

**The Accuracy of Ultrasound versus Clinical Methods for Estimating
Fetal Weight among Term Pregnant Women Delivering at
Kiryandongo General Hospital
Uganda**

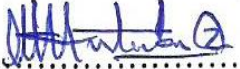
**Fred Mutabazi, MBChB (Butare University) 2006
MMED/12220/181/DU**

**A Dissertation Submitted in Partial Fulfillment of the Requirements for the
Award of the Degree of Master of Medicine in Obstetrics and
Gynecology of Kampala International University**

November 2023

Declaration

I **Fred Mutabazi**, hereby declare that the work presented in this dissertation titled “the accuracy of ultrasound versus clinical methods for estimating fetal weight among term pregnant women delivering at Kiryandongo general hospital, Uganda” is original and a product of my effort. It has never been presented anywhere by me or any other person for any award or any other reason.

Signature:

Date

DR FRED MUTABAZI

MMED/12220/181/DU

Department of Obstetrics and Gynecology

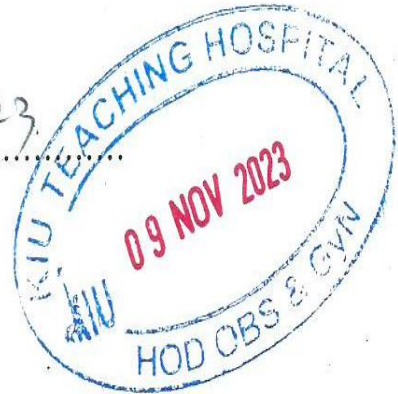
Kampala International University Teaching Hospital, Uganda

+256777-178949

Approval

I have supervised **Fred Mutabazi** in the process of developing this dissertation entitled “the accuracy of ultrasound versus clinical methods for estimating fetal weight among term pregnant women delivering at Kiryandongo general hospital, Uganda” and I hereby approve this work to be forwarded to the postgraduate directorate for consideration

Signature: Date 9/10/2023



Dr Rukamba Jean de Dieu

Signature: Date 9/11/23

Acknowledgement

To my supervisors Prof. Fernando Perez Ramirez and Dr Rukamba Jean de Dieu for their guidance right from the proposal to the final beat.

I also acknowledge the special mentorship of Dr. Muhumuza Joy and Dr. Baluku Ismael towards the development of the concept and proposal.

I am very grateful to all the study participants who accepted to participate in the study for all your time and cooperation rendered to me.

I thank my family which was there for me all the time I developed this great work.

May God reward you all abundantly.

Dedication

I dedicate this dissertation to my family, siblings, colleagues and friends. I will always remain indebted to you.

Table of Contents

Declaration.....	i
Approval	ii
Acknowledgement	iii
Dedication	iv
List of Tables	ix
List of Figures	x
List of Acronyms and Abbreviations	xi
Operational Definitions.....	xii
Abstract	xiii
Chapter One	1
Introduction.....	1
1.1 Background of the study	1
1.1.1 Historical background	1
1.1.2 Theoretical background	2
1.1.3 Conceptual background	2
1.1.4 Contextual background	3
1.2 Problem statement.....	4
1.3 Study objectives	5
1.3.1 General objective	5
1.3.2 Specific objectives	5
1.4 Research questions.....	5
1.5 Justification	5
1.6 Significance of the study.....	6
1.7.0 Study scope	7
1.7.1 Geographical scope	7
1.7.2 Time scope	7

1.7.3 Content scope.....	7
1.8 Description of conceptual frame work.....	8
Chapter Two.....	9
Literature Review.....	9
2.1 Accuracy of ultrasonography fetal weight estimates produced using the Hadlock method compared to actual birth weight among term pregnant women.....	9
2.2 Accuracy of Johnson’s formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women	10
2.3 Accuracy of Dare’s formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women.....	11
Chapter Three.....	13
Materials and Methods.....	13
3.1 Study design.....	13
3.2 Study site and setting	13
3.3 Target population	13
3.4 Study population	13
3.5 Eligibility criteria	13
3.5.1 Inclusion criteria	13
3.5.2 Exclusion criteria	14
3.6 Sample size determination	14
3.7 Sampling technique.....	15
3.8 Data collection	15
3.8.1 Data collection instruments.....	15
3.8.2 Data collection for actual birth weight.....	16
3.8.3 Data collection for estimated fetal weight	16
3.9 Validity and Reliability of the instruments used to collect data	17
3.10 Study procedure	17
3.11 Data quality control.....	19

3.12 Data management.....	19
3.13 Ethical consideration.....	19
3.13.1 Informed Consent for participants	19
3.13.2 Risk and adverse events to study participants.....	20
3.13.3 Benefits of the research.....	20
3.13.4 Privacy and confidentiality	20
3.13.5 Selection of participants.....	20
3.13.6 Incentives and reimbursement	21
3.13.7 Approval procedure	21
3.13.8 Respect for community.....	21
3.14 Dissemination of results.....	21
Chapter Four	22
Study Results	22
4.1 Study profile and overview of the results	22
4.2 Baseline characteristics of the study participants	23
4.2.1 Sociodemographic characteristics of the study participants	23
4.3 Actual, clinical and ultrasound fetal weight characteristics.....	24
4.4 Accuracy of USS FWT estimates produced using the Hadlock method compared to actual BWT among term pregnant women delivering at KGH.....	24
4.5 Accuracy of Johnson’s formula as clinical procedure for estimating weight of fetus with actual BWT among term pregnant women delivering at KGH	26
4.6 Accuracy of Dare’s formula as clinical procedure for estimating weight of fetus with actual BWT among term pregnant women delivering at KGH.....	27
Chapter Five.....	29
Discussion, Conclusions and Recommendations.....	29
5.1 Discussion of the findings.....	29
5.1.1 Accuracy of ultrasonography fetal weight estimates produced using the Hadlock method compared to actual birth weight among term pregnant women.....	29

5.1.3 Accuracy of Dare’s formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women.....	31
5.3 Study limitations and delimitations	32
5.4 Conclusions.....	32
References.....	33
Appendix I: Informed Consent	36
Appendix II: Questionnaire.....	40
Appendix III: Investigation form (for the principal investigator only).....	41

List of Tables

Table 1: Sociodemographic characteristics of the study participants (N= 246)	23
Table 2: The mean actual fetal weight and that measured by clinical and ultrasound methods	24
Table 3: Underestimated and overestimated FWT estimates produced using the Hadlock method.....	25
Table 4: Percentage error generated using the Hadlock method	25
Table 5: Underestimated and overestimated fetal weight estimates produced using the Johnson's formula.....	26
Table 6: Percentage error generated using the Johnson's formula	27
Table 7: Underestimated and overestimated fetal weight estimates produced using the Dare's formula.....	28
Table 8: Percentage error generated using Dare's formula	28

List of Figures

Figure 1: Conceptual framework showing interaction of the different study variables	7
Figure 2: Study procedure's flow chart	18
Figure 4: Scatter plot of weight determined by USS vs actual weight at birth.....	24
Figure 6: Scatter plot of weight determined by Johnson's formula vs actual weight at birth .	26
Figure 5: Scatter plot of weight determined by Dare's formula vs actual weight at birth.....	27

List of Acronyms and Abbreviations

ABW	Actual birth weight
ACOG	American College of Obstetrics & Gynecology
EFW	Estimated fetal weight
IREC	International Research & Ethics Committee
KIU-REC	Kampala International University Research Ethics Committee
LBW	Low birth weight
NIH	National Institute of Health
PI	Principal Investigator
TBW	Term birth weight
UNCST	Uganda National Council for Science and Technology
WHO	World Health Organization

Operational Definitions

Accuracy of the method: Referred to the method that showed the strongest positive linear correlation (R^2) with the actual birth weight

Actual birth weight: This denoted the baby's first weight as measured immediately after delivery using Uganda ministry of health standard weighing scale

Clinical fetal weight estimation methods refers to use Johnson's formula and Dare's formula as for estimating the weight of a fetus among term pregnant women as described in section 3.8.3.

Early active phase of labor: This referred to labor from 4 cm cervical dilatation to not beyond 6 cm following vaginal examination of the woman in labor

Term pregnancy: This referred to 37 weeks to 42 weeks of amenorrhea calculated basing on the last normal menstrual period or first trimester ultrasound scan

Ultrasound fetal weight estimation refer to use of Hadlock formula to estimate the weight of a fetus among term pregnant women as described in section 3.8.3.

Abstract

Background: The EFW established in the third trimester, usually around 30 weeks of gestation, is normally used to predict the fetal weight at term. Researchers have proposed various formulae to estimate fetal weight over the years, but no simple and easily applied formula has yet been proposed to transform an external maternal measurement into an EFW.

Aim of the study: To determine the accuracy of ultrasound versus clinical methods for estimating fetal weight among term pregnant women delivering at Kiryandongo hospital.

Materials and Methods: A 3-months cross-sectional study involving 246 participants was conducted from December 2022 to February 2023 at Kiryandongo general hospital. Interviewer administered questionnaires were used to obtain data. Data was analyzed in line with study objectives using STATA version 14.2. Correlation coefficient "r" was computed to determine the relationship between weight at birth and weight determined clinically and sonographically

Results: A linear relationship (R^2) between ultrasound scan fetal weight estimation and clinical methods with actual birth weights at varying levels; with ultrasound scan as the highest ($R^2 = 0.593$) followed by Dares' formula ($R^2 = 0.447$) and lastly Johnson's formula ($R^2 = 0.383$)

Conclusions: Hadlock ultrasonography EFW were more precise than the clinical methods used to estimate birth weight. Johnson's method was less accurate than both Hadlock ultrasonography method and Dare's clinical method. Dare's method was less accurate than Hadlock method, however was more accurate than Johnson's formula among the clinical techniques.

Recommendation: Ultrasound scan should be emphasized in estimating fetal weight at this facility. Where ultrasound scan services are not available or affordable, a simple and low-cost Dare's clinical method over Johnson's clinical method should be employed by the attending doctor or midwife in estimating fetal weight at this facility

Recommendations: The ministry of health and other pertinent individuals or groups must stress the significance of EFW during the prenatal and intrapattern phases. At this facility, the ultrasound scan should be prioritized for EFW. The attending physician or midwife at this facility should use the straightforward and less expensive Dare's method rather than Johnson's clinical method when calculating EFW in cases of no/expensive ultrasound scan services.

Chapter One

Introduction

1.1 Background of the study

1.1.1 Historical background

Birth weight is one of the key elements of a birth chart today (Shittu et al., 2007). Clinical methods, which have their roots in conventional obstetric practices, were the first to be used by obstetricians to palpate and measure the mother's belly to determine the size and position of the fetus (Yomibo- et al., 2021). The Johnson-Toshach formula, often known as the Johnson formula, was the first clinical method for calculating fetal weight. It was created in 1956 by Drs. James W. Johnson and Janet M. Toshach (Wilcox, 2001). Some of the maternal and fetal parameters used in this computation to determine fetal weight are the fetal biparietal diameter, fetal head circumference, and fetal femur length (Wilcox, 2001).

Over time, there have been substantial improvements in clinical practice for estimating fetal weight. Technology advancements, a deeper understanding of fetal growth, and the inclusion of new parameters to the equations have been the main drivers of these developments. (Campbell, 2012). As result, a variety of techniques have been developed to estimate birth weight (Shittu et al., 2007) and ultrasound the supposedly accurate method was developed in the middle of the 20th century. Actually, researchers and medical practitioners started utilizing ultrasonography to see the growing fetus in the womb in the 1950s and 1960s (Donald, 2013). In 1975, Campbell and Wilkin created the first precise ultrasound algorithm for calculating fetal weight from ultrasound readings. The Campbell's formula, which is still one of the most used formulas for calculating fetal weight, is known (Campbell, 2012).

