

## Comparative study of fetal weight estimation by various methods at term and its correlation with the actual birth weight

**Authors:** Anjali Singh<sup>1\*</sup>; Anjani K. Srivastava<sup>2</sup>; Ankit Singh<sup>2</sup>

**Affiliations:** <sup>1</sup>Department of Obstetrics and Gynaecology, United Institute of Medical Sciences and United Medicity, Prayagraj, Uttar Pradesh, India; <sup>2</sup>Department of Community Medicine, United Institute of Medical Sciences and United Medicity, Prayagraj, Uttar Pradesh, India

### ABSTRACT

**INTRODUCTION:** Modern obstetrics aims to achieve the best quality of life for both mother and her unborn child. Birth weight is an important predictor of neonatal outcome, and its prenatal estimation plays a significant role in the comprehensive evaluation and management of high-risk pregnancies. This study aims to estimate fetal weight using different clinical methods and ultrasonography and compare these methods with the actual birth weight.

**METHODS:** A prospective cross-sectional comparative study of 200 full-term pregnant women admitted to the Northern Railway Central Hospital, New Delhi, between June 2014 and June 2015 was conducted. Patients in whom delivery was anticipated and completed within 1 week were included. Fetal weights were estimated clinically using Insler's and Johnson's formula and ultrasound using Hadlock's formula. Estimates were then compared with actual birth weight.

**RESULTS:** Both the clinical methods showed underestimation of fetal weight, while ultrasound estimation of fetal weight showed overestimation. Clinical methods had a lower average error in fetal weight estimation than ultrasonography methods. Reliability statistics showed a better prediction of fetal weight if all three methods were used in conjunction.

**CONCLUSION:** Clinical methods were found to be better than the ultrasonography method for fetal weight estimation. Clinical methods are easy and cost-effective for the patients, so all relevant health workers should be taught how to undertake this skill competently. However, all the methods must be used in conjunction.

**Keywords:** Fetal Weight, Methods, Birth weight, Ultrasonography, Prenatal

### INTRODUCTION

Accurate estimation of fetal weight is of prime importance in the management of labor and delivery [1]. During the last few decades, estimation of fetal weight has been incorporated

into the standard routine antepartum evaluation of high-risk pregnancies, delivery and intrapartum evaluation, and management of fetuses [2,3]. Estimating fetal weight antenatally is very important for the clinical team (e.g., obstetricians, midwives, etc) so that relevant intervention can be done to

\*Corresponding author: Dr. Anjali Singh, Assistant Professor, Department of Obstetrics & Gynaecology, United Institute of Medical Sciences & United Medicity, Prayagraj, Uttar Pradesh, India – 211012, email: dr.anjalisingh.srivastava@gmail.com; **Potential Conflicts of Interest (Col):** All authors: no potential conflicts of interest disclosed; **Funding:** All authors: no funding has been sought or gained for this project; **Academic Integrity.** All authors confirm that they have made substantial academic contributions to this manuscript as defined by the ICMJE; **Ethics of human subject participation:** The study was approved by the local Institutional Review Board. Informed consent was sought and gained where applicable; **Originality:** All authors: this manuscript is original has not been published elsewhere; **Review:** This manuscript was peer-reviewed by three reviewers in a double-blind review process; **Type-editor:** King (USA).

**Received:** 30<sup>th</sup> March 2023; **Initial decision given:** 4<sup>th</sup> April 2023; **Revised manuscript received:** 29<sup>th</sup> April 2023; **Accepted:** 3<sup>rd</sup> August 2023.

**Copyright:** © The Author(s). This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY-NC-ND) ([click here](#)) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. **Publisher:** Rwanda Biomedical Centre (RBC)/Rwanda Health Communication Center, P. O. Box 4586, Kigali. ISSN: 2079-097X (print); 2410-8626 (online)

**Citation for this article:** Anjali Singh; Anjani K. Srivastava; Ankit Singh. Comparative study of fetal weight estimation by various methods at term and its correlation with the actual birth weight. Rwanda Medical Journal, Vol. 80, no. 3, p. 9–14, 2023. <https://dx.doi.org/10.4314/rmj.v80i3.2>

avoid any complications. Accurate estimation of fetal weight is very important in the antepartum and intrapartum management of pregnancy, along with gestational age and adequacy of maternal pelvis, to decide the management of labor and mode of delivery [1].

