COLLEGE OF HEALTH SCIENCES, SCHOOL OF MEDICINE, ANATOMY DEPARTMENT

PLACENTAL AND UMBILICAL CORD INDICES AND THEIR ASSOCIATION WITH PERINATAL OUTCOME IN HADIYA ZONE PUBLIC HOSPITALS, SOUTHERN ETHIOPIA

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A thesis submitted to Addis Ababa University, College of Health Sciences, School of Medicine, Department of Anatomy in partial fulfillment of the requirement for the Degree of Master of Science (MSc.) in Human Anatomy.

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Declaration

This is to certify that the thesis prepared by Simeon Meskele, entitled: Placental and Umbilical Cord indices and their association with perinatal outcome in Hadiya zone Public Hospitals in year 2018 and submitted to AAU, CHS, Department of Anatomy in partial fulfillment of the requirements for the Degree of Masters of Science in Human Anatomy which complies with regulations of the university and meets 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.

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List of Abbreviations and Acronyms

AAU……Addis Ababa University

ANC ……Antenatal Care

BL.....Body Length

CCI…….. Cord Centrality Index

CI…….Confidence Interval

CPA……..Chorionic Plate Area

DI……Distance of umbilical cord insertion from margin

EI…….Eccentricity Index

FMOH…….Federal Minster of Health

GA……...Gestational Age

HC……Head Circumference

HZHO……...Hadiya Zone Health Office

IUFD…….Intrauterine Foetal Demise

IUGR…….Intrauterine Growth Restriction

LBW……..Low Birth Weight

MiD……Placental minor Diameter

MjD……..Placental major Diameter

WUNEMRTH……..Wachemo University Nigist Eleni Mohammed Memorial Referral Teaching Hospital

NICU……Neonate Intensive Care Unit

OR……...Odds Ratio

PW……...Placental Weight

SNNPR…….Southern Nation, Nationalities and Peoples Region

SPSS…….Statistical Package for the Social Sciences

UCL…….Umbilical Cord Length

WHO……...World Health Organization

Abstract

Back ground: Mother and Foetus come in close contact with each other by the Placenta. The placenta and umbilical cord have been considered to significantly contribute to the perinatal outcome. The conditions of placental and umbilical cord indices have contribution in some degree for neonatal mortality and are important factors in foetal growth retardation. Nowadays, very little is known about measurements of placental and umbilical indices in Ethiopia and there is a gap to quantitatively describe the relationship between parameters of placenta and umbilical cords such as placental weight, shape, thickness, length of umbilical cord and their association with foetal outcome.

Objective: To assess placental and umbilical indices and to determine association with perinatal outcome in public hospitals Hadiya Zone, Southern Ethiopia, 2018.

Method: Institution based cross-sectional study design was conducted in public hospitals of Hadiya Zone, Southern Ethiopia from September 1 to November 30, 2017. A total of 249 placentae from normal singleton with known gestational live birth with attached umbilical cord were collected and included in this study. Data was collected by using check list adopted from different literature and modified according to objectives of this study. Systematic sampling technique was used to select study respondents. Bivariate and multiple variable logistic regressions (Odds Ratio) analyses were calculated at 95% CI.

Result: Low placental weight [AOR=6.57; 95%CI: 2.47, 17.48], preterm birth before 34weeeks [AOR=21.16; 95% CI: 5.00, 89.53] and preterm between 34-37weeks [AOR=7.28; 95 % CI: 2.12, 25.04] were significantly associated with LBW. And also short cord length (<40cm) [AOR=3.43; 95% CI: 1.66, 7.09], long cord length (>70cm) [AOR=7.55; 95% CI: 2.07, 27.53], Preterm birth before 34weeks, Thin Placenta, Apgar score<7 at five and one minute were association with foetal distress. Prevalence of short, long and normal cord length were 32.9%, 5.2% and 61.8% respectively in this study.

Conclusion: Low Placental Weight and Preterm birth before 34 complete weeks were significantly associated with LBW. Deviation of UCL from normal range, preterm delivery (<34weeks), Apgar score<7 at five and Apgar score<7 at one minute were significantly associated with foetal distress at $p<0.05$.

Recommendations: Examination of the placenta and umbilical cord should be performed routinely in the delivery rooms to provide valuable information that are important to the care of both mother and new born.

Key words: placental indices, umbilical cord indices, foetal outcome, Hadiya, Ethiopia

1. Introduction

1.1. Background

Mother and Foetus are the two important ends of reproduction and come in close contact with each other by a vital organ known as the Placenta (Patel et al.,2016). Because of its delicate and important nature, some authors stated it as the 'mirror of the perinatal period', which has not been sufficiently polished (Adesina et al., 2016).

The human placenta is a discoid-shaped foeto-maternal organ which has contribution from the uterus and the developing embryo. It is a highly vascularised organ that functions in the maintenance of pregnancy and promotes normal foetal development (Adesina et al., 2016).

At term, the expelled placenta attains approximately circular or oval outline, with average weight 500 gms (range 200–800g), average diameter 185 mm (range 150–200 mm) and average thickness at centre 23 mm (range 10–40 mm) (Patel et al., 2016). In addition , Janthanaphan et al., (2006) indicated the placental indices on average at term as185 mm in diameter, 23 mm in thickness, and weight of 508g.

In clinical areas, physicians and other health professionals encounter variation of cord attachment on to placentae. Sarwar et al., (2015) stated such variation as, 99(66%) of placenta showed the eccentric, 36(24%) central, 12(08%) marginal and 03(02%) velamentous from the total observed 150 specimens and associated these variations with abnormalities in the foetus as well as the mother. In contrast to (Sarwar et al., 2015) finding, morphological studies of normal human placenta in India by Lakshmi et al., (2013) stressed, eccentric attachment was observed in only 20% of cases, central in 58%, marginal in 20% and velamentous 2% of cases from the total of 50 studied placentae. After about four weeks of gestation the only link of the foetus to the placenta is the umbilical cord, which begins to form around this time replacing the yolk sac and through which all exchanges and other activities of the mother and the foetus via the placenta are carried out. It is embryologically derived from both mother and foetus and normally contains two arteries and one vein, buried within Wharton's jelly and all enclosed within a layer of amnion (Arora et al., 2016).

The study in Nigeria reveals that the length of the umbilical cord varies from no cord (achordia) to 300cm, especially at term measured 55 to 60cm in length. About 5% of cords are shorter than 35 cm and 5% are longer than 80 cm (Ogunlaja, 2015). Though it is not fully understood what controls cord length, various authors correlate cord length with foetal

activity and movement. It is suggested that sufficient space in the amniotic cavity for movement and the tensile force applied to the umbilical cord during foetal movements are two main factors that determine cord length (Bimpong, 2012).

An umbilical cord less than 40 cm is said to be short and has been associated with ante partum abnormalities and risk factors for complications of labour and delivery where as long umbilical cords, which measures over 70cm and associated with a number of circumstances which can impact on foetal life including foetal anomalies, increased birth weight and respiratory distress (Ogunlaja, 2015).

1.2. Statement of the Problem

The umbilical cord and placental have been considered to significantly contribute to the perinatal outcome. However, the attempt to explore its usage globally as well as in Africa has been limited due to paucity of information on the value of the placenta and umbilical cord, which is further worsened due to the prevailing sociocultural believe which ensures that the placenta and umbilical cord is handed over to the relatives following delivery. As a result of this, using the placenta and umbilical cord for biomedical research has been significantly limited (Ogunlaja, 2015).

It is estimated that more than 7.6 million perinatal deaths occur each year worldwide. Of these, 4.3 million are foetal deaths. Ninety-eight percent of perinatal deaths have been take place in developing countries, and the perinatal mortality rate is estimated to exceed 55 per 1000 births (Schindler, 1991). The conditions of placental and umbilical cord indices have contribution in some degree for neonatal mortality and are an important factor in foetal growth retardation (Londhe and Mane, 2012).

Even though numerous researchers have related their study finding on placental and umbilical indices with some maternal diseases like diabetes mellitus, pregnancy induced hypertension and anemia, none of them tried to associate quantitative measurements of placental and umbilical cord indices with foetal outcome. Ethiopia is no exception to this finding.

Nowadays, very little is known about measurements of placental and umbilical indices in Ethiopia and there is a gap to quantitatively describe the relationship between parameters of placenta and umbilical cords such as weight of placenta, the shape of placenta, insertion of umbilical cord in to the placenta, the length of umbilical cord and its association with foetal outcome. Moreover, information about these variables and their association with perinatal outcomes is scanty. For this reason, the aim of this study is to quantitate placental and umbilical cord parameters in Hadiya zone public Hospitals, Southern Ethiopia and to

investigate their association with perinatal outcome, which may be baseline for those researchers who have interest in this area. Furthermore, the findings from this study will provide health professionals and other concerning body's pertinent information about placental and umbilical cord indices and their association with foetal outcome.

1.3. Significance of the Study

The examination of the placenta in utero as well as postpartum provides crucial information about the status of the foetal wellbeing (Londhe and Mane, 2012; Elangovan and Raviraj, 2016) and is helpful to plan a safe pregnancy and a healthy baby outcome at its end (Keche, 2015). In addition, postnatal examination of the placenta can yield information that may be important for immediate and late management of the maternal and neonatal complications (Akhter et al., 2011; Sarwar et al., 2015).

Therefore, this study will explore the relationship between placental and umbilical cord variables and foetal outcomes and provide some information on measurements of the placenta and umbilical cord which will be helpful to the paediatricians, obstetricians and other health professionals in Hadiya Zone in particular and those enrolled in Ethiopian health institutions at large.

2. Literature Review

The placental complex formed by the cooperative effort between the extra embryonic tissue of the embryo and the endometrial tissue of the mother represents symbiosis between the two separate organisms without rejection. The formation of placenta is a biological event which is important both embryologically and immunologically (Lakshmi et al., 2013). The human placenta is a foetus's lifeline during gestation, providing nutrients and antibodies, while eliminating waste products via the mother's blood supply and is an integral part of the child's development (Chang et al., 2012).

The human placenta is a highly vascularised discoid-shaped organ which develops with contribution from the uterus and the developing embryo functions in the maintenance of pregnancy and promotes normal foetal development. Owing to the delicate and important nature, it is sometimes referred to as the 'mirror of the perinatal period', which has not been sufficiently polished' (Adesina et al., 2016).

The placenta is a complex multifunctional structure (Appiah, 2009). It provides an indirect link between the maternal and foetal circulation; serves as the organ for the exchange of nutrients, gases and waste products through diffusion and has metabolic and endocrine functions like; hormone production for maintaining pregnancy, foetal weight and relaxation of the cervix during parturition (Adesina et al., 2016). In generally, it is important for basic metabolic needs of foetus including respiration, nourishment and excretion by acting as a temporary lung, liver and kidney (Lakshmi et al., 2013).

