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RESEARCH PAPER:

Accuracy of ultrasound in fetal sex and weight determination in the 2<sup>nd</sup> & 3<sup>rd</sup> trimester when performed by radiology residents & recent graduates: A Cross sectional facility based study

PRINCIPAL INVESTIGATOR; YASMIN HASHIM

Radiology resident, Department of Radiology

ADVISOR: DR. TEFAYE KEBEDE (Associate professor of radiology)

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## **Acronyms**

AC .....Abdominal Circumference

ABW.....Actual birth weight

BLH.....Black Lion Hospital

BPD.....Bi-parietal diameter

EFW.....Estimated Fetal weight

ETH.....Ethio-Tebib Hospital

FL .....Femur length

HC .....Head Circumference

PH .....Police Hospital

## Abstract

**Background:** Ultrasound is one of the non invasive methods for fetal sex determination and with its introduction visualization of the fetal genitalia has become possible. Although mainly fetal sex determination is done for parental curiosity it has also some clinical implication. Accurate prenatal EFW in late pregnancy and labor is extremely useful in management of labor, aiding in decision making about instrumental delivery, trial of labor after caesarean delivery and elective Cesarean section for patients suspected of having a macrosomic fetus.

**Objective:** Purpose of this study was to assess the accuracy of ultrasound in fetal sex determination in 2<sup>nd</sup> & 3<sup>rd</sup> trimester & weight determination in those  $\geq 38$ wks when it is performed by those with lesser experience and exposure

**Methods:** Obstetric ultrasound and ultrasound of the perineal region of the fetus was done on 600 pregnant women to detect the sex of the fetus with gestational age from 16 weeks to term. Completer data and information was available in 550 of the study. There were 20 twins in the study making the overall fetuses in the study 570. For fetal weight accuracy study 235 mothers with gestational age of  $\geq 38$ weeks were included. Ultrasound results were registered on pre-prepared form at the time of examination. The sex & weight was confirmed at the expected time of delivery through a phone call to the mothers and for some by revising their medical cards.

**Results:** Out of 570 fetuses ultrasound was able to determine the sex for 527 (92.5%); 287 of whom were confirmed female and 240 were male. Overall accuracy was 84.92%. Accuracy for females was 91.63% and for males was 92.08%. When the not sure cases are excluded and samples for which actual sex determination was done are analyzed the accuracy was found to be 92%. From the 235 samples with GA of  $\geq 38$  weeks the accuracy of ultrasound fetal weight estimation within 10% of actual birth weights was 85.5%. The mean absolute error of estimated fetal weight was 226.67gm. Ultrasound generally underestimated the birth weight. Specifically ultrasound overestimated the fetal weight in those  $< 2500$ gm and underestimated in those  $> 4000$ gm.

**Conclusion:** Ultrasound is an accurate method to determine the fetal sex in the second and third trimesters with a sensitivity of 90% and specificity of 93.2% even when it is performed by those with less experience and exposure. In conclusion EFW by ultrasound in term pregnancies using the Hadlock formula was found to have a high accuracy rate when it is performed by those with less experience and exposure. So it can be applicable to make clinical decisions even when it is done by those with less experience. The over estimation of LBW and under estimation of macrosomia found in ultrasound weight estimation should be given due attention

## CHAPTER ONE: INTRODUCTION

### 1.1. Background of the study

For centuries guessing the sex of the unborn child has been a popular activity amongst expectant parents and their families. With the introduction of ultrasound of the fetus visualization of the genitalia has become possible. Fetal sex can be assigned reasonably accurately from approximately 12 weeks of gestation onwards (1).

Although determining the gender at ultrasound is still mainly attempted because of parental curiosity, it can sometimes form part of a protocol, as it can be clinically important. For example accurately assessing fetal sex assist in assigning zygosity in twin pregnancies. Whilst ambiguity of genitalia, which can occasionally be detected at times of routine ultrasound, is more commonly found at a detailed ultrasound after detecting other abnormalities. In women at risk of X-linked genetic disease like hemophilia or of ambiguous development of external genitalia, early gender assignment may give parents the option to avoid invasive tests. (1)

Fetal sex can be determined by different means, invasive and non-invasive. Among the invasive methods chorionic villous sampling (CVS) done at 11 weeks and amniocentesis at 15-16 weeks of gestation are the common ones. These procedures are associated with a risk of miscarriage (11). From the non-invasive methods analysis of fetal DNA in maternal blood and colorimetric assay of pregnant women's urine as well as ultrasound are used for fetal sex determination.

First trimester sonographic prenatal sex determination can be done from 11 weeks of gestation using the direction of genital tubercle and the 'sagittal sign'. The downward

direction of the tubercle is considered as female while upward direction as a male (1, 8). In sagittal sign, examination of the genital region in the midline sagittal plane demonstrates a caudal notch in female and cranial notch in male (12, 13). Prenatal determination of fetal gender by ultrasound of the fetal perineum during second and third trimester of pregnancy is based on the demonstration of the penis and/or scrotum in males and labial folds or the three echogenic lines in females. Absence of scrotum or penis was previously considered as a female (2) but recent mention that absence of scrotum or penis must not be taken as sufficient evidence for female. Unfortunately first trimester ultrasound sex determination has false negative rate. The ability to assign fetal gender correctly increases with increasing gestational age (1). Studies done in the second has better sensitivity values. Correct visualization of fetal part depends on many factors like fetal position, amount of amniotic liquor, maternal abdominal wall thickness and technical skill of the operator. In correctly determined sex can have some psychological effect on the family (1).

Accurate prenatal estimation of fetal weight (EFW) in late pregnancy and labor is extremely useful in the management of labor and delivery, permitting obstetricians to make decisions about instrumental vaginal delivery, trial of labor after caesarean delivery and elective caesarean section for patients suspected of having a macrosomic fetus (14). An accurate diagnosis of macrosomia for patients with gestational diabetes can reduce perinatal morbidity as it may assist the physician and staff in deciding the appropriate route of delivery to prepare for shoulder dystocia or to prevent a traumatic injury.

EFW can be done by mothers (if they are parous), by clinicians using Leopold maneuvers or by ultrasound. In the 1970s, the use of ultrasound to estimate fetal weight gained popularity because of the perceived ability to standardize and reproduce measurements, although the technique can be challenging, depending on the mother's physique, uterine anomalies or amniotic fluid index (14).

Clinical EFW has been shown to accurately predict birth weight. For example, Baum et al. showed no significant difference between clinical and sonographic estimates of fetal weight;



64.0% versus 62.5% of the estimates respectively were within 10% of the actual birth weight. Maternal EFW is comparable to both clinical or ultrasound predictions in both term and postdate babies. (23, 24)

The accuracy of ultrasound depends on, the technician's skill, the position of the baby at the time of examination, the amount of liquor, and thickness of abdomen.

In the Ethiopian context, so far, a single study has been conducted on the accuracy of ultrasound gender identification and to the authors knowledge there was no study done in Ethiopia which evaluated the accuracy of ultrasound in estimating fetal weight.

The objective of this study is to assess accuracy of ultrasound in fetal sex determination and identify the different factors that affect its correct determination in the second and third trimester and also to determine the accuracy of ultrasound in EFW which is important in making the appropriate decision in clinical management of the pregnant women. This study is mainly aimed at assessing the accuracy of ultrasound done by radiology trainees and recent graduates who have no much exposure in fetal sex determination and weight estimation.