Estimation of fetal weight would help in the successful management of labor, care of newborns in the neonatal period, and avoiding complications associated with fetal macrosomia, as shoulder dystocia is mostly associated with macrosomia. Large babies are large for gestational age or macrosomic babies of diabetic mothers, who may experience complications such as brachial plexus injuries, facial palsies, birth canal injuries, and post-partum hemorrhage. Estimating fetal weight (EFW) also helps diagnose IUGR, thereby reducing perinatal morbidity and mortality. Low birth weight (LBW) is a major problem in India, and it accounts for more than half of neonatal deaths [4,5,6]. Estimation of fetal weight is also important in breech deliveries and vaginal birth after cesarean section.

EFW can be undertaken either by clinical methods or by ultrasonography. Clinical methods of fetal weight estimation in this study include Insler's and Johnson's methods, and then there is the ultrasound method of fetal weight estimation. The aim of this study is to estimate the fetal weight by using different clinical methods and ultrasonography and to do a comparative evaluation of these methods with the actual birth weight of the baby.

## METHODS

A prospective, cross-sectional comparative study was conducted among 200 women with full-term pregnancies admitted to Northern Railway Central Hospital, New Delhi, for a period of 1 year, i.e., from June 2014 to June 2015.

**Study participants:** The study participants were selected from antenatal clinics and maternity wards of the hospital and informed consent was taken from the participants to enroll for the study and publish the findings of this research study; also, no personal details of the study participants were disclosed in this study.

The study's findings were calculated based on their last fetal weight estimation done within one week of delivery.

**Inclusion criteria:** Patients in whom delivery was anticipated within 1 week were included in this study. And those who did not deliver within 1 week of fetal weight estimation were excluded from the study. Our Inclusion criteria included patients with term pregnancy, singleton pregnancy, admission for planned delivery and cephalic presentation. The exclusion criteria included a patient with multiple gestations, malpresentation, poly or oligo hydramnios, fibroids or adnexal masses, known foetal malformation and obesity

These women were from all socio-economic classes. Detailed obstetric and menstrual history was taken. Significant antenatal history such as history of antepartum hemorrhage, hypertensive disorders, diabetes mellitus, cardiac disease, anemia and tuberculosis, were also noted. The duration of gestation was calculated according to Naegle's rule or by first trimester scan report.

**Study tool and data collection:** The study was undertaken to compare fetal weight estimation in term pregnancy using Insler's formula, Johnson's formula and Hadlock's formula using ultrasonography. Also, the fetal weight estimated by the above three methods was compared with the baby's actual weight at birth.

**Estimation of fetal weight:** Fetal weight estimation by Insler's formula [7]: Fetal weight (grams) = abdominal girth (cm) x Symphysis-fundal height (cm). After emptying the bladder, patient should lie supine with legs flat on the bed i.e. extended both at hip and knee. Abdominal girth is measured at the level of umbilicus and expressed in centimeter. After correction of dextrorotation, McDonald's measurements of height of the fundus from upper edge of Symphysis pubis following the curvature of abdomen were taken in centimeter tape. The upper hand was placed firmly against the top of the fundus, with the measuring tape pressing between the index and middle fingers readings were taken from perpendicular intersection of the tape with the fingers.

Fetal weight estimation by simplified Johnson's formula [8]: Fetal weight (gm) = (McDonald's measurement – 13) x 155. As above McDonald's measurement of Symphysis-fundal height is done. When the presenting part was at 'minus' station = (McDonald's measurement – 12) x 155, when presenting part was at 'zero' station = (McDonald's measurement – 11) x 155, when

presenting part was at plus station.