Researchers, for a long time, have emphasized the benefits which were associated with the anatomical examination of the placenta, without adequate examination. The examination of the placenta in utero as well as postpartum, gives valuable information about the state of the foetal wellbeing (Elangovan and Raviraj, 2016). It is clear that a normally functioning placenta is critical for normal foetal growth and development (Azpurua et al., 2010). Placenta is the major cause of prenatal mortality if it is not normal; After delivery if the placenta is observed carefully, it can provide much insight into the prenatal health of the baby (Elangovan and Raviraj, 2016).

2.1. Placental Weight

Placental weight is the most common way to characterize placental growth, and is a summary of many dimensions of placental growth (Macdonald, 2012) and approximately weights $1/6^{th}$ of the foetal weight (Elangovan and Raviraj, 2016). The wellbeing of the foetus is highly dependent on the placenta since it serves as a link between the mother and the developing

foetus for nutritional support, excretory functions as well as immunological and hormonal support (Appiah, 2009).

The placenta forms an organ for the interchange of material between foetal and maternal blood streams without mixing or physical contact of two blood streams (Lakshmi et al., 2013) and its weight increased according to the birth weight (Londhe and Mane,2012) and showed a strong correlation with foetal weight (Elangovan and Raviraj, 2016)

An abnormally decreased placental weight has been linked to increased perinatal complications, including intrauterine foetal demise (IUFD) and intrauterine foetal growth restriction (IUGR) (Azpurua et al.,2010).

As Janthanaphan et al.,(2006) published, low placental weight was associated with medical complications in the mother, whereas a high placenta weight was associated with a poor perinatal outcome, low Apgar score, respiratory distress and perinatal death.

More recently, McNamara et al.,(2014) showed low placental weight was more common among stillbirths while high placental weight was associated with neonatal death and serious neonatal morbidity, including seizures, low 5-min Apgar score, and respiratory distress.

Gross examination of the placenta, especially its weight, has been found to be an important source of information in the delivery room for the paediatricians on intrauterine wellbeing of the foetus (Adebami et al.,2007). The placenta weight can be a 'sentinel' indicator of nutritional and/or environmental problems. However, it is not clear whether weighing the placenta reflects the “true” weight as it is extremely difficult to evaluate the exact amount of foetal and maternal blood present in the placenta at the time of weighing (Pathak, 2010), because it is difficult to assess the amount of blood remained in the inter villous space and amount of foetal blood trapped in the placenta depend for some extent on the timing of cord clamping after delivery of the baby.

Traditionally, the measurements of the placenta weight after delivery forms part of clinical practice in most advanced cultures. However, lack of standard technique in the measurement of the placental weight subjects these values to questioning (Bimpong, 2012). Asgharnia et al.,(2008) stated that placental weight reflects placental development and functions and is correlated with maternal age, gestational age, history of maternal diabetes, preeclampsia, birth weight, parity, route of delivery, infants’ gender, Apgar score, foetal distress, maternal height and maternal weight.

In a longitudinal cross-sectional study, women with single pregnancy, Asgharnia et al.,(2008) divided placental weight in to three category, as those weighting (<330g) were low, between (330-750g) normal and those weighting (>750g) as high placental weight. The same researchers examined mean and standard deviation of neonates' weights at birth and placental weights as 3214.28± 529 and 529.72 ± 113g and reported prevalence's of low and high placental weights as 2% and 2.8%, respectively and illustrated statistically significant relationships between placental weight and birth weight, foetal distress, Apgar score, and approaches of deliveries (α=0.05). More importantly, one has to consider the fact that a placenta loses a variable but progressive weight while kept in the refrigerator, if not weighed soon after delivery. The placenta stored in the lab to be weighed later, loses weight over a period of time,4% of its weight in 12 hours, 6% in 24 hours and 10% in 48 hours (Pathak, 2010).

2.2. Placental Shape

Many reports by different researchers indicated that the placental shape, size and cord insertion vary between pregnancies. Factors that influence the shape of the placenta are believed to include; site of implantation in the uterus, regional variations in the decidua, changes in maternal vascular supply and probably the manner of its original implantation (Benirschke et al., 2006). The placenta is normally considered to be a round discoid shape; however the shape has been described in various ways such as round, oval, irregular, star shaped, bi-lobate, multi-lobate, circumvallate, circummarginate and many more (Yampolsky et al.,2008). And also Pathak et al.,(2010) stated the placental shape as round or oval but irregular shapes are also common. By determining the shape, Elangovan and Raviraj, (2016) recorded 7% of placental as oval and 93% as circular. However, other study conducted in clinical practice showed the chorionic plate is not circular but the shapes varies from round to oval, bi-or multi-lobate, or could be considered as irregular and drawn conclusion as quantifying abnormality of the chorionic plate shape is a useful tool in clinical practice (Salafi et al., 2010). On the other hand, Yampolsky et al., (2008) stated that an irregular chorionic plate shape has been associated with lower birth weight to placental weight ratio which presupposes an altered placental function.

2.3. Placental diameter and Thickness

At term the placenta is approximately 3cm thick and measures 15 to 25cm in diameter (Abu et al., 2009). Similarly, Appiah,(2009) found placental indices measurements are noticed as 15-22 cm in diameter and 2-4 cm thick. Both placental diameter and thickness has relation with

neonatal conditions. The studies conducted by (Abu et al.,2009) associated large placentae with haemolytic disease of newborn, severe anemia and intrauterine foetal infections whereas small placentas with chronic foetal infections and intrauterine growth restriction. After Statistical analysis of all the parameters of the placenta, (Elangovan and Raviraj,2016) reported strong correlation between foetal weight and placenta weight, volume, diameter, and circumference.

2.4. Measuring foetal indices

Size at birth is an important predictor of health and therefore should be measured as accurately as possible for planning and implementation of infant care accordingly. Accurate and reliable monitoring of infant size is especially important for infants at risk for inadequate growth or other health conditions. Size is estimated also during pregnancy possibly to detect possible abnormalities in growth, but exact measurements can be obtained just after birth. There are several anthropometric measurements used to evaluate newborn size at birth; birth weight, birth length, head circumference, chest circumference, mid-upper arm circumference (MUAC) and abdominal circumference. Of the above-mentioned, birth weight, length and head circumference are most commonly used globally (WHO, 2008).

2.5. Birth weight

Birth weight is a straightforward measure of the outcome of births and affected by several factors which could be directly or indirectly necessary for perinatal survival. Available evidence suggest that the influence of birth weight is felt throughout the entire life–time of the individual, and could stimulate the risk of cardiovascular diseases such as hypertension, heart attack and stroke, diabetes and obesity, osteoporosis, breast and prostate cancers and neuro-developmental outcomes (Misra et al., 2009).

Birth weight of an infant is the most important determinant of its chances of survival, healthy growth and development. According to the World Health Organization (WHO) estimation, globally about 25 million low birth weight (LBW) babies are born each year (Londhe an Mane, 2012). In similar way (Tabrizi and Saraswathi, 2012) reported more than 20 million infants are born each year weighing less than 2500g, accounting for 17 percent of all births in the developing world. In Africa, especially in many sub-Saharan countries, LBW continues to remain a major public health problem which estimated about 3.1 million. LBW was strongly associated with gestational age below 37 weeks (OR=2; CI=1.5, 2.8) (Siza,2008). In Ethiopia having an infant mortality rate of 59/1000 live births with limited data on birth weight estimates as most deliveries take place at home (Meseret et al.,2012) and showed the

mean and standard deviations of the birth weights were 2976±476g with incidence of LBW 17.1% (95%CI 13.3%, 21.6%) and associated with first delivery (AOR=2.85), lack of antenatal care follow up (AOR=5.68) and being HIV positive (AOR=3.22). Wado et al.,(2014) also found from prospective study in south west Ethiopia, mean and standard deviations of birth weights as 2989±650.4g with incidence of 17.88%. Low birth weight was associated with preterm gestational age less than 37 weeks (AOR=18.5 (95 % CI=4.94-69.4)) (Gebremedhin et al., 2015). The cross-sectional study in Gondar town showed 17.4% of prevalence of LBW and covariates which affect LBW as; pregnancy-induced hypertension (AOR 9.2(95%CI 3.36, 25.3)), malaria attack during pregnancy (AOR 4.9(95%CI 1.95, 12.3)), female sex newborn (AOR 2.1, (95%CI 1.18, 3.76)) and gestational age less than 37 weeks (AOR 18, 95%CI 5.8, 31.2)) (Zenebe et al., 2014).

In similar way, study in Axum and Maichew district Hospital revealed the prevalence of LBW was 9.9% [n=25, 95% CI: (0.96, 1.62)] and 6.3% [n=16, 95% CI: (0.52, 1.13)] with mean and standard deviations of the neonates 3055±556 and 3188±554 grams respectively (Teklehaimanot et al.,2014). Another study showed a little bit lower prevalence 8.8% was also reported in Addis Ababa city by (Mulatu et al.,2017).

Low birth weight is a significant risk factor for adverse health outcomes including many childhood diseases (Tabrizi and Saraswathi, 2012). The key determinant of birth weight is the transfer efficiency of placental nutrients and oxygen that enable foetal growth and development which also leads to the pathway in explaining why birth weight is connected with mortality and morbidity in infants, children and adults (Misra et al., 2009). With respect to the constitutional growth potential; maternal weight gain, prepregnancy weight, maternal height, parity, maternal age, gestational age, marital status, life-style, heredity, foetal sex, birth order, working hours and various socio-economic factors influence size at birth and adulthood (Mamelle et al., 2006; Bugssa et al.,2014).

2.6. Umbilical cord length

After about four weeks of gestation the only link of the foetus to the placenta is the umbilical cord which begins to form around this time replacing the yolk sac. Umbilical cord develops from the extra embryonic mesoderm and becomes the channel for blood vessels, through which all exchanges and other activities of the mother and the foetus via the placenta are carried out. It is a cylindrical structure with two arteries and one vein embedded in a gelatinous Wharton's jelly (Appiah, 2009).

Though it is not fully understood what controls cord length, various authors correlate cord length with foetal activity and movement. It is suggested that sufficient space in the amniotic

cavity for movement and the tensile force applied to the umbilical cord during foetal movements are two main factors that determine cord length. Most umbilical cords have been reported to be 50-60 cm and very few have been observed were abnormally short or long (Cunningham et *al.*, 2005).

