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# Role of Fetal Mid- Thigh Soft Tissue Thickness in Prediction of Fetal weight and Comparing It with other Ultrasound Methods

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**Abstract**

Background: Researchers are paying a lot of attention to measurement of mid-thigh soft-tissue thickness (MTSTT), one of the soft tissue parameters. This study's objective was to evaluate MTSTT measurement accuracy and femur length, in calculating the anticipated foetal birth weight. Methods: This is cross-sectional research that enrolled 130 singleton pregnant women revealed for planned delivery at term (among 37 and 40 weeks) either by induction of labor and vaginal delivery or elective cesarean section within 48 hours. Each patient underwent a thorough clinical assessment, thorough history collection, and an ultrasound investigation. Results: When assessing the Hadlock formula in estimating fetal weight compared to actual fetal weight, the sensitivity was 82.8%, specificity was 88.1% with area under the curve 87.1% as fetal weight was equal or lower than 3500 gm. A significant positive moderate correlation among weight by Hadlock formula and actual fetal weight. While a critical positive strong correlation was present between actual fetal weight and weight by Scioscia's formula (P-value <0.001). When assessing the Hadlock formula in estimating fetal weight compared to actual fetal weight, the sensitivity was 82.8%, specificity was 88.1% with area under the curve 87.1% as fetal weight was equal or lower than 3500 gm. When assessing the Scioscia's formula in estimating fetal weight compared to actual fetal weight, the sensitivity was 72.4%, specificity was 86.1% with area under the curve 84.1% as fetal weight was equal or lower than 3500 gm. Conclusions: We concluded that MTSTT, a linear measurement, can be added to normal biometric parameters to enhance foetal weight prediction by ultrasound at term prior to delivery because it is simple, straight forward, and easy to obtain.

**Keywords:** MTSTT; Fetal Birth Weight and Ultrasound.

## 1. Introduction

In modern obstetrics, it is crucial to have accurate foetal weight information prior to deciding delivery method. It is also well-known that allowing vaginal delivery in cases of undiagnosed fetopelvic disproportion is associated with a higher incidence of maternal and neonatal morbidity, including reproductive trauma and birth injuries due to problems with the second stages, such as shoulder dystocia and birth trauma resulting in significant and long-lasting health issues [1].

Only clinical estimates utilising various formulae based on symphysis fundal height parameters, belly girth, and position of the foetal head is possible in low resource situations to estimate approximation before birth. Nevertheless, these techniques are linked to estimate errors of the birth weight (BW) of between 10 and 20 percent, that can be either an underestimation or an overestimation. Labor anomalies include a protracted descent of the presenting part, an extended active phase, and shoulder dystocia are linked to underestimation of the potentially large infant [2].

The assessment of foetal weight has been changed since Prof. Ian Donald introduced ultrasonography to obstetrics, and there is a wealth of information available on this part of ultrasound practise. Numerous foetal biometric characteristics, including as head circumference, biparietal diameter, belly circumference, and femur length, may now be quantified, and numerous equations with varied degrees of accuracy have been generated through regression analysis for both low BW and macrosomic infants. These biometric characteristics are derived from linear or planar measurements of sections of the fetus collected in utero, and particular measuring standards have been created [3].

A BW estimation formula should have minimal systematic and random errors and a minimum dependability of 90 percent. Nevertheless, at this time, it seems that ultrasound formulas utilising traditional biometric criteria have exceeded their diagnostic limitations due to biological, ethical, geographical, and many other unknowable aspects. This suggests that in order to increase the accuracy of BW prediction models, more measurements are required [4].

Neonatal medicine is well aware of the usefulness of mid-arm circumference to identify new-borns with low BW. This can be generalized to intrauterine assessment of body fat in places like the circumference of the cheek to cheek and the mass of the subscapular fat in the abdomen. Studies have shown that the amount of subcutaneous fat distribution also affects foetal weight, and using fat thickness in ultrasonography formulas considerably improves the accuracy of antenatal BW prediction [5].