Fetal weight estimation by Hadlock's formula using ultrasonography: Sonographic examination was done in all patients using 3.5 MHz convex assay and linear assay transverse (Transverse sumen's sonoline SL grey scale model with M & B mode for simultaneous imaging and calculating fetal heart rate).

After biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL) were measured in centimeters, the sonography machine calculated fetal weight. Fetal weight was calculated using the formula:

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

Predicted EFW by each method was compared with respective neonatal actual birth weight using electronic machine in the hospital which showed the accurate birth weight.

Practitioners undertaking the estimations: All the measurements were done by the Principal investigator/first author during her post-graduation training, after receiving approval from her mentor/guide about the required skill, to perform the measurement efficiently.

**Actual birth weight:** Actual birth weight was

measured just after the baby was born, preferably within the first hour of life, before significant postnatal weight loss has occurred. Weight of the baby was measured without any clothes using digital weighing scale.

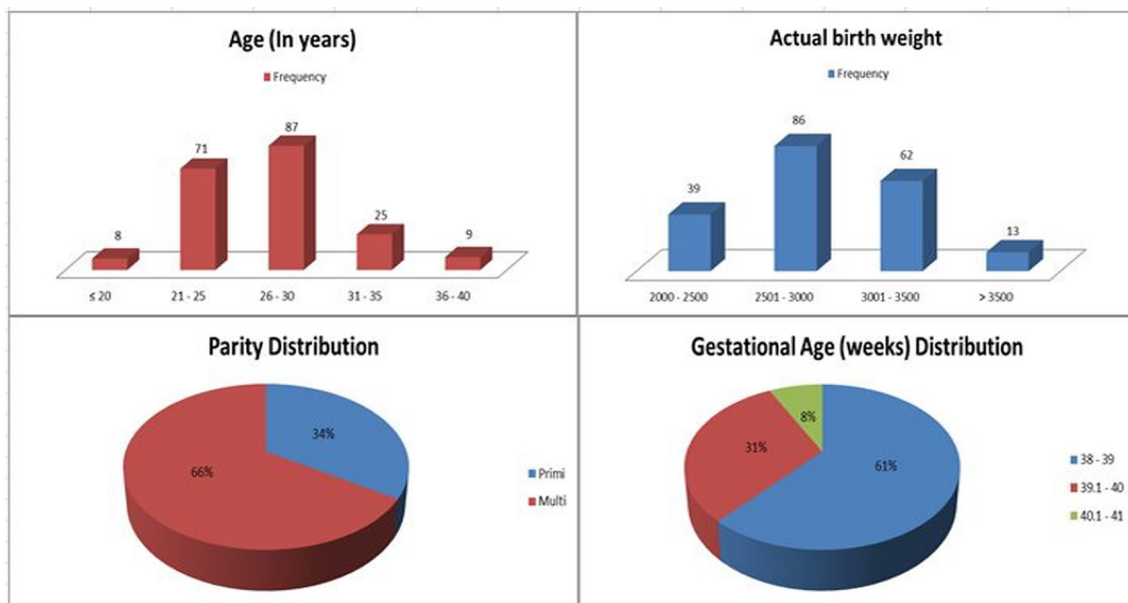
**Statistical analysis:** Data was entered in Microsoft Excel 2010 spread sheet, and subsequently it was analyzed using R Software version 4.3.1. The quantitative variables were expressed as Mean  $\pm$  SD and compared between more than two groups using ANOVA followed by Post Hoc Analysis. The pair wise correlation between quantitative variable was evaluated using Pearson's correlation coefficient and Interclass correlation along with Cronbach's alpha. P-value <0.05 was considered as statistically significant.

Ethical clearance was obtained from institutional ethical committee with Reference number NRCH/IEC/2013/186 and informed consent from study participants was taken.

## RESULTS

Most of the study participants were between 26-30 years of age followed by 21-25 years (Figure 1). 39 out of 200 newborns that were delivered was low birth weight (Figure 1).