Study conducted in Japan defined cords in different categories as long, short and normal. Long and short umbilical cords were defined as those umbilical cords measuring approximately +1.5 standard deviations above and -1.5 standard deviations below the mean are ≥ 74 and ≤ 38 cm respectively while normal umbilical cords length (45-68 cm) measuring within ±1.0 standard deviations of the mean(Suzuki and Fuse,2012).The umbilical cord length is documented factor to exhibit high risk for poor foetal outcome with average length of 50–60cm is considered as normal in full–term newborn. Short umbilical cords are proposed to be less than 40cm whereas long umbilical cords are greater than 70cm long (Bimpong, 2012; Ogunlaja, 2015). Gupta et al., (2006) and (Abaidoo and Warren, 2008)reported mean and standard deviations length of cord as 44.3±9.2 and 47.04cm ±12.8 respectively. Although, reference standards for cord length have been reported, variation exists in the definition of short cords. for instance, Naeye (1985) adopted a cord length of 40 cm whereas Yetter (1998) and (Bimpong, 2012; Ogunlaja, 2015) proposed cord length less than 40 cm as short. The umbilical cord at term has been reported to have an average length of 55 to 60 cm with normal length between 40-70 cm (Yetter, 1998) even thought, cord length up to 300cm have also been reported (Valsamakis et al., 2006).

The presence of a short umbilical cord has been associated with ante partum abnormalities and risk factors for complications of labour and delivery(Suzuki and Fuse,2012). But long umbilical cords are associated with increased birth weight and respiratory distress. Infants with excessively long umbilical cords are found to be at significantly increased risk of brain imaging abnormalities and/or abnormal neurological follow-up (Ogunlaja, 2015). A short umbilical cord may be associated with a delay in the second stage of labour, adverse perinatal outcomes such as foetal growth restriction, congenital malformations, intrapartum distress, and foetal death whereas long cord has a significant association with birth weight, adverse neonatal outcome, low Apgar score, and cord entanglement (Elarbah et al., 2014).

2.7. Umbilical Cord Insertion

The Anatomy of the umbilical cord point of insertion onto the placenta relies heavily on the implantation of the blastocyst. Umbilical cord usually insert into the placenta at the center (Centric) or near the center (Eccentric). However, when the blastocyst fails to attach at the embryonic pole, the connecting stalk may attach at the margin or to the smooth adjacent chorion resulting in marginal or velamentous insertions respectively as pregnancy advances in age. Centric and eccentric umbilical cord insertions are found in more than 90%; while marginal and the least frequent velamentous forms the remaining10% (Bimpong, 2012).

The centric and eccentric cord insertions are considered as normal and have no medical importance. Prevalence of abnormal cord insertion in Norway was 7.8% (1.5% velamentous and 6.3% marginal) for singleton pregnancies and 16.9% (6% velamentous and 10.9% marginal) for twins and shared risk factors; twin gestation and pregnancies conceived with the aid of assisted reproductive technology were the most important, while bleeding in pregnancy, advanced maternal age, maternal chronic disease, and previous pregnancy with anomalous cord insertion were other risk factors (Ebbing et al., 2013).Velamentous cord insertion is diagnosed when the umbilical vessels insert into the membranes before they reach the placental margin. A marginal cord insertion is where this distance is reduced to a minimum, but the insertion site is supported by very little placental tissue (Ebbing et al., 2013). Marginal cord insertion is known to be associated with vessel rupture, preterm labour, intrauterine growth restriction, stillbirth, and neonatal death.

(Pathak et al.,2010) qualitatively define the types of umbilical cord insertions as follow:

Centric insertion: umbilical cord inserting within 2 cm of the center of the chorionic plate.

Eccentric insertion: umbilical cord inserting greater than 2 cm from the center and within the margin of the chorionic plate.

Marginal insertion: umbilical cord inserts into the margin of the chorionic plate.

Velamentous insertion: umbilical cord inserts outside the chorionic margins into the membranes and described the cord centrality and eccentricity indices mathematically to describe the nearness or farness of the cord insertion from the placental center.

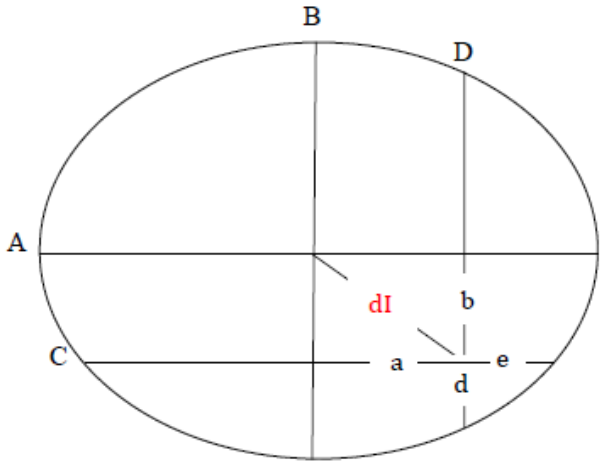


Figure1: Description of measurement of Umbilical Cord insertion on Placental to estimate distance of cord insertion from center.

Where, a = (½ C) - e, b = (½ D) - d, dI= distance of cord insertion from centre**.**

Distance of umbilical cord insertion from placental centre was calculated mathematically according to the Pythagorean Theory [Figure1]. "a" was calculated by subtracting "e"(shortest distance of umbilical cord insertion to the chorionic plate margin on X-axis) from the half of "C"(X-axis passing through the insertion of umbilical cord). "b" was calculated by subtracting "d"(shortest distance of umbilical cord insertion to the chorionic plate margin on Y-axis) from half of "D"(Y-axis passing through the insertion of umbilical cord). Since $dI^2 = a^2 + b^2$, where dI is the distance of umbilical cord insertion from the Centre. The formula for calculating the distance of the cord insertion from the Centre is:

$$dI = \sqrt{a^2 + b^2} = \sqrt{(\frac{1}{2}C - e)^2 + (\frac{1}{2}D - d)^2}$$(Pathak et al., 2010)

3. Objectives

3.1. General objective:

- To assess placental and umbilical cord indices and their association with perinatal outcome among mothers who gave birth in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

3.2. Specific objectives:

- To assess the association between placental indices and perinatal outcome.
- To assess the association between umbilical cord length and perinatal outcome.
- To determine prevalence of umbilical cord length.

4. Materials and Methods

4.1. Study area

The study was conducted in Hadiya Zone public Hospitals, Southern Ethiopia on delivered placentae and foetal anthropometry. The Hadiya zone is one of the 14 zones in Southern Nations Nationalities and Peoples Regions (SNNPRs), Ethiopia and has total area of 3850.2 square kilometers which divided into ten districts (locally termed "woredas") with total population of nearly 1.6 million, of which 817,267 were males and 826,201 were females and altitude ranged between 2276-3000meters above sea level. In Hadiya Zone, there are three public Hospitals named as, Homacho Primary Hospital, Shone Primary Hospital and Wachemo University Nigist Eleni Mohammed Memorial Referral Teaching Hospital (WUNEMRTH) which serves over one million people residing in urban and rural area of southern Ethiopia. WUNEMRTH has a monthly average of 350 deliveries with annual average of 4200 and Shone and Homacho Primary Hospitals respectively have 123 and 120 deliveries on monthly average. (Hadiya zone health bureau report, 2009)

4.2. Study period

- ✓ The study was conducted from September 1 to November 30,2017

4.3. Study design

- ✓ Institution based cross-sectional study design was used.

4.4. Populations

4.4.1. Source population

- ✓ All women who gave birth in Hadiya zone Public Hospitals

4.4.2. Study population

- ✓ All selected women who gave birth in all Public Hospitals during study period and fulfill inclusion criteria

4.5. Eligibility Criteria

4.5.1. Inclusion criteria

- ➢ Women with complete information on their socio-demographic characteristics,
- ➢ Known gestational age,
- ➢ Singleton pregnancy,
- ➢ Live birth neonate,
- ➢ Availability of mother's ANC card and
- ➢ Sample with the number sticker attached and is identifiable.

4.5.2. Exclusion criteria

- ✓ Women with multiple pregnancies,
- ✓ Maternal diseases affecting placental weights such as diabetes mellitus, hypertensive disorders, maternal anaemia, vascular diseases and other relevant medical problems,
- ✓ Congenital anomalies,
- ✓ Abnormalities of the placenta including placenta adherence, placenta previa and placental abruption detected after delivery
- ✓ Unknown gestational age,
- ✓ Unavailability of ANC card and
- ✓ Sample without number sticker or sticker cannot be read.

4.6. Sample size determination

Sample size was determined by using single population proportion formula based on the following assumptions: since there is no prior study regarding umbilical cord and placental indices and associated it with perinatal outcome in Ethiopia, to determine required sample size, the proportion (p) was taken as 0.5 at 95% confidence level and at margin of error (5%).

$$n = \frac{(Z\alpha_{/2})^2 .\ pq}{d^2}$$

Where:

n= sample size

p = sample proportion

q = 1-p

d = margin of error (5%).

$z\alpha$ = the standard normal value at the level of confidence desired at 95% CI

n= (1.96 × 1.96 × 0.5 × 0.5)/ (0.05 × 0.05)

n=384

Since the total population of 593 deliveries on monthly average in three public Hospitals (350 deliveries in WUNEMRTH,123 in Shone Primary Hospital and 120 in Homacho Primary Hospital) were less than 10,000 and the proportion of sample size to total population was greater than 0.05, correction formula was used to determine final sample size. The final sample size calculated as:

$$Nf = \frac{n}{1+ n/N} = 233$$

Where;

Nf = final sample size

N = total population (593)

n= sample size (384)

Expecting a 10% non-response rate, the final sample size calculated was 256.

4.7. Sampling procedure

All public hospitals were enrolled in study and the study was conducted in all of them simultaneously. Before conducting the study, case load of each hospital was obtained for three months since data collection took three consecutive months. The sample size was distributed to each selected hospital using proportional to population size.

The respondents were selected by using systematic random sampling techniques until the required sample size reached. To determine sampling frame, the expected total number of delivery service on monthly average (593) divided by the total sample size (256). To determine sampling interval (K), the number of unit in population (N) was divided by desired sample size (n). K= N/n, N=593, n=256, k=593/256=2.31 ~2. With this proportional to the unit participant numbers (size), every 2nd mothers' placenta with attached umbilical cord was enrolled in study starting from the randomly selected (2nd) newly delivered eligible mothers' placentas and umbilical cord.

