GRAYSCALE AND FETAL UMBILICAL ARTERY DOPPLER FINDINGS AMONG PREGNANT WOMEN WITH CHRONIC ILLNESSES ATTENDING MUHIMBILI NATIONAL HOSPITAL ANTENATAL CLINIC.

Maria A. Shemweta, MD

MMed (Radiology) Dissertation

Muhimbili University of Health and Allied Sciences

October, 2024

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
DEPARTMENT OF RADIOLOGY & IMAGING

FETAL UMBILICAL ARTERY DOPPLER ULTRASOUND FINDINGS IN PREGNANT WOMEN WITH CHRONIC ILLNESSES ATTENDING ANTENATAL SERVICES AT MUHIMBILI NATIONAL HOSPITAL

By;

Maria A.Shemweta

A Dissertation Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Medicine (Radiology) of the Muhimbili University of Health and Allied Sciences

October, 2024

CERTIFICATION

The undersigned certifies that she has read and hereby recommends for acceptance by Muhimbili University of Health and Allied Sciences for the dissertation entitled, **‘‘Grayscale and Umbilical Artery Doppler Ultrasound Findings among Pregnant Women with Chronic Illnesses Attending Antenatal Care at MNH’’,** in (partial) fulfillment of the requirements for the degree of Master of Medicine-Radiology of Muhimbili University of Health andAllied sciences.

_____

Dr. Helena Machibya

Supervisor

_____

Date

_____

Dr. Zuhura Nkurumbih

Co-Supervisor

_____

Date

DECLARATION AND COPYRIGHT

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

Signature…… Date ……

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ACKNOWLEDGEMENT

First of all, I extend my thanks to Almighty God for protecting me throughout the conduction and completion of this dissertation. I am indebted to Drs Helena Machbya and Zuhura Nkrumbih for the guidance that rendered me during the preparation of this Dissertation. I would like also to thank all the specialists in the Radiology department (MUHAS and MNH) for the valuable assistance and support they accorded me during the preparation of this work, special thanks to Dr. R.Kazema and Dr. Lilian Saligwa for their tireless support and encouragement.

The contributions from specialists (Dr.Sophia Kiwango and Hellen Mrina), Sonographers (Saada and Rosena) and other health workers from the Obstetric department were valuable for permitting me to collect data in the facility and support during the process.

Thanks go to the Statisticians and epidemiologists who despite their busy schedules, spare time to sit with me and help with statistical data analysis and skills, my colleagues and research assistants were now and then reminding me which contributed to the completion of this work.

I am grateful for the sponsorship offered to me by Muhimbili University of Health and Allied Science(MUHAS).

The Muhasso stationery is appreciated for the assistance in the secretarial work from the development of the dissertation proposal, questionnaires, and finally to this report.

I want to thank my dear Parents Augustino Shemweta and Rosemary Shemweta for always praying for and encouraging me in every step of this work.

Last but not least, I can't forget to thank my husband Lumuliko Nyika & my daughter Philomena who always supported and cheered me up at the moment when I felt low and exhausted.

DEDICATION

This dissertation is dedicated to

My dearest Father and Mother for their endless love, care and support

My beloved Husband Lumuliko Nyika for unconditional love, care and support

My adorable daughter For the love, charming and understanding

ABSTRACT

Background: Chronic illnesses in pregnancy are increasing, with the incidence in Germany at 21.3%, India at 10.6%, and Africa at 24.3%, which affects both maternal and fetal health. These conditions cause poor placenta formation with placenta hemodynamic disturbance, fetal complications of low birth weight, congenital malformations and low Apgar score. This study uses grayscale and umbilical artery Doppler ultrasound to evaluate fetal well-being in pregnant women with chronic illnesses.

Objective: To evaluate the estimated fetal weight, umbilical artery Doppler, and other grayscale findings among pregnant women with chronic illnesses from September 2023 to March 2024

Methodology: A 7-month hospital-based study enrolled 155 pregnant women with chronic medical conditions. Data was collected through structured questionnaires of maternal clinic information, grayscale and Duplex color Doppler ultrasounds. Fetal growth restriction was identified at estimated fetal weight(EFW)< 10^{th} percentile and abnormal umbilical artery indices values at > 95^{th} percentile. Fisher's exact test was used to evaluate the association of the variables, together with multivariate analysis to determine the independent factor under the outcome of interest in this study.

Results: The study enrolled 155 pregnant women with a median age of the participants of 34 years, IQR (31–37)years. The majority of them were married (82.6%) and about 50.3% had acquired a secondary school education. The key factor strongly associated with intrauterine growth restriction (EFW<10th percentile) is the abnormal pulsatility index (adjusted odds ratio(AOR)=20.35, 95% CI: 6.03–68.66, P<0.001*). On the other hand, reversed end-diastolic flow (REDF) and chronic hypertension were independent predictors of intrauterine growth restriction(IUGR) at AOR = 3.56, 95% CI: 1.38–9.18, P<0.001*) for chronic hypertension.

Conclusion: Reversed end-diastolic flow (REDF) is a strong sonographic predictor of IUGR and chronic hypertension has been shown to increase the risk threefold in our cohort.

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ABBREVIATIONS

AC:	Abdominal circumference
AEDF:	Abscent end diastolic flow
ANC:	Antenatal care
AUDS:	Abnormal umbilical Doppler studies
BPD:	Biparietal diameter
C/S:	Cesarean section
CHD:	Congenital heart disease
CVD:	Cardiovascular disease
DM:	Diabetes mellitus
EFW:	Estimated fetal weight
FGR	Fetal growth restriction
FL:	Femur length
GA:	Gestation age
HC:	Head circumference
MNH:	Muhimbili National Hospital
PI:	Pulsatility index
REDF:	Reversed end-diastolic flow
RHD:	Rheumatic heart disease
RI:	Resistive index
S/D:	Systolic to diastolic ratio
SCD:	Sickle cell disease
SGA:	Small for gestation age
UAD:	Umbilical artery Doppler
USS:	Ultrasound
WHO:	World health organization

DEFINITION OF TERMS:

Chronic hypertension	Refers to raised blood pressure >140/90 before pregnancy or before 20 weeks gestation[1].
Doppler ultrasound	A non-invasive test that can be used to investigate movement and particularly evaluate blood flow in arteries and veins also provides information regarding the perfusion of blood flow in an organ or within an area of interest[2].
Absent diastolic flow	There is no flow in the umbilical artery at the end of diastole.
Chronic illnesses	Chronic illness according to the World Health Organization (WHO) is a long-lasting condition that progresses slowly .
Gray-scale ultrasound	Refers to a two-dimensional image in which the organs and tissues of interest are depicted as points of variable brightness[2].
Intrauterine growth restriction/Fetal growth restriction	Is a pathologic slowdown in the fetal growth pace resulting in a fetus that cannot reach its growth potential,with ultrasonographically estimated weight being below the 10th percentile [3].
Pulsatility index	A Doppler USS parameter serves as both an indicator of the impedance of the fetal placenta's circulation and an oblique measurement of the resistance flow within its vessels[4].
Reduced diastolic flow	The end-diastolic low is in a forward direction, but the diastolic flow is reduced and the characteristic saw-tooth pattern is lost
Reversed diastolic flow	It is the normal forward direction of the end-diastolic flow when is reversed
Umbilicalartery doppler	Doppler ultrasound in the umbilical artery[4].

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The growth of the fetus in utero largely depends on the health status of the mother which influences fetal development and good perinatal and post-natal outcome. Studies show that intrauterine fetal growth is affected by the chronic illnesses of the pregnant woman such as chronic hypertension, diabetes mellitus, sickle cell disease, chronic kidney disease, cardiovascular disease and other chronic infectious conditions because it results in poor placental blood flow and affects the health of the placenta, especially in the anemic state[5]. Chronic kidney disease and diabetes mellitus are associated with poor placentation, the latter also causes an increase of vascular resistance in the state of hyperglycemia consequently resulting in Intrauterine growth restriction(IUGR)[5–7]. The prevalence of chronic illness in pregnancy is gradually increasing this is shown in the population-based study done in Germany by kersten, et al in 2014reports that chronic illness in pregnancy is about 21.4% [8]. Among the frequently noted chronic diseases are hypertension, Diabetes mellitus(DM), sickle cell disease, epilepsy, heart diseases (congenital/acquired) and chronic kidney disease [8].

The study done by Kersen et al from Germany in 2014 shows that in every five pregnant women, one of them has a chronic disease [8]. In the African population, the study conducted in Nigeria by Babah, et al in 2017 shows the prevalence of maternal disorders in pregnancy is 24.3%, and among the diseases mentioned are diabetes, sickle cell disease, chronic hypertension and hepatitis [9,10].

A population-based cross-sectional study of non-communicable diseases in Northwestern Tanzania and southern Uganda by Kavishe et al in 2015 reports the high prevalence of hypertension ranges(16%-17%,19%-26%) and DM(1%-2%,2%-4%)respectively, the noted rise of these diseases gives indirect information that even the women of reproductive age are also affected[11].

Chronic illnesses in pregnancy have been associated with several derangements which can be assessed by both grayscale and Doppler ultrasound. Intrauterine growth restrictions (IUGR), stillbirth and fetal macrosomia are the abnormalities detected in grayscale scanning[12]. The abnormalities detected in Doppler scanning are derangement of the Resistive index(RI), PI, S/D ratio and derangement of normal umbilical artery Doppler waveforms[4,13].

Doppler ultrasound in pregnancy is one of the important parameters that play important roles in the study of fetal circulation/ hemodynamics [4]. The Doppler ultrasounds include both uterine artery and umbilical artery which investigate the uteroplacental and fetoplacental circulations and give information about perfusions and diagnosing any resistive conditions that can hinder fetal well-being and the possibility of IUGR[2,4,14]. For the second and the third trimesters Doppler USS is used to assess the fetal well-being and noninvasively to monitor the feta placenta unit, the middle cerebral artery and umbilical artery are used which the umbilical artery Doppler is reported to be the best[2,15]

The Doppler parameters that are used for the assessment of perfusion are spectral Doppler waveforms, RI, S/Dratio and PI, the PI and S/D ratio are the most accurate parameters used as they are not affected by the angle of insonation[15–18].