Measurement of MTSTT, one of the soft tissue dimensions, is receiving a lot of interest from researchers, although there aren't many Indian studies in this area [6].

The current study aimed to evaluate the reliability of MTSTT and femur length measurements in estimating predicted foetal birth weight.

## 2. Methods

This cross-sectional research was performed at Benha University Hospitals between over a period of one year from February 2022 to February 2023. The study included 130 singleton pregnant women hospitalised for induction of labour followed by a vaginal delivery or elective caesarean section within 48 hours during a planned delivery at term (between 37 and 40 weeks).

The study was performed after being accepted by the Institutional Ethical Committee, Faculty of Medicine, Benha University. Each patient provided their consent after being fully informed.

**Inclusion criteria for the study** comprised term pregnant women referred to the obstetric ward who intended to deliver within 48 hours, cephalic presentation, viable single fetus, typical amniotic fluid index for gestational age in women among ages of 20 and 35 years is between 37 and 40 weeks.

**Exclusion criteria were** mothers with any risk factors that would impair foetal growth, such as (HTN and DM), Oligohydramnios, Breech presentation, congenital malformations, and foetal growth limitation, as well as women younger than 20 and older than 35 years.

**In the study, all cases involved were submitted to A) Detailed history taking** involving personal history: name, residence, age, occupation, and smoking. Obstetric history: parity, preeclampsia or gestational diabetes, mode of previous delivery, weight gain in current pregnancy. Menstrual history: First day of last menstrual period and regularity. Contraceptive history: to ensure reliability of last menstrual period. Past history: Medical disease especially hypertensive disorders and diabetes, surgical and gynecological history.

**B) Detailed clinical examination:** A general examination should include checking for lower leg oedema, body mass index, and vital signs. To confirm a cephalic presentation, perform a local examination (abdominal examination).

**C) Ultrasound examination:** 48 hours or less prior to an elective caesarean section for foetal weight assessment. 5.0 MHz convex trans-abdominal ultrasonography with a trans-abdominal ultrasound probe were used for all measures in the foetal ultrasound unit (mindray Dc 70, x-In sight).

Every foetus underwent a single examination. The gestational age was supplied in precise weeks after being calculated from the latest menstrual cycle and verified by ultrasonography. The patient was lying flat when conducting gel was applied after a good exposure, after a quick overview to ensure that the foetal life, longitudinal lie, and cephalic demonstration were all confirmed to be true, measurements of the bi-parietal diameter, abdominal circumference, head circumference, femur length, and MTSTT were taken.

**Technique:**

**BPD:** Determining the midline echo acquired from the falx cerebri and accounting for the head's posture were the first steps in determining the head's longitudinal axis. The longitudinal axis inclination was then fixed by rotating the scanning probe 90 degrees and tilting it. The cavum septum pellucidum is found in the anterior part of the head section, and the basal ganglia and thalami were only visible lateral to the head section's midline after scanning the internal brain structures. The BPD was calculated by comparing the inner edge of the farthest parietal bone to the outer echo of the closest parietal bone [7].

**HC:** The elliptical method was used to compute HC. The first cursor on the screen is situated at the Occiput on the outside table of the skull. The second cursor is then set on the synciput's outer table of the skull [7].

**AC:** AC was calculated utilizing the elliptical approach and the same method used to determine the head circumference. Finding the aorta longitudinal axis allowed researchers to calculate the foetal body long axis and orientation. To suit the long axis, the transducer was then turned through a 90-degree angle.

The transducer was then shifted until the plane including the foetal stomach and portal umbilical venous complex was acquired. The foetal heart and kidneys should not be transported on the plane.

**FL:** The transducer is rotated 90 degrees to generate a cross-sectional image of the foetal trunk following the long axis of the foetus has been determined. The angle is maintained until the lower spine and iliac crest have been determined, at which point the transducer is rotated until a full femur has been observed. The greater trochanter and distal metaphysis are used to estimate the length of the femur (from the centre of the "U" shape at each end of the bone, this represents the length of the metaphysis) [7].

