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DIAGNOSTIC ACCURACY OF THE HADLOCK METHOD FOR ULTRASONOGRAPHIC ESTIMATION OF FETAL WEIGHT USING ACTUAL BIRTH WEIGHT AS THE REFERENCE STANDARD: A CROSS-SECTIONAL VALIDATION STUDY

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Abstract

Background: *Accurate estimation of fetal weight is important for antenatal assessment and obstetric decision-making, particularly for identifying fetuses at the extremes of growth. Ultrasonographic estimation using the Hadlock method is widely used, but its diagnostic performance may vary between populations.*

Objective: *To determine the diagnostic accuracy of the Hadlock method for identifying abnormal fetal weight in term singleton pregnancies, using actual birth weight as the reference standard.*

Methods: *This cross-sectional diagnostic-accuracy study included 186 women aged 18-40 years with non-anomalous singleton pregnancies at 37- 42 weeks of gestation. Estimated fetal weight (EFW) was obtained by ultrasonography using the Hadlock formula incorporating biparietal diameter, head circumference, abdominal circumference and femur length. To account for fetal growth between ultrasound examination and delivery, 25 g was added to the EFW for each day elapsed between the examination and delivery. This growth-adjusted EFW was used for diagnostic classification. Abnormal fetal weight was predefined as EFW or actual birth weight below the 10th percentile or above the 95th percentile for gestational age. Actual birth weight was measured within one hour of delivery using a calibrated digital neonatal weighing scale and served as the reference standard. Diagnostic performance was assessed using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy.*

Results: *The mean maternal age was 29.39 ± 5.33 years and the mean gestational age was 39.03 ± 1.41 weeks. The mean growth-adjusted estimated fetal weight and actual birth weight were both 3.12 kg. Among the 186 pregnancies, 27 had abnormal birth weight according to the predefined criteria. The Hadlock method correctly identified 24 of these 27 cases, while 3 abnormal cases were classified as normal by ultrasonography. Five fetuses classified as having abnormal growth-adjusted estimated weight had normal birth weight. The sensitivity of the Hadlock method for detecting abnormal fetal weight was 88.89%, specificity was 96.86%, PPV was 82.76%, NPV was 98.09%, and* *overall diagnostic accuracy was 95.70%.*

Conclusion: *The Hadlock method demonstrated high diagnostic accuracy for identifying abnormal fetal weight in term, non-anomalous singleton pregnancies in this cohort. Its high specificity and negative predictive value suggest good performance in identifying pregnancies unlikely to have abnormal fetal weight. Nevertheless, individual estimation errors remain possible, and ultrasonographic fetal-weight estimates should be interpreted alongside gestational age, fetal-growth assessment and other clinical findings.*

INTRODUCTION

Accurate estimation of fetal weight is an important component of antenatal assessment because fetal size influences obstetric decision-making, including the timing and mode of delivery and preparation for neonatal care. Identification of fetuses at the extremes of growth is particularly important because small-for-gestational-age and large-for-gestational-age fetuses are associated with increased risks of adverse perinatal outcomes. Ultrasonographic assessment of fetal biometry therefore plays an important role in the evaluation of fetal size and growth and in guiding subsequent obstetric management.[1,2]

Ultrasonography is the most widely used non-invasive method for estimating fetal weight. Standard fetal biometric measurements include biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL), which can be combined using regression-based formulae to derive an estimated fetal weight (EFW).[2] The Hadlock method is among the most widely used approaches for sonographic fetal-weight estimation. In a prospective study, Hadlock et al. demonstrated that models incorporating measurements of fetal head size, abdominal size and femur length provided more accurate estimates of fetal weight than models based on fewer biometric parameters.[3] Subsequent large-scale evaluation of fetal-weight estimation formulae has continued to demonstrate good performance of Hadlock-based models. In a study of 5,163 singleton pregnancies, Hammami et al. found that the Hadlock model was among the most accurate previously published formulae, with an estimated fetal weight within 10% of actual birth weight in approximately 80% of pregnancies.[4]