## **1.2. Statement of the problem**

Accurate sex determination is important for a multitude of social and clinical reasons. Fetal sex assignment by conventional sonographic evaluation of the external fetal genitalia in the second and third trimesters is possible in most cases with modern ultrasound equipment and trained personnel, even towards the end of first trimester. Despite the suspected straightforward technique in determining fetal sex, physicians may make errors in their prenatal diagnosis. This has a risk affecting the psychosocial and/or economical aspects in the over expectant and disappointed parents (6).

The ultrasound estimation of fetal weight in term pregnancies is used to determine growth, and this may affect the timing and route of delivery. Ultrasound is also important in estimating fetal weight in macrocosmic babies in whom delivery is associated with higher

rates of adverse outcomes for both mothers and infants in comparison to the delivery of a normal weight infant. Several technical limitations of the sonographic technique for estimating fetal weight are well-known. Among these are maternal obesity, oligohydramnios, and anterior placentation (15).

Conducting this study will help to assess the accuracy of ultrasound in determining fetal sex in the second and third trimester and EFW in those 38 weeks and above when is done by recent radiology graduates and trainees. It will also try to identify the factors which contribute to its accuracy and limitations.

### **1.3. Research objectives**

The overall objective of this study is to assess the accuracy of ultrasound in fetal sex determination and fetal weight estimation when it is done by recent radiology graduates & trainees using three hospitals from Addis Ababa as a sample.

The specific objectives of the study are:

- Determine the accuracy of ultrasound in fetal sex determination in the second and third trimester of pregnancy when done by recent radiology graduates & trainees.
- Determine the factors that affect the accuracy of ultrasound in fetal sex determination.
- Determine the accuracy of ultrasound in fetal weight estimation in Gestational age of 38 weeks and above when done by recent radiology graduates & trainees.
- Determine the factors that affect the accuracy of ultrasound in fetal weight estimation.

### **1.4. Significance of the study**

This study will try to assess the accuracy of ultrasound in fetal sex determination in the second and third trimester of pregnancy and fetal weight estimation in gestational age of 38 weeks and above when it is done by those with less experience and also asses the factors associated with its outcome and finally document the outcome by which the physician can

confidently tell the clients the gender of their unborn child and use the EFW to guide patient management.

#### **1.5. Constraints and Scope of the study**

Many of its major constraints are concerns of time, available data (since most of the obstetric ultrasound are done in the department of gynecology and obstetrics this makes the number & type of obstetric ultrasound done in the radiology department very few & difficult ones and this could lead to non-representativeness of the samples collected) and resource to accomplish the stated tasks. The other limitation is in fetal weight estimation where there is wide range of time gap from the date of examination to delivery which gives a lot of time for the fetus to grow. Scope wise, the study was limited only in three hospitals (two governmental and one private hospital).

## CHAPTER TWO: LITERATURE REVIEW

### 2.1. Determination of fetal sex by ultrasound

When dealing with pregnant clients medical personnel encounter requests for possible assessment of the sex of the unborn child. The possibility of establishing the diagnosis of fetal sex was first apparent during the scanning of a fetus with bilateral hydroceles (2). Since 1985, 2 dimensional ultrasound has been the predominate method for determining prenatal sex and as the technology has improved over the years, so has the reliability and accuracy of sex assignment (3). The improvement of high-resolution ultrasound equipment has provided the possibility of detailed visualization of the fetal anatomy in the first trimester. However, because of the way in which the genitalia develop, this is not the most accurate way of assigning gender in early pregnancy (1). At this stage the diagnosis of gender is based upon the orientation of the genital tubercle in the mid-sagittal plane. In these studies, accuracy was lower than that achievable in the second trimester, with only a few authors reporting reliable fetal gender assignment between 11 and 14 weeks (4).

Different studies have been conducted in different trimesters to identify the accuracy of ultrasound in fetal gender assignment. The earliest study done on fetal sex determination by ultrasound, was in 1977 by Stocker and Evans, after 30 weeks of gestation and had a high rate of accuracy (95.6% overall, 99.5% for male and 91.5% for females). Sex determination was believed at that time to be unreliable between 26 and 30 weeks, and impossible if fetal age was less than 26 weeks (2).

In 1980 another study done by Scholly et al after 25 week of gestational age showed that of the 112 fetuses scanned, gender was determined in 72, (42 males and 30 females) and there were no errors in prediction. In the 40 failures, the fetal genitalia could not be detected; hence, determination was not volunteered. Follow-up showed that the failure group was equally divided between males and females, indicating that absence of detection of penis or scrotum certainly does not indicate a higher probability of the fetus being female. Although

the rate of visualization of genitalia was only 64%, accuracy of determination of gender within that group was 100%. Failure of sonographic determination of fetal gender after 25 weeks was largely due to crowding of the uterine contents in the vicinity of the genitalia due to the various combinations of fetal presentation, fetal lie, and placental position, number of fetuses, fetal activity, and amniotic fluid volumes. Maternal factors also played a role (6).

In a study conducted by Plattner et al from 14 weeks to term, it was possible to see male genitalia in the early second trimester, as early as 14 weeks, with real time scanners. The accuracy for cases below 24 weeks of gestation was 86% and for those above 24 weeks were 98%. The prediction accuracy for gestational age 20 to 24 weeks was 93% but accuracy dropped sharply for those under 20 weeks, in which it was only 80% (7).

In the subsequent years with the advent of high resolution and transvaginal ultrasounds fetal sex determinations in the first trimester were possible and different studies were done to assess its accuracy. For example, Efrat *et al.* examined the angle between the genital tubercle to a horizontal line through the lumbosacral skin surface, to provide an accurate prediction of the fetal sex from 12 weeks onwards. In male fetuses the angle was  $>30^\circ$  from the horizontal line and increased with advancing gestation. Fetal gender assessment by ultrasound was prospectively carried out in 172 singleton pregnancies at 11–14 weeks of gestation and showed that the accuracy of sex determination increased with gestation from 70.3% at 11 weeks, to 98.7% at 12 weeks and 100% at 13 weeks(8). This shows that the overall success of correctly assigning fetal gender increased with gestational age (8, 11).

The use of three dimensional sonographic examinations in the assignment of fetal sex was also studied. One of the documented advantages of three dimensional ultrasound is that information can be extracted from the stored volume of data in innumerable planes, regardless of the fetal position during acquisition. A study by Lev-Toaff et al. done at 10-24 weeks of gestation showed that using 3D ultrasound gender assignment was possible as early as 11 weeks. In early gestation 11-14 weeks, accuracy was 100% (9).

Another study compared 2 dimensional & 3 dimensional ultrasounds in prenatal sex identification in GA ranging from 19 to 26 weeks and found that 2 dimensional ultrasounds had an accuracy of 96.5% and 3 dimensional 93.2% concluding that there was no significant difference between 2 and 3 dimensional ultrasounds in fetal sex prediction (3).