**MTSTT:** The greater and lesser trochanters were rotated upward to guarantee an accurate picture of femur lateral side a, and the mid-thigh STT was computed linearly from skin outer edge to femur shaft outside border in the middle third of the foetal thigh using the same image [8].

**The estimated fetal body weight was estimated twice as follow:** Utilizing Hadlock's formula, which had been measured by the machine programmed software, employing BPD, HC, AC and FL. Making use of Scioscia's formula, which was manually determined utilizing FL and MTSTT as follows: **EFW= −1687.47 + (54.1× FL) + (76.68 ×MT STT).** N.B: MTSTT by millimeter, FL by millimeter.

The baby actual birth weight was determined as soon as it was born, after the umbilical cord was severed and clamped 5 centimetres from the foetal abdomen without the use of any towels or clothing. The same calibrated scale was used to measure all of the foetuses.

This Cross-sectional research was assessed and studied by contrasting the EFBW findings with the recently shown **Scioscia's formula** [employing FL and MTSTT] and probably constructed frequently employed **Hadlock's formula** [utilizing BPD, HC, AC and FL] with **actual birth weight**.

**Statistical analysis**

The SPSS application, version 26, was used to computerise and statistically analyse the data that had been obtained. Using the Shapiro Walk test, it was determined whether or not the data had a normal distribution. When appropriate, data were presented as tables and graphs. To illustrate qualitative data, frequencies and relative percentages were employed. To determine the difference between qualitative variables, the chi-square and Fisher exact tests were employed. To evaluate the difference between qualitative variables, the chi-square and Fisher exact tests were utilized. Also established was a ROC (receiver operating characteristic) curve analysis. Level of P-value < 0.05 indicates significant.

## 3. Results

Average age of the participated pregnant women was 26.2± 5.2 years and ranging from 18 to 35 with the median of 26.5. Their gestational age was 38.3± 1.1 weeks and ranging from 37 weeks to 40 weeks. Fifty-three participant was primigravida (40.8%) while 77 (59.2%) were multipara. **Table (1).**

**Table (1):** Age, gestational age, Parity of the participating group.

| **Variable** | | **Total (N= 130)** |
|---|---|---|
| **Age** (years) | Mean ± SD | 26.2± 5.2 |
| | Median (range) | 26.5 (20, 35) |
| **Gestational age** (weeks) | Mean ± SD | 38.3± 1.1 |
| | Median (range) | 38 (37, 40) |
| **Parity** | Primigravida | 53 (40.8) |
| | Multipara | 77 (59.2) |

According to fetal gender, 64 (49.2%) were males while 66 (50.8%) were females. **Fig (1)**

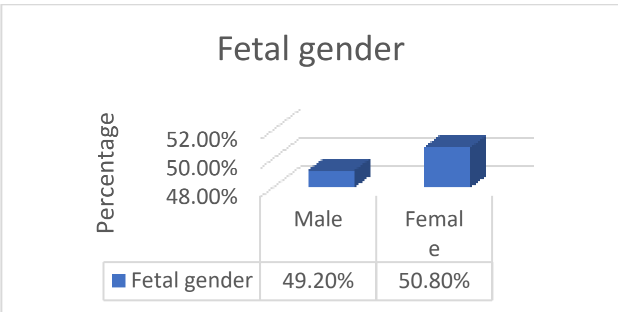


**Fig (1):** Fetal gender among the participating pregnant women.

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The mean MTSTT was 13.1± 0.6 mm, the mean Femur length was 76.0± 0.6 mm, the mean Bi-parietal diameter was 87.8± 4.1 mm, the mean Abdominal Circumference was 321.1± 14.8 mm, and the mean Head circumference was 339.3± 5.9 mm. The mean actual fetal weight was 3446.5± 89.9 gm with a median 3451 gm and ranging from 3190 gm to 3693 gm. While by Hadlock formula, the mean weight was 3438.6± 99.8 gm and by Scioscia's formula, the mean weight was 3434.3± 80.9 gm. **Table (2).**

No critical change was seen among males and females concerning mid-thigh STT, FL, BPD, AC and HC. No critical change was seen among males and females concerning the fetal weight by Hadlock or Scioscia's formula. **Table (3).**

