Sudan university of Science and Technology

College of Graduate Studies

Evaluation of Fetal Weight in the Third Trimester For Ladies of Low class Status

تقييم وزن الجنين في الشهور الأخيره للسيدات الحوامل من الطبقه الفقيره

a thesis submitted as partial fulfillment of requirements for the Degree of Msc in Medical Ultrasound

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September 2016

الأيـــــه

بسم الله الرحمن الرحيم

(وقل رب زدني علمـا)

الايه (114) سورة طه

صدق الله العظيم

Dedication

To the Soul of my Beloved

Father

I Wish if you Were With Me Now

So many Beautiful Memories in my Heart

You left us Suddenly

I Wish if you Were with Me Now

I Give you My Success

May Allah Bless you

Father

Miss you So Much

Acknowledgment

My great thanks and gratitude at the beginning and last to Allah who guide me and help me a lot throughout

All of my life .

Without his help I wouldn't be able to fulfill

This study.

My cordial and sincere thanks and gratitude also to all of

My family , friends and fellow colleagues and Most

Importantly to My supervisor

Dr : Caroline Edward

who help me a lot in this study

to all of you

I like to say again

thank you very much

God bless you

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Abbreviation	Meaning
AC	Abdominal circumference
BPD	Biparietal Diameter
HC	Head Circumference
FL	Femur length
AFI	Amniotic fluid index
GS	Gestational age
CRL	Crown l lump length
FHB	Fetal heart beats
EDD	Estimated day of delivery
EFBW	Estimated fetal body weight
RI	Resistive index
PI	Pulse index
S/D	Systolic Diastolic Ratio
BMI	Body mass index
Wt	Weight
Ht	Height
ACOG	American college of obstetricians and gynecologist
CS	Cesarean section
U/S	Ultrasound
IUGR	Intrauterine growth retardation
LBW	Low birth weight
WHO	World health organization

Abstract

This study has been done to evaluate the low fetal weight in the third trimester for pregnant ladies of low socioeconomic status.

The general objective of this study is to investigate the major factors that predispose or contribute to low fetal weight. These factors are maternal demographic factors , fetal biometry factor , amniotic fluid factor , abnormalities of umbilical artery Doppler factors .

A total of fifty patients from poor areas such as Elengaz , Mayo , alsalama were studied in different hospitals and clinics which are Jarash hospital , Alfouad hospital , Al academy hospital , Ibrahim Malik hospital , Jadin maternity clinic , Hamori maternity clinic .

Maternal demographic Data (age , weight , Height , BMI) together with fetal biometry (Biparietal diameter , head circumference , abdominal circumference , femur length) , amniotic fluid index and umbilical Doppler artery indices Data are collected and analyzed . the study is compared with previous study done in Pakistan and India .

The study found out that only Maternal demographic factor that play major impact in fetal weight is Maternal health , Anemic mothers have pregnancy with low fetal weight in their third trimester of pregnancy.

Fetal biometry (Biparietal diameter , head circumference , abdominal circumference and femur length) have major impact in determination of fetal weight.

The study also found that Oligohydraminous affect the fetal weight . All pregnancy with Oligohydraminous have low fetal weight .

Umbilical Doppler artery indices abnormalities directly affect the fetal weight . all pregnancies with abnormal umbilical Doppler artery indices have low fetal weight.

الخلاصه

إجريت هذه الدراسه بغرض تقييم وزن الجنين في الشهور الأخيره للحمل للأمهات من الطبقه الفقيره.

وقد تم دراسة خمسون حاله للأمهات الحوامل من الطبقه الفقيره في مستشفى إبراهيم مالك ومستشفى

الاكاديمي ومستشفى جرش ومستشفى الفؤاد وعيادة الطيب جادين للنساء والتوليد وعيادة دكتور حموري

للنساء والتوليد . وقد تم جمع بيانات الامهات (العمر ، الطول ، الوزن) .

وتم جمع القياسات الحيويه للجنين والسائل الأمنيوني (عرض الرأس ، حجم الرأس ، حجم البطن ، طول

عظمة الخصر، كمية السائل الأمنيوني ، الموجات الملونه لشريان الحبل السري) لكل سيده حامل وذلك باستخدام مسبار محدب 3.5 ميقاهيرتز لاجهزة ميندري 10 و جهاز توشيبا و جهاز نيروسوفت.

وتم تحليل تلك البيانات وعمل مقارنة لنتيجة الدراسة مع نتائج الدراسات التي أجريت في الهند وباكستان .

وعند تحليل تلك البيانات وجدنا أن صحة الأم تؤثر بشكل مباشر في وزن الجنين ، حيث أن السيدات الحوامل

اللاتي يعانين من فقر الدم يكون وزن الجنين ناقصا عن المعدل الطبيعي .

كم بينت الدراسة أن قياسات الموجات الصوتيه للجنين والسائل الأمنيوني (عرض الرأس ، حجم الرأس ، حجم البطن ، طول عظمة الخصر، كمية السائل الأمنيوني ، الموجات الملونه لشريان الحبل السري) إذا

كانت أقل من المعدل الطبيعي فإنها تؤدي إلى نقص وزن الجنين .

خلصت هذه الدراسه إلى توصيات بالمتابعه الطبيه للنساء الحوامل خصوصا في الشهور الأخيره .

Chapter one

1:1 Introduction

World Health Organization (1992) classifies infants with birth weights of less than 2,500 grams as Low Birth Weight (LBW). World-wide, regarding 16% of newborns, or over 20 million infants per year, are born with less than 2.5 kg of weight and interestingly more than 90% of them are born in developing countries (Roudbari et al., 2007; WHO, 2004).

LBW indicates present and past health status of the mother and is also associated with infant growth (Harun-or-Rashid & Sakamoto, 2010). The incidences of LBW assume as a general indicator of morbidity, both mothers and children, and consider a significant determinant of social circumstances in the future (Roy et al., 2009). New born LBW babies face an elevated chance of higher rates of morbidity and mortality caused by infectious diseases in the neonatal, childhood and adulthood (Kodzi & Kravdal, 2013; WHO, 2004; Strauss, 2000; Huxley et al., 2000). Thus LBW has been debated as one of the major causes of neonatal death (Rizvi et al., 2007; Bhutta, 1997).Despite of the efforts made in reducing incidences of LBW worldwide, the issue remains an ongoing policy concern for the global health. Therefore, World Health Organization (WHO) and United Nation Development Program (UNDP) are continuously addressing this issue through their developmental programs (Haggaz, Radi & Adam, 2010; Wardlaw, 2004).

Various factors cause LBW and these factors vary across the globe (Fraser, Brockert, & Ward, 1995). Kramer (1987) categorized the determinants of LBW in seven categories and identified 43 factors. He placed demographic and psychological factors at second level. The factors included in this category were maternal age, socio-economic status (education, occupation and income) and psychological factors. Thus, maternal characteristics determine new born baby's health and consider major predictor of LBW babies. These characteristics include; socio-demographic status, mother's education, mother's age at the time of birth, pregnancy interval and weight before pregnancy. Studies suggest that socio-demographic status play a part to affect unfavorably birth weight (Meggiolaro, 2009;Mulder et al., 2002; Pattenden et al., 1999). Findings show that less educated mothers are at greater risk of producing LBW baby (Arif et al, 1998). Teenage mothers and those aged 35 or more are more likely to have LBW baby (Machado, 2006; Khoshwood, 2005; Astolfi & Zonta, 1999; Amin & Sampathkumar, 1993). Jafari *et al.* (2010) analyzed the factors of LBW in Iran. The primary objective of their study was to describe socioeconomic and medical factors related to LBW when have people free and universal access to primary health care. A sample of 4510 respondents was surveyed from the hospitals. Their findings showed that

mothers' education was one of the key determinants in LBW babies. Li and Sung (2007) did a longitudinal study to investigate the socio-cultural factors of LBW babies in Taiwan. The findings reported an association between mothers' education and the prevalence of LBW babies.
Rocha et al. (2010) conducted a study with Brazilian adolescents for analyzing maternal age as a factor of LBW. A sample of 1124 participants was investigated. Findings showed that the rate of low birth weight were significantly higher among young adolescents as compared to older adolescents and young adults. Fraser, Brockert and Ward (1995) also earlier reported that the prevalence of LBW babies was much higher than in adolescent mothers and young adult mothers. Furthermore, studies show higher risks of LBW children at low parities (Wilcox, 2001; Wilcox, Cheng & Johnson, 1996) and tend to be high birth weights with parity up to a certain level (Phung et al., 2003; Wilcox, Cheng & Johnson, 1996). The literature confirms that short or long pregnancy intervals can increase risk of various adverse birth outcomes, particularly incidences of LBW babies (Zhu, 2005; Klerman et al., 1998). Pre-pregnancy weight and body mass index (BMI) also determine the prevalence of LBW (WHO, 1995).
Low birth weight (LBW) is an important determinant of childhood morbidity and mortality. Child's birth weight is a significant factor which determines vulnerability for risk of childhood illnesses and childhood survival. Consequently, children who are born with weight less than 2.5 kg are vulnerable for dying during their early childhood. Moreover, research highlight strong associations between LBW and increased risk of infections, malnutrition, poor academic performance and problems related to mental, behavior and learning difficulties during childhood. Consequences of LBW trek into adulthood and can cause range of chronic diseases, e.g., ischemic heart disease, stroke, hypertension, diabetes, metabolic syndrome, malignancies, dementia, and osteoarthritis.

This study has been conducted to evaluate the fetal weight in the third trimester among low socioeconomic patients. in order to find out the rate of IUGR among this group of patients and trying to investigate any other factors that may contribute for IUGR development.

The causes can be many but most often involve poor maternal nutrition and lack of adequate oxygen supply caused by placental insufficiency which regarded as the most serious and may involve grief and irreversible consequences as greater chance of prenatal and postnatal morbidity.

The diagnosis of IUGR secondary to placental insufficiency is based upon the following diagnostic criteria :

- abnormal umbilical Doppler (specially chronic placental insufficiency)
- May show reduction of fetal Biometeric parameters (symmetric reduction which shows decrease fetal weight) .
- Oligohydraminous (not seen in all cases).\

Reference (www.radiopedia.com)

1: 2 Objectives

1:2:1 General objectives :

This study have been conducted to evaluate the fetal weight in the third trimester among low socioeconomic patients. And find out prevalence of intrauterine growth retardation among the group of patients being studied secondary to placental insufficiency.

1:2:2 Specific objectives :

- To evaluate maternal Demographic Data (weight , Height , Body mass index)
- To evaluate maternal past medical history .
- To measure the fetal weight (fetal biometry Biparietal diameter , Femur length , Abdominal circumference & Head circumference)
- To evaluate Amniotic fluid index
- To measure Doppler indices (Resistive index , Pulse index , systolic over diastolic Ratio)
- To correlate the fetal weight with maternal weight , Amniotic fluid index , Doppler indices , placental grading.

1:3 Problem of study

This study mainly investigate how low socioeconomic and demographic maternal Determinants affect the fetal weight . and the rate of pregnancies with Intrauterine growth restriction secondary to placental insufficiency.

normally. The earlier in the pregnancy that this occurs, the more severe the problems. If placental insufficiency occurs for a long time during the pregnancy, it may lead to intrauterine growth retardation (IUGR).

Placental insufficiency is not considered life-threatening to the mother. However, she may be at risk for significant illness or even death if she has an underlying condition such as high blood pressure or diabetes. (reference : Loughna et al 2009)

Placental insufficiency may cause serious conditions in the newborn, such as pneumonia, cerebral palsy, or other respiratory problems. A newborn who is born prematurely or with serious medical conditions may need an incubator, a special enclosed bed that can control temperature and oxygen levels.

(reference : GRIT multicentre randomized controlled trial. The Lancet. 2004;364:513-20)

If a child is born with cerebral palsy, there may be disabilities that require therapy, use of appliances such as crutches or canes, and a daily struggle with medical problems. As the child gets older, there may be a need for special education programs for learning disabilities caused by oxygen and nutritional deprivation while in the uterus.

The fact that many low socioeconomic patients cannot afford to pay the expenses of private medical care is challenging. that's why early diagnosis and medical care will definitely decrease the prenatal and postnatal morbidity and mortality rate especially among low socioeconomic patients .

1:4 overview of the study

The study contains five chapters

Chapter one introduction

Chapter two literature Review

Chapter three Materials and Methods

Chapter four Results

Chapter five Discussion , conclusion and Results . references and appendices.

