



CORRELATION OF ULTRASONOGRAPHIC ESTIMATED FETAL WEIGHT AT TERM WITH ACTUAL BIRTH WEIGHT IN A TERTIARY HEALTH CARE FACILITY

Obstetrics & Gynaecology

Dr Rashi Batra	Postgraduate, Dept of OBG, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore
Dr U Ashwini Nayak	Professor, Dept of OBG, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore
Dr Radhika Sood	Postgraduate, Dept of OBG, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore

ABSTRACT

Background: Accurate estimation of fetal weight is important for obstetric decision-making, particularly at term, but ultrasound-based prediction may vary across populations. **Objective:** To evaluate the correlation and agreement between ultrasonographically estimated fetal weight (EFW) at term and actual birth weight (ABW) in singleton term pregnancies. **Methods:** This cross-sectional observational study included 135 women with singleton term pregnancies (37–41+6 weeks) who delivered within 7 days of ultrasound at a tertiary care hospital in Bengaluru, India, between October 2023 and April 2025. Fetal biometry, including biparietal diameter, head circumference, abdominal circumference, and femur length, was obtained by an experienced radiologist. EFW was calculated using the Hadlock formula. ABW was measured immediately after birth. Correlation between EFW and ABW was assessed using Pearson's correlation coefficient, and agreement was evaluated using Bland–Altman analysis. **Results:** The mean EFW was 3196 ± 315 g, while the mean ABW was 2976 ± 346 g. Pearson's correlation demonstrated a strong positive correlation between EFW and ABW ($r=0.716$, $p<0.001$). The Bland–Altman analysis showed most observations within the 95% limits of agreement, with mild overestimation of birth weight by ultrasound. **Conclusion:** Ultrasonographic fetal weight estimation showed a significant correlation with actual birth weight in term singleton pregnancies. Despite a tendency toward mild overestimation, ultrasound demonstrated clinically useful agreement with birth weight and may support routine clinical obstetric decision-making at term.

KEYWORDS

Estimated Fetal Weight, Actual Body Weight, Hadcock's Formula, Ultrasound

INTRODUCTION

Fetal weight estimation is crucial for prenatal and intrapartum clinical decision-making.¹ It is an essential measure that is frequently used during the antepartum period to assess high-risk pregnancies, including diabetic pregnancies, post-term pregnancies, hypertensive disorders in pregnancy, vaginal birth following a prior cesarean delivery, and intrapartum management of fetuses with malpresentation. It is also used in the management of labor and deliveries.²

The delivery of macrosomic fetuses is a significant obstetric challenge, and any attempt at vaginal delivery frequently requires "considered attention" by an experienced obstetrician as well as "preparedness for operative delivery, shoulder dystocia, and newborn asphyxia." Infant mortality rates (prenatal and perinatal) are more sensitive to fetal birth weights than to their gestational ages.^{3,4} A higher risk of neonatal problems during labor and the puerperium is linked to both low birth weight and high fetal weight.⁵ Preterm delivery, fetal growth restriction (FGR), or both are perinatal issues linked to low birth weight, whereas shoulder dystocia, brachial plexus injuries, bony injuries, and intrapartum hypoxia are complications linked to macrosomia. Some researchers have proposed that precise fetal weight prediction helps clinicians control labor as well as minimize difficulties typically associated with macrosomia, which lowers maternal and perinatal morbidity and mortality.^{5,6}

Older clinical methods for estimating fetal weight rely on physical touch and maternal measurements rather than modern ultrasound. They combine Leopold's maneuvers (systematic abdominal palpation to check fetal position)⁷ with clinical formulas like Dare's formula⁸, which multiplies abdominal girth by symphysio-fundal height. Ultrasonography is widely used for prenatal fetal weight measurement.⁹ It was quickly hailed as being superior to several clinical models of fetal weight estimation after it was used to predict prenatal fetal weight (the majority of the very well-known clinical models, including the tactile method, evaluation of clinical risk factor, and use of birth weight estimation formulae, are associated with considerable variation). It was proposed that sonographic fetal weight estimation has an advantage over clinical methods because it eliminates the subjectivity associated with clinical methods by relying on objective intrauterine linear and/or planar measurement of fetal parameters.^{5,9}

Over time, the ultrasound-based techniques have changed as many models as possible with various combinations of fetal biometry characteristics have been proposed by researchers. Nevertheless, it has

been demonstrated that these models have large systematic and random errors; also, no single model has been demonstrated to be relevant for all populations due to variations in demographic characteristics. Therefore, before using these models in regular practice, comprehensive validation studies are necessary.¹⁰

The present study was designed to evaluate the correlation between ultrasonographically EFW at term and the actual birth weight (ABW) in patients attending a tertiary care hospital.