A critical positive moderate correlation among actual fetal weight and weight by Hadlock formula. While a critical positive strong correlation among and weight by actual fetal weight Scioscia's formula. **Table (4).**

When assessing the Hadlock formula in estimating fetal weight compared to actual fetal weight, the sensitivity was 82.8%, specificity was 88.1% with area under the curve 87.1% as fetal weight was equal or lower than 3500 gm. **Table (5) and Fig (2).**

When assessing the Scioscia's formula in estimating fetal weight compared to actual fetal weight, the sensitivity was 72.4%, specificity was 86.1% with area under the curve 84.1% as fetal weight was equal or lower than 3500 gm. **Table (6) and Fig (3).**

**Table (2):** Fetal ultrasound measures among the participating group.

| **Variable** | | **Total N= 130** |
|---|---|---|
| **Mid-thigh STT** (mm) | Mean ± SD | 13.1± 0.6 |
| **FL** (mm) | Mean ± SD | 76.0± 0.6 |
| **BPD** (mm) | Mean ± SD | 87.8± 4.1 |
| **AC** (mm) | Mean ± SD | 321.1± 14.8 |
| **HC** (mm) | Mean ± SD | 339.3± 5.9 |
| **Actual fetal weight** | Mean ± SD | 3446.5± 89.9 |
| | Median (Range) | 3451 (3190, 3693) |
| **Hadlock formula** | Mean ± SD | 3438.6± 99.8 |
| | Median (Range) | 3444.2 (3146, 3719) |
| **Scioscia's formula** | Mean ± SD | 3434.3± 80.9 |
| | Median (Range) | 3433.8 (3104, 3684) |

STT; Soft tissue thickness, FL; Femur length, BPD; Bi-parietal diameter, AC; Abdominal Circumference, Hc; Head circumference.

**Table (3):** Comparing fetal ultrasound and fetal weight measures among the participating group.

| **Fetal ultrasound** | | **Male** | **Female** | **P value** |
|---|---|---|---|---|
| **Mid-thigh STT** (mm) | Mean ± SD | 13.1± 0.6 | 13.1± 0.6 | 0.898 |
| | Median (Range) | 13.2 (12, 14) | 13.3 (12, 14) | |
| **FL** (mm) | Mean ± SD | 76.0± 0.6 | 76.1± 0.6 | 0.641 |
| | Median (Range) | 76.1 (75, 77) | 76.2 (75, 77) | |
| **BPD** (mm) | Mean ± SD | 87.3± 3.9 | 88.2± 4.2 | 0.174 |
| | Median (Range) | 87 (81, 94) | 88 (81, 94) | |
| **AC** (mm) | Mean ± SD | 320.4± 13.7 | 321.7± 15.8 | 0.499 |
| | Median (Range) | 320.5 (295, 344) | 322.5 (295, 345) | |
| **HC** (mm) | Mean ± SD | 340.2± 5.9 | 338.4± 5.9 | 0.081 |
| | Median (Range) | 340 (330, 350) | 338 (330, 350) | |
| **Fetal weight** | | | | |
| **Actual fetal weight** | Mean ± SD | 3457.4± 95.7 | 3435.9± 83.3 | 0.176 |
| **Hadlock formula** | Mean ± SD | 3452.3± 105.2 | 3425.4± 93.2 | 0.126 |
| **Scioscia's formula** | Mean ± SD | 3444.9± 78.4 | 3424.1± 82.6 | 0.145 |

*p is significant at <0.05.

