

## Fetal Thigh Circumference for the Prediction of Fetal Birth Weight using Ultrasound

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### ABSTRACT

**Background:** Accurate foetal birth weight estimate is crucial for detecting growth limitation, preterm, and situations where clinical decisions affecting labour induction or delivery mode need to be made. This research study was conducted to determine the accuracy of predicting prenatal weight using foetal thigh circumference (TC).

**Patients and methods:** Between November 2018 and September 2019, we performed a cross-sectional study of pregnant women. We included single intrauterine pregnant women with no complications, and who delivered within 48 hours after examination, with gestational ages ranging from 38 to 41 weeks. Within 48 hours following birth, the true foetal weight was estimated.

**Results:** We included 123 pregnant women, with a mean gestational age of 38.78 (SD 0.85) weeks and a mean age of 26.68 (SD 5.24) years. Of them, 21.1% were nulliparous. We found an ultrasound parameter-to-actual-weight association that was statistically significant in favour. The greatest association between actual foetal weight and TC ( $r = 0.685$ ;  $p < 0.001$ ). Simple linear regression showed that TC is a predictor of estimated fetal weight ( $B = 153.5$ ,  $p < 0.001$ ). Between estimated foetal weight and actual weight, as well as between estimated and real TC, we found no discernible difference ( $p$  values 0.398 and 0.06, respectively).

**Conclusion:** When used in conjunction with other fetal measures, the foetal thigh circumference may aid in the precise computation of fetal birth weight. To increase the accuracy of birth estimations, regular ultrasound examinations should include fetal thigh circumference measurement.

**Keywords:** Fetal, Thigh circumference, Fetal weight, IUGR, Macrosomia.

### INTRODUCTION

Fetal weight evaluation is crucial for detecting prenatal development diseases such as macrosomia and intrauterine growth restriction (IUGR). The estimated foetal weight (EFW) is a critical tool in obstetric practise for diagnosing and treating both tiny and big pregnancies<sup>(1)</sup>.

Low birth weight foetuses (<2500 gm) are more likely to suffer from starvation, recurrent infection, neurodevelopmental disabilities, diabetes, hypertension, and coronary heart disease. Maternal difficulties such as diabetes, delayed labour, greater lower segment caesarean section rates, and foetal issues such as brachial plexus injury, clavicle fracture, electrolyte imbalance, newborn jaundice and hypoglycemia are connected with macrosomic infants (4000 gm or more)<sup>(2-5)</sup>.

As a result, a precise assessment of birth weight might aid in labour management, perhaps averting some of these difficulties. In utero foetal growth and weight have been estimated using clinical investigations and ultrasound approaches<sup>(6-9)</sup>.

In the early 1980s, many equations were developed that used various combinations of standardised foetal biometric parameters such as head circumference (HC), biparietal diameter (BPD), femur length (FL), and abdominal circumference (AC)<sup>(10)</sup>. However, intra- and inter-observer variability compromises the accuracy of EFW, and many of the available equations are typically erroneous at extremes of foetal weight<sup>(11)</sup>.

The high rate of perinatal mortality continues to be a significant topic of concern in a number of developing countries. The main problem is the birth weight, which is still the most important factor in determining the survival rate of newborns. Babies that vary from the physiological recommendations for weight for gestational age (GA) are more likely to suffer from perinatal morbidity and death<sup>(12,13)</sup>.

At the extremities of the weight scale, the estimation error in foetal weight is highest. As a result, a better method for calculating foetal weight in all weight categories is required. To increase the accuracy of the existing approach, one new parameter, foetal mid-thigh circumference, is included<sup>(13)</sup>.

Many investigations have shown that EFW measured using standard methods is not a reliable indication of growth anomalies such as macrosomia; as a result, numerous additional echographic tests have been suggested<sup>(14)</sup>.

The accuracy of determining birth weight by ultrasound was improved by adding thigh circumference measures to their algorithm in addition to HC, AC, BPD, and FL measurements<sup>(15-17)</sup>.

The aim of our research was to detect the result of measuring foetal mid-thigh circumference by ultrasound in predicting foetal birth weight and to compare it to other ultrasonographic foetal characteristics.

## PATIENTS AND METHODS

Between November 2018 and September 2019, the Obstetrics and Gynecology Department at Zagazig University Hospital in Zagazig, Egypt, performed a prospective cross-sectional study, which included 123 pregnant women with live singleton term babies to investigate the accuracy of foetal TC in the prediction of foetal weight.