For early sonographic diagnosis of perinatal fetal abnormalities such as placental insufficiency and fetal growth restriction, this study, therefore, intended to determine grayscale and umbilical artery Doppler findings among pregnant women with chronic illnesses such as chronic hypertension, diabetes mellitus, sickle cell diseases, cardiovascular disease and other chronic infectious conditions as these diseases affect the fetoplacental unit and normal intrauterine growth.

1.2 Problem statement

The overall incidence of chronic illnesses in pregnancy is rising day by day, this is shown by the population-based study in Germany by kersten, et al in 2014 where it is 21.4%, the study done in America by Chatterjee, et al the prevalence of chronic illness in productive age is 27% and for the Indian population the study by Kumari et al, the prevalence is high with chronic hypertension(30.8%) and diabetes mellitus(10.8%)[8,19,20].

In the African population, the study done in Nigeria by Babah, et al in 2017 reports the prevalence of maternal chronic illness in pregnancy to be 24.3%, on Eastern Africa the rising of non-communicable diseases of hypertension(17%,26%) and diabetes mellitus(1%,4%) in the rural and urban population of Northwestern Tanzania and southern Uganda respectively, has been noted to raise and assumed to affect the female of reproductive age as well has been reported by Kavishe et al in 2015 [9,11].

The effects of chronic illnesses are seen in both maternal and fetal, the fetal complications being preterm delivery, low estimated fetal weight/low birth weight, perinatal mortality, and low Apgar score[6,8]. The effects of fetal weight are more shown by Keram et al where low birth weight is mainly detected in pregnant mothers with chronic illnesses such as diabetes, hypertension and anemia [21].

The use of umbilical artery Doppler scan is indicated in pregnant women at high risks like as pre-eclampsia, eclampsia, oligohydramnios, chronic hypertension, anemia in pregnancy HB<8g/dl, non-gestational diabetes and in a fetus with suspected small for gestation age(SGA) and IUGR [13,16].

The consequence of not using umbilical Doppler ultrasound in risk pregnancy leads to perinatal death, induction of labor, low Apgar score and C/S delivery [21].

There is limited data for reporting the prevalence of chronic illnesses in pregnancy, this leads to most of the focus of obstetric ultrasound intervention based on umbilical Doppler ultrasound in pre-eclampsia and eclampsia which are hypertensive disorders acquired

during pregnancy and not in women with chronic illnesses before the onset of pregnancy[22,23].

In our locality, there is a lack of clear scheduled care using obstetric umbilical Doppler ultrasound in pregnant women with chronic illnesses like chronic hypertension, sickle cell disease, non-gestational diabetes, anemia in pregnancy and chronic kidney disease.

Thus this study aimed to impart the use of grayscale and umbilical Doppler ultrasound to pregnant women with chronic illnesses for early intervention of any fetal and placenta circulation compromise.

1.3 Rationale

Grayscale and Umbilical Doppler USS in obstetrics are cheap and easily accessible sonographic techniques that are available in ultrasound units and found in almost every district hospital in Tanzania.

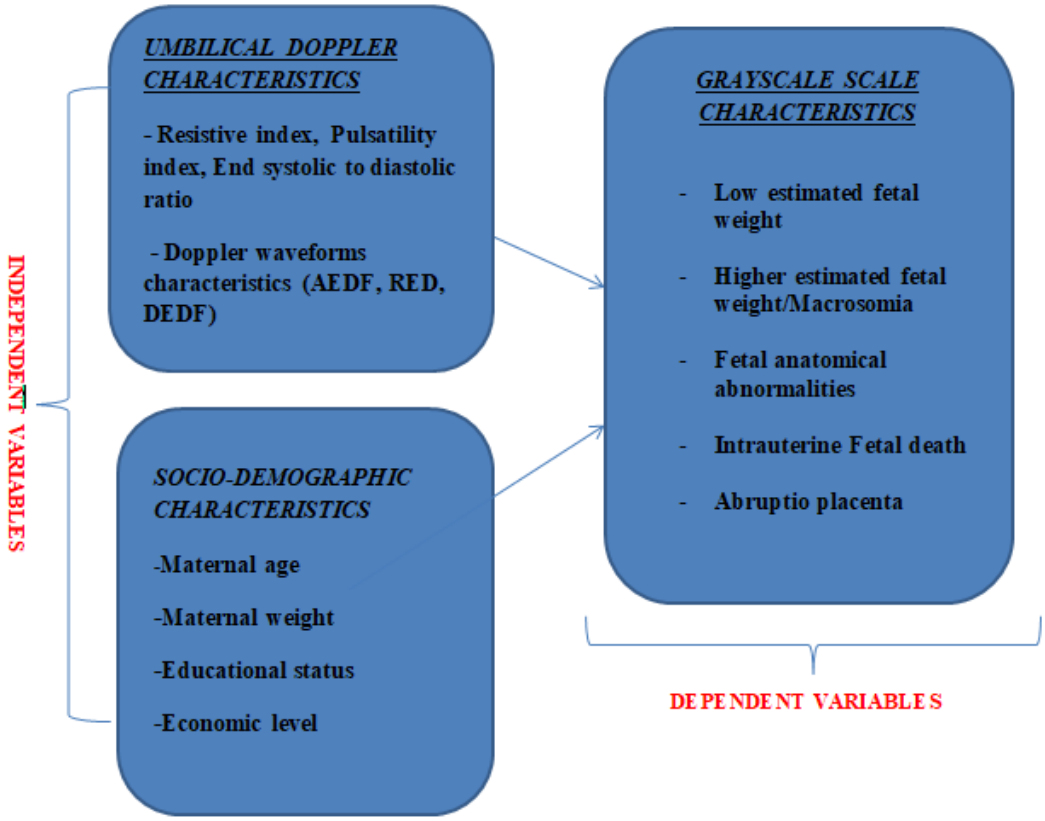
At Muhimbili National Hospital, obstetric ultrasounds are routinely carried out for the assessment of fetal well-being and anatomical survey; occasionally umbilical Doppler USS may be used in the evaluation of fetoplacental blood circulation in high-risk pregnancies like preeclampsia and eclampsia. However, Doppler ultrasound in pregnant women with chronic medical conditions has not yet become a routine practice.

The rise of chronic maternal disorders in pregnancy and possible consequences in fetal placental circulation and fetal well-being compromise has created a need to perform umbilical Doppler, this study aimed to investigate obstetric ultrasound findings in pregnant women with chronic illness for early detection of any umbilical Doppler indices and grayscale abnormalities such as low estimated fetal weight. The findings of this study may be applied to advocating for early obstetric observation in this group of pregnant mothers thus avoiding the further progression of placental insufficiency and its potential complications in the prenatal and postnatal phases of pregnancy. Ultimately, the use of umbilical artery Doppler may be integrated into protocols as an investigating/monitoring tool in pregnant women with chronic medical conditions in detecting any fetal compromise conditions such as intrauterine growth restriction.

Additionaly the completion of this dissertation is one of the the requisite being awarded a master's degree in Radiology and Imaging.

1.4 Conceptual framework

Chronic illnesses in pregnancy have been associated with poor placentation, poor healthy placenta, and deranged normal blood flow in the placenta with increased placenta vasculature resistance that leads to the derangement of normal umbilical circulation of which the umbilical Doppler volumetric indices are deranged. Poor placentation and decreased placenta blood flow cause indirect effects on fetal development such as low estimated fetal weight/IUGR, macrosomia, preterm birth, stillbirth/intrauterine fetal death and low Apgar score.



1.5 Research questions

What are the grayscale and umbilical artery Doppler ultrasound findings among pregnant women with chronic illnesses attending antenatal care at Muhimbili National Hospital.

1.5.1 Specific research questions

1. What are the social-demographic characteristics among pregnant women with chronic illness attending ANC at MNH?
2. What are the estimated fetal weight and other grayscale findings among pregnant women with chronic illness attending ANC at MNH?
3. What are umbilical artery Doppler indices findings among pregnant women with chronic illness attending ANC at MNH?
4. What is the relationship between umbilical artery Doppler indices and Estimated fetal weight among pregnant women with chronic illness attending ANC at MNH?

1.5.2 Null hypothesis

There is no relationship between umbilical artery Doppler indices derangement due to placenta insufficiency in pregnant women with chronic illness and the development of intrauterine fetal growth restriction/(IUGR).

1.6 Objectives

1.6.1 Broad objective

To determine grayscale and umbilical artery Doppler USS findings among pregnant women with chronic illnesses attending antenatal care at MNH from September 2023 to March 2024.

1.6.2 Specific objective

1. To determine socio-demographic characteristics among pregnant women with chronic illnesses attending ANC at MNH from September 2023 to March 2024.
2. To determine grayscale findings among pregnant women with chronic illnesses attending ANC at MNH from September 2023 to March 2024.
3. To determine umbilical Doppler artery indices findings among pregnant women with chronic illnesses attending ANC at MNH from September 2023 to March 2024
4. To investigate the relationship between Umbilical Artery Doppler findings indices and estimated fetal weight among pregnant women with chronic illnesses from September 2023 to March 2024

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Socio-demographic characteristics

According to a study by Kumari et al in India., the majority of pregnant women with chronic illnesses were between the ages of 20 and 29 (38.7%), and majority were primigravidas (35.2%) ,another study from America the age ranges from 18-45 with the majority of them being unmarried followed by married and cohabiting couples with about 40% reports to have higher education level with acquired professional training and higher economic income [8][20] . Argwu et al. in Nigeria found that pregnant women with chronic medical disorders ranged in age from 26 to 35 (56.7%) and that the majority of them were married (97%). A different study from Nigeria also found that the age range was 31.8±6.2 years on average, with the median number of parity one [9,24].

In another study from Kenya, the age of pregnant women with cardiovascular disease is at the mean age of 26 years with the gravidity ranging from 1-6 and the median number of parity 1 [19,25].

2.2 Grayscale findings and estimated fetal weight among pregnant women with chronic illnesses

Works of the literature show the outcome of pregnant women with sickle cell anemia, chronic kidney disease and diabetic nephropathy is IUGR and low birth weight compared to normal pregnant women [6,28,29,32]. For pregnant women who have DM with insulin-dependent, there is a high risk of getting macrosomia baby EFW>95th percentile or >4kg, also a high rate of congenital malformations(4%), intrauterine fetal death and a threefold increase in neural tube defects and cardiac anomalies like the septal hypertrophic cardiomyopathy has been noted compared to the general population[6,29]. Another study reports the chance of pregnant women with DM getting the SGA fetus (14%) and also IUGR seen in pregnant women with SCD(12.2%), CKD(1.1%) and DM(6.7%)[29,33]. The grayscale abnormalities revealed in SCD pregnant women by which the EFW was <10th percentile(<2.5kg) in the third trimester which was more severe in sickle cell anemia than

sickle cell trait [12]. Other studies report the IUGR, intrauterine fetal death, and SGA in pregnant women with cardiovascular diseases [25,34,35].

