

Comparison Of Shepard And Hadlock Method Of Sonographic Fetal Weight Estimation In Term Pregnancy

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Keywords: Fetal Weight Estimation, Ultrasonography, Hadlock Method, Shepard Method, Term Pregnancy, Prenatal Care.

Received on 10 Apr 2026

Accepted on 25 Apr 2026

Published on 08 May 2026

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Abstract

Background: Accurate fetal weight estimation is a key component of antenatal care, influencing obstetric management decisions and perinatal outcomes. Ultrasonography-based formulas, including the Shepard and Hadlock methods, are widely used; however, variations in their accuracy may impact clinical judgment.

Objective: To compare the accuracy and precision of the Shepard and Hadlock methods in estimating fetal weight in term pregnancies.

Methodology: This cross-sectional comparative study was conducted on 50 term pregnant women. Estimated fetal weight (EFW) was calculated using both the Shepard and Hadlock ultrasonographic formulas for each participant. Paired sample analysis was performed to compare mean EFWs between the two methods. Measures of variability, including standard deviation and standard error of the mean, were used to assess precision. Additional variables such as maternal sociodemographic characteristics and fetal presentation were evaluated for their potential influence on estimation differences.

Results: The mean EFW calculated by the Shepard method was 1.9987 kg, while the Hadlock method yielded a slightly higher mean of 2.06162 kg. Although both methods showed comparable results, the Hadlock method demonstrated relatively greater

accuracy in fetal weight estimation. The difference between the two methods was not statistically significant.

Conclusion: Both Shepard and Hadlock methods provide reliable estimates of fetal weight in term pregnancies, with the Hadlock method showing marginally better accuracy. Selection of an appropriate estimation method is important for optimal clinical decision-making. Further large-scale studies are recommended to validate these findings and improve estimation techniques.

Introduction

Fetal weight is a fundamental indicator of fetal growth, development, and overall pregnancy outcome. Accurate assessment of fetal weight plays a pivotal role in antenatal care, as it assists healthcare providers in identifying deviations from normal growth patterns and enables timely clinical interventions. A fetus is expected to gain weight progressively throughout gestation; any deviation may indicate complications such as intrauterine growth restriction, low birth weight, or macrosomia, all of which are associated with increased perinatal morbidity and mortality (Lees et al., 2022; Lu et al., 2020). Consequently, fetal weight estimation is not only essential for fetal surveillance but also for improving maternal and neonatal health outcomes.

Beyond fetal well-being, estimated fetal weight (EFW) also reflects maternal health status. Conditions such as inadequate maternal nutrition, gestational diabetes mellitus, and hypertensive disorders of pregnancy significantly influence fetal growth patterns (Lu et al., 2019). Therefore, regular monitoring of fetal weight provides indirect insight into maternal physiological status and helps guide clinical management. Furthermore, fetal weight estimation is critical in determining the mode and timing of delivery. For instance, suspected macrosomia may necessitate cesarean delivery to prevent complications such as shoulder dystocia, whereas low birth weight infants may require specialized neonatal care (Caradeux et al., 2019; Preyer et al., 2019).

Globally, accurate fetal weight estimation remains a key challenge in obstetrics. International studies have highlighted the importance of ultrasonography as a reliable and non-invasive tool for estimating fetal weight (Ahmed et al., 2022; Caswell et al., 2020). Regionally, including in South Asia and Pakistan, variability in fetal weight estimation methods and limited standardized practices contribute to inconsistent clinical decision-making. This underscores the need for comparative evaluation of commonly used formulas to determine the most reliable method in specific populations. Several techniques are employed for fetal weight estimation, including clinical methods (such as fundal height measurement) and imaging-based approaches. Among these, ultrasound-based methods are the most widely accepted due to their higher accuracy and reproducibility. These methods rely on fetal biometric parameters such as abdominal circumference (AC), head circumference (HC), femur length (FL), and biparietal diameter (BPD), which are incorporated into mathematical models to estimate fetal weight.

The **Shepard method** is one of the earlier ultrasound-based techniques, primarily utilizing abdominal circumference due to its strong correlation with fetal weight (Bourke et al., 2019). Its simplicity and ease of use make it suitable for routine clinical practice; however, reliance on a single parameter may limit its accuracy, particularly in cases of abnormal fetal growth. In contrast, the **Hadlock (Hadlock) method** incorporates multiple fetal biometric parameters, enhancing its predictive accuracy and making it one of the most widely used formulas in modern obstetrics (Lin et al., 2020). Despite its advantages, it requires precise measurements and technical expertise, which may influence its reliability in different clinical settings.

