using SPSS version 20.0 for Windows (IBM Corp., Armonk, NY). Accuracy was assessed using mean error (ME), mean percentage error (MPE), mean absolute percentage error (MAPE), and the proportion of estimates within ±10% of ABW. Descriptive statistics (mean, standard deviation) and inferential tests (paired t-test, Pearson's correlation coefficient) were applied. A p-value < 0.05 was considered statistically significant.

## Ethical Approval

Ethical clearance was obtained from the Research and Ethics Committee of the College of Health Sciences, Bayero University, Kano.

## Results:

Eighty-eight (88) participants met the inclusion criteria and were recruited for the study, out of which twenty-eight (28) failed to deliver within seven (7) days of estimating the fetal weight therefore, they were excluded. Thus, sixty (60) participants completed the study.

The mean maternal age of the study participants was 29.3833±5.096 (Range 20-42) years. Majority of the participants were between the ages 25-34 years (65%), followed by the age range 18-24 years and ≥35 years at 20 and 15% respectively. The parity and gravidity stood at a mean of 2.4667±2.24 (Range 0-8) and 3.8±2.52 (Range 1-12) respectively. Most of the women were multi-parous with a frequency of 26 (43.3%) while nulliparous, primiparous and grand multi-parous women had a frequency of 13 (21.7%), 13 (21.7%), and 8 (13.3%) respectively.

The mean maternal BMI at term was 28.24±4.78 Kg/m2 (Range 19.88-40.89) while average weight participants were 16 (26.7%) while none was under-weight..

Table 1: Table 2: Intraclass correlation Coefficient of Acromioclavicular joint space measurement

| | Intraclass correlation[b] | 95% confidence interval | | F Test with True Value 0 | | | |
|---|---|---|---|---|---|---|---|
| | | Lower Bound | Upper Bound | Value | df1 | df2 | Sig |
| Single measures | 0.925[a] | 0.729 | 0.981 | 25.636 | 9 | 9 | 0.000 |
| Average measures | 0.961 | 0.843 | 0.990 | 25.636 | 9 | 9 | 0.000 |

Table 2: Table 3: Percentile chart of Mean Acromioclavicular joint with Age.

| AGE (YRS) | 5TH Centile | 50TH Centile | 95th Centile | S/D | AGE (YRS) | 5TH Centile | 50th Centile | 95th Centile | S/D |
|---|---|---|---|---|---|---|---|---|---|
| 18 | 2.83 | 3.94 | 4.21 | 0.42 | 46 | 2.01 | 3.01 | 3.26 | 0.38 |
| 19 | 2.80 | 3.91 | 4.18 | 0.42 | 47 | 1.98 | 2.98 | 3.22 | 0.38 |
| 20 | 2.77 | 3.87 | 4.14 | 0.42 | 48 | 1.95 | 2.95 | 3.19 | 0.38 |
| 21 | 2.74 | 3.84 | 4.11 | 0.42 | 49 | 1.92 | 2.91 | 3.16 | 0.38 |
| 22 | 2.71 | 3.81 | 4.07 | 0.41 | 50 | 1.89 | 2.88 | 3.12 | 0.38 |
| 23 | 2.68 | 3.77 | 4.04 | 0.41 | 52 | 1.83 | 2.81 | 3.05 | 0.37 |
| 24 | 2.65 | 3.74 | 4.01 | 0.41 | 53 | 1.80 | 2.78 | 3.02 | 0.37 |
| 25 | 2.62 | 3.71 | 3.97 | 0.41 | 54 | 1.77 | 2.75 | 2.99 | 0.37 |
| 27 | 2.56 | 3.64 | 3.90 | 0.41 | 55 | 1.74 | 2.72 | 2.95 | 0.37 |
| 28 | 2.53 | 3.61 | 3.87 | 0.41 | 56 | 1.71 | 2.68 | 2.92 | 0.37 |
| 29 | 2.50 | 3.57 | 3.84 | 0.40 | 57 | 1.68 | 2.65 | 2.89 | 0.37 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 30 | 2.48 | 3.54 | 3.80 | 0.40 | 58 | 1.65 | 2.62 | 2.85 | 0.36 |
| 31 | 2.45 | 3.51 | 3.77 | 0.40 | 59 | 1.62 | 2.58 | 2.82 | 0.36 |
| 32 | 2.42 | 3.48 | 3.73 | 0.40 | 60 | 1.59 | 2.55 | 2.78 | 0.36 |
| 33 | 2.39 | 3.44 | 3.70 | 0.40 | 61 | 1.57 | 2.52 | 2.75 | 0.36 |
| 34 | 2.36 | 3.41 | 3.67 | 0.40 | 62 | 1.54 | 2.48 | 2.72 | 0.36 |
| 35 | 2.33 | 3.38 | 3.63 | 0.40 | 64 | 1.48 | 2.42 | 2.65 | 0.36 |
| 36 | 2.30 | 3.34 | 3.60 | 0.39 | 65 | 1.45 | 2.39 | 2.61 | 0.35 |
| 37 | 2.27 | 3.31 | 3.56 | 0.39 | 66 | 1.42 | 2.35 | 2.58 | 0.35 |
| 38 | 2.24 | 3.28 | 3.53 | 0.39 | 68 | 1.36 | 2.29 | 2.51 | 0.35 |
| 39 | 2.21 | 3.24 | 3.50 | 0.39 | 69 | 1.33 | 2.25 | 2.48 | 0.35 |
| 40 | 2.18 | 3.21 | 3.46 | 0.39 | 70 | 1.30 | 2.22 | 2.44 | 0.35 |
| 41 | 2.15 | 3.18 | 3.43 | 0.39 | 71 | 1.27 | 2.19 | 2.41 | 0.35 |
| 42 | 2.12 | 3.15 | 3.39 | 0.39 | 72 | 1.24 | 2.15 | 2.38 | 0.34 |
| 43 | 2.09 | 3.11 | 3.36 | 0.39 | 75 | 1.15 | 2.05 | 2.27 | 0.34 |
| 44 | 2.06 | 3.08 | 3.33 | 0.38 | 80 | 1.01 | 1.89 | 2.10 | 0.33 |
| 45 | 2.03 | 3.05 | 3.29 | 0.38 | | | | | |

