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Study of Specific Mean Birth Weight Using Hadlocks Formula among Regional Population of Raichur, Karnataka

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ABSTRACT
The latest and most technologically advanced technique for estimating fetal weight is based on fetal measurements taken through ultrasonography, which is now considered the gold standard in contemporary obstetrics. This study seeks to determine if the ultrasound-based Hadlock's formulas are appropriate for our region-specific population. This study was a forward-looking observational analysis carried out with pregnant women having a single fetus, with a verified gestational age of 37-42 weeks. The anticipated fetal weight was acquired from scans conducted within a week before delivery and these women gave birth in our hospital. In the current study, 100 pregnant women who met the study criteria were examined. Their ages ranged between 19 and 35 years, with an average age of 25.09 years. The largest group was those aged 21-25 years, making up 47%, followed by those aged 26-30 years at 38%. Multigravida participants (those who have been pregnant more than once) were more common at 57% compared to primigravidas (those pregnant for the first time) at 43%. In most cases, the actual birth weight ranged from 2501-3000 g (49%), followed by 3001-3500 g (32%). The average actual birth weight was 2952.87 g. Using Hadlock's formula, the estimated average birth weight was 3062.49 g. Notably, although the mean difference of 109.62 g might appear minor, it was statistically significant. The study found an average error of 220.97±176.80 g, with a mean percentage error of 7.80±7.39%. The average actual birth weight of the samples was 2952.87 g, representing the regional population of the Raichur district. Using the Hadlock formula to estimate fetal weight can be highly beneficial in a developing nation like ours.

INTRODUCTION

Ultrasound is a well-known prenatal test used by many pregnant women to assess the health and development of their baby[1]. Over the past ten years, the estimation of fetal weight has become a standard part of the antepartum assessment for high-risk pregnancies and deliveries. For example, the care approach for diabetic pregnancies, vaginal births following a prior cesarean section and the intrapartum handling of fetuses with a breech presentation are significantly guided by the estimated fetal weight[2].

Several methods exist for estimating fetal weight at term, including the Johnsons and Dawns formula, among others. However, the most advanced and technology-reliant approach for assessing fetal weight is based on measurements acquired through ultrasonography. This method, particularly the Hadlock's model, has become the gold standard in contemporary obstetrics for estimating fetal birth weight[3].

Determining which standard formula stored in most ultrasound machines provides the closest estimate to the actual birth weight for our regional Indian population remains an open question. The current study seeks to assess the accuracy of the ultrasound-based Hadlock's formula for our specific regional demographic. Additionally, the study endeavors to compare the average birth weights within specific subsets of the population.

MATERIALS AND METHODS

The current research was a prospective, observational study carried out in the Department of Radiodiagnosis at Navodaya Medical College and Hospital, Raichur, Karnataka, India. The study spanned a duration of 2 years, from September 2019 to March 2021. Approval for the study was secured from the institutional ethical committee.

Pregnant women, Singleton pregnancy, with confirmed gestational age 37-42 weeks, expected fetal weight obtained by scan within week a prior to delivery, delivering in our hospital, willing to participate in present study.

Exclusion criteria:

- Pre term
- Multifetal pregnancy and Congenital anomaly
- Patient in who did not deliver within 1-2 weeks of USG examination

The study took place in the department of radiology, with patients being referred from the Obstetrics and Gynecology department. The study's objectives and procedures were thoroughly explained to the patients in their local language. After ensuring they understood, written consent was obtained from those willing to participate.

Various details were gathered, including identification information, demographic traits and findings from obstetric examinations. A comprehensive obstetric and menstrual history of each patient was documented. The gestational age was determined either using Naegle's rule or based on the first trimester ultrasound scan report.

Relevant antenatal histories, including occurrences of antepartum hemorrhage, hypertensive disorders, diabetes mellitus, cardiac conditions, anemia and tuberculosis, were meticulously recorded.

All patients underwent sonographic assessment using a 3.5 MHZ convex probe and a linear array transducer (with the transverse Philips grey scale model equipped with M and B mode for concurrent imaging and fetal heart rate calculation). Once the biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL) were measured in centimeters, the estimation of fetal weight was carried out using Hadlock's formula via ultrasonography.

$$\text{Log}_{10}\,(\text{EFW}) = 1.4787\text{-}0.003343\ \text{AC}\times\text{FL}+0.001837\ \text{BPD}^2 +0.0458\ \text{AC}+0.158\text{FL}$$

The predicted estimated fetal weight from each method was contrasted with the actual birth weight of the neonate, which was measured using an electronic machine at Navodaya Hospital. This machine provided an accurate reading of the birth weight. Additionally, a calibrated weighing machine at the Navodaya Hospital and Research Center was used. There was a 50 g discrepancy between the two measurements, which was factored in to determine the true birth weight of the babies.

