# VALIDITY OF ULTRASOUND IN ESTIMATING FETAL WEIGHT IN SINGLETON PREGNANCIES AT MUHIMBILI NATIONAL HOSPITAL

**Living Colman (MD)**

**MMed (Obstetrics and Gynaecology) Dissertation**

**Muhimbili University of Health and Allied Sciences**

**November 2012.**

## CERTIFICATION

The undersigned certify that he has read and hereby recommend for examination of a dissertation entitled: **validity of ultrasound in estimating fetal weight in singleton pregnancies at Muhimbili National Hospital**, in partial fulfillment of the requirements for the degree of Master of Obstetrics and Gynaecology of the Muhimbili University of Health and Allied Sciences.

……

Dr. Projestine Muganyizi

(Supervisor)

.....

Date

## DECLARATION AND COPYRIGHT

I **Dr. Colman Living**, I declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature…… Date……

## COPYRIGHT

**ACKNOWLEDGEMENTS**

I wish to thank the Almighty God who has guided me throughout my life. I also thank the Ministry of Health for sponsoring my studies and Muhimbili National Hospital.

My sincere gratitude goes to Dr. Projestine Muganyizi, my supervisor; for his dedicated supervision, constructive criticism, instructions and his patience, during the preparation of the study proposed and this dissertation.

I wish to thank all consultants, specialists and my colleagues in the department of Obstetrics and Gynaecology, for their valuable inputs during the proposal development, analysis of results, and helping me get something useful from this study.

## DEDICATION

This dissertation is dedicated to my mother Lucy Colman Kimaro, my father the Late Colman Sylvester Kimaro, my wife Oliver .J. Almada and my daughter Lucygift Living Colman.

**ABSTRACT**

**Background:** Ultrasound to estimate fetal weight is done often in our country as part of investigations of pregnant women. In most of the developed countries and some developing countries, studies have been done to determine the validity of an ultrasound in estimating fetal weight, but no similar studies which have been done in Tanzania.

**Objective:** To determine validity of ultrasound in estimating fetal weight in singleton pregnancies at MNH.

**Methodology**: A diagnostic study was conducted from 1st June 2011 to 31st December 2011 at Muhimbili National Hospital Dar es salaam. All women who met inclusion criteria with indication for elective delivery were identified. Data on demographic, obstetric, social and medical history, the indication for elective delivery was collected. Ultrasound to estimate fetal weight was done 24 hours before delivery. The actual birth weight of the fetus was measured by using a desktop baby scale weighing machine. The estimated fetal weight by ultrasound was correlated with direct birth weight as gold standard. Data was entered in epi info version 6 and analyzed by using SPSS version 16.

**Results:** A total of 800 pregnant women were recruited for the study. All of women consented and underwent an ultrasound estimation of fetal weight 24 hours before delivery.

The median age was 30 years (range 25-34years). Most were married or cohabiting (97. 8%). about half of the participants (51.2%) had primary school education. The median actual birth weight was 3040 g (range 1200–5000 g). One hundred and twenty two infants (15.2%) weighed less than 2500 g and 31 (3.9%) weighed more than 4000 g.

Good correlation was established between actual birth weight and estimated birth weight($r = 0.892$, $p<0.001$), the sensitivity of ultrasound in detecting birth weight below 2500g was 59.8% and specificity was 99.3%. In the study population in estimating low birth weight, there was positive predictive value of 93.6%, negative predictive value of 93.2% and likelihood ratio of 87. The sensitivity of ultrasound in detecting birth weight more than 4000g was 54.8% and specificity was 97.8%. In this study population there was positive predictive value of

47.2%, negative predictive value of 98.2% and likelihood ratio of 22 in estimating large birth weight babies.

**Conclusion;** In a clinical setting Ultrasound is useful in diagnosing low birth weight babies while its usefulness in detecting large birth babies is questionable. As the sensitivity of ultrasound estimation of fetal weight to detect larger babies is poor, the use of such an objective measurement in the management of suspected macrosomia in singleton pregnancies should complement other clinical diagnostic methods.

**LIST OF TABLES AND FIGURES**

**ABBREVIATIONS**

| | |
|---|---|
| AC | Abdominal Circumference |
| GA | Gestational Age |
| BPD | Biparietal Diameter |
| BMI | Body mass index |
| FL | Femur Length |
| HC | Head Circumference |
| IUGR | Intra Uterine Growth Retardation |
| LBW | Low Birth Weight |
| MNH | Muhimbili National Hospital |
| USA | United States of America |
| USS | Ultrasound scan |
| IPPM | Intramural Private Practice at Muhimbili National Hospital |
| RCH4 | Reproductive and Child Health card number 4. |
| PPV | Positive Predictive value |
| NPV | Negative Predictive value |
| MUHAS | Muhimbili University of Health and Allied Sciences |

**TABLE OF CONTENTS**

# CHAPTER ONE

## 1.0 INTRODUCTION AND LITERATURE REVIEW

## 1.1 INTRODUCTION

Accurate estimation of foetal weight is of paramount importance in the management of labor and delivery. In the last decade, estimated fetal weight has been incorporated into the standard routine antepartum evaluation of high-risk pregnancies and deliveries. In instances like diabetes in pregnancy, vaginal birth after a previous caesarean section, and intrapartum management of fetuses presenting by the breech, estimation of fetal weight[1] will greatly influence their management. Also, when dealing with anticipated preterm delivery, perinatal counseling on likelihood of survival, the intervention undertaken to postpone preterm delivery, optimal route of delivery, or the level of hospital where delivery should occur may be based wholly or in part on the estimation of expected birth weight. Categorization of foetal weight into either small or large for gestational age may lead to timed obstetric interventions that collectively represent significant departure from routine antenatal care[2, 3] . High rate of perinatal mortality (42 per 1,000 total births) is still a major cause for concern in developing countries such as Tanzania[4]. A simple and accurate method of estimating intrauterine fetal weight that can be easily applied to all pregnancies is an important means of reducing perinatal mortality and morbidity through early detection of faltering growth. Birth weight is a composite of fetal growth and length of gestation, each of which has different contributions and different sequel. Removing the contribution of gestational age, birth weight remains the single most important parameter that determines neonatal survival[5]

It is estimated that 16% of liveborn infants have low birthweight, a condition associated with high perinatal morbidity and mortality. Fetal macrosomia is associated with maternal morbidity, shoulder dystocia, birth asphyxia, and birth trauma[6]