Table 3: Table 4: Pearson Product Moment Correlation Coefficient of the Mean ACJ and Age

| | | Age |
|---|---|---|
| Mean ACJ | Pearson Correlation | -0.795(**) |
| | Sig. (2-tailed) | 0.000 |
| | N | 628 |

** Correlation is significant at the 0.01 level (2-tailed).

Table 4: Table 5: Independent Sample T-Test Analyses for the Relationship between Acromioclavicular joint space and Sex

| | Levene's Test for Equality of variances | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SEX | F | Sig | t | df | Sig.(2-tailed) | Mean Difference | Std.Error Difference | 95% Confidence interval difference lower | upper |
| Equal variances assumed | 0.664 | 0.416 | -1.385 | 627 | 0.168 | -0.137 | 0.098 | -0.331 | 0.058 |
| Equal variances not assumed | | | -0.138 | 622.985 | 0.169 | -0.136 | 0.09879 | -0.332 | 0.059 |

**Discussion:**

Accurate estimation of fetal weight (EFW) at term is a critical component of obstetric management, guiding decisions about mode of delivery and minimizing the risk of feto-maternal morbidity and mortality. This study compared the clinical (Dare's formula) Dare et al., 1990 and sonographic (Hadlock-4) methods of fetal weight estimation, using actual birth weight (ABW) as the reference standard.

Numerous studies have assessed the reliability of clinical fetal weight estimation using Dare's or similar formulas.Aruna et al., 2017, Bajaj et al., 2017, and Mohamadi and Haji 2016 reported variable accuracy levels depending on gestational age, maternal BMI, and parity. The foundational work by Dare et al.,1990 established the clinical formula used in many low-resource settings, while newer studies such as Sinha et al., 2015, Tlale, 2011, and Yiheyis et al.,2016 have validated or adapted these formulas in different African and South Asian populations. Asto and Crisologo, 2014 and Mallikarjuna and Rajeshwari,2015 further emphasized the formula's ease of use despite its relatively wide error margins.

The use of sonographic formulas such as Hadlock remains widely accepted, yet interobserver variability and equipment differences can affect accuracy. Studies by Aksoy et al., 2016 and Mohamed et al., 2013 assessed interobserver agreement and underscored the impact of sonographer experience. Colman,2012 and Larsen et al.,1995 explored how repeated sonographic measurements may improve prediction accuracy. Güdücü et al., 2013 and Kathiriya et al., 2014 demonstrated improved performance in specific fetal weight ranges, while Peregrine et al., 2017 and Yau et al., 2013 evaluated the performance of residents and specialists in fetal weight estimation. Bolanca et al., 2005 highlighted the variability among residents, and Gajendra et al., 2017 compared multiple formulas, suggesting contextual adaptations.