### Eligibility Criteria

*Pregnant women who met these criteria were included in our study:*

1. Singleton intrauterine pregnancy.
2. At term (38-41 weeks).
3. Uncomplicated pregnancy.
4. Delivery within 48 hours after evaluation.

**Pregnant women who met any of these criteria were excluded:**

1. Chronic or medical conditions that affect pregnancy (Hypertension, DM, and heart disorders)
2. GA <38 weeks or >41 weeks.
3. Twins pregnancy.
4. Hydrops or congenital anomalies.
5. IUFD.

### Study process and evaluations:

*Before being accepted into the research, verbal consents were sought. After that, all patients underwent:*

1. A thorough history is taken, paying particular attention to the mother's age, parity, GA, obstetrics, menstrual cycle, and past medical histories.
2. Sonographic evaluation with GE LOGIQ P5 ultrasonography by professional sonographer. The typical foetal biometric measures were included in the ultrasound examination of foetal anatomy and biometry (Biparietal diameter, head circumference, femur length, and abdominal circumference). During 48 hours following birth, the exact foetal weight was estimated.

A supine posture was used for all patients throughout the ultrasonographic test.

To produce a sectional profile of the centre of the foetus thigh at a place where the profile was as round as was practicable and the border of the thigh profile was clearly defined, the transducer was rotated 90 degrees.

This technique, developed by **Vintzileos et al.** (15), was used to measure the thigh circumference (**Figure 1**).



**Figure (1): The thigh circumference (TC) measurement.**

The newborn weights were recorded to the nearest 10 g by the lead investigator within 10 to 15 minutes after delivery employing the same baby scale weighing device on a desktop. The EFW was matched to the actual birth weight using ultrasonography. Tape also measured the mid-thigh of the foetus.

### Sample size calculation:

The sample size was calculated using EPI info 7 software. In all, we estimated that 1080 women gave birth at the obstetrics centre over the course of six months. The prevalence of low birth weight, with a 95% confidence interval, is 10% across all 123 women.

### Ethical consent:

This research was conducted in accordance with the Helsinki Declaration of 1975, as amended in 2000, the World Medical Association's code of ethics for human studies. An approval of the study was obtained from Zagazig University Academic and Ethical Committee. After being informed of the study's goals, participants consented to take part. By making sure no names were used that might be used to identify the subject, confidentiality was maintained throughout the research.

### Statistical analysis

The Statistical Package for the Social Sciences (SPSS) software version 20.0 was used to conduct the statistical analysis. Frequency and percentage charts were used to illustrate the qualitative data. The mean, standard deviation (SD), and median were used to characterize the quantitative data (range). To compare differences in continuous data, a t-test was used. Depending on the situation, Pearson's or Spearman's correlation was used for the correlation study. We used linear regression for the regression analysis and prediction algorithm. For significant findings, the P-value was set  $\leq 0.05$ , and for highly significant results, it was set  $\leq 0.001$ .

**RESULTS**

**Characteristics of the study population:**

One hundred twenty-three pregnant women were included in our survey. The included women's average age was 26.68 (5.24) years, and the average gestational age was 38.78 (0.85) weeks. The most common parity (64.2%) ranged between 1 and 2, while 21.1% of the included women were nulliparous. The mean BPD, HC, FL, AC, and TC were 9.0, 32.82, 7.15, 33.26, and 15.1, respectively. Table 1 shows the characteristics and the ultrasonographic parameters.

**Table (1):** The characteristics of the included women and the ultrasonographic parameters of the fetuses (n=123).

<b>Maternal age (years)</b>	<b>Mean ± SD</b>	<b>26.68 ± 5.24</b>
	Median (Range)	27 (18-39)
<b>Gestational age (weeks)</b>	<b>Mean ± SD</b>	<b>38.78 ± 0.85</b>
	Median(Range)	39.0 (38-41)
<b>Parity, n (%)</b>	No	26 (21.1%)
	;1-2	79 (64.2%)
	>2	18 (14.7%)
<b>Biparietal diameter (BPD)</b>	<b>Mean ± SD</b>	<b>9.0 ± 0.34</b>
	Median (Range)	9.0 (8.1-9.9)
<b>Head circumference (HC)</b>	<b>Mean ± SD</b>	<b>32.82 ± 0.91</b>
	Median (Range)	32.91 (30.4-35.6)
<b>Femur length (FL)</b>	<b>Mean ± SD</b>	<b>7.15 ± 0.43</b>
	Median (Range)	7.09 (6.2-8.9)
<b>Abdominal circumference (AC)</b>	<b>Mean ± SD</b>	<b>33.26 ± 1.64</b>
	Median (Range)	33.61 (29.5-38.5)
<b>Thigh circumference (TC)</b>	<b>Mean ± SD</b>	<b>15.1 ± 0.91</b>
	Median (Range)	15.2 (13-19.1)