The ultrasound fetal weight estimation method involves measuring multiple fetal biometric parameters (Eze et al., 2017) and many equations are available for it based on standard ultrasound fetal measurements but the most accurate includes circumferential parameters, such as head circumference, femur length and abdominal circumference (Barros et al., 2016). Sheppard, Warsof's with Sheppard's modification, and Hadlock are the most widely used formulas with most kits of ultrasound equipment contain these formulas (Ayad et al., 2016). However, Hadlock formula that first described by Hadlock et al., (1985) has proven to be most accurate (Preyer et al., 2019).

Up until the early 1980s, clinical procedures based on abdominal palpation and uterine measurements were the primary applications of both clinical and ultrasound fetal weight assessment techniques (Torloni et al., 2008). As early as 2003 in United Kingdom, it was a routine obstetric practice that the symphysio-fundal height was assessed at each antenatal appointment to determine the fetal weight and then request for a sonographic evaluation if the fetal weight is out of the normal range for the gestation (RCOG, 2003). To date, estimated fetal weight has been included in routine antepartum evaluations of high risk pregnancies and deliveries (Ugwa, 2015) and ultrasound is regarded as the most accurate though it is largely inaccessible in many developing countries like Uganda.

1.1.2 Theoretical background

The Health Belief Model was used in this research. Health Belief Model stands for social, psychological, and health-related behaviour modification. It was developed in the 1950s by social scientists Hochbaum, Rosenstock and others, who were working in the U.S. Public Health Service to comprehend why some people may be hesitant to use disease prevention techniques or early illness detection screening procedures (Abraham & Sheeran, 2014). The Health Belief Model theory has evolved to address newer concerns in prevention and detection of health related problems (Sallis JF, Owen N, 2008). Health Belief Model theorizes that the messages will achieve optimal behavior change if they successfully target perceived barriers, benefits, self-efficacy, and threats (Kacunko, 2018). It posits that six constructs predict health behavior, that is; risk susceptibility, risk severity, benefits to action, barriers to action, self-efficacy, and cues to action (Washburn, 2020).

Health Belief Model was deemed an appropriate theory applicable to this study because the purpose of accurate fetal weight estimation methods is to improve the quality of antenatal care services. Fetal weight estimation methods are paramount in monitoring fetal growth and development during antenatal periods. A number of factors can hinder women from seeking antenatal service for example, high costs, accessibility and poor antenatal services (barriers to action) among others. The reverse is true, good and high quality antenatal care services will lead to high number of pregnant women to seek antenatal care services (cues to actions). Therefore the Health Belief Model is deemed appropriate theory applicable to this study.

1.1.3 Conceptual background

The accurate estimation of fetal weight is critical in labor management, and the two main methods used in our setting are ultrasound and clinical fetal weight estimation (Wanjaria,

2016). The ultrasound fetal weight estimation method involves measuring multiple fetal biometric parameters (Eze et al., 2017) and many equations are available for it based on standard ultrasound fetal measurements but the most accurate includes circumferential parameters, such as head circumference and abdominal circumference (Barros et al., 2016). In addition, the most common ultrasonic methods for calculating fetal weight are based on measuring fetal abdominal circumference and estimated fetal weight with a formula first described by Hadlock et al., (1985), and the sufficient accuracy of this model has recently been proven (Preyer et al., 2019).

The clinical method of fetal weight estimation involves measurement of symphysiofundal height and abdominal girth at the level of the umbilicus (Eze et al., 2017). Clinical methods include tactile assessment of fetal size, such as the Leopold maneuver; clinical risk factor; maternal self-estimated fetal weight; and prediction of birth-weight equations (Shittu et al., 2007). Johnson and Toshach were the first to derive a birth weight prediction formula from SFH in 1954 and this formula was later simplified by Johnson in 1957. Furthermore, the Johnson formula has been validated in various countries, and most studies have confirmed that Johnson's formula correctly predicts actual birth weight from 61 to 72% of the time (Yiheyis et al., 2016).

The other method used estimate birth weight from symphysiofundal height is Dare formula which is the product of symphysio-fundal height (Mc Donald's measurement) and abdominal girth at the level of umbilicus measured in centimeters. The estimation of this method also correlated well with birth weight (Sharma et al., 2014). In this study, the dependent variable will be actual birth weight and the independent variables will be the methods used to estimate the birth weight done on the mother in labor. Clinical procedures and ultrasound fetal weight assessment are the two primary approaches for estimating weight of the neonate at birth in obstetrics of the 21st century (Ashrafganjooei, Naderi, Eshrati, & Babapoor, 2010). Therefore, a study determining the most accurate fetal weight estimation method in relation to actual birth weight is critical in resource-constrained locations since it provides the best choices in the event of a lack of resources.

1.1.4 Contextual background

Several studies have showed diversions regarding accuracy of these methods for example a study done in Germany showed that ultrasound fetal weight estimates are most accurate results (Lanowski, Lanowski, & Schippert, 2017). This was supported by a study done in Egypt which

found that the sensitivity of ultrasound was 82.0% higher than clinical (76.7%) (El-Sayed, Soliman, Zaitoun, & El-Shorbaji, 2020). A study done in Kenya showed contrary findings that is clinical methods had higher sensitivity of 98.8% as compared to 97.6% sensitivity for ultrasound (Wanjaria, 2017). Whereas, a study done in Nigeria found that both clinical and ultrasound estimated fetal weights demonstrated a high positive connection with actual birth weight (Njoku, et al., 2014).

Despite the diversions regarding accuracy of fetal weight estimation methods, it is crucial to emphasize that ultrasonography calculating the weight of a fetus in underdeveloped countries needs costly equipment, well-trained people, as well as being time-consuming, whereas clinical procedures are free and simple to perform, even for inexperienced examiners (Sharma, Srinivasan, Sagayaraj, & Lal, 2014). The most clinical fetal estimation methods used in most developing countries are Dare's formula used to palpate the abdomen of fetal body parts and Johnson's technique used to calculate the fundal height (Khani, Ahmad-Shirvani, & Mohseni-Bandpei, 2011).

1.2 Problem statement

The estimated fetal weight established in the third trimester, usually around 30 weeks of gestation, is normally used to predict the fetal weight at term (Faschingbauer, Dammer, & Raabe, 2015). Researchers have proposed various formulae to estimate fetal weight over the years, but no simple and easily applied formula has yet been proposed to transform an external maternal measurement into an estimated fetal weight (Ugwa, 2015). Furthermore, it is unclear how accurate fetal weight estimation methods are, prior to delivery (Vidarsdottir, et al., 2015) and based on previous research, there isn't any fully precise technique for determining fetal weight (Preyer et al., 2019). The retrospective cohort study included the electronic medical records of 38,484 women indicated that among women who had a primary cesarean delivery for suspected fetal macrosomia 41.9% weighed less than 4,000 g (Boyle et al., 2013). In addition, the dependence on ultrasound-based fetal weight estimations has been challenged with current evidence that indicates significant error levels and a lack of consistency as they require skilled and experienced health workers (Milner & Arezina, 2018).

At Kiryandongo general hospital, the ultrasound machine is run by a sonographer. However, due to some charges and unavailability of the sonographer, fetal weight assessment is not performed frequently. Furthermore, there are more patients than sonographers at the hospital

due to the high patient volume. Alternative clinical techniques are never applied. As a result, women have been denied safe methods for determining fetal weight that can lessen the negative effects on both the fetus and the mother. This study at Kiryandongo General Hospital compares the estimated weight of the fetus based on clinical and ultrasound measurements with the weight at birth.

1.3 Study objectives

1.3.1 General objective

To determine the accuracy of ultrasound versus clinical methods for estimating fetal weight among term pregnant women delivering at Kiryandongo general hospital, Uganda

1.3.2 Specific objectives

1. To determine the accuracy of ultrasonography fetal weight estimates produced using the Hadlock method compared to actual birth weight among term pregnant women delivering at Kiryandongo general hospital
2. To determine the accuracy of Johnson's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women delivering at Kiryandongo general hospital
3. To determine the accuracy of Dare's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women delivering at Kiryandongo general hospital

1.4 Research questions

1. What is the accuracy of ultrasonography fetal weight estimates produced using the Hadlock method compared to actual birth weight among term pregnant women delivering at Kiryandongo general hospital?
2. What is the accuracy of Johnson's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women delivering at Kiryandongo general hospital?
3. What is the accuracy of Dare's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women delivering at Kiryandongo general hospital?

1.5 Justification

The reason why this research should be done in pregnant women during first stage of labor will be to prevent or reduce the complication of wrong fetal weights estimation. The World Health

Organization has noted that nearly 810 women died every day in 2017 from preventable causes associated to pregnancy and delivery (WHO, 2019). Accurate prediction of estimated fetal weight has a strong impact on decreasing morbidity and mortality in newborns and women (Daniel, 2016). It can also prevent complications in the mother, such as injury to the perineum, rupture of the uterus, cephalopelvic imbalance and its consequences; vaginal fistula, recto-vaginal fistula, and foot drop (Ekele & Otubu, 2016). In addition, estimation of fetal weight facilitates clinician's choice of decision on the type delivery (vaginal delivery versus cesarean delivery) (Ugwa, Gaya, & Ashimi, 2015). However, it is unclear how accurately fetal weight can be predicted prior to delivery (Vidarsdottir, Geirsson, & Hardardottir, 2011). Clinical estimation of fetal weight is an important and necessary skill in obstetrics patient management because of its simplicity; and if it is found to be as accurate as sonographic measurement, as some studies suggest, it may be considered for screening of fetal weight, particularly in low-resource settings where ultrasound is unavailable.

At Kiryandongo general hospital, there is ultrasound machine operated by qualified staff and has resulted in dependence on ultrasound results despite the fact that there are other methods used to estimate fetal weight. Clinical methods for estimated fetal weight are also significant, given its global importance of simple, effective, and affordable reproductive health. Ultrasound requires expensive machines and trained personnel and lack of its access in some medical centers. Thus, this study in Kiryandongo general hospital seeks to compare the fetuses clinical and ultrasound weight estimates with actual birth weight.

1.6 Significance of the study

1.6.1 To obstetricians and other health workers

The research will aid in determining the accuracy of routine ultrasonography fetal weight assessment methods to actual birth weight. The research will also aid in determining the clinical fetal weight estimate methods, as well as their accuracy in determining the actual birth weight. This will also help also to establish the precision of ultrasound versus clinical methods in calculating the weight of a fetus when measuring the weight at birth.

1.6.2 To the body of science and researchers

The study will also help generate baseline information that might subsequently be used to produce or make standard protocol on fetal weight estimation.

1.6.3 To the community

The findings will be used to minimize adverse neonatal and maternal outcomes resulting from wrong fetal weight estimation hence reduce associated morbidities and mortalities.

1.7.0 Study scope

1.7.1 Geographical scope

Kiryandongo general hospital, also known as Kiryandongo hospital, was the site of this research. Kiryandongo hospital is approximately 225 kilometers from Kampala on the Gulu-Kampala route. In Kiryandongo district, the hospital is located in Kikube parish, Kibanda county, Kiryandongo sub-country. Kiryandongo general hospital is located at 01°52'46.0"N, 32°03'43.0"E (Longitude: 32.061950; Latitude: 1.879439).

1.7.2 Time scope

The study was conducted over a period of three months; that is from 15th/December/2022 to 28th/February/2023.