The mean ABW observed was 3240.83 ± 483.85 g, closely aligning with previous Nigerian studies (Shittu et al., 2007; Njoku et al., 2014; Enaohwo et al., 2016; Eze et al., 2015), but lower than findings from Turkey (Güdücü et al., 2013) and France (Mbu et al., 2014). These disparities may reflect population-level differences in ethnicity, maternal nutrition, and socioeconomic status.

Both estimation methods demonstrated statistically significant differences from the ABW. The sonographic method yielded a mean EFW of 3090.05 ± 349.27 g ($p = 0.001$), while the clinical method produced a substantially higher estimate of 3665.03 ± 525.33 g ($p < 0.001$). The clinical method consistently overestimated fetal weight, whereas sonography slightly underestimated it. This pattern is in line with studies such as Panse and Boricha (2017) and Shittu et al. (2007), who also reported systematic underestimation by sonography and overestimation by clinical methods.

The mean error (ME) was +424.20 g for the clinical method and −150.78 g for the sonographic method. These results suggest that the clinical method poses a greater risk of incorrectly categorizing macrosomic fetuses, potentially leading to unnecessary caesarean deliveries.

Of the 60 neonates studied, 81% had normal birth weights, 10% were macrosomic, and 5% had low birth weights. The clinical method misclassified 5% of low birth weight neonates as normal and 15% of normal birth weight neonates as macrosomic. In contrast, the sonographic method demonstrated superior sensitivity in detecting low birth weight, though it failed to identify any macrosomic neonates—underestimating 10% of them as normal. A comparative analysis by Titapant et al., 2001 found that clinical estimation methods outperformed ultrasound in certain macrosomic cases, echoing similar findings from resource-constrained environments.

In terms of accuracy metrics, the sonographic method outperformed the clinical method across all indicators:

MPE: −3.71% ± 9.50 (sonography) vs. 14.54% ± 16.59 (clinical)

MAPE: 7.97% ± 6.28 (sonography) vs. 17.02% ± 13.97 (clinical)

MAPE provides a better assessment of systematic error by accounting for both under- and over-estimations. The sonographic MAPE observed is consistent with values reported by Basha et al. (2012), El Helali et al. (2018), and Njoku et al. (2014), all of whom support ultrasound's utility in routine obstetric care.

Furthermore, sonographic EFW had a strong correlation with ABW ($r = 0.711$, $p < 0.001$), indicating its high predictive reliability. The clinical method showed only a moderate correlation ($r = 0.531$, $p < 0.001$), reinforcing its relatively lower diagnostic accuracy. Similar findings have been reported by Ugwu et al. (2014), though some variability in correlation coefficients has been noted across different studies (El Helali et al., 2018).

Importantly, 75% of sonographic estimates fell within ±10% of the ABW, compared to only 36.67% for the clinical method. This again confirms the greater accuracy and clinical utility of the sonographic method. These values are consistent with prior literature—Njoku et al. (2014) reported 72%, Basha et al. (2012) 78.8%, and Yadav et al. (2016) 79% accuracy within the same margin for sonographic EFW.

CONCLUSION

This study demonstrates that the sonographic method (Hadlock-4) provides significantly greater accuracy and reliability in estimating fetal weight at term compared to the clinical method (Dare's formula). Sonography showed lower mean absolute error, stronger correlation with actual birth weight, and a higher proportion of estimates within ±10% of the true weight. Given these findings, routine use of ultrasound for fetal weight estimation is recommended, particularly in settings where precision is critical for obstetric decision-making. However, the clinical method may still hold value in resource-limited environments, though its limitations should be acknowledged. Further large-scale, multi-center studies are warranted to validate these results and support the development of context-specific estimation protocols.

Limitations of the Study

This study had several limitations. Some participants left before ultrasound and physical assessments were completed, while others delivered at home, making it impossible to retrieve birth weights. Additionally, participants who delivered beyond seven days post-estimation were excluded, potentially introducing selection bias.

Gestational age was estimated using the last menstrual period, but where this was unreliable, first-trimester ultrasound was used instead, which may introduce minor variability.

Only one ultrasound model and a single formula (Hadlock-4) were used, limiting the generalizability of findings across different settings or equipment. The relatively small sample size and single-center design also limit broader applicability. Finally, fetal weight estimations were performed by one operator per method, so inter-observer variability was not assessed. Future studies should address these issues through larger, multi-center trials involving multiple operators and estimation formulas.

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