In Ethiopia one study was done in 2011 assessing the accuracy of ultrasound in determining fetal sex using a routinely used ultrasound and setup in a sample size of 275 by Gelaw and Bisrat and found an overall accuracy of 93.8% and also showed that accuracy was higher for the gestational age above 28 weeks (third trimester): 95.5% versus 89.8% for 16-28 weeks (second trimester) (10).

Factors that inhibited visualization and resulted in poor images of the genitalia were fetal hyperactivity, crowding of fetal parts, oligohydraminos, breech presentation and maternal bowel gas shadowing (6, 7).

The clinical value of determination of fetal sex by ultrasound in early pregnancy is in deciding whether to carry out prenatal invasive testing in pregnancies at risk of sex-linked genetic abnormalities, because invasive testing would be necessary only in pregnancies with male fetuses (8). Even though there is no striking application for the knowledge of fetal sex during the late periods of gestation, besides parental wish, it is difficult to predict the role this information play on the interested parties. It has been said that the severity and incidence of respiratory distress syndrome in premature female is lower than in male. So diagnosing a female fetus in premature labor could decrease the need for pharmacologic attempts in counteracting uterine activity and enhancing pulmonary maturity. Also diagnosing different sexes in twin pregnancy can rule out monozygotic origin with its slight increased risk of complications (2).

## **2.2. Determination of fetal weight by ultrasound**

Assessment of fetal weight is a vital and universal part of antenatal care, not only in the management of labor and delivery but often during the management of high risk pregnancies and growth monitoring (19). Birth weight of an infant is the single most important determinant of newborn survival (19, 22).

Both low and excessive fetal weights at delivery are associated with an increased risk of newborn complications during labor and puerperium. The high perinatal morbidity and mortality associated with low birth weight are attributable to preterm delivery, intrauterine growth restriction, or both. For excessively large fetuses, the potential complications associated with vaginal delivery include shoulder dystocia, brachial plexus injury, bone injuries, and intrapartum asphyxia, while the maternal risks include birth canal and pelvic floor injuries, increased rate of operative vaginal and caesarean deliveries, and postpartum hemorrhage. Limiting the potential complications associated with the birth of both small and excessively large fetuses requires that accurate estimation of fetal weight occurs before decision to deliver is made [20].

Different studies have been done to study the accuracy of ultrasound in estimating the fetal weight comparing it with the actual birth outcome and with other methods of estimating fetal weight like clinical and maternal estimations.

T.Prioret al conducted a study on the accuracy of ultrasound determined estimated fetal weight at term in a low risk population and found that the estimated fetal weight showed strong correlation with birth weight with a mean absolute percentage error of 6.7% (16).

Another study done by T. Ashrafganjooei et al tried to compare the three different methods of EFW, clinical, maternal and ultrasound measurements on 246 parous women and found that the sensitivity values of predicting birth weights for ultrasound, clinical and maternal

EFW were 17.6%, 11.8% and 6.3%, with specificity of 93.5%, 99.6% and 98.0%, respectively. The study also showed that ultrasound EFW offers no advantage over clinicians EFW when performed during the late pregnancy and labor (14)

In a study conducted from January 2010 to February 2012 in Nepal showed that fetal ultrasound using Hadlock's formula has error in estimation of fetal weight by about 290 gm  $\pm$  250 gm. In 40% of the cases, there is an error of estimation by more than 10% compared to actual weight. The study concluded that significant error was seen while estimating fetal weight by ultrasound and depending only on the fetal ultrasound for the estimation of fetal weight can lead to unnecessary obstetrical intervention (22)

A prospective validation study done between January 2012 and July 2012 at General Hospital Ampara, Sri Lanka in 393 pregnancies at gestational age between 35 and 41 weeks came with an overall result which showed that all EFW formulae either under or overestimated the birth weight in singleton pregnancies. Almost all the formulae overestimated the fetal weight in low birth weight babies whilst underestimating the fetal weight in birth weight >3500g (15)

A study done in Enugu, Southeastern Nigeria tried to compare / evaluate the accuracy of clinical and ultrasound EFW in predicting actual birth weight in 200 term pregnancies. Overall, both the clinical and ultrasound methods systematically overestimated the actual birth weight. The proportion of the clinical estimated weights that were within 10% of the actual birth weight was significantly lower than that of ultrasound method for babies of all birth weights (35.0 vs. 67.5%;  $P < 0.001$ ) and for macrosomic babies (76 vs 100%,  $P = 0.009$ ). For babies with normal birth weights (2.5-3.9 kg), ultrasound method error values were significantly lower than those of clinical method for both the mean percentage error (5.4 vs 19.6%;  $P < 0.001$ ) and the mean absolute percentage error (9.97 vs 20.6%;  $P < 0.001$ ) (19).

A prospective study carried out in Khartoum, Sudan in a total of 533 participants within 36 months of time found significant association between birth weight, Gestational age and



maternal weight and it concluded that predicting fetal weight using the formula derived by Hadlock et al is accurate and valid (18).

Ultrasound is routinely used to estimate the fetal weight and is often used as a proxy to actual birth weight. Accuracy of ultrasound in predicting birth weight is more precise in early gestations, since at term there is significant deterioration of ultrasound resolution as the fluid to fetus ratio decreases, bony structures become increasingly calcified, and the vertex descends into the pelvis, making measurements of head circumference and bi-parietal diameter more difficult (14). Despite these limitations clinicians routinely take decisions based on ultrasound estimation of fetal weight.

There was no study done in Ethiopia which evaluated the accuracy of ultrasound in estimating fetal weight.

So this study tried to determine the accuracy of sex assignment by ultrasound in the second and third trimesters of pregnancy and estimated fetal weight in those 38weeks and above when it is done by recent radiology graduates and residents. It also tried to assess the factors associated with its outcome and finally document the outcome whether the physician can confidently tell the client the gender of its unborn child and use the EFW to guide patient management.

## **CHAPTER THREE: METHODOLOGY, DATA COLLECTION, CONCEPTUAL FRAMEWORK, AND RESEARCH HYPOTHESIS**

### **3.1. Methodology and Data Collection**

#### **3.1.1. Data sources and Methods of data collection**

Because of the methodological specificity in one hand and the nature of data required to test the hypotheses of the study on the other hand, the search for hospital based prospective study design was the best option to follow. A prospective study design was applied to assess the accuracy of ultrasound in fetal sex determination and estimating fetal weight as done by recent radiology graduates and residents and also identify the factors that affect its determination. The following hospitals were included in the sample as potential sources of information: Black Lion hospitals, Ethio Sudan Tebib Mother's and Children's hospital and Police hospital.

Study samples were assigned from those mothers visiting Black Lion hospital, Ethio Sudan Tebib Mother's and Children's hospital and Police hospital for routine obstetric ultrasound evaluation. Obstetric ultrasound and ultrasound of the perineal area were done by Sonoscape and Samsung ultrasound machines trans abdominally using a 3.5MHz curvilinear transducer to assign the sex of the fetus on clients with gestational age of 16 weeks and above. Fetal biometry including BPD, HC, AC and FL were done to estimate the fetal weight in those with GA are 38 weeks and above and EFW calculated by the ultrasound machine using the Hadlock method.

Then ultrasound results were recorded just after the examination and contact phone numbers were taken following verbal consent from the mothers. Phone calls were made to the mothers by the time of the expected date of delivery for those examined in BLH and hospital cards were revised for those from PH and ETH to confirm the actual gender of the babies and to know the weight of the baby at delivery which was then filled in the forms.

