ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF GRADUATE STUDIES DEPARTMENT OF ANATOMY

Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, Ethiopia

The Thesis Submitted to Department of Human Anatomy, School of Medicine, College of Health Sciences, Addis Ababa University in Partial Fulfillment of The Requirements for the Degree of Masters of Science (MSc) in Human Anatomy.

By Damtew Solomon (BSc)

December, 2017

Addis Ababa, Ethiopia

DECLARATION

This is to certify that the thesis prepared by Damtew Solomon, entitled: Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, Ethiopia, at Addis Ababa University on year 2017 and submitted in partial fulfillment of the requirements for the Degree of Masters of Science in Medical Anatomy complies with the regulations of the university and meets the accepted standards with respect to originality and quality. This thesis has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged. The thesis was passed with EXCELLENT remark.

	Name	Signature	Date
Principal investigator	-----------------------	----------	---------------
Principal advisor	-----------------------	----------	-----------------
Co-advisor	------------------------	----------	----------------
Examiner	------------------------	----------	----------------
Department Head	------------------------	----------	----------------

Dedication

I dedicate this study to my dear wife Lamrot Fekade who is my life companion and who through the advancement of her own education also has provided me with an enormous stimulus to undertake a Master Degree study in Medical Human Anatomy. Thereby she has assisted me to finally arrive at a more balanced view of the art and practice of this field.

IDENTIFICATION

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Full title of project: Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, Ethiopia

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LIST OF ABBREVIATIONS AND ACRYNOMYS

AAU	Addis Ababa University
ANOVA	Analysis of Variance
BMI	Body mass Index
CHS	College of Health Sciences
CI	Confidence Interval
CPD	Cephalopelvic Disproportion
CS	Cesarean Section
ETB	Ethiopian birr
EPHI	Ethiopian Public Health Institute
GA	Gestational Age
HC	Head Circumference
IUFD	Intra Uterine Fetal Death
L3,4,5	Lumbar Vertebrae Number 3,4,5
LNMP	Last Normal Menstrual Period
PPV	Positive Predictive Value
ROC	Receiver Operating Characteristics
SPSS	Statistical Package for Social Sciences
USA	United State of America
WHO	World Health Organization

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ABSTRACT

Background: CPD (Cephalopelvic Disproportion) is defined as a mismatch between the maternal birth canal (the pelvis), and the fetal head. Detection of women at risk for CPD will allow physicians to make preparations and treatment decisions that can minimize maternal and neonatal morbidity.

Objective of the study: the general objective of the study was to assess Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, Ethiopia

Methods: Hospital based prospective cohort study was carried out at Governmental Hospitals in Addis Ababa. The sample size was 384 which were recruited consecutively until the required numbers were achieved. Three hospitals were purposely selected from governmental hospitals in Addis Ababa. The data was entered and analyzed using SPSS (Statistical Package for Social Sciences) version 23 statistical package. Analysis of variance (ANOVA), 95%CI (Confidence Interval) and P-values less than 0.05 were used to examine association between dependent and independent variables.

Results: Among 384 primigravid mothers 337 of them were delivered through spontaneous vaginal delivery and 47 mothers gave birth by CS due to confirmed Cephalopelvic Disproportion. Significant differences were noted for height, foot length, Michaelis horizontal and head circumference of mothers with and without CPD. combined anthropometric measurements showed increment in sensitivity, specificity and PPV. Foot length alone has a sensitivity percentage of 27.8, specificity percentage 89.6 and a PPV of 21.7%. When foot length is combined with other anthropometric measurements such as height, Michaelis horizontal and maternal head circumference its sensitivity increased to 59.6%, 33.3% and 30.4% respectively.

Conclusions: In the present study, **t**he variable that predicted Cephalopelvic Disproportion the most was maternal height. In addition, foot length, head circumference and Michaelis horizontal diameter were also found to be predictors of Cephalopelvic Disproportion.

Key words: Cephalopelvic disproportion, Spontaneous vaginal delivery, maternal anthropometric measurements, fetal birth weight

1. INTRODUCTION

1.1Background

Cephalopelvic disproportion (CPD) occurs in a pregnancy where there is mismatch in size between the fetal head and the maternal pelvis, resulting in 'failure of the fetus to pass safely through the birth canal for mechanical reasons'.[1] This may be caused by the fetal head outgrowing the capacity of the maternal birth canal, or by presentation in a position or attitude that will not allow descent through the pelvis. It is diagnosed when there is evidence of either (a) a prolonged first stage (>12 hours) in spite of effective uterine activity or (b) failure of the head to descend or evidence of severe molding or fetal distress in late first stage with secondary arrest or prolonged second stage.[2]

In developing countries, a significant number of maternal deaths are attributable to the complications of obstructed labor leading to birth canal trauma, postpartum hemorrhage, and genital infections, etc. Of patients with CPD, delay in the decision to seek care or delay in arrival to an appropriate medical care facility is common in rural hospitals.[3]

Detection of mothers at a higher risk of CPD is therefore important for higher precaution, close attention or preparation of cesarean section or timely labor induction in daytime when more manpower and experienced physicians are available. This is particularly crucial in settings where cesarean section is not feasible, so that women at high risk for CPD may be referred to a hospital equipped with an operating theatre before the onset of labor.[3]

Women who experience CPD often undergo surgical interventions such as emergency cesareans, vacuum or forceps deliveries which cause considerable physical problems for mothers, in addition to stress and an economic burden on the family and community. [3] Identifying women at risk for CPD prepare physicians for on time treatment and enable them to minimize maternal-fetal trauma.[4]

Numerous investigators have attempted to find indexes to identify high risk women during pregnancy. Factors such as mother's age, height, weight before pregnancy, body mass index (BMI), weight gain during pregnancy, fundal height, birth weight, and foot length of the mother as risk factors. These factors, however, are controversial.[5]

1.2Statement of Problem

Maternal deaths remain a major problem in developing regions of the world such as sub-Saharan Africa and south Asia. [1, 6] Cephalopelvic disproportion (CPD) is in such circumstances an important cause of maternal and perinatal mortality and is also associated with considerable morbidity for both the mother and the baby. [1, 6, 7] Perineal tears, postpartum hemorrhage, and obstetric fistulae in the mother, and birth asphyxia and birth trauma in the newborn are all associated with CPD. [8-10]

The direct clinical consequence of CPD is responsible for 8% of maternal deaths worldwide, according to figures quoted in the 2005 World Health Report of the World Health Organization (WHO).[11] A systematic review of caesarean section in Africa, published by the MOMA study group[12], reported rates of CPD ranging from 1.4% to 8.5%. Retrospective study conducted in the northern part Ethiopia (Adigrat, Tigray region), by reviewing patients' records, maternity registers and Operating Room books of 5,980 deliveries 195(3.3%) cases of obstructed labour was diagnosed. Their result showed as the causes for the obstruction of labour were CPD in 64.9% in which they found the prevalence of CPD was 2.1%.[13] Another cross-sectional prospective study conducted in Jimma specialized hospital for a period of 6 months till April 30, 2009, showed an incidence of 12.2% obstructed labour among 1,468 deliveries. The causes for the obstruction of labour were CPD in 67.6% of the cases and they noted as prevalence of CPD were 8.2%.[14]

In many developing countries, most women deliver at home or in facilities without operative capability. Identification before labour of women at risk of CPD and timely referral to a district hospital for delivery is one strategy to reduce maternal and perinatal mortality and morbidity. The consequences of late detection are particularly grave in the developing world where the mother may go into labor in a setting where facilities for performing cesarean section are inadequate. [14] In such situations, it is vital that women at potential risk of CPD are identified prior to the onset of labor to facilitate referral to a center where a cesarean delivery can be performed.[14]

The advanced plevimetry techniques such as plevimetry through computer-based tomography, Magnetic Resonance Imaging, radiography and ultrasound are expensive and scarce in the developing countries.[15] Anthropometric measurements of mother are simple, inexpensive and available for patients which had been introduced as the first technique to predict CPD.[16]

1.3 Significance of the Study

The current study was done with the aim of determining the predictive value of different maternal anthropometric measurements of nulliiparous mothers which would be useful to diagnose women at risk of CPD.