It has been suggested that accurate estimation of foetal weight would help in successful management of labour and care of the newborn in the neonatal period and help avoidance of complications associated with fetal macrosomia and low-birth weight babies, thereby decreasing perinatal morbidity and mortality.[7] However ultrasound-derived fetal weight estimation alone is not sufficient grounds for deciding the route of delivery. To assess the risk of macrosomia, other known risk factors should also be taken into account. To determine the mode of delivery, clinical assessment of pelvic capacity should be added to the sonographic fetal weight estimate, with consideration of the risk factors for macrosomia[8]. Obstetric sonographic assessment for the purpose of obtaining fetal biometric measurements to predict fetal weight has been integrated into the mainstream of obstetric practice during the past quarter century. From its inception, this method has been presumed to be more accurate than clinical methods for estimating fetal weight[1]. The reasons for this assumption vary, but the fundamental underlying presumption is that the sonographic measurements of multiple linear and planar dimensions of the fetus provide sufficient parametric information to allow for accurate algorithmic reconstruction of the 3-dimensional fetal volume of varying tissue density. Consistent with these beliefs, much effort has generated best-fit fetal biometric algorithms that can help make birth weight predictions based on obstetric ultrasonography measurements. As such, the ultrasonographic technique represents the newest and most technologically sophisticated method of obtaining birth weight estimations[9.] Modern

algorithms that incorporate standardly defined fetal measurements (e.g. some combination of abdominal circumference, femur length, and either biparietal diameter or head circumference) are generally comparable in terms of overall accuracy in predicting birth weight.[2, 6]

When other sonographic fetal measurements are used to estimate fetal weight (e.g. humeral soft tissue thickness, ratio of subcutaneous tissue to FL, cheek-to-cheek diameter), these nonstandard measurements do not significantly improve the ability of obstetric sonography to help predict birth weight, except in special patient subgroups (eg, mothers with diabetes)[10] .

Ultrasound measurements give the appearance of precision, but the accuracy of ultrasonic estimations of fetal weight is limited by the fact that the mature fetus is an irregular, three dimensional structure of varying density, the weight of which cannot be calculated with certainty from biometric measurements[10.] Ultrasound fetal weight estimations are undertaken as part of the routine management of pregnant women with diabetes. Ultrasound estimations of fetal weight are also undertaken in cases where there is a clinical suspicion of abnormal growth. The appropriate clinical response to an ultrasound diagnosis of macrosomia is unclear, in part because the predictions have been considered unreliable[11]

Several factors influence fetal weight, for example gestational age at delivery[12]. It is estimated that fewer than 3% of births occur at precisely 40 weeks' gestation and because the standard deviation for term pregnancies is 1 week, the normal range of term birth weight is typically referenced to the mean birth weight for pregnancies delivered at 38-42 weeks' gestation. During this 4-week interval, the typical fetus gains approximately 20 g per day, on average.[13] The average birth weight during this period of gestation age ( 38-42 weeks) varies

substantially and depends on many factors, including maternal race, size, parity, pregnancy weight gain, hematocrit, and ambient elevation.[14]

One study has shown birth weight estimation at different gestation age to be larger at 25–36 weeks' gestation than the actual birth weight. This was important because estimation of birth weight earlier in gestation can be used to monitor fetal growth. This is simple and direct indicator of fetal growth that is easy to use for doctors and easy to understand for patients.[32]

Several technical limitations of the sonographic technique for estimating foetal weight are well-known, including oligohydramnios, polihydramnios and anterior placentation[15]. Other disadvantages of ultrasonography are that it is both complicated and labour intensive, potentially being limited by suboptimal visualization of foetal structure. It also requires costly sonographic equipment and specially trained personnel.[16]

## 1.2 LITERATURE REVIEW

The ultrasound estimation of fetal weight in term pregnancies is used to determine growth, and this may affect the timing and route of delivery.[17]

In a study done to determine the accuracy of ultrasonographically predicted birth weights in Boston, Benacerraf et al[18] found that overall three quarters of the infants had birth weights within 10% of the ultrasonographic estimates and 42% had birth weights within 5% of the ultrasonographic estimates and the sensitivity for identifying a fetus with macrosomia (birth weight greater than 4000 gm) with an estimated weight of greater than or equal to 4000 gm was 65%. The specificity or percent of fetuses correctly identified ultrasonographically as not macrosomic was 90%. This shows that USS can accurately estimate the non macrosomic than in macrosomic fetus.

Several studies obtain similar findings; for example Colman et al[19] in his study found that three quarter of estimates were within 10% of the actual birth weight and the sensitivity and specificity were low but high positive predictive value and negative predictive value in estimating large birth weight and there was a positive correlation between the estimated and the actual birth weight. Srippayawan et al[20] found the sensitivity and specificity for prediction of low birth weight to be 60% and 93.8% respectively and the positive predictive value and negative predictive value were 38.7% and 97.3% respectively and the likelihood ratio of 10. In estimating birth weight between 2,500-4,000g sensitivity and specificity were 92.5% and 56.5% and the positive predictive value and negative predictive value were 96.6% and 36.1% respectively and the likelihood ratio was 2.1. In estimating large birth weight the sensitivity and specificity were; 33.3% and 98.8%, respectively, the positive predictive value and negative predictive value were; 20% and 99.4%, respectively. The likelihood ratio was 33.

In estimating low birth weight and large birth weight, Cohen et al[21] obtained somehow different results from those above, for the low birth weight, the sensitivity was 69%. , Specificity was 93%. The positive predictive value (PPV) was 61%, the negative predictive value (NPV) was 95% and likelihood ratio was 9.4. While in diagnosing large birth weight, the sensitivity was 68%, specificity was 94%, PPV was 54%, NPV was 96% and the likelihood ratio was 11.2.

Another study by Alsulyman et al [22]in USA found that the ultrasound estimation of fetal weight was less accurate in macrosomic infants than in non-macrosomic infants and sensitivity of estimating macrosomic fetus was 59% versus 85% of that of non macrosomic fetus.

Other studies have shown that overall ultrasound estimation of birth weight is lower than the actual birth weight but it has high validity and there was a positive correlation between estimated and actual birth weight.[23] Similar findings were also obtained by Kurmanavicius et al[24] who showed that USS tend to overestimate low birth weight and underestimate high birth weight. Noumi et al[25] did a study to assess the accuracy of clinical and sonographic estimations of fetal weight performed during the active phase of labor by resident physicians, and he found the correlation between the clinical and sonographic estimates and actual birth weight was 0.59 and 0.65, respectively. He also found that clinical estimates were correct to within ± 10% in 72% of cases, and sonographic estimates were correct in 74%. However, the sensitivity of predicting birth weight of 4,000 g or more was only 50% for both methods, with 95% and 97% specificity, respectively. He then concluded that both clinical and sonographic estimates of fetal weight by resident physicians had poor sensitivity for detecting macrosomic fetuses, and that the sonographic estimates offered no advantage over clinical ones. Similar study was done in Nigeria to compare clinical palpation and ultrasonic estimation in fetal weight, and found about 68% of birth weight estimated by USS to be within 10% of the actual birth weight, this was more or less the same as clinical palpation where by 70% of the birth weight were within 10%. Both methods were found to positively correlate with the actual birth weight (0.78 and 0.74 respectively). [26]

Belete and Gaym[27] did a study to determine usefulness of clinical palpation in estimating birth weight and found that the mean of all errors in terms of estimated fetal weight with palpation method were significantly smaller and rate of estimates within 10% of actual birth weight was significantly higher. For birth weights less than 2500 g clinical palpation

overestimated the birth weight; and in the 2500-4000g birth weight range, the palpation method had no systematic error while in the larger weight (>4000 g), clinical palpation method had less systematic error.