Schematic Diagram of Sampling Procedure

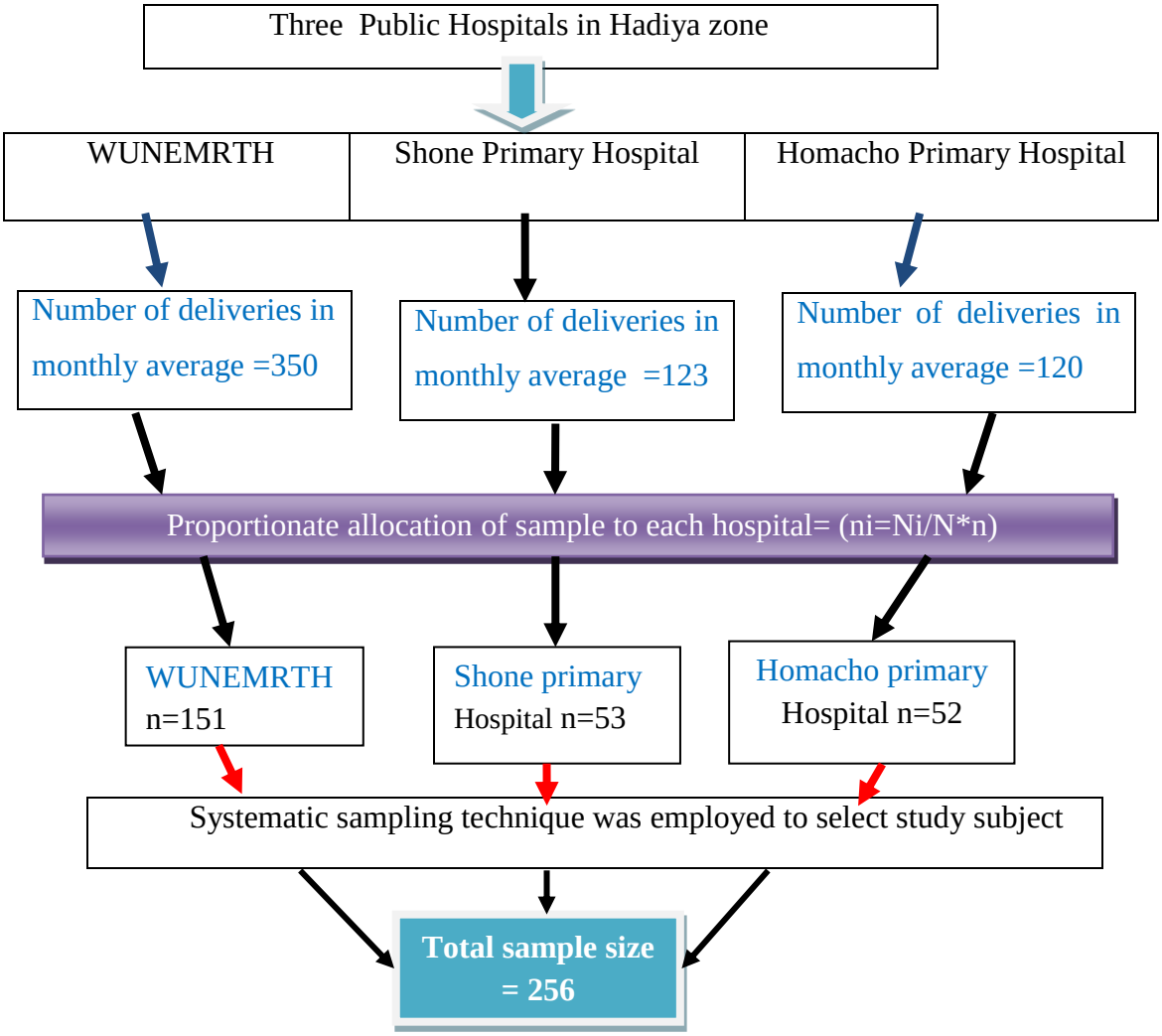


Figure2: Schematic presentation of sampling procedure to select case to assess placental and umbilical cord indices and their association with perinatal outcome in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

Proportionate probable sample to each Hospital was calculated by using formula: ni =Ni/N*n
Where: -

ni =number of mothers who are needed for the study in each hospital.

Ni=total number of women's who gave deliveries in previous one month at each hospital.

n=calculated sample size

N= total number of deliveries in three hospitals.

4.8. Study Variables

4.8.1. Dependent variable

- Perinatal outcome (low birth weight, foetal distress)

4.8.2. Independent variables

- Maternal Socio-demographic characteristics(Age, Parity, Gravidity, Mode of delivery, Marital status, Residence, Educational status, Occupation)
- Placental indices(Shape, Diameter, Thickness and Weight)
- Umbilical cord indices (Umbilical Cord length and insertion)

4.9. Operational Definitions

Foetal distress: An emergency pregnancy, labor and delivery complication in which a baby experiences oxygen deprivation (birth asphyxia), causing changes in the baby's heart rate, decreased foetal movement, and abnormal substances in the amniotic fluid.

Perinatal outcome: foetal status which occur during or after delivery (foetal distress, low birth weight).

Irregular shape of placenta: All placental shapes except circular and oval like star shaped and others.

Low birth weight: Birth weight <2500g.

Post term birth: infants with gestational age greater than 42 complete weeks.

Preterm birth: infants with gestational age less than 37 complete weeks.

Term birth: infants with gestational age between 37 to 42 weeks.

Umbilical cord length: total length of cord measured from the foetal end to its point of insertion into the placenta

Placental indices: Placental parameters measured on gross placenta which includes placental weight, thickness, shape and diameter.

Umbilical Cord indices: Umbilical Cord length and Umbilical Cord insertion on to Placenta

4.10. Materials and Apparatus

Materials and apparatus that were used include 10% formalin, 0.5% formaldehyde, plastic container, flat tray, blade with holder, long needle, surgical and clean glove, meter (cm), weighing machine (g), digital camera, towel, mask and normal saline.

4.11. Specimen Collection and Preparation

The placentae from normal singleton with known gestational age and live birth neonate delivered at the delivery room were collected and washed under normal saline to wash off blood smear and clots. The umbilical cord was cut leaving a length of 5 cm from its foetal site of insertion (Adesina et al., 2016; Elangovan and Raviraj, 2016; Zia-ur-rehman et al., 2013). The specimens then placed in plastic container filled with formalin (10%) within 20min of delivery to prevent drying out (Pathak et al., 2010) and kept at room temperature. All the specimens were labeled with number sticker after washing for the purpose of identification and stored again in a solution of 0.5% formaldehyde in saline for further detailed examination and measurement.

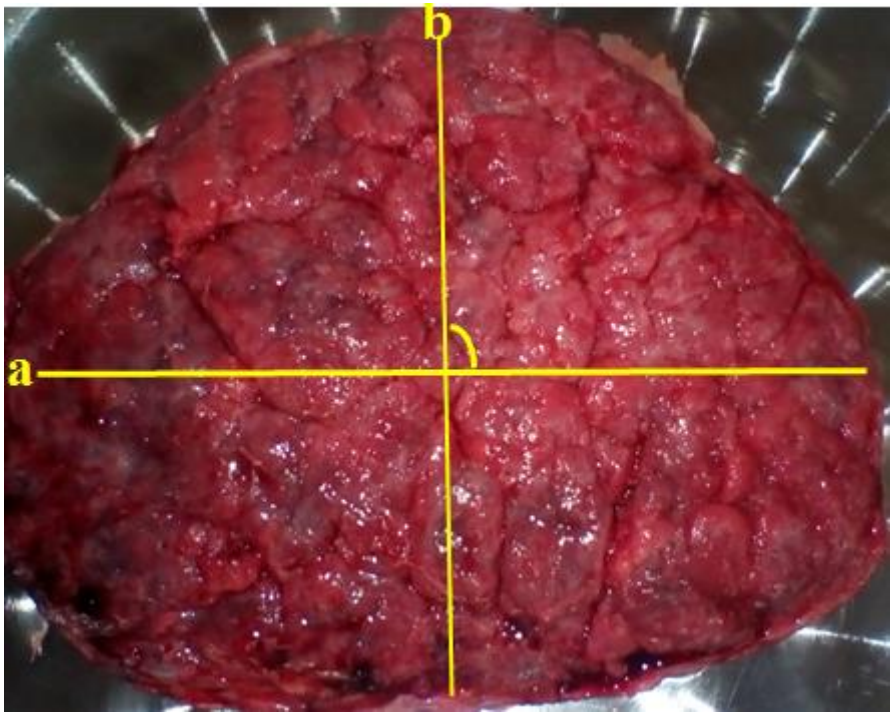
4.12. Data collection procedures

4.12.1. Placental variables

First, placentae were checked for completeness, then an accurate weighing of the placentae were done by trimming off all membranes and removing of umbilical cord (Madkar et.at, 2015). Then, washed in normal saline (Keche, 2015), mopped by towel and tagged with the numbers sticker for coding purpose. After all, the following parameters were measured:

4.12.1.1. Chorionic Disc Diameters (Major, Minor)

Diameters (major and minor) of the chorionic disc were recorded in cm using a standard non-elastic tape measure. The placenta was placed in a flat tray. First, the maximum diameter (a) was measured with standard non-elastic tape measure graduated in centimetres (cm). Then a second maximum diameter (b) was measured at right angles to the first one. Finally the mean of two measurements were considered as the diameter of the placenta expressed in centimetres (Akhter et al., 2011;Segupta et al., 2009;Zia-ur-rehman et al., 2013).



Photograph1: Demonstrate how average Placental Diameter was measured in Hadiya zone Public Hospitals, 2018

4.12.1.2. Placental Weight

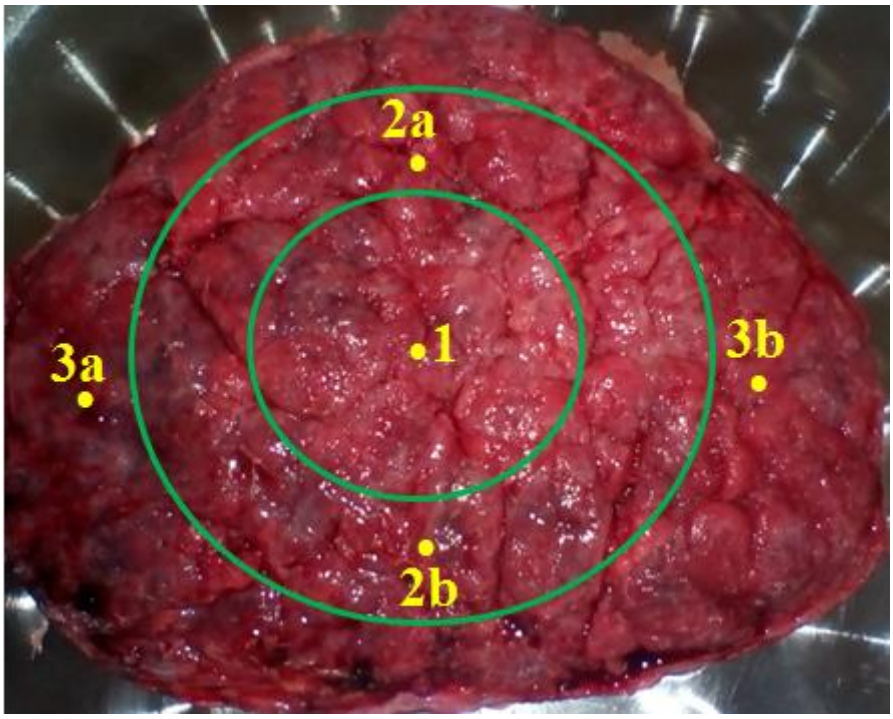
Placentae were weighed using a weighing machine scaled in grams (Akhter et al., 2011).