As caesarean section cannot be performed in peripheral health centres, it is crucial to identify women at risk of CPD before labour, and to refer them for delivery in district hospitals and also for limiting unnecessary referrals

As a result of the present study, it might be easier to manipulate different maternal anthropometric measurements to diagnose CPD and the measurements are simple, inexpensive and available techniques to predict CPD of labor. Since the study was the first study done in Ethiopia and East Africa it may be used as a base line for further investigation.

2. LITERATURE REVIEW

2.1 CPD as a public health problem

Maternal mortality is unacceptably high. About 830 women die from pregnancy- or child birth-related complications around the world every day. It was estimated that in 2015, roughly 303 000 women died during and following pregnancy and childbirth. Almost all of these deaths occurred in low-resource settings, and most could have been prevented.[17] The high number of maternal deaths in some areas of the world reflects inequities in access to health services, and highlights the gap between rich and poor. Almost all maternal deaths (99%) occur in developing countries.[18] More than half of these deaths occur in sub-Saharan Africa and almost one third occur in South Asia. More than half of maternal deaths occur in fragile and humanitarian settings.[18]

The maternal mortality ratio in developing countries in 2015 is 239 per 100 000 live births versus 12 per 100 000 live births in developed countries. There are large disparities between countries, but also within countries, and between women with high and low income and those women living in rural versus urban areas.[19]In sub-Saharan Africa, a number of countries halved their levels of maternal mortality since 1990. In other regions, including Asia and North Africa, even greater headway was made. Between 1990 and 2015, the global maternal mortality ratio (the number of maternal deaths per 100 000 live births) declined by only 2.3% per year between 1990 and 2015. However, increased rates of accelerated decline in maternal mortality were observed from 2000 onwards. In some countries, annual declines in maternal mortality between 2000–2010 were above 5.5%.[18]

If CPD is not diagnosed and treated on time, it will result in hemorrhage due to uterine rupture or atony following prolonged labour, or sepsis following prolonged rupture of membranes. [20] It can also lead to severe maternal morbidity (e.g. genital fistula), perinatal death or severe morbidity in the neonate such as cerebral damage, birth asphyxia, septicemia, nervous trauma and death. [8, 9, 21, 22] Most of such outcomes can be prevented through recognizing women at risk of CPD of labor and referring them to medical centers.[23] Access to district hospitals to perform obstetrical interventions when needed is essential to reduce maternal and perinatal mortality.[24] Caesarean section can be life-saving for both the mother and the infant in case of severe CPD. As caesarean section cannot be performed in peripheral health centers, it is crucial to identify women at risk of

CPD before labour, and to refer them for delivery in district hospitals. This concerns mainly nulliparous women.[25, 26]

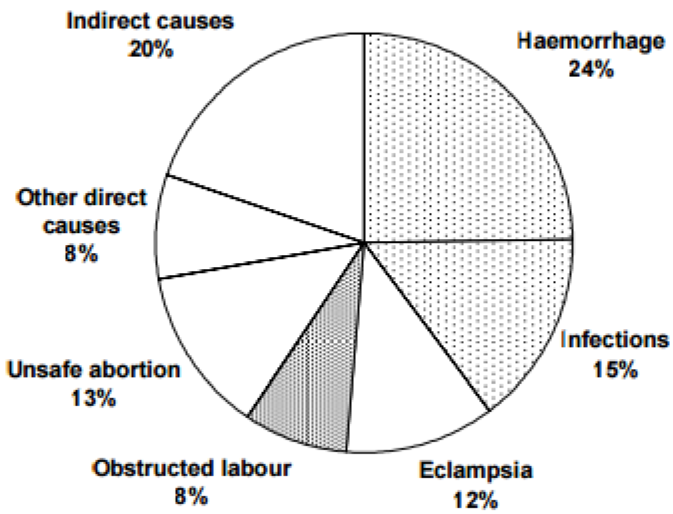


Figure:-1.The contribution of obstructed labour (dark shading) to the causes of maternal mortality worldwide. In addition, a significant but unknown proportion of deaths resulting from haemorrhage and infection (light shading) may be associated with obstructed labour. (Adapted from the WHO's World Health Report 2005.[11])

2.2 Prevalence of CPD

Estimates on the prevalence of CPD vary widely, depending on the criteria for diagnosis. Where CPD is diagnosed by the need to undertake caesarean section for poor progress in labour, this further depends on the clinicians' threshold for caesarean section. Mahmood, Campbell and Wilson (1988)[27] reported as prevalence of CPD in white primigravidae in the United Kingdom were 13%.Young and Woodmansee,(2002)[28] described a private practice population of mostly white primigravidae in the USA and showed as prevalences of CPD was 12%. However, United States National Center for Health Statistics figures, [29] based on over eight million births from 1995 to 1997, suggest that the caesarean section rate for CPD is 2.3% in the USA for infants weighing 3000 to 3999 g at birth, and 5.8% for those weighing 4000 g or more.

Dystocia of labor or abnormally slow progress of labor, in which the most prevalent cause of dystocia in the undeveloped countries is CPD[30], occurs in 25-30 percent of primiparous women and justifies two third of cesarean operations prescribed for such women.[31] African estimates of CPD prevalence, based on the need for caesarean section, vary from 2.8% and 4.5% in Nigeria[32,33] to 4.3% in the Democratic Republic of Congo[34] and 4.7% in Johannesburg, South Africa.[35] A systematic review of caesarean section in Africa, published by the MOMA study group[12] ,reported rates of CPD ranging from 1.4% to 8.5%.

CPD was found to be the commonest indication for caesarean section in sub-Saharan Africa. O'Driscoll, Jackson and Gallagher (1970)[36] studied 1000 consecutive Irish primigravidae and found that disproportion could be confirmed in only 0.9% of these women. They felt that reported high rates of CPD from other centres were the result of 'confusion between inefficient uterine action and cephalopelvic disproportion'. Their series showed how a closely monitored trial of labour, with early recourse to oxytocin stimulation ('active management of labour'), could produce safe and successful vaginal delivery in almost all primigravidae. In a later review, O'Driscoll and Meagher (1980)[37] wrote that obstetricians' preoccupation with CPD could be traced to the early 20th century when rickets was an important cause of pelvic contraction in European women. In similar work in Zimbabwe, Philpott and Castle (1972)[38, 39] followed the progress of 624 primigravidae in labour. By using a policy of epidural analgesia, amniotomy and oxytocin stimulation in women who crossed alert and action lines on a labour graph, only 16 (2.6%) required caesarean section.