Methodology

This was a cross-sectional observational study conducted on 135 participants in Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore from October 2023 to April 2025 (1 year 6 months). The ethical approval was obtained from the institutional ethical committee post which the study was commenced.

The study participants constituted consecutive pregnant women with singleton term pregnancies (37 weeks to 41 + 6 weeks), cases uncomplicated by maternal and fetal infections and those who delivered within 7 days of ultrasound. The women had their gestational age confirmed by the last menstrual period (LMP) or ultrasound scanning at 5–20-week gestation. They had been booked for antenatal care and managed according to the existing departmental protocols. Pregnant women with the following conditions were excluded from the study: multiple pregnancies, FGR, Hypertensive diseases, gestational diabetes mellitus, amniotic fluid disorders, anemia, Rh negative pregnancy, congenital anomalies and delivery after 7 days of ultrasound (this was to minimize fetal weight changes before delivery). Those in whom fetal parts could not be adequately visualized were also excluded from the study.

All patients were explained about the procedure in detail and written informed consent was obtained for the same. Information on age, LMP, gestational age, and parity was obtained. The patient was placed in the supine position, abdomen exposed, and coupling gel applied before scanning. Ultrasound scans were performed using Voluson E6 with a 3.5 MHz curvilinear transducer by an experienced radiologist. The biparietal diameter (BPD) was measured from the outer table of the proximal fetal skull to the inner table of the opposite side of the skull at the level of the falx cerebri, the thalamus, and the cavum septum pellucidum.¹¹ Femoral length (FL) was measured using the length of the ossified diaphysis of the fetal femur from the greater trochanter to the femoral condyles.¹² Abdominal circumference (AC) was measured at the level of the junction of the umbilical vein and portal sinus around

the fetal abdomen.¹³ The head circumference (HC) was measured using elliptical calipers over the four points of BPD and occipital frontal diameter in the same plane as BPD, between the leading edge of the frontal bone and the outer edge of the occiput.¹⁴ Ultrasound estimates were recorded in the study pro forma. Following the ultrasonography, the estimated weight for each fetus was calculated using Hadlock's formula as mentioned below:¹⁵

$$\log_{10}(\text{EFW}) = 1.326 - 0.00326 (\text{AC} \times \text{FL}) + 0.0107 (\text{HC}) + 0.0438 (\text{AC}) + 0.158 (\text{FL})$$

All babies delivered by vaginal or through cesarean section were weighed using the electronic baby weighing machine soon after birth.

Statistical Analysis

The data was collected, compiled and compared statistically by frequency distribution and percentage proportion. Quantitative data variables were expressed using Descriptive statistics (Mean ± SD). Qualitative data variables were expressed by using frequency and percentage (%). P values of <0.05 were considered statistically significant. Data analysis was performed by using SPSS Version 20. The analysis included computation of Pearson's correlation coefficient and Bland–Altman plots to assess agreement between USG estimates and actual birth weights.

Results

Table 1: Age Distribution of Study Samples

Age group	Frequency	Percent
Up to 20 years	9	7
21-25 years	51	38
26-30 years	51	38
31-35 years	21	16
36 & above	3	2
Total	135	100
Mean ± SD	26.47 ± 4.14	

The mean age of the study participants was 26.47 with a standard deviation of 4.14 years. The highest proportion was observed in the 21–25 years and 26–30 years age groups, each comprising 38% of the sample. (Table 1)

Table 2: Type of Gravida

Gravida Type	Frequency	Percent
Primi gravida	50	37
Multi gravida	85	63
Total	135	100

Among the 135 participants, 37% were primigravidae, 63% were multigravidas. (Table 2)

Table 3: Distribution of USG Weights

USG Weight	Frequency	Percent
2000-2499 grams	1	1
2500-2999 grams	35	26
3000 grams & above	99	73
Total	135	100
Mean ± SD	3196 ± 315	

The mean USG-estimated fetal weight was 3196 grams with a standard deviation of 315 grams. Estimated weights ≥3000 grams accounted for 73% of the cases, while 26% were between 2500–2999 grams. (Table 3)