Chapter Two

Literature Review

2:1 Fetal Biometry & Growth scan

2:1:1 BPD (Biparietal Diameter)

" BPD should not be used in routine clinical practice for the estimation of gestational age or the appropriateness of fetal size in later pregnancy " (Loughna et al 2009) .

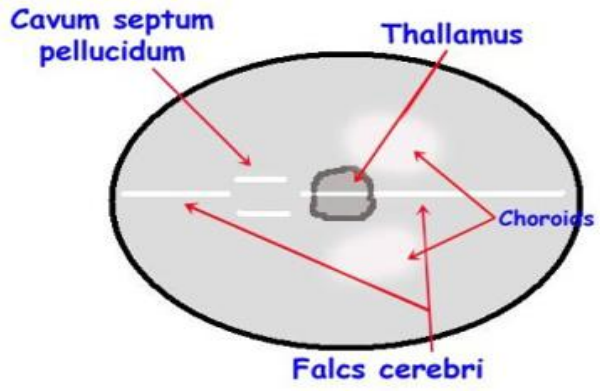


figure 2:1:1 BPD landmarks

The correct plane for the measurement of the head circumference (HC) and bi-parietal diameter (BPD)must include the cavum septum pellucidum, thallamus and choroid plexus in the atrium of the lateral ventricles.
(Loughna et al 2009)

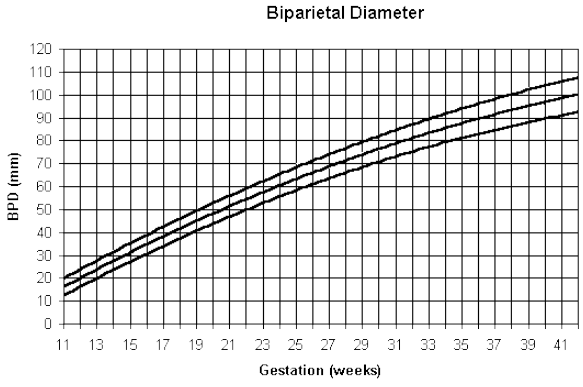


figure 2:1:2 correlation between BPD and AOG

ref. (www.radiopedia.com)

2:1:2 HC (head circumference)

• A cross-sectional view of the fetal head at the level of the ventricles should be obtained
• Rugby football shape; centrally positioned,
• Continuous midline echo broken at one third of its length by the cavum septum pellucidum
• Anterior walls of the lateral ventricles centrally placed around the midline
• Choroid plexus should be visible within the posterior horn of the ventricle in the distal hemisphere. (Loughna et al 2009).

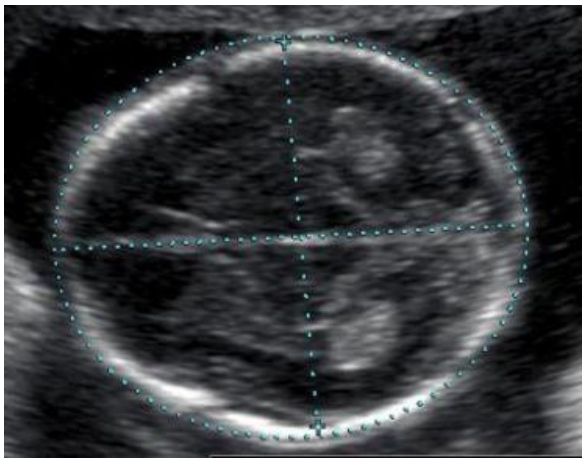


Figure 2:1:3 head circumference measurement

HC: Measure around the outer table of the skull.
Ref (Loughna et al 2009).

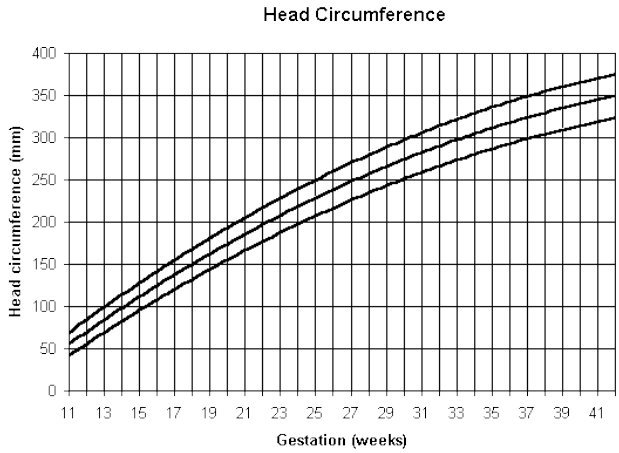
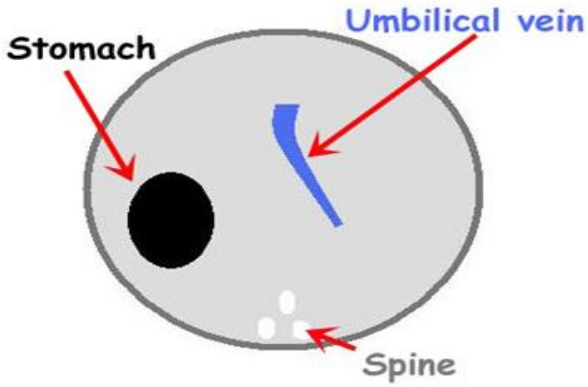


figure 2:1:4 correlation between fetal head circumference and AOG. Ref. (Loughna et al 2009).

2:1:3 AC (Abdominal circumference)

Circular transverse section of the fetal abdomen at the should contain the following :

- level of the liver. Visualizing the whole circumference without indentation.
- Short section of the of the intra hepatic umbilical vein - one third from the anterior abdominal wall
- Stomach
- Spine and descending Aorta
- Short 'unbroken' rib echo
- Ideally spine at 9 or 3 O'clock position



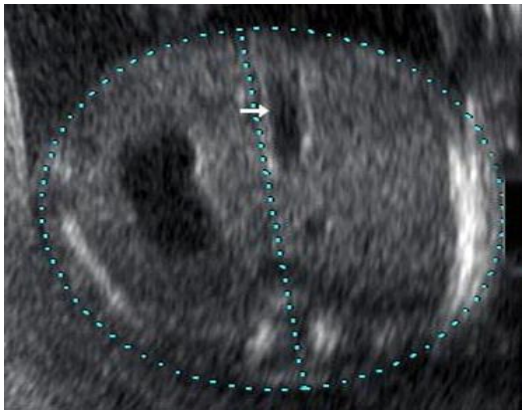


Figure 2:1:5 abdominal circumference measurement ref.(Loughna et al 2009)

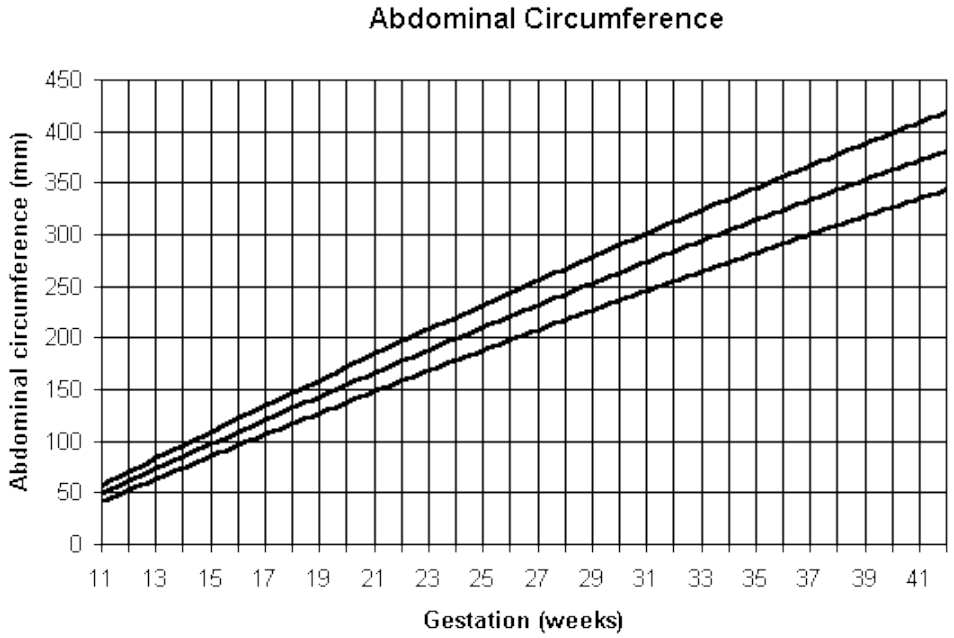


Figure 2:1:6 correlation between abdominal circumference and AOG ref (Loughna et al 2009)

AC Best of other biometeric values for determination of fetal weight :

- Chitty et al (1994) – " Single measurement that fulfilled all criteria"
- BMUS (2009) Loughna et al – "Single measurement should be used provided it is of good technical quality and obtained using the techniques and planes described"
- Sarris et al 2012 used 2 measurements with 2 operator www.intergrowth2.org.uk
- Hargreaves et al 2011- no information on US sections or measurements at all
- RCOG Green top guideline no 31 2013/14 "There is no evidence to recommend one specific method of measuring AC"

2:1:4 Femur Length

- The femur should be imaged lying as close as possible to the horizontal plane, angle of insonation of the ultrasound beam is 90° .
- Care should be taken to ensure that the full length of the bone is visualized and the view is not obscured by shadowing from adjacent bony parts.
- Provided a technically good image is obtained, a single measurement is adequate

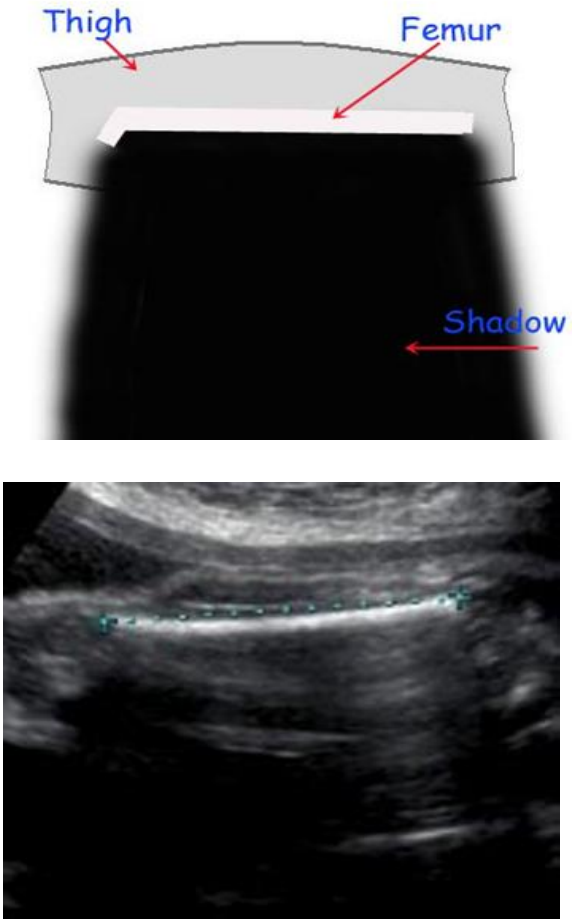


Figure 2:1:7 femur length measurement Ref (Loughna et al 2009)

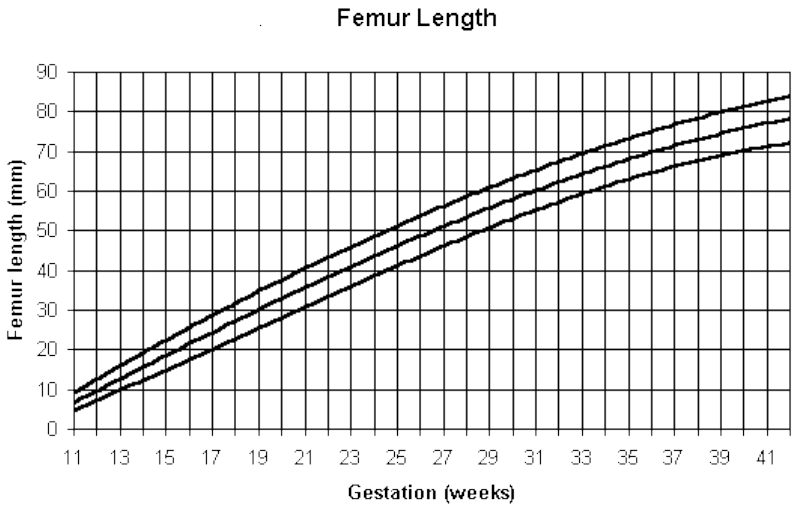


Figure 2:1:8 correlation between femur length and AOG.
Reference (Loughna et al 2009)

2:1:5 AFI (amniotic fluid index)

The amniotic fluid index (AFI) is an estimate of the amniotic fluid volume in a fetus. It is part of the fetal biophysical profile.