A retrospective study was conducted in Jimma district hospital, in south western Ethiopia to assess the incidence of obstructed labour and identify the sociodemographic and clinical variables that occur in these mothers. During the study period 7% of all the deliveries attended were cases of obstructed labour. The author noted that 80.6% of all cases of obstructed labour were due to Cephalo-Pelvic-Disproportion (CPD) with prevalence of 5.6%.[40]

2.3 Risk factors for CPD

The risk of maternal mortality is highest for adolescent girls under 15 years old and complications in pregnancy and childbirth is a leading cause of death among adolescent girls in developing countries. [18, 19] According to the findings of Geraldine, *et al*. (2009)[53] the most important anthropomorphic risk factors for CPD were maternal head circumference in relation of height ($P < 0.001$).

Maternal height reflecting maternal pelvic size has been shown to be predictive for obstructed labor. This measurement is routinely used in most antenatal clinics, despite a limited prediction. Maternal height, as a simple tool requiring no any special skills, has been investigated extensively especially in developing countries for predicting obstructed labor.[41-45] However, whereas the inverse relationship between maternal height and the cesarean rate has been consistently demonstrated, the application of height to predict risk of obstructed labor or cesarean section remains controversial. [46] Furthermore, no universal definition of short stature in pregnant women has been well accepted. This is due to the fact that maternal height distribution is varied among different geographic or ethnic groups of study.[46] According to the findings of study conducted by Rusleena, *et a.l* (2012)[46] women's with the height less than 145 cm are complicated with CPD and undergo cesarean section. Another study conducted in African women by Hubert, *et al.* (2000)[47] showed as the proportion of women with height < 150 cm was 7.3% and they undergo CS due to CPD. Finally they conclude as height has high predictive value to diagnose CPD.

The clinical pelvimetry (touching the inner walls of pelvis) is widely used to identify the diameter of pelvis which is very irritating for the patient and it suffers from high rates of mental errors. [48] A number of studies have reported that measuring external diameters of pelvis is hardly useful for identifying women at risk of CPD; however, Rozenholc, *et al.* (2007)[49] and Liselele, et *al*. (2000)[16] showed that some pelvic diameters particularly transverse diagonal of the Michaelis sacral rhomboid area and intertrochanteric line has high predictive value to predict CPD. Liselele, *et al.* (2000)[34] showed that the addition of the measurement of the transverse diagonal of the Michaelis sacral rhomboid area (in short the Michaelis transverse) to the maternal height could increase the sensitivity in predicting CPD from 21% to 52%, with a positive predictive value of 24%. Measurement of the transverse diagonal of Michaelis sacral rhomboid area have been suggested as screening procedure in remote areas.[16] Accorging to the findings of Benjamin, *et al.* (2012)[50] about 55.6% women's with Michaelis-transverse diameter ≤10.4 undergo CS for CPD and women's with Michaelis-vertical diameter ≤10.1 undergo CS for CPD.

Other studies showed foot length < 23 cm is risk factor for CPD.[50] Study conducted by Benjamin, *et al.* (2012) [50] found in Indian population women's with foot length ≤23cm are at high risk for CPD and finally from their result they conclude that 77.8% of women's who undergo CS for CPD are with foot length ≤23cm. Similarly Benjamin, *et al*. (2012)[50] tried to measure Bi-acromial diameter during his study he state as 55.6% of women's who undergo CS for CPD is ≤33.4cm and he concluded as bi-acromial diameter is the most predictive maternal anthropometry to predict CPD with the p-value less than 0.014.

Anthropometric measurements cannot estimate pelvic dimensions precisely [49], but they do help in drawing attention to the possibility of CPD. Different researchers attempt to combine more than one anthropometric measurement in the hope that the predictive value of the combined measurements would be greater. [16, 49, 51] According to findings of Benjamin, *et al*. (2012)[50] combining maternal height, foot length and clinical estimate of fetal weight increased the predictive value to 24.1 from 15.4 when maternal height alone was used as a predictor for CPD.

2.4 Conceptual Framework

Different variables which are related with CPD are developed from different literature reviews. In this conceptual framework, maternal anthropometric measurements such as maternal height, foot length, Bi-acromial diameter, maternal head circumference, Michaelis transverse diameter, Michaelis vertical diameter and fetal birth weight are included.

