

# **Fetal Weight Prediction by Thigh Volume Measurement with Three-Dimensional Ultrasound**

*Thesis*

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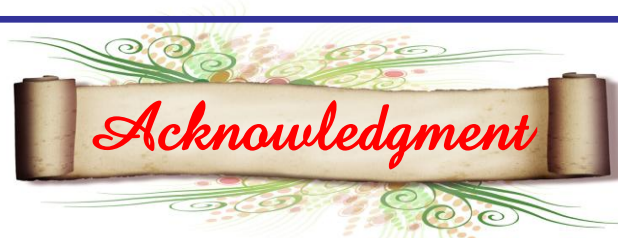
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## List of Abbreviations

|                 |                                                |
|-----------------|------------------------------------------------|
| <b>AC</b>       | : Abdominal circumference                      |
| <b>AFI</b>      | : Amniotic fluid index                         |
| <b>AFVs</b>     | : Amniotic fluid volume                        |
| <b>ANOVA</b>    | : Analysis of variance                         |
| <b>ATD</b>      | : Abdominal transverse diameter                |
| <b>BMI</b>      | : Body mass index                              |
| <b>BPD</b>      | : Biparietal diameter                          |
| <b>DM</b>       | : Diabetes mellitus                            |
| <b>EDD</b>      | : Expected day of delivery                     |
| <b>EFBW</b>     | : Estimated fetal body weight                  |
| <b>EFW</b>      | : Estimated fetal weight                       |
| <b>FGR</b>      | : Fetal growth retardation                     |
| <b>FL</b>       | : Femur length                                 |
| <b>GA</b>       | : Gestational age                              |
| <b>HAPO</b>     | : Hyperglycemia and Adverse Pregnancy Outcomes |
| <b>HC</b>       | : Head circumference                           |
| <b>IgG</b>      | : Immunoglobulin G                             |
| <b>IUGR</b>     | : Intra uterine growth retardation             |
| <b>LBW</b>      | : Low birth weight                             |
| <b>LGA</b>      | : Large size for gestational age               |
| <b>LMP</b>      | : Last menstrual period                        |
| <b>MHz</b>      | : Mega Hertz                                   |
| <b>MTh vol.</b> | : Modified thigh volume                        |
| <b>NPV</b>      | : Negative predictive value                    |
| <b>PI</b>       | : Pulsatility index                            |
| <b>PPV</b>      | : Positive predictive value                    |
| <b>PSV</b>      | : Peak systolic velocity                       |
| <b>SD</b>       | : Standard deviation                           |
| <b>SGA</b>      | : Small for gestational age                    |
| <b>SPSS</b>     | : Statistical Package for Social Science       |
| <b>UA</b>       | : Umbilical artery                             |
| <b>VOCAL</b>    | : Virtual Organ Computer-aided Analysis        |
| <b>2D</b>       | : Two-dimensional                              |
| <b>3D</b>       | : Three-dimensional                            |

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# Introduction

Estimation of fetal weight is essential in our daily obstetric practice, especially at third trimester for women with potential risks of intra uterine growth retardation (IUGR) or macrosomia. It guides obstetricians to make up their decisions as regard time and mode of delivery to guard against complications of low birth weight and macrosomic babies during labor and puerperium (*Owen et al., 2003, Zhang et al., 2012*).

The perinatal complications associated with low birth weight are most often attributable to fetal prematurity, but may sometimes also arise as the result of intrauterine growth restriction (*Langer et al., 1991*). For macrosomic fetuses, potential complications associated with delivery include shoulder dystocia, brachial plexus injuries, bony injuries and intrapartum asphyxia, as well as maternal risks that include birth canal injuries, pelvic floor injuries and postpartum hemorrhage (*Jolly et al., 2003*).

Tactile assessment of fetal size, also referred to as clinical palpation or Leopold maneuvers, is considered the oldest technique for assessing fetal weight. It involves manual assessment of fetal size by the obstetricians (*Horta et al., 1997*). Worldwide, this method is used extensively because it is both convenient and virtually costless; however, it is a subjective

method associated with notable predictive errors (*Saqib et al., 2008*).

Initial attempts to estimate fetal weight by ultrasound consisted of individual fetal measurements such as biparietal diameter (BPD) or abdominal circumference (AC), and femur length (FL), accuracy of estimated fetal weight is improved when multiple fetal measurements are used. The simplest methods that give reasonably accurate results are based on two measurements, AC and BpD or AC and FL (*Song et al., 2000*).

*Isobe (2004)* derived a formula from only thigh measurements using conventional two-dimensional ultrasound. The newly derived formula was quite simple, involving only two thigh parameters without the need for head measurement.

Estimated fetal body weight (EFBW) is needed especially when head measurement is impossible whenever the fetal head is positioned low in the pelvic brim. A convenient method for estimating fetal body weight without head measurement was thus required (*Saqib et al., 2008*).

The majority of the commonly used formulas for EFBW include measurements of the head circumference, abdominal circumference and femur length, either alone or in combination (*Saqib et al., 2008*).

The value of the fetal thigh circumference measurement using Isobe's formula in addition to the head, abdominal circumference and femur length measurements showed a

significant correlation with the actual birth weight as in 90% of cases EFBW was within 10% of the actual birth weight (**Dudley, 2005, Saqib et al., 2008**).

The use of three-dimensional ultrasound was found useful for fetal weight estimation by using limb circumferences, upper arm volumes, and thigh volumes (**Lee et al., 2009**).

Three-dimensional ultrasound accuracy in volumetry has been validated in many organ system *in vivo* and *vitro* as lung-heart and hepatic volumes. Meanwhile limb volume as a soft tissue parameter was related to both fetal growth and nutritional status (**Peralta et al., 2006**).

The fetal liver makes up most of the abdomen, as measured by means of abdominal circumference. Measuring of fetal hepatic volume to identify growth restriction, since both the human and the rats have severely depleted hepatic glycogen stores associated with growth restriction (**Bioto et al., 2002**).

**Song et al. (2000)** found that modified thigh Volume measurements using three cross-sectional images of femur by 3D U/S were correlated strongly with birth weight when using linear and polynomial regression and calculated by a new best-fit formula.

$$\begin{aligned} \text{Fetal birth weight (in grams)} = \\ 165.32 + 28.78 \times \text{modified thigh} \\ \text{volume (ml)}. \end{aligned}$$