Technique

- uterus is divided into four imaginary quadrants with lineal nigra and umbilicus acting as the vertical and the horizontal axis respectively
- the deepest pocket devoid of umbilical cord and fetal parts is measured in the vertical dimension
- measurement of the four pockets is in centimeters
- sum of all the four quadrant measurements is AFI
- normal AFI values range from 5 to 25 cm

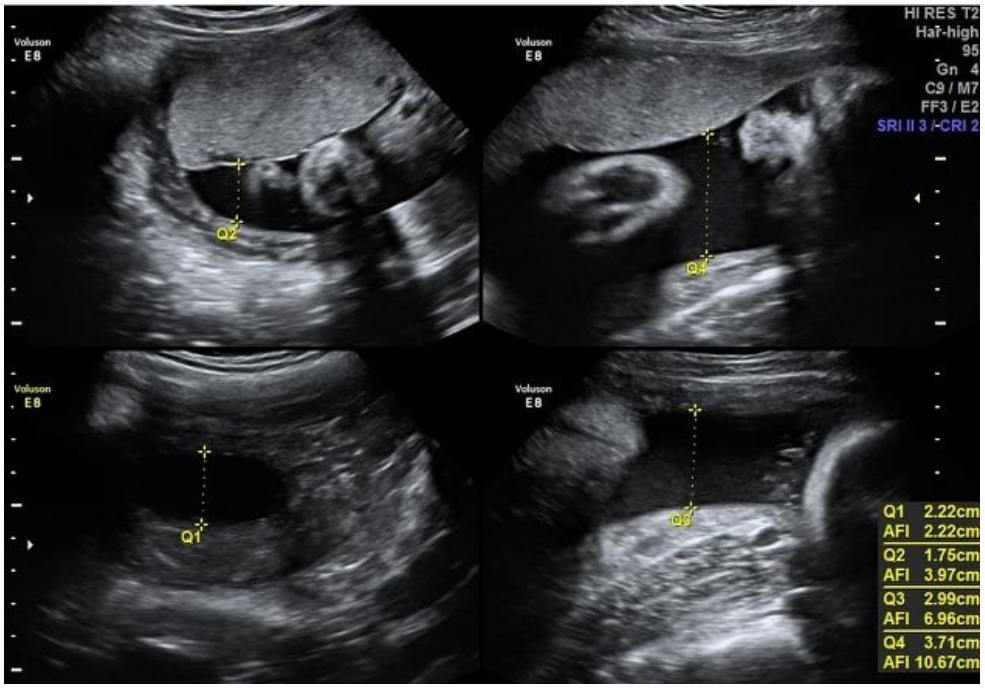
Values

- AFI between 8-18 cm is considered normal; median AFI level is ~14 cm from week 20 to week 35, after which the amniotic fluid volume begins to reduce
- AFI <5-6 cm is considered as Oligohydraminous
    - value changes with age: the 5^{th} percentile for gestational ages is most often taken as the cutoff value
- AFI >20-24 cm is considered as Polyhydraminous

The normal range for amniotic fluid volumes varies with gestational age. As a rule of thumb:

- AFI of <8 implies Oligohydraminous
- AFI of >25 implies polyhydramnios (www.radiopedia.com)

AFI (amniotic fluid index) measurement



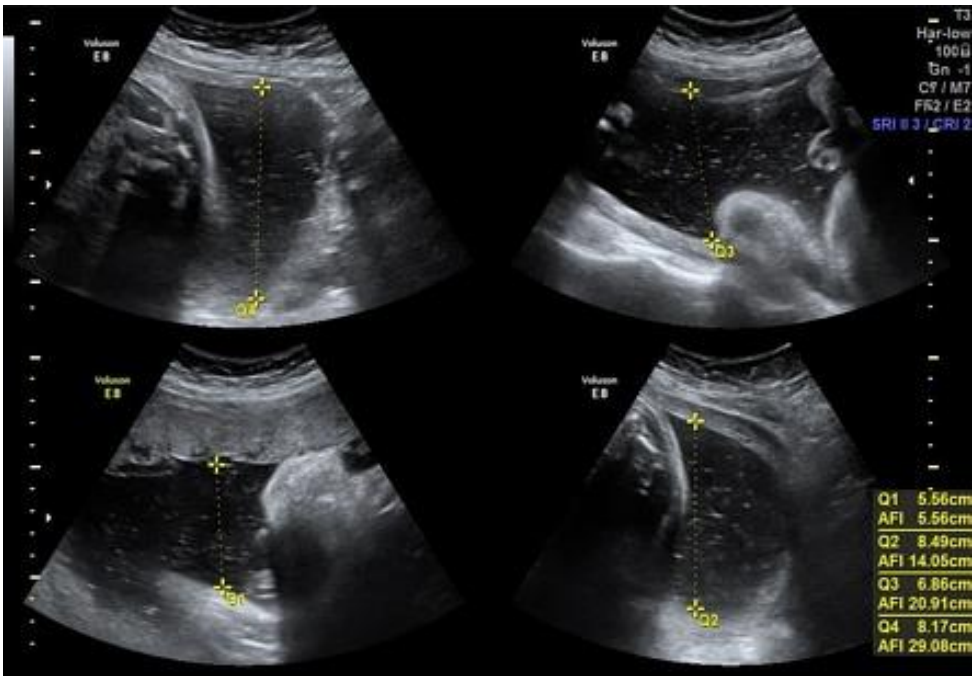


Figure 2:1:9 AFI measurement
Ref (Loughna et al 2009)

2.2 Polyhydraminous

refers to a situation where the amniotic fluid volume is more than expected for gestational age.

It is generally defined as:

- amniotic fluid index (AFI) > 25 cm
- largest fluid pocket depth (maximal vertical pocket (MVP)) greater than 8 cm : although some centers particularly in Australia, NZ and the UK use a cut off of 10 cm
- overall amniotic fluid volume larger than 1500-2000 cc^3
- two diameter pocket (TDP) > 50 cm^2

2.2.1 Clinical presentation

The patient may clinically present as a large for dates uterus.

2.2.2 Pathology

Polyhydraminous occurs as a result of either increased production or decreased removal of amniotic fluid. The etiology of Polyhydraminous can be due to a vast variety of maternal and fetal disorders. It is usually detected after 20 weeks (often 3rd trimester).

2.2.3 Causes :

The potential causes of Polyhydraminous are protean

- idiopathic: 60-65%: this is a diagnosis of exclusion despite accounting for a majority of cases, also termed idiopathic Polyhydraminous
- maternal: 25-30%

  diabetes: commonly gestational diabetes

  maternal congestive heart failure

- fetal: 10-20%

  CNS lesions (e.g. neural tube defects): fetal CNS abnormalities tend to be the commonest out of all fetal causative associations

  proximal gastro-intestinal obstruction

gastrointestinal atresia(s)

oesophageal atresia

duodenal atresia

jejuno-ileal atresia

abdominal wall defects

gastroschisis

omphalocoele

fetal intestinal volvulus, e.g. from an intestinal malrotation

fetal cervico-thoracic abnormalities

fetal cervical masses

congenital cervical teratoma/epignathus

large fetal goitre

thoracic masses

congenital pulmonary airways malformation (CPAM)

congenital high airways obstruction syndrome (CHAOS)

congenital diaphragmatic herniation

fetal cardiovascular anomalies

sustained fetal tachycardia (e.g. supraventricular tachycardia (SVT), atrial flutter, ventricular tachycardia)

2.2.4 Associations

- fetal macrosomia: independant of maternal diabetes , in idiopathic form
- mesoblastic nephroma
- Pena Shokeir syndrome
- maternal overhydration

Polyhydramios is associated with poor outcome if present in combination with intra uterine growth restriction (IUGR); usually seen in aneuploidies 18,13, and 21.

2.2.5 Classification

This classification is general consensus based on common practices at time of writing (July 2016) but this varies according to countries and gynecologist association guidelines.

Some classify the severity of polyhydramnios as

mild: single deepest pocket at 8-11 cm or AFI 25-30

moderate: single deepest pocket at 12-15 cm or AFI 30.1-35

severe: single deepest pocket >16 cm or AFI >35

2.2.6 Treatment and prognosis

The prognosis is variable dependent on associated conditions. Usually minimal or no interventional required for idiopathic mild uncomplicated cases. Options include:

improved maternal diabetes control

caesarian section if there is profound macrosomia

therapeutic amniocentesis / amnioreduction

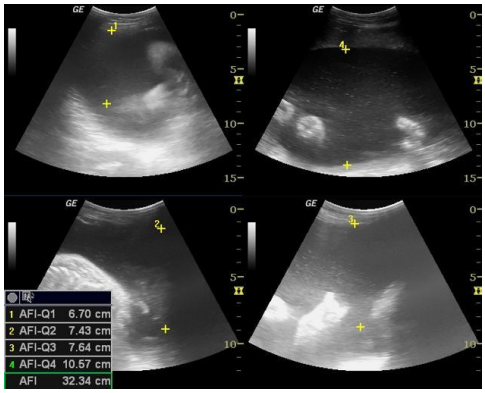


Figure 2:2:1 Polyhydraminous ref . (www.radiopedia.com)

2.3 Oligohydraminous

refers to a situation where the amniotic fluid volume is less than expected for gestational age. Often these fetuses have <500 mL of amniotic fluid.

2.3.1 Epidemiology : The estimated prevalence can be up to ~6% of pregnancies.

2.3.2 Causes : The causes of Oligohydraminous are protean and one way to simplify them is by using the mnemonic DRIPPC:

- D:
  - demise
  - drugs: e.g. prostaglandin inhibitors (indomethacin)
- R: renal abnormalities (from decreased urine output)
  - renal agenesis
  - renal dysplasia
  - posterior urethral valves
  - polycystic kidneys
  - multicystic dysplastic kidney (MCDK)
  - urethral atresia
- I: IUGR (intra-uterine growth restriction): 80% may occur from decreased renal perfusion due to sparing effect
- P: premature rupture of membranes
  - premature rupture of membranes (PROM)
  - preterm premature rupture of membranes (PPROM)
- P: post dates
- C: chromosomal anomalies (especially if other anomalies are found)
  - trisomy 18
  - trisomy 13
  - triploidy

2.3.3 Associations

- Potter sequence
- underlying fetal hypoxia and fetal cardiovascular compromise: from preferential flow to the fetal brain at the expense of diminished renal blood flow
- twin pregnancy related complications:
  - twin to twin transfusion syndrome: in pump twin

2.3.4 Antenatal ultrasound

Several sonographic criteria can be used which include:

- four quadrant amniotic fluid index (AFI): <5 cm
- two diameter pocket method: < 1 x 1 cm or <15 cm^2
- maximum vertical pocket depth: <2 cm

2.3.5 Treatment and prognosis

Development of oligohydramnios early in pregnancy is generally a poor prognostic marker. Amnio-infusion can be attempted in severe cases if appropriate.

Complications

- first trimester oligohydramnios can result in failure of pregnancy in up to 95% from complications such as
    - pulmonary hypoplasia: implies a very poor prognosis
    - fetal limb contractures

reference (www.radiopedia.com)

2.4. Placenta

the size of the placenta is proportional to the size of the fetus. A small placenta is usually associated with a small-for-dates baby and is not indicative of a cause-and-effect relationship.
Although methods have been proposed to measure the volume of the placenta, the demise of the static B-mode scanner has made this measurement difficult to obtain with any degree of accuracy. Other researchers have measured placental thickness. In practice, however, the size of the placenta is usually assessed visually. The following pitfalls may occur when visually assessing placental size. contractions may simulate placental thickening . severe Polyhydraminous may cause the placenta to appear artifactually small; and Oligohydraminous may make the placenta seem large.
Placentas that are too large or too small may be seen in various fetal and maternal conditions .

Placental grading : (Grannum classification) refers to a ultrasound grading system of the placenta based on its maturity. This primarily affects the extent of calcifications. In some countries the use of placental grading has fallen out of obstetric practice.