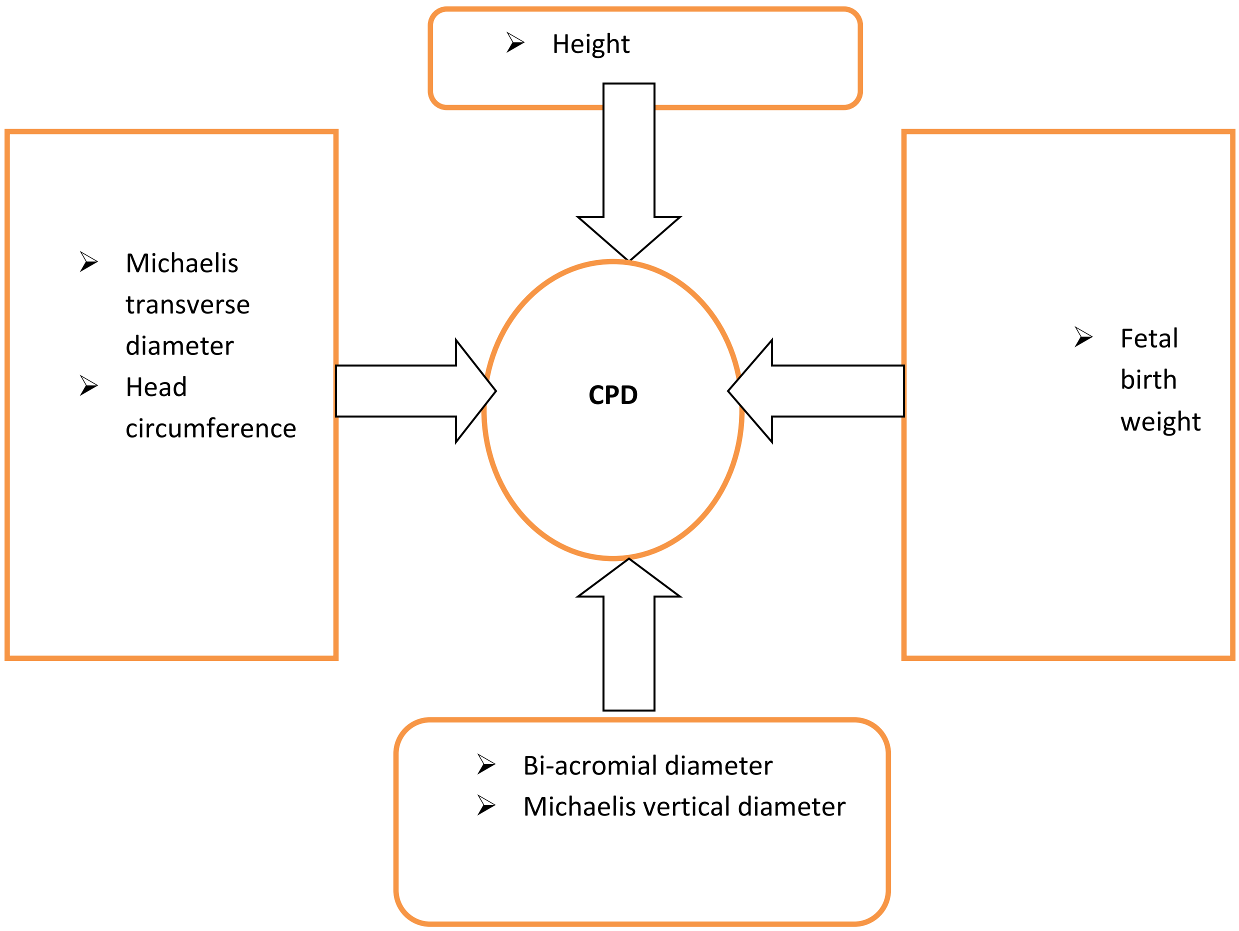


Figure 2:-Conceptual framework on Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, Ethiopia

(Developed from different literatures).[16,49,51,53,56,58,60,61]

3. OBJECTIVES

3.1General Objective

To assess Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa from June 2017-Oct.2017

3.2 Specific Objectives

- To investigate the relation between maternal Anatomical anthropometric measurements and CPD
- To investigate the relation between fetal birth weight and CPD
- To assess validity of combined anthropometric measurements to predict CPD
- To identify the most sensitive anthropometric measurement for prediction of CPD

4. MATERIALS AND METHODS

4.1 Study Area

The study was conducted at governmental hospitals in Addis Ababa involving Gandhi Memorial, Zewditu Memorial and Tikur Anbesa Hospitals.

4.2 Study Period

The study was conducted from June 2017 – Oct. 2017.

4.3 Study Type

Hospital based prospective cohort study was carried out.

4.4 Source Population

All term primigravidae women present for delivery to Governmental Hospitals in Addis Ababa

4.5 Study Population

All term primigravidae women present for delivery to selected Governmental Hospitals in Addis Ababa during the study period

4.6 Inclusion and Exclusion Criteria

4.6.1 Inclusion Criteria

- primigravid mother
- Full term pregnancy
- Mothers with singleton pregnancy
- Mothers with IUFD due to CPD

4.6.2 Exclusion Criteria

- ✓ Mothers who undergo CS for:
- Non-vertex presentation
- Obvious congenital abnormalities of fetus,
- Abruptio placenta , preeclampsia, eclampsia
- Placenta previa
    - ✓ Women who had hip fractures, asymmetrical pelvis, multiple pregnancy, polyhydroamnions, Preterm delivery
    - ✓ Elective CS

- ✓ Instrumental delivery
- ✓ Repeat caesarean section

4.7 Sample Size

Since there is no published article in Ethiopia and East Africa on Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, thus estimated predicting capacity of these anthropometric measurements is taken to be 50%. The minimum number of sample required for this study is determined by using single population proportion formula.

$$n = \frac{(Z\alpha/2)^2\, p\,(1-p)}{d^2}$$

Where:

n= minimum sample size required for the study

Z= standard normal distribution (Z=1.96), CI of 95% = 0.05

P= prevalence of Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa is unknown in my study area; Hence; p=50 %(0.5) will be used

d=Absolute precision or tolerable margin of error= 5 %(0.05)

$$n = \frac{(1.96)2 \times 0.5(1-0.5)}{(0.05)2} = 384$$

So using the above formula 384 women's who fulfill the inclusion criteria are consecutively recruited, counseled and, after consenting, they were included in the study.

4.8 Sampling Procedure

From a total of Governmental Hospitals in Addis Ababa, three of them were selected purposely; because in this Hospitals delivery services are higher, referral cases are available and since these hospitals are near to each other it makes data collection easy. The selected Governmental

Hospitals includes: Tikur Anbessa Hospital, Zewditu memorial Hospital, and Gandhi memorial Hospital.

4.9 Study Variables

4.9.1 Dependent Variable

Mode of delivery

4.9.2 Independent Variables

- Socio demographic characteristics of the mother such as age, residence, occupation and level of education
- Maternal anthropometric measurements such as: height, Foot length, transverse and vertical Michael's sacral rhomboid diameter, Bi-acromial diameter and Head circumference of the mother.
- Fetal birth weight

4.10 Operational Definitions

CPD- is mismatch between the maternal birth canal (the pelvis), and the fetal head. Data for CPD cases were collected from medical chart after delivery which was diagnosed and written by physician who performed the surgical procedure.

Dystocia- as abnormal progression of labor as , cervical dilation of less than 1 cm/h in the active phase for 2 h, duration of the second stage beyond 2 h or 3h if epidural anesthesia is applied, or fetal head descent less than 1 cm/h.[56]

Nulliparous-women who have never given birth to child

Maternal height- measured in the standing position following standards of measuring height by using standardized standiometer (mothers stood next to a wall with their feet and knees together, knees straight, heels, legs, hip, shoulders, back of the head parallel to the wall, their body completely flat and stretched, hands hanging on both sides, and looking straight ahead. The horizontal plate of the standiometer was placed over the mother's head and standing height was measured

Foot length- is distance from heel to the tip of longest toe.

Bi-acromial diameter-distance between the two acromial ends.

Michaelis transverse diameter- distance between two depressions of posterior superior spines at two horizontal ends of the sacral bone

Michaelis vertical diameter- distance between L5 and carina ani

Head circumference-is the distance between the highest occipital peak and mid fore head line

Spontaneous vaginal delivery - women's who gave birth spontaneously through vaginal canal without the use of forceps or vacuum to assist delivery

Term pregnancy - pregnancy with GA between 37 -42 weeks

Primigravidae-mother who become pregnant for the first time

Sensitivity-probability that values of variables are below cut-off point when CPD is present (true positive rate, expressed as a percentage)

Specificity-probability that the result of variables are above cut-off values when CPD is not present (true negative rate, expressed as a percentage)

Positive predictive value-probability that the CPD is present when the variables are below cut-off values (expressed as a percentage)

4.11 Data Collection Tools and Techniques

4.11.1 Data Collection Instruments

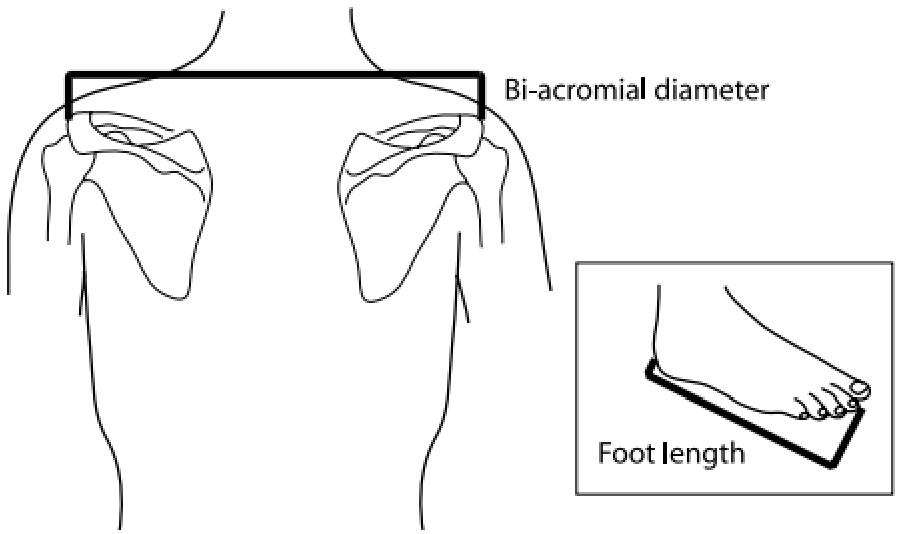
The following data collection tools were used: Check list, weight scale, non elastic tape meter, wooden centimeter and Standiometer. These standardized instruments were sponsored by department of Nutrition of the Ethiopian Public Health Institute.