Although both methods are commonly used, existing literature reveals variability in their accuracy and reliability, with no clear consensus regarding the superior technique. This gap is particularly evident in local contexts, where population-specific factors such as maternal nutrition, genetics, and healthcare accessibility may influence fetal growth

patterns. Therefore, a direct comparison of these methods in term pregnancies is necessary to guide evidence-based clinical practice.

The rationale for this study is grounded in the need to identify the most accurate and reliable ultrasonographic method for fetal weight estimation in term pregnancies. Establishing a standardized and precise method can improve obstetric decision-making, reduce complications during delivery, and enhance neonatal outcomes. Moreover, this study contributes to the existing body of knowledge by providing locally relevant data that may inform clinical guidelines and future research.

Objective:

To determine and compare the accuracy and precision of the Shepard and Hadlock ultrasonography methods in estimating fetal weight in term pregnancies.

MATERIALS AND METHODS

This was a hospital-based comparative cross-sectional study designed to evaluate and compare the accuracy of the Shepard and Hadlock ultrasonographic methods for fetal weight estimation in term pregnancies.

The study was conducted in the Gynecology and Radiology Departments of Social Security Hospital Lahore, Al-Rehman Hospital Makhdoom Pur, and Al-Shifa Hospital Gujrat. The duration of the study was four months, commencing after approval of the research synopsis.

A total sample size of 50 pregnant women was included in the study. The sample size was determined based on feasibility and previous similar studies. A non-probability convenient sampling technique was employed to recruit participants.

Sample selection was based on predefined inclusion and exclusion criteria. Pregnant women aged 20–53 years with singleton pregnancies in the second and third trimesters who were willing to participate and provided informed consent were included in the study. However, women with conditions that could affect the accuracy of fetal weight estimation or pregnancy outcomes were excluded, including those with polyhydramnios or oligohydramnios, eclampsia, maternal obesity (≥ 90 kg), and known fetal congenital anomalies.

Procedure

Ultrasonographic examinations were performed for all participants using the same ultrasound machine (Toshiba, Japan) to ensure consistency and reduce inter-instrument variability. All scans were conducted under the supervision of an experienced consultant radiologist using a low-frequency convex transducer. Standard fetal biometric parameters were obtained during each examination. Biparietal diameter (BPD) was measured from the outer table of the proximal skull to the inner table of the distal skull at the level of the thalamus, falx cerebri, and cavum septum pellucidum. Femur length (FL) was measured along the ossified diaphysis from the greater trochanter to the distal femoral condyles. Abdominal circumference (AC) was measured at the level of the junction of the umbilical vein and portal sinus, while head circumference (HC) was measured using elliptical calipers at the level of the biparietal diameter and occipitofrontal diameter. All obtained measurements were carefully recorded in a structured data collection proforma for subsequent analysis.

Estimated fetal weight (EFW) was calculated using the following formulas:

Shepherd Method:

$$EFW = 10^{-1.7492 + 0.166 \times BPD + 0.046 \times AC - 0.002546 \times AC \times BPD}$$

Hadlock Method:

$$EFW = 10^{-1.3596 + 0.0064 \times HC + 0.0424 \times AC + 0.174 \times FL + 0.00061 \times BPD \times AC - 0.00386 \times AC \times FL}$$

(Where BPD = biparietal diameter, AC = abdominal circumference, HC = head circumference, FL = femur length)

Ethical approval was obtained from the Ethical Review Committee of The University of Lahore and the study adhered to institutional ethical guidelines. Written informed consent was obtained from all participants, and confidentiality and anonymity were strictly maintained. Participation was voluntary, with the right to withdraw at any time, and no known risks were associated with the study.

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 20 (IBM Corp., New York, USA). Descriptive statistics were computed, with continuous variables such as maternal age and estimated fetal weight expressed as mean \pm standard deviation, while categorical variables were presented as frequencies and percentages. To evaluate the accuracy of the two ultrasonographic methods, mean error (ME), mean absolute error (MAE), and mean absolute percentage error (MAPE) were calculated. A paired sample t-test was applied to compare the mean estimated fetal weights obtained by the Shepard and Hadlock methods, and correlation coefficients were determined to assess the relationship between the two methods. A p-value of <0.05 was considered statistically significant.