Despite its widespread clinical use, ultrasonographic fetal-weight estimation is not perfectly accurate. Measurement error, operator experience, gestational age, fetal size and population characteristics may influence the agreement between estimated fetal weight and actual birth weight. A systematic review by Milner and Arezina demonstrated clinically relevant random error in ultrasound-based fetal-weight estimation and highlighted variation in performance between formulae and clinical settings.[5] Differences in maternal anthropometry, nutritional status, ethnicity and fetal growth patterns may also affect the applicability of a formula developed in one population to another. For this reason, assessment of the performance of established fetal-weight estimation methods in different populations remains clinically relevant.[4,5]

Evidence from Pakistan supports the clinical usefulness of ultrasonographic fetal-weight estimation but also demonstrates variation in its accuracy. Nasir et al. compared clinical and ultrasonographic methods of fetal-weight estimation with actual birth weight in term pregnancies and highlighted the role of ultrasound in antenatal fetal-weight assessment.[6] Jesrani et al., in a prospective study of 470 term pregnancies in Quetta, reported that 85.5% of ultrasound estimates were within 10% of actual birth weight, with a mean absolute error of 226.67 g.[7] Similarly, Rauf et al. reported a strong positive correlation between ultrasonographically estimated fetal weight and actual birth weight in a Pakistani population ($r = 0.93$, $p < 0.01$).[8] However, these findings cannot necessarily be extrapolated to all Pakistani populations because fetal-weight estimation may vary according to population characteristics, gestational-age distribution, operator expertise and the ultrasound formula used.

Given the clinical importance of identifying abnormal fetal weight and the potential variation in the performance of ultrasound-based estimation across populations, local validation of commonly used fetal-weight estimation methods is warranted. In the present study, abnormal fetal weight was defined as estimated or actual fetal weight below the 10th percentile or above the 95th percentile for gestational age. Therefore, this study aimed to determine the diagnostic accuracy of the Hadlock method for identifying abnormal fetal weight in term, non-anomalous singleton pregnancies by comparing ultrasonographically estimated fetal weight with actual birth weight as the reference standard.

MATERIALS AND METHODS

Study design and setting

This cross-sectional diagnostic-accuracy study was conducted in the Department of Radiology, Ayub Teaching Hospital, Abbottabad, Pakistan. The study spanned from January 2025 to December 2025 (data collection lasted approximately one year). The recruitment of participants started following approval from the Institutional Ethical Review Board (Approval No. RC-EA-2024/199) and College of Physicians and Surgeons Pakistan (CPSP). The study was designed and reported with reference to the Standards for Reporting Diagnostic Accuracy Studies (STARD 2015) framework.[9]

Participants and sampling

The study included 186 pregnant women recruited using consecutive non-probability sampling. Women aged 18-40 years with non-anomalous singleton pregnancies between 37 and 42 weeks of gestation were eligible. Women with multiple pregnancies, known congenital fetal anomalies, polyhydramnios, oligohydramnios, or incomplete clinical records were excluded. Written informed consent was obtained from all participants.

The sample size was calculated using the WHO sample size calculator for diagnostic-accuracy studies, assuming an anticipated sensitivity of 97.37%, specificity at 40.97%, prevalence was assumed to be 50%, a 95% confidence level, and a 10% margin of error.[7] The calculated minimum sample size was approximately 180 participants; 186 women were ultimately included.

Ultrasonographic estimation of fetal weight

Obstetric ultrasonography was performed using a Toshiba Xario™ 100 Platinum ultrasound system (Canon Medical Systems Corporation, Otawara, Japan) equipped with a 3.5-5.0 MHz convex transducer. Standard fetal biometric parameters, including biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL), were measured using a standardized scanning technique. Estimated fetal weight (EFW) was calculated using the ultrasound system's built-in Hadlock formula incorporating BPD, HC, AC, and FL. The Hadlock approach has been widely used for sonographic estimation of fetal weight and incorporates multiple fetal biometric parameters to improve estimation compared with models using fewer measurements.[3,4]

All ultrasound examinations were performed by an experienced senior radiologist using a standardized technique.

Because fetal growth continues between the time of ultrasonographic assessment and delivery, the estimated fetal weight was adjusted for the interval between ultrasound examination and delivery. A fetal weight increment of 25 g per day was added to the ultrasonographically estimated fetal weight for each day elapsed between the ultrasound examination and delivery. The resulting growth-adjusted estimated fetal weight was used for comparison with actual birth weight and for diagnostic classification.

