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Ultrasonographic Value of Measuring Fetal Liver Length for Estimation of Fetal Weight

Manahil Abdelazim Suliman[1]*, Asma Alamin[2], Kamal Mahgoub Omer[1], Mohammed Abdelaziz Alauda[3], Ikhlas Abdelaziz Hassan[2], Eman Mahgoub Mustafa[4]

[1]College of Graduate Studies, College of Medical Radiological Sciences, Sudan University of Science and Technology, Khartoum, Sudan
[2]Department of Diagnostic Radiology, Collage of Medical Radiological Sciences, Sudan University of Science and Technology, Khartoum, Sudan
[3]Administrative Director of Al-Auda Medical Center, Hafar Al-Batin, Saudi Arabia
[4]Al-Alami Medical Group, Al-Riyadh, Saudi Arabia

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***Corresponding author:** Manahil Abdelazim Suliman
College of Graduate Studies, College of Medical Radiological Sciences, Sudan University of Science and Technology, Khartoum, Sudan

Abstract

Background and Objectives: Accurately estimating fetal weight is critical for optimal obstetric management. This study aimed to evaluate the efficacy of using fetal liver length, measured via ultrasonography, to predict estimated fetal weight (EFWG). The specific objectives were to assess fetal weight using fetal liver length, establish predictive mathematical formulas, correlate liver length with EFWG, and quantify the strength of the association between fetal liver parameters and fetal weight. ***Methods:*** A cross-sectional study was conducted on a sample of 173 pregnant women with confirmed normal pregnancies at Ultrasound Department of Al-Auda Medical Center in Hafr Al-Batin, KSA; Pregnancies with suspected congenital abnormalities were excluded. Sonographic evaluations were performed using a real-time grayscale scanner (Mindray and Fujifilm) equipped with a 3.5 MHz curvilinear array transducer. Data collection involved measuring fetal liver length, and the data were analyzed using bivariate correlation and multiple linear regression methods. ***Results:*** The proposed simple linear regression analysis revealed that fetal liver length demonstrated a strong positive linear correlation with estimated fetal weight ($R = 0.766$). The coefficient of determination ($R^2 = 0.587$) confirms that approximately 58.7 % of the total variance in fetal weight can be directly explained by liver length alone. The adjusted R^2 (0.585) further substantiates the stability and reliability of the model. The analysis of variance yielded an F-statistic of 243.082 ($p < 0.001$), verifying that the regression model is highly significant and that the relationship is robust rather than a result of random chance. The derived unstandardized model provides a direct mathematical formula for clinical application: EFW G = -1637.782 + 492.151 X (Liver Length). The unstandardized coefficient for liver length ($B = 492.151$, $t = 15.591$, $p < 0.001$) confirms its critical role in assessing fetal growth parameters. Overall, these findings validate fetal liver length as a dependable, highly accurate metric for clinical estimation of fetal weight in routine obstetrical evaluations. This equation specifies that for every 1 cm increase in fetal liver length, the estimated fetal weight increases by approximately 492.15 g. ***Conclusion:*** The findings demonstrate that fetal liver length is a robust and statistically significant predictor of estimated fetal weight, offering a reliable, alternative parameter for comprehensive fetal growth assessment in clinical practice.

Keywords: Fetal Liver Length (FLL), Estimated Fetal Weight (EFW), Ultrasonography.