2.3 Umbilical Doppler findings in pregnant women with chronic medical conditions

The study done at Johns Hopkins University in America shows the high rates of abnormal umbilical artery studies among pregnant women with chronic illnesses compared to normal pregnant women which are chronic hypertensive(11.2%) and non-gestational diabetes(9.2%)[26]. Other studies report abnormal UAD waveforms in pregnant women with chronic hypertension of REDF and AEDF (20.6%)[27].

The study done in Mater Mother's Hospital Australia to determine the UAD outcomes in pregnancy with pre-existing DM in the second and third trimesters showed an elevation of PI indices (22.1%) above the 95th percentile for the specific GA. Also, the abnormal spectral Doppler waveforms of UAD have been reported in other studies where the abnormal diastolic notch is visualized[13,28]. Another study done in Malaysia shows absent diastolic or reverse end-diastolic flow in UAD in pregnant women with DM; these findings differ from a study in New Zealand where DM mothers had abnormal Doppler waveforms at 24 weeks of GA [27,29].

In addition, the study done by Anyaegbunam et al shows the significant derangement of S/D>3 of the umbilical artery in a pregnant woman with sickle cell anemia compared to sickle cell trait individuals with a P value of <0.05 at intervals of gestational age of 28-40 weeks, which the same abnormalities showed by the study done in Nigeria pregnant women with SCD the S/D was reported to be raised during the third trimester[12], while in other studies no abnormal Doppler waveforms were reported[13,17,30]

The effect of chronic hypertension is proved again by Ayyuba et al in Nigeria which shows the abnormality of Umbilical artery Doppler indices with the increase in the resistive index (RI>0.58) and diastolic notches among 60% of women with chronic hypertension at 20-24 weeks GA[13].

The Doppler indices parameters also are deranged in pregnant women with vascular disorders, this is presented by the study done by S.Lantam et al in western Africa revealing the increase of resistive index (RI) in pregnant women with anemia for about 40% (30).

2.4 The relationship between umbilical artery doppler indices and estimated fetal weight among pregnant women with chronic illness

The study done by Hamayel et al in America reveals the abnormal umbilical artery indices(6.9%) are twice high in a fetus who is SGA (EFW<10th percentile) than in a Non-SGA fetus with the P<0.001, at which 26(26.5%) of the 98 women with abnormal Doppler indices are of low estimated fetal weight, also abnormalities in PI, S/D and RI each reported to be statistically significantly associated with SGA[(26)].

A study done by Abimboli et al in Nigeria shows at 26 weeks the S/D ratio ranges from 2.8 to 2.92 with a strong positive correlation of low birth weight in 21 to 25 years of age for pregnant women with SCD (P =0.026)[(12)].

The correlation of umbilical Doppler findings is seen in a fetus with SGA < 10th of GA and <2500gram where they present with abnormal umbilical artery Doppler findings[(22)].

The S/D >3.1 at term pregnancy was shown to be associated with Low birth weight babies 36/90(76.6%) and the abnormal Doppler waveforms have been reported in a fetus with IUGR compared to normally growing fetus with the decreased end-diastolic flow 48/90(53.3%), AEDF 14/90(15.6%) and REDF 8/90(8.9%)[(27)]. Those pregnant women with chronic hypertension have been reported to have a fetus with IUGR that is associated with abnormal Doppler waveforms[(27)](31). Abnormal UAD was also associated with Low birth weight P<0.002, oligohydramnios, C/S delivery, and delivery at <36 weeks GA in pregnant women with chronic illness (32)**.** However in our locality no reported data yet concerning umbilical artery Doppler abnormality in pregnant women with chronic illnesses.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study design

A cross-sectional study design was used to collect prospective data from pregnant women with various chronic illnesses attending MNH's obstetric unit.

3.2 Study area

The study was carried out at the Muhimbili National Hospital (MNH), which is situated in the Ilala District of Dar es Salaam, Tanzania's largest commercial capital.

It is the largest National referral hospital in Tanzania, Muhimbili National Hospital also serves as a research center and a teaching hospital for the Muhimbili University of Health and Allied Sciences(MUHAS). The departments that are found are obstetrics/gynecology, Surgery, Internal medicine, Pediatrics, Anaesthesia, Radiology and Imaging.

MNH contains about 1500 beds and around 1000 -1200 patients attending outpatient visits per week, also it can admit 1000 to 1200 patients per week, with a large number of pregnant women attending the outpatient department as well. The large numbers of women attending the obstetric unit are those with complications during pregnancy or those referred from regional referral hospitals for expertise management.

The Department of Radiology and Imaging is well equipped with advanced imaging technology of 3T-MRI, 128-slice Multi-Detector CT, fluoroscopy machines, mammography, and ultrasound machines. The acquired imaging and patient reports from imaging are stored in a well-designed radiology information system and hospital information system which can easily be retrieved.

3.3 Study population

The study population included all expectant mothers in the second and third trimesters who received antenatal care at MNH from September 2023 to March 2024 and had a variety of chronic illnesses before becoming pregnant, such as chronic hypertension,

sickle cell anemia, diabetes mellitus, chronic kidney diseases, cardiac conditions, autoimmune diseases, and other chronic infectious conditions. The study sample consisted of pregnant women who met the necessary inclusion criteria and had chronic illnesses as stated above which has been reported to interfere with fetal-maternal well-being and hence high risk in pregnancy.

3.3.1 Inclusion criteria

- Pregnant women with chronic illnesses in the second trimester of GA (> 22 weeks) and third trimester.

3.3.2 Exclusion criteria

- Chronic hypertension superimposed with preeclampsia and eclampsia
- Pregnant women with chronic illness and twin pregnancy
- Severely ill patient
- Those who refused to participate in the study

3.4 Sample size

Using a formula, the sample size was determined by the use of the prevalence of umbilical Doppler abnormality in high-risk pregnancies including Diabetes mellitus and hypertensive disorders from a study done in Mulago Hospital in Uganda, which shows a prevalence of 10.97%(33).

The sample size formula is as follows:

n= Z^2p (1-p)/e^2

n= (1.96) ^2 X10.97%(100-10.97)/5^2=150

n=minimum sample size

z= standard normal deviate set at 95% confidence limit = 1.96

p = prevalence of umbilical Doppler abnormalities from the previous study (10.97%)

=1-p (complementary probability)

e= margin of error= 5%= 0.05

By calculation, the sample size is 150

Assuming the Nonresponse rate by 10%(By smith and Day 1984) the sample size becomes 166

3.5 Sampling techniques

The study utilized a probability sampling technique as each pregnant woman with chronic illness who attended the obstetric unit for obstetric ultrasound on the date of data collection and met the inclusion criteria was selected randomly in the study until the sample size was reached.

3.6 Instruments and data collection methods

3.6.1 Equipment

GE Health Care(Model: LOGIQ V5 Expert) and Mindray System Ultrasonography machines(DC-40) with a curved transducer of 3.5Hz-5Hz were used for scanning pregnant women with chronic illnesses at GA 22 weeks and above. The machines contained parts of Obstetric parameters of Doppler scanning and grayscale components for measuring the parameters of EFW(BPD, HC, FL, and AC)and fetal anatomy evaluations.

3.6.2 Data collection, imaging, and evaluation

The data was collected at the Department of Radiology and Imaging, at the obstetric ultrasound subunit. Data was collected by the principal investigator and two senior sonographers who have more than 10 years of experience in obstetric ultrasound, the interobserver difference and consensus were made and averages were obtained for data accuracy when any discrepancy of the collected data happened. The senior radiologist was consulted only when there were misunderstandings and at some point for the verification of the collected.

The structured questionnaire was adopted from the previous studies and modified according to the requirements of this study and specific objectives.

The social demographic characteristics were collected by asking patient-specific questions structured from the questionnaire.

Gestational age was calculated based on the last normal menstrual period (LNMP) and/or ultrasound calculations by asking the patient, for the first USS scan in case the pregnant mother was not able to remember the date properly.

Fetal weight estimation by USS

The pregnant mother was instructed to lie in the semi-recumbent position with a slight lateral tilt to avoid the inferior vena cava syndrome from the gravid uterus. Fetal growth assessment was obtained by grayscale ultrasound where the fetal measurement Parameters for fetal weight estimation were calculated from BPD, FL, AC, and HC where the machines estimated the fetal weight automatically.

BPD was measured at the level of the thalami, from the outer edge of the proximal skull to the inner edge of the distal skull, HC was measured at the same level as the biparietal diameter, around the outer perimeter of the calvarium, AC was obtained in true transverse view at the level of the junction of the umbilical vein, portal sinus and fetal stomach at which the kidneys were not included and the FL was measured in the long axis of femoral shaft at which the femoral epiphysis excluded.

The normal EFW was taken at exactly 10^{th} percentile values or above at the given specific gestational age and abnormal values below the 10^{th} percentile for the specific given gestational age. These reference ranges are adopted from the University of Cincinnati College of Medicine and IUGR clinical management protocol.

Umbilical artery Doppler flow measurements

The umbilical artery was identified by placing the transducer over the lower abdomen and by randomly directing it towards the uterine cavity to identify the umbilical cord using an amniotic fluid acoustic window. The angle between the ultrasound beam and the direction of the blood was adjusted to less than 60 degrees and at other times exactly 0

degrees was used; Color Doppler was used to differentiate the umbilical artery from the umbilical vein as the vessels with a color code of red and towards the transducer was taken as the umbilical artery.

The floating umbilical artery was used in pulsed wave Doppler as the artery near the placenta insertion and fetal abdomen was reported to have high resistance. Spectral waveforms were examined by placing the pulsed- Doppler range gate within the vessel. The Doppler scale was adjusted such that the velocity was measured without an aliasing effect. The recording of the result for analysis was only taken at the clear state where at least three pulsatile arterial waves were observed. The waveform was taken in a state where there was no fetal breathing, body movement, or cardiac arrhythmias. After obtaining the Doppler indices values (PI, S/D and RI), the findings were compared with the percentiles charts for Doppler indices for specific gestation ages and specific sites where the pulsed Doppler was taken and thus the normal and deranged values were easily detected after comparison. The normal umbilical Doppler indices of S/D, RI and PI were taken below the 95^{th} percentile for specific gestational age and values above the 95^{th} percentile for specific gestational age were regarded as abnormal, these references adopted from New Zealand Obstetric Ultrasound Guideline version 2022 and Guideline from Society for Maternal, Fetal Medicine.