1.7.3 Content scope

The research focused on determining the accuracy of Hadlock's ultrasound method for fetal weight estimation, as well as Johnson and Dare's formulas as clinical methods for calculating and estimating the weight of a fetus, with actual birth weight among term pregnant women delivering at Kiryandongo general hospital.

1.8 Conceptual frame work

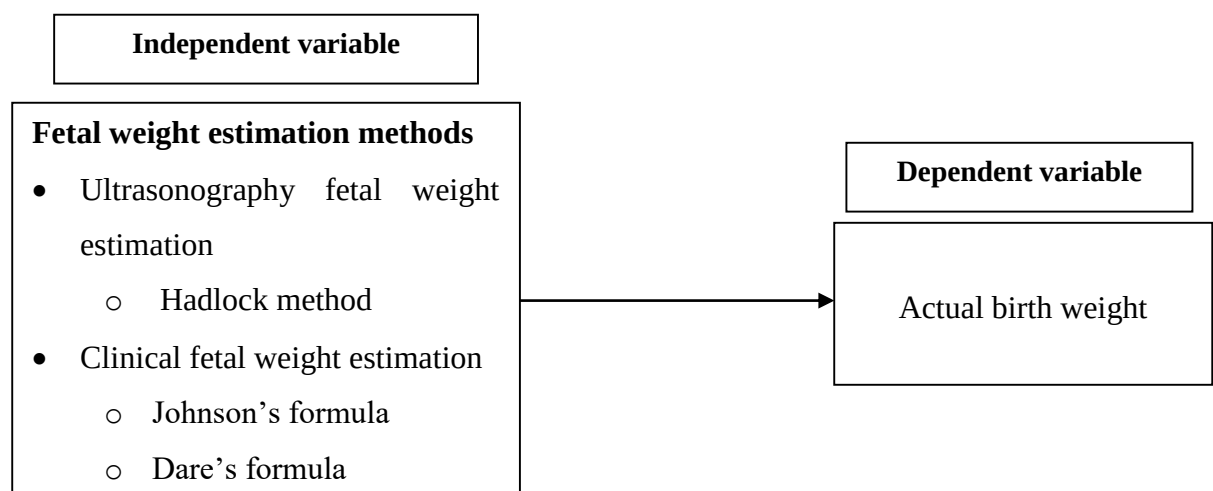


Figure 1: Conceptual framework showing interaction of the different study variables

1.8 Description of conceptual frame work

The conceptual framework shows that the actual birth weight (dependent variable) can be predicted by the independent variables that is clinical and ultrasound (Hadlocks) fetal weight estimation methods. The clinical fetal weight estimation methods will specifically include Johnson's and Dare's formulae. Both clinical and ultrasound methods can be used with some level of precision and thus it is important to establish this kind of relationship for a more precise method to be used by clinicians.

Chapter Two

Literature Review

2.1 Accuracy of ultrasonography fetal weight estimates produced using the Hadlock method compared to actual birth weight among term pregnant women

In 95% of the instances, a prospective research conducted on 600 pregnant women at term at Index Medical College and Hospital and Research Centre in Indore, Madhya Pradesh, India discovered that, ultrasound method correlated well with Term Birth Weight with error of 15% and its deviation was 142.8g (Pradesh et al., 2017). A prospective observational study conducted at Gujarat Medical & Education Research Society in India among 227 women at term pregnancy over a period of 2 years found that number of overestimated cases were 62.56%, the number of underestimated cases were 37% and number of correct estimation were 0.44 % for ultrasound results using Hadlock formula (Prajapati & Patel, 2018). In addition, ultrasound results using Hadlock formula showed that the mean error was -36.34 ± 118.74 g, the mean absolute error was 91.74 ± 83.51 g, the mean percentage error was $-1.541 \pm 4.425\%$ and the mean absolute percentage error $3.374 \pm 3.245\%$ compared to weight at birth. Lastly, the ultrasonography association value was +0.947 when compared to weight at birth (Prajapati & Patel, 2018).

The ultrasonography fetal weight estimates produced using the Hadlock method compared to actual birth weight were found to have a good correlation among singleton fetuses with known dates in a prospective cross-sectional study done in Bangladesh. The estimated fetal weight was 2753.4g (Rashid, 2015).; Hadlock ultrasound method estimated fetal weight using the Hadlock formula and actual birth weight were found to have a good correlation in a prospective cross-sectional study on well-dated singleton fetuses in Bangladesh (Rashid, 2015). The estimated fetal weight was 2753.4g, which was similar to but not identical to 2817.9g, weight at birth (Rashid, 2015). According to a prospective cross-sectional study conducted at the College of Medical Sciences-Teaching Hospital in Bharatpur on 120 women with singleton term pregnancies, it was found that the mean estimated fetal weight using the Hadlock ultrasonography method was 2863.5 ± 441.9 g and the weight at birth was 2822.5 ± 407.7 g (Prasad et al., 2020). The ultrasonography fetal weight estimates produced using the Hadlock method and weight at birth had a substantial good connection. Hadlock ultrasonography method fetal weight calculations exhibited a mean absolute percentage error of $8.8 \pm 7.5\%$ and the mean percentage error was $1.9 \pm 11.4\%$ (Prasad et al., 2020).

Another cross section study done Nepal among 106 singleton term women over a period of 6 months found that the Hadlock ultrasonography method projected the mean birth weight to be 3230.02407.2g, but the mean weight at birth was 3236.3g. The ultrasonographic method's estimated birth weight had a somewhat stronger positive relationship ($r=0.54$) with weight at birth (Joshi et al., 2017). The ultrasonographic approach's sensitivity and specificity for detecting the weight of the fetus at birth was greater than 3500g were 46.15% and 80.6%, respectively (Joshi et al., 2017).

A prospective hospital-based cross-sectional study involving 109 patients with term, viable and singleton pregnancies who were scheduled for an elective cesarean delivery at El-Obeid Teaching Maternity Hospital in Sudan found that the mean error of estimated fetal weight using Hadlock method was 68g (4% of weight at birth) (Awadalla et al., 2018). However, this method over estimated all fetuses with birth weight less than 2500g by a mean error of 585g (percent error 26.7%), and underestimated all fetuses with a birth weight more than 3500g by a mean error of 755g (percent error 20.4%) (Awadalla et al., 2018).

According to a prospective cohort research carried out at Mulago National Referral Hospital, Uganda found that a prospective cohort study conducted at Mulago National Referral Hospital, Uganda, showed that the shepard technique was better at guessing weight at birth of less than 4000g, whereas Hadlocks in general were more precise when the weight at birth was less than 4000g (Sereke, Omara, & Bongomin, 2021).

2.2 Accuracy of Johnson's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women

In Torbat Heydariyeh, Iran, a cross-sectional investigation comprising 147 singleton, full-term, cephalic pregnancies discovered that considering a maximum error of $\pm 10\%$ from the weight at birth, the overall estimated accuracy of fetal weight for Johnson's formula was 66% being 35.9% for normal babies, 25% for low birth weight babies and 57.1% for macrosomic babies (Alirezai et al., 2018). In addition, the overall mean absolute percentage errors this formula was 9.68 ± 9.41 being 8.30 ± 7.33 in normal babies (2.5-3.9kg), 21.06 ± 15.24 in low birth weight babies and 12.82 ± 7.52 macrosomic babies (Alirezai et al., 2018).

In 95% of the instances, a prospective research conducted on 600 pregnant women at term at Index Medical College and Hospital and Research Centre in Indore, Madhya Pradesh, India

discovered that, Johnson's formula weight correlated well with TBW with error of 20% and its deviation was 175.1g (Pradesh et al., 2017).

A prospective observational study conducted at Gujarat Medical & Education Research Society in India among 227 women at term pregnancy over a period of 2 year found that the number of overestimated cases were 90.75%, number of underestimated cases were 8.81%, and the number of correct estimation were 0.44 % for Johnson's formula. Furthermore, when comparing actual birth weight to Johnson's calculation, the mean error was -284.51 ± 215.43 g, the mean absolute error was 304.11 ± 186.60 g, the mean percentage error was -10.529 ± 7.983 %, and the mean absolute percentage error was 11.091 ± 7.178 % (Prajapati & Patel, 2018). The Johnson's formula correlation coefficient is +0.8182 (Prajapati & Patel, 2018).

Another 6 months cross section study conducted in Nepal indicated that the weight of the fetus estimated using clinical method (Johnson's formula) was 3492.75393.16g and the weight at birth was 3236.32g (Joshi et al., 2017). The clinically weight of the fetus had a positive connection ($r=0.44$) with the weight at birth (Joshi et al., 2017). Furthermore, the sensitivity and specificity of clinical method (Johnson's formula) for detecting infant birth weights greater than 3500 g were 69.23% and 65.67%, respectively (Joshi et al., 2017). A prospective cohort study conducted at Mulago National Referral Hospital, Uganda, showed that the clinical methods, Johnson's formulae were not accurate at estimating fetal weights in Uganda except estimating birth weights above 3500.0g (Meregurwa, 2018).

2.3 Accuracy of Dare's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women

In Torbat Heydariyeh, Iran, a cross-sectional investigation comprising 147 singleton, full-term, cephalic pregnancies discovered that considering a maximum error of $\pm 10\%$ from the weight at birth, the overall accuracy of Dare's formula for estimating fetus weight at birth was 58.5% being 69.5% for normal babies, 12.5% for low birth weight babies and 28.6% for macrosomic babies (Alirezai et al., 2018). In addition, the overall mean absolute percentage errors was 10.62 ± 10.12 being 15.20 ± 11.21 in normal babies (2.5-3.9 kg), 21.22 ± 15.71 in low birth weight babies, and 10.25 ± 4.81 macrosomic babies (Alirezai et al., 2018).

In 95% of the instances, a prospective research conducted on 600 pregnant women at term at Index Medical College and Hospital and Research Centre in Indore, Madhya Pradesh, India

discovered that, Dare's formula weight correlated well with TBW with error between 10-15% of the TBW and its deviation was 120.8gms (Pradesh et al., 2017). A prospective observational study conducted at Gujarat Medical & Education Research Society in India among 227 women at term pregnancy over a period of 2 year found that the number of overestimated cases were 72.25%, the number of underestimated were 26.87% and the number of correct estimation were 0.88% for Dare's formula (Prajapati & Patel, 2018). In addition, results obtained using Dare's formula showed that the mean error was $-92.92 \pm 159.43\text{g}$, the mean absolute error was $147.37 \pm 110.78\text{g}$, the mean percentage error $-3.510 \pm 5.688\%$, and the mean absolute percentage was $5.298 \pm 4.067\%$ compared to actual Birth weight. Lastly, the correlation coefficient for the Dare's formula was $+0.9026$ (Prajapati & Patel, 2018).

There is a scarcity of information in Uganda about the relationship between clinical and ultrasound approaches for assessing fetal weight (Sereke, Omara, & Bongomin, 2021). However, prospective cohort study conducted at Mulago National Referral Hospital, Uganda, showed that the shepard technique was better at guessing weight at birth of less than 4000g, whereas Hadlocks in general were more precise when the weight at birth was less than 4000g (Sereke, Omara, & Bongomin, 2021). While regarding clinical methods, a study done at Mulago Hospital comparing Johnson's and Risanto's formula found that Johnson's and Risanto's formulae were not accurate at estimating fetal weights in Uganda except estimating birth weights above 3500g (Meregurwa, 2018).

Chapter Three

Materials and Methods

3.1 Study design

This was a cross sectional comparative study involving term pregnant women delivering at Kiryandongo general hospital, Uganda regardless of method they use to deliver.