### **Study design**

Hospital based prospective study design was applied to assess the accuracy of ultrasound in fetal sex determination and fetal weight estimation.

### **Study period**

This study was conducted starting from January 1, 2013 until June 30, 2015.

### **Source population**

All pregnant women visiting Black Lion hospital, Police hospital and Ethio Tebib Mother's and Children's hospital for their routine obstetric ultrasound evaluation during the study period.

### **Study population**

All pregnant women who are sent to the radiology ultrasound unit for obstetric ultrasound and who fulfill the inclusion criteria.

### **Inclusion and Exclusion criteria**

#### ❖ Inclusion criteria`

- All pregnant women visiting the radiology ultrasound department with gestational age of 16 weeks and above for fetal sex determination and 38 weeks and above for ultrasound fetal weight estimation, willing to participate in the study and able to provide a verbal consent are included in fetal sex determination and weight estimation.

#### ❖ Exclusion criteria

- Pregnant mothers who are not able to give telephone number for contact to obtain the final gender and weight outcome after delivery (only for participants from Black Lion hospital, this is because the feed back after delivery from this hospital could only be collected through phone calls). For Police and Ethio Tebib Mother's and Children's hospital medical records/cards were used to gather the final gender and weight outcome after delivery.
- Those who are critically ill and cannot give informed consent.
- For fetal weight estimation those with still birth and other fetal anomalies.

### **Sample size**

A proportional sample technique formula was used to estimate the sample size of clients to be enrolled. Sample size for fetal sex determination was calculated assuming an average accuracy of ultrasound 93%, a desired precision of 4%, 95% confidence interval and 10% allowance for non-respondents. The minimum sample size required for the study was 172 pregnant women. For fetal weight determination assuming an ultrasound accuracy of 80%, a desired precision of 5% and with a 95% confidence interval sample size calculated was 245.

### **3.1.2. Description of study area**

This study was conducted in the department of Radiology of Addis Ababa University (AAU). The three hospitals which are included in the study are Black Lion hospital, Police hospital and Ethio Tebib Mother's and Children's hospital.

3.1.2.1. Black lion hospital is a governmental hospital found in the capital city of Ethiopia, Addis Ababa, near to Ethiopian radio and television center and gives both teaching and clinical services in various departments.

3.1.2.2. Police hospital is also another referral governmental hospital found in the capital city around Mexico area giving medical service to Addis Ababa and regional state officers and their Families.

3.1.2.3. Ethio Sudan Tebib Mother's and Children's hospital is a private hospital for mothers and children sited also in the capital city, Addis Ababa where a dedicated maternal service is given with high patient flow.

### **3.1.3. Data collection procedure**

A self-prepared data collection sheet / questionnaire / was developed. The collected data included the socio-demographic characteristics and possible determinant variables for the accuracy of ultrasound including gravidity, parity, last normal menstrual period, gestational age both by last menstrual period and ultrasound, fetal presentation/lie, number of gestation, amniotic fluid amount, placental position and estimated fetal weight at 38 weeks and above.

The data from Police and Ethio Tebib hospitals were collected by a radiologist working in the hospitals who recently completed her residency program and the data from Black Lion hospital were collected by the principal investigator and other residents who work in the hospital. Before starting data collection verbal consent were taken from the participating client. When the expected date of delivery reached participants from Black Lion hospital were contacted through telephone while for police hospital and Ethio Tebib Mother's and Children's hospital participants their medical document records were revised to find the final outcome of the fetal sex and weight after delivery.

#### **3.1.4. Data management**

Data was entered and cleaned using Excel and Epi info and analyzed using statistics, graphics and data management software (STATA). In analysis errors related to inconsistency of data was checked and corrected during data cleaning. The data was described using proportions and percentages, while appropriate graphic presentations besides measures of central tendency and measures of dispersion was used for further describing. Bi-variate analysis of socio-demographic and other independent variables are analyzed. Multivariate logistic regression model was employed to control for confounders.

#### **3.1.5. Ethical considerations**

Ethical clearance was obtained from the research committee of radiology department of Addis Ababa university school of medicine and the same document was used to secure a written permission from the administration of Ethio Tebib Mother's and Children's and Police hospitals. Efforts were made to maintain the confidentiality of the data. All the study participants were reassured that no personal identifiers will be used and verbal consent were taken from each participant. Charts were retrieved from the archives of Ethio Tebib Mother's and Children's and Police hospitals by using the client's card number and participants from Black Lion hospital were contacted through telephone to document the sex after delivery. This study was conducted without any discrimination of ethnicity, religion or language.

## 3.2. CONCEPTUAL FRAMEWORK, RESEARCH HYPOTHESIS AND METHODOLOGY

### 3.2.1. Conceptual Framework and Research Methodology

Obstetric ultrasound & ultrasound of the perineal area was done trans abdominally using a 3.5 MHz curvilinear transducer to assign the sex of the fetus on clients with gestational age of 16weeks and above determined by ultrasound using BPD and FL measurements.

And fetal biometry including BPD, HC, AC and FL were done to estimate the fetal weight in those with GA are 38 weeks and above determined by ultrasound and EFW were calculated by the ultrasound machine using the Hadlock method.

Diagnosis for sex determination was made based on the following criteria:

1. If three white lines or labia seen, as female (Figure 1);
2. If scrotum and/or penis seen, as male (Figure 2);
3. If perineum is tight (not well visualized) or operator failed to visualize the genitalia it is entered as Not sure



Figure 1: Us of Perineum When Three White Lines Demonstrated for Female  
BLH, Addis Ababa, 2014-15.  
P=Perineum Fem = Femur Arrow= 3 echogenic lines



Figure 2: US of the Perineum when Scrotum and/or Penis Seen indicating Male  
BLH, Addis Ababa, 2014-15.  
Arrow=Penis, Scrotum

Evaluation of estimated fetal weight was done by using the different fetal biometries (HC (Figure 3), BPD (Figure 4), AC (Figure 5) & FL (Figure 6)) and then calculated using the Hadlock method.

The accuracy was determined using percentage error, absolute percentage error, and proportion of estimates within 10% of actual birth weight.