2.4.1 The grading system is as follows:

- grade 0: <18 weeks
  - uniform echogenicity
  - smooth chorionic plate
- grade I: 18-29 weeks
  - occasional parenchymal calcification/hyperechoic areas
  - subtle indentations of chorionic plate
- grade II: >30 weeks
  - occasional basal calcification/hyperechoic areas
  - deeper indentations of chorionic plate (does not reach up to basal plate)
    - seen as comma type densities at the chorionic plate
- grade III: >39 weeks
  - significant basal calcification
  - chorionic plate interrupted by indentations (frequently calcified) that reach up to basal plate: cotyledons
  - an early progression to a grade III placenta is concerning and is sometimes associated with placental insufficiency
    - associated with smoking, chronic hypertension, SLE, diabetes

Placental thickness tends to gradually increase with gestational age in a linear fashion. Sonographically, this can be seen to be approximately 1 mm per week and the thickness of the placenta can be used to approximate gestational age:

- approximate gestational age (in weeks) = placental thickness +/- 10 mm

The maximum thickness of a normal placenta at any point during pregnancy is often taken considered to be 4 cm

An abnormally increased placental thickness falls under the spectrum of placentomegaly. This can happen with number of conditions and is associated with increased risk of placental insufficiency. Causes include:

- upper limit of normal variation
- fetal macrosomia
- fetal hydrops

- maternal medical conditions
    - maternal anaemia
    - maternal diabetes

reference (www.radiopedia.com)

2.5 Applications of Doppler Ultrasound in Fetal Growth Assessment

- The main use of Doppler Ultrasound in Obstetrics is to identify and monitor those fetuses at risk of perinatal mortality or morbidity due to uteroplacental insufficiency
- This is achieved by investigating blood volume flow to the placenta; in the umbilical
  arteries and in the fetus.

2.5.1 Colour flow imaging and Spectral Doppler

- Colour Doppler gives a map of blood flow superimposed on the normal 2D image and is used to identify a particular blood vessel and sample the blood velocity within that vessel.
- Spectral Doppler gives a graph of blood velocity versus time – the Doppler waveform. This waveform is analysed to detect changes in resistance to blood flow.

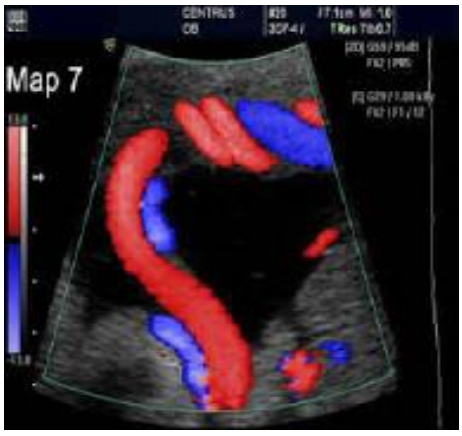


Figure 2.5.1
Placenta Colour Doppler

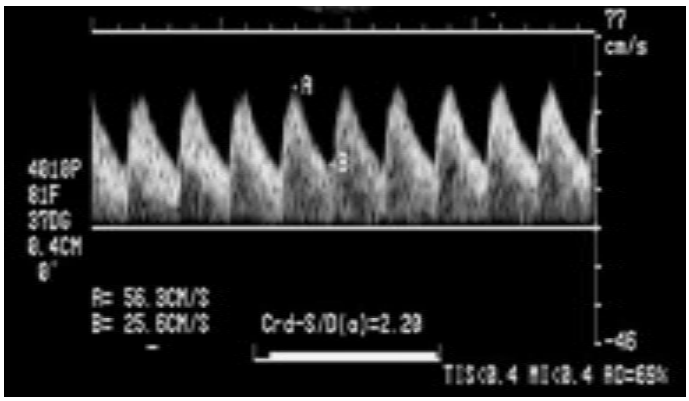


Figure 2.5.2
placenta Spectral Doppler

interpretation of the spectral Doppler waveform

• The Doppler waveform represents the velocities of blood cells within the sample volume plotted
against time.

• The waveform can be analysed by:
– Waveform pattern recognition.
– Waveform shape analysis

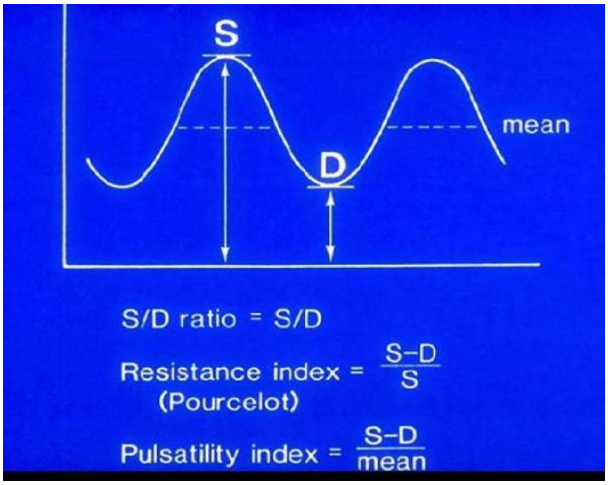


figure 2.5.3 wave form analysis

Umbilical artery Doppler

• Primary surveillance tool in the SGA fetus
• When Doppler indices are normal it is reasonable to repeat every 14 days
• More frequent measurements if the fetus is severely SGA

NORMAL VALUES

VESSELS	PI	RI
Umbilical artery	Early 2nd trimester (1.5-2) Term = 1 (1-1.5)	<0.7
Middle cerebral artery	At 28-32 wks (>1.45) Term =1	0.7-0.9
Uterine artery	18-22 wks(<1.2) If PI >1.45 with b/l notching then it indicates severe ischaemia.	0.33-0.55

Figure 2.5.4 normal values

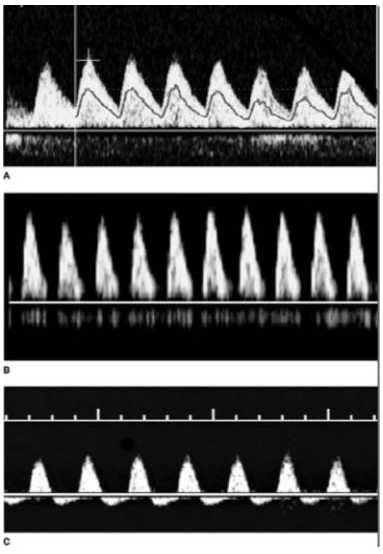
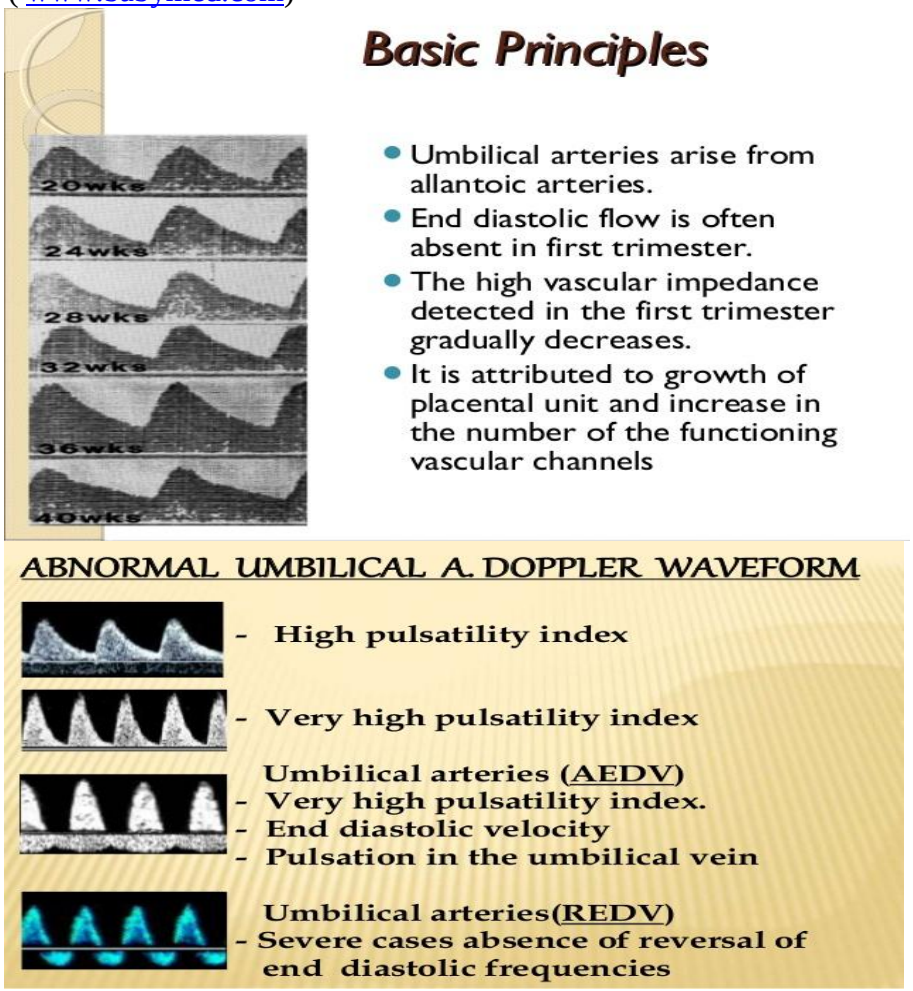


figure 2.5.5 wave form analysis

(www.babymed.com)

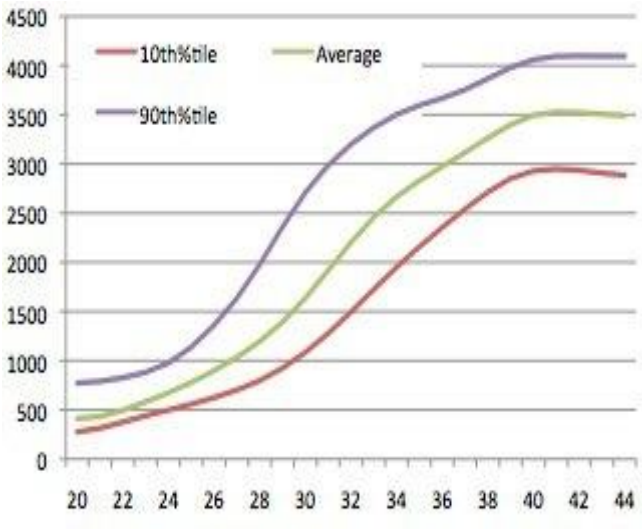


www.babymed.com)

figure 2:5:6 Basic priciples and waveform analysis

Fetal weight table & Diagram

Weeks	10th%tile	Average	90th%tile
20	275	412	772
	314	433	790
22	376	496	826
	440	582	882
24	498	674	977
	558	779	1138
26	625	899	1362
	702	1035	1635
28	798	1196	1977
	925	1394	2361
30	1085	1637	2710
	1278	1918	2986
32	1495	2203	3200
	1725	2458	3370
34	1950	2667	3502
	2159	2831	3596
36	2354	2974	3668
	2541	3117	3755
38	2714	3263	3867
	2852	3400	3980
40	2929	3495	4060
	2948	3527	4094
42	2935	3522	4098
	2907	3505	4096
44	2885	3491	4096



(www.babymed.com)