3.2 Study site and setting

Kiryandongo general hospital hosted the research. Kiryandongo Hospital is approximately 225 kilometers from Kampala on the Gulu-Kampala route. In Kiryandongo district, the hospital is located in Kikube parish, Kiryandongo sub-country, Kibanda Country. Kiryandongo general hospital is located at 32°03'43.0"E, 01°52'46.0"N (Longitude: 32.061950; Latitude: 1.879439). The hospital has 109 beds and serves nearly 400,000 individuals from the various districts which include Masindi, Kiryandongo, Amuru, Oyam, Nakasongola, Apac, and Nwoya. The hospital's services include outpatient, ophthalmology, inpatient, X-ray, orthopedics, ultrasound, occupational therapy, health promotion and education, HIV testing, environmental health, immunization, and special clinics. It was built because it was close to the Kampala-Gulu highway, as there were no other hospitals in the area other than Masindi Hospital, which was regarded to be too far away. Prior to this, there was a minor health clinic established in the 1930s. The hospital's development began in the early 1970s and it was completed in 1974. This study considered Kiryandongo general hospital because it is a rural hospital serving significant-high a population of pregnant women from Kiryandongo and neighboring districts since its elevation to a teaching hospital. An estimated 2880 deliveries occur at Kiryandongo General Hospital each year, of which roughly 1080 are Caesarean and the remainder are normal deliveries.

3.3 Target population

All term pregnant women delivering at Kiryandongo general hospital were selected.

3.4 Study population

All term pregnant women in latent stage of labor attending maternity ward at Kiryandongo general hospital during the course of the research.

3.5 Eligibility criteria

3.5.1 Inclusion criteria

Pregnant women at term (gestational age of 37 weeks to 42 weeks of gestation in latent stage of labor, with an ultrasound scan that confirmed singleton pregnancy, live, and cephalic

presentation attending Kiryandongo general hospital who consented to participate in the research.

3.5.2 Exclusion criteria

The study excluded pregnant women with pelvic mass, polyhydramnios, oligohydromis and those who were seriously sick such as those that were unconscious and those who required immediate intervention due to serious obstetric conditions such as fetal distress, cord prolapse and antepartum hemorrhage as well as those who lacked clear evidence for estimating their gestational age.

3.6 Sample size determination

Specific objective one: A study done by a Sudanese researchers conducted a prospective hospital-based cross-sectional study by (Awadalla et al., 2018) was considered where the percent mean error of estimated fetal weight using Hadlock was 4% of actual weight. Using the modified Daniels formula (Daniel, 1999) to compute the sample size;

$$n = \frac{z^2 pq}{d^2}$$

Where:

$$Z=1.96$$

$$P= 4\% = (0.04) \text{ (percentage mean error of estimated fetal weight using Hadlock)}$$

$$Q = 1- 0.04 =0.96$$

$$n = \frac{3.841(0.04*0.96)}{0.05^2} = 58.998$$

Therefore **n= 59**

Specific objective two: A cross section study done by (Pradesh et al., 2017) was considered. It was observed that Johnson's formula weight correlated well with term birth weight with error of 20%. Using the modified Daniels formula (Daniel, 1999) to compute the sample size;

$$n = \frac{z^2 pq}{d^2}$$

Where:

$$Z=1.96$$

$$P = 0.20 = (0.20) \text{ (percent error of 20\% generated using Johnson's formula)}$$

$$Q = 1- 0.20 =0.80$$

$$n = \frac{3.841(0.2*0.8)}{0.05^2} = 245.8$$

Therefore **n= 246**

Specific objective three: A cross section study done by Pradesh et al., (2017) was considered which showed that Dare's formula weight correlated well with term birth weight with error between 10-15% of the term birth weight. Using the modified Daniels formula (Daniel, 1999) to compute the sample size;

$$n = \frac{z^2 pq}{d^2}$$

Where:

$$Z=1.96$$

$$P= 10\% = (0.90) \text{ (percent error generate using Dare's which is 10-15\%)}$$

$$Q = 1- 0.817 = 0.183$$

$$n = \frac{3.841(0.10*0.90)}{0.05^2} = 125.3$$

Therefore **n= 125**

Therefore, the largest sample size of **246** was used as the sample size

3.7 Sampling technique

Participants in this research were enrolled consecutively to capture all possible participants on daily basis until required sample size.

3.8 Data collection

Respondents who met the study's inclusion criteria were informed and counseled about it. Those who agreed to participate were provided with a written consent form and enrolled in the study. Data was collected from participants using pre-tested questionnaires.

3.8.1 Data collection instruments

Questionnaire

For each participant, the information on socio-demographic characteristics was gathered using a standardized pre-tested questionnaire. A complete history was taken (in English), with translations provided for those who did not speak English; and a physical examination was made to determine whether or not the woman was in the latent stage of labor.

Investigation form

This was used to obtain information from the investigations such as fetus's head circumference, femur length and abdominal circumference, abdominal girth, symphysio-fundal height, fundal height and station which serves as a requirement for estimating fetal weight using ultrasound Hadlock method, as well as Dare's and Johnson's clinical methods. The estimated fetal weight

results of the three methods were recorded in the questionnaire of each respondent. The respondent was followed till delivery and then the actual birth weight was also recorded in the questionnaire of each respondent too.

3.8.2 Data collection for actual birth weight

A standardized newborn weighing scale (model: crown) was used to measure each participant's neonate's actual birth weight shortly after delivery. Every neonate's results were reported as real birth weight data.

3.8.3 Data collection for estimated fetal weight

Data collection for estimated fetal weight was collected based on the following fetal weight estimation methods:

Estimating weight of the fetus using Dare formulae

This was calculated following the equation below;

$$EFW (g) = AG \times SFH$$

Where,

EFW (g) = estimated weight of the fetus in grams

AG= abdominal circumference/girth in centimeters measured at the umbilicus level. It was obtained using a standard measuring tape

SFH= Symphysio-Fundal Height in centimeters taken after the dextrorotation had been corrected, from the upper border of the symphysis pubis to the height of the fundus using a standard measuring tape calibrated in centimetres. The measuring tapes were the standard ministry of health supplied tapes to Kiryadongo hospital and are recommended by the World Health Organization.

Estimating weight of the fetus using Johnson Formula

This was calculated following the equation below;

$$\text{Fetal weight (g)} = 155 \times (\text{Symphysio-Fundal Height} - x)$$

Where

$x = 12$ at zero station; $= 11$ at plus station, $= 13$ at minus station

Symphysio-fundal height in centimeters stood for height taken after the dextro-rotation had been corrected, from the upper border of the symphysis pubis to the height of the fundus using a standard measuring tape calibrated in centimeters. The measuring tapes were the standard ministry of health supplied tapes to Kiryadongo hospital and are recommended by the World Health Organization.

Station was the relationship of the bony portion of the fetal head to the level of the maternal ischial spine. When the bony portion of the fetal head was at the level of ischial spine the station was zero `0`, when it was above ischial spine it was denoted negative sign (-) and when it was below ischial spine, it was denoted a positive sign (+).

Ultrasonography fetal weight estimates produced by Hadlock's formula

The mother was sent to radiologist to obtain the automated fetal weight scan results using Hadlock method (the fetus's head circumference, femur length and abdominal circumference in centimeters). The sonography machine used to calculate fetal weight was a brand new ultrasound-digital imaging system mindray brand, product number 11103/CTU501. The mother came with the results from the radiographer.

3.9 Validity and Reliability of the instruments used to collect data

Data was collected using a questionnaire. The questionnaire was edited and reviewed with the help of three obstetricians based on test validity, they were requested to rate each item in the questionnaire based on relevance, clarity, simplicity and ambiguity, the agreement of more than 75% was considered to give the actual true picture of the study by the questionnaire. To determine the reliability, 10 respondents who were not part of the sample population were administered questionnaires. The information collected was entered into Microsoft excel and then exported into IBM SPSS version 20. A calculated Cronbach's coefficient alpha of more than 0.8 indicated that the item of the questionnaire were reproducible and consistent. In order to establish an estimated fetal weight, normal operational procedures were followed.

3.10 Study procedure

Term pregnant women who satisfied the study's inclusion criteria were informed, educated, and counseled about the study before giving their written consent to participate. The questionnaire was used to collect socio-demographic information such as age, parity, gravidity, religion, residence, marital status and education level. After obtaining socio-demographic data, the participants were sent to the radiographer who works full time at Kiryandogo general hospital to obtain the ultrasound results in line with the Hadlock method. The estimated fetal weight together with fetus's head circumference, femur length and abdominal circumference in centimeters were recorded by the radiographer and given to the mother. The principal investigator got ultrasound results from the mother and then proceeded with the clinical examination to obtain measurements required by clinical methods (Dare's and Johnson's method) to calculate the fetal weight. Finally weight at birth was measured immediately after

delivery. The ultrasound results, clinical method results and actual birth weight were recorded on the investigation form attached on each questionnaire filled by that specific mother.

3.11 Study procedure's flow chart

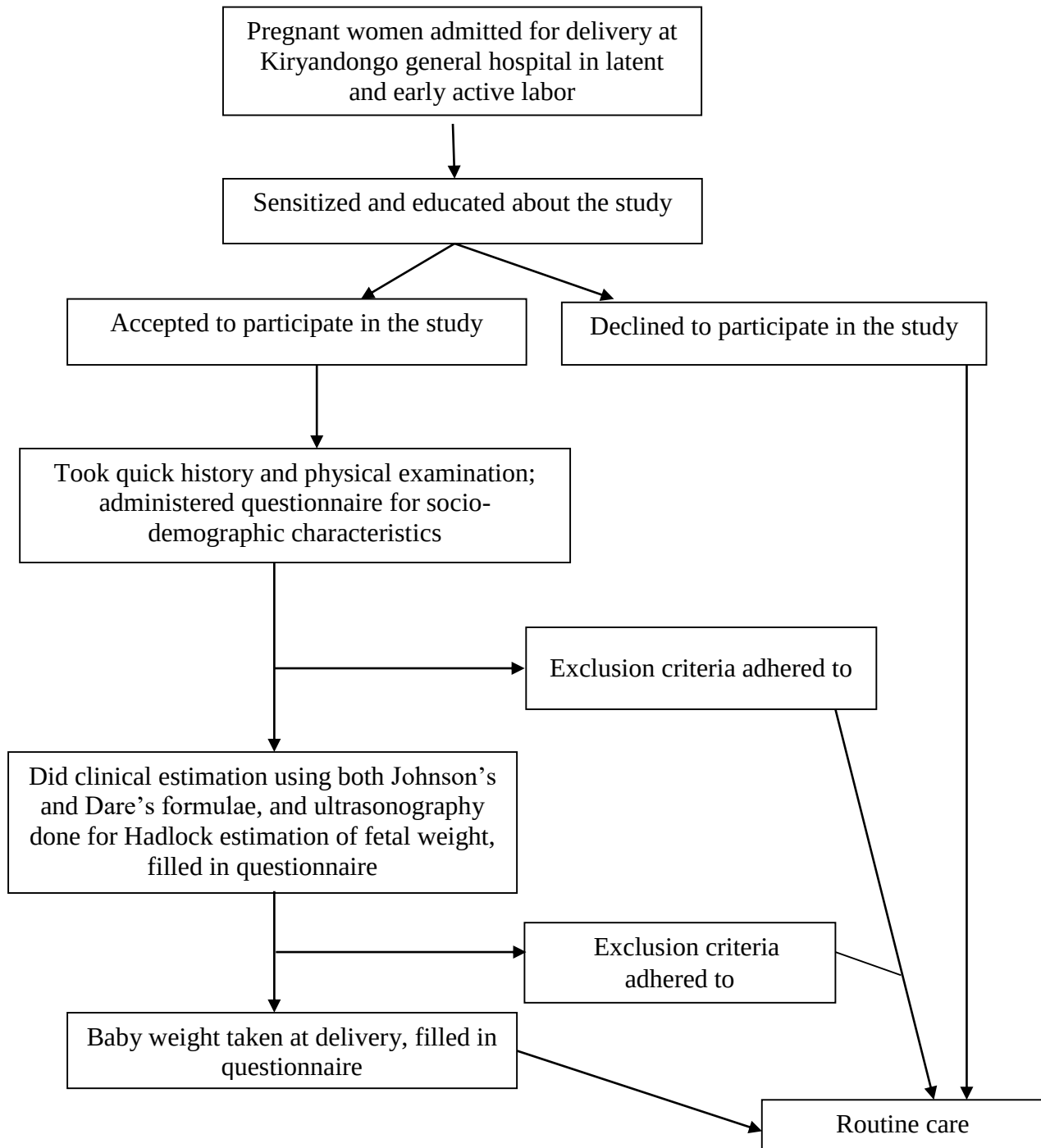


Figure 2: Study procedure's flow chart

3.11 Data quality control

The criteria for inclusion and exclusion were carefully followed. To guarantee that legitimate data was obtained, the questionnaires were reviewed for completeness prior to collection. The research assistants was sufficiently educated and overseen by the primary investigator on a regular basis to ensure proper data collection techniques and ethical principles were followed. For simple identification, questionnaires were labeled with the individuals' numerical codes.