Definition of abnormal fetal weight

For the purpose of this study, fetal weight was considered abnormal when the estimated fetal weight or actual birth weight was below the 10th percentile or above the 95th percentile for gestational age. Fetuses with weights between the 10th and 95th percentiles were classified as having normal fetal weight. The same predefined classification criteria were applied to the

ultrasonographic estimate and the reference-standard birth weight to construct the diagnostic 2 × 2 contingency table.
Editorial point for author confirmation: the specific fetal-growth reference chart used to determine the 10th and 95th percentiles should be inserted here before submission.

Reference standard
Actual birth weight (ABW) was used as the reference standard for evaluating the diagnostic performance of ultrasonographic fetal-weight estimation. Following delivery, the newborn was weighed within one hour of birth using a calibrated digital neonatal weighing scale. The measured birth weight was subsequently classified as normal or abnormal according to the predefined gestational-age-specific percentile criteria. The reference-standard assessment was performed after delivery and was independent of the antenatal EFW classification.

Assessment of diagnostic accuracy
The diagnostic performance of the Hadlock method was assessed by comparing the growth-adjusted estimated fetal weight with the corresponding classification based on actual birth weight, which served as the reference standard. For diagnostic-accuracy calculations, abnormal fetal weight was considered the positive condition. A 2 × 2 contingency table was constructed to determine true-positive, true-negative, false-positive and false-negative classifications. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated accordingly. Pearson's correlation coefficient (r) was used to assess the linear association between growth-adjusted EFW and ABW. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate, and a p-value ≤ 0.05 was considered statistically significant. Participant confidentiality was maintained by anonymizing the dataset before analysis.

RESULTS

Participant characteristics
A total of 186 pregnant women fulfilling the eligibility criteria were included in the analysis. The mean maternal age was 29.39 ± 5.33 years, while the mean gestational age was 39.03 ± 1.41 weeks. The mean growth-adjusted estimated fetal weight was 3.12 ± 0.52 kg and the mean actual birth weight was 3.12 ± 0.51 kg. Median values and interquartile ranges are presented in Table 1.

Table 1. Descriptive statistics and normality assessment

Variable	Mean ± SD	Median (IQR)
Age (years)	29.39 ± 5.33	30.0 (25.25–34.00)
Height (cm)	159.64 ± 7.98	160.0 (153.00–166.75)
Weight (kg)	70.03 ± 13.18	70.0 (59.00–81.00)
Gestational age (weeks)	39.03 ± 1.41	39.0 (38.00–40.00)
Estimated fetal weight (kg)	3.12 ± 0.52	3.11 (2.76–3.54)
Actual birth weight (kg)	3.12 ± 0.51	3.11 (2.74–3.57)

All quantitative variables failed the Shapiro–Wilk normality test ($p < 0.05$); therefore, median (IQR) was used as the preferred summary measure.
The distribution of maternal and obstetric history is shown in table 2. The study population included 96 (51.6%) women from urban areas and 90 (48.4%) from rural areas. Ninety-seven (52.2%) women were primigravida and 89 (47.8%) were multigravida. Normal vaginal delivery occurred in 123 (66.1%) cases and cesarean delivery in 63 (33.9%) cases. (Table 2).

Table 2. Distribution of maternal and obstetric characteristics

Characteristic		n (%)
Residence	Urban	96 (51.6)
	Rural	90 (48.4)
Parity	Primigravida	97 (52.2)
	Multigravida	89 (47.8)
Education	Illiterate	26 (14.0)
	Primary	40 (21.5)
	Secondary	66 (35.5)
	Graduate	54 (29.0)
Profession	Housewife	58 (31.2)
	Employed	63 (33.9)
	Self-employed	65 (34.9)
Socioeconomic status	Low	51 (27.4)
	Middle	80 (43.0)
	High	55 (29.6)
Mode of delivery	Normal vaginal delivery	123 (66.1)
	Cesarean section	63 (33.9)

Diagnostic classification

Using actual birth weight as the reference standard, 159 fetuses were classified as having normal fetal weight and 27 as having abnormal fetal weight. According to the predefined diagnostic classification, the growth-adjusted Hadlock estimate identified 24 of the 27 fetuses with abnormal fetal weight correctly, while three were classified as normal. Among the 159 fetuses with normal birth weight, five were incorrectly classified as abnormal and 154 were correctly classified as normal as shown in table 3.