The range of maternal age was 19 to 39 years, with



**Figure 1: Distribution of age, parity, gestational Age and Actual birth weight among the study participants**

**Table 1: Descriptive Statistics of different variables among study participants (n=200)**

Variables	Minimum	Maximum	Mean	SD
Maternal Age	19.0	39.0	26.95	4.27
Gestational age (weeks)	38.0	41.0	38.82	0.74
Insler's Formula	2460.0	3565.0	2973.20	226.34
Johnson's Formula	2020.0	3515.0	2864.56	243.45
USG	2160.0	4400.0	3045.14	417.74
Actual birth weight	2000.0	4100.0	2924.26	409.79

USG: Ultrasonography; SD: Standard deviation

a mean of 26.95 years and a standard deviation of 4.27 years. Gestational age exhibited less variation, with a range of 38 to 41 weeks and a mean of 38.82 weeks. In estimating birth weight, Insler's and Johnson's formulas yielded mean values of 2973.20 grams and 2864.56 grams, respectively. The ultrasonography (USG) method had a greater range, with values ranging from 2160 to 4400 grams and an average birth weight of 3045.14 grams, but a relatively high standard deviation of 417.74 grams. The range of actual birth weight was 2000 to 4100 grams, with a mean of 2924.26 grams and a standard deviation of 409.79 grams (Table

1). The mean actual birth weight of the infants was 2924g (Table 2). While comparing the groups using the ANOVA statistical test, it is found that there is a statistically significant difference between the groups ( $p < 0.05$ ).

There was a non-significant underestimation of fetal weight by Insler's and Johnson's method in comparison to actual birth weight; however, it was not statistically significant, while there was a significant overestimation of birth weight by ultrasonography method in comparison to actual birth weight and it was statistically significant

**Table 2: Comparison of estimated fetal weight by different methods with the actual birth weight among study participants (n=200)**

Birth Weights	Minimum	Maximum	Mean $\pm$ SD	95% CI_LL	95% CI_UL	p-value
Insler's	2460.0	3565.0	2973.2 $\pm$ 226.33	2841.64	2999.76	
Johnson's	2020.0	3515.0	2864.56 $\pm$ 243.45	2815.61	2943.50	
USG	2160.0	4400.0	3045.13 $\pm$ 417.74	2986.89	3103.38	0.0014
Actual Birth weight	2000.0	4100.0	2924.26 $\pm$ 409.78	2867.12	2981.40	

USG: Ultrasonography; SD: Standard deviation; CI: Confidence interval; LL: Lower level; UL: Upper level

**Table 3: Comparison of different estimated birth weights (Within Groups) – Post Hoc analysis among study participants (n=200)**

Birth weight	Mean Difference	Std. error	95% CI_LL	95% CI_UL	p-value
Insler's	-41.06	33.65	-117.69	35.57	0.427
Actual Johnson's	-96.7	33.65	-128.33	71.93	0.972
USG	120.88*	33.65	34.24	207.51	0.002

Std.error: Standard error; CI: Confidence interval; LL: Lower level; UL: Upper level

(Table 3). The average error in USG method of fetal weight estimation is 32g in comparison to actual birth weight, and it is the highest among all three methods; Johnson's method has an average error of 23g, which is followed by Insler's method with an average error of 14g (Table 4).

Intraclass correlation (ICC) is used to assess agreement when there are two or more independent methods, and the outcome is measured continuously (Table 5). All three methods are independent. It shows that while measuring consistency, average measures ICC are almost identical to Cronbach's alpha ( $\alpha$ ) which shows the reliability of methods as  $\alpha=0.895$ , which is reassuring of a high level. Average measures show a positive strong correlation ( $\alpha=0.881$ ), and how reliably all the three groups agree, whereas single measures also show a strong positive correlation ( $\alpha=0.649$ ), and how reliable to use just one method. It shows high agreement between the methods and reliability among them, which is statistically significant ( $p<0.05$ ).