## CHAPTER TWO

## 2.0 PROBLEM STATEMENT

Both low birth weight and excessive fetal weight at delivery are associated with an increased risk of newborn complications during labor and the puerperium.[28] .The perinatal complications associated with low birth weight are attributable to preterm delivery, intrauterine growth restriction or both.[29]

For excessively large fetuses, the potential complications associated with delivery include shoulder dystocia, brachial plexus injuries, bony injuries, and intrapartum asphyxia.[4]

The estimation of fetal birth weight is currently done by using various methods, but ultrasound remains the most objective technic used. However USS standards are basically standardized for non Tanzanian population and no evidence of systematically documented data for Tanzania to show validity of USS in estimating fetal birth weight and so this study will show the usefulness of USS in estimating of the fetal weight in our setting.

## 2.1 RATIONALE

Birth weight is known to influence perinatal morbidity and mortality. Accurate estimation of fetal weight is of paramount importance in the management of labor and delivery. For instance, management of diabetic pregnancy, vaginal birth after a previous caesarean section, and intrapartum management of fetuses presenting by the breech will be greatly influenced by estimated fetal weight. Also, when dealing with anticipated preterm delivery, perinatal counselling on likelihood of survival, the intervention undertaken to postpone preterm delivery, optimal route of delivery, or the level of hospital where delivery should occur may be based wholly or in part on the estimation of expected birth weight. However there is no study which has been done in Tanzania to show the validity of estimating the fetal weight by

using USS. The results will enable us obtain validity of estimating fetal weight by using USS. Results will also be used as a basis for further research in issues concerning ultrasonic fetal weight estimation at MNH.

**2.2. STUDY QUESTION;**

Is antepartum ultrasound taken 24 hours before delivery valid in estimating fetal birth weight?

**2.3 HYPOTHESIS;**

**Ho** Using pre natal ultrasound to detect birth weight identifies same percentage of LBW babies in the population as the actual measurement taken immediately after birth.

**Ho** Using pre natal ultrasound to detect birth weight identifies same percentage of newborns weighing 2500- 4000g in the population as the actual measurement taken immediately after birth.

**Ho** Using pre natal ultrasound to detect birth weight identifies same percentage of newborns weighing more than 4000g in the population as the actual measurement taken immediately after birth.

## CHAPTER THREE

## 3. OBJECTIVES;

### 3.1 Broad Objective.

To determine validity of an ultrasound in estimating fetal weight in singleton pregnancies at MNH.

### 3.2 Specific Objectives

1. To determine the correlation between fetal weights obtained with USS done within 24 hours before birth and actual birth weight.
2. To assess proportion of LBW, normal weight, and macrosomic babies that can be identified by prenatal ultrasound and actual birth weight measurement.
3. To determine the usefulness of pre natal ultrasound in detecting birth weight.

## CHAPTER FOUR

## 4.0 STUDY METHODOLOGY

### 4.1 Study design:

This was a diagnostic study.

### 4.2 Study setting

The study was conducted at the Muhimbili National Hospital for a period of 7 months (1st June to 31st December)**.** MNH is a tertiary hospital receiving referrals from all over the country as well as hospitals around Dar es Salaam. The maternity building consists of seven wards; four wards each with a capacity of 38 beds serve for antenatal care and postnatal women, one is a labor and one for semi intensive care where sick women such as eclampsia and severe pre eclampsia are admitted, there is one special ward for sick neonates such as premature and low score delivered at MNH or referred from other health facilities. there is also a private ward for patients opting for private care. On average the labor ward conducts 20 to 30 deliveries per day.

On average at least 4 elective deliveries were conducted per day. Patient for elective delivery were admitted a day before the procedure, normally a routine USS to determine fetal weight is not done to the patient admitted for elective delivery at MNH. So on the day of admission, uss to estimate fetal weight was done by one sonographer 24hrs before delivery by using a 2 dimensional Ultrasound machine which used an abdominal sector 3.5 MHz transducer on the mindray DP 2200 ultrasound machine made in China. Its formula for estimating foetal weight is that devised by Hadlock et al[31] on the basis of biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femoral length (FL) parameters. Maternal weights were measured by using a platform weighing scale made in china and the weight was recorded to the nearest 0.1kg. Maternal heights were measured by the use of length board and recorded to the nearest 0.1 cm. After delivery the fetal birth weight was taken by the principle investigator at the labor ward using a desktop baby scale weighing machine made in China and the weights were recorded to the nearest 10g. The calibration was done each day to avoid zero error. The actual birth weight was then compared to that obtained by USS.

**4.3 Study population**

All women admitted in maternity ward for elective delivery both vaginally or by caesarian section during the study period.

**4.4 Inclusion criteria**

All singleton pregnancies admitted for elective delivery

**4.5 Exclusion criteria**

Polyhydramnios; tends to overestimate fetal birth weight.

Oligohydramnious; tends to underestimate fetal birth weight

**4.6 Sample size Calculation**

The sample size to be screened was based on achieving suitable screening test characteristics and precise estimates of their values. Given the prevalence of low birth weight at MNH of 20% [29]with a prior probability of 0.2, then a post test probability of 50% or more will make the test useful based on current clinical practice. The test should then have ability such that the post test probability does not fall below 50% of babies with LBW. By using the formula

$$n = \frac{[z_1-\beta\sqrt{\prod(1-\prod)} + z_1-\alpha\sqrt{(\prod-\delta)(1-\prod+\delta)}]}{\delta^2}$$

Where; $\prod$ = sensitivity of the diagnostic test = 0.5

$z_1 - \alpha = 1- \alpha$ equal to lower confidence limit= 0.95

$z_1-\beta = 1- \beta$ pre test probability= 0.2

$\delta$= prevalence of LBW = 0.2

Therefore the sample size of 800 will be obtained.