**Table (4):** Correlation between actual fetal weight and the 2 formulae.

| Variable | r | P value |
|---|---|---|
| **Hadlock formula** | 0.665 | <0.001* |
| **Scioscia's formula** | 0.767 | <0.001* |

**Table (5):** Sensitivity and specificity of Hadlock formula to estimate fetal body weight.

| Variable | Hadlock formula |
|---|---|
| **AUC** | 87.1% |
| **Sensitivity** | 82.8% |
| **Specificity** | 88.1% |
| **P value** | <0.001* |
| **95% CI** | 0.793, 0.962 |

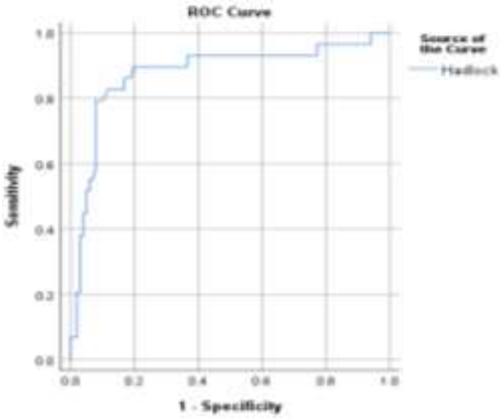


**Fig (2):** ROC curve analysis for Hadlock formula compared to actual fetal weight for weight ≤ 3500 gm.

**Table 6: Sensitivity and specificity of Scioscia formula to estimate fetal body weight.**

| Variable | Hadlock formula |
|---|---|
| **AUC** | 84.1% |
| **Sensitivity** | 72.4% |
| **Specificity** | 86.1% |
| **P value** | <0.001* |
| **95% CI** | (0.752, 0.930) |

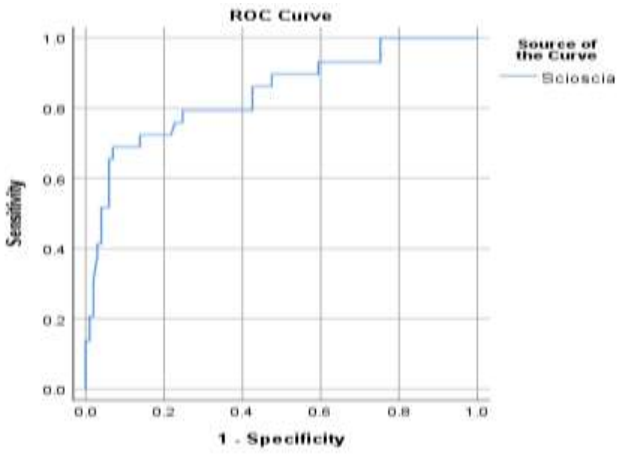


**Fig (3):** ROC curve analysis for Scioscia formula compared to actual fetal weight for weight ≤ 3500 gm.

## 4. Discussion

In technologically advanced obstetrics, it is crucial to have accurate fetal weight information before deciding on the delivery method. Additionally, it is widely recognized that permitting vaginal delivery in cases with undiagnosed fetopelvic disproportion may increase the risk of maternal and newborn morbidity, involving birth injuries and reproductive trauma caused by problems with the second stages of labor, such as birth trauma and shoulder dystocia that result in serious and persistent health issues [9].

Regarding the demographic data in our study, in agreement with us, these results are approximately like the study of Abuelghar et al. that assessed the MTSTT and found that the mean age of participants was 27.6 ± 5.5 years, and the mean gestational age was 38.7 + 1.2 weeks. Between study population and against our findings, 67 women (22.3 %) were Para 1, 80 (26.7 %) were Para 2, 89 (29.7 %) were Para 3, 45 (15.0 %) were Para 4, 18 (6 %) were Para 5, and 1 (0.3 %) was Para 6 [10].

Contrary to our results, Hebbar conducted a similar study and its demographic data revealed that mean ± (SD) for mothers' age was 28.4 ± 4.025 years. However, mean gestational age at delivery was found to be 38.4±1.08 weeks and majorities were primigravida [11].

In terms of ultrasound measure in the current work, in the same line with our findings, Broere et al. revealed that no substantially critical change was seen among males and females regarding mid-thigh STT, bi-parietal diameter, the fetal weight by Hadlock or Scioscia's formula, however against us, significant difference was found regarding femur length, abdominal circumference and head circumference. Male foetuses had bigger HC and AC than female foetuses, although male foetuses' FL was smaller [12].