4.12.1.3. Shape of placenta

The shape of the placenta and presence of accessory lobe were recorded after proper observation and then categorized as round, oval or irregular in shape (Segupta et al., 2009;Zia-ur-rehman et al., 2013).

4.12.1.4. Thickness of placenta

With a long needle placental thickness was measured at five points of each placenta. After placing each placenta on foetal surface, it was divided arbitrarily into three zones of equal parts by drawing two circles on the maternal surface. These circles cut the radius of the placenta into three equal parts. One thickness was measured from the Centre of the central zone, two from middle zone and another two from peripheral zone. The peripheral points were taken within the outer zone on a line perpendicular to the previous imaginary line. Finally, the mean of all five measurements were calculated and considered as thickness of the placenta (Akhter et al., 2011; Segupta et al., 2009; Zia-ur-rehman et al., 2013).



Photograph2: Demonstrate How Surface of Placenta was divided into three zones to measure its Thickness in Hadiya zone Public Hospitals, 2018

4.12.2. Umbilical Cord Length

Each umbilical cord was immediately clamped and cut leaving 5cm from its foetal site of insertion at foetal end with scissors in all cases. The remaining cord from the cut end to the placental insertion was measured using a standard non–elastic tape measure in centimetres and five centimetres (length of the cut end attached to the foetus) was added to the length of the measured umbilical cord to determine entire length of umbilical cord (Adesina et al., 2016; Elangovan and Raviraj, 2016; Ogunlaja, 2015; Zia-ur-rehman et al., 2013).

4.12.3. Infant Anthropometry

Infant anthropometric parameters including birth weight, body length, head circumference, and sex were determined in all infants. All measurements were measured by the same trained birth attendant within 24 hours after delivery. Birth weight was measured with weighing scale calibrated in kilograms when the infant is naked. Body length and Head circumference were measured with a non–elastic standard tape measure to the nearest centimeter when the infant lies in a quiet position.

4.12.4. Maternal Indices

Data on maternal age at delivery, parity were obtained from records in the Antenatal care Cards of the mothers established by Federal Ministry of Health of Ethiopia for the purpose of maintenance of maternal health. Gestational age was expressed in complete weeks from the Last Normal Menstrual Period confirmed by ultrasound scan report.

4.13. Data management and Analysis

The collected data was checked manually for its completeness, coded and entered into Epi-Data version 2.1 statistical packages then exported to SPSS Version 20.0 for further analysis. Inconsistent values were double checked against the filled data extract format and corrected as necessary. Frequency, percentage, tables and pie chart were used to represent the results of categorical variables and means and standard deviations to represent continuous variables. Cross tabulation was used to describe frequency or percentage of study participants. Bivariate and multivariate logistic regression analyses were used to determine the association of independent variables with the dependent variable. Variables with $p<0.25$ in bivariate analysis were entered into multivariate logistic regression model to identify the important determinants by controlling confounders. Odds ratios with 95% confidence were computed to identify the presence and strength of associations, and statistical significance was declared if $p<0.05$. The final model was checked using the Hosmer–Lemeshow goodness of fit test. Co-founders, interaction and multi-collinearity were checked to minimize bias.

4.14. Data Quality Assurance

Before data collection to assure the quality of data, data collecting check lists which adapted from different literatures and modified according to this study objectives were checked for clarity, understandability, uniformity and completeness. Training was given to data collectors (six BSc. Midwives, two from each consecutive Hospital) and supervisors (three MPH/RH from Wachemo University) for two days about the objectives, process of data collection and standard operating procedure. The pretest was carried out in 5% of sample size prior to the actual data collection time outside of study population. Necessary adjustments, important amendments and logical flow of ideas were maintained based on the pretest result. Everyday close supervision was undertaken by trained supervisors and every other day by principal investigator. All necessary feedbacks were offered to data collectors in the next morning before data collection and quality of equipment were also checked to ensure the accuracy.

4.15. Ethical Consideration

Ethical clearance letter was obtained from Addis Ababa University, College of Health Sciences, Department of Research and Ethical Review Committee (DRERC) and Department of Anatomy prior to data collection.

Accordingly, letter of cooperation obtained from Hadiya zone health department to Public Hospitals. Finally, permission was got for corresponding obstetric ward coordinators in each Hospital.

Moreover, all the study participants were informed orally about the purpose and benefit of the study along with their right to refuse. Furthermore, the study participants were reassured for an attainment of confidentiality and orally informed consent was obtained.

5. Results

5.1. Maternal socio-demographic characteristics

Out of 256 reproductive age child bearing women planned to be included in the study, 249 respondents were included in study with the response rate of 97.26%. However, a total of 7 women failed to remember their LNMP and had no ultrasound gestational age estimate documented, referral cases and placental anomalous were excluded from further analysis to maintain the unbiased effect. The age of respondents included in this study were ranged between 18 to 46 years with mean age of 30 years (SD±6.78). Fifty one (20.5%) of mothers were unable to read and write whereas fifty eight (23.3%) of mothers had followed more than secondary education. More than half of mothers 169 (67.9%) were live in urban area and 80 (32.1%) were rural resident. Governmental employee and housewife were the predominant maternal occupation in the study group 98(39.4%) and 88(35.3%) respectively. All most all of respondents 229(92.0%) were married and 165(66.3%) were multiparous. One hundred and seven (43.0%) and 85(34.1%) of mothers had 1-2 and 3-4 children respectively [Table1].

Table1: Socio-demographic characteristics of the mothers in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

Background Variables	Categories	Frequencies	Percent
Maternal age	<20 years old	7	2.8
	20-34 years old	169	67.9
	35-49 years old	73	29.3
Place of residence	Urban	169	67.9
	Rural	80	32.1
Maternal educational status	No formal education	51	20.5
	Primary	74	29.5
	Secondary	66	26.5
	More than secondary	58	23.5
Occupation of the mother	Farmer	39	15.7
	House wife	88	35.3
	Governmental employee	98	39.4
	Merchant	6	2.4
	Unemployed	18	7.2
Marital status of the mother	Married	229	92.0
	Single	14	5.6
	Divorced	6	2.4
Parity	Nulliparous	90	36.1
	Multiparous	159	63.9
Gravidity	1-2	107	43
	3-4	85	34.1
	>=5	57	22.9
Mode of delivery	Normal vaginal delivery	222	89.2
	Caesarean section	4	1.6
	Vacuum extraction	12	4.8
	Forceps extraction	11	4.4

5.2. Placental indices

5.2.1. Placental Diameter and Thickness

The mean major diameter (MjD) of placenta was 18.30 (SD±2.70; range =12.0–24.20cm) and the minor diameter (MiD) was 17.15(SD±2.56; range=10.5–23.5cm) with mean diameter of two 17.73±2.61 (ranged=11.25–23.75cm).Three-fourth 189(75.90%) of diameter of studied placenta was in normal range and 45(18.10 %), 15(6.0%) below and above normal range respectively. The mean placental thickness on gross measurements was 2.43± 0.41 with a range of 1.6 cm to 3.9 cm.

5.2.2. Placental Weight and Shape

In this study mean placental weight (PW) was 448.26g (SD±100.93; range=299.0–723.0g). More than Three-fourth 204(81.9%) of placental weight was within normal range (330-750g).

The placenta is normally considered to be a round discoid shape; however the shape has been described in various ways such as round, oval, irregular, star shaped bi-lobate, multi-lobate, circumvallate, circummarginate and many more. In this study majority (71.5%) of shape of placenta was round in shape with rare case of irregular shape (7.6%).

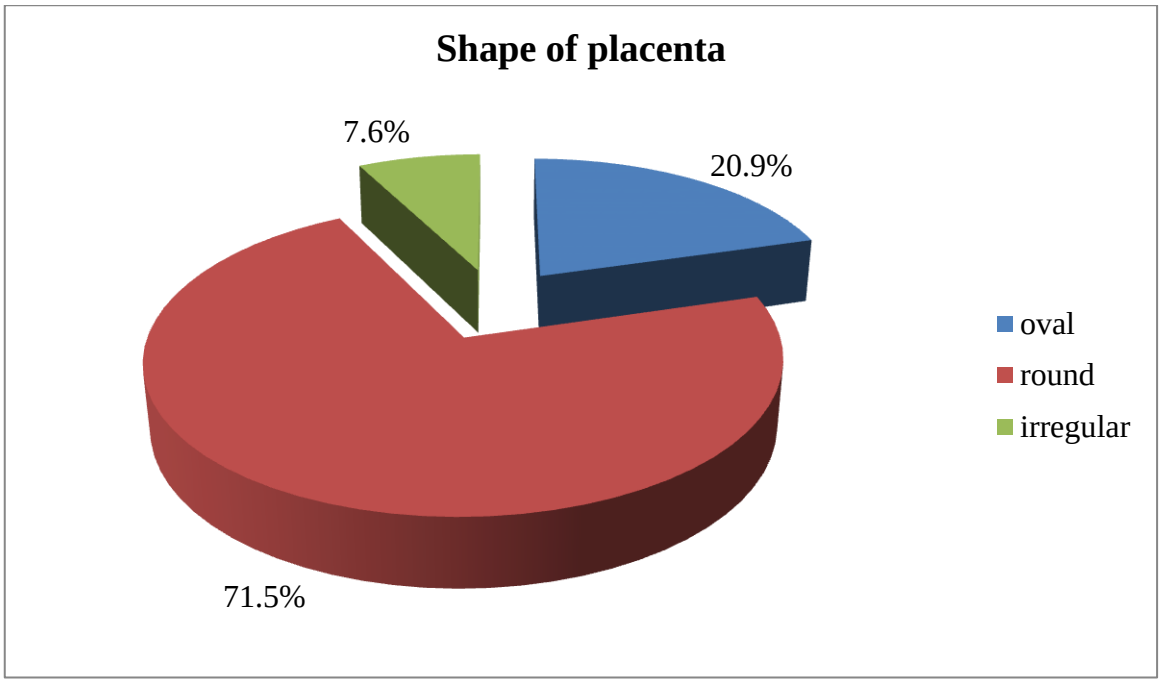


Figure3: Distribution of placental shape in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