A statistical analysis was conducted to determine the difference between the estimated fetal weight and the actual birth weight across all methods. The accuracy of birth weight estimation was then compared based on the mother's parity and age. The corresponding observations were documented.

Data was collected and and organized using Microsoft Excel and then analyzed using SPSS version 23.0. For continuous variables, frequency, percentage, means and standard deviations (SD) were calculated. For categorical variables, ratios and proportions were determined. To test the differences between qualitative variables, the chi-square test or Fisher exact test was used, as appropriate. A p-value of less than 0.05 was deemed statistically significant.

RESULTS

In this study, 100 pregnant women who met the study criteria were analyzed. The ages of the participants ranged from 19-35 years, with an average age of 25.09 years. The largest group was aged 21-25 years, accounting for 47% of the cases, followed by

those aged 26-30 years, comprising 38%. There were more multigravida women (those who have been pregnant more than once) at 57% compared to primigravida women (those pregnant for the first time) at 43%. For most of the participants, the actual birth weight of their babies fell between 2501-3000 g (49%), with the next most common weight range being 3001-3500 g (32%).

The average actual birth weight of the babies was 2952.87 g. When estimated using Hadlock's formula, the average birth weight was 3062.49 g. Notably, while the mean difference of 109.62 g might appear to be minor, it holds statistical significance (Table 1).

The average error in fetal weight estimation varied among different birth weight categories. For babies in the ≤2500 g category, the average error was 312.85 g. This was followed by the 3501-4000 g category with an average error of 240.50 g and the 3001-3500 g category with an average error of 208.28 g. The category with the smallest average error, 202.49 g, was the 2501-3000 g birth weight classification (Table 2).

During the study, the mean average error in fetal weight estimation was determined to be 220.97 g, with a standard deviation of 176.80 g. The mean percentage error was 7.80% with a standard deviation of 7.39% (Table 3).

When comparing the maximum errors across different fetal weight categories using the USG method, the largest error was observed in the birth weight category of ≤2500 g, with an error of 1290 g. This was followed by the 3001-3500 g category with an error of 600 g. The smallest error was in the 3501-4000 g category, with an error of 374 g. Nonetheless, the overall maximum error across all categories was 1290 g (Table 4).

The percentage error is inversely proportional to the birth weight (measured in grams). The data indicates that an error percentage up to 5% corresponds to an error of 36 g when estimated using the USG method, demonstrating a statistically significant relationship. On the other hand, error estimates that were equal to or exceeded 10% of the birth weight were not found to be statistically significant during the study's duration (Table 5).

In the study over estimates are 67% and under estimates are 33% (Table 6).

Prediction of birth weight by USG method, the correlation coefficient was positive and explains nearly 72% of correlation for estimates with standard error of 227.98 g during the prediction by using prediction equation 582.00±0.774 for calculating birth weight, difference were statistically significant ($p<0.001$) (Table 7).

DISCUSSIONS

Birth weight stands as a paramount determinant of neonatal survival when considering the independent extrauterine existence and optimal survival of a fetus. Its importance has grown, particularly in the prevention of prematurity, assessing pelvic disproportion before labor induction and in the identification of intrauterine growth restriction[4].

A primary challenge in evaluating fetal growth is the fetus's inaccessibility to the external environment[5]. Classifying fetal weight as either small or large for gestational age can prompt specific obstetric interventions. These interventions can notably deviate from standard antenatal care practices[6,7]. Later on, researchers utilized measuring tapes and pelvimeters to gauge uterine height and volume, aiming to derive a quantitative estimate of fetal weight[8]. Following the introduction of ultrasonography, it has demonstrated itself as a straightforward, vital and non-invasive instrument for

Table 1: General characteristics

Characteristics	No. of patients	Percentage
Age groups (years)		
≤20	10	10.0
21-25	47	47.0
26-30	38	38.0
31-35	5	5.0
Mean age (mean±SD)	25.09±3.26	
Parity		
Primi	43	
Multi	57	
Birth weight (g)		
2001-2500	13	13.0
2501-3000	49	49.0
3001-3500	32	32.0
3501-4000	6	6.0
Mean birth weight (mean±SD)	2952.87±363.74	

Table 2: Comparison of mean birth weight by ultrasound method (N = 100)

Method	Mean (SD)	Range	Mean differences
Actual birth weight	2952.87 (363.74)	2050-3800	-109.62
USG	3062.49 (341.30)	2160-4174	

Paired t-test, p-value <0.001, significant

Table 3: Comparison of average error in various foetal weight groups (N = 100)

Methods	USG
≤2500	312.85 (388.81)
2501-3000	202.49 (118.48)
3001-3500	208.28 (117.94)
3501-4000	240.50 (91.19)
Overall	220.97 (176.80)

Table 4: Comparison of average Error by ultrasound Method (N = 100)