**4.7 Operational Definitions**

**Validity:** generally refers to the extent to which a measurement is well-founded and corresponds accurately to the real world**.**

**Polyhydromnious:** is the presence of excess amniotic fluid in the uterus, diagnosed if the deepest vertical pool is more than 8 cm or amniotic fluid index is more than 95th percentile for the corresponding gestational age.

**Oligohydramnious:** Amniotic fluid index of less than 5 cm or less than the fifth percentile for the corresponding gestational age.

**Diagnostic study**: is the type of study in which a certain instrument (ultrasound machine) is compared against a gold standard (weighing machine) to see how valid can it measure a certain condition (birth weight).

**4.8 Study duration**

The study was conducted for 7 months, from June 1st 2011 to December 31st 2011

**4.9 Data collection**

Data was collected through Check list which had all the required information from the patient's RCH4 card.

The check list contained the following categories of variables: Socio-demography, physical findings on examination during admission and maternal/fetal outcome.

Patient details of antenatal care, parity, age and last normal menstrual period were recorded. Expected date of delivery was calculated by Naegele's formula by adding seven days to the first day of last normal menstrual period and adding nine months to the last month, for those with a 28 day cycle. Gestational age in weeks was then calculated. Those who were not sure of their dates or with variable cycles other methods for obtaining GA was used including extrapolation from the first trimester USS, booking fundal height or from the date the woman experienced fetal kicks for the first time. Reasons for elective delivery include diabetic mellitus, severe pregnant induced hypertension, post date, breech presentation in primigravida, previous caesarian section scar. Those patients aimed at elective vaginal delivery were induced by using misoprostol 25mcg 6 hourly within 24 hours.

Three research assistants (Nursing Officers) underwent a training program by the Principal Investigator. One was from the antenatal ward, the second from the labor ward and the third from the theatre. They were trained on the objectives of the study, on proper checklist filling, on counseling and identifying eligible clients for the study purpose.

The principal investigator crosschecked the checklist to ensure proper filling of information.

**4.10. Data analysis**.

Data collected was coded and then entered into computer using EPI-info version 6 which allowed double entry and validation. Clean data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 16. The proportion of estimates within 10% of the actual birth weight (birth weight +/- 10%) was accepted.

Correlation was estimated by plotting scatter diagram and calculating the correlation coefficient R, the closer the r to 1 the stronger is the correlation. Proportion (matched) was compared using McNemar's statistical test for dependent variables. The usefulness of an USS as diagnostic test was measured by calculating sensitivity, specificity, positive predictive value and negative predictive value. Likelihood ratios were also calculated in order to determine the post-test probability of low birth weight and large birth weight. In all statistics p value less than 0.05 was considered significant.

**4.11. Ethical issues consideration**

Consent was sought from each participant after reading to her information statement about the study. Participants were informed about objectives of the study and they were assured of voluntary participation. Confidentiality was maintained throughout by ensuring that no names that would identify the participant.

**4.12. Ethical clearance**

Ethical clearance was obtained from MUHAS research and publication committee and permission to conduct the study was obtained from Executive Director of MNH.

## CHAPTER FIVE

## 5.0 RESULTS

During the study period a total of 843 pregnant women were admitted for elective delivery at MNH. Out of these, 800 met the inclusion criteria for the study. All these women consented and underwent an ultrasound estimation of fetal weight 24 hours before delivery.

The median age was 30 years (range 25-34years). Most were living in a married life (97. 8%); about half of the participants (51.2%) had primary school education. Majority of the participants had parity of $\leq$2 (60.7%), the mean parity was 1.4 births (S.D 1.3).

Majority of women (75.7%) were at term (37- 42 weeks) and 24. 4% were preterm (< 37 weeks) The mean gestation age was 38 weeks, (SD 1.9) The median actual birth weight was 3040 g (range 1200–5000 g). One hundred and twenty two infants (15.2%) weighed less than 2500 g and 31 (3.9%) weighed more than 4000 g. About 46.9% were scheduled for elective delivery due to previous scar (table 1)