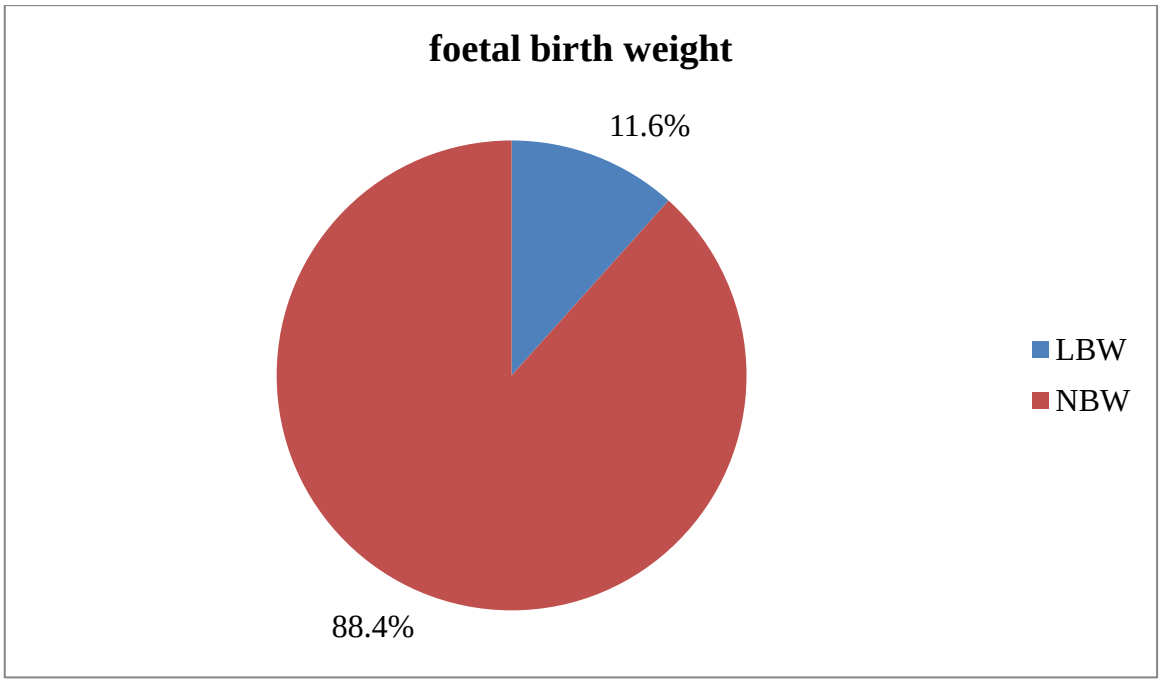
5.3. Foetal indices

5.3.1. Gestational age

Among the 249 neonates studied 136(54.60%) were males and 113(45.40%) were females. The mean gestational age (GA) was 37.03weeks (SD=2.29, range =30.3–41.5 weeks). Over half of, 60.6% (n=151) delivered babies were term whereas 98(39.4%) were preterm, of which more than half 60.2% (n=59) of studied case were male while remaining 39.8% (n=39) were female.

5.3.2. Foetal birth weight

Birth weight (BW) babies had a mean of 3270.68g (SD=565.67, range=2000–4500g). Out of the 249 babies, majority 220(88.4%) had birth weight within normal range. Twenty nine (11.6%) had birth weight <2.5 kg. Of these, 89.7% (n=26) was preterm delivered babies whereas 10.3% (n=3) delivered after complete weeks of gestational age [figure4].



**LBW (Low Birth Weight), NBW (Normal Birth Weight)*

Figure4: Distribution of foetal birth weight in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

5.3.3. Foetal distress

Among studied cases, majority 162(65.1%) had no distress, but about 87(34.9%) of babies were with foetal distress and admitted to NICU for resuscitation. Of those with distress, 43(52.4%) were having short umbilical cord length whereas 8(61.5%) were with long cord length. Apgar score at one minute and at five minutes respectively ranged from 2-9 and 3-10 with a mean of 7.12 ±1.45 and 8.21±1.39.

5.4. Body length

In this study new born length was measured from top of the head to heels positioned straight on his/her back in the center of the board head touching the headpiece and eyes looking straight up. The mean body length (BL) is 48.57cm (SD=5.90, range=38.0 to 61.0cm). Nearly half (43.8%) of the baby's body length were in normal range followed by short or below normal and long or above normal respectively, while mean head circumference (HC) of babies were 33.70cm (SD=2.14, range=29.5 to 38.0 cm).

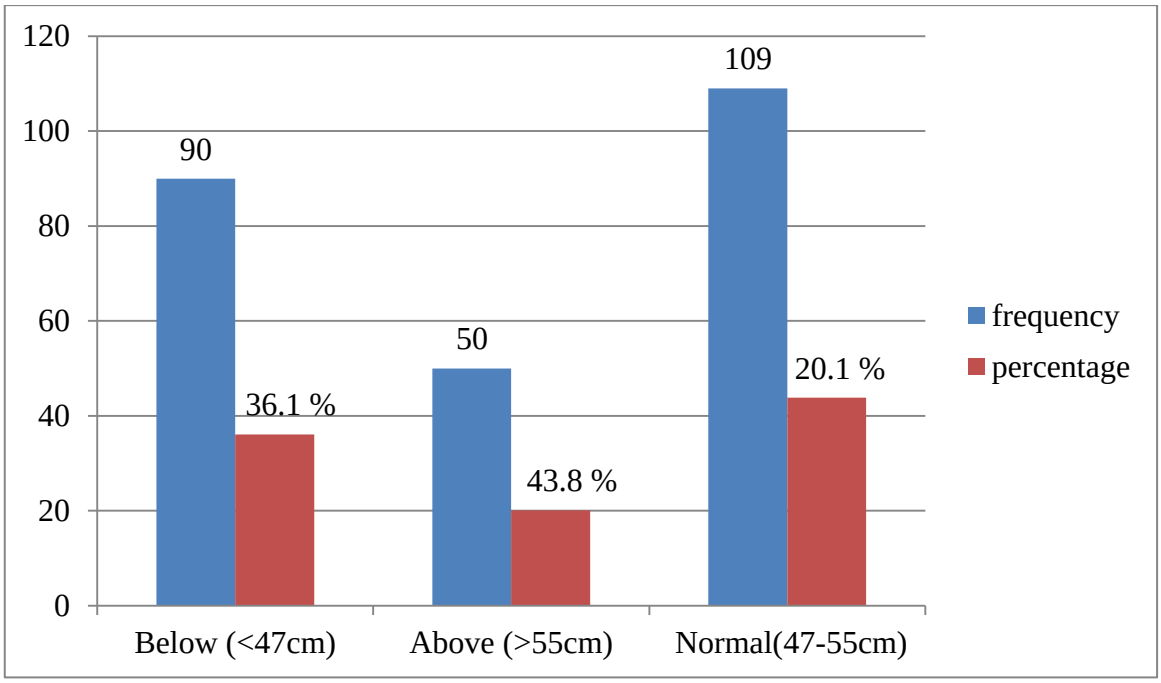


Figure5: Distribution of new born body length in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

5.5. Umbilical cord parameters

5.5.1. Umbilical cord length

A total of 249 placentae with their attached umbilical cords were collected from the Hadiya zone public hospitals from September 1 to November 30, 2017. Cord length ranged from 22 to 80.1 cm with a mean of 46.34±10.72 cm. Out of the 249 cords examined, 82 (32.90%) were short cord length (<40cm), 154 (61.80%) were of normal length (40-70cm) and 13 (5.2%) were longer than normal range (>70cm).

5.5.2. Umbilical cord attachment

The insertions of the umbilical cord in those placentae with attached cord for combined Centric and eccentric umbilical cord insertions were found in 90.8% (i.e. 25.7% and 65.1% respectively) of all cord insertions into the placenta, followed by marginal which also known as battledore 8.8%. The least occurring, 0.4% of cord insertion in this study was velamentous cord insertion.

Table2: Distribution of Umbilical Cord Attachment in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

Umbilical cord attachment	Frequency	Percent	Cumulative percent
Central	64	25.7	25.7
Eccentric	162	65.1	90.8
Marginal	22	8.8	99.6
Velamentous	1	0.4	100.0
Total	249	100.0	

5.6. Factors associated with foetal birth weight.

In binary logistic regression; educational status of mothers, placental weight, placental thickness, Apgar score at one minute, Gestational age of foetus, parity, Residence and maternal occupation were found independently associated with LBW at p-value<0.25. Multivariate logistic regression showed that placental weight, gestational age and parity were predictors for LBW and significant association at p-value<0.05).

The odds of low birth weight among delivered babies who had low placental weight were 6.57 folds higher [AOR=6.57; 95%CI: 2.47, 17.48] when compared with those who had normal placental weight [Table3].

Gestational age of delivered foetus also had showed significant association with Infants born with weight below normal (<2.5kg), where Infants who had delivered before 34weeks of gestation and 34-37weeks were Twenty [AOR=21.16; 95% CI: 5.00, 89.53] and 7.28 [AOR=7.28 95% CI: 2.12, 25.04] times more likely to become low birth weight compared with their counterparts. The parity of mothers was also significantly affects birth weight [Table3]. The odds of delivering LBW were reduced by73% among nulliparous women compared with those of multiparous.

