

**COMPARATIVE STUDY OF FETAL WEIGHT ESTIMATION BY CLINICAL AND
ULTRASOUND METHODS AND ITS CORRELATION WITH ACTUAL BIRTH WEIGHT**

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ABSTRACT

Introduction: Accurate estimation of fetal weight is of paramount importance in the management of labour and delivery. High rate of perinatal mortality in developing countries makes estimation of fetal weight (EFW) antenatally pivotal to the obstetricians. **Aim:** EFW by Hadlock's formula, Vintzileos, Johnson's formula and Insler Berstein's compare their accuracy with that of actual birth weight. **Materials and Methods:** A prospective study of 120 antenatal women between 37 and 40 weeks gestation with a singleton pregnancy with reliable date/dating scan, with no fetal anomalies, undergoing obstetric scan were taken. EFW was estimated by clinical method using Johnson's, Insler Berstein's formula and by ultrasound using Hadlock's, Vintzileo's formula and compared with the actual birth weight. **Results:** In our study, it was inferred that the mean actual birth weight was 2900 ± 287 grams. The mean weight estimated by Vintzileo's 2850 ± 275 grams was very close to the actual birth weight. The mean of Johnson's estimated birth weight was 2992 ± 281 gms. The mean of Hadlock's estimated birth weight was 2790 ± 328 grams which is slightly lower than actual birth weight. Insler's method of prediction was slightly higher 3070 ± 323 grams than actual birth weight. By Anova method, Vintzileo's, Johnson's prediction of birth weight was insignificant $P > 0.05$ but by Bonferroni Post HOC method P value < 0.05 was significant for Vintzileo's. **Conclusion:** Clinical fetal weight estimation was relatively accurate however ultrasonographic EFW by Vintzileos formula was more in congruence with the actual birth weight.

Keywords: Antenatal, Birth weight, Hadlock, Johnson, Vintzileos, Insler Berstein's.

1. INTRODUCTION

Birth weight is a single most important factor that determines the neonatal outcome and survival. Fetal and Neonatal life are affected by many factors including genetic, socio economic and environmental factors.

Both low birth weight and excessive fetal weight at delivery are associated with an increased risk of newborn complications during labour and the puerperium. The perinatal complications associated with low birth weight are attributable to either preterm delivery or intrauterine growth restriction (IUGR)

For excessively large fetuses, the potential complications associated with delivery include shoulder dystocia, brachial plexus injuries, intrapartum asphyxia, hypoglycemia, electrolyte imbalance and neonatal jaundice.

World Health Organization (WHO) has recommended that newborns with birth weight less than 2500 grams may be considered to fall in low birth weight categories carrying relatively higher risk of perinatal and neonatal morbidity and mortality. About 80% of neonatal death and 50% of infant deaths occur among these group. These infants are more prone to develop recurrent infection, malnutrition, diabetes, hypertension and neuro developmental handicaps in their life time. Hence low birth weight is an important risk factor for adverse outcome in later life.

Therefore estimation of fetal birth weight in intra uterine period happens to be of greater significance in early detection of intra uterine growth restriction and prevention of prematurity. Based on clinical trials and observation various methods to estimate birth weight of the fetus are approved for clinical use.

Estimated fetal weight is taken into consideration when making clinical decisions involving induction (or) delay of

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labor and also in deciding the method of delivery and newborn care.

AIMS AND OBJECTIVES:

1. To estimate the fetal weight by ultrasound, using Vintzileo's formula [mid thigh circumference] and Hadlock's formula.
2. To estimate the fetal weight by clinical method, using Insler and Bernstein's formula and Johnson's formula.
3. Comparing the accuracy of estimated fetal weight by Vintzileo's formula, Hadlock's formula, Johnson's formula, Insler and Bernstein's formula and with the actual neonatal birth weight.

2. MATERIALS AND METHODS

SETTING:

The study was conducted in Department of Obstetrics and Gynaecology Rajah Muthiah Medical College and Hospital, Annamalai University Chidambaram from October 2014 to October 2015.