RESULTS:

50 pregnant women were enrolled in our study to estimate fetal weight using 2 different ultrasound methods of fetal weight estimation namely HADLOCK method and SHEPARD method. It was observed that the results note down by HADLOCK method were more accurate. Regardless there was no remarkable difference between both formulas.

Table 1 presents the combined frequency distribution of obstetric variables among 50 participants. The findings demonstrate that breech presentation was more common, observed in 34 participants (68%), whereas cephalic presentation was identified in 16 participants (32%). Regarding gestation, the majority of participants had a single fetus pregnancy, accounting for 49 cases (98%), while twin pregnancy was observed in only 1 participant (2%). In terms of fetal lie, oblique lie was slightly more frequent, reported in 28 participants (56%), whereas transverse lie was present in 22 participants (44%). These findings indicate that singleton pregnancies and breech presentations were predominant within the study population.

Table 2 illustrates the frequency distribution of placenta positions among the participants. The most frequently observed placental position was posterior upper segment, recorded in 11 participants (22%), followed by anterior upper segment in 9 participants (18%). Anterior placenta position accounted for 7 cases (14%), while anterior upper position was observed in 5 participants (10%). Other placental positions

such as posterior lower, posterior upper, and posterior positions were comparatively less common. Overall, posterior upper segment placentation appeared to be the dominant placental location among the study participants.

Table 3 demonstrates the descriptive statistics of fetal biometric parameters among the participants. The mean biparietal diameter (BPD) was 7.882 ± 0.7027 , while the mean femur length (FL) was 6.070 ± 0.6899 . The mean fetal abdominal circumference (FAC) was 28.108 ± 3.1877 , and the mean fetal heart rate (FHR) was 141.68 ± 2.832 . These findings suggest normal fetal growth parameters and physiological fetal heart activity among the study participants.

Table 4 presents the paired sample statistics of estimated fetal body weight (EFBW) calculated using Hadlock and Shepard methods. The mean EFBW estimated by the Hadlock method was 2.06162 ± 0.574913 , whereas the Shepard method showed a slightly lower mean value of 1.9987 ± 0.55270 . Although minor differences were observed between the two methods, both demonstrated relatively comparable fetal weight estimations.

Table 5 shows the paired sample correlation between Hadlock and Shepard methods for fetal weight estimation. A strong positive correlation was identified between both methods ($r = 0.758$, $p = 0.000$), indicating a significant relationship and consistency between the fetal weight estimations obtained through the two ultrasonographic formulas.

Table 6 presents the paired sample t-test comparing fetal weight estimations obtained through Hadlock and Shepard methods. The mean difference between both methods was 0.062956 with a p-value of 0.288, which is greater than the significance level of 0.05. This indicates that there was no statistically significant difference between the Hadlock and Shepard methods for estimating fetal body weight. Therefore, both methods can be considered similarly effective for fetal weight estimation among the study participants.

Table 1: Combined Frequency Distribution of Obstetric Variables in a Sample of 50 Participants

Variable	Category	Frequency (n)	Percentage (%)
Fetal Presentation	Breech	34	68%
	Cephalic	16	32%
Gestation (Fetus)	Single	49	98%
	Twins	1	2%
Fetal Lie	Oblique	28	56%
	Transverse	22	44%

Table 2: frequency table for placenta position in sample of 50 patients.

Placenta Position	Frequency	Percent (%)
A Posterior / Lower Anterior	1	2.0
Ant Posterior / Lower Seg	1	2.0
Anterior	2	4.0
Anterior	7	14.0

Anterior / Upper	5	10.0
Anterior / Upper Seg	4	8.0
Anterior / Upper Seg	9	18.0
Posterior	1	2.0
Posterior / Lower	4	8.0
Posterior / Upper	2	4.0
Posterior / Upper Seg	3	6.0
Posterior / Upper Seg	11	22.0
Total	50	100.0

Seg = Segment.

Table 3: descriptive statistics of biparietal diameter, femur length, fetal abdominal circumference and fetal heart rate among 50 participants.

Parameter	N	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation
BPD	50	3.4	6.4	9.8	7.882	0.0994	0.7027
FL	50	3.5	4.2	7.7	6.070	0.0976	0.6899
FAC	50	20.2	14.4	34.6	28.108	0.4508	3.1877
FHR	50	11	135	146	141.68	0.400	2.832

BPD = Biparietal Diameter; FL = Femur Length; FAC = Fetal Abdominal Circumference; FHR = Fetal Heart Rate; Std. = Standard.