USG	Mean (SD)	Range	Median
Average error	220.97 (176.80)	12-1290	192.0
Percentage error	7.80 (7.39)	0.406-51.60	6.45

Table 5: Comparison of maximum error in various foetal weight groups (N = 100)

Methods	USG
≤2500	1290
2501-3000	459
3001-3500	600
3501-4000	374
Overall	1290

Table 6: Comparison of percentage error by ultrasound method (N = 100)

Methods	USG
Upto 5%	36
Upto 10%	43
Upto 15%	15
Upto 20%	4
Upto 25%	0
Upto 30%	0
>30%	2

Table 7: Comparison of overestimation and underestimation by ultrasound method (N = 100)

USG method	Percentage
Overestimation	67
Underestimation	33

Table 8: Prediction of birth weight by ultrasound method (N = 100)

Methods	Correlation coefficient	Prediction equation	Standard error
USG	0.726	582.00±0.774	227.98

*p-value significant <0.001

obstetricians to estimate fetal weight[9]. Due to financial constraints, ultrasound isn't accessible in many centers across India.

A swift and simple clinical method to estimate fetal weight in utero would be advantageous not just for obstetricians but also for birth attendants and paramedical staff in rural areas. Such a method would assist them in making informed decisions about referrals to more specialized centers[10]. Conversely, precise estimation of fetal weight plays a crucial role in informed decision-making for cases involving a preterm fetus, small for gestational age (SGA) fetus, intrauterine growth retardation (IUGR), preterm premature rupture of membranes, large for gestational age (LGA) fetus and macrosomic fetus. Additionally, for women with previous cesarean sections, determining the appropriate timing and method of delivery in advance is essential. This helps in reducing potential risks for both the expectant mothers and their newborns.

The precision in estimating fetal weight plays a crucial role in managing labor and delivery[11]. Recently, estimations concerning fetal weight have been integrated with standard antepartum evaluations of high-risk pregnancies and deliveries. Numerous research studies have explored the accuracy of various methods for estimating fetal birth weight. The differences and nuances among these methods have been highlighted, especially in the contemporary era of ultrasound studies.

In the study, the average actual birth weight was recorded as 2952.87 g, while the average estimated birth weight using Hadlock's formula came to 3062.49 g. The average actual birth weight of the sampled population, which was 2952.87 g, was representative of the Raichur district's regional population. The percentage error of the fetal weight estimated through ultrasound using Hadlock's formula was 7.8%. Furthermore, the study highlighted that the most frequent actual birth weight fell within the 2501-3000 g category. Mean birth weight noted by various authors was Titapant *et al*.[3] (2,993.33 ± 473 g), Shittu *et al*.[11] (2500±340 g) and Present study (2952.87±363.74 g). All the research studies encompassed a range of clinical and ultrasonographic techniques for estimating fetal weight.

Hadlock's formula was able to predict the birth weight within 10% of the actual birth weight in 81% of the instances. The least average error in birth weight estimation using Hadlock's formula was 202.49 g, particularly in the fetal weight group ranging from 2501-3000 g. As such, when clinical methods suggest a weight below 2,500 g, a follow-up sonographic estimation is advised. This not only provides a more accurate prediction but also allows for further assessment of fetal health, especially in cases where other complications like oligohydramnios might be present.

Bhandari *et al*.[12] reported that the rates of estimated weights within 10% of actual birth weights using the USG method were not statistically significant, with figures standing at 67 and 62%, respectively. Conversely, a study by Melamed *et al*.[13] consistently indicated a mean percentage error of 68% when using the Hadlock formula. In the current study, the average percentage error was recorded at 7.8% when employing the Hadlock formula. This error rate was the second lowest in comparison to other methods used.

Several factors pose technical challenges in estimating birth weight using sonography. These include maternal obesity, a reduced amount of amniotic fluid (oligohydramnios) and the placement of the placenta at the front (anterior placentation). Additionally, reliable sonographic evaluations demand expensive equipment and specialized training for the personnel operating it. The accuracy of the measurements largely depends on the experience and dedication of the practitioner. Guidance and mentorship from seasoned doctors can further

enhance the precision of birth weight estimations using sonographic parameters. Based on the findings of this research, it appears that no single method significantly outperforms the other in accurately determining birth weights. When prioritizing "accuracy in prediction," it's advisable to employ multiple methods, compare their outcomes and then select the most appropriate approach based on the comparative results.

CONCLUSION

The regional population of Raichur district had an average actual birth weight of 2952.87 g per sample. Today's advanced methods of determining fetal weight use ultrasonography to obtain fetal measurements. The strength of this method lies in its use of objective and reproducible linear or planar measurements of the fetus while it's still in the womb. In developing countries such as ours, estimating fetal weight using the Hadlock formula proves to be highly valuable.

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