## DISCUSSION

Accurate estimation of fetal weight is critical in labor and delivery management. EFW has been included in a standard routine antenatal assessment of high-risk pregnancies and deliveries for the past two decades.

As fetal weight cannot be measured directly, it must be approximated from fetal and maternal anatomical characteristics or ultrasound estimation. Of the various methods, the most regularly used are the clinical methods (i.e., Insler's & Johnson's method) and ultrasonography methods, as in this study. Both macrosomia and intrauterine growth restriction increase the risk of perinatal morbidity and mortality as well as long-term neurologic and developmental impairment. Identifying intrauterine growth restriction and macrosomia will reduce the chances of fetal morbidity and mortality [9,10].

In the present study, fetal weights were underestimated by Insler's and Johnson's method while it was overestimated by the USG method, which was similar to the finding of Bhandary Amritha et al. where also Insler's underestimated while USG overestimated the fetal weight [11]. The average error of Insler's method in each fetal weight group was 13.8 gm, which was the smallest error compared with other methods; this is similar to the findings of Surapaneni et al. [12]. Aruna S et al. also found that Insler's had the smallest average error compared to Johnson and Hadlock's (USG) method. In contrast to our study, Nasir et al. found that the average error in fetal weight estimation by ultrasound (361 + 278 gm) was significantly lower than that of the Johnson method (586 + 344gm).

**Table 4: Average error in each method of fetal weight estimation in comparison to actual birth weight**

Methods	Birth Weight (in grams)				Average error
	2000-2500	2501-3000	3001-3500	>3500	
	Average error (gm)				
Insler's	3.81	9.03	24.21	18.33	13.845
Johnson's	58.49	10.75	15.23	7.5	22.9925
USG	34.17	13.02	14.39	67.47	32.2625

**Table 5: Reliability Statistics of different birth weights among study participants (n=200)**

Reliability Statistics	Intraclass Correlation	Cronbach's Alpha	95% CI_LL	95% CI_UL	p-value
Single Measures	0.649	0.895	0.570	0.718	0.0022
Average Measures	0.881		0.841	0.911	0.0010

LL: Lower level; UL: Upper level

According to the error comparison of the birth weight category, it is found that the clinical method has the largest error in the birth weight category of 2000-2500gm [13] [14]. The ultrasound showed a 664 gm error for this group. Average errors for all categories decreased with increasing birth weight. The accuracy of the clinical method was found to be acceptable at birth weights above 3500gm. In this study, we found an underestimation of fetal weight by clinical methods, i.e., Insler's and Johnson's methods which were not statistically significant, and an overestimation by the USG method, which was statistically significant. The mean difference here was found to be more in the USG method than both clinical methods. Dongol et al. [15] found that sonological method has more accuracy in the estimation of fetal weight with minimal variation than the clinical method, which was found to be statistically significant.

## CONCLUSION

Estimation of fetal weight plays an important role in labor and delivery management of term pregnancy. In our study of the two formulations, Insler's method had better predictive results for fetal weight estimation than Johnson's method. As earlier anticipated, the USG method may provide objective criteria for identifying abnormally sized fetuses for gestational age but has recently been undermined by prospective studies showing that ultrasound estimates of fetal weight do not Superior to clinical estimates of fetal weight. Several technical limitations of the ultrasound approach are maternal obesity, oligohydramnios, and anterior placenta. It also requires an expensive ultrasound equipment setup and specially trained personnel. Therefore, according to this study, a clinical approach to fetal weight estimation could be of great value in developing countries like India, where ultrasound is not available in many healthcare delivery centers. It's affordable and simple enough that any healthcare professional can use it. Therefore, the clinical approach to fetal weight estimation should be taught to all medical personnel, including paramedics. Clinical methods of fetal weight estimation should be used as a screening tool for all term or laboring mothers. Ultrasonography (if available and affordable) must be used in conjunction with a clinical approach for high-risk pregnancies.