The Spectral Doppler waveform patterns that were recorded are the normal diastolic flow of the saw-tooth pattern, abnormality of Doppler waveform of the absence of end-diastolic flow(AEDF), decreased-end-diastolic flow (DEDF) and reversed diastolic flow(REDF). The Doppler waveform patterns were compared to the normally adopted spectral waveforms from previous studies, and articles, such as Evicore Health Care Obstetrical Imaging Guidelines and New Zealand Obstetric Doppler Guidelines.

3.7 Data analysis

The collected data was analyzed by SPSS version 26 by which objectives one, two and three were analyzed by the use of frequency distribution 2x2 tables at which the proportions and prevalence were obtained. For objective four the chi-square test (X^2)

was obtained by determining the relationship between the two variables, and then the multivariate analysis was carried out to determine the independent factor under the outcome of interest in this study. The P value of <0.05 was taken as statistical significance at the 95% confidence interval.

3.8 Ethical clearance

This study received ethical clearance from the Institutional Review Board of MUHAS with Ref **No.DA.282/298/01.C/1864**, then clearance was submitted to the Muhimbili National Hospital Administration office that deals with research and Continuing Education programs, after that the introduction letter was given to collect data in the Department of Radiology and Obstetrics ultrasound subunit. Patient informed consent was obtained verbally by narrating to the patient what the study deals with, what would be done, and explaining the importance of performing the study as well the patient was ensured that no harm would be introduced to her or her fetus in the womb. Also, the patients were assured that the information collected was not displayed to different people as the findings were only accessed by the principal investigator. After the patient agreed with the explained information, then the data was collected as per questionnaires.

3.9 Validity and Reliability

Validity issue: Every tool that was created and used in this study was standardized to assure validity. The questionnaires developed for this study were evaluated to make sure they are user-friendly and capture all the necessary data. To make sure that participants understand and submit accurate information, the surveys were translated into Swahili.

Reliability issue: To ensure the reliability of the data and procedures in this study, Doppler sonographic findings were collected and reviewed by reexamination by a senior radiologist/ experienced sonographer in Obstetric Doppler ultrasound to confirm the inter-observer differences. The results were recorded only when consensus had been reached and then verified by a senior radiologist.

3.10 Dissemination plan

The results obtained from this study will be distributed to obstetricians and radiology staff at MNH. The final report will be submitted to the Muhimbili University of Health and Allied Science as part of the fulfillment for the award of the Master of Medicine in Radiology. Later on, presentations at numerous national and international conferences and symposia, including the Tanzania Health Summit, the National Conference on Non-Communicable Diseases and the MUHAS Annual Scientific Conference will be done under the assistance of my supervisors.

CHAPTER FOUR

4.0 RESULTS

4.1 Social-demographic characteristics of the participants

A total of 155 participants were successfully enrolled in this study, the median age of the participants was 34 years (IQR=31,37) with over half of them found between 18-34. In addition, the majority of participants were in the third trimester (96.1%), married (82.6%) and about half (50.3%) had reported having completed secondary education, with more than a quarter working as petty traders (37.4%). Their socio-demographic characteristics are shown in **(Table 01).**

Table 01: Social demographic characteristics of pregnant women with chronic illinesses undergoing obstetric ultrasound at MNH from September 2023-March 2024 n=155

Variable	Frequency (n)	Percent (%)
Age group (years)		
18 – 34	81	52.3
35 – 44	74	47.7
Median age in years (IQR)	34 (31, 37)	
Marital status		
Married	128	82.6
Cohabiting	27	17.4
Level of education		
Primary	22	14.2
Secondary	78	50.3
Higher	55	35.5
Occupation		
Unemployed	19	12.3
Housewife	34	21.9
Self-employed/Petty trader	58	37.4
Peasant	1	0.6
Formal employment	43	27.7
Alcohol consumption		
Yes	4	2.6
No	151	97.4

Maternal weight		
50 – 100	152	98.1
101 – 149	3	1.9
Trimester		
2nd Trimester	6	3.9
3rd Trimester	149	96.1
Median calculated GA (IQR)	34 (31, 36)	
Median maternal weight (IQR)	76.0 (68.0, 82.0)	
Number of parities		
0	56	36.1
1	36	23.2
≥ 2	63	40.6
Median parity (IQR)	1 (0, 2)	
Dietary education		
Yes	96	61.9
No	59	38.1

The leading chronic condition was chronic hypertension (43.9%), followed by diabetes mellitus (20.6%) and the least chronic infectious conditions of HIV(7.7%) & chronic hepatitis(7.1%) were seen**. (Figure 01).**

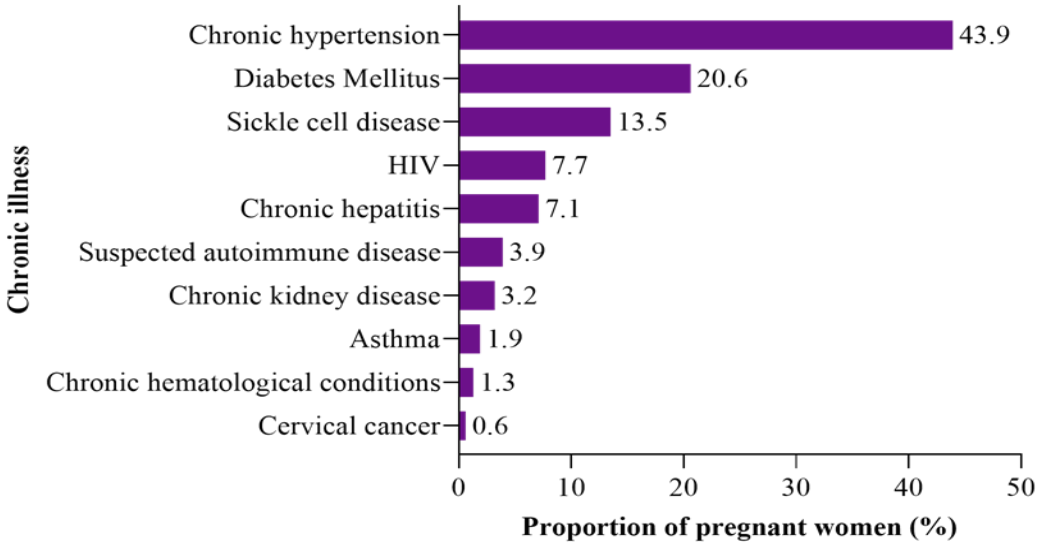


Figure 01: Proportion of pregnant women with chronic illinesses undergoing obstetric ultrasound at MNH from September 2023 to March 2024

4.2 Estimated fetal weight and other grayscale findings among pregnant women with chronic illnesses attending ANC at MNH, from September 2023 to March 2024.

Among 155 pregnant women with chronic illnesses, 44(28.4%)had fetuses with estimated fetal weight(EFW) at < 10th percentile of their growing percentile charts at the mean of 1412.48(± 577.37) grams. In addition, reduced liquor volume was the most prevalent grayscale characteristic. **(Table 02).**

Table 02: Estimated fetal weight and other grayscale findings among pregnant women with chronic illnesses undergoing obstetric ultrasound from Sept to March 2024. N=155

Variable	Frequency (n)	Percent (%)
EFW by the 10^{th} percentile		
$< 10^{th}$ percentile	44	28.4
$>10^{th}$ percentile	111	71.6
Mean EFW (± SD) gm	2068.80 (± 752.27)	
Mean EFW $< 10^{th}$ (± SD)	1412.48 (± 577.37)	
Mean EFW $>10^{th}$ (± SD)	2294.57 (± 624.41)	
Normal grayscale ultrasound		
Yes	109	70.3
No	46	29.7
Type of abnormal grayscale ultrasound (n = 46)		
Reduced liquor volume	21	45.6
Early placentae calcification	9	19.6
Intrauterine fetal death	6	13
Placenta lake	3	6.5
Polyhydramnios	1	2.2
Fetal tachycardia	1	2.2
Mild ventriculomegaly	1	2.2
Low lying placenta	1	2.2
Intramural myoma	1	2.2
Cystic hygroma	1	2.2
Abruptio placenta	1	2.2

$<10^{th}$ Percentile=FGR , $>10^{th}$ Percentiles=Normal growth

4.3 Umbilical Doppler artery indices findings among pregnant women with chronic illness

Three umbilical artery Doppler indices were evaluated in this study, normal Doppler indices of <95th percentiles were noted in the majority of the participants of which PI, S/D and RI were in the proportion of 84%,86%, 84% respectively.Few number of the participants were having DEDF(7.1%),AEDF(6.5%) and REDF(3.9%). **(Table 03).**

Table 03: The umbilical Doppler artery indices findings among pregnant women with chronic illnesses undergoing obstetric ultrasound from September 2023 to March 2024

Variable	Frequency (n)	Percent (%)
Pulsatility indices/PI		
Normal value	126	84.0
Abnormal value	24	16.0
Mean Pulsatility Index (± SD)		
Normal	0.96 (± 0.17)	
Abnormal	1.81 (± 0.71)	
End Systolic/ End diastolic ratio (S/D)		
Normal Values	129	86.0
Abnormal Values	21	14.0
Mean Systolic/diastolic ratio (± SD)		
Normal value	2.71 (± 0.57)	
Abnormal value	4.64 (± 1.08)	
Resistive Index (RI)		
Normal value	126	84.0
Abnormal value	24	16.0
Mean Resistive Index (RI) (± SD)		
Normal value	0.68 (± 0.53)	
Abnormal	0.94 (± 0.13)	
Umbilical artery Spectral Doppler waveforms		
Normal saw-tooth pattern waveform	122	78.7
Decreased end diastolic flow(DEDF)	11	7.1
Absent end-diastolic flow(AEDF)	10	6.5
Reversed end-diastolic flow(REDF)	6	3.9
Undetectable waveform	6	3.8

Normal Value= <95th Percentiles, Abnormal Value= >95th Percentiles.