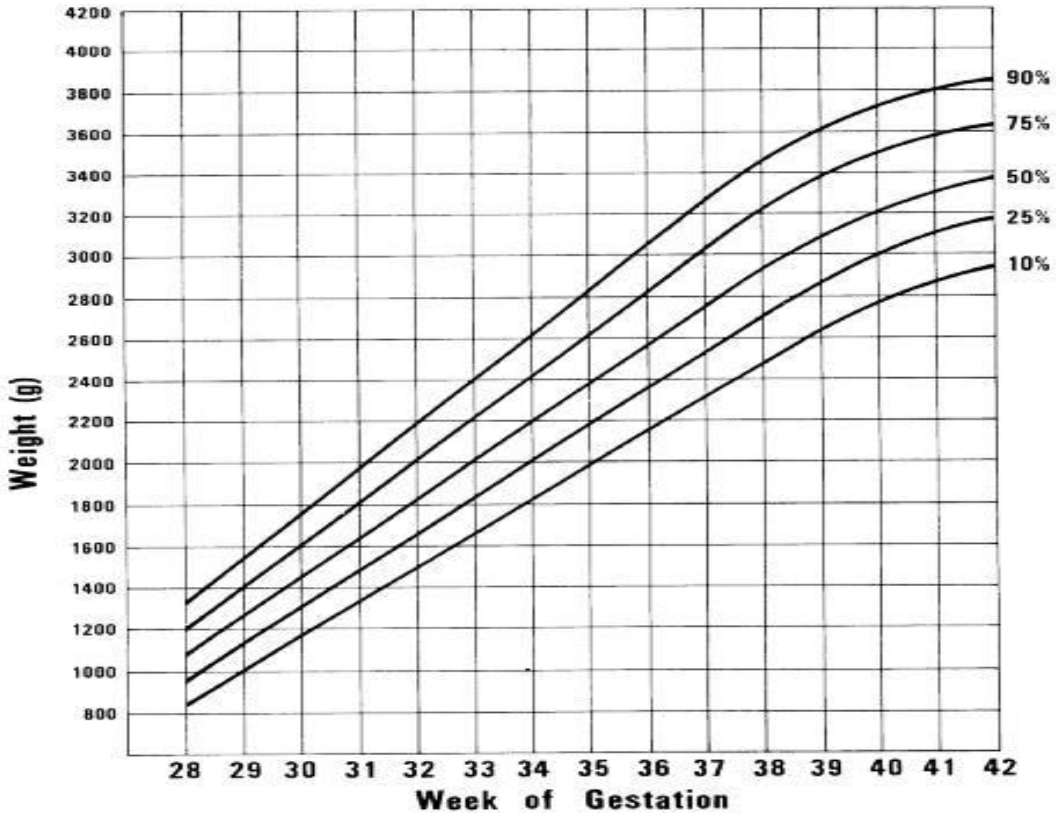


Figure 2:5:7 correlation between fetal weight and AOG. Ref. (brimingham university)

Previous studies

Study done by (Kramer MS 1998) in R.N.T. Medical College& Hospital, Udaipur (india)

The study was done in 200 women admitted to the labour rooms of the hospital (either directly or through the antenatal wards).All the cases were within the age group of 18-40 years, of average height and weight and includes both primigravida and multigravida.
They divided their patients into two groups which are :
GROUP 1CONTROL- NORMAL PREGNANCY
100 patients included in this group, normal patients , not associated with any disease.
GROUP 2 RESEARCH-IUGR CASES 100 cases patient . IUGR were included.
Then a perfoma is made about socioeconomic status and Occurrence of IUGR

OBSERVATION

TABLE NO-I CONTROL GROUP

STATUS	*NO.OF PATIENTS*	*%*
Upper	10	10
Upper Middle	31	31
Lower Middle	23	23
Lower	36	36

TABLE NO-II RESEARCH GROUP (IUGR)

STATUS	NO.OF PATIENTS	%
Upper	1	1
Upper Middle	36	36
Lower Middle	17	17
Lower	45	45

They compare their results with other studies done in low socioeconomic status group.

Researcher	Place	Number of cases	Result
Nancy Hendrix et al(2008)5	Philadelphia	300	Significant*
Low JA et al(1982)6	US	164	Significant*
Neel NR(1991)7	Guatemala	306	Significant*
S Muthayya et al(2006)8	Bangalore	377	Significant*
Present study	India-Udaipur	200	Significant*

Significant $p<0.01$

The present study showed significant positive correlation between IUGR and Low socioeconomic status. The study is found consistent with the study of S Muthayya 8,Low JA6 .Neel NR7 found that socioeconomic status had a significant positive effect on birth weight

Kramer MS. (1998) found that in countries with high prevalence's of maternal under nutrition, it is more prevalent among those from unfavorable socioeconomic backgrounds. Similar to our study Nancy Hendrix et al also found significant value of IUGR in Low socioecomic group said that Placental insufficiency, in some form or fashion, is associated with the majority of cases of intrauterine growth restriction (IUGR). There are numerous causes of IUGR which are not caused primarily by placental insufficiency, but indirectly lead to it. The causes of IUGR can be subdivided into fetal and maternal etiologies. The fetal etiologies consist of genetic diseases, congenital malformations, infections, multiple gestations, and placental/cord abnormalities. The maternal etiologies are categorized as follows: (1) decreased uteroplacental blood flow, (2) reduced blood volume, (3) decreased oxygen carrying capacity, (4) nutrition status, (5) teratogens, and (6) miscellaneous causes such as short interpregnancy intervals, race, maternal age, and low socioeconomic status S Muthayya et al(2006)8 demonstrates associations between educational status with IUGR., suggesting that better socioeconomic conditions, improved nutritional status are likely to play an important role in reducing IUGR. In our study socioeconomic status is statistically significant factor causing IUGR (Kramer MS 1998)

They concluded that low Socioeconomic status, Education ,Income Level and living conditions surely affect weight of Baby .

Another Study done in india about the effects of Socio-Economic and Nutritional Determinants of Low Birth Weight done by National Family Health Survey (NFHS . 2005-2006).

Their study aims to identify significant socioeconomic and nutritional determinants associated with LBW in India.

They collected Data from 2005 to 2006 . National Family Health Survey(NFHS) of India was analyzed. A total of 20,946 women (15-49 years) who gave birth at least once 5 years preceding the NFHS were included in this study. Infant's LBW (<2500 grams) as outcome variable was examined in association with all independent predictors as infant's sex, maternal household wealth status, caste, age, education, body mass index (BMI), stature, anemia level, parity, inter-pregnancy interval, antenatal care received, and living place.

Their result showed that Almost 20% of the infants were born with LBW. Mother's low education level, BMI <18.5, short stature (height <145 centimeters) and lack of antenatal visits (<4 visits) were significant predictors of LBW. Male gender has a protective effect against LBW.

Maternal education, nutritional status and antenatal care received are key determinants that need to be addressed to reduce prevalence of LBW in India.

Another Study of Maternal Demographic Determinants of Low Birth Weight Babies in District Jhang (Pakistan) (Arif et al,1998)

study was carried in 2012. Two groups of post natal mothers who delivered babies in the preceding 7 days were included in the study.
First group included mothers who gave delivery to term low birth weight babies. Low birth weight was defined as birth weight less than 2500 grams. Term was defined as completion of 37 weeks of gestation mothers who had significant illnesses during pregnancy were excluded and mothers who delivered babies with significant congenital anomalies were excluded. Second group included mothers who delivered normal birth weight babies normal birth weight was defined as birth weight of 2500 to 4000 grams. Each group included 60 mothers. Mothers were interviewed and 5
demographic variables age of the mother , conception, educational status of mother occupation of the mother. Monthly family income and history of consanguinity recorded.

Their results of the study showed that 36 out of 60 low birth weight babies belonged to families with monthly income less than Rs 5000 where as 19 out of 60 normal birth we babies belonged to families with monthly income less than Rs. 5000. T significant association between low birth weight and family income (p value 0.002) 27 out of 60 low birth weight babies are the product of consanguineous marriage but only 11 out of 60 normal birth weight babies are the socio-economic status of mothers.

Their study showed the influence of the maternal demographic profile on the out pregnancy. In the last few decades there increase in the average birth weight of the babies. This improvement is to some extent due to changing demographic profile of the mothers. There is an increase in the age at conception. Maternal education, occupational per capita income of the family significantly correlated with birth the sex and the religion of the baby. Young mothers, women with low antenatal care, also with more children, are at relative risk of having low birth weight babies Mothers in deprived socio-economic frequently have low birth weight babies. In such conditions, the infant's low birth primarily from mother's poor health over a long period . pregnancy, and the high prevalence of specific infections, or from pregnancy complications,
underpinned by poverty. Improved nutritional status of the mother due to increased per income and increased health awareness due to improved literacy but still there are large number of pregnancies affected by the maternal demographic variables .

Chapter three

Materials and methods

3-1 Materials

3-1-1 study population

This study has been conducted in different hospitals . the study is about pregnant ladies in third trimester age between 16 – 46 years old who are from low socioeconomic status areas . those patients are coming from poor regions such as Al engaz , Mayo , Al salama and some other remote areas . the cases were collected from the following medical institutions :

- Al academy hospital .
- Ibrahim Malik hospital .
- Alfouad hospital .
- Jarash hospital .
- Hamori maternity clinic .
- Jadeen maternity clinic .

3-1-2 Duration of study

The study has been carried out from the first of April 2016 to the end of June 2016 . three month of Data collection and two weeks of Data analysis .

3-1-3 Machines used

- Mindray DC N3 ultrasound machine (convex 3.5 MHZ probe)
- Mindray Z 5 ultrasound machine. (convex 3.5 MHZ probe)
- Mindray 2200 ultrasound machine . (convex 3.5 MHZ probe)
- Sonoace ultrasound machine . (convex 3.5 MHZ probe)
- Neurosoft ultrasound machine . (convex 3.5 MHZ probe)

3-2 Method of study

50 patients were carefully selected based on their socioeconomic status background . The patient's age , weight , height , BMI , past medical history were reviewed and recorded . a through transabdominal fetal Sonographic scan by using 3.5 MHZ probe was done to obtain the following :

- Fetal biometry (BPD , HC , AC , FL .EDD)
- Fetal body weight.
- Liquor volume.
- Placental location .
- Umbilical Doppler indices (RI , PI , S/D)

3-3 Data Analysis

The data were analyzed through statistical method (SPSS version 16) .that include frequency , tables , percentage , correlation and cross tabulation .

Chapter four
Results

Table 4.1.1 : Maternal Age class , frequency and percentage

	Frequency	Percent
16-26	30	60.0
27-36	14	28.0
37-46	6	12.0
Total	50	100.0

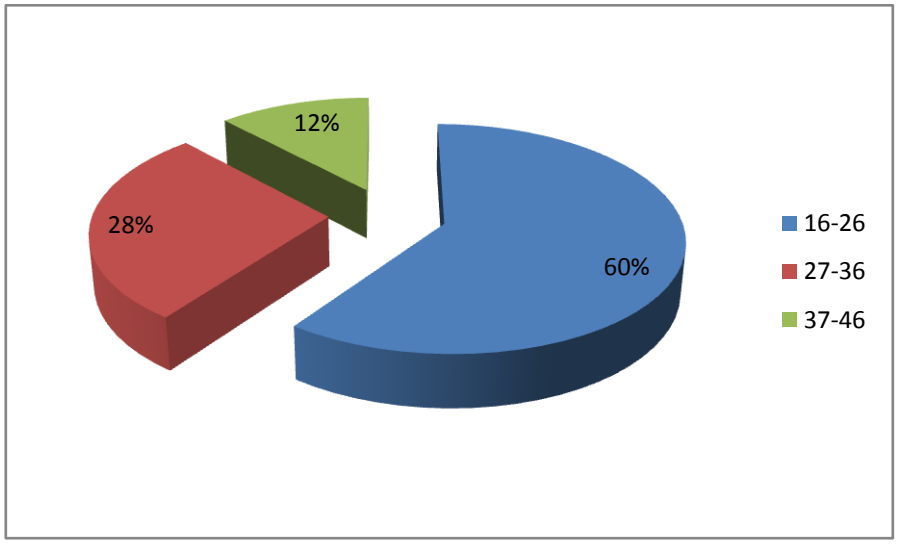


Figure 4.1.1 Maternal age class , frequency and percentage

Table 4.1.2 Fetal Biometry

	*BPD/mm	**AC/mm	***HC/cm	****Fl/mm	Fetal weight/gram
Mean	**89.36**	**299.62**	**326.32**	**70.56**	**2892.58**
Std Deviation	**2.44**	**45.64**	**12.03132**	**2.79**	**499.07**
Minimum	**83.00**	**220.00**	**305.00**	**62.00**	**2100.00**
Maximum	**93.00**	**355.00**	**345.00**	**76.00**	**3700.00**

***BPD stands for Biparietal diameter**
****AC stands for abdominal circumference**
***** HC stands for head circumference**
****** FL stands for femur length**

Table 4.1.3 Maternal Demographic Data

	Maternal age	Maternal Weight	Maternal Height	Maternal BMI
Mean	26.16	77.28	159.32	30.66
Std. Deviation	7.69	14.46	7.39	6.45
Minimum	16.00	50.00	150.00	19.00
Maximum	46.00	100.00	185.00	46.00

BMI measured by (weight/height2)

Table 4.1.4 fetal umbilical artery Doppler indices

	*RI	**PI	***S/D	****AFI	Gestational age
Mean	.6898	.8436	2.4240	9.6200	38.0000
Std. Deviation	.15425	.03596	.25440	6.15079	1.45686
Minimum	.52	.78	2.20	1.00	36.00
Maximum	.92	.93	2.80	18.00	40.00

***RI stands for Resistive inde**
****PI pulse index**
***** S/D stands for systolic over diastolic**
******AFI stands for amniotic fluid index**

