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A prospective study on Estimation of Fetal Weight Using Johnson's Formula and Ultrasonographically using Hadlock's formula and its Correlation with Actual BirthWeight in term pregnancies

Brinda K[1], Ramya K[2], Anusuya SK[3]

[1]Junior Resident, Department of Obstetrics and Gynaecology, Akash Institue of Medical Sciences and Research Centre, Devanahalli
[2]Associate Professor, Department of Obstetrics and Gynaecology, Akash Institue of Medical Sciences and Research Centre, Devanahalli.
[3]Professor, Department of Obstetrics and Gynaecology, Akash Institue of Medical Sciences and Research Centre, Devanahalli.

A B S T R A C T

OBJECTIVES: To determine the accuracy of estimated fetal weight by using Johnson's formula and comparing it with fetal weight estimated by ultrasound, and correlating with the actual birth weight.

METHODS: A Prospective study was conducted in akash medical college, Devanahalli where 102 term pregnancies fulfilling the inclusion criteria were included. Symphysio-fundal height was performed and fetal weight estimation done by adopting johnson's formulae and ultrasound estimated fetal weight by Hadlock's formula has been done between 37- 40 weeks gestation and the results were correlated with actual birth weight.

RESULTS: In our study the mean birth weight by johnsons formulae was 3446.47 (SD ± 314.70), Mean Ultrasound estimated fetal weight was 3275.81(SD ± 345.52) and mean actual birth weight was 3011.96 (SD ± 404.85). The maximum error in fetal weight measurement was observed with Johnson's formula (1365gms) as compared to ultrasonography (960gms). Clinically Johnson's formulae over estimating the fetal weight when the baby is < 3kgs but margin of error is negligible when baby weight is between 3-3.5kgs.

CONCLUSION: The study highlighted that the Johnson's formuale is a good clinical measure when we are dealing with average babies and whereas ultrasound is better indicator when the baby is 2.5-3.5kgs. Margin of error is increased when the weight is >3.5kgs, thus stressing the need of using clinical and ultrasound parameters together to decrease the margin of error in predicting the actual birth weight.

KEY WORDS: Birth weight, Estimated fetal weight, Hadlock's formula, Johnson's formula, Symphysio-fundal height

INTRODUCTION

In modern obstetrics accurate estimation of fetal weight is of paramount importance in the management of labor and delivery as it is one of the risk factors which can be anticipated during antenatal period and guides in making decision regarding mode of delivery and in prevention of many complications, like maternal exhaustion, prolonged labor, atonic and traumatic postpartum hemorrhage[1].

Precise fetal weight assessment is a problem where resources are low or subject to availability,especially in developing countries where major population still resides in rural area[2].

To prevent maternal morbidity associated with macrosomic baby and neonatal morbodity and mortality associated with LBW, Macrosomic babies. where babies handled better in level II and level III NICU, hence estimation of fetal weight is of paramount importance.

Objectives of study:

To determine the accuracy of estimated fetal weight by using Johnson's formula and comparing it with fetal weight estimated by ultrasound, and correlating with the actual birth weight.

Materials and methods:

Source of data:

All Antenatal cases between 37-40weeks of gestation as per the inclusion and exclusion criteria attending the OPD or admitted under OBG department , AKASH HOSPITAL, DEVANAHALLI, BENGALURU.

Inclusion Criteria :
1. Gestational age between 37 to 40 weeks
2. Pregnancy with singleton fetus
3. Vertex presentation
4. Intact membranes
5. Those delivered within 7- 10 days of USG and fundal height measurement.
6. Pregnancy with AFI 8-20 cm .

Exclusion Criteria:
1. Patients with sonographically diagnosed IUGR.
2. Pregnancy with diagnosed oligohydramnios and polyhydroamnios as confirmed by USG .
3. Pregnancy with Intra uterine death .
4. Pregnancy with uterine or abdominal mass. 5.Pregnancy with fetal anomaly as detected by USG .
5. Patients with LMP not known or unsure of LMP .

Methodology :

This is a prospective observational study conducted from june 2024 to october 2024 in the Department of Obstetrics and Gynecology, Akash hospital , Devanahalli . All the ANC who are attending OPD and are between 37-40weeks , fulfilling the inclusion criteria will be enrolled for the study after obtaining informed consent .

A flexible, non-elastic standard measuring tape was used to measure the symphysio- fundal height (SFH) in a relaxed uterus following bladder evacuation. The measurements were made in centimeters with the patient lying supine with both legs extended and hands by herside. The distal point of the SFH was designated as the highest point of the uterine fundus after the uterus had been centralised, starting from the middle of the upper limit of the symphysis pubis.