Table 04: Association between chronic medical conditions and Pulsatility indices among the pregnant women with chronic illinesses undergoing obstetric ultrasound from September 2023 to March 2024.

	Pulsatility indices (PI)		
Variable	**Normal value**	**Abnormal value**	**p-value**
Chronic hypertension			
Yes	48 (72.7)	18 (27.3)	< 0.001*
No	78 (92.9)	6 (7.1)	
Diabetes mellitus			
Yes	30 (96.8)	1 (3.2)	0.028
No	96 (80.7)	23 (19.3)	
Sickle cell disease			
Yes	17(85.0)	3 (15.0)	1.000
No	109(83.8)	21(16.2)	
Cardiovascular disease			
Yes	14 (87.5)	2 (12.5)	1.000
No	112 (83.6)	22 (16.4)	

<95th percentile=Normal value,
>95th percentile =Abnormal value

Table 05: Association between chronic medical disease and Peak Systolic/end-diastolic ratio among pregnant women with chronic illnesses undergoing obstetric ultrasound from September 2023 to March 2024.

	Systolic/diastolic ratio		
Variable	**Normal value(n%)**	**Abnormal value(n%)**	**p-value**
Chronic hypertension			
Yes	49 (74.2)	17 (25.8)	< 0.001
No	80 (95.2)	4 (4.8)	
Diabetes mellitus			
Yes	30 (96.8)	1 (3.2)	<0.028
No	96 (80.7)	23 (19.3)	
Sickle cell disease			
Yes	18 (90)	2 (10)	0.741
No	111 (85.4)	19 (14.6)	
Cardiovascular disease			
Yes	15 (93.8)	1 (6.3)	0.345
No	114 (85.1)	20 (14.9)	

Pregnant women with chronic hypertension had higher proportion of abnormal PI and S/D in comparison to non-hypertensive individuals and the differences were statistically significant with P-values (0.001*). **(Table 04&05)**

4.4 Relationship of chronic medical conditions and estimated fetal weight(EFW)

Pregnant women with chronic hypertension had a high proportion (44.1%) of fetuses with EFW<10th Percentile (Fetal growth restriction) compared to those without hypertension of which the difference is statistically significant with the P-value of (<0.001*). (**Table 06**).

Table 06: The relationship between chronic medical conditions and estimated fetal weight among pregnant women with chronic illnesses undergoing obstetric ultrasound from September 2023 to March 2024.

	Estimated fetal weight		
Variable	**< 10th (%)**	**>10th (%)**	**p-value**
Chronic hypertension			
Yes	30 (44.1)	38 (55.9)	< 0.001
No	14 (16.1)	73 (83.9)	
Diabetes mellitus			
Yes	5 (15.6)	27 (84.4)	0.072
No	39 (31.7)	84 (68.3)	
Sickle cell disease			
Yes	7 (33.3)	14 (66.7)	0.500
No	37 (27.6)	97 (72.4)	
Cardiovascular disease			
Yes	4 (25.0)	12 (75.0)	1.000*
No	40 (28.8)	99 (71.2)	

* p values were obtained from the Fisher Exact test

4.5 Relationship between Umbilical Artery Doppler findings indices and estimated fetal weight

The majority of the participants with abnormal umbilical Doppler indices of PI, S/D and RI were associated with estimated fetal weight(EFW) below the 10thpercentile, compared to those with normal umbilical Doppler indices at which the difference is statistically significant with a P- value of (<0.001*). Furthermore, the participants with Reversed end diastolic flow (REDF) were strongly associated with EFW <10th Percentile with a P-Value of (0.001*). **(Table 07)**

After adjusting for the confounders the Pulsatility Index(PI) was the independent factor to associate with IUGR with 20 times risk. Individuals with chronic hypertension have three times the risk of having a fetus with IUGR**. (Table 08)**

Table 07: The relationship between Umbilical Artery Doppler findings indices and estimated fetal weight (EFW) of the participants from September 2023 to March 2024.

	Estimated fetal weight (in percentiles)		
Variable	**< 10th (%)**	**>10th (%)**	**p-value**
Pulsatility indices (PI)			
Normal value	21 (16.7)	105 (83.3)	< 0.001
Abnormal value	20 (83.3)	4 (16.7)	
Systolic to diastolic ratio (S/D)			
Normal value	23 (17.8)	106 (82.2)	< 0.001
Abnormal	18 (85.7)	3 (14.3)	
Resistive index (RI)			
Normal value	21 (16.7)	105 (83.3)	< 0.001
Abnormal value	20 (83.3)	4 (16.7)	
Umbilical Artery Spectral Doppler waveforms			
Normal saw-tooth pattern waveform	20 (16.3)	103 (83.7)	< 0.001*
Decreased end-diastolic flow	8 (72.7)	3 (27.3)	
Absent end-diastolic flow	7 (70.0)	3 (30.0)	
Reverse end diastolic flow	6 (100.0)	0 (0.0)	
Undetectable waveform	3 (60.0)	2 (40.0)	

* p values were obtained from Fisher Exact test,
Normal value<95th percentile, abnormal value >95th percentile

Table 08: Univariate and multivariate analysis of the factors associated with the low estimated fetal weight(EFW<10th Percentiles)

	Univariate analysis			Multivariate analysis		
Variable	**cOR**	**95% CI**	**p-value**	**aOR**	**95% CI**	**p-value**
Pulsatility indices (PI)						
>95th percentile	25.00	7.75 – 80.65	< 0.001	20.35	6.03 – 68.66	< 0.001
< 95th percentile	Ref					
Systolic to diastolic ratio (S/D)						
>95th percentile	27.65	7.52 – 101.74	< 0.001*			
< 95th percentile	Ref					
Resistive index (RI)						
>95th percentile	25.00	7.75 – 80.65	< 0.001*			
< 95th percentile	Ref					
Chronic hypertension						
Yes	4.12	1.95 – 8.68	< 0.001	3.56	1.38 – 9.18	0.009
No	Ref					
Diabetes mellitus						
Yes	0.40	0.14 – 1.11	0.079	1.26	0.38 – 4.23	0.706
No	Ref					
Sickle cell disease						
Yes	1.31	0.49 – 3.50	0.590			
No	Ref					
Cardiovascular disease						
Yes	0.82	0.25 – 2.71	0.751			
No	Ref					

Key: cOR: crude Odds Ratio, aOR: adjusted Odds Ratio, Ref: Reference

*Were not included in the multivariate because they have collinearity with Pulsatility indices (PI)

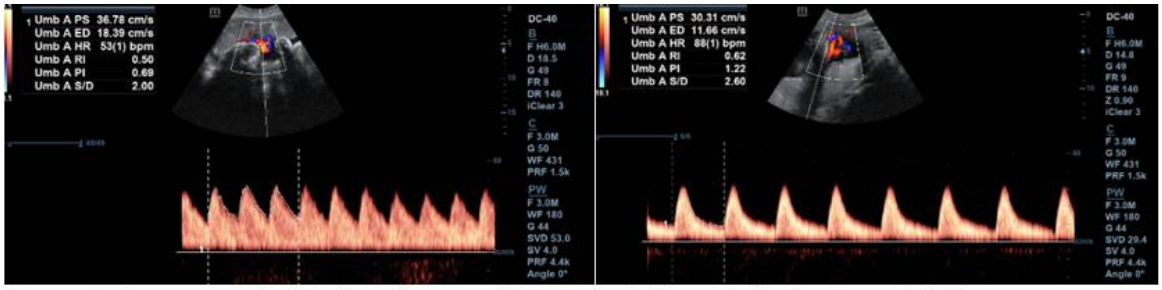


Figure 02:Two spectral Doppler ultrasound images of the umbilical artery of different pregnant women one with Sickle cell disease on the left and the other with chronic hypertension on the right.

Figure 02: *The right image was from 28 years pregnant woman with sickle cell disease at GA of 34weeks which shows normal spectral Doppler waveforms that resemble like saw-tooth appearance, while the left spectral color Doppler image was from 35 years pregnant woman with chronic hypertension at GA of 31 weeks which revealed reduced end diastolic flow as there is loss of normal saw-tooth pattern of spectral doppler waveforms.*

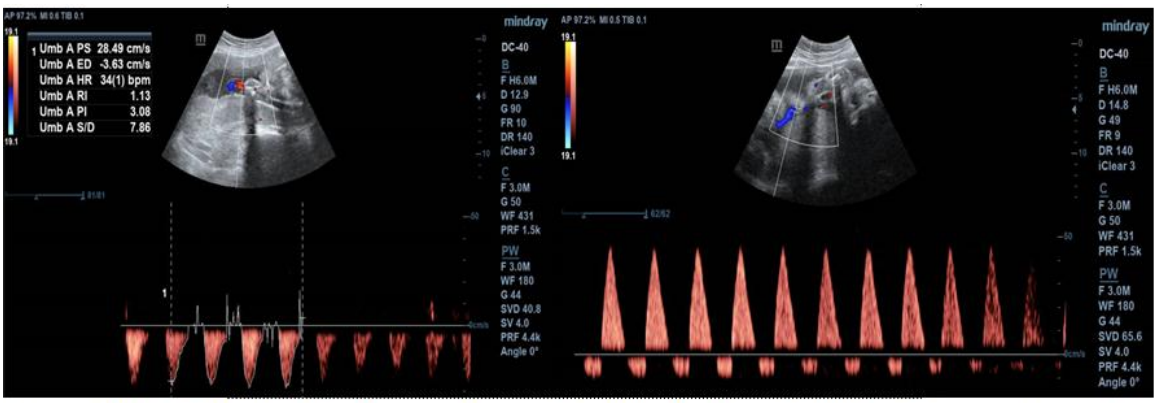


Figure 03:Spectral color Doppler waveforms of umbilical arteries in different pregnant women at third trimester .