3.12 Data management

Before the participant exits the interview, physical examination and ultrasound room, the collected data will be double-checked for accuracy. The information gathered will be coded and entered into Excel version 2016 before being exported to STATA version 14.2 for analysis.

3.13 Data analysis

Data was analyzed in line with study objectives using STATA version 14.2. For specific objective one, two and three, the percentage errors, average errors, and mean average errors were calculated using the formulas shown below.

$$\text{Average error} = \frac{1}{n} \sum (\text{weight at birth} - \text{estimated weight of the fetus})$$

Where n=total number of study participants

$$\text{Percentage error} = \frac{\text{error in gm}}{\text{weight at birth in gm}} * 100$$

Mean average error = mean actual weight of the fetus – mean estimated weight of the fetus at birth

Standard deviation was calculated using mean.

$$\text{Standard deviation} = \sqrt{\sum (\text{weight at birth} - \text{estimated weight of the fetus})^2 / n}$$

Where n = total number of study participants

Finally, the correlation coefficient "r" was computed to determine the relationship between weight at birth and weight determined clinically and sonographically.

3.13 Ethical consideration

3.13.1 Informed Consent for participants

Voluntary recruitment was done and an informed consent was signed. Informed consent from participants were obtained after fully explaining the details of the study to them in English and local languages (copies attached as appendices). There was no coercion of any sort. Emancipated minors did not require presence of their guardians to consent. Participants were not forced to enroll themselves if they did not want to. Participants were free to withdraw from

the study at any time they wished without coercion or compromise of care they were entitled to.

3.13.2 Risk and adverse events to study participants

There were no big hazards to the participants that were predicted, with the exception of social harm in the event of a violation of confidentiality. However, social harm was reduced by ensuring that the highest level of confidentiality was maintained.

3.13.3 Benefits of the research

The community benefited because I distributed crucial study findings that might contribute significantly to the reduction of maternal and neonatal morbidity and mortality in these vulnerable populations.

3.13.4 Privacy and confidentiality

Numerical codes were used to identify participants. To ensure privacy and confidentiality, the information provided by respondents was kept strictly confidential under lock and key for the duration of the study. The respondents' rights were scrupulously respected, and they were treated fairly, resulting in the least amount of injury and inconvenience for them. There was no public disclosure of participant information without their permission.

3.13.5 Selection of participants

During the study time, a patient who was a term pregnant woman in latent stage in maternity department at Kiryandongo general hospital was educated and counseled about the study, and then consented to participate after being fully informed about the study in English and local languages. The subject was asked to consent to a medical history and physical examination in order to determine whether she was in the latent stage of labor. Recruitment was done on a voluntary basis, and informed consent were signed. The participant were allowed to leave the study at any moment she desired, without fear of being coerced or losing access to the care they were entitled to. Participants were not forced to enlist if they do not wish to do so. Minors (emancipated minors or those under the age of 18) did need their guardians' permission to consent. The study gave all participants an equal chance to participate. Priority was not granted based on tribal affiliation, interest group membership, race, or religion. Participants were chosen using a successive sampling procedure to ensure that everyone had an equal chance of being chosen for the study.

3.13.6 Incentives and reimbursement

Those who consented to take part in the proposed study were neither paid nor given any form of compensation for participating in the study but their participation in the study contributed to the health sector by providing information which improved the management of complications of labor.

3.13.7 Approval procedure

The study was carried out only after approval by the Research and Ethics Committee of Kampala International University. Approval was also sought from the administration of Kiryandongo general Hospital where the research was conducted. Approval to carry out the study was acquired from the department of obstetrics and gynecology, the faculty and post graduate directorate and finally the Kampala International University Research Ethics Committee with a reference number “KIU-2022-178”. After approval by the KIU-REC the study was registered with the Uganda National Council for Science and Technology. The UNCST certificate was presented to the hospital administration of Kiryandongo general hospital prior to data collection to acquire permission to proceed with the study at the study area.

3.13.8 Respect for community

The procedures involved in this study did not go against the local community beliefs, traditions and culture.

3.14 Dissemination of results

The study findings are meant to be presented to the department of obstetrics and gynecology, faculty, and postgraduate directorate after the final report is approved. The findings will be submitted in bound form to the university library, post-graduate directorate, director of Kiryandongo general hospital, and Kiryandongo district health officer. A manuscript is being drafted for submission to a PubMed indexed peer reviewed journal for publication.

Chapter Four

Study Results

4.1 Study profile and overview of the results

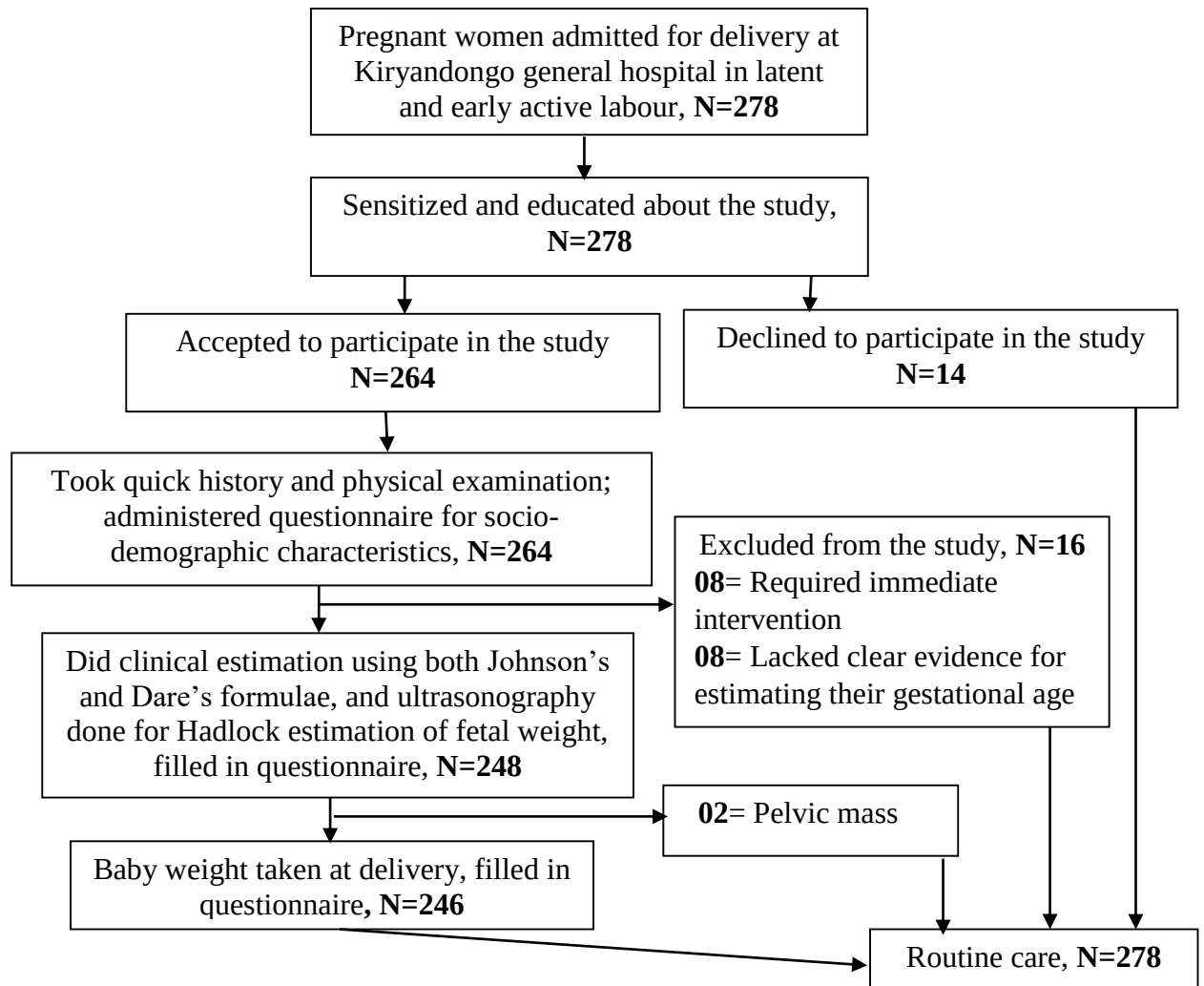


Figure 3: Showing the study profile and overview of the results

As illustrated in the figure 3 above, 278 women met the inclusion criteria and were accordingly educated and counseled about the study. Of these, 278 consented to participate in the study while 14 declined to consent for the study. Of the 278 participants who consented however, 18 were excluded because they required immediate intervention at the time of assessment (08), were not sure of their dates and yet lacked clear evidence for estimating their gestational age (08), and had coincidental pelvic masses (uterine fibroids) (02) on ultrasonography. Overall, 246 participants were successfully assessed for fetal weight both clinically and ultrasonographically, and subsequently had their baby's weight taken immediately after delivery. These had their data entered and analyzed accordingly and presented as shown in the subsections below.

4.2 Baseline characteristics of the study participants

4.2.1 Sociodemographic characteristics of the study participants

Table 1: Sociodemographic characteristics of the study participants (N= 246)

Variable	Statistic	
Age (years)	Mean=25.7, SD=5.9, Min=19.0, Max=44.0	
	Frequency (n)	Percentage (%)
Educational level		
Primary	170	69.1
Secondary	66	26.8
Tertiary	10	4.1
Marital status		
Married	228	92.7
Single	18	7.3
Religion		
Muslim	29	11.8
Christian	215	87.4
Others	2	.8
Residence		
Rural	210	85.4
Urban	36	14.6
Occupation		
Farmer	166	67.5
Civil servant	21	8.5
Business	42	17.1
Unemployed	17	6.9
Tribe		
Munyoro	81	32.9
Muruli	30	12.2
Alur	51	20.7
Achooli	23	9.3
Muganda	21	8.5
Others	40	16.3

SD=Standard Deviation, Min=Minimum, Max= Maximum

In this study, the mean age of the study participants was 25.7 (SD=5.9) years. Majority of study participants were of primary level of education 170(69.1%), married 228(92.7%), Christians 215 (87.4%), from rural areas 210 (85.4%), farmers 166 (67.5%), and Banyoro by tribe 81(32.9%).The details of the baseline characteristics are shown in table 1 above.