The placement of the foetal head was then determined by performing a pelvic examination. The vertex, the lowest portion of the foetal head, was classified as being in the minus station when it was higher than the ischial spines, the zero station when it was at the ischial spines, and the plus station when it was lower than the ischial spines. All the measurements were used to calculate fetal weight by the following formulas.

JOHNSON'S FORMULA : Fetal weight (grams) = 155 x (symphysiofundal height-X) X= 12 at zero station
X=11 at plus station X=13 at minus station

Ultrasonographic EFW obtained by Hadlock's formula using ultrasonographic measurements of biparietal diameter, abdominal circumference, and femur length.

Hadlock's Formula
$10^{(1.335(0.0034*AC*FL)+(0.0316*BPD)+(0.0457*AC)+(0.1623*FL))}$

The formula gave estimated fetal weight in grams when BPD (biparietal diameter), AC (abdominal circumference) and FL (femur length) in centimeters.

The patients were followed till delivery. Actual birth weight was noted by weighing machine. Women who do not deliver within 7-10 days of fetal weight estimation were excluded from the study.

Fetal Outcome (weight in grams) : The birth weight of the baby checked as per the scale which was properly balanced the baby has been placed unclothed in the centre of it , in labour room or in operation theater , later in ward doubly verified .
After delivery, intrapartum and neonatal outcome data collected from patients case notes.

Statistical analysis:

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions.

Correlations were performed with Pearson Correlation coefficient
Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs
P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.
Statistical software: MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyze data .

RESULTS

Table 1:- Distribution of subjects according to age group

	Frequency	Percent
<20yrs	8	7.8%
21-25yrs	41	40.2%
26-30yrs	41	40.2%
30yrs	12	11.8%

In our study , A Total of 102 patients studied from the month of June 2024 to october 2024 . 51 patients were excluded based on exclusion criteria .The maternal age distribution was in the range of 19-39 yrs , mean age being 21.84 (SD± 2.298).
Maximum number of cases studied was in the age group of 21–30 years. As shown in table-1 .

Table 2 -Socioeconomic Status and Educational Background

	N	%
Education		
Degree	13	12.7%
Illiterate	4	3.9%
Intermediate	10	9.8%
School	75	73.5%
SES		
Lower class	14	13.7%
Lower middle	67	65.7%
Upper class	4	3.9%
Upper lower	15	14.7%
Upper middle	2	2.0%

Majority of the patients belongs to lower middle class 67 (65.7%) as on and only 4 (3.9%) were illiterate . As shown in table-2

Table 3:- Distribution of subjects according to mode of delivery

	Frequency	Percent
LSCS	68	66.7%
NVD	34	33.3%
Total	102	100.0

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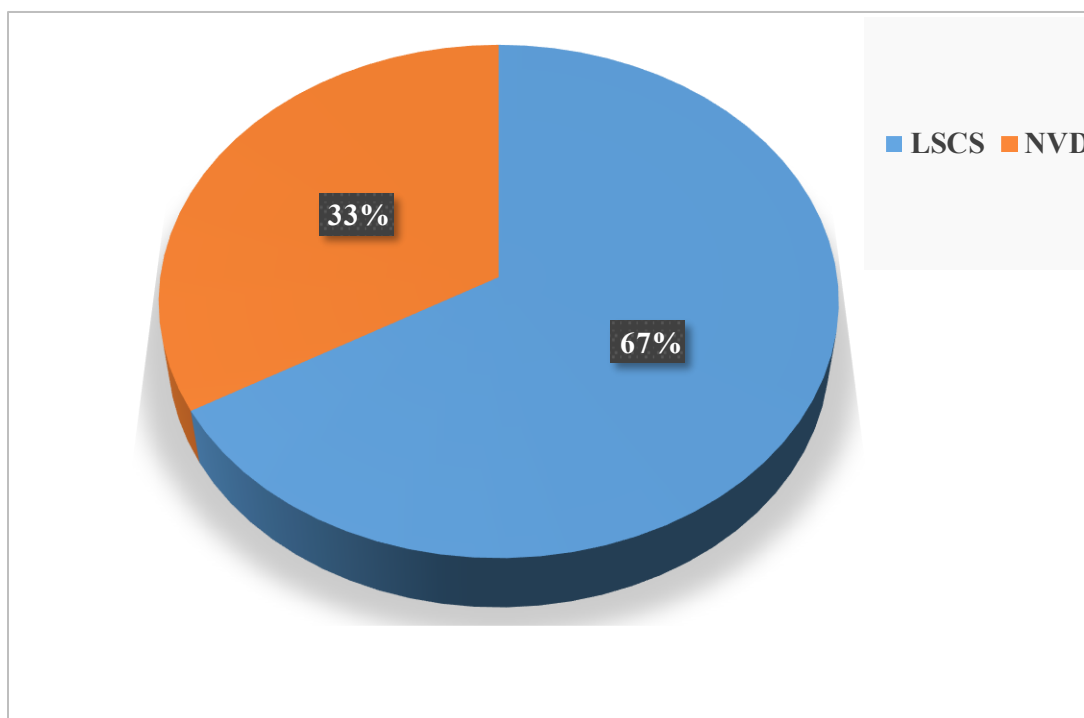
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Figure 1:- Graph showing Distribution of subjects according to mode of delivery

Out of 102 mothers 27 (26.5 %) were primigravida and 75 (73.5 %) multiparous women . In that 68 (66.7%) underwent c-section and 34 (33.3%) had vaginal delivery .