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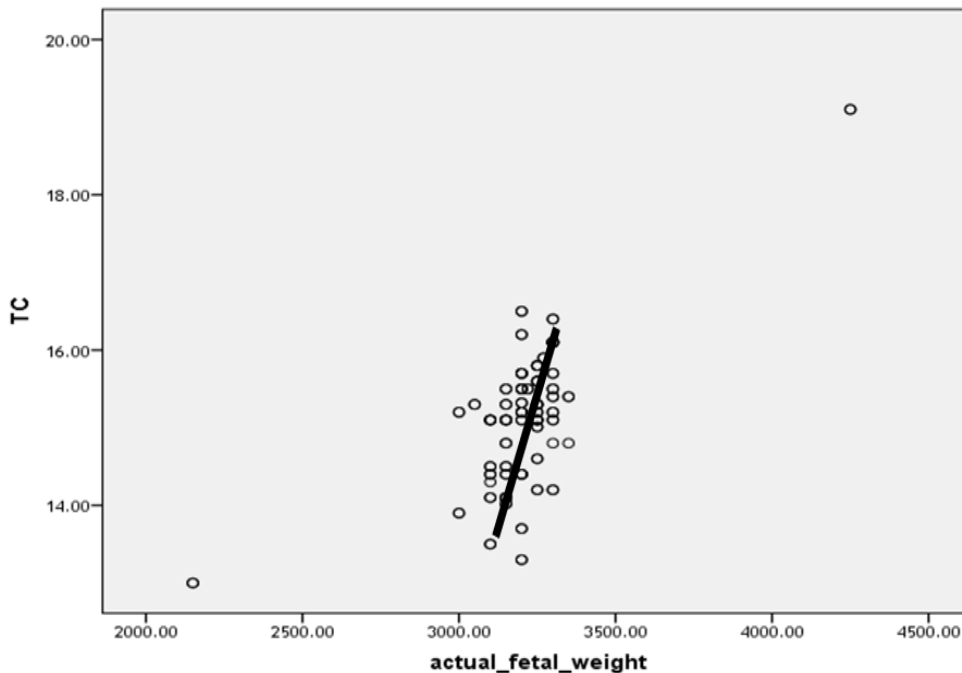
**Correlations between various factors and actual weight:**

Indicative positive correlations between several ultrasonography parameters and actual weight were found.

The relationship between actual foetal weight and thigh circumference showed the strongest correlation value (r= 0.685; p<0.001) (**Figure 2 and Table 2**).

**Table (2):** Correlations between actual weight and different parameters

<b>Variable</b>		<b>Actual fetal weight</b>
<b>Biparietal diameter</b>	r	0.306**
	P-value	0.001
<b>Head circumference</b>	r	0.590**
	P-value	<0.001
<b>Femur length</b>	r	0.409**
	P-value	<0.001
<b>Abdominal circumference</b>	r	0.544**
	P-value	<0.001
<b>Thigh circumference</b>	r	0.685**
	P-value	<0.001



**Figure (2):** The correlation between actual fetal and TC.

**Regression analysis:**

Actual weight and foetal thigh size were statistically significantly correlated, according to simple linear regression ( $p < 0.001$ ). The beta coefficient was 153.5, and the intercept was 885.3. Thus, based on the formula  $[Y = a + (B * x)]$ , the estimated weight =  $885.3 + (\text{thigh circumference} * 153.5)$ .

**Paired analysis:**

As shown in Table 3, we found no discernible difference between the TC's estimated weight and the foetal weight, or between the TC's estimated weight and the TC's actual weight (P value 0.398 and 0.06, respectively).