Figure 03: *Shows two spectral color Doppler waveforms of the umbilical artery, the right image(inverted Doppler) was taken from a 32-year-old lady who had chronic hypertension and Chronic kidney disease in the third trimester which revealed the absence of End diastolic flow with raised Doppler indices marker and on the right image was from 35 years old lady with Chronic HTN that shows reversed end Diastolic Flow.*

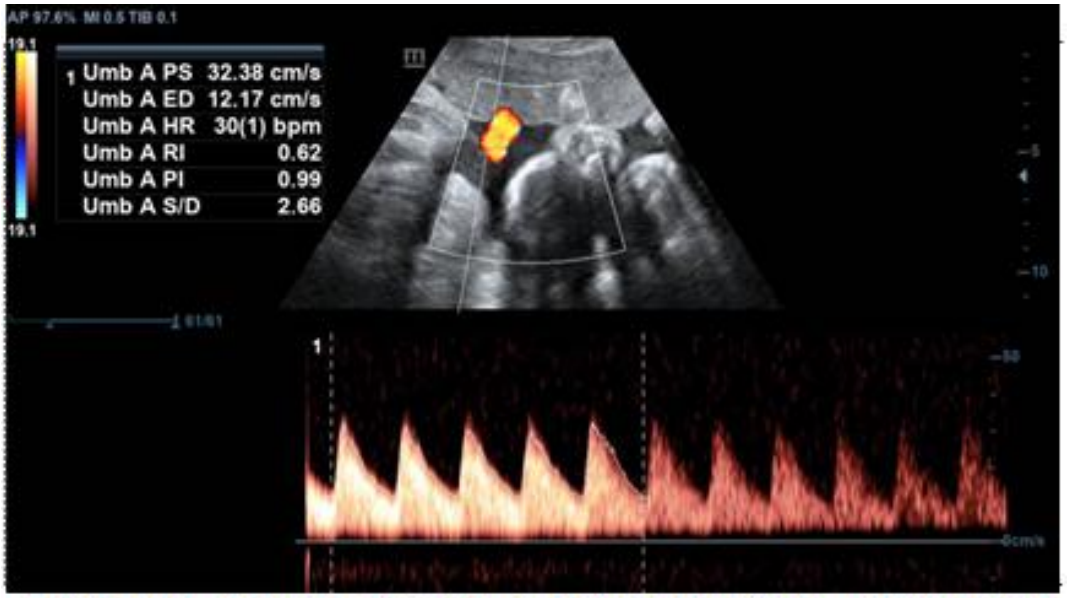


Figure 04: Normal spectral Doppler waveform in pregnant women with chronic hypertension at the second trimester.

Figure 04 shows one spectral Doppler of 35 years old pregnant woman with chronic hypertension at 32weeks of gestation age ,the image shows normal diastolic flow in saw- tooth like configuration with the normal umbilical artery Doppler indices of PI,RI &S/D.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Discussion

Grayscale ultrasound and umbilical artery Doppler are low-cost, non-invasive methods that can identify any intrauterine fetal abnormality, such as hemodynamic changes within the placenta with the consequence of placenta insufficiency that leads to Intrauterine Growth restriction(33). An increase in chronic illnesses among expectant mothers has been documented; these conditions are associated with effects on fetal well-being such as poor placenta formation and vascular resistance. In our community, the use of umbilical artery Doppler ultrasound in assessing the fetal-placental unit is not routinely done.

Our study enrolled 155 pregnant women with chronic medical conditions, the age of the participants ranged from 18 - 44 years at the IQR(31,37) this tallies with the study done by Kersten et al and Kumari et al in India where the age range of pregnant women with chronic illnesses were 14-45 and 19-40 years respectively[9,20], again most of the participants are married(82.6%) which correlate with a study done in Nigeria by Agwu, et al where 97.9% of pregnant women with chronic disorders were married[24]. The majority of participants (50.3%) have completed secondary education, which is considered a high level of education in our community. These findings are consistent with previous research that found that 40% of participants had high levels of education. However, the results differ in that the majority of participants in those other studies had high-income levels which is different from this study this could be explained by the fact that the participants were from developing country [9,25].

We found most prevalent chronic illness in this study is chronic hypertension (43.9%), this concurs with the study done by Kumari, et al about non-communicable diseases in pregnant where chronic hypertension ranked by 30.8% in comparison to other chronic medical conditions[20], again we found fewer participants having chronic medical

conditions of cardiovascular and autoimmune diseases, these contradict the study done in India by kumari, et al at which cardiovascular disease(15.7%) and autoimmune disease(7.6%) were seen in slightly higher proportion[20], the difference of this could be explained by the small sample size that we used in this study**.**

About a quarter of the participants had fetuses with EFW<10th percentiles which indicates fetal growth restriction(IUGR) that could be caused by poor placenta health and hemodynamic disturbance of the fetal-placental unit that contributed by their chronic illnesses conditions. There 44.1% of the participants with chronic hypertension had a fetus with EFW below the 10th percentile. This is comparable to the study done by P. Komuhangi et al Uganda, where IUGR was noted in pregnant women with chronic hypertension(33). A similar study done by Rajarajeswari R et al India showed the IUGR in pregnant women with bronchial asthma and Chronic hypertension (34),6 participants had Intrauterine fetal death(IUFD)this could have been attributed to the severity of placenta insult that causes marked fetal hypoperfusion this finding correlates with other studies where IUFD has been reported in women with SCA, cardiovascular disease and DM[12,25,28,35]. Early placenta calcification was seen in 9(19.6%) of the participants which indicates the placenta aging process, the evidence has been reported in another study by Jamal et al where early placenta calcification was seen in DM, HTN however no definite relationship existed(36), again early placenta calcification was seen in AEDF/REDF(36)**.** This study found reduced liquor volume in about 13.5% of the participants, these findings have also been reported in pregnant women with chronic illnesses by Backsh et al l and Kersten et al (8,37). These reduced fetal liquor volumes could be due to the chronic illness of the mother or the existence of any fetal abnormalities.

In this study, three Umbilical artery Doppler indices were evaluated, indices <95th percentiles in comparison to the specific gestation age were regarded as normal values and were seen in the majority of the participants of which the PI, S/D and RI were a proportion of 84%,86%,84% respectively. We found a raised abnormal value of peak systolic to an end-diastolic ratio(S/D) to a patient with sickle cell anemia 2(10%), this is

different from the study done by Anyaegbunam et al where abnormal S/D was noted in slightly higher percentage 8(75%) this is because of the different study methodology as Anyaegbunam et al recruited only pregnant women with sickle cell anemia(38), we found one patient with diabetes mellitus having abnormal S/D ratio, this is different from the study done by Landon and college where there was significant abnormal S/D ratio to diabetic women with Vasculopathy, this difference could be caused by the fact that our study participants might have well-controlled DM does the fact that all patients are followed by a fetal maternal specialist[7]. Furthermore, we found only one patient with Diabetes mellitus having a high PI, and S/D ratio this concurs with the study done by Salvesen et al where he found the normal umbilical Doppler in maternal complicated by Diabetes mellitus except for those with IUGR and pre-eclampsia(37), again from the study done by Leung ta et al showed no REDF or AEDF to pregnant women with DM**.**

In addition, the majority of the participants122(78.7%) had normal umbilical artery Doppler waveforms, which is different from the prior research findings in which most of the pregnant women had abnormal umbilical artery Doppler >95th percentile (13,38)**,** these variations might be the result of the study's larger sample size and the likelihood that our patients are treated well by fetal-maternal specialists, which lowers pregnancy complications.. Also, few numbers of the participants had umbilical Doppler waveforms DEDF(7.1%), AEDF(6.5%) and REDF(3.9%) the findings go parallel with another study done in Uganda where abnormal umbilical Doppler waveforms of AEDF and REDF were seen in patients with chronic hypertension(27,34), again the findings concur with the study done by Dicke et al found five pregnant women with chronic hypertension had abnormal PI and AEDF in comparison to other groups(39). There were no abnormal umbilical artery Doppler waveforms in patients with Diabetic Mellitus this tallies with the study done by P. Komuhangi et a where no abnormal Doppler waveforms were seen in pregnant women with DM(33)

This study found a strong association between abnormal umbilical artery Doppler indices of PI, RI and S/D>95th percentiles which were noted in high proportion in pregnant

women with EFW<10th percentiles compared to those with EFW >10th percentiles, which indicates IUGR and this different was statistically significant with P-value (<0.001*). These results go parallel with a previous study showing that low EFW<10th percentiles in pregnant women with chronic illness was associated with elevated values of PI, RI (>5.8) and S/D(>3.1) ratio[22,26]. In addition, there was a strong relationship found between the DEDF, AEDF, and REDF with EFW<10th percentiles, this agrees with previous research that found the fetuses with IUGR had reduced end-diastolic flow 48/90 (53.3%), AEDF 14/90 (15.6%), and REDF 8/90 (8.9%)(31), further proved from P. Komuhangi et al in Uganda where DEDF, AEDF and REDF were seen in the fetus with IUGR(33). In addition, a study done by J.A. Gurgel Alves in Spain showed the abnormal umbilical artery Doppler in high proportion to Fetus with IUGR where raised PI, AEDF(52.94%) & REDF were seen in pregnant women with hypertension(40). Also the the study done by Rajarajeswari R et al found raised umbilical artery Doppler index and AEDF/REDF in pregnant women with IUGR this is seen in high proportion different from this study as the investigator recruited only pregnant women with IUGR (34).

These findings increase the body of evidence supporting IUGR and abnormal umbilical artery Doppler indices and spectral Doppler waveforms in pregnant women with long-term medical conditions. Furthermore, individuals with chronic hypertension have more than three times the risk of having a fetus with Intrauterine growth restriction.

5.2 Limitations

1. Doppler ultrasound is operator dependent, hence concern for the information bias.

5.2.1 Mitigation

1. Two sonographers were used at the point when there was data discrepancy and a senior radiologist for data verification.

5.2.2 Strength of the Study

Since the study was conducted at a tertiary hospital with a larger sample size, it is a good study to be representative. As a result, these results demonstrated the scope and existence of the problem, and all hospital levels are encouraged to implement obstetric ultrasound procedures for pregnant patients to prevent any fetal complications.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Reversed end-diastolic flow (REDF) is a strong sonographic predictor of intrauterine fetal growth restriction and chronic hypertension has been shown to increase the risk threefold in our cohort**.**

6.2 Recommendations

1. There should be a hospital policy to integrate the routine use of Umbilical artery Doppler ultrasound for early assessment of intrauterine fetal health in pregnant women with chronic illnesses.

2. There should be more research done to determine a relationship between fetal outcomes and umbilical artery Doppler findings.

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APPENDICES

Appendix 1: Consent Form (Swahili Version)

CHUO KIKUU CHA AFYA NA SAYANSI SHIRIKISHI MUHIMBILI

KURUGENZI YA TAFITI NA UCHAPISHAJI

FOMU YA RIDHAA

Namba ya utambulisho……..