Table3: Result of Bivariate and multivariate logistic regression for factor associated with low birth weight in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

Variables	Categories	Foetal Birth Weight >=2.5kg N (%)	Foetal Birth Weight <2.5kg N (%)	COR at 95% CI	AOR at 95% CI
Educational status	No edu	46(85.2%)	8(14.8%)	4.87(0.99,24.07)	1.23(0.10,14.85)
	1st edu	58(81.7%)	13(18.3%)	6.28(1.35,29.08)**	1.31(0.13,13.20)
	2nd edu	60(90.9%)	6(9.1%)	2.80(0.54,14.45)	0.70(0.09,5.46)
	More 2nd	56(96.6%)	2(3.4%)	1	1
PW	Low	30(66.7%)	15(33.3%)	6.79(2.98,15.47)*	6.57(2.47,17.48)*
	Normal	190(93.1%)	14(6.9%)	1	1
PT	Low	24(77.4%)	7(22.6%)	2.60(1.01,6.72)***	2.52(0.76,8.38)
	Normal	196(89.9%)	22(10.1%)	1	1
AP1	Poor	59 (80.8%)	14(19.2%)	2.55(1.16,5.60)***	2.55(0.89,7.28)
	Good	161(91.5%)	15(85.0%)	1	1
GA	<34wk	14(56%)	11(44%)	27.90(7.84,99.25)*	21.16(5.00,89.53)*
	34-37wk	64(82.1%)	14(17.9%)	7.77(2.46,24.52)*	7.28(2.12,25.04)*
	>=37wk	142(97.2%)	4(2.7%)	1	1
Parity	Nullipa	71(84.5%)	13(15.5%)	1	1
	Multipa	149(90.3%)	16(9.7%)	0.59(0.27,1.29)	0.27(0.09,0.80)**
Residence	Urban	158(93.5%)	11(6.5%)	1	1
	Rural	62(77.5%)	18(22.5%)	4.17(1.86,9.33)***	2.57(0.93,7.10)
Occupation	Farmer	31(79.5%)	8(20.5%)	0.77(0.23,2.59)	2.76(0.48,15.74)
	HW	77(87.5%)	11(12.5%)	0.43(0.14,1.31)	0.69(0.16,3.01)
	GE	94(95.9%)	4(4.1%)	0.13(0.03,0.50)***	0.84(0.15,4.73)
	Others	18(75.0%)	6(25.0%)	1	1

AOR= Adjusted Odd Ratio; CI=Confidence Interval, COR= Crude Odd Ratio; ***p-value <0.05, **p value=0.001,*p-value<0.0001, 1st edu=primary education, 2nd edu=secondary education, others=merchant, unemployed, PW=Placental Weight, PT=Placental Thickness, AP1=Apgar score at 1 minute, GA=Gestational Age, HW=House Wife, GE=Governmental Employee.

5.7. Factor associated with foetal distress

In the bivariate analysis, sex, placental weight, placental thickness, umbilical cord length, shape of placenta, gestational age of foetus, Apgar score at five minute, Apgar score at one minute, parity and gravidity were found independently associated with foetal distress at p-value<0.25.

Multivariate logistic regression showed that placental thickness, sex of the foetus, umbilical cord length, gestational age, gravidity, Apgar score at five minute and at one minute were significantly associated with foetal distress at p<0.05.

Newborns who had short cord length [AOR=3.43; 95% CI: 1.66, 7.09] and long cord length [AOR=7.55; 95% CI: 2.07, 27.53] were nearly three and eight times more likely to develop foetal distress as compared to newborns with normal cord length. Another variable which had association with foetal distress independently and in combined form was gestational age. Gestational age of delivered foetus had significant association with LBW (<2.5kg), where Infants who had delivered before 34 complete weeks were 20 folds [AOR=20.77; 95% CI: 5.98, 72.15] more likely to develop foetal distress as compared with their counterparts. In addition, Thin placenta(<2cm), Apgar score at five minute, Apgar score at one minute, being female and Gravidity (women with 3-4 children) were also had association with outcome variable of interest [Table4].

Table4: Result of Bivariate and multivariate logistic regression for factors associated with foetal distress in Hadiya zone Public Hospitals, Southern Ethiopia, 2018

Variable	Categories	Foetal distress		COR at 95% CI	AOR at 95% CI
		Yes N (%)	No N (%)		
PW	Low	26(57.8%)	19(42.2%)	3.21(1.65, 6.23)**	1.71(0.65,4.46)
	Normal	61(29.9%)	143(70.1%)	1	1
PT	Low	18(58.1%)	13(41.9%)	2.99(1.39,6.45)**	3,43(1.25,9.40)*
	Normal	69(31.7%)	149(68.3%)	1	1
Sex	Male	57(41.9%)	79(58.1%)	1	1
	Female	30(26.5%)	83(73.5%)	0.50(0.29, 0.86)**	0.38(0.18, 0.81)*
UCL	Short	43(52.4%)	39(47.6%)	3.62(2.04, 6.40)*	3.43(1.66,7.09)*
	Long	8(61.5%)	5(38.5%)	5.24 (1.62, 17.03)*	7.55(2.07, 27.53)*
	Normal	36(23.4%)	118(76.6%)	1	1
PS	Oval	14(24.1%)	44(75.9%)	1	1
	Round	64(36.8%)	110(63.2%)	1.83(0.93, 3.59)	1.96(0.77, 5.04)
	Irregular	9(52.9%)	8(47.1%)	3.54(1.15, 10.91)**	3.76(0.89, 15.84)
GA	<34wk	20(80%)	5(20%)	13.70(4.77,39.30)*	20.77(5.98,72.15)*
	34-37wk	34(43.6%)	44(56.4%)	2.65(1.46,4.78)*	1.47(0.70,3.08)
	>=37wk	33(22.6%)	113(77.4%)	1	1
AP5min	Poor	32(68.1%)	15(31.9%)	5.70(2.87,11.34)*	5.27(2.28,12.21*
	Good	55(27.2%)	147(72.8%)	1	1
AP1min	Poor	35(47.9%)	38(52.1%)	2.20(1.25 ,3.85)**	2.30(1.11, 4.77)**
	Good	52(29.5%)	124(70.5%)	1	1
Parity	Nullipa	37(44.0%)	47(56.0%)	1	1
	Multipa	50(30.3%)	115(69.7%)	0.55(0.32,0.95)**	0.76(0.24,2.40)
Gravidity	1-2	47(43.9%)	60(56.1%)	1	1
	3-4	27(31.8%)	58(68.2%)	0.59(0.33,1.08)	0.37(0.17,0.80)**
	>=5	13(22.8%)	44(77.2%)	0.38(0.18,0.78)**	0.38(0.13,1.06)

AOR=Adjusted Odd Ratio; CI=Confidence Interval, COR=Crude Odd Ratio; **p-value<0.05; Nullipa=Nulliparous; Multipa=Multiparous; AP5min=Apgar score at 5 minute, AP1min=Apgar score at 1 minute, PW= Placental Weight, PT= Placental Thickness, UCL=Umbilical Cord Length, PS = Placental Shape, GA= Gestational Age, *p-value<0.0001.

6. Discussion

This study aimed to assess placental and umbilical cord indices and their association with perinatal outcome presents the report of 249 birth episodes of placentae from normal singleton with known gestational age and live birth with attached umbilical cord in Public Hospitals of Hadiya zone, Southern Ethiopia.

The prevalence of LBW in this study was 11.6% (95% CI: (7.6-15.6)). This study finding is in agreement with study conducted in Jimma referral Hospital, western Ethiopia 11.2% (Gebremariam, 2005). But higher than studies conducted in FelegeHiwot Referral Hospital, Bahridar, Ethiopia 8.8% (Mulatu et al., 2017) and Axum and Laelay Maichew district 9.9% (Teklehaimanot et al.,2014) and lower than studies at tertiary hospital in Gondar, Northern Ethiopia 17.1%, 17.4% (Meseret et al., 2012) and (Zenebe et al.,2014) respectively and 17.9% in south west Ethiopia (Wado et al.,2014). This difference might be explained by the time gap between these studies and seasons of the year as birth weight may have seasonal variations (Enquoselassie and Minyilshewa, 2000). It also might be due to different factors which influence the weight of newborn like maternal factors (e.g. race, stature and genetics), paternal factors (paternal height, genetics), environmental influences (e.g. altitude, availability of adequate nutrition), physiologic factors (e.g. altered glucose metabolism, haemoglobin concentration, micro vascular integrity), pathologic factors (e.g. hypertension, uterine malformation) (Van den Broek et al., 2005).

In present study low placental weight (<330g) was associated with low birth weight (<2.5 kg).There was higher odd of low birth weight among newborn with low placental weight [AOR=6.57; 95%CI: 2.47, 17.48]. Possible explanation for this is the fact that the growth of the foetus depends upon the functional capacity, location and integrity of the placental attachment. Placental weight is known to be a reflection of placental development and functions in early intrauterine environment. Therefore, foetal wellbeing is highly dependent on the placenta since it serves as a link between the mother and the developing foetus for nutritional support, excretory functions as well as immunological and hormonal support (Appiah, 2009).

And it also could be explained in terms of placentae surface area. Large placentae provide a large surface area (Appiah, 2009). Minor placentae size restricts transfer of nutrients whiles major placentae distribute nutrients to itself, thereby affecting foetal size (Harding, 2001). Moreover, (Bimpong, 2012) explained this association in terms of structural organization of the chorionic plate vascularization. The chorionic plate vessels form a high capacitance and

low resistance of foeto–placental vascularization linking the umbilical cord vessels to the sites of oxygen and nutrient exchange in the placental villi. Thus, this might lead to wider distribution of chorionic vessels to allow for efficient exchange of materials at the placental villi with the umbilical cord vessels. Therefore, if there is any potential limitation on placental ability to transfer any necessity that enables foetal growth and development, this might affect overall status of foetus and resulting in low birth weight and placental weight lower than 330 g can be a warning sign (Asgharnia et al.,2008).

Placental weight is the most common way to characterize placental growth, and is a summary of many dimensions of placental growth (Macdonald, 2012) and approximately weights $1/6^{th}$ of the foetal weight (Elangovan and Raviraj, 2016). Similarly, Londhe and Mane, (2012) concluded that placental weight increased according to the birth weight and showed a strong correlation with foetal weight (Elangovan and Raviraj, 2016).Thus, birth weight is a straightforward measure of the outcome of births and is affected by several factors which could be directly or indirectly necessary for perinatal survival (Misra et al., 2009).

Another determinant of birth weight in this study was gestational age. Gestational age was found to be a strong, independent predictor of birth weight which was independently associated with the occurrence of low birth weight; the likelihood of having LBW in new-born delivered before gestational age less than 34 weeks was twenty times higher compared to their counter parts. This study is in agreement with study findings in Brazil(Coutinho et al.,2011) where they found that LBW were over 20 times more at risk of being preterm (<37 weeks) than normal weight new-borns, in Tigray(Gebremedhin etal., 2015) 18.5 times (AOR=18.5 (95 % CI=4.94-69.4)) and in Gondar (Zenebe et al., 2014) 18.0 times(AOR 18, 95%CI 5.8, 31.2)). Another studies goes in line with this study were (Mamelle et al.,2006; Bugssa et al.,2014; Siza, 2008). It might be due to the fact that as the gestational age of the foetus falls below the acceptable range of time, the body weight of the foetus falls dramatically due to prematurity.

In current study cord length ranged from 22 to 80.1 cm with a mean of 46.34 cm ±10.72. Out of the 249 cords examined, 82 (32.9%) were short (cord length <40cm), 154 (61.8%) were of normal length (40-70cm) and 13 (5.2%) were longer than normal (>70cm).