4.3 Actual, clinical and ultrasound fetal weight characteristics

Table 2: The mean actual fetal weight and that measured by clinical and ultrasound methods

Weight (gm)	Mean± SD	Min	Max
Weight by USS	3387.8±414.4	2100.0	4600.0
Weight by Dare's formula	3542.0±318.8	2580.0	4300.0
Weight by Johnson formula	3575.1±376.3	2480.0	5425.0
Actual weight after birth	3371.7±401.7	2200.0	4500.0

SD=Standard Deviation, Min=Minimum, Max= Maximum, USS=Ultrasound scan, gm=Gram

Table 2 above shows the mean actual fetal weight and that measured by clinical and ultrasound methods. The mean estimated birth weights by Dare's formula, Johnson's formula and ultrasound were 3544.7 ± 316.2 gm, 3577.3 ± 375.5 gm and 3387 ± 414 gm respectively, while the mean actual fetal weight as measured at delivery was 3372.7 ± 401.2 gm

4.4 Accuracy of USS FWT estimates produced using the Hadlock method compared to actual BWT among term pregnant women delivering at KGH

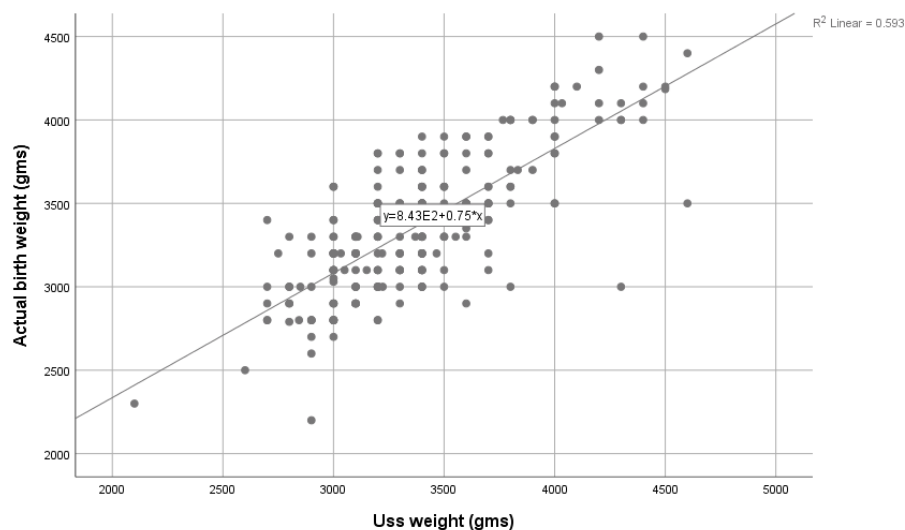


Figure 3: Scatter plot of weight determined by USS vs actual weight at birth

Figure 4 above is a scatter diagram showing the relationship between ultrasound fetal weight estimation and actual birth weight. Ultrasound method of fetal weight estimation showed a strong positive correlation with the actual birth weight of the fetus after delivery. There was a linear relationship between ultra sound fetal weight estimation and actual birth weight. In the above scatter diagram, R^2 value was 0.593.

Underestimated and overestimated FWT estimates produced using the Hadlock method.

Table 3: Underestimated and overestimated FWT estimates produced using the Hadlock method

	Overestimate cases	Underestimated cases	Correctly estimated cases	Total
Frequency n (%)	125(50.8%)	116 (47.2%)	5 (2.0%)	246 (100%)

Table 3 show underestimated and overestimated fetal weight estimates produced using the Hadlock method. Results showed that the percentage of number of overestimated cases was 50.8%, percentage of underestimated cases was 47.2% and percentage of correct estimation was 2.0%.

Percentage error generated using the Hadlock method.

Table 4: Percentage error generated using the Hadlock method

Error	Frequency n (%)	Cumulative percentage
< 5%	98 (39.8%)	39.8%
5-10%	108 (43.9%)	83.7%
10-15%	26(10.6%)	94.3%
15-20%	8(3.3%)	97.6%
> 20%	6(2.4%)	100%

Table 4 shows error in percentage related to Hadlock method of birth weight estimations. Results from the table shows that estimations with error of <5% of actual fetal weight were 39.8% and those with error 5-10% were 43.9%. Thus, 83.7% of estimations using Hadlock method had error of <10% of actual fetal weight.

4.5 Accuracy of Johnson's formula as clinical procedure for estimating weight of fetus with actual BWT among term pregnant women delivering at KGH

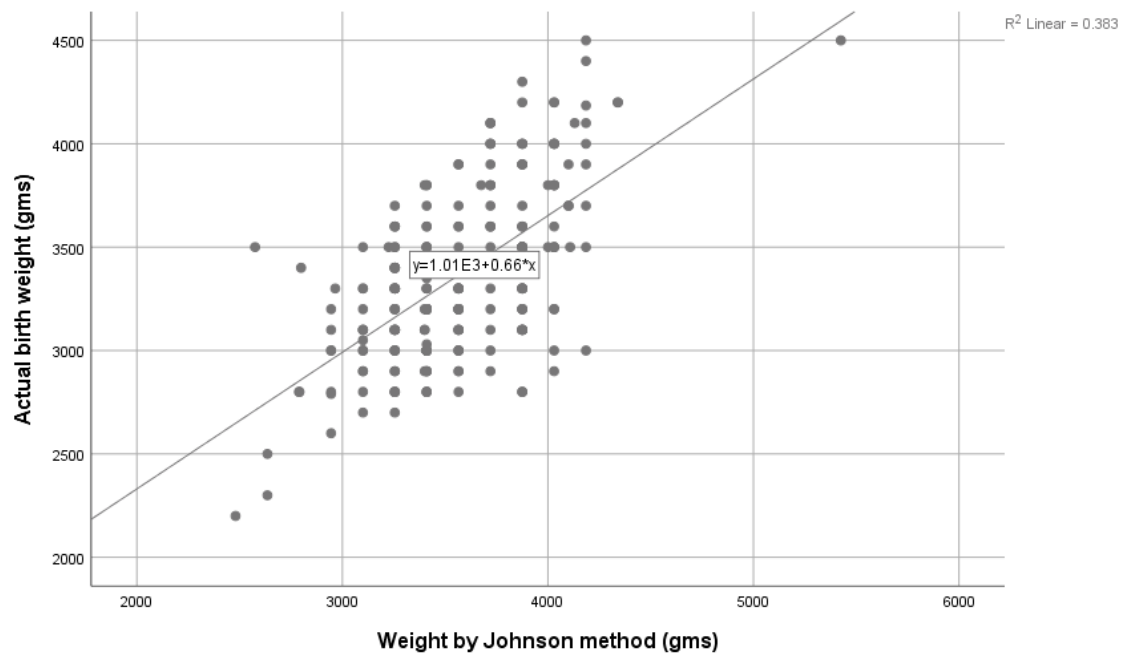


Figure 4: Scatter plot of weight determined by Johnson's formula vs actual weight at birth

Figure 6 is the scatter diagram showing the relationship between Johnson's formula fetal weight estimates and actual birth weight. Johnson's formula fetal weight estimation showed a weak positive correlation with the actual birth weight of the fetus after delivery. There is a linear relationship between Johnson's formula fetal weight estimation and actual birth weight. In above scatter diagram, R^2 value was 0.383.

Underestimated and overestimated fetal weight estimates produced using the Johnson's formula.

Table 5: Underestimated and overestimated fetal weight estimates produced using the Johnson's formula

	Overestimate cases	Underestimated cases	Correctly estimated cases	Total
Frequency n (%)	173(70.3)	69(28.0%)	4(1.7%)	246 (100%)

Table 5 show underestimated and overestimated fetal weight with Johnson's formula. The results from the table shows that percentage of overestimated cases was 70.3%, percentage of underestimated cases was 28.0% and percentage of correct estimation was (1.7%).

Percentage error generated using the Johnson's formula.

Table 6: Percentage error generated using the Johnson's formula

Error	Frequency n (%)	Cumulative percentage
< 5%	74(30.1%)	30.1%
5-10%	71(28.8%)	58.9%
10-15%	48(19.6%)	78.5%
15-20%	26(10.5%)	89.0%
> 20%	26(10.6%)	100%

Table 6 shows error in percentage related to Johnson's formula of birth weight estimations. Results from the table shows that estimations with error of <5% of actual fetal weight were 30.1% and those with error 5-10% were 28.8%. Thus, 58.9% of estimations using Hadlock method had error of <10% of actual fetal weight.

4.6 Accuracy of Dare's formula as clinical procedure for estimating weight of fetus with actual BWT among term pregnant women delivering at KGH

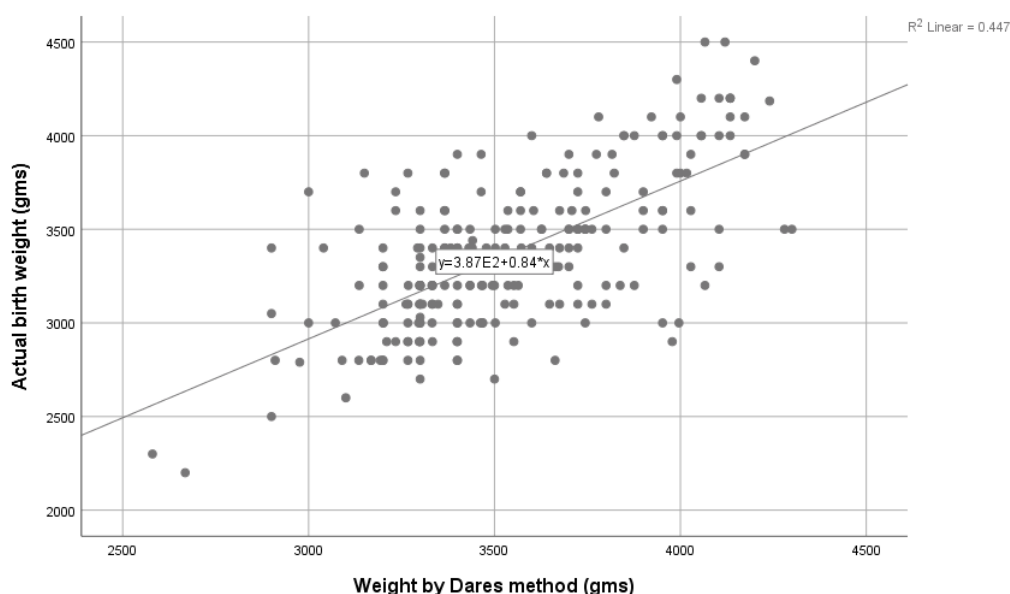


Figure 5: Scatter plot of weight determined by Dare's formula vs actual weight at birth

Figure 5 above is the scatter diagram showing the relationship between Dare's formula fetal weight estimates and actual birth weight. Dares's formula fetal weight estimation showed a moderate positive correlation with the actual birth weight of the fetus after delivery. There was a linear relationship between Dares' formula fetal weight estimation and actual birth weight. In the above scatter diagram, R^2 value was 0.447.

Underestimated and overestimated fetal weight estimates produced using the Dare's formula.

Table 7: Underestimated and overestimated fetal weight estimates produced using the Dare's formula

	Overestimate cases	Underestimated cases	Correctly estimated cases	Total
Frequency n (%)	178(72.4%)	63(25.6%)	5 (2.0%)	246 (100%)

Table 7 show underestimated and overestimated fetal weight with Dare's formula. Results from the table shows that the percentage of overestimated cases was 72.4%, percentage of underestimated cases was 25.6% and percentage of correct estimation was 2.0 %.