Table 4.1.5 Maternal health status

	N	Mean	Std. Deviation	Minimum	Maximum	P-value
Anemia	23	2497.04	395.74	2100.0	3377.0	0.000
None	15	3246.06	315.94	2220.0	3700.0	
Hypertension	7	3154.42	320.61	2440.0	3323.0	
Asthma	5	3285.00	74.61	3200.0	3356.0	
Total	50	2892.58	499.07	2100.0	3700.0	

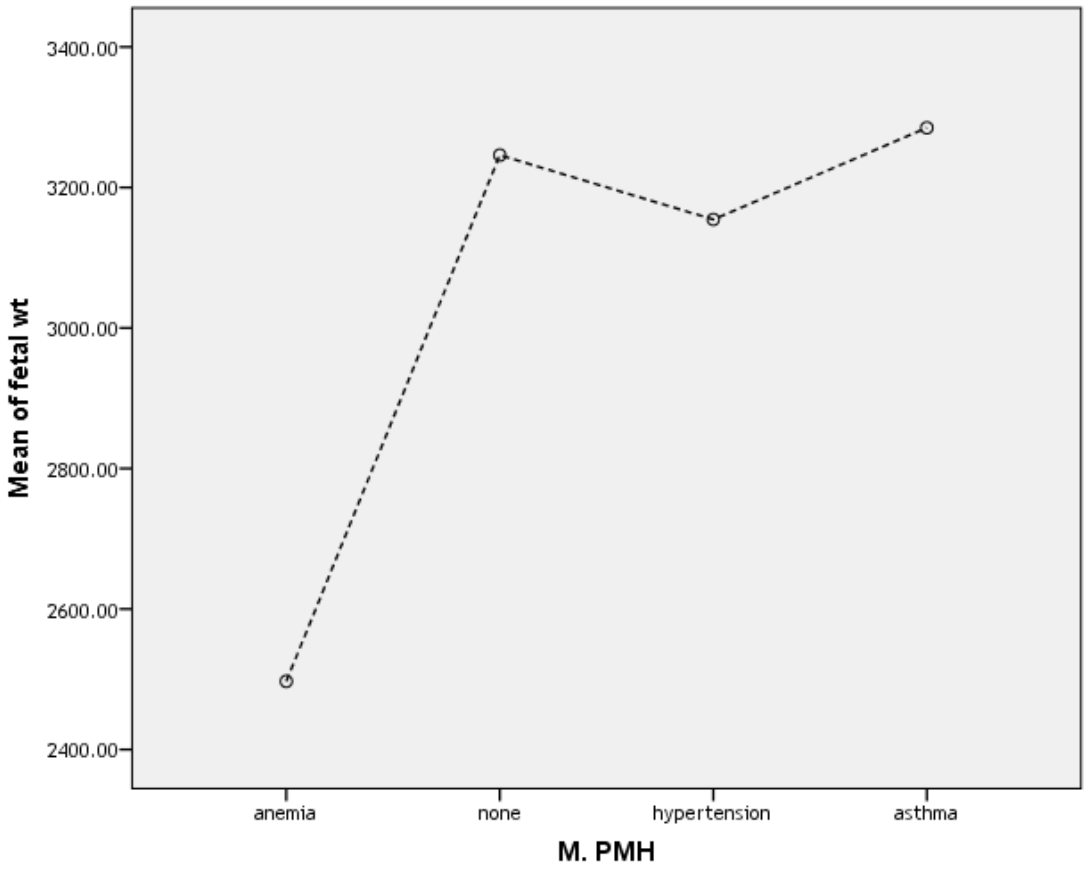


Figure 4.1.2 correlation between maternal health status and fetal weight

Table 4.1.6 amniotic fluid index

Amount of amniotic fluid	N	Mean	Std. Deviation	Minimum	Maximum	P-value
Oligohydramious	22	2366.13	216.69	2100.0	2885.00	0.000
adequate	28	3306.21	110.68	3100.00	3700.00	
Total	50	2892.58	499.07	2100.00	3700.00	

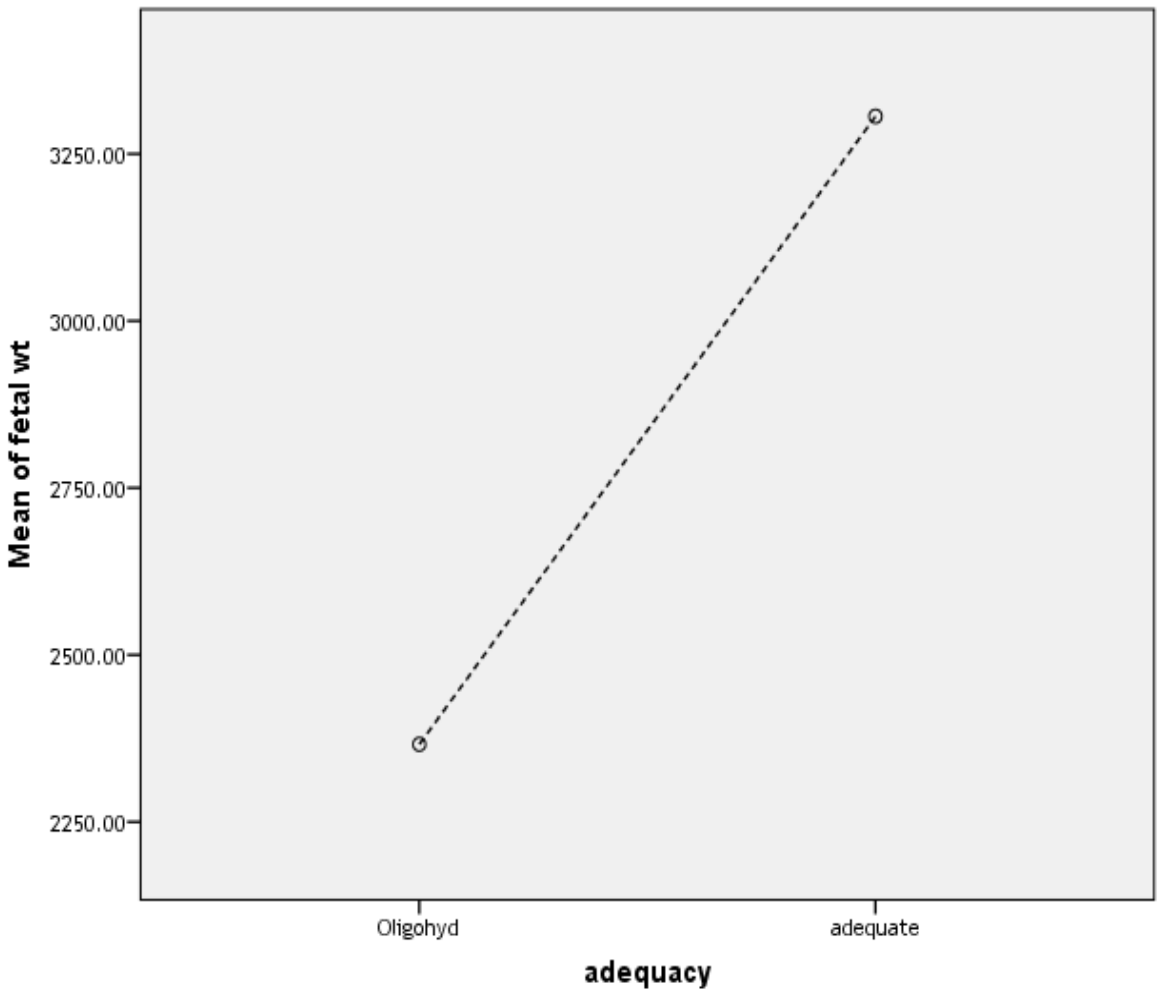


Figure 4.1.3 correlation between amniotic fluid index and fetal weight

Table 4.1.7 of correlation between Maternal age and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3102.093	252.976		12.262	.000
	M. age	-8.009	9.284	-.124	-.863	.393

Predictive equation to establish the predictive fetal weight from mother of known age :

Fetal wt = 3102.093 – 8.009 * Maternal age

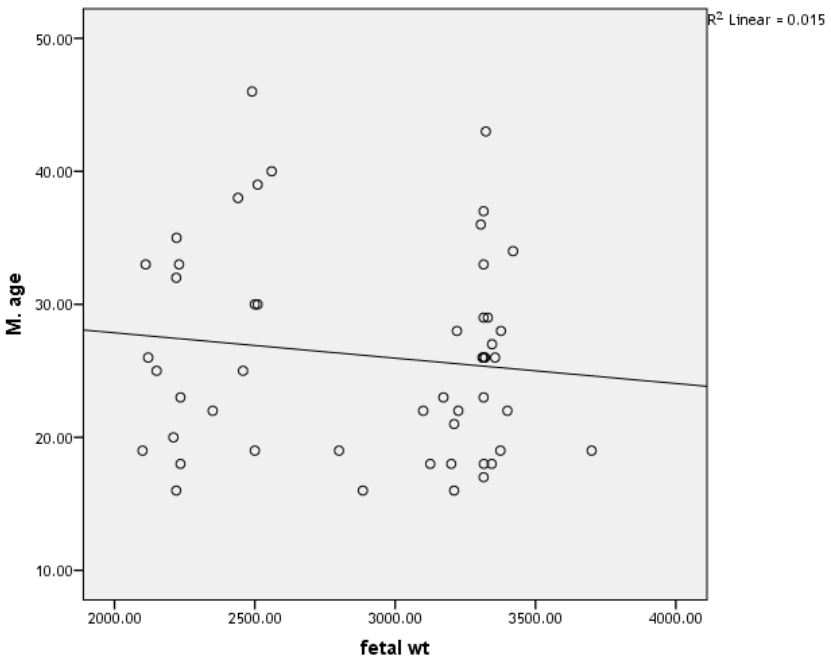


Figure 4.1.4 correlation between Maternal age and fetal weight

Tabe 4.1.8 correlation between Maternal weight and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2656.485	389.799		6.815	.000
	M Wt	3.055	4.960	.089	.616	.541

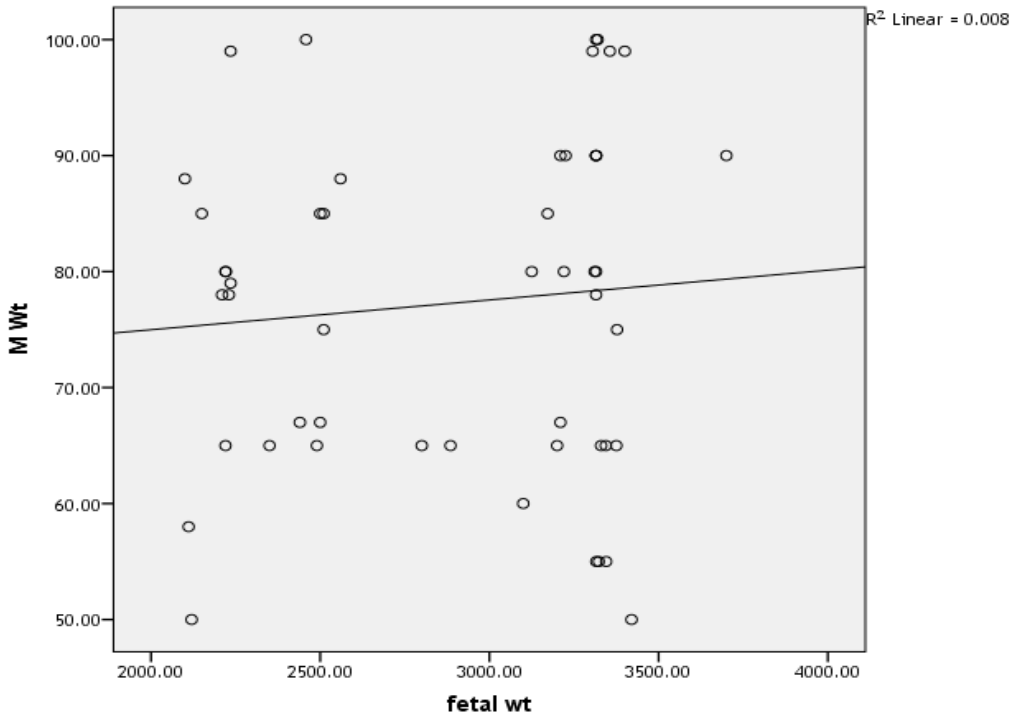


Figure 4.1.5 correlation between Maternal weight and fetal weight

Table 4.1.9 correlation between Maternal Height and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3053.528	1553.040		1.966	.055
	M. Ht	-1.010	9.738	-.015	-.104	.918