In terms of delivery outcomes from 102 mothers , our study found that cesarean sections were
total of 68 cases accounts for 67% in that 49 multigravidas with previous cesarean sections , primigravidas were 19 cases , various reasons in our study was maternal request(6), fetal distress (7) , non progression of labour (01) , failed indiction (3) and CPD (2) .
Normal vaginal deliveries were 34 accounts for 33% , out of which primigravidas were 19 and previous NVD were 15 cases.

Table4: - Distribution of subjects according to gender of baby

	Frequency	Percent
BOY	58	56.9%
GIRL	44	43.1%
Total	102	100.0

Distribution of subjects according to gender of baby - 44 (43.1%) babies were female while 58 (56.9 %) were male .

Table 5: Birth Weight Distribution Compared to Johnson's, USG, and Combined Estimates

	Actual		Johnsons formula		USG scan		Combined	
	N	%	N	%	N	%	N	%
<2kg	2	2.0%	0	0%	0	0%	0	0%
2-2.5kg	7	6.9%	1	1.0%	2	2.0%	1	1.0%
2.5-3kg	41	40.2%	11	10.8%	16	15.7%	9	8.8%
3-3.5kg	40	39.2%	35	34.3%	58	56.9%	60	58.8%
>3.5kg	12	11.8%	55	53.9%	26	25.5%	32	31.4%

Birth weight wise most of them belong normal birth weight 2.5 - 3kgs were 41 (40.2%) and the distribution of the actual birth weight were compared with EFW by Johnsons formulae , sonography given in table -5

Table6 : Mean and Standard Deviation of Estimated and Actual Weights

	Minimum	Maximum	Mean	Std. Deviation
EFW BY SCAN	2115	4018	3275.81	345.527
EFW BY JOHNSONS FORMULA	2325	4030	3446.47	314.704
ACTUAL WIEGHT	1920	3750	3011.96	404.859
SFH	28	38	35.00	1.935
AGE	19	39	25.75	3.853

The mean birth weight by johnsons formulae was 3446.47 (SD ± 314.70) , Mean Ultrasound estimated fetal weight was 3275.81(SD ± 345.52) and mean actual birth weight was 3011.96 (SD ± 404.85) . as shown in table -6

Table 7: Accuracy of Johnson's and USG Estimation

	Johnsons formula		USG scan	
	N	%	N	%
EXACT	1	1.0%	0	%
OVER	96	94.1%	87	85.3%
UNDER	5	4.9%	15	14.7%

When it comes to estimation of actual birth weight from Johnson's formula and ultrasound , ultrasound is a more relaiable source as johnsons formula over festimates in 96 (94.1% 0 of cases .

Table 8- Mean difference between johnsons formula and actual weight

Minimum	Maximum	Mean	Std. Deviation
-310	1365	434.51	292.987

Between clinical as well as the actual birth weight the mean variance was an overestimation of 1365 gms (Mean - 434.51 gms , SD - 292.987) . Clinically Johnson's formulae over estimates the fetal weight when the baby is < 3kgs but margin of error is negligible when baby weight is b/w 3-3.5kgs

Table 9- Mean difference between USG Scan and actual weight

Minimum	Maximum	Mean	Std. Deviation
-820	960	263.85	312.887

When it comes to ultrasonological method the actual birth weight was over estimated in 87 (85.3%) cases by 960gms (Mean - 263.85 , SD-312.887). Ultrasound overestimate the fetal weight when the baby is >3kgs but margin of error is negligible when baby is >3.5kgs.

Discussion

Birth weight is an important parameter to predict the neonatal outcome and its prenatal estimation plays a significant role in the management of high-risk pregnancies. In the clinical practice the fetal weight estimation is rarely done by abdomen palpation. As we rely on readily available and accessible ultrasonography.

Numerous well-known technical limitations are there for analysing foetal weight using sonographic technique. Amongst these given are as oligohydramnios,
"maternal obesity, and anterior placentation. There are other drawbacks of ultrasonography that is equally complicated as well as labour intensive, being limited" as in potential manner by foetal structure's suboptimal consideration.