STUDY POPULATION:

All antenatal women between 37 to 40 weeks gestation with no fetal anomalies attending RMMCH OPD and antenatal mothers admitted in maternity ward for whom ultrasound and clinical fetal weight estimation was done within 7 days before delivery.

TYPE OF STUDY:

Prospective study

SAMPLE SIZE:

120

STUDY PERIOD:

2014-2015

INCLUSION CRITERIA:

1. All antenatal women between 37-40 weeks of gestation
2. Vertex presentation
3. Singleton pregnancy
4. Patient with Reliable date
5. Ability to give informed consent
6. Irrespective of parity and socio economic status

EXCLUSION CRITERIA:

1. Wrong dates
2. Congenital anomalies
3. Polyhydramnios / Oligohydramnios
4. IUGR, multiple gestation
5. Obesity, Diabetes, Hypertension, Heart disease, PIH
6. Presentations other than vertex
7. Preterm / Postterm pregnancy
8. Uterine / adnexal Tumour complicating pregnancy
9. In ability to give informed consent

The patients who were selected from antenatal clinics and maternity wards had their last fetal weight estimation done within 1 week of delivery. Prior to allocation, participants

were counseled regarding the study, and explained that ultrasound which is a routine for obstetrics cases is a non-invasive and safe procedure and consent obtained in a designated form and they were formally included in the study. Patients in whom delivery was anticipated within 1 week and women who were in labor were also included in this study. Patients who did not deliver within 1 week of fetal weight estimation were excluded from this study. These women were from all socioeconomic classes. Detailed obstetric and menstrual history was taken. The duration of gestation was calculated according to Nagle's rules patients with associated diseases such as anemia, heart disease was also included.

Significant antenatal history such as history of antepartum hemorrhage, hypertensive disorders, diabetes mellitus, cardiac disease, anemia and tuberculosis were noted. Routine hematological and biochemical investigations were carried out.

Foetal Weight Estimation by Simplified

1. Johnson's Formula (1957)

After emptying the bladder, patient placed in the supine position. After correction of dextrorotation, McDonald's measurement of height of the fundus from the upper edge of the symphysis pubis following the curvature of the abdomen was taken with centimeter tape. The upper hand was placed firmly against the top of the fundus, with the measuring tape pressing between the index and middle finger.

Station of presenting part was assessed by abdominal examination and by vaginal examination when they were in labor. Condition of the membranes was also noted (intact or ruptured).

Fetal weight was estimated as follows:

Fetal weight (g) = (McDonald's measurement - 13) × 155

When the presenting part was at "minus" station

= (McDonald's measurement - 12) × 155 when presenting parts at "zero" station

= (McDonald's measurement - 11) × 155 when presenting part at plus station

If woman weighed more than 91 kg, 1 cm was subtracted from fundal height. 6-8

2. Insler's Formula:

According to this formula Fetal weight in grams = Symphysiofundal height in cms X Abdominal Girth in cms. Abdominal girth is measured in cms at the level of the umbilicus.

Fetal Weights Estimation by

1. Hadlock's Formula using Ultrasonography (USG)

Sonographic examination was done in all patients using 3.5 MHz convex array and linear array transducer (Transverse Siemen's Sonoline SL grey scale model with M and B mode for simultaneous imaging and calculating fetal heart rate). Biparietal diameter (BPD) abdominal circumference (AC) and femur length (FL) were measured in centimeters, the sonography machine calculated fetal weight. 9,10

BPD Measurement

The BPD was measured at right angles to the longitudinal axis of the elliptical skull at a level at which a clear midline

echo and easily discernable lateral ventricle could be visualized. At this level, the transverse scan also should show cavum septum pellucidum and the thalamus. BPD was measured from the outer table of anterior skull to the inner table of the posterior skull (Figure 1).11,12

AC Measurement

The measurement of the fetal AC was made from a transverse axial image of the fetal abdomen at the level of the liver. The major landmark in this section is the umbilical portion of the left portal vein deep in the liver, with the fetal stomach representing a secondary landmark.13

FL Measurement

The shaft of the femur is the easiest fetal long bone to visualize and measure. FL measurement was obtained from the greater trochanter to the lateral condyle.14 The head of the femur and the distal femoral epiphysis, when present, was not included in the measurement. The measured ends of the bone were blunt and not pointed. The 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 estimated fetal weight by each method was compared with respective neonatal actual birth weight using weighing scale.