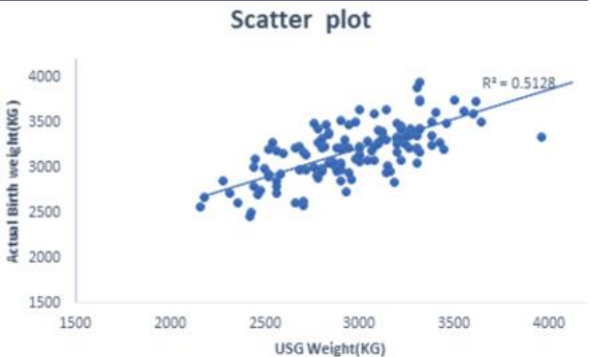
Table 4: Distribution of Actual Birth Weights

Actual Birth Weight	Frequency	Percent
2000-2499 grams	12	9
2500-2999 grams	57	42
3000 grams & above	66	49
Total	135	100
Mean ± SD	2976 ± 346	

The mean actual birth weight was 2976 grams with a standard deviation of 346 grams. Birth weights ≥3000 grams constituted 49% of cases, and 9% were between 2000–2499 grams. (Table 4)

Table 5: Pearson Correlation Coefficient Between Actual Birth Weight and USG Weight

Variables	N	Correlation Coefficient	Sig.
Actual birth weight and USG weight	135	0.716	0.000



The results of Pearsons correlation coefficient show a strong positive correlation between USG estimated fetal weight and actual birth weight ($r = 0.716$, $p < 0.001$). The relationship is statistically significant, implying good predictive accuracy of ultrasonographic estimation. (Table 5, Figure 1)

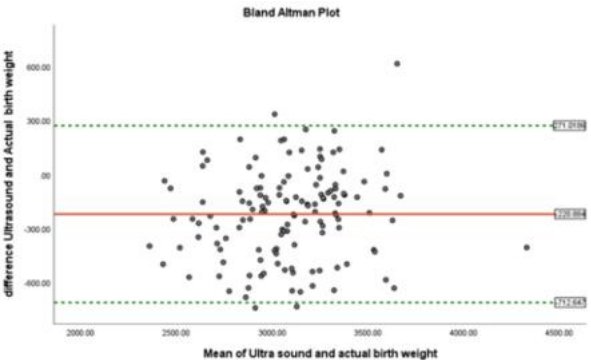


Figure 2: Bland Altman Plot

The Bland–Altman plot demonstrates the agreement between USG-estimated and actual birth weights. The mean difference (bias) appears small, indicating no systematic over- or under-estimation across the range of measurements. Most data points lie within the 95% limits of agreement, suggesting good concordance between the two measurement methods. (Figure 2)

DISCUSSION

The main factor influencing prenatal and neonatal morbidity and mortality is fetal weight. Both intrauterine growth restriction and fetal macrosomia raise the risk of long-term neurological and developmental problems as well as neonatal morbidity.¹⁶ In order to lower the risk of intrauterine fetal death, delivery is recommended if an intrauterine growth-restricted fetus is discovered after 37 weeks of gestation. In a similar vein, a diagnosis of fetal macrosomia, particularly in the pelvis, may indicate a cesarean delivery. Therefore, fetal health and labor and delivery care are significantly impacted by accurate fetal weight estimation.^{1,16}

EFW is a crucial indicator of fetal development and health and gives the obstetrician crucial information to determine the best course of action. Therefore, it is essential that EFW precisely represent the weight of the infant in utero at that moment.^{10,17} Hadlock regression model (Hadlock-4) employs four fetal measurements: HC, BPD, AC, and FL that are commonly utilized and are dependable. Although American demographic data used as the foundation for the Hadlock-4, several research have discovered that this approach is more accurate when applied to an Indian population.^{18,19} The majority of ultrasound equipment systems currently on the market in India are set up with Hadlock-4.¹⁰

In the present study, most patients belonged to the age group of 21–25 years and 26–30 years; each comprising 38% of the sample. In a study by Amrita et al.,²⁰ most patients (54%) belonged to the age group of 25–30 years while a study by Patil et al.,²¹ noted 21–25 years age group to be the most common in their study. Among the 135 participants, majority (63%) were multigravida contrasting with studies by Amrita et al.,²⁰ and Khatri et al.,²² where majority were primigravida.