1. INTRODUCTION

The Ultrasonographic evaluation of fetal weight helps predict fetal birth weight precisely and can influence obstetric management decisions concerning timing and route of delivery, thus reducing perinatal morbidity and mortality (Ranjumoni Konwar *et al*, 2021). Estimation of fetal weight in utero had formed a significant component in obstetrical practices, ever since the inception of ultrasonography pioneered by Dr. Ian Donald in 1958 (Campbell S 2013). Fetal weight estimation plays a vital role in many obstetrical decisions regarding intrauterine growth monitoring, delivery, as well as determining high-risk pregnancies (Ugwu E. *et al*, 2014, Njoku C *et al* 2014). Fetal weight is considered an independent risk factor of high perinatal morbidity and mortality. Both low and high fetal weight at delivery may lead to complications in labor and delivery to both the child and mother (UGu E. *et al*, 2014, Bajracharya J 2012, Ranjumoni Konwar *et al*, 2021). Macrosomia is defined as a fetal weight above 4000 g or a birth weight above the 90th percentile for gestational age. Inaccuracy in the estimation of fetal weight may also increase the risk in management and during delivery, specifically in suspected macrosomia (Ray E. M., Alhusen J. L 2016). Before the availability of ultrasound, conventional methods such as palpation of the maternal circumference and measurement of the maternal abdominal circumference and uterine height were used to estimate fetal weights. Though the traditional methods are easy to use, several maternal factors may affect assessment abilities, such as myomas, obesity, multiple gestations, and the amount of amniotic fluid. Hence, the assessments by the conventional methods may be inaccurate sometimes (Ugwu E. *et al*, 2014, Fox N. S *et al* 2009). Ultrasound is a reliable method for establishing the length of pregnancy and in this way can improve obstetric care. Use of the multiple parameters method of assessing gestational age is valid when the gestational age estimates of the various ultrasound parameters are similar. If the gestational age estimates of one or several parameters is greater than 2 weeks different than the estimates of the other parameters, either the abnormal ultrasound parameters should be excluded or a different method should be used to estimate gestational age. When the various ultrasound parameters predict different gestational ages, the fetus should be further evaluated to explain these differences. For example, an abnormally small FL measurement may suggest short-limb defects, a large BPD may be secondary to hydrocephalus and an abnormally small or large AC measurement may suggest asymmetric intrauterine growth retardation or macrosomia, respectively. As mentioned previously, the different ultrasound ratios (CI, HC/AC, and FL/BPD) may be used to identify abnormally small or large parameters. In the instance of an abnormal cephalic index, the HC should be used to estimate gestational age, rather than the BPD measurement (Gregor, S, Sabbagha, R, Glob 2008).

2. MATERIALS AND METHODS

2. 1 Materials

2.1.1 Sample size:

A cross-sectional study conducted in Al-Auda Medical Centre in Hafer AL-batin Area, Saudi Arabia, 173 pregnant women with confirmed pregnancy were included. All women with suspected fetuses of having congenital abnormalities were excluded.

2.1.2 Machine Used:

The sonographic evaluation was performed using Mindary, a real-time grayscale scanner using a 3.5 MHz transducer. A curve- linear array probe was preferably used for the examination. The study begins, 2023 till 2026.

2.2 Methods:

2.2.1Ultrasound Technique:

2.2.1.1 Patient preparation:

The pregnant woman is positioned in the supine position on the examination table with the lower abdomen exposed. If she experiences discomfort, she may be slightly tilted to the left lateral position.
Ultrasound gel is applied to the abdomen to enhance the transmission of ultrasound waves and eliminate air between the transducer and the skin.
* A 3–5 MHz curvilinear transabdominal transducer is used for the examination.
* Longitudinal and transverse scans are performed to assess the fetal presentation, placental location, and amniotic fluid volume.
* Standard fetal biometric measurements

2.2.1.2 Patient positioning and ultrasound scanning protocol and Fetal Liver Length measurement methodology:

All ultrasound examinations were performed using a real-time grayscale Mindray scanner equipped with a curvilinear array transducer. The protocol commenced with a comprehensive sonographic evaluation, including routine fetal biometry and a targeted anomaly screening. Patients were placed in the supine position on the examination table with appropriate draping to ensure privacy and dignity. Acoustic coupling gel was applied to the maternal abdomen to optimize ultrasound wave transmission. A curvilinear transducer was selected due to its low frequency profile, which ensures adequate tissue penetration and high-resolution imaging of deep intra-abdominal fetal structures. A systematic scanning approach utilizing both longitudinal and transverse planes was executed to evaluate standard fetal biometric parameters. Initial visualization of the upper fetal abdomen in an axial view at the level of the stomach demonstrated that the liver occupies a significant portion of the abdominal cavity. The aorta was identified in the longitudinal plane, and the transducer was adjusted to visualize the right hepatic lobe and right hemidiaphragm. Slight angulation or rotation of the transducer was occasionally required to optimize the visualization of the superior border and the inferior tip of the right lobe.