Mid thigh circumference:

Mid thigh circumference is a three dimension measurement. First whole length of femur from greater trochanter to the distal metaphysis was imaged.

Rules of measurement:

After the image of the thigh is imaged the transducer is rotated by 90degrees to obtain a cross sectional profile of the middle of the thigh at a position where

1. The bone profile is as round as possible
2. The boundary of the thigh profile is well defined.

Thigh circumference is determined with elliptical approximation three times and the average is taken as the final measurement.

2. Vintzileo's Formula:

This utilizes mid thigh circumference. Thigh circumference is one of the parameters that reflects soft tissue mass. It reflects directly upon the fetal nutritional status. Also it is easily measurable and reproducible. The measurement error is also small in the range of 4 %.This measurement is comparable with other fetal parameters in variability. This parameter is also useful in predicting the birth weight where fetal growth abnormalities are present.

According to this formula,
 $\text{Log}_{10}(\text{BW}) = 1.897 + (0.015 \times \text{AC}) + (0.057 \times \text{BPD}) + (0.054 \times \text{FL}) + (0.01 \times \text{XTC})$



BPD is measured at the level of third ventricle and thalami.



Abdominal Circumference is measured at the level of gall bladder and stomach where rib is symmetrical and right and left portal vein are continuous with each other.



Only the ossified portion of the metaphysis and diaphysis excluding the cartilage is measured for FL.



Thigh circumference is measured at the middle of the thigh where bone profile is as round as possible and the boundary of the thigh profile is well defined.

Statistical analysis of the difference between calculated EFW and actual birth weight was done by Anova and Post HOC methods. Birth weight estimation accuracy was compared with parity, age of the mother, weight and height of the mother. The relative observations were recorded and subjected to statistical analysis.

3.RESULTS

Among 120 women with singleton term pregnancies in whom fetal anomalies ruled out were selected for study.

50% of the patients were in the age group of 24 – 28 years with average year of 24.98 ± 3.22 years (Table 1).

54.2% cases were primi gravida and 45.8% were multigravida (Table 2).

Socio economic class of IV is more common (54.2%) (Table 3)

The majority of women (48.3%) have gestational age of 38 weeks at the time of evaluation (Table 4), (Graph 1).

45 % delivered vaginally and 55% delivered by LSCS (Table 5).

The majority of women are normal BMI 65% (Table 6).

The fetal weight measurements by clinical and USG methods were taken 7 days before delivery. 50.8% were delivered during second and third day of fetal weight estimation. The actual fetal weight was calculated within one hour of delivery in a weighing scale (Graph 2).

In comparisons of different methods of birthweight is presented. It was inferred that the mean actual birth weight was 2900 ± 287 gms. The mean weight estimated by vintzileos was 2850 ± 275 grams, By Johnson’s estimation birth weight was 2992 ± 281 grams. The mean of hadlock’s

estimated birth weight was 2790 ± 328 grams. By Insler’s method the birth weight was 3070 ± 323 grams (Table7), (Graph 3).

By Anova Method Vintzileo’s and Johnson’s formulas showed insignificant ‘p’ value ($p > 0.05$) when compared to the actual birth weight. Between these two, Vintzileo’s was superior because the mean difference was lowest when compared to actual birth weight (Table 8).

And further Post Hoc multiple comparisons shows significant ($p = 0.004$) difference which again confirms superiority of Vintzileo’s (Table 9).