**Figure 1, Flow chart on recruitment of women for the study**

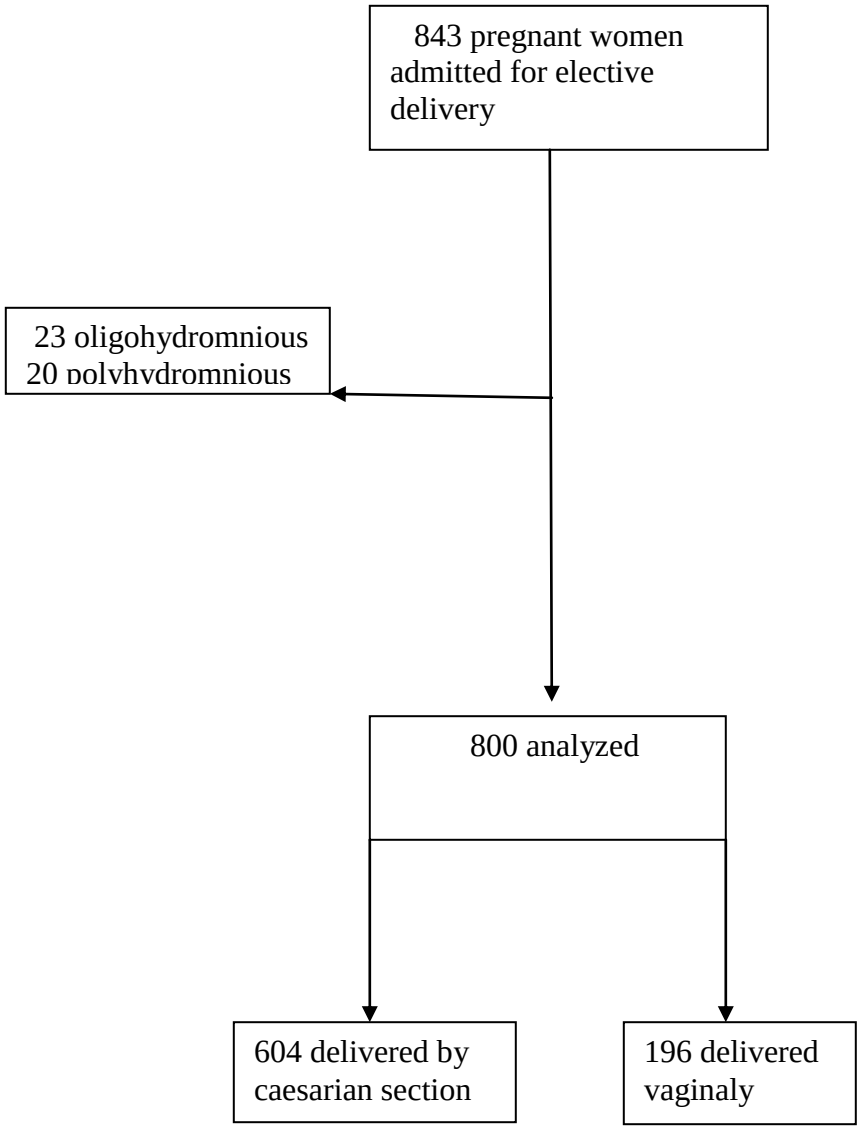
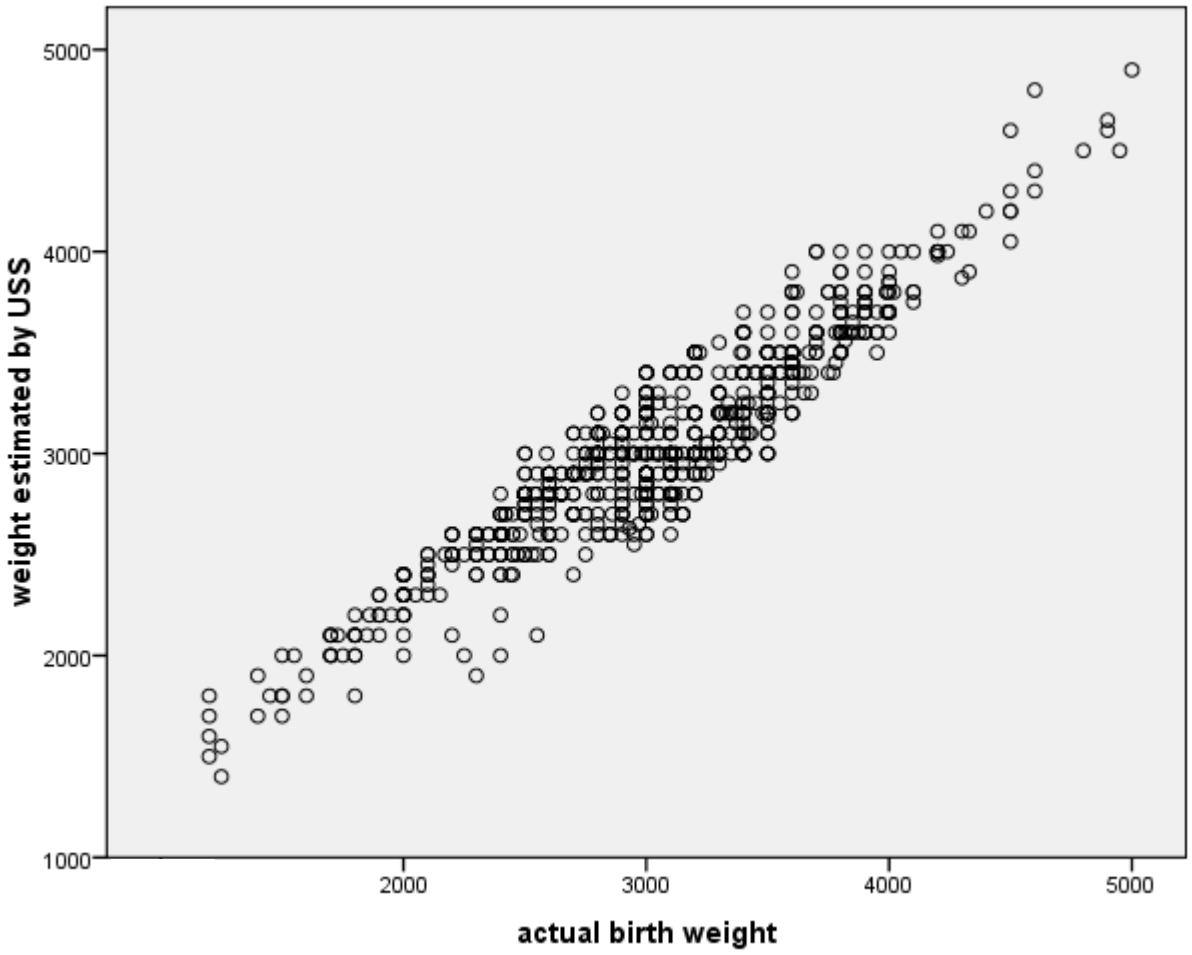


Table 1: Distribution of participants by socio-demographic characteristics (N = 800)

| Socio-demographic characteristics | Number | Percent |
|---|---|---|
| **Age** | | |
| 18- 24 | 129 | 16.1 |
| 25 – 34 | 512 | 64.0 |
| 35 – 44 | 159 | 19.9 |
| **Marital status** | | |
| Single | 18 | 2.2 |
| Married/ Cohabiting | 782 | 97.8 |
| **Level of education** | | |
| No formal education | 21 | 2.6 |
| Primary | 410 | 51.2 |
| Secondary | 257 | 32.1 |
| College | 112 | 14.1 |
| **Occupation** | | |
| House wife | 466 | 58.2 |
| Employed | 163 | 20.4 |
| Business | 165 | 20.6 |
| Others | 6 | 0.8 |
| **Parity** | | |
| 0 | 198 | 24.8 |
| 1-2 | 486 | 60.7 |
| ≥3 | 116 | 14.5 |
| **Gestation age(wks)** | | |
| <37 | 195 | 24.4 |
| 37-40 | 526 | 65.8 |
| >40 | 79 | 9.9 |
| **Reasons for delivery** | | |
| Post date | 75 | 9.4 |
| Previous scar | 375 | 46.9 |
| PIH | 209 | 26.1 |
| Diabetic | 12 | 1.5 |
| Others | 129 | 16.1 |

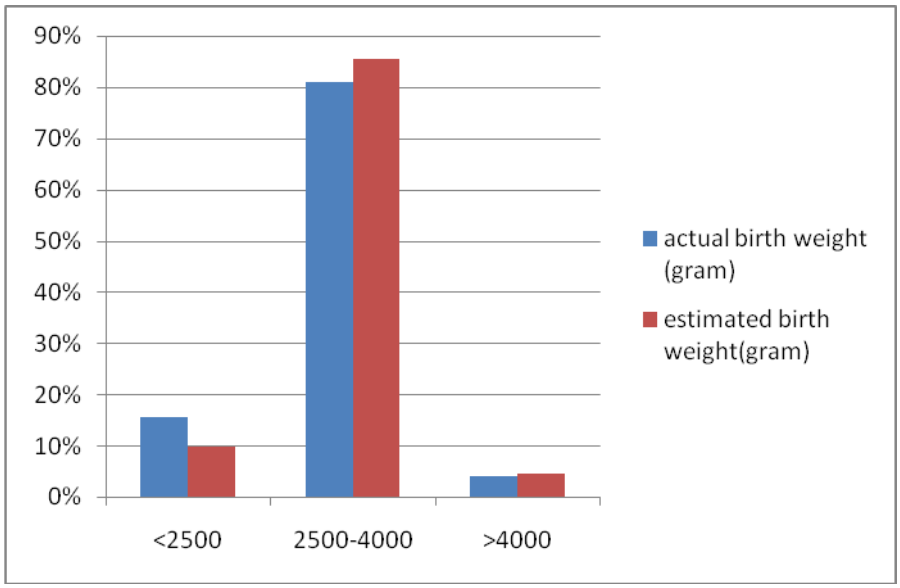
**Figure 2, Correlation between estimated birth weight and actual birth weight**




There was a strong correlation between the two methods in the estimation of birth weight, (R=0.892, p<0.001, n= 800)

.