## REFERENCES

1. Sirohiwal, D.; Singal, S.R.; Passi, V.; Sen, J.; Estimation of fetal weight. *Obst. Gynaecol. Today*. 2004, 9, 247-9.
2. Chauhan, SP.; Hendrix, NW.; Magann, EF.; Morrison, JC.; Kenny, SP.; Devoe, LD.; Limitations of clinical and sonographic estimates of birth weight: Experience with 1034 parents. *Obstet. Gynaecol.* 1998, 91, 72-7, doi: 10.1016/s0029-7844(97)00590-5.
3. Sherman, DJ.; Tovbin, J.; Caspi, E.; Bukovsky, IA.; A comparison of clinical and ultrasound estimation of fetal weight. *Obstet. Gynaecol.* 1998, 91, 212-7, doi: 10.1016/s0029-7844(97)00654-6.
4. Wilcox, AJ.; SK, Jaervan, R.; Birthweight and perinatal mortality. The effect of gestational age. *A.M. J Public. Health.* 1992, 82, 378-82, doi: 10.2105/ajph.82.3.378.
5. Arias, F.; *Instrumental delivery: Practical guide to high risk pregnancy and delivery, 4th edition*; Elsevier. India. Pvt. Ltd; New Delhi. 2015; Chapter 22, 336-348.
6. Arias, F.; *Indian experience of fetal growth restriction: In practical guide to high risk pregnancy and delivery, 4th edn.* Elsevier. India. Pvt. Ltd; New Delhi: 2015, Chapter 5, 99-106.
7. Insler, V.; Bernstein, D.; Rikover, M.; Segal, T.; Estimation of fetal weight in utero by simple external palpation. *A. M. J. Obstet. Gynaecol.* 1967, May 15, 98(2), 292-3, doi: 10.1016/s0002-9378(16)34601-4.
8. Johnson, R.W.; Toshach, E.; Estimation of fetal weight using longitudinal measurement. *A. M. J. Obstet. Gynaecol.* 1954, 5(1), 68, 891, doi: 10.1016/s0002-9378(16)38330-2.
9. Ekele, B.; Otubu, J. A. M.; "Maternal and perinatal mortality," in *Textbook of Obstetrics and Gynecology for Medical Student, 2nd edition*, Heinemann. Educational. Books. Ibadan, Nigeria 2006, 2 (1), 526-531.
10. Westerway, S. C.; "Estimating fetal weight for best clinical outcome," *Aus. J. Ult. Med.* 2012, 15(1), 13-17, doi: 10.1002/j.2205-0140.2012.tb00136.x.
11. Bhandary, Amritha, A.; Pinto, Patric, J.; Shetty, Ashwin, P.; Comparative studyv of various methods of fetal weight estimation at term pregnancy. *J. Obstet. Gynaecol. Ind.* 2004, 54(4), 336-9.
12. Surapaneni, D.; Kothari, D.; Anand, D.; Estimation of fetal actual weight with various methods in term pregnancy - a comparison. *Int. J. Adv Res.* 2016, 4(7), 1073-1076, doi: 10.21474/

IJAR01/935.

13. Aruna, S.; Yalla, S.; Yellayi, ASS.; Bai, KS.; Estimation of Fetal Weight by Clinical Methods and Ultrasound and Correlating its Accuracy with Actual Birth Weight in Term Pregnancies. *Int. J. Sci. Stud.* 2017, 5(4), 265-269, doi: 10.17354/ijss/2017/376.

14. Nasir, M.; Sohail, I.; Siraj, N.; Estimated Fetal Weight; A Comparison between Clinical and

Ultrasonographical Measurements. *J. Soc. Obstet. Gynaecol. Pak.* 2019, 9(3), 135-140.

15. Dongol, A.; Bastakoti, R.; Pradhan, N.; Sharma, N.; Clinical Estimation of Fetal Weight with Reference to Johnson's Formula: An Alternative Solution Adjacent to Sonographic Estimation of Fetal Weight. *Kathmandu University medical journal (KUMJ)* 2020, 18(70), 111–116.