The mean EFW was 3196 ± 315 grams. This was slightly higher than that reported in studies by Zaman et al.,²³ and Nayak et al.,²⁴ who

reported EFW of 2942 ± 395 (gm) and 3026.05 ± 391.33 (gm) respectively. Around 73% of the fetuses weighed ≥ 3000 grams. Eze et al reported similar results with over 74% fetuses weighing over 3000 grams.⁵ The mean ABW was 2976 ± 346 grams. Similarly, Fatima et al in their research reported a ABW of the mean actual birth weight was 2930 grams.²⁵

The Bland and Altman plot is a graphical technique for examining the reproducibility and reliability of sonographic measurements by comparing such replicate measurements to ascertain their agreement.²⁶ The present study revealed a strong positive correlation between EFW and ABW implying good predictive accuracy of ultrasonographic estimation. Most data points lie within the 95% limits of agreement, suggesting good concordance between the two measurement methods. A mild overestimation of birth weight was noted. Similar results were obtained in studies by Eze et al⁵ while Joish et al²⁷ noted that the EFW with Hadlock-4 overestimated ABW by a mean of 12.8%. Therefore, it may be inferred that sonographically EFWs seem to have accurately predicted ABWs in the population. This finding supports earlier researchers' findings that sonography is a reliable indicator of ABW.^{5,28}

Our findings have important ramifications because ultrasound is not widely available in many healthcare delivery systems in resource-limited settings particularly in rural areas.

Strengths

Only singleton term pregnancies (≥ 37 weeks) were included in the study which reduced biological growth variability. The Hadlock Formula 4 used for measurement incorporates BPD, HC, AC, FL which provides better accuracy at term & higher birth weights. The Voluson E6 equipment used for ultrasound provides high-resolution imaging owing to its precise caliper placement. Further the scans were performed by an experienced radiologist ensuring minimal inter-observer variation. There was a short interval between USG and delivery leading to reduced error due to fetal weight gain. A uniform protocol was followed during the conduct of the study with adequate sample size (= 135)

Limitations

The single-center design, sample size, operator dependence, and restricted inclusion criteria may limit external validity. Further studies with larger, multi-center samples are recommended to validate these findings across diverse populations.

CONCLUSION

Ultrasonographic estimation of fetal weight at term showed a significant positive correlation with actual birth weight and demonstrated acceptable agreement on Bland–Altman analysis. Although ultrasound tended to mildly overestimate birth weight, it provided a useful estimate of fetal weight in singleton term pregnancies. Ultrasonographic fetal weight estimation may therefore serve as a valuable adjunct to clinical assessment and support obstetric decision-making at term.

REFERENCES

- Aye AA, Agida TE, Babalola AA, Isah AY, Adewole ND. Accuracy of ultrasound estimation of fetal weight at term: A comparison of shepard and hadlock methods. *Ann Afr Med*. 2022;21(1):49-53.
- Sherman DJ, Arieli S, Tovbin J, Siegel G, Caspi E, Bukovsky I. A comparison of clinical and ultrasonic estimation of fetal weight. *Obstet Gynecol*. 1998;91(2):212-7.
- Henriksen T. The macrosomic fetus: a challenge in current obstetrics. *Acta Obstet Gynecol Scand*. 2008;87(2):134-45.
- MacGregor SN, Sabbagha R. Assessment of gestational age by ultrasound. *Glob libr women's med*. 2008;10.
- Eze CU, Abonyi LC, Njoku J, Okorie U, Owonifari O. Correlation of ultrasonographic estimated fetal weight with actual birth weight in a tertiary hospital in Lagos, Nigeria. *Afr Health Sci*. 2015;15(4):1112-22.
- Mohammadbeigi A, Farhadifar F, Soufi zadeh N, Mohammad-salehi N, Rezaiee M, Aghaei M. Fetal Macrosomia: Risk Factors, Maternal, and Perinatal Outcome. *Ann Med Health Sci Res*. 2013;3(4):546-50.
- Superville SS, Siccardi MA. Leopold Maneuvers. In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; 2026 [cited 2026 Aug 8]. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK560814/> PubMed PMID: 32809649.
- Kumari V, Singh A. Accuracy of Dare's formula in estimating fetal birth weight in pregnant women. *International Journal of Gynecology & Obstetrics*. 2024;166(1):368-72.
- Titapant V, Chawanpaiboon S, Mingmitpatanakul K. A comparison of clinical and ultrasound estimation of fetal weight. *J Med Assoc Thai*. 2001;84(9):1251-7.
- Hiwale SS. A Systematic Evaluation of Ultrasound-based Fetal Weight Estimation Models on Indian Population. *J Med Ultrasound*. 2017;25(4):201-7.
- Mavalankar DV, Trivedi CR, Gray RH. Levels and risk factors for perinatal mortality in Ahmedabad, India. *Bull World Health Organ*. 1991;69(4):435-42.
- Bossak WS, Spellacy WN. Accuracy of estimating fetal weight by abdominal palpation. *J Reprod Med*. 1972;9(2):58-60.
- Johnson RW, Toshach CE. Estimation of fetal weight using longitudinal mensuration. *Am J Obstet Gynecol*. 1954;68(3):891-6.
- Woo J. Short History of Development of Ultrasound in Obstetrics and Gynaecology. 2002. [Last accessed on 2026 Aug 08]. Available from: <http://www.ob-ultrasound.net/history1.html>.