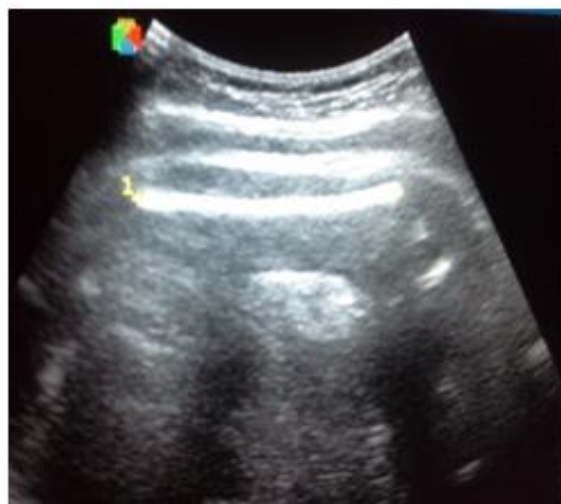
Picture 3: HC measurement at the level of the thalamus, BLH, Addis Ababa, 2014-15



Picture 4: BPD measurement at the level of thalamus, BLH, A.A, 2014-15



Picture 5: AC taken at the level of the Stomach & portal vein, BLH, Addis Ababa, 2014-15



Picture 6: Femur length measurement BLH, Addis Ababa, 2014-15

## **Study Variables**

### **Dependent variables**

- Determination of fetal sex by ultrasound
- Determination of fetal weight by ultrasound

### **Independent variables**

- Socio demographic variables
  - Age
- Obstetric variables
  - Gravidity
  - Parity
  - Last normal menstrual period (LNMP)
  - Gestational age by LNMP
- ultrasound finding variables
  - Gestational age by ultrasound
  - Estimated fetal weight by ultrasound
  - Fetal lie
  - Number of gestation
  - Amniotic fluid amount
- Prenatal outcome variables
  - Weight after delivery
  - Fetal sex after delivery

### **Operational definitions**

- Gravidity: Determined to all previous pregnancies irrespective of the site and outcome of the pregnancy



- Parity: Determined to all the number of previous pregnancies resulting in either live births or still births after 28 weeks of gestational age
- Gestational age: Is the time measured from the first day of the women's last menstrual cycle to the current date
- Male sex on ultrasound: when scrotum or penis or both are seen
- Female sex on ultrasound: when three echogenic lines or labial folds are seen
- Sex not sure on ultrasound: when the penis/scrotum or labia/three echogenic lines are not seen or when the perineum is tight and could not be visualized
- Second trimester: the time of pregnancy between 14 and 27 weeks
- Third trimester : the time of pregnancy 28 weeks and above
- Estimated fetal weight: The fetal weight calculated using different fetal biometry like bi-parietal diameter, Head circumference, abdominal circumference and femur length
- Oligohydramnios: When the amniotic fluid is less than expected for the GA.
- Polyhydramnios: When the amniotic fluid is greater than expected for the GA.
- Adequate amniotic fluid: When the fluid is within the normal amount for the GA.

### **3.2.2. Hypothesis of the study**

1. Utilizing ultrasound in fetal sex determination in the second & third trimester of pregnancy is significantly accurate
2. Utilizing ultrasound in fetal weight estimation in GA of 38 weeks & above is significantly effective.
3. The determinant factors which we used in our study as independent variables do have a significant effect in the accuracy of ultrasound in fetal sex determination.
4. The determinant factors which we used in our study as independent variables do not have a significant effect in the accuracy of ultrasound in fetal weight estimation.
5. Ultrasound fetal sex determination & weight estimation can accurately be done by recent radiology graduates & trainees.

## CHAPTER FOUR: ANALYSIS AND RESULT

### 4.1. Analysis and Result for fetal sex determination

The relevant ultrasound and other examinations were done for a total of 600 mothers; however, 50 of them were excluded from the sample observation due to unfilled information. A total of 550 mothers with 570 fetuses (20 twins) were included in the analysis for ultrasound sex determination. Of those 550 pregnant women who were sent to the radiology ultrasound unit for obstetric ultrasound examination: 148 (26.9%) were from Black Lion hospital, 190 (34.5%) from Police hospital and 212 (38.54%) from Ethio Tibeb hospital. Moreover, all the sample observations were in the category of second and third trimester, starting from 16 weeks up to 41 weeks of gestation and among these most of the observations were in the third trimester (see Table 1).

Table 1: Examination area proportion for the study subjects

Place of referral	Number	Percent %	Trimester	
			Second	Third
Black Lion Hospital	148	26.9	40	108
Police Hospital	190	34.5	58	132
Ethio Tebib Hospital	212	38.54	76	136
Total	550	100	174	376

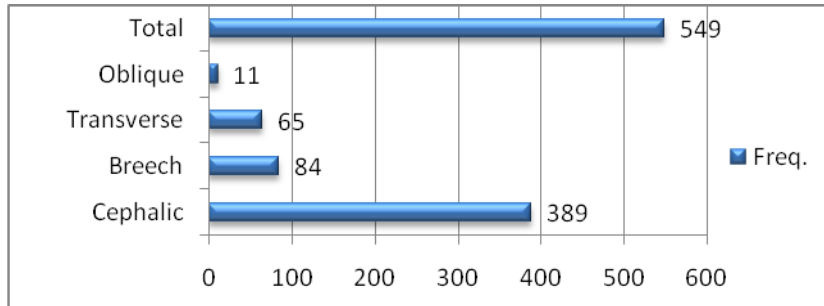
*Source: Own computation, 2015*

The mean ( $\pm$ SD) age of the mothers was 27.08 ( $\pm$ 4.49) years with a range of 16 yrs - 40 years. Mean gravidity was 1.95 with a range of 1-6. Mean gestational age was 35 weeks and 5 days with a range of 16 -41 weeks.

Fetal lie was evaluated for 549 fetuses; the most common observation was cephalic 389 (70.85%) (See Figure 7). Amniotic fluid was evaluated for 550 mothers, of those 534 (97.09%) had adequate amniotic fluid volume, 8 (1.45%) Polyhydramnios & 8 (1.45%)

Oligohydramnios. Placental position was also assessed and anterior fundal and /or anterior being the frequent observation was seen in 287 (52.18%) (See Figure 8).