Our study on Estimation of Fetal Weight Using Johnson's Formula and Ultrasonographically using Hadlock's formula and its Correlation with Actual BirthWeight in term pregnancies a prospective study , In terms of age distribution, our study found that the highest proportion belongs to 21-30yrs with 80.4% . Our study revealed that Majority of the patients belongs to lower middle class 67 (65.7%) as on and only 4 (3.9%) were illiterate .

When evaluating parity in our study Out of 102 mothers 27 (26.5 %) were primigravida and 75 (73.5 %) multiparous women . In that 68 (66.7%) underwent c-section and 34 (33.3%) had vaginal delivery . Gender distribution revealed Slightly more male babies were delivered than females, though the distribution is fairly balanced in our study .

In our prospective study, we evaluated and compared the accuracy of fetal weight estimation using **Johnson's clinical formula** and **Hadlock's ultrasonographic formula**, and correlated them with the **actual birth weight** in term pregnancies. The **mean actual birth weight** in our study population was 3011.96 **grams**, mean fetal weight estimated by Johnson's formula (3446.47 g), whereas the **mean fetal weight estimated by ultrasound (Hadlock's formula)** was **3275.81 grams**. The mean in Johnson's estimate and actual weight, this was coincidental, as shown by a higher **mean difference of 434.51 g** and **standard deviation of 292.98**, suggesting **overestimation** by Johnson's formula in most cases. In fact, **94.1%** of estimates using Johnson's formula **overestimated** the fetal weight, whereas USG overestimated in **85.3%** and underestimated in **14.7%** of cases.

The **mean difference between USG estimates and actual weight** was lower at **263.85 g**, with a standard deviation of **312.88**, reflecting relatively better accuracy and less variability compared to Johnson's method.

When evaluating **percentage error**, **USG had a higher proportion of estimates within ±10% error** (48.1%) compared to Johnson's (34.3%). Additionally, only **1%** of cases had exact estimates using Johnson's formula, and none using ultrasound—highlighting that while absolute accuracy is rare, **USG provides estimates closer to actual birth weight** more consistently.

Modi et al. (2018, India) Reported that **Hadlock's formula was more accurate**, with a **mean absolute error of ~280 g**, which matches our finding of 263.85 g.Their study emphasized **ultrasound accuracy in 50% of cases within ±10% error**, compared to **32.4% in our study**—suggesting some variation potentially due to operator skill or equipment differences[4].

Shittu et al. (2007, Nigeria) Found that **Johnson's formula overestimated fetal weight**, with a **mean error of 458 g**, very similar to our result of 434.5 g.They concluded Johnson's formula was less accurate, especially in macrosomic babies.Our study similarly found overestimation in the majority (94.1%) of cases[5].

where as **Kumar et al. (2016)**Found that **Johnson's formula was more reliable in fetuses weighing <3.5 kg**, but **underperformed** in macrosomic babies.In our study, Johnson's formula tended to overestimate weights >3.5 kg in **53.9%** of cases—supporting our study[6] .

Sherer et al. (1994) Showed that **Hadlock's formula had 70-80% estimates within ±10% of actual birth weight**.In our study, this figure was **48.1%** for Hadlock's formula—possibly indicating variability due to machine calibration, population differences, or sonographer expertise[7].

These findings align with other studies in literature that show **ultrasound-based estimations**, particularly Hadlock's formula using multiple fetal biometric parameters (BPD, HC, AC, FL), have a stronger predictive value and lower mean absolute error than clinical palpation-based methods like Johnson's. However, it is noteworthy that **Johnson's formula**, being quick, simple, and cost-effective, can still serve as a useful tool, particularly in **resource-limited settings** or when USG is unavailable.

Our study revealed a **trend of overestimation by Johnson's formula**, likely influenced by factors such as maternal obesity, fetal position, and operator variability, which can affect symphysiofundal height measurement. In contrast, the **ultrasound method**, though not perfect, is less susceptible to such external influences and provides a **more standardized and objective approach**.

Our study Limited by small sample size, limited period of observtion and potential **inter-observer variability** in both SFH measurement and USG parameters. Additionally, **maternal factors** (like BMI, parity) and **fetal presentations** were not independently analyzed in relation to their impact on the fetal birth weight estimation, which could be explored in future research.

CONCLUSION
When Johnson's formula used as individual predictor with a P-value of < 0.001 and the Pearson's correlation is 0.663 as a good predictor and Ultrasound with a P-value <0.001 and Pearson's correlation 0.695 is a reliable predictor but When ultrasound and Johnson's formula used as a combined tool the Pearson's correlation is 0.756 which is equivalent to 0.8 , which indicates when both parameters combined as excellent tool for prediction of actual birth weight .
From our study we found that pooled data of both Johnson's formula and ultrasound helps us in predicting estimated fetal weight in our regular clinical pratice .

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