TABLE1 - AGE DISTRIBUTION

Age (in years)	Number of persons	Percentage
19-23	41	34.2
24-28	60	50.0
29-33	19	15.8
Total	120	100

Age (in years)	Mean	S.D
	24.98	3.22

TABLE 2 - PARITY DISTRIBUTIONS

Parity	Number of persons	Percentage
Primi	65	54.2
Multi	55	45.8
Total	120	100

TABLE 3 - SOCIO-ECONOMIC STATUS

Socio economic status	Number of persons	Percentage	Mean birth weight in grams	SD
3	25	20.8	2856	323
4	65	54.2	2925	309
5	30	25.0	2911	386
	120	100	-	-

TABLE 4 - GESTATIONAL AGE

Gestational age	Number of persons	Percentage
37	27	22.5
38	58	48.3
39	27	22.5
40	8	6.7
Total	120	100

GRAPH 1

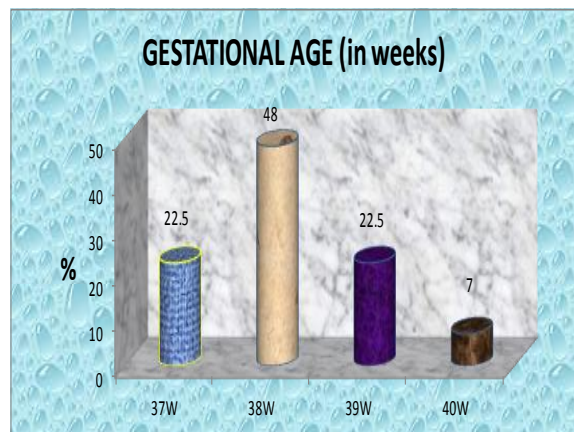


TABLE 5 - MODE OF DELIVERY

Mode of delivery	Number of persons	Percentage
LSCS	66	55
Normal	54	45
Total	120	100

TABLE 6 - BMI DISTRIBUTIONS

BMI	Number of persons	Percentage
18.5-24.9	78	65
25-30	42	35
Total	120	100

GRAPH 2

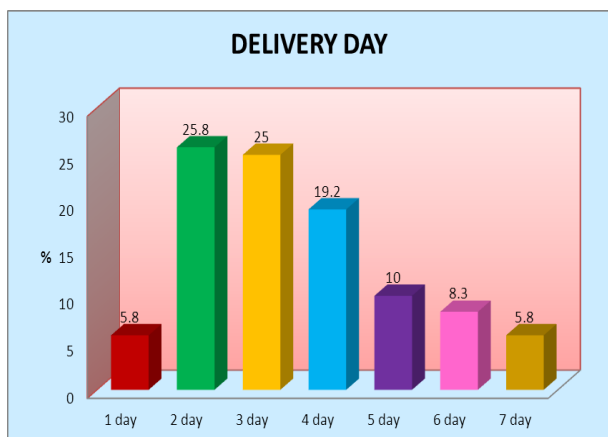


TABLE 7 - COMPARISONS OF DIFFERENT METHODS OF BIRTH WEIGHT ESTIMATION (IN GRAMS)

Methods	Mean	S.D
Johnson	2992	281
Insler	3070	323
Hadlock's	2790	328
Vintzileos	2850	275
Actual birth weight	2900	287

GRAPH 3

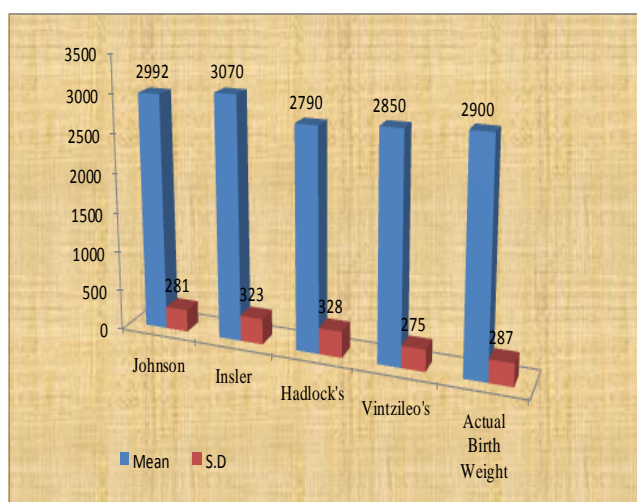


TABLE 8

	'F' value	Significant
ANOVA	15.94	0.001

TABLE 9 MULTIPLE COMPARISONS (BONFERRONI POST. HOC)