Table 4: Paired Sample Statistics of EFBW by Hadlock and Shepard Methods

Method	Mean	N	Std. Deviation	Std. Error Mean
EFBW by Hadlock Method	2.06162	50	0.574913	0.085703
EFBW by Shepard Method	1.9987	50	0.55270	0.08239

EFBW = Estimated Fetal Body Weight; Std. = Standard.

Table 5: Paired Sample Correlation of EFBW (Hadlock vs Shepard)

Pair	Variables Compared	N	Correlation	Sig.
1	Hadlock vs Shepard Method	50	0.758	0.000

EFBW = Estimated Fetal Body Weight; Sig. = Significance.

Table 6: Paired Sample Test of EFBW by Hadlock and Shepard Method

Pair	Variables Compared	Mean Difference	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	df	Sig. (2-tailed)
1	Hadlock – Shepard	0.062956	0.392411	0.058497	-0.054938	0.180849	1.076	44	0.288

EFBW = Estimated Fetal Body Weight; Std. = Standard; CI = Confidence Interval; df = Degrees of Freedom; Sig. = Significance.

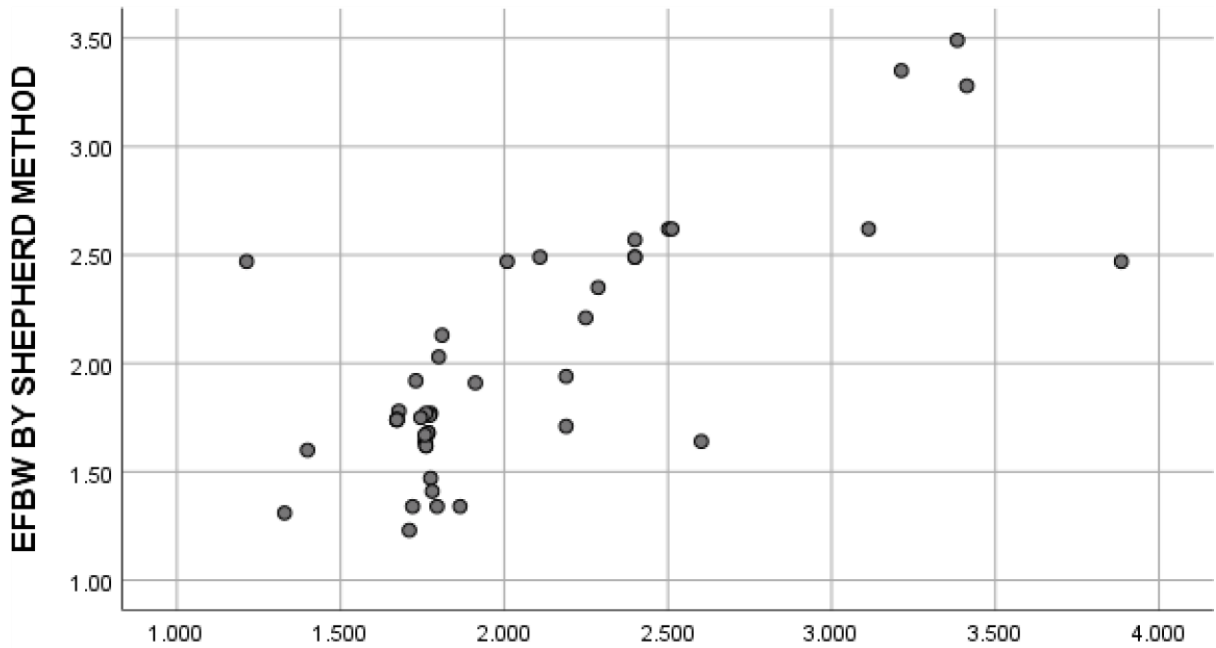


Figure 1: Scattered distribution of EFBW comparison by Hadlock and Shepard method.

Figure1: Represents scattered graph for the comparison of fetal weight estimation by Hadlock and Shepard method. This shows there isn't much difference between the results of both methods.



Image 1: In the case ultrasound image shows FL measuring 07.26cm in 3rd trimester using Hadlock method



Image 2: In this case ultrasound image shows BPD measuring 09.24 cm in 3rd trimester. Using Shepard method.