Fetal liver length (FLL) was measured using electronic calipers along the cranio-caudal axis, extending from the superior border of the right hemidiaphragm - adjacent to the right cardiac margin- to the inferior tip of the right hepatic lobe. Minimal transducer pressure was applied to prevent anatomical distortion, and the ultrasound beam was maintained as perpendicular as possible to the structure being measured. Electronic magnification (zoom) was adjusted to maximize screen occupancy by the target structure, thereby enhancing measurement accuracy.

Imaging Plane:

Measurements were obtained in a strict sagittal plane, ensuring comprehensive visualization of the liver, the superior diaphragmatic boundary, and the portal vein as an internal anatomical landmark. The right hepatic lobe was preferentially evaluated due to its prominent size and clear demarcation.

Image Optimization:

Magnification was adjusted so that the liver occupied the majority of the display frame. Clear visualization of echogenic margins was prioritized, while rib shadowing and oblique sections were systematically avoided.

Measurement Technique:

Calipers were placed vertically along the cranio-caudal axis from the superior border (inferior to the diaphragm) to the inferior border of the liver. Strict boundaries were maintained to exclude adjacent structures, such as the right kidney and stomach.

2.2.3 Methods of data collection: Data was collected using data collection sheet.

2.2.4 Data analysis and presentation: The data were analyzed using Microsoft Excel and SPSS version 16. A p value <0.05 was considered significant. Prior collection of the ethical data approval was taken from the Research Committee of College of medical radiological sciences, Sudan University of science and technology and the participant's oral informed consent.

3. RESULTS

The results presented the findings of the study of Estimation of Fetal Weight (EFWG) by Liver length and Umbilical Cord Using Ultrasonography to: Assess the utility of fetal liver length independent predictor for calculating Estimated Fetal Weight (EFW). Characterize the population data by analyzing the frequency distributions of EFW, umbilical cord diameter, and fetal liver length. Quantify the strength of the association between fetal liver length, umbilical cord diameter and EFW (correlation). A quantitative data result is reported to two types of analyzes descriptive statistics and inferential statistic using SPSS version 24.

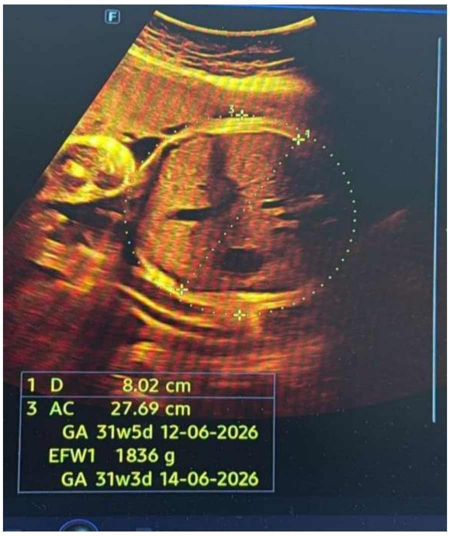

Image 1: Shows pregnant woman 25 years old demonstrates 27.69 cm fetal liver length

Image 2: Shows pregnant woman 27 years old demonstrates 29.33 cm fetal liver length