- Hadlock FP, Harrist RB, Sharman RS, Deter RL, Park SK. Estimation of fetal weight with the use of head, body, and femur measurements—a prospective study. *Am J Obstet Gynecol*. 1985;151(3):333-7.
- Ekele B, Otubu JA. Maternal and perinatal mortality. In: Agboola A, editor. *Textbook of Obstetrics and Gynaecology for Medical Student*. 2nd ed. Ibadan: Heinemann Educational Books; 2006. pp. 526–31.
- Mlynarczyk M, Chauhan SP, Baydoun HA, Wilkes CM, Earhart KR, Zhao Y, et al. The clinical significance of an estimated fetal weight below the 10th percentile: a comparison of outcomes of <5th vs 5th-9th percentile. *Am J Obstet Gynecol*. 2017;217(2):198.e1-198.e11.
- Manoj K, Deepali J. Accuracy of ultrasound determination of estimated fetal weight in small for gestational age pregnancies. *Int J Med Res Prof*. 2016;2(4):57-61.
- Sanyal P, Ghosh TK, Dasgupta S, Karim R, Mukherjee A, Das A. Predictability of fetal birth weight from measurement of fetal thigh circumference by two-dimensional ultrasound: a prospective study. *Journal of South Asian Federation of Obstetrics and Gynaecology*. 2012;4:35-8.
- Amrita A, Kumari J, Biswas P, Sinha A, Prasad D, Pushpa P. A comparative study of estimation of fetal weight in term pregnancy by clinical and sonographic method. *J Family Med Prim Care*. 2026;15(1):386-90.
- Patil S, Sarvamangala B, Malipatil V. Comparative analysis of clinical and sonographic estimation of fetal weight in term pregnancy at a tertiary care hospital. *MGM Journal of Medical Sciences*. 2023;10(3):562-7.
- Khatir R, Bhardwaj G, Rawal S, Kumar RR, Malik N. A comparative study of clinical methods and ultrasound methods for prediction of fetal birth weight at term gestation. *N Indian J OBGYN*. 2024;10:349-56.
- Zaman JA, Kheya AK, Sultana F, Lia LN, Sultana R. Comparative study between clinical and sonographic estimation of foetal weight in 3rd trimester. *Journal of Pediatrics, Perinatology and Child Health*. 2024;8(3):98-104.
- Nayak L, Pradhan K, Kruthika M. Comparative study on Johnson's formula, Insler's formula and Hadlock's formula for estimating foetal weight at term. *J evid based med healthc*. 2017;4(11):600-5.
- Fatima SA, Devi VVLA, Kallur MB, Basha NM, Kabir MA. A comparative study on estimation of fetal weight in term pregnancy by clinical methods and USG with actual birth weight in a tertiary care center. *International journal of health sciences*. 2022;6(S8):1165-74.
- Bland JM, Altman DG. Measuring agreement in method comparison studies. *Stat Methods Med Res*. 1999;8(2):135-60.
- Joish UK, Rathod T, Anitha PS. Sonographic Estimated Fetal Weight Within an Indian Cohort: Is the Hadlock Four Regression Model Appropriate or Does It Merit Adjustments? *Journal of Diagnostic Medical Sonography*. 2022;38(2):137-45.
- Shittu AS, Kuti O, Orji EO, Makinde NO, Oggunniyi SO, Ayoola OO, et al. Clinical versus Sonographic Estimation of Foetal Weight in Southwest Nigeria. *J Health Popul Nutr*. 2007;25(1):14-23.