Percentage error generated using Dare's formula.

Table 8: Percentage error generated using Dare's formula

Error	Frequency n (%)	Cumulative percentage
< 5%	92(37.4%)	37.4%
5-10%	70(28.5%)	65.9%
10-15%	45(18.2%)	84.1%
15-20%	18(7.4%)	91.5%
> 20%	20(8.1%)	100%

Table 6 shows error in percentage related to dare's formula of birth weight estimations. Results from the table shows that estimations with error of <5% of actual fetal weight were 37.4% and those with error 5-10% were 28.5%. Thus, 65.9% of estimations using Hadlock method had error of <10% of actual fetal weight.

Chapter Five

Discussion, Conclusions and Recommendations

5.1 Discussion of the findings

5.1.1 Accuracy of ultrasonography fetal weight estimates produced using the Hadlock method compared to actual birth weight among term pregnant women

In this study, ultrasound scan fetal weight estimation showed a positive linear correlation with the actual birth weight ($R^2=0.593$) among all three methods ($R^2=0.447$ and $R^2=0.383$ for Dare's formula and Johnson's formula respectively). This was comparable to Prajapati and Patel, (2018) results in India which found that the ultrasonography association value was +0.947 when compared to weight at birth (Prajapati & Patel, 2018). It was also consistent with a study conducted by Pradesh et al., (2017) in Indore, Madhya Pradesh, India; Rashid, (2015) in Bangladesh and Joshi et al., (2017) in Nepal. The consistent results showing a strong positive linear correlation with the actual birth weight could be because the ultrasound machine minimizes the inter-personal skills that change from one person to another.

In this study, ultrasound method correlated well with Term Birth Weight with mean percentage error of 0.46% (15g) and its deviation was 276.9g. Though not identical, the mean estimated birth weights by ultrasound were comparable to mean actual fetal weight; that is 3387 ± 414 gm versus 3372.7 ± 401.2 g. This was in line with results in a study done in Bangladesh which showed that the ultrasonography fetal weight estimates produced using the Hadlock method was 2753.4 g and it was similar to but not identical to 2817.9 g, weight at birth (Rashid, 2015) and one done in Nepal by Joshi et al., (2017) where Hadlock ultrasonography method projected the mean birth weight to be 3230.02407g which was comparable to the mean weight at birth was 3236.32472g (Joshi et al., 2017). The consistent results showing low mean percentage errors could also be a result that the ultrasound machine minimizes the inte-personal skills that change from one person to another.

This study showed that number of overestimated cases were 50.8%% by a mean error of 215 ± 142.2 , the number of underestimated cases were 47.2% by a mean error of 234 ± 1185.3 and number of correct estimation were 2% for ultrasound results using Hadlock formula. This is comparable to results in a prospective observational study conducted at Gujarat Medical & Education Research Society (GMERS Medical College and Hospital) in India among 227 women at term pregnancy over a period of 2 years which found that number of overestimated cases were 62.56%, the number of underestimated cases were 37% and number of correct estimation were 0.44 % for ultrasound results using Hadlock formula (Prajapati & Patel, 2018).

A prospective hospital-based cross-sectional study involving 109 patients with term, viable and singleton pregnancies who were scheduled for an elective cesarean delivery at El-Obeid Teaching Maternity Hospital in Sudan found that the EFW using Hadlock method overestimated all fetuses with birth weight less than 2500 gm by a mean error of 585 gm (percent error 26.7%), and underestimated all fetuses with a birth weight more than 3500 gm by a mean error of 755 gm (percent error 20.4%) (Awadalla et al., 2018). According to a prospective cohort research carried out at Mulago National Referral Hospital, Uganda found that Hadlocks in general were more precise when the weight at birth was less than 4000 g (Sereke, Omara, & Bongomin, 2021).

5.1.2 Accuracy of Johnson's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women

In this study, considering a maximum error of $\pm 10\%$ from the weight at birth, the overall estimated accuracy of fetal weight for Johnson's formula was 58.9%. This was low compared to results documented by Alirezaei et al., (2018) in Iran which discovered that considering a maximum error of $\pm 10\%$ from the weight at birth, the overall estimated accuracy of fetal weight for Johnson's formula was 66% being 35.9% for normal babies, 25% for low birth weight babies and 57.1% for macrosomic babies (Alirezaei et al., 2018). Unlike their study which considered all deliveries no matter the gestational age, that is; term, preterm and post term women, our study considered only those women who were at term (37 to 42 weeks of gestational age). The varying errors can be attribute to inte-personal skills that change from one person to another however regardless of that percentage errors are high.

In this study, the mean error for Johnson's formula was $203.3 \pm 304.3\text{g}$ and the mean percentage error Johnson's formula was $6.02 \pm 9.02\%$ and its deviation was 304.3g . This was low compared to one presented by Alirezaei et al., (2018) in Iran of 9.68 ± 9.41 , one by Pradesh et al., (2017) in India of 175.1g (Pradesh et al., 2017) and Prajapati and Patel, (2018) of $284.51 \pm 215.43\text{g}$ (Prajapati & Patel, 2018).

In this study, Johnson's formula fetal weight estimation showed a weak positive linear correlation with the actual birth weight ($R^2=0.383$). This finding was consistent with results of Pradesh et al., (2017) in India which showed that Johnson's formula weight correlated well with term birth weight (Pradesh et al., 2017) and Prajapati and Patel, (2018) of $+0.8182$ (Prajapati & Patel, 2018). This finding was also comparable to results in a cross section study conducted in Nepal which indicated that the clinically weight of the fetus had a positive

connection ($r=0.44$) with the weight at birth (Joshi et al., 2017). Though there is positive linear correlation the strength varies and this could be due to inter-personal skills that change from one person to another as well as equipment used

5.1.3 Accuracy of Dare's formula as clinical procedure for estimating the weight of a fetus with actual birth weight among term pregnant women

In this study, considering a maximum error of $\pm 10\%$ from the weight at birth, the accuracy of Dare's formula for estimating actual weight at birth was 65.9%. This result was more accurate compared to Alirezaei et al., (2018) in Iran which discovered that considering a maximum error of $\pm 10\%$ from the weight at birth, the overall accuracy of Dare's formula for estimating fetus weight at birth was 58.5% (Alirezaei et al., 2018).

Dare's formula fetal weight estimation showed a moderately strong positive linear correlation with the actual birth weight ($R^2=0.447$). This finding was comparable to results in a prospective research conducted by Pradesh et al., (2017) and Prajapati & Patel, (2018) in India which found that the correlation coefficient for the Dare's formula was +0.9026. Though there is positive linear correlation the strength varies and this could be due to inter-personal skills that change from one person to another as well as equipment used

This study showed that the mean error for Dare's formula was 170.3 ± 302.8 gm and its mean percentage error was $5.05 \pm 8.98\%$. This was better compared to the overall mean percentage errors of 10.62 ± 10.12 in a cross-sectional investigation done in Tor-bat Heydariyeh, among 147 singleton, full-term, cephalic pregnancies (Alirezaei et al., 2018). A prospective research conducted on 600 pregnant women at term at Index Medical College and Hospital and Research Centre in Indore, Madhya Pradesh, India discovered that, Dare's formula weight had the error between 10-15% of the TBW and its deviation of 120.8gms (Pradesh et al., 2017). A prospective observational study conducted at Gujarat Medical & Education Research Society (GMERS Medical College and Hospital) in India among 227 women at term pregnancy over a period of 2 year which found that Dare's formula showed that the mean error was -92.92 ± 159.43 gm (Prajapati & Patel, 2018).

In this study, the number of overestimated cases were 72.4%, the number of underestimated were 25.6% and the number of correct estimation were 2% for Dare's formula. This comparable to results in a prospective observational study conducted at Gujarat Medical & Education Research Society (GMERS Medical College and Hospital) in India among 227 women at term

pregnancy over a period of 2 year which found that the number of overestimated cases were 72.25%, the number of underestimated were 26.87% and the number of correct estimation were 0.88% for Dare's formula (Prajapati & Patel, 2018).

5.2 Study strength

The current study is probably the first study done to assess the accuracy of ultrasound (Hadlock method) versus clinical methods (Johnson's formula and Dare's formula) for estimating fetal weight among term pregnant women delivering at Kiryandongo general hospital. The major strength of this study was strict data concealment and therefore the results were at lower risk of bias.

5.3 Study limitations and delimitations

The study was limited to two clinical methods thus there is need to study other clinical methods besides Johnson's and Dare's formula/methods. The study was limited to time labor and delivery when it is equally needed during the course of pregnancy.

5.4 Conclusions

1. Hadlock ultrasonography fetal weight estimates were more accurate than the clinical methods (Dare's formula and Johnson's formula) used to estimate birth weight
2. Johnson's method was less accurate than both Hadlock ultrasonography method and Dare's clinical method
3. Dare's method was less accurate than Hadlock method, however was more accurate than Johnson's formula among the clinical techniques

5.5 Recommendations

1. There need for ministry of health and responsible persons/organization to emphasis the importance of fetal weight estimation both during antenatal and intra-pattern period.
2. Ultrasound scan should be emphasized in estimating fetal weight at this facility
3. Where ultrasound scan services are not available or affordable, a simple and low-cost Dare's clinical method over Johnson's clinical method should be employed by the attending doctor or midwife in estimating fetal weight at this facility
4. More research should be carried to back up this study findings

References

- Abraham, C., & Sheeran, P. (2014). The health belief model. *Cambridge Handbook of Psychology, Health and Medicine, Second Edition, June 2015*, 97–102.
<https://doi.org/10.1017/CBO9780511543579.022>
- Alirezaei, S., Azmoude, E., & Ghaderi, A. (2018). *Error Analysis for Determination of Accuracy of Johnson ' s Formula , Dare ' s Formula and Mother ' s Opinion for the Estimation of Birth Weight : Results of an Iranian Cross - Sectional Study*. 29(55), 320–329. <https://doi.org/10.2478/afmnai-2018-0034>
- Awadalla, K. E., Yusuf, A. Y. A., & Ahmed, S. M. (2018). *Sudan Medical Journal*. 54(1), 53–56.
- Ayad, C. E., Abdelrahim, A., Ibrahim, M., Elfadil, M., Garelnabi, M., Ahmed, B. H., Abdalla, E. A., Ahmed, M., & Saleem, E. (2016). *Assessment of Used Formulae for Sonographic Estimation of Fetal Weight in Sudanese Population*. June, 113–120.
- Barros, J. G., Reis, I., Pereira, I., Clode, N., & Graça, L. M. (2016). Estimation of Fetal Weight during Labor: Still a Challenge TT - Estimativa do peso fetal intraparto: ainda um desafio. *Rev. Bras. Ginecol. Obstet*, 38(1), 4–8.
http://www.scielo.br/scielo.php?script=sci_arttext&
- Boyle, A., Reddy, U. M., Landy, H. J., Driggers, R. W., & Laughon, S. K. (2013). *Primary Cesarean Delivery in the United States*. 0(0), 1–8.
<https://doi.org/10.1097/AOG.0b013e3182952242>
- Campbell, S. (2012). *Estimating fetal weight for best*. 15(February), 13–17.
- Daniel WW. (1999). *Biostatistics: A Foundation for Analysis in the Health Sciences*. 7th edition. New York: John Wiley & Sons.
- Donald, I. (2013). *History A Short History of Sonography in Obstetrics and Gynaecology*. 5(3), 213–229.
- Eze, C., Ohagwu, C., Abonyi, L., Irurhe, N., & Ibitoye, Z. (2017). Reliability of sonographic estimation of fetal weight: A study of three tertiary hospitals in Nigeria. *Saudi Journal*