4.11.2 Methods of Data Collection

Data was collected by principal investigator and three assistant data collectors were (midwifery, BSc) trained for the first two days concerning the objectives of the study, about inclusion and exclusion criteria and procedures of anthropometric measurements. Check list was coded by using client's card number. The data include socio-demographic characteristics such as age, residence, level of education and occupation of mothers. Data for gestational age, fetal birth weight, socio demographic and mode of delivery was collected from ante natal care follow up chart. Every data was collected before delivery and data which did not fulfill the inclusion criteria was rejected. Data on CPD cases were collected from antenatal card after delivery and

CPD was diagnosed and documented by the physician who performed the surgical procedure. During collection of the data for CS, only the mothers who had CPD were included. Other causes of obstruction of labor such as breech presentation, shoulder presentation, footling were excluded.

Maternal height was measured in the standing position following standards of measuring height by using standardized standiometer (mothers stood next to a wall with their feet and knees together, knees straight, heels, legs, hip, shoulders, back of the head parallel to the wall, their body completely flat and stretched, hands hanging on both sides, and looking straight ahead. The horizontal plate of the standiometer was placed over the mother's head and standing height was measured) and foot length is measured by wooden centimeter from heel to the tip of longest toe. The distance between the two acromial ends was taken by using standardized non elastic tape meter. Michaelis transverse diameter (distance between two depressions of superior posterior spines at two horizontal ends of the sacral bone) and Michaelis vertical diameter (distance between L5 and carina ani) was measured using a centimeter non elastic tape measure with the mother in the standing position. Head circumference-is the distance between the highest occipital peak and mid fore head line[57] measured by standard non elastic tape meter. All measurements were taken three times and the average was taken. Every measurement was recorded to the nearest 0.5 cm interval. Data for mode of delivery was collected from delivery report recorded in patient card and subjects were divided into two groups: normal delivery and subjects with CPD.



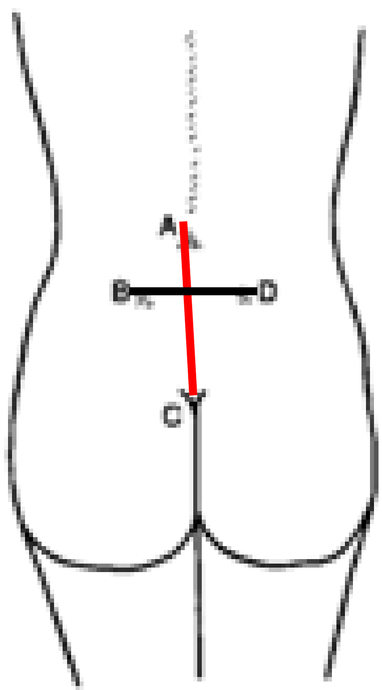


Figure3:-Various anthropometric measurements made in this study. Bi-acromial diameter is measured between the two acromial ends. Foot length is measured from heel to tip of longest toe. The transverse diameter of the Michaelis sacral rhomboid was measured between the two posterior superior iliac spines (**B** to **D**). The vertical diameter of the rhomboid was measured between the L5 spine (one space below the L3–L4 disc which is in line with the uppermost point of the iliac crest) and the upper limit of the natal cleft (**C**) (taken and modified from Benjamin, *et al*. 2012)[50]

4.12 Data Quality Control

To maintain data quality, properly designed data collection materials were developed. The principal investigator checked whether the assistant data collectors were using the right data collection procedures and techniques .Supervision was carried out by the principal investigator on a daily basis to maintain consistency of measurements and to assure completeness of data. In addition, cross checks between client card number and check list were performed to validate the accuracy of collected data and whenever an error occurred at any level, the investigator would trace back and manages accordingly.

4.13 Data Processing and Analysis

Data entry, cleaning and analysis was done by the principal investigator. Data were checked for values that were inconsistent with other information gathered in the study. The data were also checked for missing item and check list with missed data's were discarded. Finally data were entered and analyzed with SPSS version 23 statistical package. SPSS version 23, analysis of variance (ANOVA) followed by Tukey, 95%CI and P-values less than 0.05 were used to examine significant association between dependent and independent variables. Cut off values for maternal age and anthropometric measurements were defined as the values closest to the 10th percentile of our population. Sensitivity, specificity and positive predictive values with their 95% confidence intervals (CI) were calculated using these thresholds. The data were presented by using statements, frequency tables, figures and percentages.

4.14 Ethical Considerations

Ethical clearance was obtained from Institutional Review Board of College of Health Science, Addis Ababa University and from Addis Ababa Public Health Research and Emergency Management Core Process. The same document and letter from department of medical anatomy was used to secure written permission from the administration of Gandhi Memorial Hospital, Zewditu Hospital and Tikur Anbessa Hospital. All the study participants were briefed on the research activities and confidentiality of the information to be collected was assured. Written consent was obtained from each participant. The participants were told that they had the right not to participate or could even exclude themselves from the study, for any reason, at any time during the study.

4.15 Result Dissemination

Results of the study will be disseminated to Addis Ababa Public Health Research and Emergency Management core process and to selected governmental Hospitals.

5. RESULTS

5.1 Socio-demographic Characteristics

To conduct the study a total of 384 primigravid women were recruited for the study based on established inclusion criteria. Among these 337 of them were mothers who delivered through spontaneous vaginal delivery without any complication and the rest 47 mothers gave birth by CS due to confirmed CPD. The number of mothers who gave birth through CS appears to be unexpected. This higher number of deliveries by way of CS may have been because in this study non probability sampling method that did not involve random sampling was used. That is the sample was recruited continuously until the required sample size (384) was obtained. The result of Socio-demographic characteristics of the women who gave birth through spontaneous vaginal delivery and by CS is shown in table 1.

Table 1:- Socio-demographic characteristics of the women who gave birth through spontaneous vaginal delivery and by cesarean section due to CPD.