**Figure 3: Proportion of birth weight group as determined by USS and direct measurement by weighing scale.**




In all the groups there were no statistical difference in proportional distribution; Chi square 1.45, df 2 pvalue 0.45

**Table 2 Percentage distribution of USS and actual birth weight estimates in low birth weight.**

| | | ultrasound diagnosis (g) | | |
|---|---|---|---|---|
| **actual birh** | | **≥2500** | **<2500** | **total** |
| **weight(gram)** | **≥2500** | 673(9.1%) | 49(0.6%) | 722(9.7%) |
| | **<2500** | 5(6.1%) | 73(84.2%) | 78(90.3%) |
| **total** | | 678(15.2%) | 122(84.8%) | 800(100%) |

The proportion of LBW detected by the two methods did not significantly differ (mcNemars Chi Square statistics=3.022; 1 df=1; 0.05<P<0.1. Sensitivity in of USS in diagnosing fetal

weight below 2500g is 59.8% and Specificity is 99.3 %. The prevalence of the infants weighing below 2500 is 15.2% and a Positive predictive value (PPV) is 93.6%. The Negative predictive value (NPV) is 93.2%. The positive likelihood ratio is 85.4 indicating that a positive result is 85 as likely to occur in a low birth weight baby as in one without LBW. All these results indicate the usefulness of USS in the diagnosis of LBW for the study setting.

**Table 3 Percentage distribution of USS and actual birth weight in estimates in birth weight between 2500-4000**

| | | | **ultrasound diagnosis (g)** | | **total** |
|---|---|---|---|---|---|
| | | | **not within 2500-4000** | **within 2500-4000** | |
| **actual birth weight(g)** | **not within** | **2500-4000** | 91(11.4%) | 23(2.9%) | 114(14.3%) |
| | **within** | **2500-4000** | 62(7.7%) | 624(78%) | 686(85.7%) |
| **total** | | | 153(19.1%) | 647(80.9%) | 800(100% |

There was statistical significant difference between the two methods in estimating birth weight between 2500-4000g (mcNemars Chi square statistics 2.17, df 1, p>0.1,)

Sensitivity is 96.4%, specificity 59.5%, positive predictive value is 91% and negative predictive value is 79.8%, the prevalence in estimating normal birth weight is 80.9% and the likelihood ratio is 2.4

**Table 4 Percentage distribution of uss and actual birth weight estimates in large birth weight**

| | | **ultrasound diagnosis** | | **total** |
|---|---|---|---|---|
| | | **<4000** | **≥4000** | |
| **actual birth Weight(g)** | **<4000** | 750(93.7%) | 14(1.8%) | 764(95.5%) |
| | **≥4000** | 19(2.4%) | 17(2.1%) | 36(4.5%) |
| **total** | | 769(96.1%) | 31(3.9%) | 800(100%) |

There was statistical significant difference in the proportion of large birth weight detected by the two methods (mcNemars Chi square statistics 0.985, df 1, p>0.1,)

Sensitivity in estimating large birth weight is 54.8% and specificity is 97.5%

The prevalence of infants weigh more than 4000g is 3.9%. PPV 47.2% and NPV is 98.2%, the likelihood ratio 22, indicating that a positive result is 22 as likely to occur in a large birth baby as in one without large birth weight. It indicates that uss is less useful in diagnosing of large birth weight babies for the study setting.

## CHAPTER SIX

## 6.0 DISCUSSION

In this study validity of ultrasound in estimating fetal weight in singleton pregnancies was determined. It is shown that there is strong correlation between ultrasound and the weighing machine in estimating birth weight. The study shows that the positive predictive value and negative predictive value in diagnosing low birth weight were 93.6% and 93.2% respectively and the positive likelihood ratio was 85.4. It also shows that ultrasound has a positive predictive value and negative predictive value of 91% and 79.8% respectively and positive likelihood ratio of 2.4 in detecting normal birth weight. In diagnosing large birth weight in the study setting it is shown that ultrasound has a positive predictive value of 47.2, negative predictive value of 98.2 and the likelihood ratio of 21.9. Therefore ultrasound was found to be useful in diagnosing low birth weight but less so in detecting normal birth weight and large birth weight for the study setting.

The strong correlation (0.892) between direct birth weight and that estimated by ultrasound shows that, an increase or decrease in fetal weight has a direct effect in both methods. This could be explained by the similar proportion distribution of birth weight among the groups between the two methods. Similar findings were also reported in studies done previously.[19, 25, 26]. It is therefore shown that overall, ultrasound fetal weight estimation is well correlated to the actual birth weight, for the study settings.

This study shows that the positive predictive value and negative predictive value of an ultrasound in diagnosing low birth weight were 93.6, 93.2 respectively. These high values

mean that ultrasound as a diagnostic tool can give best results when estimating low birth weight in this study setting. The positive likelihood ratio of an ultrasound in this weight group was 85.4, indicating that a positive result is 85 times as likely to occur in a low birth weight baby than those without low birth weight in the study setting. Therefore there is substantial evidence that both ultrasound and weighing machine will give similar measurements in estimating low birth weight. This shows that ultrasound is of great importance in diagnosing low birth weight in the studied population. This is important because early planning of management can be done in case of intrauterine growth restricted babies. This is different from findings obtained from other studies [20, 21]. The difference could be speculated by the different prevalence of low birth weight among the studies.

This study reveals a positive predictive value and negative predictive value of ultrasound in detecting normal birth weight as 91%, 79.8%, respectively, indicating that ultrasound has high positive predictive value but somehow low negative predictive value, therefore its ability to correctly diagnose babies who are not within the normal range is a bit low. Since the positive likelihood ratio of an ultrasound in this age group was 2.4, meaning that positive result is 2 times as likely to occur in normal birth weight as in those without normal birth weight, it shows that ultrasound is less useful in diagnosing normal birth weight for the study setting. Similar findings were obtained from study done by Srippayawan et al[20.] In diagnosing large birth weight the positive predictive value was 47.2%, negative predictive value was 98.2%. The low positive predictive value shows that ultrasound has low ability in diagnosing large birth weight. The positive likelihood ratio was 21.9, indicating that a positive result is 22 times as likely to occur in a large birth weight babies compared to the one without large birth weight. There is no substantial evidence that ultrasound and weighing machine will give similar measurement in estimating normal birth weight and large birth weight respectively. Therefore in clinical setting ultrasound is less useful in diagnosing of both normal birth weight and large birth weight babies. Similar findings were also obtained in other studies[20,21].