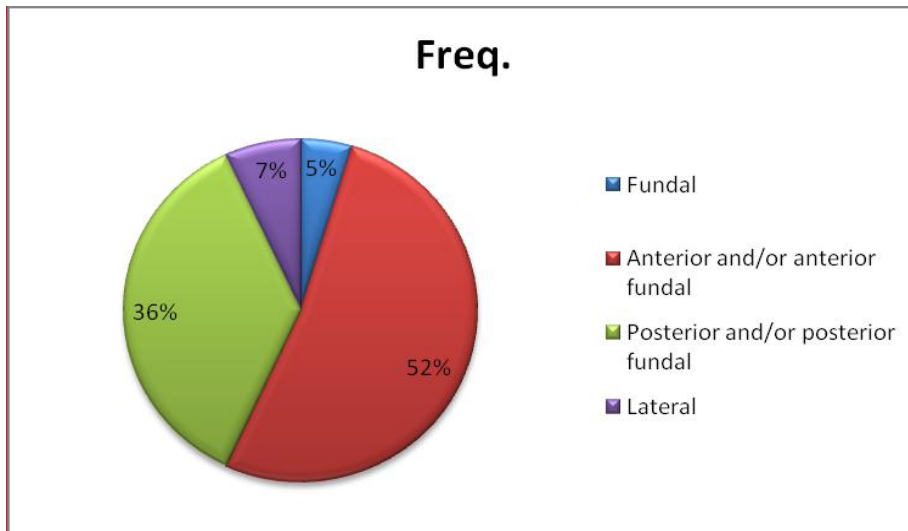
Figure 7: Fetal Lie by Ultrasound



NB. One of the sample observations was dropped due to unfilled information

Source: *Own computation, 2015*

Figure 8: Placental Position by Ultrasound



Source: *Own computation, 2015*

#### 4.1.1. Accuracy of Fetal Sex Determination Using Ultrasound

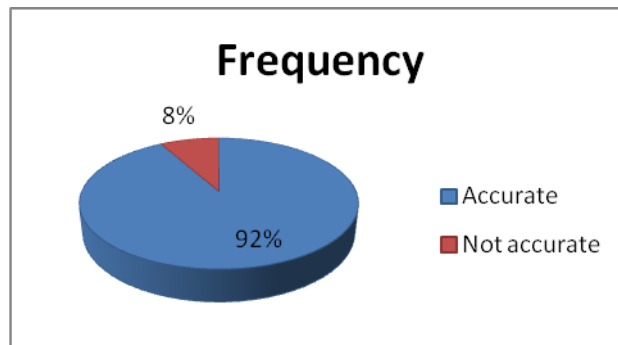
Accuracy of determination of the fetal sex by ultrasound was examined using a sample of 550 observations. This was carried out by comparing the sex determined by ultrasound with the sex of the baby after delivery. The result is presented using Table 2 and figure 9. Table 2 indicates that from the total sample of 550 pregnant women ultrasound was able to accurately determine the fetal sex in 84.92% of the 570 cases (20 twins). However, if we consider only the actual determined result (i.e. exclude the not sure sample result) the accuracy rate reaches 91.84%. This result depicts that there is high accuracy result in determining fetal sex by ultrasound. (Figure 9)

Table 2: Accuracy of determination of fetal sex by ultrasound

Accuracy status	Frequency	Percent %
Accurate	484	84.92
Not accurate	43	7.54
Not sure	43	7.54
Total	570	100

Source: Own computation, 2015

Figure 9: Accuracy of determination of fetal sex by ultrasound excluding the not sure result



Source: Own computation, 2015

In fact, it is crucial to see whether the accuracy of ultrasound fetal sex determination varies based on gender and number of gestation. This is analyzed making use of table 3. The table shows that if the sex of the child at delivery is female, accuracy of the fetal sex determination reaches about 91.63% (263 out of 287 observations); if the sex of the child at delivery is male, accuracy of the fetal sex determination is 92.08% (221 out of 240 observations). This implies that there is no significant variation in ultrasound fetal sex determination for both sexes.

However, accuracy of the expectation seems to be different for number of gestation of the fetus. The result showed that, it is for 82.86% of the twins (29 out of 35, 5 of them were not sure) that the fetal sex was accurately determined. This shows that the level of accuracy is less than that of the singleton; implying that determination of the fetal sex is likely to be difficult if the number of gestation is more than one (i.e. for twins and more).

Table 3: Accuracy of ultrasound determination of fetal sex for female & male

Accuracy status	Female		Male	
	No of obs.	Percentage	No of obs.	Percentage
Accurate	263	91.63%	221	92.08%
Not accurate	24	8.36%	19	7.91%

*Source: Own computation, 2015*

Regarding the accuracy based on the examinations done in the different trimesters, it was found that the accuracy of ultrasound sex determination in the second trimester was 85.96% and in the third trimester 85.67% (Table 4). When comparing the results between the second and third trimesters, there was no significant difference in the accuracy of ultrasound sex determination in these two trimesters.

Table 4: Ultrasound Determined sex Vs Fetal Sex after delivery Stratified by GA

Accuracy status	Second trimester		Third trimester	
	No of obs.	171		356
Accurate	147	85.96%	305	85.67%
Not accurate	24	14.04%	51	14.33%

*Total obs= 527 excluding the not sure samples*

*Source: Own computation, 2015*

#### **4.1.2. Determinants of Accuracy of Fetal Sex Determination**

In order to identify the statistically significant determinants affecting accuracy of the fetal sex determination using ultrasound, logistic regression model was used to analyze the effects. This regression model was carried out taking the possibility of making accurate expectation of the fetal sex as dependent variable and different explanatory variables which are expected to influence the accuracy of this expectation as independent variables.

In the analysis, the variables considered in this regression were found to be jointly significant to influence the possibility of making accurate fetal sex determination, at 1% level of significance.

The individual significance test of the regression shows that 5 of the 14 stated variables were found to affect the probability of making accurate fetal sex determination, significantly at 1% and 10% levels of significance. These include age of the pregnant woman, adequate amniotic fluid, parity, gravidity and placental location of anterior and placental location of posterior.

The result shows that the presence of adequate amniotic fluid more likely aids in knowing the fetal sex accurately than in the presence of oligohydramnios. In other words having an adequate amniotic fluid have a positive contribution for the accuracy of ultrasound in determination of fetal sex (coefficient of adequate amniotic fluid is positive having P-value of

0.098). Even though, coefficient of polyhydramnios amniotic fluid has negative value (which states that polyhydramnios amniotic fluid has a negative contribution for the accuracy of ultrasound in determination of fetal sex), the P-value is not significant enough to conclude its direct effect (P=0.784).

Regarding the fetal lie the values are not significant enough to affect the sex determination outcomes.

Finally, placental locations of anterior and posterior were found to be among the significant variables to influence the accuracy of ultrasound fetal sex determination positively, at 1% level of significance. The result showed that both variables have positive coefficients with P-values of 0.004 and 0.002, respectively. Hence, it can be inferred that the fetal sex of the child can easily be identified using ultrasound if its placental location is either anterior or posterior.

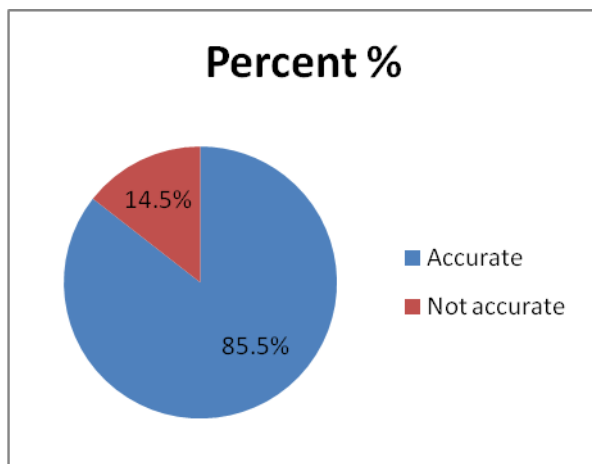
## **4.2. Analysis and Result for estimated fetal weight determination**

### **4.2.1. Accuracy of determination of fetal weight using ultrasound**

From the total sample size of this study 235 of them were eligible to be incorporated in the analysis for the accuracy of ultrasound in fetal weight determination after the relevant ultrasound examination was done.

Accuracy of birth-weight was determined by calculating the percentage error  $(EFW-ABW) \times 100/ABW$ , the absolute error, i.e.  $[\text{absolute value } (EFW-ABW)] \times 100/ABW$  and the ratio by percentage of ultrasound estimate within 10% of actual birth-weight. Having the above justifications, the result is presented using Figure 10. The Figure shows that from the total sample of 235 pregnant women; for about 85.53% the test of the examination was found to be accurate and for about 14.46% of them, the examination was inaccurate.