		Frequency(percentage)	
Variables	**Category**	ND(n=337)	CPD(n=47)
Residence	Addis Ababa	321(95.3%)	33(70.2%)
	Others	16(4.7%)	14(29.8%)
Age in year	≤20	25(7.4%)	10(21.3%)
	21-25	207(61.4%)	24(51.1%)
	26-30	93(27.6%)	8(17.0%)
	31-35	12(3.6%)	5(10.6%)
	>35	0(0%)	0(0%)
Level of education	Cannot read and write	32(9.5%)	3(6.4%)
	Can read and write	79(23.4%)	14(29.8%)
	Primary school	100(29.7%)	7(14.9%)
	Secondary school	68(20.2%)	5(10.6%)
	College and above	58(17.2%)	18(38.3)
Occupation	House wife	158(46.9)	18(38.3%)
	Government employed	48(14.2%)	16(34%)
	Self employed	128(38%)	11(23.4)
	Others	3(.9%)	2(4.3%)

ND-Normal Delivery, CPD (Cephalopelvic Disproportion), Result in bracket shows percentage

5.2 Result of Maternal of Maternal Anatomical Anthropometric Measurements and Fetal Birth Weight

As shown below in table 2, about 384 primigravid mothers were included in the present study. Based on their mode of delivery, these mothers were grouped into two groups: - (spontaneous vaginal delivery (SVD) and CPD group). The mean fetal weight who delivered through spontaneous vaginal delivery was 2.96 with standard deviation of 0.55 (table 2). The mean fetal weight delivered by CS was 3.38 with standard deviation of 0.4 as shown in table 2.In the present study, statistically significant decrease (p=0.013) in the mean fetal weight was observed in mothers who gave birth through SVD. Several measurements were lower in mothers who had cesarean delivery for CPD when compared with mothers who delivered vaginally. The mean maternal height, foot length, Michaelis horizontal diameter and maternal head circumference also were smaller in the CPD group than in the SVD group. Significant differences were noted for height, foot length, Michaelis horizontal and head circumference of mothers with and without CPD. The mean of Michaelis vertical diagonal and bi-acromial diameter did not have significant difference between the SVD and CPD groups as shown in Table 2.

Table 2:- Comparison of maternal and fetal characteristics between Spontaneous Vaginal delivery and CPD group.

Variables	**Normal delivery(n=337)**	**Cephalopelvic disproportion (*n*=47)**	***P****
Height (cm)	1.65±.06	1.53±.06	0.000
Foot length(cm)	23.7±0.92	22.6±.72	0.000
Michaelis Horizontal diameter(cm)	9.1±0.83	8.5±.56	0.000
Michaelis vertical diameter(cm)	9.3±0.92	9.3±.52	0.883
Head circumference(cm)	53.4±2.91	48.9±4.90	0.000
Bi-acromial diameter(cm)	33.6±3.11	33.2±2.84	0.428
Fetal Birth weight	2.96±0.55	3.38± 0.40	0.013

Values are expressed as mean ±SD, fetal birth weight is in kilogram

P* *v*alues <0.05 were considered significant (ANOVA).

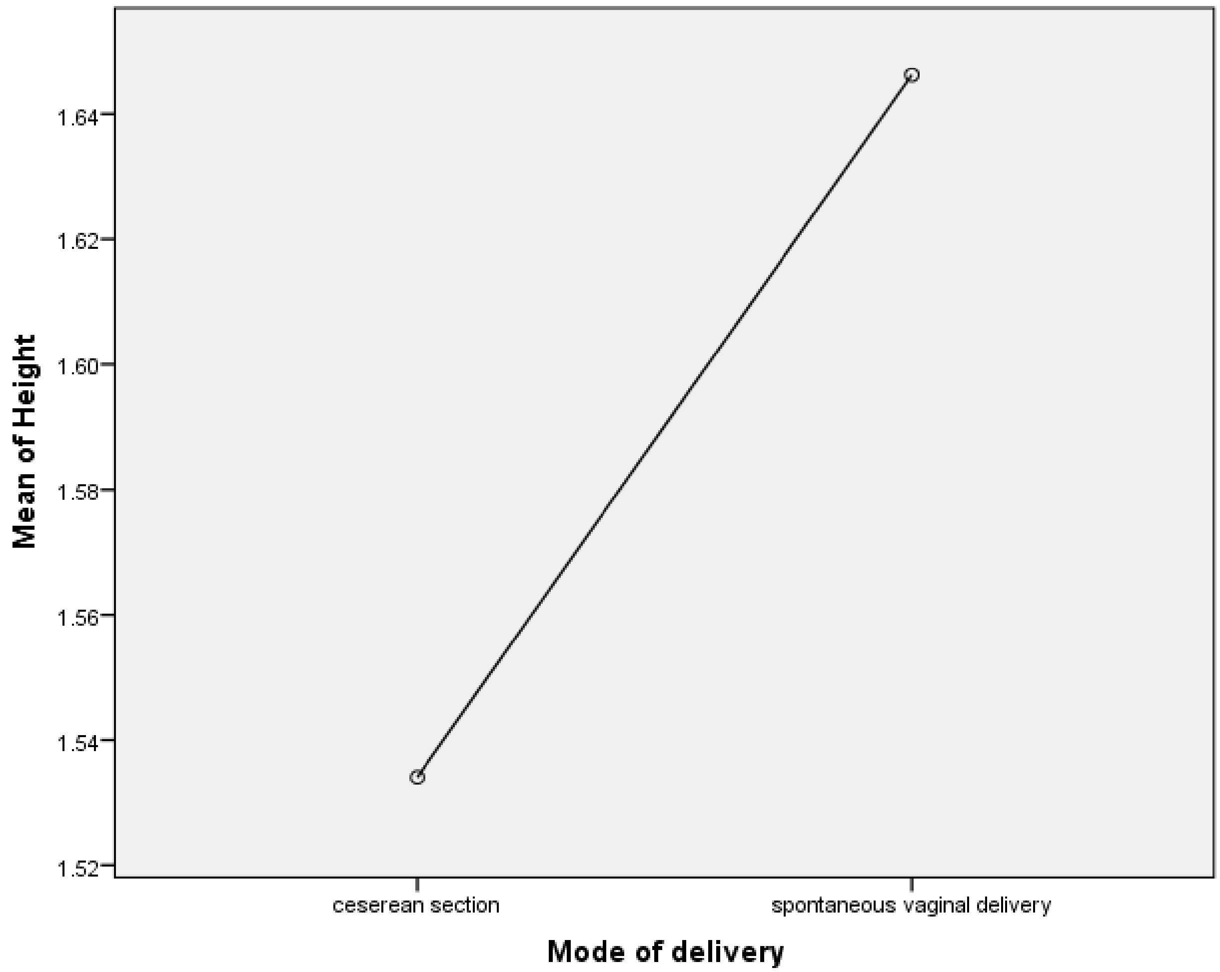


Figure 4:- A plot of mean height among SVD and CPD (who gave birth by cesarean section) groups

As shown below in table 3,maternal height, Michaelis transverse diameter, maternal head circumference and foot length had the highest sensitivity, specificity and positive predictive value respectively (Table 3).The results in table 3 were computed by using 10th percentile of fetal birth weight and all measurements as Cut-off values. After cut-off values were determined sensitivity percentage, specificity percentage and Positive Predictive Value (PPV) percentage were calculated.