Ridhaa ya kushiriki kwenye utafiti

Habari! Jina langu ni Maria Augustino Shemweta.Ninafanya utafiti wa kuangalia matumizi ya ultrasound kwa kuangalia ukuaji wa mtoto tumboni kwa wamama wajawazito wenye magonjwa sugu, wanaohudhuria kliniki katika hospital ya Taifa ya Muhimbili.

Madhumuni ya Utafiti

Utafiti huu unafanywa kama utimilifu wa sehemu ya mahitaji ya Shahada ya Uzamili ya Tiba katika Radiolojia katika chuo cha MUHAS. Utafiti huu unalenga kutathmini jukumu la matumizi ya Ultrasound na Umbilical Doppler ultrasonography katika kutathmini changamoto zozote za ukuaji wa mtoto tumboni kwa wamama wajawazito wenye magonjwa sugu. Hili ni la umuhimu mkubwa kwani litasaidia kugundua changamoto zozote zinazoweza kumuathiri mtoto, hivyo kupelekea hatua za kitabibu za haraka kuchukuliwa. Unaombwa kushiriki katika utafiti huu kwa sababu maelezo yako na matokeo ya sonografia ya ugonjwa yatasaidia kupata takimwi sahihi ya utafiti huu. Tafadhali kuwa mkweli na mwaminifu kwani usahihi wa matokeo yatasaidia uingiliaji kati bora na mapendekezo katika siku zijazo

Jinsi ya kushiriki

Ukikubali kushiriki katika utafiti huu, utasailiwa alafu utatakiwa kujibu maswali kutoka kwenye dodoso lililoandaliwa alafu utaendelea na kipimo kama kawaida.

Usiri

Taarifa zote zitakazokusanywa kupitia dodoso hili zitakuwa ni siri. Jina lako halitatumika

badala yake tutatumia namba ya utambulisho.

Uhuru wa kushiriki na haki ya kujitoa

Kushiriki kwenye utafiti huu ni hiari. Unaweza kushiriki au kukataa kushiriki na hii haitakuondolea haki ya kupata matibabu yako.

Nani wa kuwasiliana naye

Kama una maswali kuhusiana na utafiti huu, wasiliana na mtafiti mkuu Dkt. Maria.A.Shemweta, Chuo Kikuu cha Afya na Sayansi ya Tiba Muhimbili, S. L. P. 65001, Dar es Salaam, Simu 0714195233, au msimamizi wa utafiti huu Dr. Zuhura Nkrumbih (baruapepe znkrumbih@yahoo.com) na Helena Machibya (Barua pepe machibyahelena54@gmail.com

Na kwa maelezo zaidi juu ya ushiriki wako, unaweza wasiliana na mkurugenzi wa utafiti na machapisho Muhas:

Dr.Nahya Salim, kwa S.L.P 65001 /au kwa barua pepe E-mail:drp@muhas.ac.tz au simu:+255-22-2150302/6 na pia simu:+255-22-2152489

Kama umekubali kushiriki weka sahihi

Mshiriki amekubali

Mimi..... nimesoma maelezo ya fomu hii nimeyaelewa na nimekubali kushiriki katika utafiti huu.

Sahihi ya mshiriki…… Tarehe ya kutia sahihi…….....

Sahihi ya mtafiti…… Tarehe ya kutia sahihi…….

Appendix II: Data collection tool

GRAYSCALE AND UMBILICAL ARTERY DOPPLER FINDINGS AMONG PREGNANT WOMEN WITH CHRONIC MEDICAL CONDITIONS ATTENDING ANC AT MHN.

Identity number ……Interviewee initials…….address…….

1. Social and demographic characteristics

i) **Patient age** ……

ii) **Maternal weight**……..

iii) **Number of Parity** ……..

a. Nullparity

b. Parity(1-2)

c. Parity >3

iv) Number of gravidities ---------

a.Primegravidity

B.2-3

c.>3

(v) Marital status

a) Married c) Single

b) Cohabiting d) Divorced

e) Widow

(vi) Educational level

a) Illitelite/No formal Education c) Secondary education

b) Primary Education d) Higher education/College

(vii) Occupational

a) Unemployed d) Peasant

b) Housewife e) Formal employment

c) Self-employed/petty trade

(viii) **Cigarrete smoking use** 1.Yes 2.No

(ix) **Alcohol use** 1.Yes 2.No

(x) Dietary education given 1.Yes 2.No

2. Which chronic illnesses have you been diagnosed with/by asking the patient or taking the patient's information from a doctor

I. Chronic hypertension ☐

II. Sickle cell disease ☐

III. Diabetes mellitus ☐

IV. Cardiovascular disease(CHD, RHD, or any reported heart disease) ☐

V. Suspected autoimmune diseases(SLE and Antiphospholipid syndrome)

VI. Any other chronic disease. (eg chronic kidney disease, infectious disease TB, HIV)……

3. **Pregnancy gestation age…….**

a. By LNMP……

b. By USS…… (Consider early OBS USS and correct date of LNMP)

4. **Estimated fetal weight by grayscale USS**

Calculated Gestation age	Estimated fetal weight(EFW)	EFW by the 10^{th} percentile	
		$<10^{th}$ value	$>10^{th}$ value

5. Grayscale ultrasonographic findings

I. Normal grayscale ultrasound YES NO

II. Neural tube defect YES NO

III. Any cardiac anomalies YES NO

IV. Absence of cardiac activity/fetal death. YES NO

V. Abruptio placenta YES NO

VI. Any other grayscale abnormalities ……..(mention)

6. **Umbilical artery Doppler indices findings**

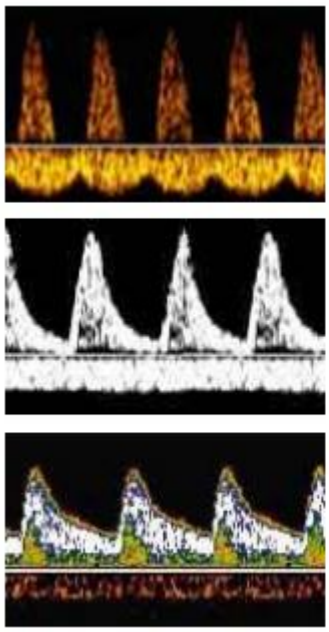
Gestation age	Pulsatility indices/PI		Systolic/diastolic ratio(S/D)		Resistive index(RI)	
	<95th value	>95thpercentile	<95thpercentile	>95th percentile	<95th value	>95th percentile

7. Umbilical artery Spectral Doppler waveform findings

Doppler waveform	**YES**	**NO**
Normal saw-tooth pattern waveform		
Decreased end-diastolic flow		
Absent end-diastolic flow		
Reversed end-diastolic flow		
Undetectable waveform		

Appendix III: Important charts and images for references

1. Normal UAD waveforms according to gestational age, image from Patterson R et al 2020.

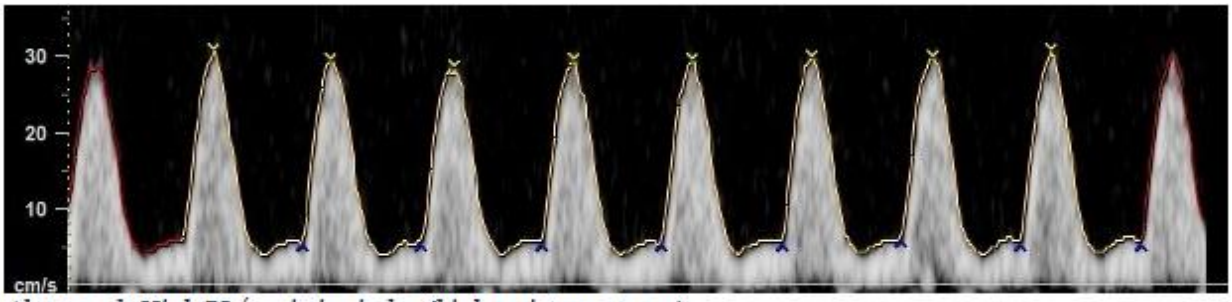


Normal impedance to flow in the umbilical arteries and normal pattern of pulsatility at the umbilical vein in 1º trimester

Normal impedance to flow in the umbilical arteries and umbilical vein in early 2ºtrimester

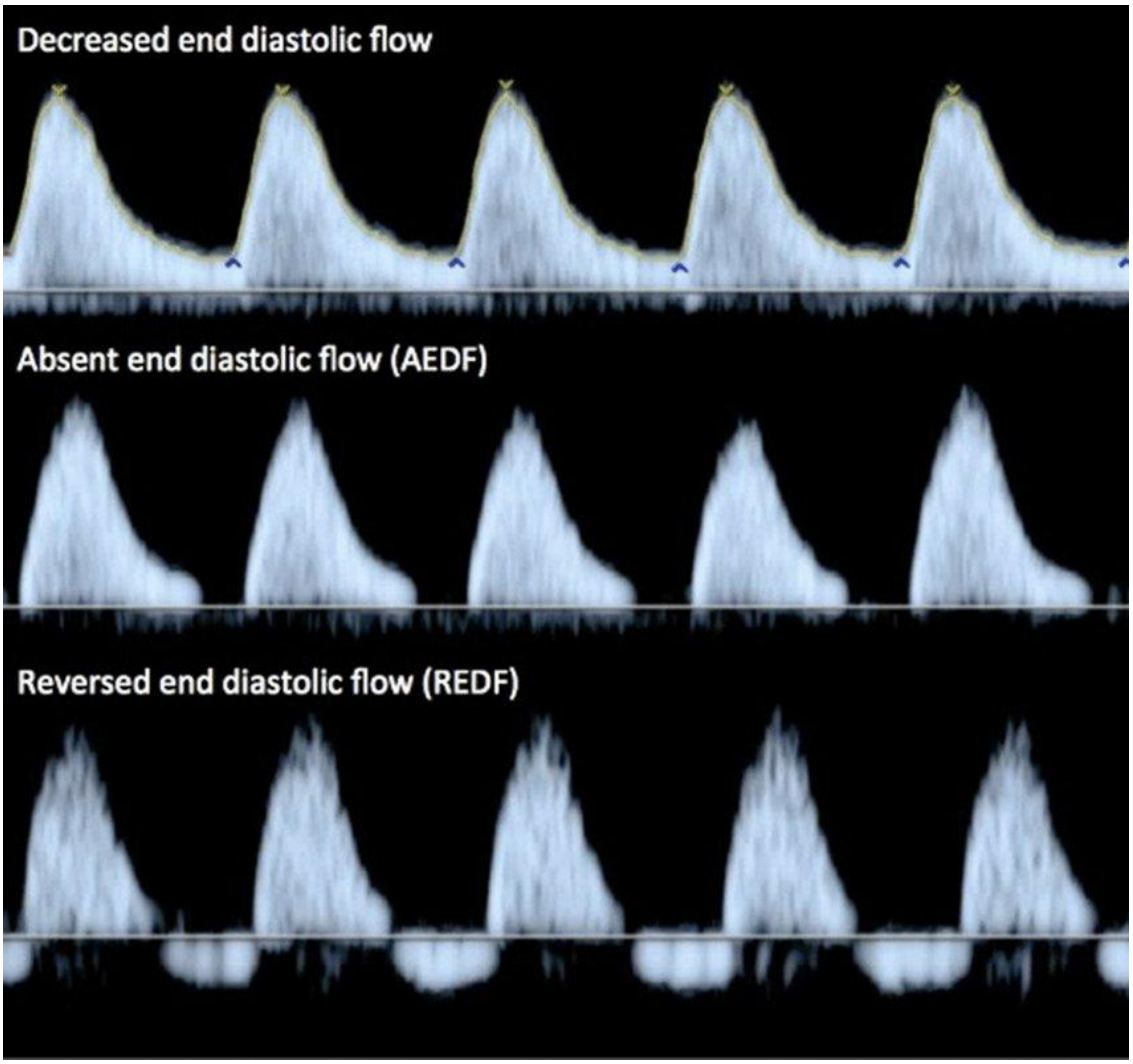
Normal impedance to flow in the umbilical arteries and umbilcal vein in late 2º and 3º trimester