On the other side, Kurmanavicius et al. revealed that between different formulas for fetal weight estimation, using both Hadlock formulae, the highest intraclass correlation coefficient was produced. In disagreement with us, they found a critical positive strong association among actual fetal weight and weight by Hadlock formula [13].

Also, Hammami et al. demonstrated that the Hadlock formula with three fetal biometry parameters was the best (AC, HC and FL). With Shepard formula, the lowest intraclass association was discovered. Some of these formulas have been proved to be more accurate than earlier ones with lower error percentages [14].

Similar to our study, Scioscia et al. emphasize the effect of MTSTT on birth weight. In this study, it was found that adding the mid-thigh tissue area to other common ultrasonography factors significantly improved birth weight prediction models. When compared to other formulas in this investigation, the new formula had a much lower error margin (p value less than 0.05) [15]

Barros et al. conducted a prospective research to examine the accuracy of foetal weight prediction using ultrasonography, employing the same algorithm as our work. Using a model based on the length of the femur and the thickness of the soft tissue at the mid-thigh, both of which are linear parameters, they observed that there was minimal correlation between the actual birth weight and the anticipated foetal weight [16].

In accordance with us, Hebbar conducted a prospective observational study to evaluate incorporation benefits of MTSTT in fetal weight estimation formulae. They discovered that include MTSTT in models of foetal weight estimation enhances neonatal birth weight prediction. This backs up what we discovered in this investigation [11].

Another study that highlights our findings was carried out by Abdalla et al. in 2015 to determine the relationship among selected foetal ultrasonographic and maternal anthropometric characteristics and the ultrasonographic measurement of FTSTT. They found that there was substantially critical association among ultrasonographically expected fetal weight and HC, BPD, FL, AC, and FTSTT, also as FTSTT and mother pre-pregnancy and pre-delivery weight, as well as between FTSTT and neonatal birthweight and length [17].

Furthermore, in the same previously mentioned study, FTSTT assessment may be helpful in determining foetal weight, however it is not helpful in the diagnosis of foetal macrosomia, according to Abdalla et al. These results came to support our findings in our study [17].

Regarding ROC analysis of the present work, in the same direction, a prospective study was carried out by Scioscia M. et al. to evaluate the precision of sonographic birthweight prediction in suspected macrosomic foetuses. They discovered that the revised formula had a smaller standard deviation, which implies a less forecast internal error. This research demonstrates the possibility of this novel method for estimating birth weight in big pregnancies using only sonographic linear measures [8].

Another study by Kalantari et al. demonstrated that the accuracy of BW prediction is increased by including mid-thigh tissue factors in the traditional biometric calculation [18].

In addition to that, Abuelghar et al. found a relationship among actual BW and fetal thigh measurements [10].

Ugowe et al. established that the addition of more variables to a formula increases the probability of multicollinearity and the internal inaccuracy of each measurement. The proposed formula can theoretically be useful when fetal head engagement prevents accurate head measurements from being taken [19].

The risk of newborn complications during labor and the postpartum is increased for both low and large birth weights. Low birth weight is associated with substantial perinatal morbidity and mortality, which may be attributable to preterm birth, intrauterine growth restriction, or both [19].

Shoulder dystocia, brachial plexus damage, bone injuries, and intrapartum hypoxia are potential consequences of vaginal birth for overly big babies, according to Pongtipakorn. Risks for moms include birth canal and pelvic floor injuries, an increase in surgical vaginal and caesarean births, and postpartum hemorrhage [20].

## 5. Conclusion

We found that MTSTT, a linear parameter, might be added to standard biometric parameters to improve foetal weight estimation by ultrasonography at term before to delivery since it is simple, basic, and straightforward to collect. These findings suggest that the addition of gestational age-specific MTSTT ranges into intrauterine growth charts during future ultrasound scans may help in the diagnosis of foetal growth issues. Our work emphasizes the need of combining STT into other ultrasound parameters in order to improve foetal weight prediction models and recommends more research on the problem of substituting STT for AC. This is anticipated to be useful in clinical practice, especially when AC measurement is biased.

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