Thus, the contingency table comprised 24 true-positive, 154 true-negative, 5 false-positive and 3 false-negative classifications.

Table 3. 2 × 2 contingency table for detection of abnormal fetal weight

Growth-adjusted EFW	Actual abnormal	Actual normal	Total
Abnormal	24 (TP)	5 (FP)	29
Normal	3 (FN)	154 (TN)	157
Total	27	159	186

Diagnostic accuracy

The sensitivity of the Hadlock method for detecting abnormal fetal weight was 88.89%, indicating that 24 of 27 fetuses with abnormal birth weight were correctly identified. Specificity was 96.86%, with 154 of 159 fetuses with normal birth weight correctly classified. The positive predictive value was 82.76%, while the negative predictive value was 98.09%. The overall diagnostic accuracy was 95.70%, with 178 of 186 fetuses correctly classified. (table 4). The association between ultrasonographic classification and reference-standard classification was statistically significant (χ^2 test, $p < 0.001$).

Table 4. Diagnostic performance of the Hadlock method

Diagnostic measure	Value
Sensitivity	88.89%
Specificity	96.86%
Positive predictive value	82.76%
Negative predictive value	98.09%
Overall diagnostic accuracy	95.70%

Maternal and demographic subgroup analysis

No statistically significant association was observed between diagnostic classification and maternal age, weight, height, parity, residence, profession, education, monthly income or socioeconomic status. Because the number of abnormal-weight cases was relatively small, these subgroup findings should be interpreted cautiously and should not be regarded as evidence that maternal or sociodemographic characteristics have no effect on the accuracy of fetal-weight estimation. (Table 5).

Table 5. Post-stratification analysis of diagnostic accuracy

Variable	χ^2	df	p-value
Age group (20–25, 26–30, 31–38 years)	4.012	2	0.132
Weight group (48–59, 60–74, 75–92 kg)	0.160	2	0.924
Height group (145–154, 155–164, 165–172 cm)	4.074	2	0.130
Parity	1.035	1	0.307
Residence	2.265	1	0.132
Profession	0.768	2	0.678
Education	2.983	3	0.393
Monthly income	1.258	4	0.870
Socioeconomic status	0.680	2	0.706

DISCUSSION

The present study evaluated the diagnostic performance of the Hadlock method for identifying abnormal fetal weight in 186 term, non-anomalous singleton pregnancies, using actual birth weight as the reference standard. To account for fetal growth between ultrasound examination and delivery, the ultrasonographically estimated fetal weight was adjusted by adding 25 g for each day elapsed before delivery. Using this growth-adjusted estimate, the Hadlock method demonstrated an overall diagnostic accuracy of 95.70%, with a sensitivity of 88.89% and specificity of 96.86%. The positive predictive value was 82.76% and the negative predictive value was 98.09%. These findings indicate that the method performed particularly well in correctly classifying fetuses with normal birth weight, while also identifying the majority of fetuses with abnormal weight.

The high diagnostic performance observed in this study is consistent with the established role of multi-parameter ultrasonographic fetal-weight estimation. The original work of Hadlock et al. demonstrated improved fetal-weight estimation when multiple fetal dimensions were incorporated into regression models.[3] Hammami et al. subsequently evaluated 5,163 singleton pregnancies and 70 previously published fetal-weight models and found that models incorporating at least three biometric parameters performed better than those using fewer measurements. The 1985 Hadlock model incorporating head circumference, abdominal circumference and femur length was among the most accurate models, with a strong correlation between estimated and birth weight and approximately 80% of estimates within 10% of actual birth weight.[4]

The findings are also compatible with systematic reviews demonstrating that the Hadlock approach remains one of the more consistent methods for ultrasound fetal-weight estimation. Milner and Arezina reported that the Hadlock A formula had the lowest random error among the formulae assessed, although clinically relevant individual-level errors remained.[5] Dudley's earlier systematic review similarly emphasized that ultrasound fetal-weight estimation is affected by random error and intra- and interobserver variability.[10] These findings are important when interpreting the present study because high diagnostic accuracy at the population level does not imply that the estimated weight will be exact for every individual fetus.