DISCUSSION

A comprehensive study comparing Estimated Fetal Weights (EFWs) obtained through the Shepard and Hadlock ultrasonography methods provides important insights into the accuracy, reliability, and clinical applicability of these widely used techniques. In this study, a sample of 50 cases was analyzed using both methods, and the results were compared to evaluate differences in fetal weight estimation (EzeCu et al., 2022).

The Hadlock method incorporates multiple biometric parameters, including femur length (FL), abdominal circumference (AC), biparietal diameter (BPD), and head circumference (HC). Due to its multi-parameter approach, it is generally considered more reliable for predicting birth weight, particularly as femur length remains relatively stable and less influenced by fetal positioning. In contrast, the Shepard formula is based primarily on biparietal diameter (BPD) and abdominal circumference (AC), making it comparatively limited in parameter inclusion and potentially less reflective of true fetal weight estimation (Caradeux et al., 2019).

When comparing both methods, previous literature suggests that there is often no statistically significant difference between EFW values derived from Shepard and Hadlock formulas. However, when compared with actual fetal birth weight, the Hadlock method has generally demonstrated higher accuracy. In the present study, the mean difference between the two methods was observed, with the Shepard method tending to slightly underestimate fetal weight compared to the Hadlock method. This discrepancy highlights that even small variations in biometric parameters can influence fetal weight estimation outcomes.

The observed differences in mean EFW values may be attributed to multiple factors. Technical aspects such as transducer frequency, image resolution, and calibration of ultrasound equipment can significantly influence measurement accuracy. Additionally, operator experience plays a crucial role, as variations in sonographer skill and interpretation of fetal anatomical landmarks may lead to measurement inconsistencies (Blue et al., 2019).

Furthermore, differences between the two formulas themselves may contribute to variation in results. The Hadlock and Shepard methods rely on different combinations of biometric parameters and mathematical models, which inherently affects estimation outcomes. These methodological differences explain why discrepancies in fetal weight estimation are often observed across studies (Bourgi et al., 2020).

Clinical conditions may also influence the accuracy of both methods. Factors such as maternal obesity, fetal position, amniotic fluid volume, and multiple gestations can impact the quality of ultrasound measurements. In such cases, one method may perform better than the other depending on imaging clarity and parameter accessibility.

Therefore, understanding the strengths and limitations of each method within specific clinical contexts is essential for accurate fetal assessment.

When comparing the current findings with previous research, mixed results have been reported. For example, Jackson et al. reported minimal differences between Shepard and Hadlock methods in their sample of 100 patients, although statistical variations were noted in predictive accuracy. Similarly, Siemer et al. found no significant influence of measured parameters on accuracy, but concluded that the Hadlock method provided slightly better predictive performance. In another study by Khadka et al., involving 159 patients, both methods showed comparable results, although Hadlock still demonstrated slightly higher mean fetal weight estimates. These findings are largely consistent with the present study, which also suggests that while differences are not always statistically significant, the Hadlock method tends to provide more accurate estimations.

Overall, this study supports the evidence that both Shepard and Hadlock methods are useful for fetal weight estimation; however, the Hadlock method demonstrates slightly better reliability and closer approximation to actual birth weight.

Strengths and Limitations of the Study

One of the key strengths of this study is the use of dual-method comparison (Shepard and Hadlock) within the same sample, which reduces inter-sample variability and improves comparability of results. Additionally, the inclusion of 50 cases provides a reasonable dataset for preliminary analysis in a clinical setting.

However, this study also has certain limitations. The relatively small sample size may limit the generalizability of the findings. Operator-dependent variability in ultrasound measurements may also introduce measurement bias. Furthermore, the study did not account for all potential confounding variables such as maternal BMI, gestational age variations, and fetal position, which could influence fetal weight estimation accuracy.

CONCLUSION

In conclusion, both the Hadlock and Shepard methods demonstrated comparable results for estimating fetal weight; however, the Hadlock method showed slightly greater accuracy and precision. Overall, the Hadlock method proved to be more reliable and clinically efficient for estimating fetal weight when compared to the Shepard method.

Authors and Their Contributions

Author Name	Contribution
Shahnoor Zahra	Article write-up
Shafaq Gulzar Shaukat	Article write-up
Dr. Maj (R) Saad Qayyum	Data collection and interpretation
Sarwat Rasool	Data collection
Haleema Sadia	Data analysis
Syeda Muqaddas Zahra	Data sheet compilation

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