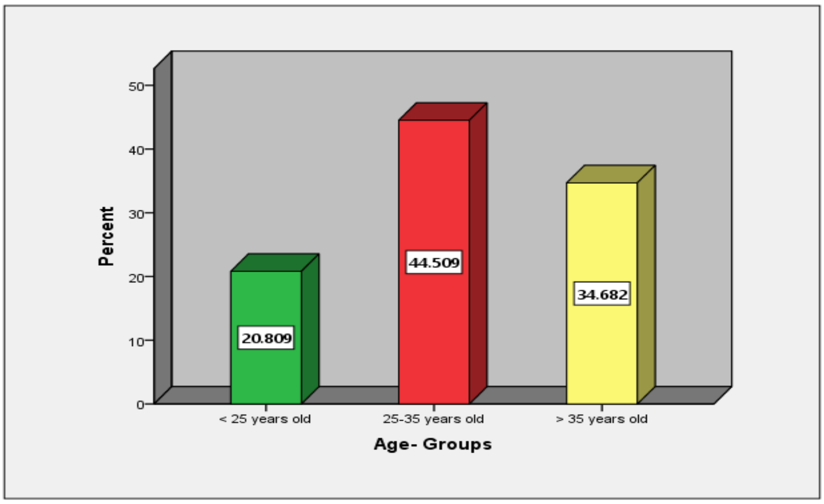

Figure 1: Represented patient age/ year's distribution

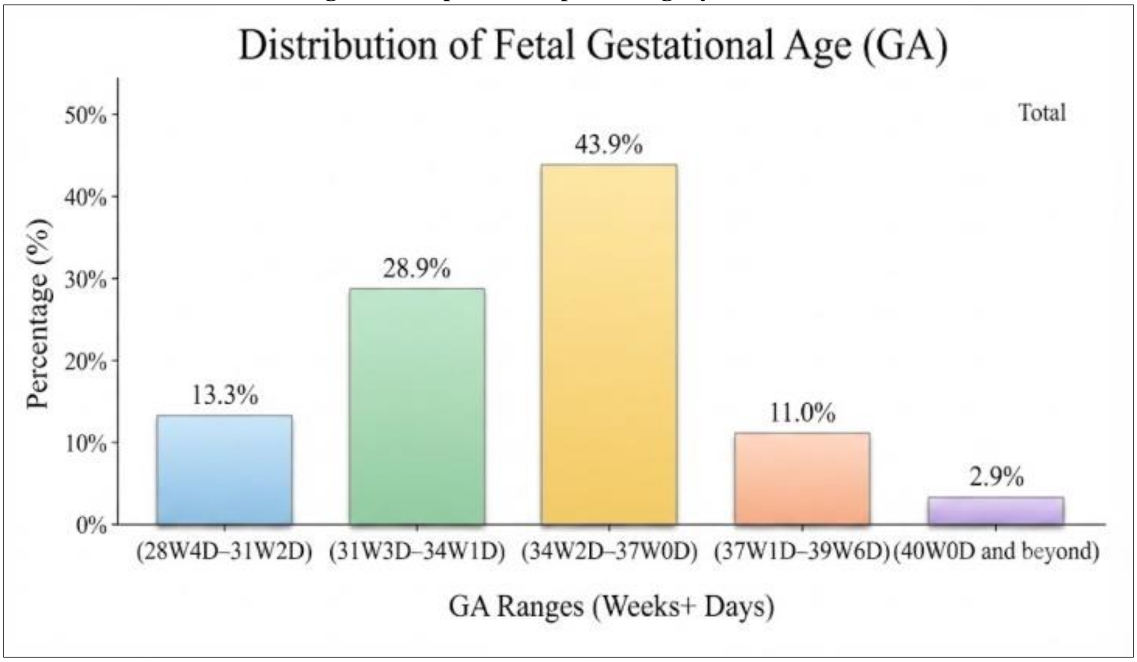

Figure 2: Showed gestational age GA ranges (Weeks+ Days) distribution

Table 1: The expected Liver length ranges (cm) distribution:

Category	Characteristic	Frequency (n)	Percentage (%)
Liver length ranges / cm	(5.50-6.50) cm	7	4.0
	(6.50-7.50) cm	29	16.8
	(7.50-8.50) cm	63	36.4
	(8.50-9.50) cm	54	31.2
	(9.50-10.50) cm	20	11.6
	Averaged mean = 8.36 ±.94		
Total	**------**	**173**	**100.0**