The present findings are broadly comparable with evidence from Pakistan. Nasir et al. reported that ultrasonographic fetal-weight estimation was a useful approach when compared with clinical estimation in 100 term pregnancies.[6] Jesrani et al., in 470 term pregnancies from Quetta, found that 85.5% of ultrasound estimates were within 10% of actual birth weight, with a mean absolute error of 226.67 g. They also observed that accuracy decreased with increasing gestational age and that ultrasound tended to overestimate lower birth weights and underestimate higher birth weights.[7] Rauf et al. reported a strong positive correlation between ultrasonographically estimated fetal weight and actual birth weight in a Pakistani population ($r = 0.93$, $p < 0.01$).[8] The high overall classification accuracy in the present study therefore adds further evidence supporting the usefulness of ultrasonographic fetal-weight estimation in Pakistani clinical settings.

International studies also demonstrate that the performance of ultrasound fetal-weight estimation varies according to population and clinical circumstances. Joish et al. evaluated the Hadlock four-parameter regression model in an Indian cohort and found a strong relationship between estimated fetal weight and actual birth weight, while also identifying systematic differences between estimated and actual weights.[11] A Nigerian study comparing the Hadlock and Shepard methods likewise demonstrated useful fetal-weight estimation at term but reported measurable estimation error.[12] Another prospective study comparing ultrasound with clinical examination found that trained ultrasound examiners achieved the most accurate estimates, emphasizing the influence of operator expertise.[13] Ezeugo et al. similarly reported greater accuracy with ultrasonographic than clinical fetal-weight estimation in a prospective Nigerian cohort.[14]

More recent large-scale evidence further demonstrates that the accuracy of fetal-weight estimation is not uniform across the fetal-weight spectrum. Lindström et al., using data from more than 31,000 singleton pregnancies, found that the performance of fetal-weight estimation varied according to gestational age and fetal size. For the Hadlock 2 formula, approximately 69% of estimates were within ±10% of birth weight, while systematic error was greater among fetuses at the extremes of size.[15] These observations are relevant to the current study because the cohort was predominantly composed of term pregnancies with a mean actual birth weight of approximately 3.12 kg. Consequently, the excellent diagnostic performance observed here may not necessarily apply to markedly growth-restricted, very large, preterm or post-term fetuses.

An important distinction in interpreting the present findings is that diagnostic classification and numerical estimation are not identical outcomes. The present study demonstrates high accuracy in classifying fetal weight as normal or abnormal according to the predefined percentile thresholds. However, sensitivity, specificity and predictive values do not describe the magnitude or direction of the error in individual fetal-weight estimates. Studies of fetal-weight estimation commonly report mean percentage error, mean absolute percentage error and the proportion of estimates within ±10% of actual birth weight.[4,5,14] These measures would provide additional information about whether the Hadlock method systematically overestimates or underestimates fetal weight in this population.

The use of actual birth weight as the reference standard is a strength of the present study. Birth weight was measured within one hour of delivery using a calibrated digital neonatal weighing scale, reducing the potential for measurement error in the reference-standard assessment. In addition, the investigators accounted for fetal growth occurring between ultrasound examination and delivery by applying a predefined increment of 25 g/day to the ultrasound-derived fetal weight. This adjustment was intended to reduce the discrepancy attributable to physiological fetal growth during the interval between the index test and delivery. The ultrasound examinations were performed using the same ultrasound platform and by an experienced senior radiologist following a standardized technique. These features are likely to have reduced variability in fetal biometric acquisition.

Another strength is the inclusion of women from both urban and rural areas and the relatively balanced representation of primigravida and multigravida women. However, the single-centre design and consecutive non-probability sampling limit the generalizability of the findings. STARD recommends that diagnostic-accuracy studies clearly describe participant selection, index-test procedures, reference-standard procedures, prespecified positivity thresholds, timing between index testing and reference-standard assessment, and estimates of diagnostic accuracy with measures of precision.[9] In the present study, the effect of the ultrasound-to-delivery interval was addressed by applying the predefined 25 g/day fetal-growth adjustment; the actual distribution of this interval should nevertheless be reported if available.