**Table (3): Paired analysis to estimate the difference between estimated weight and actual weight as well as estimated TC and actual TC.**

Variable		Mean	SD	T test	P value
Difference between estimated weight and actual weight	Actual fetal weight	3204.3	205.28	0.874	0.398
	Weight-based on thigh circumference	3218.8	149.78		
Difference between estimated TC and actual TC	Estimated thigh circumference by US	15.121	0.9541	1.9112	0.06
	Actual thigh circumference	14.999	1.8745		

**DISCUSSION**

The correct prediction of the estimated foetal weight (EFW) during labour has a substantial influence on obstetric care, particularly in situations of preterm or suspected macrosomia (18). Fetal weight is frequently measured using ultrasound in clinical practice. Multiple parameter estimate (such as foetal BPD, HC, FL, AC, and TC) is required for calculating prenatal foetal weight and may be more accurate than one parameter alone (19). None of the formulae currently in existence have been authorised for use in determining foetal weight due to a lack of clinical evidence on their precision. It has been shown that measurement error and inherent properties of the formula combine to determine the EFW divergence from the real birth weight (20).

In order to test birth weight prediction using the method for predicting birth weight using 2D-ultrasound, this research included 123 singleton pregnant women admitted to our hospital. The included women's GA ranged from 38 to 41 weeks, with a mean of 38.78 (SD 0.85) weeks, and their average age was 26.68 (SD 5.24) years. The mid-thigh of the foetus measured between 13 and 19.1 cm in length, with a mean of 15.1 (SD 0.91) cm. The neonates born to participating moms had a mean actual birth weight of 3204.3 (SD 205.2) grammes.

The present research found that foetal TC measurement influenced the accuracy of birth weight estimate during prenatal ultrasonography in obstetric

practice. Our results are consistent with earlier research (7,9,16,21,22). Traditional ultrasonography models do not take into account the problems related to changes in thigh muscle mass and subcutaneous fat accumulation around the periphery. Favre *et al.* (23) performed a prospective research on foetal weight estimate using TC as one of the criteria to investigate the possible utility of limb measurements. They verified that employing thigh circumference enhanced both the identification of macrosomic foetuses as well as the diagnosis of small for GA foetuses. Shripad and Varalaxmi (16) have discovered that measuring the foetal thigh circumference improves the accuracy of birth weight predictions in obstetric practice, particularly in newborns weighing less than 2.5 kg, with a 95 percent predictability (16).

The deposition of muscle and fat in the developing foetus may be easily examined with TC measures. Since it is less vulnerable to form changes, these criteria were selected over diameter measurements to determine birth weight estimates more accurately. The results of the current study are in line with those of Sanyal *et al.* (21), who found that the combination of other common biometric indicators and the circumference of the foetus' thighs when used to calculate the foetus' weight by ultrasound increased predictability and may have the ability to identify intrauterine growth restriction.

The neonatal thigh circumference and sonographic estimations showed a strong correlation. It is further supported by a study that used the Isobe' formula without the need for HC and utilised thigh measurements instead, which would be helpful in routine clinical practice for determining foetal weight, especially when head measurements are not available (24). It would be the most practical approach since it would only need two thigh parameters and would calculate the foetal weight using a typical 2D ultrasound scan without the need for a close-up head measurement. An accurate forecast of the foetal weight was made possible by measuring the foetal thigh, according to prenatal limb volume imaging using a three-dimensional ultrasound (25, 26).

By combining the AC and the fractional thigh volume, Lee *et al.* (26) developed a model to estimate foetal weight. They showed that the predictions of foetal weight had a 0.5 systematic error and a 7 percent random error, and that their method outperformed commonly used techniques based on standard ultrasound formulas (9% systematic error and 9% random error). There are considerable limits to 3D imaging techniques that prevent clear visualisation of surface anatomical components, especially in cases of foetal malpresentation and malposition, and not all facilities have 3D ultrasound technology. In addition, not many doctors and ultrasonographers are now proficient in 3D ultrasound. It may be inferred that 2D ultrasound thigh circumference measurements enhance obstetricians' capacity to predict IUGR till these

problems are rectified<sup>(27)</sup>. The embryo's accumulation of muscle and fat may be detected via TC measures. This parameter benefits because its susceptibility to shape change is reduced. Finally, incorporating foetal TC improves projection of foetal weight. TC aids in precisely determining foetal weight when combined with other prenatal traits. Since ultrasound can accurately replicate the true thigh circumference and there was a strong correlation between prenatal and postnatal thigh circumference estimations, using it in routine ultrasound is strongly advised to improve birth estimates.

## CONCLUSION

When used in conjunction with other fetal measures, the foetal thigh circumference may aid in the precise computation of fetal birth weight. To increase the accuracy of birth estimations, regular ultrasound examinations should include fetal thigh circumference measurement.

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**Author contribution:** Authors contributed equally in the study.

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