- of Medicine and Medical Sciences*, 5(1), 38. <https://doi.org/10.4103/1658-631x.194256>
- Hadlock, F. P., Harrist, R. B., Sharman, R. S., Deter, R. L., & Park, S. K. (1985). Estimation of fetal weight with the use of head, body, and femur measurements-A prospective study. *American Journal of Obstetrics and Gynecology*, 151(3), 333–337. [https://doi.org/10.1016/0002-9378\(85\)90298-4](https://doi.org/10.1016/0002-9378(85)90298-4)
- Joshi, A., Panta, O. B., & Sharma, B. (2017). *Estimated Fetal Weight : Comparison of Clinical Versus Ultrasound Estimate*. 15(1), 51–55.
- Kacunko, S. (2018). Immediation. *Artnodes*, 2018(21), 154–176. <https://doi.org/10.7238/a.v0i21.3154>
- Pradesh, M., Pradesh, M., & Pradesh, M. (2017). *Comparison of estimation of fetal weight by two clinical methods and ultrasound at term pregnancy* 1 1. 3(2), 25–28.
- Prajapati, D. G., & Patel, R. M. (2018). *Comparison of various method of fetal birth weight estimation in term pregnancy*. 7(3), 1058–1064.
- Prasad, V. N., Poudel, P., & Chhetry, P. K. (n.d.). *Accuracy of sonographic fetal weight estimation in a tertiary care hospital in Bharatpur , Nepal*. 0657(4).
- Preyer, O., Husslein, H., Concin, N., Ridder, A., Musielak, M., Pfeifer, C., Oberaigner, W., & Husslein, P. (2019). Fetal weight estimation at term - Ultrasound versus clinical examination with Leopold's manoeuvres: A prospective blinded observational study. *BMC Pregnancy and Childbirth*, 19(1), 1–9. <https://doi.org/10.1186/s12884-019-2251-5>
- Rashid, S. Q. (2015). *ScienceDirect Accuracy of Sonographic Fetal Weight Estimation in Bangladesh*. 82–85. <https://doi.org/10.1016/j.jmu.2015.02.004>
- Sallis JF, Owen N, F. E. (2008). Social and Behavioral Theories. *Health Behavior and Health Education: Theory, Research, and Practice*, 4th, 465–486. <https://doi.org/10.1146/annurev.publhealth.012809.103604>
- Sharma, N., Srinivasan, K. J., Sagayaraj, M. B., & Lal, D. V. (2014). Foetal weight estimation methods – Clinical, Sonographic and MRI imaging. *International Journal of Scientific and Research Publications*, 4(1), 2250–3153. www.ijsrp.org

- Shittu, A. S., Kuti, O., Orji, E. O., Makinde, N. O., Ogunniyi, S. O., Ayoola, O. O., & Sule, S. S. (2007). Clinical versus sonographic estimation of foetal weight in Southwest Nigeria. *Journal of Health, Population and Nutrition*, 25(1), 14–23.
- Torloni, M. R., Sass, N., Sato, J. L., Renzi, A. C. P., Fukuyama, M., & de Lucca, P. R. (2008). Clinical formulas, mother's opinion and ultrasound in predicting birth weight. *Sao Paulo Medical Journal*, 126(3), 145–149. <https://doi.org/10.1590/s1516-31802008000300002>
- Ugwa, E. (2015). Advances in clinical estimation of foetal weight before delivery. *Nigerian Journal of Basic and Clinical Sciences*, 12(2), 67. <https://doi.org/10.4103/0331-8540.158888>
- Wanjaria, D. K. (2016). a Correlation of Ultrasound and Clinical Fetal Weight. *Journal of Medical Ultrasound*, 24(2004), 144–148.
- Washburn, L. (2020). Understanding the Health Belief Model. *University of Tennessee*. <https://extension.tennessee.edu/publications/Documents/W931-C.pdf>
- Wilcox, A. J. (2001). On the importance-and the unimportance-of birthweight. *International Journal of Epidemiology*, 30(6), 1233–1241. <https://doi.org/10.1093/ije/30.6.1233>
- Yiheyis, A., Alemseged, F., & Segni, H. (2016). *Johnson ' s Formula for Predicting Birth Weight in Pregnant Mothers at Jimma University Teaching Hospital ,. 4.*
- Yomibo-, T. A., Ariba, A. J., Abiodun, O., Egunjobi, A. O., Ojo, O. S., Kuti, O. R., Hospital, M., State, O., Owode-, G. H., State, O., Groups, M., State, O., Hospital, T., State, O., Hospital, H., State, O., & African, W. (n.d.). *Reliability of a clinical method in estimating foetal weight and predicting route of delivery in term parturient monitored at a voluntary agency hospital in Southwest Nigeria.* 1–6.

Appendix I: Informed Consent



Kampala International University Western Campus

Research Ethics Committee (REC)

P.O. Box 71, Bushenyi, Uganda; Tel: +256 758 096 775

E-mail: kiurec2017@kiu.ac.ug; Website: www.kiu.ac.ug

Informed Consent Document

Study title: The accuracy of ultrasound versus clinical methods for accurate estimation of fetal weight among term pregnant women delivering at Kiryandongo general hospital, Uganda

Principal investigator: Dr Fred Mutabazi

Introduction

What you should know about this study

- You are being asked to join this research study voluntarily;
- This consent form explains the research study and your part in the study;
- Please read it carefully, and take as much time as you need to understand it well;
- You can choose not to take part; and if you join, you may quit at any time. There will be no penalty if you decide to leave the study.

Leave blank (for REC Office only): NAME OF REC CHAIR: <i>Dr. Patrick Mbyemeire</i> TELEPHONE: +256 772601482 KIU REC STAMP:	For REC Office use only: APPROVAL DATE: APPROVED CONSENT REC VERSION NUMBER: PI's NAME: REC NO: <i>UG-REC- 023</i>
---	--

Brief background to the study

The estimated fetal weight established in the third trimester, usually around 30 weeks of gestation, is normally used to predict the fetal weight at term (Faschingbauer, Dammer, & Raabe, 2015). Accurate prediction of estimated fetal weight has a significant role in prevention of maternal and neonatal morbidity and mortality (Daniel, 2016). It can also prevent maternal complications such as a cephalopelvic disproportion and its sequale; vaginal fistula, recto-vaginal fistula, perineal injuries, foot drop, and uterine rupture (Ekele & Otubu, 2016). In addition, estimation of fetal weight facilitates clinician's choice of decision between allowing labor with intent of vaginal delivery or opting for cesarean delivery in patients with suboptimal clinical parameters (Ugwa, Gaya, & Ashimi, 2015). However, it is unclear how accurate fetal weight estimation methods are, prior to delivery (Vidarsdottir, et al., 2015) and there is no truly accurate technique for evaluating fetal weight based on existing literature (Preyer et al., 2019). There is still a debate about which method is the most reliable and valid (Lanowski, Lanowski, & Schippert, 2017).

Purpose of the research project

This study is intended to relate fetal weight estimation by clinical and ultrasound methods with actual birth weight among term pregnant women delivering at Kiryandongo general hospital.

Why you are being asked to participate?

Your participation will be of great importance to Kiryandongo general hospital community, Kiryandongo community, and Uganda at large. This information will also help to generate the required protocol for the management of labor in this institution.

Procedures

If you agree to participate, you will answer some questions related to labor (study topic)

Leave blank (for REC Office only): NAME OF REC CHAIR: Dr. Patrick Mbyemeire TELEPHONE: +256 772601482 KIU REC STAMP:	For REC Office use only: APPROVAL DATE: APPROVED CONSENT REC VERSION NUMBER: PI's NAME: REC NO: UG-REC- 023
--	--

Risks/Discomforts

There are no major foreseeable risks to the participant's social harm if there is a breach of confidentiality. However, social harm will be mitigated by ensuring that the most confidentiality is upheld.

Benefits

There will be no material benefits for participating in the study apart from the medications that will be prescribed. It is also anticipated that the results of the study will help the management of the facilities and other stakeholders to develop a protocols for managing labor.

Incentives/Rewards for participating

There will be no cash rewards or any other incentives for participating in this study although some reimbursements and refreshments may be given when warranted. Only indirect benefit in form of treatment to the participants will be given.

Protecting data privacy and confidentiality

Privacy during interviewing and confidentiality of information is guaranteed. You will be interviewed separately from other clients and in case you know one of the researchers, you can be interviewed by someone else or withdraw from the study. You are not required to give your name to avoid information being traced back to you. The information collected will only be accessible to the research team.

Right to refuse/withdraw

Participation in this study will not in any way be compulsory. Detailed information about the study will be explained to the participants and after demonstrating understanding of all the details of the study, informed consent forms will be issued and signed by the participants before the interviews and clinical examination. Any participant who will feel uncomfortable continuing with the study will be allowed to withdraw without any penalty.

Leave blank (for REC Office only): NAME OF REC CHAIR: <i>Dr. Patrick Mbyemeire</i> TELEPHONE: +256 772601482 KIU REC STAMP:	For REC Office use only: APPROVAL DATE: APPROVED CONSENT REC VERSION NUMBER: PI's NAME: REC NO: UG-REC- 023
--	--

Who do I ask/call if I have questions or a problem?

Please contact the KIU REC Office for any questions/problem on the addressed indicated below:

The KIU REC Chair

P.O.Box 71, Bushenyi

Mobile: +256-772601482

Email: kiurec@kiu.ac.ug

Principal Investigator(s): +256 777178949

What does your signature (or thumbprint/mark) on this consent form mean?

Your signature on this form means that you have:

- Been informed about this study's purpose, procedures, and possible benefits and risks;
- Been given the chance to ask questions before you sign; and
- Voluntarily agreed to be in this study.

_____	_____		_____
Patient number	Signature of participant/ Legally authorized	Thumb print	Date
_____	_____	_____	_____
Name of person obtaining Consent	Signature		Date
_____	_____		_____
Name of the witness	Signature of witness	Thumb print	Date

Leave blank (for REC Office only): NAME OF REC CHAIR: Dr. Patrick Mbyemeire TELEPHONE: +256 772601482 KIU REC STAMP:	For REC Office use only: APPROVAL DATE: APPROVED CONSENT REC VERSION NUMBER: PI's NAME: REC NO: UG-REC- 023
--	--

Appendix II: Questionnaire

Kindly respond to the following questions and if you feel any discomfort, you are free to discontinue the study or leave the question blank

Section A: Socio-demographics			
1.	Age	2.	Education level a) Primary b) Secondary c) None d) Tertiary or university
3.	Marital status a) Married b) Single c) Cohabiting Other specify.....	4.	Monthly income
5.	Religion a) Moslem d) Christian e) Other specify	6.	Residence a) Rural b) Urban
7.	Occupation a) Farmer b) Civil servant c) Business d) Unemployed e) Other specify.....	8.	Parity
9.	Gravidity.....	10.	Tribe.....
11.	Gestation age LNMP EDD..... Weeks amonoria First trimester sound		

Appendix III: Investigation form (for the principal investigator only)

1. Ultrasound results.....g
2. Dares clinical method
 - i. Abdominal Girth centimeters
 - ii. Symphysio-Fundal Height centimeters
3. Johnson clinical method
 - i. fundal height centimeters
 - ii. station
 - a) plus station
 - b) zero station
 - c) minus station
- 3 Actual birth weight gs