The percentile-based definition used in this study also warrants careful consideration. A fetal weight below the 10th percentile is widely used in defining small-for-gestational-age status, although fetal growth restriction cannot be diagnosed solely on the basis of fetal size and requires consideration of additional clinical and Doppler findings.[2] The upper threshold used in this study was the 95th percentile. Because fetal-growth reference standards can differ between populations, the specific growth chart or reference standard used to determine the 10th and 95th percentiles should be stated explicitly in the Methods section. This is particularly relevant when comparing the present findings with studies using different definitions of SGA or LGA.

The high negative predictive value of 98.09% observed in this cohort suggests that a fetus classified as having normal weight by the Hadlock method was unlikely to have abnormal birth weight according to the study definition. Nevertheless, predictive values are influenced by the prevalence of the target condition in the study population and therefore should not be interpreted as fixed properties of the test. The relatively small number of abnormal-weight pregnancies in the present sample also results in wider statistical uncertainty around the sensitivity and PPV estimates.

The clinical relevance of accurate fetal-weight estimation extends beyond predicting birth weight alone. Identification of suspected fetal growth abnormality can influence surveillance, delivery planning and preparation for neonatal management. However, current fetal-growth guidance emphasizes that fetal size should be interpreted in the context of gestational age, growth trajectory and other indicators of fetal well-being rather than used as an isolated determinant of management.[2] Similarly, ACOG emphasizes that ultrasonographic estimation of fetal weight has limitations, particularly when suspected macrosomia is being evaluated, and that clinical decisions should incorporate the overall obstetric context.[16]

The present study also has implications for resource-constrained healthcare settings. Ultrasonography is relatively accessible, non-invasive and does not involve ionizing radiation. In settings where access to more advanced fetal imaging is limited, improving the standardization and quality of routine obstetric ultrasound may provide greater practical benefit than introducing more complex techniques. The high diagnostic accuracy demonstrated in this cohort supports continued use of the Hadlock method, provided that ultrasound findings are interpreted appropriately and measurement quality is maintained.

Limitations

This study has several limitations. First, it was conducted at a single tertiary-care centre with a relatively modest sample size of 186 women and used consecutive non-probability sampling, limiting generalizability. Second, the study included only term, non-anomalous singleton pregnancies and therefore does not establish the accuracy of the method in preterm pregnancies, multiple gestations, fetal anomalies or complicated pregnancies.

Third, all ultrasound examinations were performed by one experienced radiologist. Although this reduces inter-observer variability, it may limit external validity because diagnostic performance may differ when scans are performed by operators with varying levels of experience. Operator experience, image quality and measurement technique are recognized sources of error in fetal-weight estimation.[5,10]

Finally, the manuscript should report the specific fetal-growth reference chart used to determine the 10th and 95th percentiles. Although a 25 g/day adjustment was applied to account for fetal growth between ultrasound examination and delivery, the validity of this fixed increment should be considered in future studies because fetal growth is not necessarily constant across gestation or across individual pregnancies. The choice of growth reference can also influence classification of abnormal fetal size.

Implications for future research

Future multicentre Pakistani studies should include larger and more heterogeneous populations and should evaluate fetal-weight estimation across the full range of gestational ages and fetal sizes. Studies should also report mean percentage error, mean absolute percentage error, the proportion of estimates within ±10% of birth weight and Bland–Altman limits of agreement. Comparison of Hadlock with other contemporary fetal-weight models and assessment of inter-observer variability would further clarify whether population-specific calibration is warranted.

CONCLUSION

The Hadlock method demonstrated high diagnostic accuracy for identifying abnormal fetal weight in term, non-anomalous singleton pregnancies, with an overall accuracy of 95.70%, sensitivity of 88.89% and specificity of 96.86% when actual birth weight was used as the reference standard. The high negative predictive value suggests that the method performed particularly well in excluding abnormal fetal weight in this cohort.

These findings support the continued clinical use of the Hadlock method for fetal-weight assessment in term singleton pregnancies. However, ultrasonographic fetal-weight estimation remains subject to individual measurement error and should be interpreted together with gestational age, fetal-growth assessment, Doppler findings and the broader clinical context. Larger multicentre studies in Pakistan, incorporating standardized measures of percentage error and agreement, are warranted to determine the generalizability of these findings.

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