Figure 10: Accuracy of determination of fetal weight by us



Source: Own computation, 2015

Table 5: Accuracy of fetal weight estimation among the different gestational ages by us

Accuracy status	38 weeks		39 weeks		40 weeks		41 weeks	
No of obs.	181		46		6		2	
Accurate	159	87.8%	38	82.6%	4	66.6%	1	50%
Not accurate	22	12.2%	8	17.4%	2	33.3%	1	50%

Source: Own computation, 2015

Accuracy of fetal weight estimation by ultrasound was also evaluated across the different gestational ages. The accuracy of weight estimation was seen to decline as the gestational age increased from 87.85% at 38 weeks to 50% at 41 weeks as indicated in Table 5.

From those evaluated at 38 weeks , 22 were not accurate and ultrasound overestimated 6 of them and underestimated 16 of them , of those at 39 weeks 8 were not accurate all of them were underestimated and at 40 weeks 2 were not accurate and all were underestimated.

Of the 235 mothers examined in determining the accuracy of ultrasound EFW, the weight difference between expected fetal weight and weight at delivery was analyzed and the mean



weight difference was 226.67gm (the average difference between the expected and actual fetal weight). The standard deviation is 196.75 (average difference among each observation) in rang of 9gm up to 1193gm (the minimum and maximum difference among observations). This implies in average there is 226.67gm over or under estimated weight in the examination.

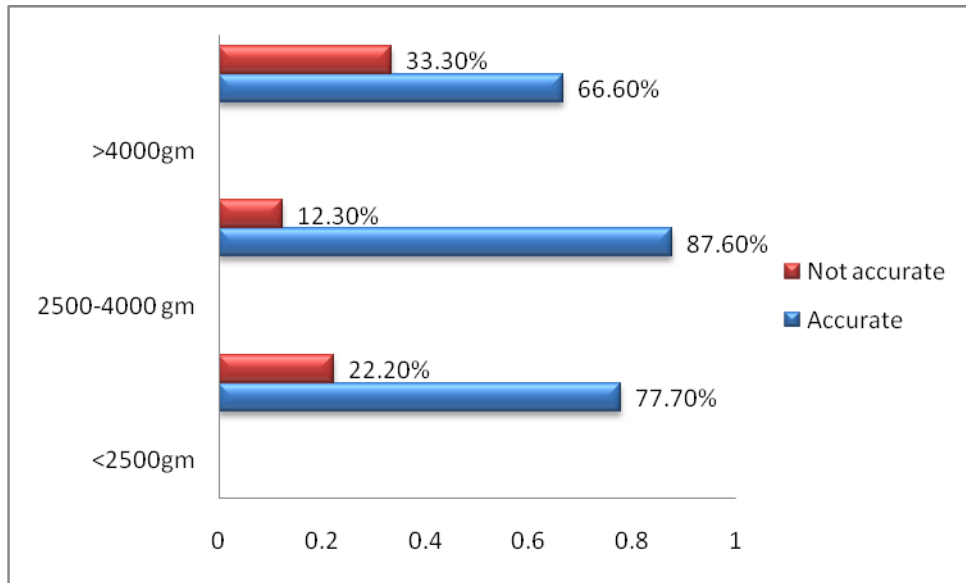
The proportion in the extent of the deviation in fetal weight away from expectation was with a mean value of 0.0741 (the proportion of difference between expectations and actual fetal weight differ by 7.4%) and standard deviation of 0.0716. The most accurate estimation had a 0.02% variation from the actual and the worst estimation had 45.7% variation from the actual weight. Generally the determination of fetal weight by ultrasound was accurate with an average of 7.4% difference between the expected and actual fetal weight.

Table 6: The deviation in weight when the weight at delivery is less than 2500gm, between 2500gm and 4000gm or greater than 4000gm

<b>Size difference</b>	<b>observation</b>	<b>Mean</b>	<b>Standard deviation</b>	<b>Minimum</b>	<b>Maximum</b>
<2500	9	292.55	358.99	80	923
2500 – 4000	211	214.93	182.21	9	1192
>4000	15	351.4	232.1	100	704
<b>Total</b>	235				

*Source: Own computation, 2015*

Figure 11: The Accuracy of fetal weight determination by ultrasound when the weight at delivery is less than 2500gm, between 2500gm & 4000gm or greater than 4000gm



Source: Own computation, 2015

The above Table 6 also explains the deviation in weight at different weight categories showing that the mean difference in those >4000gm is (351.4gm) higher than the others, (292.55gm) in <2500gm and (214.93gm) in 2500-4000gm.

Among those with weight <2500gm 2 of them were not accurate and ultrasound overestimate the weight in both cases, in those 2500-4000 gm 26 of them were not accurate and among these 5 of them were overestimated and 21 of them underestimated and in those >4000 gm 5 were inaccurate and all of them were underestimated. Generally the accuracy of ultrasound fetal weight estimation is high when the fetal weight is in the range of 2500- 4000gm and low when the fetal weight is > 4000gm (Figure 11).

#### **4.2.2. Determinants of Accuracy of the Fetal Weight Examination by Ultrasound**

In order to identify the major determinants in the accuracy of the fetal weight determination, the difference between expected fetal weight and weight at delivery was used as the indicator of the extent of accuracy of the result of the examination. This variable is supposed to be the dependent variable of our regression model. However, the difference between these two variables can be either positive or negative. Since we are interested with the magnitude of the difference, only the extent of the difference was used as the dependent variable of our linear regression model. All the variables that are expected to influence the difference were used as independent variables.

The variables considered in this regression were found to be jointly non-significant to examine and Pseudo R<sup>2</sup> is also 0.0952 which depicts that the listed variables which were used for this analysis do not explain the required result. This result clearly shows that the major determinant factors for accurate fetal weight determination are other factors out of the variables which we used in this study.

The individual significance test of the regression showed that 4 of the 20 stated variables were found to affect the probability of making accurate estimation of fetal weight, significantly at 1% and 10% levels of significance. These include fetal lie cephalic, fetal lie transverse and placental location anterior fundal and posterior fundal.

The result shows that fetal lies cephalic and transverse are likely to affect the correct estimation of fetal weight negatively. It is indicated that coefficient of fetal lie cephalic and transverse are negative having P-value of 0.085 and 0.097 respectively revealing that these are among the significant variables that can affect the probability of making accurate fetal weight determination, negatively at 10% level of significance. Placental location anterior fundal and posterior fundal influences the probability of making accurate determination negatively and significantly, having negative coefficient. It has P-value of 0.079 and 0.027, respectively, which shows it is significant at 10% level of significance.

The rest of the variables remained insignificant to influence the accuracy of fetal weight determination by ultrasound.

## CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATION

### 5.1. Discussions

#### 5.1.1. Accuracy of ultrasound in fetal sex determination

From the 570 evaluated fetuses ultrasound was able to determine the fetal sex in 527 of the cases with an overall accuracy of 92%. This result is comparable with the studies done by G. Plattner which showed an accuracy of 93% (7). In contrary the result is lower from those found by Sifrash G. and Scholly et al (10, 6); the reason for this could be the wide range of technical skill/ experience difference among the operators, from recently graduated radiologist to junior residents, affecting the correct ultrasound fetal sex determination.

In this study there was no significant variation in accuracy of ultrasound fetal sex determination for both sex, 91.63% for females and 92.08% for males which is similar with the study done by J. Stocker & G. Morgan (2,25) and different from the study done by G.Plattner (7) which showed a higher accuracy for determination of the male fetal sex.