2. The UAD shows the high Pulsatility index, an image from guidelines of Obstetric Doppler USS in Newzland



Abnormal: High PI / resistive index (high resistance trace).

3. **The image shows an abnormal UAD waveform, from Dora J. Melber et, 2021 Clinical Applications for Doppler Ultrasonography in Obstetrics**



4. **The table charts adopted from the study done in Nigeria, Normogram of umbilical artery Doppler indices in singleton pregnancies in south-western Nigerian women**

Table 1 Reference limits of umbilical artery Doppler indices

GA (weeks)	PI			RI			S/D ratio		
	Percentile			Percentile			Percentile		
	5th	50th	95th	5th	50th	95th	5th	50th	95th
15	1.094	1.265	1.422	0.594	0.760	0.789	2.906	4.068	5.100
16	1.073	1.247	1.415	0.580	0.753	0.787	2.834	3.997	5.036
17	1.051	1.229	1.408	0.567	0.746	0.784	2.763	3.926	4.972
18	1.030	1.211	1.402	0.554	0.738	0.781	2.692	3.855	4.907
19	1.009	1.192	1.395	0.541	0.731	0.778	2.621	3.784	4.843
20	0.988	1.174	1.388	0.528	0.724	0.775	2.549	3.713	4.779
21	0.967	1.156	1.381	0.514	0.716	0.772	2.478	3.642	4.715
22	0.946	1.138	1.375	0.501	0.709	0.769	2.407	3.571	4.651
23	0.925	1.120	1.368	0.488	0.702	0.766	2.335	3.500	4.587
24	0.904	1.102	1.361	0.475	0.694	0.763	2.264	3.429	4.523
25	0.883	1.083	1.354	0.462	0.687	0.760	2.193	3.358	4.459
26	0.862	1.065	1.348	0.448	0.680	0.758	2.121	3.288	4.395
27	0.841	1.047	1.341	0.435	0.673	0.755	2.050	3.217	4.331
28	0.820	1.029	1.334	0.422	0.665	0.752	1.979	3.146	4.267
29	0.799	1.011	1.327	0.409	0.658	0.749	1.907	3.075	4.203
30	0.778	0.992	1.321	0.396	0.651	0.746	1.836	3.004	4.138
31	0.757	0.974	1.314	0.382	0.643	0.743	1.765	2.933	4.074
32	0.736	0.956	1.307	0.369	0.636	0.740	1.694	2.862	4.010
33	0.715	0.938	1.300	0.356	0.629	0.737	1.622	2.791	3.946
34	0.694	0.920	1.294	0.343	0.621	0.734	1.551	2.720	3.882
35	0.673	0.902	1.287	0.330	0.614	0.732	1.480	2.649	3.818
36	0.652	0.883	1.280	0.317	0.607	0.729	1.408	2.578	3.754
37	0.630	0.865	1.273	0.303	0.599	0.726	1.337	2.507	3.690
38	0.609	0.847	1.267	0.290	0.592	0.723	1.266	2.436	3.626
39	0.588	0.829	1.260	0.277	0.585	0.720	1.194	2.365	3.562

GA, gestational age; PI, pulsatility index; RI, resistivity index; S/D, systolic/diastolic.

5. **The chart adopted from WHO charts: A Multinational Longitudinal Study of Ultrasound Biometric Measurements and Estimated Fetal Weight Torvid Kiserud Jan 2017**

Table 11. Growth chart for estimated fetal weight regardless of fetal sex.

Gestational Age (Weeks)	Estimated Fetal Weight (g) by Percentile								
	2.5	5	10	25	50	75	90	95	97.5
14	70	73	78	83	90	98	104	109	113
15	89	93	99	106	114	124	132	138	144
16	113	117	124	133	144	155	166	174	181
17	141	146	155	166	179	193	207	217	225
18	174	181	192	206	222	239	255	268	278
19	214	223	235	252	272	292	313	328	340
20	260	271	286	307	330	355	380	399	413
21	314	327	345	370	398	428	458	481	497
22	375	392	412	443	476	512	548	575	595
23	445	465	489	525	565	608	650	682	705
24	523	548	576	618	665	715	765	803	830
25	611	641	673	723	778	836	894	938	970
26	707	743	780	838	902	971	1,038	1,087	1,125
27	813	855	898	964	1,039	1,118	1,196	1,251	1,295
28	929	977	1,026	1,102	1,189	1,279	1,368	1,429	1,481
29	1,053	1,108	1,165	1,251	1,350	1,453	1,554	1,622	1,682
30	1,185	1,247	1,313	1,410	1,523	1,640	1,753	1,828	1,897
31	1,326	1,394	1,470	1,579	1,707	1,838	1,964	2,046	2,126
32	1,473	1,548	1,635	1,757	1,901	2,047	2,187	2,276	2,367
33	1,626	1,708	1,807	1,942	2,103	2,266	2,419	2,516	2,619
34	1,785	1,872	1,985	2,134	2,312	2,492	2,659	2,764	2,880
35	1,948	2,038	2,167	2,330	2,527	2,723	2,904	3,018	3,148
36	2,113	2,205	2,352	2,531	2,745	2,959	3,153	3,277	3,422
37	2,280	2,372	2,537	2,733	2,966	3,195	3,403	3,538	3,697
38	2,446	2,536	2,723	2,935	3,186	3,432	3,652	3,799	3,973
39	2,612	2,696	2,905	3,135	3,403	3,664	3,897	4,058	4,247
40	2,775	2,849	3,084	3,333	3,617	3,892	4,135	4,312	4,515

doi:10.1371/journal.pmed.1002220.t011

Appendix iv: Ethical clearance and permission letter

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF HEALTH

MUHIMBILI NATIONAL HOSPITAL

In reply please quote;

Ref. No.: MNH/CRTCU/Perm/2023/493 Date: 08th September, 2023

Head of Department,
Imaging Diagnostic Section
Muhimbili National Hospital

RE: PERMISSION TO COLLECT DATA AT MNH.

Name of Student	**Maria Augustino**
Title	**"Role of Obstetrics Ultrasound in the Fetal Assessment Among Chronically Ill Pregnant Women Attending Clinic at Muhimbili National Hospital".**
Institution	Muhimbili University of Health and Allied Sciences
Supervisors	Dr. Zuhura Nkrumbih (MUHAS)
Co - Supervisor	Dr. Sophia Kiwango (MNH)
Period	08th September, 2023 to 28th February, 2024

Approval has been granted to the above mentioned student to collect data at MNH. **A final study report should be lodged with Clinical Research, Training and Consultancy Unit.** Dissemination of study findings to MNH stakeholders shall be overseen by **Dr. Sophia Kiwango** (MNH) Co – supervisor.

Kindly ensure that the student abide to the ethical principles and other conditions of the research approval.

Sincerely,

Dr. Jessie Mbwambo
Head of Clinical Research, Training and Consultancy Unit

c.c DCSS
c.c Dr. Sophia Kiwango
c.c **Maria Augustino**

Upanga West, Kalenga Street, Plot No. 1048/3, P.O. BOX 65000, Dar es Salaam, Tanzania.
Telephone: +255-22-2151367-9, Telephone: +255-22-2151351-2
Email: info@mnh.or.tz, Website: www.mnh.or.tz

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR – RESEARCH, PUBLICATIONS AND INNOVATION

Ref. No.DA.282/298/01.C/1864 Date: 20/08/2023

MUHAS-REC-08-2023-1864
MARIA AUGUSTINO SHEMWETA
SCHOOL OF MEDICINE
MUHAS

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: ROLE OF OBSTETRIC ULTRASOUND IN THE FETAL ASSESSMENT AMONG CHRONICALLY ILL PREGNANT WOMEN ATTENDING ANTENATAL CLINIC AT MNH

Reference is made to the above heading.

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 20/08/2023
EXPIRATION DATE OF APPROVAL: 20/08/2024

STUDY DESCRIPTION:
Purpose:
This prospective cross-sectional hospital-based study aims to determine any fetal growth and fetal placenta circulation abnormalities in pregnant women with chronic illnesses from the second to the third trimester of pregnancy by using grayscale and umbilical doppler Ultrasound.

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided:
https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%2014844.pdf and in the MUHAS archives.

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain data transfer agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain material transfer agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country,
8. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
9. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
10. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.

Dr. Nahya Salim Masoud,

Chairperson, MUHAS Research and Ethics Committee

Muhimbili University of Health and Allied Sciences
DIRECTOR
Research, Publications & Innovations
Box 65001