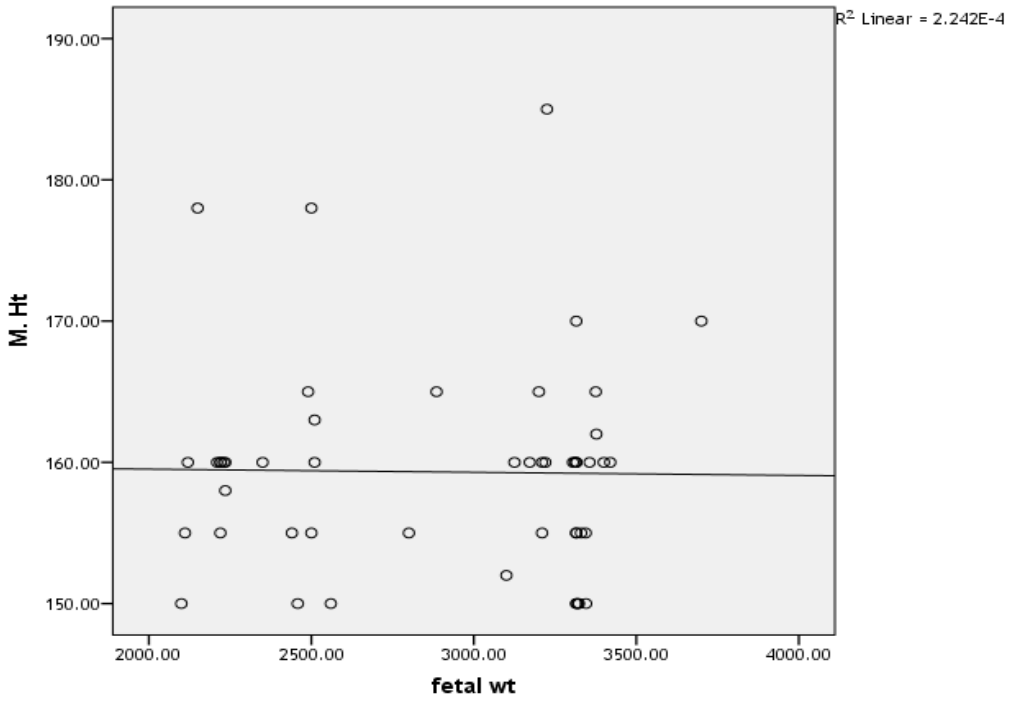


Figure 4.1.6 correlation between Maternal Height and fetal weight

Table 4.1.10 correlation between Maternal BMI and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2759.546	348.992		7.907	.000
	M BMI	4.339	11.143	.056	.389	.699

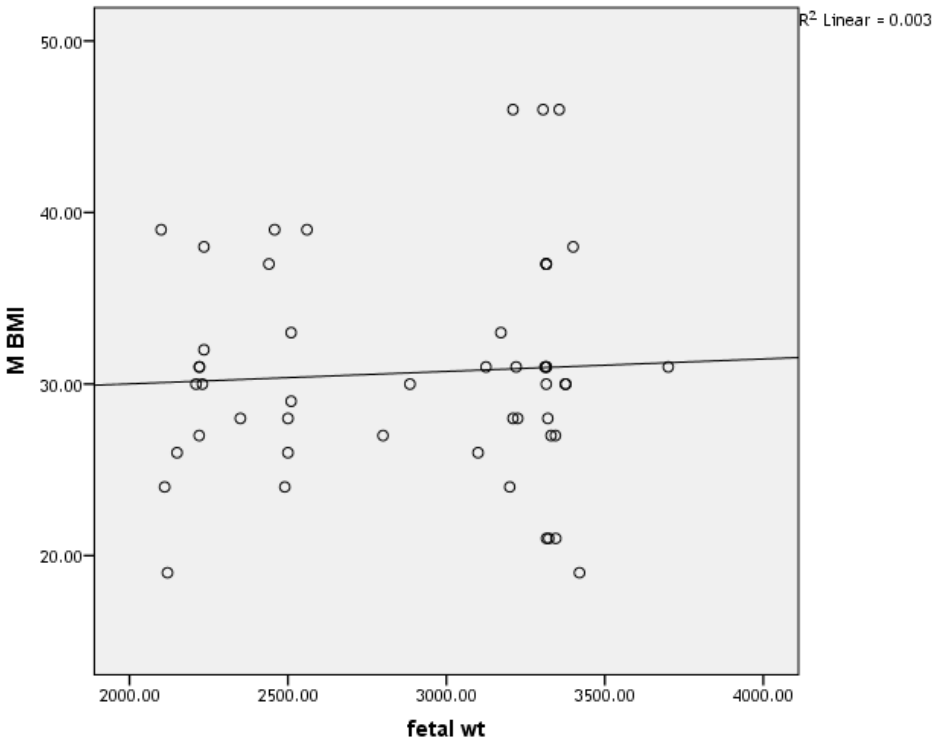


Figure 4.1.7 correlation between Maternal BMI and fetal weight

Results of fetal Biometry in correlation with fetal weight

Table 4.2.1 correlation between Fetal BBD and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-9064.879	1985.282		-4.566	.000
	BBD	133.812	22.209	.656	6.025	.000

Equation to predict fetal weight when BBD is known ;

Fetal weight= -9064.879+133.812* Fetal BBD

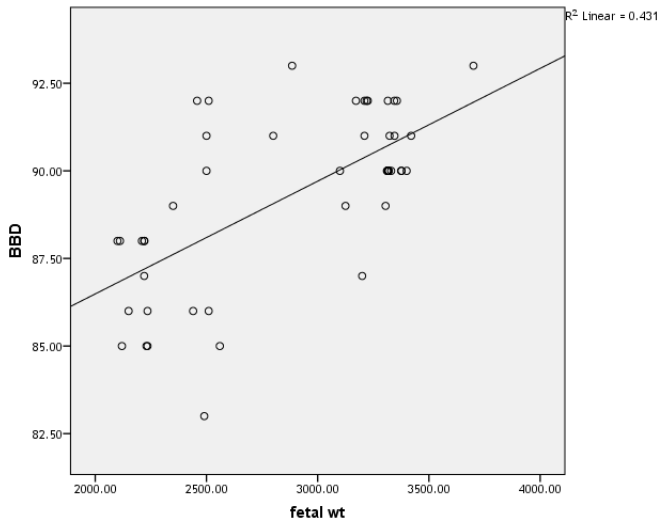


Figure 4.2.1 correlation between fetal BBD and Fetal weight

Table 4.2.2 correlation between Fetal Abdominal circumference and fetal weight

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-265.142	127.378		-2.082	.043
	AC	10.539	.420	.964	25.070	.000

Equation to predict fetal weight when abdominal circumference is known

Fetal weight = -265.142+10.539 * AC

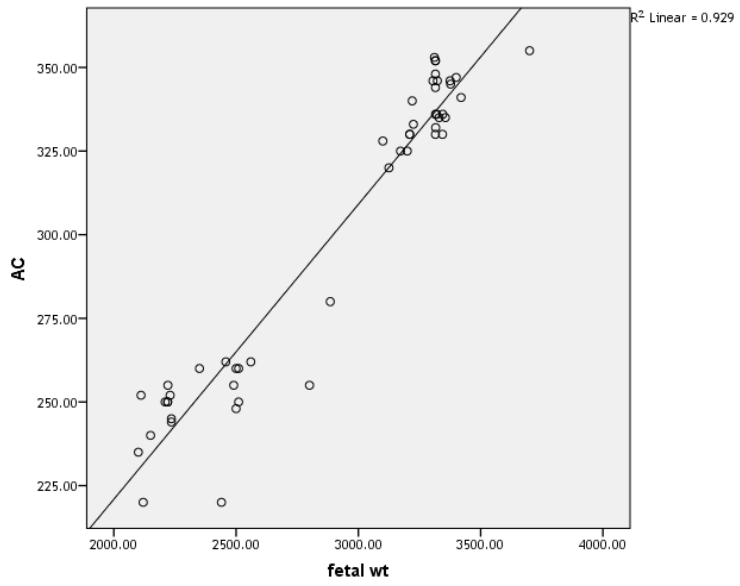


Figure 4.2.2 correlation between Fetal AC and Fetal weight

Table 4.2.3 correlation between Fetal head circumference and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3742.999	1704.047		-2.197	.033
	HC	20.335	5.219	.490	3.897	.000

Equation to predict fetal weight when fetal head circumference is known

Fetal weight = -3742.99+20.335* HC

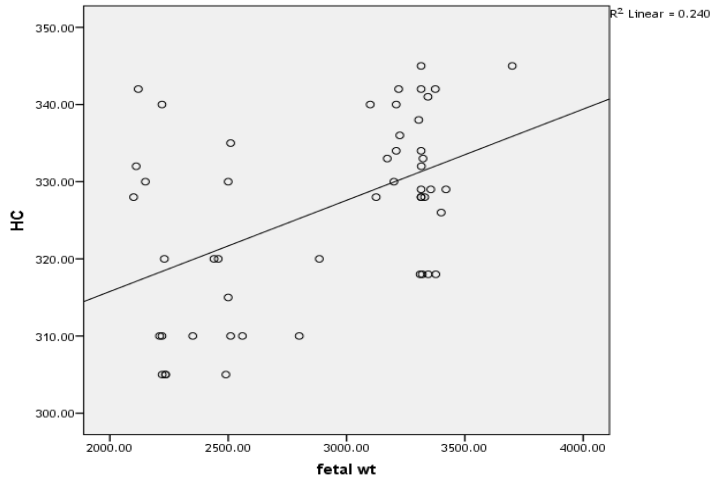


Figure 4.2.3 correlation between fetal HC and Fetal weight

Table 4.2.4 correlation between Fetal femur length and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1863.975	1686.451		-1.105	.275
	FL	67.411	23.883	.377	2.823	.007

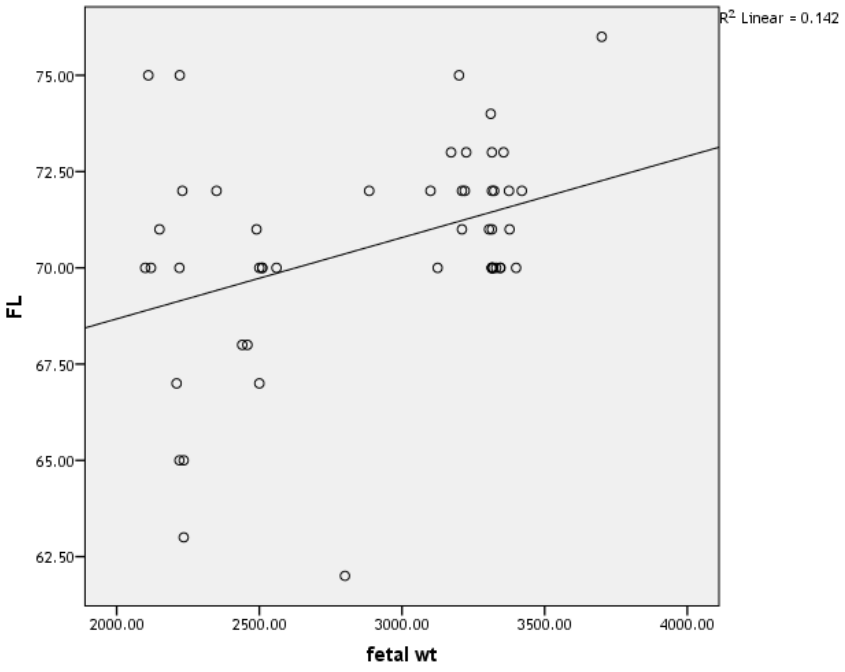


Figure 4.2.4 correlation between fetal femur length and fetal weight

4.3 the Doppler indices findings in correlation with fetal weight

Table 4.3.1 correlation between Resistive index of Fetal umbilical artery and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4993.515	111.316		44.859	.000
	RI	-3045.716	157.560	-.941	-19.331	.000