Even if the number of observations were more in the third trimester there was no significant difference in the accuracy of ultrasound fetal sex determination in the second and third trimesters: 85.96% versus 85.67% respectively, a similar result with the study done by J. Stocker (2). The result is different from the one done by Sifrash G. et al & G. Plattner (10, 7) which showed an increase accuracy as the gestational age increased.

Ultrasound fetal sex determination was not possible in 43 (7.54%) of the cases. From those in whom ultrasound sex determination was not possible to make 17 of them were female and the rest 19 were male. From this majority of them were examined in the third trimester period. The reason for failure to make ultrasound sex determination could be the crowding of fetal parts and the decrease in the amount of amniotic fluid as the gestational age increases making it difficult to see the perineal region clearly. The other possible reason could be the lack of experience of the operators resulting in a large number of undetermined cases.

The accuracy of sex determination decreased when the number of gestation increased (for those  $\geq 2$ ) with an accuracy of 82.86%. The possible reasons for this finding could be crowding of the fetal parts and examining the wrong perineum for the specific fetus due to limited personnel skill or fetal part crowding.

The presence of adequate amniotic fluid facilitates the accurate determination of fetal sex with a p value of 0.098 having a positive relationship. While the result showed that presence of oligohydramnios and polyhydramnios are not significant enough to affect fetal sex determination outcomes, the sample size is too small (8/550 for both) to reach to a conclusion. The results are also similar with those done by J. stocker indicating that the presence of adequate amniotic fluid facilitates the correct fetal sex determination (2).

For the placental position, anterior and posterior locations were found to have a significant relation with correct fetal sex determination with accuracy of 84.66% and 87.93% respectively.

Regarding the fetal lie it was found in our study that the fetal position is not significant enough to affect the accuracy of ultrasound in fetal sex determination. This finding is similar with that of Sifrash G. et al finding (10) but contradicts with the study done by Scholly et al where breech presentation was found to have a limiting factor in correct determination of fetal sex determination (6). It might be difficult to conclude by saying that there is no significant effect of fetal lie on sex determination based on this study since the number of breech and other presentations were too few.

Overall in this study ultrasound was found to have a sensitivity of 90.2% and a specificity of 93.2% with a positive predictive value of 92.08% in determining the fetal sex in utero which is a high number despite the limited experience of the operators.

### **5.1.2. Accuracy of ultrasound in fetal weight estimation**

Fetal weight estimation by ultrasound using the Hadlock's method in those 38 weeks and above is found to be accurate in this study.

A total of 235 mothers were included in the analysis for the study on accuracy of ultrasound in fetal weight determination. In 85.53% of the tests the determination of fetal weight was found to be accurate within 10% of the actual birth weight. This accuracy value is higher from those found in other studies; 72% in the study done by Charles Njoku, 75% by Atalie and 68% by S.Shittu (20, 21, and 17 respectively).

One of the main limitations of this study was that it included births that occurred over a wide range of days after the last ultrasound examination.

In cases where the estimation was either greater or less than 10% of the actual birth weight, ultrasound underestimated the fetal weight, a finding similar with the study done by Charles Njoku (20) & different from that of S.Kumarasir & EO Ugwu et al which showed overestimation (15, 19). The reason for the underestimation could be because most of the estimations done were remote from the time of delivery giving an ample time for the fetus to gain weight in the remaining time.

When comparing the estimated weight outcomes based on the different stages of GA, the accuracy within 10% of ABW dropped as the GA increased (87.7% at 38 weeks, 82.2% at 39, 66.6% at 40 and 50% at 41weeks). One reason for these result could be the larger number of sample size found in the category of 38 weeks and the small non representative sample size found in 39-41weeks of gestation. The other possible reason could be the engagement of the head as the GA increases making the correct measurement of fetal biometry (especially the BPD & HC) difficult.

In order to observe and compare any possible effect of weight categories on the accurate estimation of ultrasound, the EFW and the actual birth weight were divided into three groups, ranging between 2500-4000 grams, those <2500 grams and those > 4000 grams.

The accuracy of ultrasound estimation obtained in this study was highest in the birth-weight range of 2500-4000 gm and lowest for the low-birth-weight group (<2500 gm) and this is in consistence with what S.Shittu et al found in their study (17).

The observation in this study showed that ultrasound overestimated low birth-weight and underestimated high birth-weight which has also been previously reported in the studies done by S Kumarasiri, T.Prior, S.Shittu & Atalie (15,16, 17& 21respectively) .

Under and over estimation of weight was defined as a weight difference less than or greater than 10% of the actual fetal weight. The sensitivity, specificity & positive predictive value of ultrasound to accurately estimate the fetal weight within 10% of the actual birth weight was found to be, in those < 2500gm it was 63.63%, 66.67% & 77.78% respectively, for those between 2500 & 4000gm it was 97.37%, 40.9% & 87.68% respectively and for those >4000gm it was 26.32%,97.46% and 66.67% respectively.

## **5.2. Conclusions and Recommendations**

Our results which are also supported by previous other studies indicate that ultrasound is an accurate method to determine the fetal sex in the second and third trimesters with an accuracy of 92%, sensitivity of 90% and specificity of 93.2% even when it is done by recent graduates and radiology trainees with less experience.

The result also showed the low accuracy rate of ultrasound fetal sex determination in twin pregnancy compared to singleton pregnancy. As a result careful examination is recommended when performing ultrasound fetal sex determination in multiple pregnancies.

The accuracy of ultrasound in estimation of fetal weight performed in term pregnancies was found to be higher in our study than that reported in other studies. It is therefore recommended to use ultrasound method in estimating the fetal birth weight whenever accessible even when it is done by those with less experience.

The general over estimation of low birth weight and under estimation of macrosomia in ultrasound weight estimation should be given due attention so as not to under diagnose this conditions leading to mismanagement.

This study failed to evaluate the factors that affect the accuracy of ultrasound in fetal weight estimation. As a result further study is recommended to asses other major determinant factors for the accurate fetal weight determination using ultrasound. As a recommendation future study can also be done to compare the accuracy of ultrasound fetal weight estimation among radiologists and other professionals.



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## Annex I

### Data extraction sheet

This is a questionnaire survey on the sensitivity of ultrasound in determining the sex of a fetus. Those who are in the second trimester and above and those who are able to give a phone address (for black lion hospital participants) are included in the study.

### Telephone number

Patient's phone number----- Alternative phone number-----Card number -----

### Socio demographic data

1. Age \_\_\_\_\_
2. Gravida \_\_\_\_\_ Para \_\_\_\_\_
3. LNMP \_\_\_\_\_ Calculated GA by LNMP \_\_\_\_\_

### Ultrasound examination

4. GA by ultrasound \_\_\_\_\_
5. Fetal lie
  - a) Cephalic
  - b) Breach
  - c) Transverse
  - d) oblique
6. Number of gestation
  - a) Singleton
  - b) twin
  - c) Multiple gestations
7. Amniotic fluid index \_\_\_\_\_
8. Placental location \_\_\_\_\_
9. Estimated fetal weight at 38wks & above\_\_
10. Weight after delivery \_\_\_\_\_
11. Ultrasound sex determination report
  - a) Female
  - b) Male
  - c) Not sure
12. Fetal sex after delivery \_\_\_\_\_