Table 2: EFW ranges (cm) distribution:

EFWG ranges	Frequency (n)	Percent (%)
<1500G	6	3.5
(1500-2500) G	83	48.0
(2500-4000) G	81	46.8
> 4000G	3	1.7
Total	**173**	**100.0**
Averaged mean = 2474.15 ±.604.99		

Tables 3: Correlation between Estimation of the fetal weight (EFWG), Liver length using Bivariate T-test:

Correlations		EFW G
EFWG	Pearson Correlation	1
	Sig. (2-tailed)	
	N	173
Liver length	Pearson Correlation	.766**
	Sig. (2-tailed)	.000
	N	173
**. Correlation is significant at the 0.01 level (2-tailed).		
*. Correlation is significant at the 0.05 level (2-tailed).		

Table 4: Correlation between Estimation of the fetal weight (EFWG), Liver length using linear Multiple Linear Regression

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.766[a]	.587	.585	389.91147	.587	243.082	1	171	.000
a. Predictors: (Constant), LIVER									

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	36956038.849	1	36956038.849	243.082	.000[b]
	Residual	25997293.244	171	152030.955		
	Total	62953332.092	172			
a. Dependent Variable: EFW G						
b. Predictors: (Constant), LIVER						

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-1637.782-	265.397		-6.171-	.000		
	LIVER	492.151	31.566	.766	15.591	.000	1.000	1.000
a. Dependent Variable: EFW G								

Regression Equation:

EFW G=−1637.782+ (492.151×Liver Length)

- G: Estimated Fetal Weight (in grams)
- −1637.782: The model constant (intercept)
- 492.151: The unstandardized regression coefficient for liver length, indicating that for every 1 cm increase in fetal liver length, the estimated fetal weight increases by approximately 492.15 g.

4. DISCUSSION

A prospective, cross-sectional, quantitative approach study was conducted to assessment of the study of Estimation of Fetal Weight by Liver length using Ultrasonography in Saudi Arabia (Hafer AL-batin Area). Figure (1) represented the age distribution of the 173 participants their age (20-45) years, the results indicated that the majority of the study population fell within the 25–35 years age group, accounting for (n= 77, 44.5%) of the total participants. This was followed by the >35 years age group (n= 60, 34.7%) and the <25 years age group (n= 36, 20.8%). The mean age of the participants was calculated to be 32.3 ±7.11 years. The findings showed that the largest proportion of participants belongs to the 25–35 age range is consistent with typical obstetric study populations, as this is widely considered the peak reproductive age range. This demographic distribution suggests that the study captures a representative sample of women who are at a lower obstetric risk compared to very young (<20) or advanced maternal age (>35) populations, though a significant portion of our cohort (34.7%) did fall into the advanced maternal age category. The mean age of 32.3 ± 7.11 years in this study is comparable to findings in similar research on fetal biometry and growth parameters, where mean maternal ages often cluster in the early-to-mid thirties.

The primary objective of evaluating fetal liver length (FLL) within this cohort (n = 173) is to assess their distributions as novel anatomical predictors of fetal weight. Unlike traditional biometry (Biparietal Diameter, Head Circumference, Abdominal Circumference, and Femur Length), which measures external skeletal frames and surface contours, FLL directly evaluate the metabolic and nutritional supply line of the fetus. The fetal liver acts as the primary metabolic processing center and glucose storage reservoir (via glycogen synthesis) during intrauterine development. As shown on the table and figure 4.5 the cohort exhibited a mean liver length of 8.36 ± 0.94 cm, the distribution was unimodal and highly concentrated in the mid-to-high ranges (n=63, 36.4%) of fetuses had an fetal liver length of (7.50–8.50) cm, and (n= 54, 31.2%) fell into the (8.50–9.50) cm range. In third-trimester healthy gestations, fetal liver length is expected to range progressively from approximately 5.5 cm at 28 weeks to over 8.0 cm near term. The observed mean of 8.36 cm is highly congruent with a population predominantly in the late third trimester, indicating normal hepatic development and glycogen deposit accumulation across the majority of the cohort.