GROUPS	MEAN DIFFERENCE	SIGNIFICANT
Johnson's		
Insler	-78	0.456
Hadlock's	197	0.001
Vintzileos	138	0.004
Actual birth weight	089	0.215
Insler		
Hadlock's	275	0.001
Vintzileos	215	0.001
Actual birth weight	167	0.001
Hadlock's		
Vintzileo's	-59	1.000
Actual birth weight	-108	0.055
Vintzileo's		
Actual birth weight	-48	1.000

4.DISCUSSION

In our study of 120 cases 50% (n=50) of the cases belonged to the age group of 24-28 years. George Naomi²³ (2005) on comparing the clinical and USG estimation of fetal weight had concluded that age of the patient has no correlation to the prediction of birthweight. In our study also there was no correlation between prediction of birth weight and maternal age.

In our study 54.2% (n=65) were primi gravida and 45.8% were multigravida. Prediction of birth weight does not rely on the parity of the patient. The percentage of correct estimate, by nulliparous women did not differ significantly from that of parous women (57% Vs 68%, p = 0.38). This result was shown by Maria Torloni (2008)¹⁶. BaumJonathan (2002)²⁶ also has shown similar results.

In our study, 45% of the cases delivered vaginally and 55% underwent caesarean delivery.

In our study the predicted fetal weight was calculated by clinical and Ultrasound methods within seven days of delivery of which 70% of deliveries occurred within four days of fetal weight estimation. Sanyal, Poushali (2012)⁷ in his study stated that the mean fetal weight estimated by Vintzileo's Formula was nearer to the mean actual birth weight compared to the Hadlock's Formula. In our study also Vintzileo's Formula was near to the actual birth weight and least error percentage compared to the Johnson and Hadlock's Formula (error)- Vintzileo's Formula (3.2-4.4%), Hadlock's (7.4-8.5%), Johnson's (5.5-6.1%).

The majority of women are in the class IV (54.2%) of socio economic persons. In class III 20.8% and class V 25% of women were observed. In other categories no one was observed. In our study the actual birth weight was observed slightly higher in class III status than class IV & V.

In Our study the average birth weight in grams was – 2900, as compared to other studies which showed Raman (2008)¹⁴ 3150gms, Irina (2009)¹² 2693gms, Ayoola (2008)¹⁵ 3238gms, Hebbar (2007)²⁰ 2822gms, Atalie (2006)²¹ 3325gms, Kalantari M and Neghdari (2013)⁶ Baum(2002)¹¹ 3407gms.

In our study, it was inferred that the mean actual birth weight was 2900±287grams. The mean weight estimated by

Vintzileo's was very close to the actual birth weight, which was 2850 ± 275 grams. The mean of Hadlock's estimated birth weight was 2790 ± 328 grams which is slightly lower than actual birth weight. Insler's method of prediction was slightly higher mean 3070 ± 323 grams than actual birth weight. Hebbar (2007)²⁰ in his study has shown that Vintzileo's has least difference than other formulas within 10% of actual birth weight.

5. CONCLUSION

Clinical fetal weight estimation was relatively accurate however ultrasonographic EFW by Vintzileos formula was more in congruence with the actual birth weight. The USG is not only superior in estimating fetal weight accurately but in assessing the gestational age, fetal maturity, biophysical profile and AFI which play an important role in the management of labour and reduction of perinatal morbidity and mortality .

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