Equation to predict fetal weight when resistive index is known

Fetal weight = 4993.515-3045.716* RI

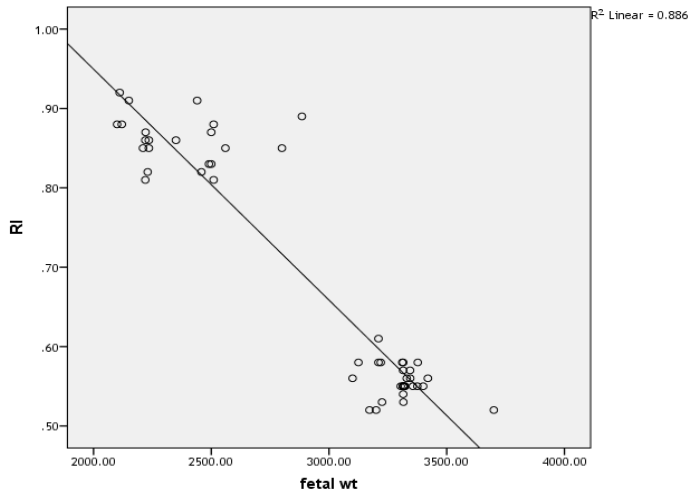


Figure 4.3.1 correlation between fetal umbilical artery Resistive index and Fetal weight

Table 4.3.2 correlation beween Pulse index of Fetal umbilical artery and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11612.005	1128.976		10.285	.000
	PI	-10335.970	1337.094	-.745	-7.730	.000

Equation to predict fetal weight when pulse index of fetal umbilical artery is known

Fetal weight = 11612.005-10335.97*PI

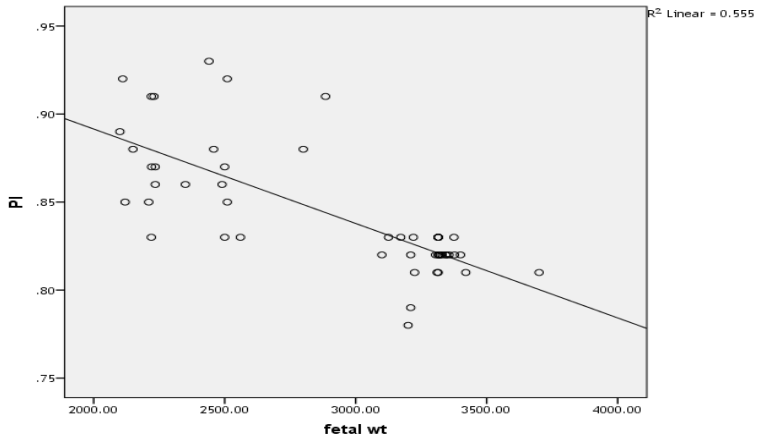


Figure 4.3.2 correlation between Fetal umbilical artery PI and Fetal weight

Table 4.3.3 correlation between S/D ratio of Fetal umbilical artery and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7337.367	245.293		29.913	.000
	S/D	-1833.658	100.652	-.935	-18.218	.000

Equation to predict fetal weight when S/D ratio of fetal umbilical artery is known

Fetal weight =7337.367-1833.658*S/D

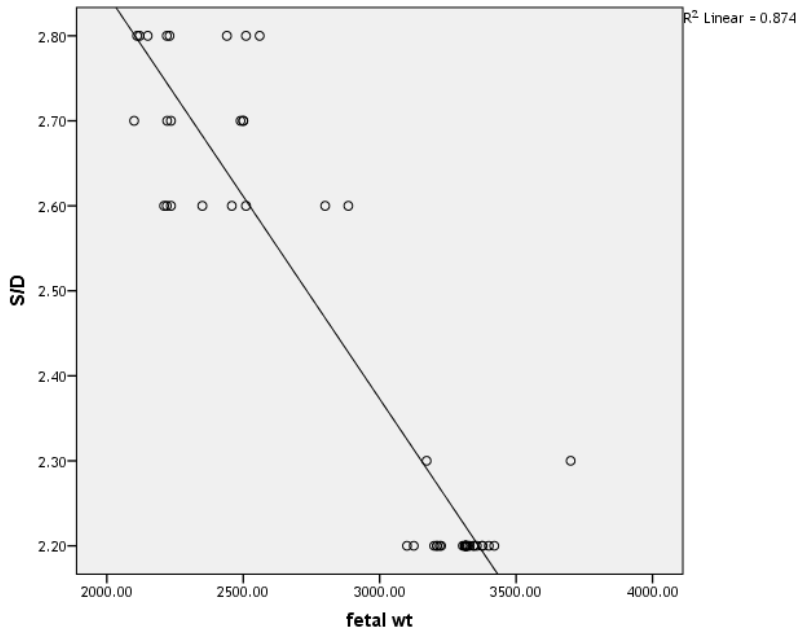


Figure 4.3.3 correlation between Fetal umbilical artery S/D ratio and Fetal weight

Table 4.3.4 correlation between Amniotic fluid index and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2175.177	52.543		41.398	.000
	AFI	74.574	4.615	.919	16.159	.000

Equation to predict fetal weight when fetal amniotic fluid index is known

Fetal weight= 2175.177+74.574*AFI

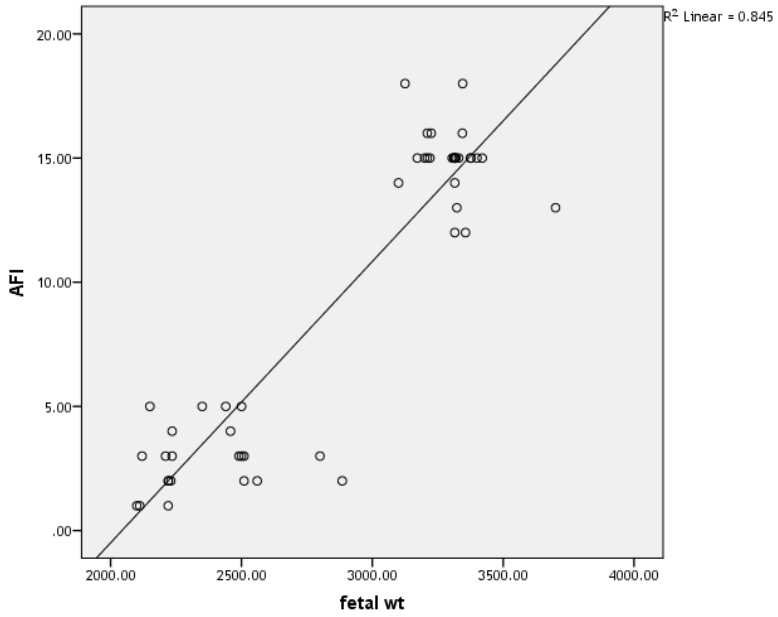


Figure 4.3.4 correlation between Amniotic fluid index and fetal weight

Table 4.3.5 correlation between fetal Age of gestation and fetal weight

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1223.868	1864.760		.656	.515
	AOG Weeks	43.913	49.037	.128	.896	.375

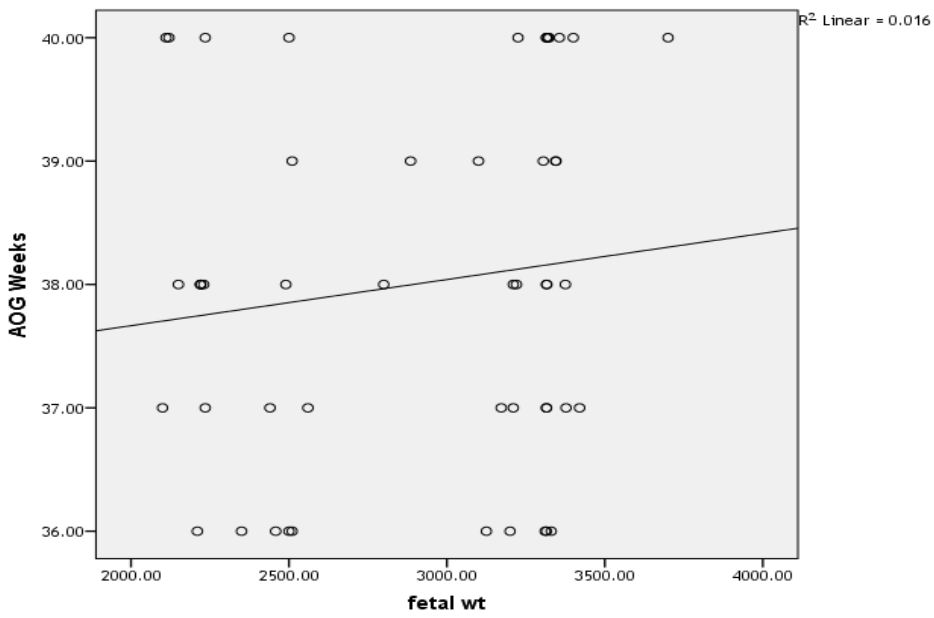


Figure 4.3.5 correlation between fetal Age of gestation and fetal weight

Chapter Five

5.1 Discussion

The study shows the Influence of four main factors on the fetal weight . these factors are :

- Maternal Demographic factors .
- Fetal biometry factor .
- Amniotic fluid index factor .
- Umbilical artery Doppler indices factor .

5.1.1 Maternal Demographic factors

Which are (maternal age , maternal weight , maternal height , maternal BMI , maternal health status) . the Maternal demographic factors are shown in the (table 4.1.1) to (table 4.1.10) and (figure 4.1.1) to (figure 4.1.7) . the study shows that only maternal health status has significant impact on the fetal weight while other demographic factors have no significant impact on the fetal weight . this in contrast to studies conducted in Pakistan and India. Study done by Kramer MS (1998) in RNT Medical college and hospital in a group of 200 pregnant ladies in their third trimester . the study showed that maternal demographic factors (maternal age , maternal weight , maternal height , maternal BMI , maternal health status , maternal socioeconomic status , maternal education and family income) have significant impact .

5.1.2 Fetal biometry factor

the study shows that fetal biometry (Biparietal diameter , head circumference , abdominal circumference) have significant impact on the fetal weight , this could be clearly seen in (table 4.2.1) to (table 4.2.4) and (figure 4.2.1) to (figure 4.2.4) . however the study shows that fetal femur length has no significant impact on the fetal weight as shown in (table 4.2.4) and (figure 4.2.4).

5.1.3 Amniotic fluid index

the study shows that amniotic fluid index has significant impact on the fetal weight as shown in (table 4.3.4) and (figure 4.3.4) . the study shows that all pregnancies with Oligohydraminous have low fetal weight this in contrast with pregnancies with adequate amniotic fluid who have normal fetal weight .

5.1.4 Umbilical artery Doppler indices

The study shows that umbilical Doppler indices (Resistive index , Pulse index , S/D ratio) have significant impact on the fetal weight . this is clearly shown in (table 4.3.1) to (table 4.3.5) and (figure 4.3.1) to (figure 4.3.5). the study shows that all pregnancies with abnormal umbilical artery Doppler indices have low fetal weight .

Study done by (alfirevil et all , 2010) concluded that abnormal fetal umbilical artery Doppler indices are associated with low fetal weight .

5.2 Conclusion

The study shows that the following factors have direct and significant impact on the fetal weight :

5.2.1 Fetal biometry : has direct proportional impact . normal fetal biometry measurement is associated with normal fetal weight . abnormally decreased fetal biometry is associated with low fetal weight .

5.2.2 Amniotic fluid index : adequate amniotic fluid index is associated with normal fetal weight . decreased amniotic fluid index (Oligohydraminous) is associated with low fetal weight.

5.2.3 fetal umbilical artery Doppler indices : normal fetal umbilical artery Doppler indices are associated with normal fetal weight . abnormal fetal umbilical Doppler indices are associated with low fetal weight .

5.2.4 Maternal health status : anemic pregnant ladies have low fetal weight. It indicates anemia in pregnancy is associated with low fetal weight .

However the study shows that Maternal demographic factors , fetal presentation and placental location have no significant impact on fetal weight .

5.3.Recommendation

further studies should be conducted to evaluate other factors that may affect fetal weight such as maternal illness other than anemia like Diabetes mellitus , epilepsy , thyroid diseases and others .

anemia should be treated before and during pregnancy as the study shows that anemia is associated with low fetal weight .

serial prenatal check ups and ultrasound scan are important during pregnancy for evaluation of fetal weight and fetal well being as general .because early recognition of any fetal abnormality means early intervention and management to minimize maternal and fetal morbidity and mortality .

there is a need to set up standard guidelines for treatment and management of intrauterine fetal growth retardation secondary to placental insufficiency . especially for those ladies from low socioecomic areas . because of greater risk of maternal and fetal morbidity and mortality .

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Severe Oligohydraminous

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