The present study presented the distribution of Estimated Fetal Weight Gain (EFWG) across four categorical ranges among 173 pregnant women. The results demonstrated a bimodal central tendency**,** with the vast majority of cases (n =164, 83, 94.8%) falling within the (1500–2500) G and (2500–4000) G ranges, accounting for (n=83, 48.0%) and (n=81, 46.8%) of the sample, respectively. The overall mean EFWG was (2474.15 ± 604.99) grams, indicating that the average fetal weight estimate in this cohort sited precisely at the boundary between the two dominant categories. Only a small minority of fetuses were classified as either below 1500g (n=6, 3.5%) or above 4000g (n= 3, 1.7%), suggesting a relatively homogeneous population with few cases of extreme fetal growth restriction or macrosomia. The mean EFWG of 2474.15g in this study aligns reasonably well with established international reference ranges. According to the WHO fetal weight standards, the expected fetal weight at approximately 32–33 weeks of gestation ranges between 2000g and 2200g, while at term (38–40 weeks), it typically reaches 3000–3338g. Given that the mean EFWG in this study falls between these gestational benchmarks, it is plausible that the majority of measurements were obtained during the late second to early third trimester, so the study was matching the IRR for EFWG (Vinmec, 2025) and Maršál *et al.,* (2021).

Table 7 showed Bivariate correlation analysis of study variables. The provided correlation matrix presented the Pearson correlation coefficients (r) and significance levels (p) for all measured study variables. This analysis is critical for understanding the inter-relationships between maternal demographics, traditional biometric parameters, and the novel markers (Fetal Liver Length) in relation to Estimated Fetal Weight (EFW): The data confirms a very strong, positive, and statistically significant correlation ($p < 0.01$) between all traditional biometric markers and EFW.

Tables 8 showed the regression analysis that demonstrated a strong, statistically significant model for predicting Estimated Fetal Weight (EFW) using only Fetal Liver Length.

The multiple correlation coefficient is R=0.766, which indicates a strong positive linear relationship between fetal liver length and estimated fetal weight. The coefficient of determination (R2) is 0.587, revealing that 58.7% of the total variance in estimated fetal weight can be independently explained by fetal liver length alone. The adjusted R2 of 0.585 further confirms the stability and reliability of this model. The analysis of variance (ANOVA) yielded an F-statistic of 243.082 with a significance value of $p<0.001$ (Sig.=0.000). This demonstrates that the regression model is statistically highly significant, proving that fetal liver length is a valid and dependable predictor of fetal weight rather than a result of random chance.

The unstandardized coefficient for liver length (B=492.151, t=15.591, p=0.000) is statistically significant. This establishes that liver length plays a critical role in estimating fetal growth parameters. Furthermore, the collinearity statistics (Tolerance = 1.000, VIF=1.000) confirm that there are no issues with multicollinearity since this is a simple linear regression model with a single predictor.

5. CONCLUSION

In conclusion, the current study demonstrated a strong, statistically significant model for predicting Estimated Fetal Weight (EFW) using Fetal Liver Length.