The mean length of cord in this study is in line with study undertaken by Gupta et al., (2006) and Abaidoo & Warren, (2008) respectively where they reported their findings as the 44.3 cm±9.2 and 47.04cm±12.8. From percentage distribution in this study, normal cord length (61.8%) is similar with (Appiah, 2009) and (Bimpong, 2012) findings 57.86% and 59.90%

respectively. However, there is higher prevalence 5.2% (95% CI :(2.8-8.0)) of long cord length and low prevalence of short cord length 32.9% (95%CI: (26.5-38.9)) compared to above researchers, where they reported (0.4% and 2.3%) as long and (39.6 % and 39.8%) as short respectively. This discrepancy might be due to exists of variation in the definition of cords length even though reference standards for cord length have been reported (Naeye, 1985;Yetter,1998; Abaidoo & Warren,2008). And also other possible reason might be genetic and environmental effects beside standards of measuring instruments, skills of data collectors, methodology and sample size.

In this study umbilical cord length measured from foetal site of insertion to placenta was categorized as short (<40cms), normal (40-70cms) and long (>70cms) based on previous studies conducted in different countries which had nearly similar ranges. For instance, (Cunningham et al.,2005) reported most measured value between 50-60 cm, study conducted in Japan revealed that ≤ 38 cm and ≥ 74cm for short and long cord length respectively while value ranging between 45-68 cm as normal (Suzuki & Fuse, 2012). In Nigeria Short umbilical cords were proposed to be less than 40cm whereas long umbilical cords were greater than 70cm (Bimpong,2012; Ogunlaja,2015). This study found that umbilical cord length deviated from normal range (40-70cms) had statistically strong association with foetal distress, where newborns who had short cord length were 3.43 folds more likely to develop foetal distress whereas those with long umbilical cord were 7.55 folds more likely to develop foetal distress as compared with their counter parts. Current study findings are supported by (Ogunlaja, 2015; Elarbah et al., 2014; Baergen et al., 2001).

Even though there was no clear cut conclusion what control umbilical cords length, various authors correlates cord length with foetal activity and movement. It was suggested that sufficient space in the amniotic cavity for movement and the tensile force applied to the umbilical cord during foetal movements are two main factors that determine cord length (Benirschke, 2004; Lyndon et al., 1994). Nilesh et al., (2012) revealed that higher variability in foetal heart rate with extremes of cord length and incidence of birth asphyxia was significantly more in long and short cords as compared to cords with normal cord length.

The presence of a short umbilical cord has been associated with ante partum abnormalities and risk factors for complications of labour and delivery. A short cord has been associated with intrauterine foetal distress and neonatal asphyxia (Elarbah et al., 2014). The reason for this is believed that excessive traction on the cord during descent of the foetus results in

occlusion of the cord vessels and associated with failed progress and cord rupture (Soliriya et al., 2017).

Long umbilical cords were associated with increased birth weight and respiratory distress (Ogunlaja, 2015; Elarbah et al., 2014) and cord prolapse, poor foetal outcome and increased operative interference (Soliriya et al., 2017). This might be explained in the term of cord entanglement (true knots or cord loops around the neck or body parts). The fact that excessively long cord loops around foetal neck or body leads to perinatal complications like IUGR, neurological damage and foetal death.

Preterm delivery before 34 complete weeks, Apgar score<7 at five and one minute, Thin placenta (placenta measured <2cm), being female and Gravidity were also had association with variable of interest. The likelihood of having foetal distress in babies born before gestational age of 34 weeks was nearly Twenty times higher compared to that of babies born at gestational age of 37 weeks or above[AOR=20.77; 95%CI: 5.98, 72.15]. The odds of foetal distress among babies who had recorded with Apgar score<7 at five and one minutes were five [AOR=5.27; 95%CI: 2.28, 12.21] and two folds [AOR=2.30; 95%CI: 1.11, 4.77] more likely to develop foetal distress as compared with their counterparts. It was confirmed by(Original, 2010) that Apgar score at five minute<7 was associated with neonatal respiratory distress and need for NICU. Foetal distress was associated with low birth scores in infants at 1 and 5 minutes of age (Souza et al.,1975).

7. Conclusion

This study revealed that low placental weight and preterm birth (<34weeks) were significantly associated with LBW. Deviations of UCL from normal range, preterm birth (<34weeks), Apgar score <7 at five minute and one minute were significantly associated with foetal distress at $p<0.05$. Prevalence of short, long and normal cord length were 32.9%, 5.2% and 61.8% respectively in this study.

8. Strength of Study

- ✓ Direct measurement of parameters (placenta and umbilical cord indices) were performed precisely to the nearest decimal and accordingly recorded by well-trained data collectors under close supervision of principal investigator.

9. Limitation of Study

- ✓ The study associated placental and umbilical cord indices only with perinatal outcome and did not consider some potential risk factors like, congenital anomalous, multiple pregnancies, maternal nutritional status and Altitude variation effect.
- ✓ Since this study was conducted in health institutions, the result of the study might not be generalized to the entire population.

10. Recommendations

- ✓ Examination of the placenta and umbilical cord should be performed routinely in delivery rooms to provide valuable information that are important to the care of both mother and new born.
- ✓ Efforts should be made to draft standardized guide lines to measure placental and umbilical cord indices which details normal range of parameters and also deviations from normal values.
- ✓ Relevant Trainings should be incorporated to health professionals specially; Midwives, Nurses and others to enhance knowledge on proper examination of the placenta and umbilical cord.
- ✓ Future studies using larger sample sizes involving different Hospitals in the Country should be conducted including, Placental anomalous, Maternal and Foetal factors.

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Annex

Annex1: Data Collection Check List

1. Data collecting check list used in this thesis to collect data from Placental, umbilical cord and foetal anthropometry has been adopted from publications by (Hargitai et al.,2004; Monograph, 2011) and modified according to objectives of this study.

I. Identification

Registration Number: ___

Last Normal Menstruation Period (LNMP):__/__/__

Expected Date of Delivery (EDD):__/__/__

Sex of foetus: ___ (1. Male 2. Female).

II. Placental parameters

1. Placental weight in grams: ____ (g).
2. Diameter of placenta in cent metres;

   1st max diameter: ___ 2nd max diameter: ___Average of two___ (cm).
3. Thickness of placenta in cent metres: ____ (cm).
4. Shape of placenta: ____ (1. Oval 2. Round 3. Irregular).

III. Umbilical cord parameters

1. Umbilical cord length in centimetres: ____ (cm).
2. Umbilical cord attachment or insertion in to placenta:___

   (1. Central 2. Eccentric 3. Marginal 4. Velamentous)

IV. Foetal anthropometry

1. Foetal Birth Weight (FBW) in grams: ____ (g).
2. Gestational Age (GA) in weeks: _____ (wks).
3. Body Length (BL) in centimetres: _____ (cm).
4. Head Circumference (HC) in centimetres: ___ (cm).
5. APGAR score: (at 1 minute: ___at 5 minute :___).
6. Admission to NICU :___(1. Present 2. Absent).
7. Foetal distress: _____ (1. Present 2. Absent).

V. Maternal socio-demographic characteristics

1. Maternal age _____
2. Parity: ____ (1. Nulliparous 2. Multiparous)
3. Gravidity:____
4. Mode of delivery: ___ (1. Normal vaginal delivery 2. Caesarean section 3. Vacuum extraction 4. Forceps extraction 5. Breech assisted)

5. Marital status: ___ (1.married 2. Single 3. Divorced 4. Widowed)
6. Residence: ____ (1. Urban 2. Rural)
7. Educational status: ___ (1. No education 2. Primary 3. Secondary 4. More than secondary)
8. Occupation :__(1.Farmer 2. House wife 3. Governmental employee 4. Merchant 5.Unemployed)

2. Collected data was categorized in SPSS version 20 accordingly for analytic purpose based on following check lists prepared separately for Placental indices, Umbilical indices, Foetal and Maternal indices based on different literature findings.

I. Placental and Umbilical cord indices

Cord attachment or insertion in to placenta

	Male		Female	
Types of attachment	n	%	n	%
Central attachment				
Eccentric insertion				
Marginal insertion				
Velamentous insertion				

Thickness of the Placentae

Thickness in (cms)	n	mean	range	%
< 2				
2 – 4				
>4				

Placental Weight

Placental weight in grams	Male				Female			
	n	mean	range	%	n	mean	range	%
< 330								
330-750								
>750								

Placental Diameter

Placental diameter in centimetres (average of 1st max diameter & 2nd max diameter)	Male				Female			
	n	mean	range	%	n	mean	range	%
< 15								
15-22								
>22								

Shape of Placenta

Placental shape	n	mean	range	%
Oval				
Round				
Irregular				

Umbilical Cord length

Cord length in Centimetres	Male				Female			
	n	mean	range	%	n	mean	range	%
< 40								
40-70								
>70								

II. Foetal Anthropometry

Variables		Male				Female			
		n	mean	range	%	n	mean	range	%
Weight In gram	< 2.5								
	≥2.5								
Body Length in cm	<47.0								
	47.0-55.0								
	>55								
HC(cms)									
Apgar score 5 minute	**<7**								
	≥**7**								
Apgar score 1 minute	<7								
	≥7								
NICU admission	Yes								
	No								
Foetal distress	Yes								
	No								

III. Maternal characteristics

Characteristics		n	%
Age group	<20 years		
	20-34 years		
	35-49 years		
Parity	Nulliparous		
	Multiparous		
Route of Delivery	Normal delivery		
	Caesarean section		
	Vacuum extraction		
	Forceps extraction		
	Breech assisted		

Annex2: Information Sheet

Good morning /afternoon, my name is_____ I am BSc. Midwife in WUNEMMRTH/Homacho Primary Hospital/Shone Primary Hospital.

This study is undertaken by candidate of MSc. student in Human Anatomy in collaboration with Addis Ababa University, College of Health Sciences, Department of Anatomy. I am also a part of data collector team to carrying out the study on placental and umbilical cord indices, and their association with perinatal outcome in Hadiya zone Public Hospitals, Southern Ethiopia.

The purpose of this study is to determine placental and umbilical cord indices and their association with perinatal outcome.

Annex3: Consent Form

I selected as a participant and heard the information in the consent sheet by the language I can understand and finally I understood the possible benefit and harm of the study. I also understand that all the information regarding me must not be transferred to the third party and I can withdraw from the study at any time without giving a reason.

Now please tell me if you agree to participate in the study or not.

The participant:

1. Agreed Hospital Registration Number _____
2. If did not agreed, thanks the participant and skip to the next.

Annex4: Data Collectors and Supervisor Agreement

I certify that I have taken written consent form from the participants who have agreed to participate in this study and I have confirmed the agreement is correct.

Data collectors name: _____ signature_____

Date |_____Month |_____| Year_____.

Specimen code_____

Supervisor name: _____signature_____

Date |_____Month |_____| Year_____.