It should be noted that ultrasound derived fetal weight estimation alone is not sufficient grounds for deciding the route of delivery especially in macrosomic babies. To determine the

mode of delivery clinical assessment of pelvic capacity should be added to the sonographic fetal weight estimate, with consideration of the risk factors for macrosomia.[8]

Generally it was shown in this study that USS can either overestimate or underestimate the fetal birth weight at a proportion of 10%, and therefore if this could be adjusted by adding or subtracting 10% to the estimated fetal weight then the USS would give exactly the same weight as the weighing machine.

## CHAPTER SEVEN

## 7.0 LIMITATION OF THE STUDY

Some of the limitations which were encountered during the study were: some pregnant mother could not remember there date of last menstruation and they had no an early ultrasound done so it was difficult to estimate the gestation age.

Also some of the pregnant mother planned for elective delivery went into an emergency delivery before ultrasonic estimation of the fetal weight.

### Conclusion

Ultrasound is useful in diagnosing lowbirth weight babies while its usefulness in detecting large birth babies is questionable. As the sensitivity of ultrasound estimation of fetal weight to detect larger babies is poor, the use of such an objective measurement in the management of suspected macrosomia in singleton pregnancies should complement other clinical diagnostic methods.

### Recommendations

Until more reliable methods are developed to determine fetal macrosomia, the use of ultrasound to assess fetal weight in singleton pregnancies should be interpreted with caution.

## REFERRENCES

1. Sherman DJ, Arieli S, Tovbin J, Siegel G, Caspi E, Bukovsky I. A comparison of clinical and ultrasonic estimation of fetal weight. *Obstet Gynecol*. Feb 1998;91(2):212-7.

2. Nzeh DA, Oyawoye O, Adetoro O. Ultrasound estimation of birth weight in late pregnancy among African women. *West African J Ultrasound.* 2000;1:9–14.
3. Hendrix NW, Grady CS, Chauhan SP. Clinical versus sonographic estimates of birth weight in term of parturients. A randomized clinical trial. *J Reprod Med*. 2000;45:317 22.
4. National Bureau of Statistics and Calverton: Tanzania demographic and health survey (TDHS) 2004-05.
5. Mavalankar DV, Trived CR, Gray RH. Levels and risk factors for prenatal mortality in Ahmadabad, India. *Bull World Health Organ.* 1991;69:35–42.
6. Nahum G. Estimation of fetal weight—a review article last updated on 17 Oct 2011.
7. Chauhan SP, Hendrix NW, Magann EF, Morrison JC, Kenney SP, Devoe LD. Limitations of clinical and sonographic estimates of birth weight: experience with 1034 parturients. *Obstet Gynecol*. Jan 1998;91(1):72-7.
8. Ben-Haroush A, Yogev Y, Mashiach R, Hod M, Meizner I. Accuracy sonographically estimated fetal weight in 840 women with different pregnancy complications prior to induction of labor. *Ultrasound Obstet Gynecol* 2004; 23: 172–176.
9. Ratanasiri T, Jirapornkul S, Sombooporn W, Seejorn K, Patumnakul P. Comparison of the accuracy of ultrasonic fetal weight estimation by using the various equations. *J Med Assoc Thai*. 2002; 85:962–7.
10. Abramowicz JS, Sherer DM, Bar-Tov E, Woods JR. The cheek-to-cheek diameter in the ultrasonographic assessment of fetal growth. *Am J Obstet Gynecol*. Oct 1991;165(4 Pt 1):846-52.
11. Chauhan SP, Grobman WA, Gherman RA, et al. Suspicion and treatment of the macrosomic fetus: a review. *Am J Obstet Gynecol*. 2005;193:332–46.
12. Gardosi J, Mongelli M, Wilcox M, Chang A. An adjustable fetal weight standard. *Ultrasound Obstet Gynecol*. Sep 1995;6(3):168-74.
13. Owen P, Donnet ML, Ogston SA, Christie AD, Howie PW, Patel NB. Standards for ultrasound fetal growth velocity. *Br J Obstet Gynaecol* 1996; 103: 60–69.

14. Sharon A. Durbin, Connie W. Lee and Veronica G. Parker: The Effect of Amniotic Fluid Index on the Accuracy of Sonographic Estimated Fetal Weight. *Journal of Diagnostic Medical Sonography* 2005 21: 329.
15. Zhang J, Bowes WA Jr. Birth-weight-for-gestational-age patterns by race, sex, and parity in the United States population. *Obstet Gynecol*. Aug 1995; 86(2):200-8.)
16. Mehdizadeh A, Alaghehbandan R, Horsan H. Comparison of clinical versus ultrasound estimation of fetal weight. *Am J Perinatol*. 2000;17:233–6.
17. Weeks JW, Pitman T, Spinnato JA II. Fetal macrosomia: does antenatal prediction affect delivery route and birth outcome? *Am J Obstet Gynecol*. 1995; 173:1215–9.
18. Benacerraf BR, Gelman R, Frigoletto FD Jr. Sonographically estimated fetal weights: accuracy and limitation. *Am J Obstet Gynecol*. Nov 1988; 159(5):111821.
19. Colman A, Maharaj D, Hutton J, Tuohy J. Reliability of ultrasound estimation of fetal weight in term singleton pregnancies. *N Z Med J*. 2006;119(1241):U2146)
20. Sritippayawan S, Anansakunwat W, Suthantikorn C. The accuracy of gestation-adjusted projection method in estimating birth weight by sonographic fetal measurements in the third trimester. *J Med Assoc Thai*. 2007 Jun; 90(6):1058-67.
21. Cohen, J. M., Hutcheon, J. A., Kramer, M. S., Joseph, K. S., Abenhaim, H. and Platt, R. W. (2010), Influence of ultrasound-to-delivery interval and maternal–fetal characteristics on validity of estimated fetal weight. *Ultrasound Obstet Gynecol*, 35: 434–441. doi: 10.1002/uog.7506.
22. Alsulyman OM, Ouzounian JG, Kjos SL. The accuracy of intrapartum ultrasonographic fetal weight estimation in diabetic pregnancies. *Am J Obstet Gynecol*. 1997;177:503–6.
23. Chien PF, Owen P, Khan KS. Validity of ultrasound estimation of fetal weight. *Obstet Gynecol* 2000; 95: 856-60.
24. Kurmanavicius J, Burkhardt T, Wisser J, Huch R.Ultrasonographic fetal weight estimation: accuracy of formulasand accuracy of examiners by birth weight from 500 to 5000 g. *J Perinat Med* 2004; 32:155–161.