REFERENCES

- Assem, A., *et al.,* (2024). The fetal liver volume assessment by three-dimensional ultrasound as a parameter to monitor fetal growth. The Medical Journal of Cairo University, Volume 90, Issue 3, pp. 351–358).
- Benjamin E. Udoh, P. Erim, A. Anthony, E. (2020). Sonographic Assessment of Umbilical Cord Diameter as an Indicator of Fetal Growth and Perinatal Outcome. Journal of Diagnostic Medical Sonography, 2021, Vol. 37(1) 41 –45.
- Bajracharya J., Shrestha N. S., Karki C. Accuracy of prediction of birth weight by fetal ultrasound. Kathmandu University Medical Journal .2012;10(38):74–76. doi: 10.3126/hren. v10i3.7053. [DOI] [PubMed] [Google Scholar].
- Chiegwu, H. U., Okafor, I. I., Ohagwu, C. C., Ogbu, S. O., Udoh, B. E., & Ugwuanyi, D. C. (2014). Relationship of fetal liver volume with estimated fetal weight and gestational age: A 2-dimensional ultrasonographic study of normal Nigerian fetuses. International Journal of Medical and Medical Sciences, 47, 1476.
- Campbell S. A short history of sonography in obstetrics and gynaecology. Facts, Views & Vision in ObGyn . 2013;5(3):213–229. [PMC free article] [PubMed] [Google Scholar]
- Isaac-Okolo, E. O., Ibitoye, B. O., Ijarotimi, O. A., Onwuka, C. C., Abidoye, I. A., & Idowu, B. M. (2022). Correlation of Foetal Liver Length with Gestational Age and Foetal Weight in Pregnant Nigerian Women. Nigerian medical journal: journal of the Nigeria Medical Association, 62(6), 353–359.
- Lindström, L., Ageheim, M., Axelsson, O., Hussain-Alkhateeb, L., Skalkidou, A., Wikström, A.K., Bergman, E., Cnattingius, S. and Granfors, M. (2021). Swedish intrauterine growth reference ranges for estimated fetal weight. Scientific Reports, 11(1), p.12464. Available at: https://doi.org/10.1038/s41598-021-92032-2
- MacGregor, S, Sabbagha, R, Glob. libr. women's med., Assessment of Gestational Age by Ultrasound, ISSN: 1756-2228) 2008; DOI 10.3843/GLOWM.1020.
- Njoku C., Emechebe C., Odusolu P., Abeshi S., Chukwu C., Ekabua J. Determination of accuracy of fetal weight using ultrasound and clinical fetal weight estimations in calabar south, south Nigeria. International Scholarly Research Notices. 2014; 2014:6. doi: 10.1155/2014/970973.970973 [DOI] [PMC free article] [PubMed] [Google Scholar].
- Phatihattakorn, C., *et al.,* (2004) 'Normal reference values for fetal liver length in Thai fetuses', Siriraj Hospital Medical Journal, 56, pp.

- Ray E. M., Alhusen J. L. The suspected macrosomic fetus at term: a clinical dilemma. Journal of Midwifery & Women's Health. 2016;61(2):263–269. doi: 10.1111/jmwh.12414. [DOI] [PubMed] [Google Scholar].
- Ranjumoni Konwar, Bharati Basumatary, Malamoni Dutta, Putul Mahanta (2021) Accuracy of Fetal Weight Estimation by Ultrasonographic Evaluation in a Northeastern Region of India, International Journal of Biomaterials Volume 2021, Article ID 9090338, 7 pageshttps://doi.org/10.1155/2021/9090338
- Sanad, A. F. A. A., Balaha, M. H., Elhalwagy, A. E., & El Namouri, M. M. (2025). Fetal liver size and hepatic artery doppler study in women with late intra uterine growth restriction versus normal pregnant women. Evidence Based Women's Health Journal, 15(15), 1–8. https://doi.org/10.21608/EBWHJ.2024.307217.1341
- Ugwu E., Udealor P., Ozumba B., *et al.,* Accuracy of clinical and ultrasound estimation of fetal weight in predicting actual birth weight in Enugu, southeastern Nigeria. Nigerian Journal of Clinical Practice. 2014;17(3):270–275. doi: 10.4103/1119-3077.130208. [DOI] [PubMed] [Google Scholar]
- Vinmec (2025) Fetal weight and length chart based on WHO standards. Available at: https://www.vinmec.com/eng/blog/table-of-fetal-weight-and-length-according-to-who-standards-en (Accessed: 26 July 2026).