Table 3:-Cut-off value, sensitivity, specificity and PPV percentage of maternal anatomical anthropometric measurements and fetal birth weight as predictors of CPD

Variables	Cut-off value	Sensitivity percentage	Specificity percentage	PPV Percentage
Height (cm)<10th percentile	1.53	86.1	95.4	65.9
Foot length (cm)<10th percentile	22.2	27.8	89.6	21.7
Michaelis transverse diameter (cm)<10th percentile	8.0	50.0	89.0	12.8
Michaelis vertical diameter (cm)<10th percentile	8.0	25.0	87.9	2.13
Head circumference(cm)<10th percentile	49.0	33.3	89.7	23.4
Bi-acromial diameter (cm)<10th percentile	31.0	18.4	88.7	14.9
Fetal Birth Weight	2.20	0	53.4	0

Different methods are applied to decide the cut-off points for maternal anthropometric measurements. The use of ROC curves to decide the cut-off limits is recommended by Ferguson, *et al.* (2000).[52] Another method of determining a cut-off limit for an anthropometric measurement to predict CPD has been identifying the 10th percentile of the measurements for the study population (Liselele, *et al*).(2000).[34] In the current study, the 10th percentiles was used as cut-off value for all measurements (Table 3).

Table 4:- Validity of combining maternal height with other anthropometric measurements for prediction of CPD

S.N	Combined Variables	Sensitivity percentage	Specificity percentage	PPV Percentage
1	Height<10^{th}percentile+foot length<10^{th} percentile	56.9	92.5	44.1
2	Height<10^{th} percentile +Michaelis vertical<10^{th} percentile	80	91.5	34
3	Height<10^{th} percentile +Michaelis horizontal<10^{th} percentile	77.1	92.1	39.4
4	Height<10^{th}percentile+head circumference<10^{th} percentile	60.9	92.2	44.7
5	Height<10^{th}percentile+bi-acromial diameter<10^{th} percentile	57.6	90.7	40.4
6	Head circumference<10^{th} percentile +bi-acromial diameter<10^{th}percentile	28.6	89.2	19.1

According to the present study combined anthropometric measurements showed increment in sensitivity, specificity and PPV. Foot length alone has a sensitivity percentage of 27.8, specificity percentage 89.6 and a PPV of 21.7%. When foot length is combined with other anthropometric measurements such as height, Michaelis horizontal and maternal head circumference its sensitivity increased to 59.6%, 33.3% and 30.4% respectively. As shown in Table 4, when height is combined with other anthropometric measurements it did not show increment in sensitivity, specificity and PPV.

Table 5:- Validity of combining maternal foot length with other maternal anthropometric measurements for prediction of CPD

S.N	Combined Variables	Sensetivity percentage	Specificity percentage	PPV percentage
1	Foot length<10th percentile + Michaelis vertical<10th percentile	27.5	89.1	11.8
2	Foot length<10th percentile + Michaelis horizontal<10th percentile	33.3	89.3	17.2
3	Foot length<10th percentile +head circumference<10th percentile	30.4	89.7	22.6
4	Foot length<10th percentile +bi-acromial diameter<10th percentile	25.7	89.1	18.3
5	Michaelis vertical<10th percentile + Michaelis horizontal<10th percentile	43.7	88.4	7.4
6	Michaelis vertical<10th percentile + head circumference<10th percentile	32.4	88.8	12.8
7	Michaelis vertical<10th percentile + bi-acromial diameter<10th percentile	23.5	88.3	8.5
8	Michaelis horizontal<10th percentile + head<10th percentile circumference	16	89.7	18.1
9	Michaelis horizontal<10th percentile +bi-acromial diameter<10th percentile	30.9	88.9	13.8

6. DISCUSSION

Cephalopelvic disproportion is a major risk factor for maternal and perinatal morbidity and mortality. Accurate prediction of women at risk for cephalopelvic disproportion is not predicted by health centers which are not equipped to perform a caesarean section, long referral distances and poor local transport may lead to obstructed labour and uterine rupture.[15,17,18] Conversely, in a resource limited setting, prediction of cephalopelvic disproportion in women at risk must be sufficiently specific to avoid unnecessary referral. In the present study, we used 384 nulliparous mothers to conduct the investigation. Among these 337 were gave birth through SVD and 47 gave birth by CS due obstructed labor as a result of CPD. The number of mothers who gave birth through CS appears to be unexpected. This higher number of deliveries by way of CS may have been because in this study non probability sampling method that did not involve random sampling was used. That is the sample was recruited continuously until the required sample size (384) was obtained.

The present study compared different maternal anthropometric measurements (height, foot length, Bi-acromial diameter, maternal head circumference, Michaelis horizontal diameter and Michaelis vertical diameter) among the two groups. These are mothers who gave birth through spontaneous vaginal delivery and those mothers who undergo CS for confirmed CPD. Anthropometric measurements are routinely taken in most of antenatal care clinic services even at the junior level (health visitor). They are simple, none invasive and inexpensive.

Maternal height and mode of delivery were significantly associated in the present study. This finding is in line with the findings of several studies that demonstrated that mothers with CPD were shorter than those who have normal vaginal deliveries [16, 22-27, 41,42,48,49]. However, the findings were not in agreement with the observations of Kara, Yesildagler and Uygur D (2005)[42]. Wongcharoenkiat and Boriboonhirunsarn (2006)[59] also failed to document a significant association between short stature and mode of delivery. The observed discrepancy on lack of significant association may be due to inconsistencies in maternal height cut off points. Several studies have used a cutoff value of 150cm for height to predict CPD[45]. However, this cut off point may not be appropriate for use in different populations because of variations in genetic factors as well as environmental factors such as nutritional status of the mother [45]. In comparison with women with normal/tall stature, fewer women with short stature delivered vaginally. This has been reported by earlier investigators [19, 46].

Michaelis horizontal diameter is significantly associated with mode of delivery in the present study (P=0.000). Results of Rozenholc, *et al*. (2007) [49] showed as Michaelis vertical diameter could identify more than 50% of abnormal labor progresses. Findings of the present study were consistent with the findings of Rozenholc, *et al*. (2007) [49]. Similarly Liselele, *et al*. (2000)[16] and Alijahan, *et al*. (2012)[60] showed as Michaelis transverse diameter has high validity to assess labor progress. Again the result of the present study is in line with findings of Hubert, *et al.* (2000) [47]which states as the size of the Michaelis transverse diameter is associated with the transverse pelvic capacity among black women. Michaelis vertical diameter did not have significant association with mode of delivery (P=0.883). The result of current study agrees with the findings of Rahele, *et al*. (2014).[56] Absence of significant association between Michaelis vertical diameter and mode of delivery also has been reported by Rahele, *et al*. (2014)[56].

About 57.4%% of women's with foot length ≤22.6cm and (p=0.000) gave birth by CS. The observation of the current study indicates as foot length has strong significant association with mode of delivery. Findings of Mohamed, *et al*. (2010)[58] showed as women with foot length less than 18cm has less chance (P<0.001) for vaginal delivery compared to the category of 18cm and more. Taking foot length as a constant factor, most women of foot length less than 18cm delivered by caesarean section than vaginal delivery[58]. Awonuga, *et al.* (2007)[61] and Tahir, *et al.* (1988) [2] found that the measurement of shoe size is not useful as predictor of the mode of delivery. However, Frame, *et al*. (1985) [51] found as shoe size is useful to predict mode of delivery. Instead of the shoe size, in this study foot length is investigated. In contrast to Van Bogaert, *et al.* (1999) [55], the current study showed as foot length has value to predict mode of delivery.