25. Noumi G, Collado-Khoury F, Bombard A, Julliard K, Weiner Z. Clinical and sonographic estimation of fetal weight performed during labor by residents. *Am Journal Obs and gyne* . May 2005, 195(5); 1407-9.
26. Akinola S. Shittu, Oluwafemi Kuti,Ernest O. Orji, Niyi O. Makinde, Solomon O. Ogunniyi, Oluwagbemiga O. Ayoola,2 and Salami S, Clinical versus Sonographic Estimation of Foetal Weight in Southwest Nigeria, *J health and population nutrition* 2007 march 25(1) 14-23.
27. Belete W, Gaym A clinical estimation of fetal weight in low resource settings. *Ethiop Med J. 2008* Jan; 46(1):37-46.
28. Jolly MC, Sebire NJ, Harris JP, Regan L, Robinson S. Risk factors for macrosomia and its clinical consequences: a study of 350,311 pregnancies. *Eur J Obstet Gynecol Reprod Biol*. Nov 10 2003; 111(1):9-14.
29. Hussein L Kidanto, Ingrid Mogren, Gunilla Lindmark, Siriel Massawe, Lennarth Nystrom. Analysis of perinatal mortality at a teaching hospital in Dar es Salaam, Tanzania. *South African medical journal* 2009; 99(2):98-102.
30. Hadlock FP, Harrist RB, Sharman RS, Deter RL, Park SK. Estimation of fetal weight with the use of head, body, and femur measurements—a prospective study. *Am J Obstet Gynaecol*. 1985; 151:333–7.
31. Solomon L.J, Bernard J.P and Ville Y; Estimation of fetal weight: reference range at 20–36 weeks gestation and comparison with actual birth-weight reference range. *Ultrasound Obstet Gynecol* 2007; 29: 550–555.

**Appendix I;**

**PROPOSED CHECKLIST (ENGLISH VERSION)**

VALIDITY OF ULTRASOUND IN ESTIMATING FETAL WEIGHT IN SINGLETON PREGNANCIES DELIVERY AT MNH.

1. Checklist number……
2. Patients registration number……
3. Age of the patient……

4. Gravidity……
5. Parity ……
6. Marital status
   a)Single
   b) Married
   c) Divorced
7. Level of education
   a)No formal education
   b) Standard seven leaver
   c) Form four leaver
   d) Form six leaver
   e)College
8. Occupation;
   a)Housewife.
   b)Employed
   c)Business
   e)Others.
9. Maternal height (in cm) ……..
10. Maternal weight (in kg)……
11. Gestational age at delivery (in weeks)….
12. Reasons for elective delivery
    a)Post datism
    b) Previous scar
    c) Severe pregnant induced hypertension
    d)Diabetic mellitus
    e) Others specify
13. Method of delivery
    a)Vaginal delivery
    b)Caesarian section

14. Estimated fetal weight by ultrasound (in gm) ……..
15. Actual fetal birth weight as obtained by weighing machine (in gm)…….
16. Fetal sex
    a)Male
    b)Female

**DODOSO (KISWAHILI VERSION)**

1. Nambari ya dodoso ……
2. Namba ya usajili ya mgonjwa …….
3. Umri ……
4. Mimba ya ngapi? …….
5. Uzao wa ngapi?
6. Kuolewa

    a) Sijaolewa
    b) Nimeolewa
    c) nimeachika
7. Kiwango cha elimu
    a)Hana elimu yeyote
    b)Darasa la saba
    c)Kidato cha nne
    d)Kidato cha sita
    e)Chuo
8. Kazi;
    a)Mama wa nyumbani
    b)Mwajiriwa
    c)Mfanyabiashara
    d)Nyingineyo.

9. Urefu wa mama ( sm) …….
10. Uzito wa mama ( kg) ……..
11. Umri wa mimba ( wiki) ……
12. Sababu ya kuzalishwa
    a)Mimba kupitisha muda wake
    b)Kovu lililopita
    c)Msukumo mkubwa wa damu kwa ajili ya mimba
    d)Kisukari
    e)Mengineyo ( fafanua)
13. Njia ya kujifungua
    a)Kawaida
    b)Upasuaji.
14. Makadirio ya uzito wa mtoto kwa mashine ya ultra sound ( gm) ……
15. Uzito halisi wa mtoto kwa mzani ( gm) …….
16. Jinsia ya mtoto
    a)Kike
    b)Kiume

**Appendix II**

**CONSENT FORM (ENGLISH VERSION)**

Hello, my name is ……, from the Muhimbili University of Health and Allied Sciences carrying out a research on 'validity of ultrasound in estimating fetal weight in singletone pregnancy women admitted for elective delivery at MNH'

The aim of the study is to assess the validity of an ultrasound in estimating fetal weight so as we can depend on it in estimating fetal weight and planning for the mode of delivery. All the information gathered will be strictly confidential and used for research purposes only. In case of any concerns about the study, feel free to contact Prof Abood, the chairperson of the Research and Publication Committee at Muhimbili University of Health and Allied Sciences (Tel :2150302); P. O. Box 65001, Dar-es-salaam.

I therefore ask for you to participate in this study for your information to be filled in this checklist, thanks.

I agree/ don't agree ……. (Name)

…… (Signature)

**FOMU YA IDHINI (SWAHILI VERSION)**

Salaam, Jina langu ni ……. Kutoka chuo kikuu cha afya na sayansi shirikishi, nafanya utafiti kuhusu uwezo wa mashine ya ultra sound katika kukadiria uzito wa mototo akiwa tumboni.

Matokeo ya utafiti huu yatatusaidia kufahamu uwezo wa mashine hii na kuweza kupanga njia sahihi ya kujifungua kama ikionekana inweza kukadiria kwa ufasaha uzito wa mototo kabla ya kuzaliwa.

Habari zote zitakazojazwa kwenye dodoso ni siri na zitatumika kwa ajili ya utafiti tu. Ukiwa una shaka kuhusu utafiti huu unaweza kuwasiliana na profesa Abood ambaye ni mwenyekiti wa kamati ya utafiti wa chuo. (Simu namba 2150302), P.O Box 65001, Dar es Salaam.

Hivyo basi nakuomba ushiriki katika utafiti huu kwa maelezo yako kujazwa katika dodoso .

Ahsante.Nimekubali / Nimekataa ……..

……... (Sahihi)