In the present study, maternal head circumference was significantly associated with mode of delivery (P=0.000). The result agrees with the findings of Connolly, *et al*. (2003) [57].According to Connolly, *et al.* (2003)[57], the most important anthropomorphic risk factors for CPD were maternal head circumference in relation to maternal height (P < 0.001). Similarly, Rahele, *et al*. (2014)[56] also reported that maternal head circumference was significantly associated with mode of delivery (P = 0.001).

Another maternal anthropometric measurement carried out in the current study was maternal Bi-acromial diameter. Bi-acromial diameter did not show significant association with mode of delivery. This observation is in agreement with the findings of Benjamin, *et al.* (2012).[50]

Until now, no definite cut off level between the estimated fetal weight and the likelihood of obstructed labor has been established [62]. According to Papungkorn and Wiboolphan 2006 [62], the best cut off level of the estimated fetal weight was choosen as 3000 gm, and they concluded as fetal weight greater than 3,000 g increased risk for cesarean section due to CPD by 3.96 folds. Findings of the current study showed as the fetal birth weight were significantly associated with mode of delivery. Observation of the current study was comparable with findings of Benjamin, *et al.* (2012).[50] ,which stated as fetal weight help in diagnosing CPD.

In the past, attempts have been made to combine more than one anthropometric measurement in the hope that the predictive value of the combined measurements would be greater [16, 22, 54]. In the present study, when foot length was combined with other anthropometric measurements such as height, Michaelis horizontal diameter and maternal head circumference, its sensitivity increased from 27.8% to 59.6%, 33.3% and 30.4%, respectively**.** However, combination of maternal height with the other anthropometric measurements such as foot length, Michaelis horizontal diameter did not show a better prediction compared to mothers height alone. This finding was not consistent with the observations of Rahele, *et al.* (2014)[56], Rozenholc, *et al*.(2007)[49] and Liselele, *et al.* (2000)[16] which reported significant association. This inconsistent observation may be due to difference in the chosen cut-off values, that is, in the present study the tenth percentile was chosen as cut off value for height while the fifth percentile was used in the other studies.

7. CONCLUSION

- Measurements of maternal height, foot length, head circumference and Michaelis transverse diameter using a measuring tape may represent a simple method to detect nulliparous women at risk for CPD.
- Maternal anthropometric measurements are may be useful in peripheral antenatal clinics to identify pregnant women at risk for CPD and to refer them to hospitals before the onset of labor.
- Maternal anthropometric measurements are helpful in determining mode of delivery in nulliparous women. However, further research using larger sample size and excluding confounders may be needed.

8. LIMITATIONS OF THE STUDY

- Factors that might have influenced the decisions of mode of delivery like maternal pelvic dimensions and fetal head size were not investigated in this study.
- Sampling method was not probabilistic and it may be difficult to generalize to the wider population.

9. RECOMMENDATIONS

- Meticulous research that assesses accuracy of maternal anthropometric measurements to predict CPD with larger sample size should be conducted
- Since there was scarcity of data from similar research, this same study should be repeated in other hospitals to see its reproducibility.
- Findings of the current study may generate a base line data for future study in our country.

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11. ANNEX-I

11.1 ASSURANCE OF PRINCIPAL INVESTIGATOR

I the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress report to my advisor and seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: Damtew Solomon Shiferaw (BSc.)

Signature: ____

Date: ____

Approval of the primary Advisor

Name of the primary advisor: Girma Seyoum (PhD), Associate Professor

Signature: ______________________

12. ANNEX-II

12.1 Check List

Date _______________ Participant code (Card No.) _______________

Part I - Socio-demographic data

1. Place of Residency A. Addis Ababa B. other, specify _______________

2. Educational level: A. cannot write B. Secondary School (9-12 grades)

C. Can write E. College and above D. Primary school (up to grade 8

3. Occupation: A. house wife C. self-employed

B. government employed D. other, specify______

4. Mother Age in year ____________

Part II - Information from ANC card

1. Number of pregnancy (Gravity) ________ 2. Gestational age by LNMP_____________

3. GA in weeks by US- -----------------------and fetal birth weight--------------------

4. Mode of delivery a. spontaneous vaginal delivery b. operative delivery (by CS) c. if b what is the reason for CS? ---

Part III –Anthropometric measurements

No	Variables	Length in cm
1	Height	
2	Michaels vertical diameter	
3	Michaels horizontal diameter	
4	Head circumference	
5	Foot length	
6	Bi-acromial diameter	

12.2 Information Sheet

Title of study: Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, Ethiopia

NAME OF INVESTIGATOR: - Damtew Solomon

NAME OF SPONSOR: Addis Ababa University College of Medicine and Health Sciences

INTRODUCTION I would like to invite you to take part in a research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read is not clear or would like more information. Take time to decide whether or not to take part.

THE PURPOSE OF THE STUDY Primarily the purpose of study is educational as part of a course in masters program. So it helps researcher for partial fulfillment of master program. Secondarily the result of research will be used as base line for further related research.

PROCEDURE To assess accuracy of maternal anthropometric measurements for prediction of CPD, your height foot length, vertical and horizontal Michaels diameter will be measured on erect position. Your head circumference and bi-acromial diameter will be measured in sitting position. Additionally data of delivery will be recorded from delivery summary card.

PARTICIPANTS COMMITMENT The study will not take extra time than that you spend for your medical evaluation for first time. Without any session in between; mode of delivery is taken from your card. But it needs your commitment for anthropometric measurements.

BENEFITS AND RISK OF THE STUDY The study has no any risk for you because this study doesn't uses invasive procedures. There is also no benefit that you gain from this study because of your participation

CONFIDENTIALITY The information collected from this study will be kept confidential. The data collected do not contain any personal information about you except your card number as code for identification purposes. No one will link the data you provided to the identifying information you supplied such as card number.

PARTICIPANTS' RIGHTS You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you provided can be destroyed.

FOR FURTHER INFORMATION I, Damtew Solomon, the principal investigator will be glad to answer your questions about this study at any time. If you need to have further information you can contact using the following address.

Persons to contact

1. Damtew Solomon Cell phone: +251-920023076 Email: fraolsolomon675@gmail.com

2. Ethical review board of College of Health Sciences, Addis Ababa University, Ethiopia Phone No - +251-118961396

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12.3 Consent Form

Code/card no_______________

Information about the study was explained to me by the investigator. I had understood that the objective of this study is to assess the Validation of Maternal Anatomical Anthropometric Measurements to Predict Cephalopelvic Disproportion Among primigravid Women Visiting Governmental Hospitals in Addis Ababa, Ethiopia. I clearly understood that all the research activities not hurt my health. It is also explained to me that I had the right to stop participation at any time. I agree to participate in the study and hereby approve my agreement with my signature.

Participant signature ______________________________Date_______________

Investigator signature_____________________________ Date_______________

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