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FAIZA HAQ NAWAZ

SU91-MSAHW-S23-091

FAHS

Doppler Evaluation of Umbilical Artery Flow Pattern in Anemic Pregnant Women

SUPERIOR UNIVERSITY

Thesis Submitted to

The Superior University Lahore

In Partial Fulfillment of the

Requirement for the Degree of

Master of Science in Allied Health Sciences

By

(FAIZA HAQ NAWAZ)

Roll No. SU91-MSAHW-S23-091

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Designation: Lecturer,M.Phill,MBBT

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This is to certify that the research work presented in this thesis, titled **"Doppler Evaluation of Umbilical Artery Flow Pattern in Anemic Pregnant Women"** was conducted by **"Faiza Haq Nawaz"** under the supervision of **"Hafiz Ayaz Ahmad"**

No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Faculty of Allied Health Sciences, The Superior University, Lahore in partial fulfillment of the requirements for the degree of Master of Science in the field of "**Allied Health Sciences"** in Faculty of Allied Health Sciences at The Superior University, Lahore.

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DEDICATION

In the name of Allah, the Most Gracious and the Most Merciful, all praises to Allah and His blessing for the completion of this thesis. I thank God for all the opportunities, trials and strength that have been showered on me to finish writing the thesis. I experienced so much during this process, not only from the academic aspect but also from the aspect of personality. My humblest gratitude to the Holy Prophet Muhammad (Peace be upon him) whose way of life has been a continuous guidance for me.

First and foremost, I would like to sincerely thank my respectful supervisor Hafiz Ayaz Ahmad for his guidance, understanding, patience and most importantly, he has provided positive encouragement and a warm spirit to finish this thesis.

I would like to express my deepest gratitude and heartfelt appreciation to my incredible parents, sisters and my respected teachers for their unwavering support, dedication, and encouragement throughout the process of preparing this research proposal. Their tireless efforts, sacrifices, and belief in my abilities have been instrumental in shaping the person I am today and have undoubtedly played a crucial role in my academic journey.

May, Allah grant my supervisor and my parents a healthy and prosperous life
and give me strength and direction for the welfare of mankind.

Faiza Haq Nawaz

ACNOWLEDGEMENT

In the name of Allah, the most Gracious, the most Merciful.

I am extremely thankful to Almighty ‘Allah’ Who is the entire source of knowledge and wisdom endowed to mankind, for providing me with the acumen and vision to complete this endeavor.

I would like to express my profound gratitude to my supervisor for his wise counsel and encouraging attitude towards this study. I am extremely grateful to him for immensely facilitating me during my study period by ensuring the provision of favorable circumstances and conducive environment. This project would not have been possible without his support and expert guidance.

In the end, I would like to extend my deepest gratitude to my family members. Without their encouragement, I would not have been able to complete this endeavor.

Faiza Haq Nawaz

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LIST OF ABBREVIATIONS

UA	Umbilical Artery
PSV	Peak Systolic Velocity
RI	Resistive Index
S/D	Systole/Diastole
PI	Pulsatility Index
WHO	World Health Organization

ABSTRACT

Background: Anaemia during pregnancy has unpleasant effects on both maternal and fetal health. Obstetrical problems like low-birth-weight babies, IUGR, increased rate of premature deliveries & increased perinatal mortality is known.

Objective: The purpose of this study is to evaluate umbilical paired artery doppler indices in anemic pregnant women for reducing adverse effects of anaemia on maternal and fetal health.

Material and Methods: This was a Descriptive cross-sectional study design which is appropriate for evaluating and analyzing the umbilical paired artery flow patterns in pregnant women diagnosed with anaemia at a specific point in time.This study was conducted at THQ Hospital Pattoki, Pakistan from August to December 2024. The study design aims to describe the relationship between anaemia severity and Doppler ultrasound findings in pregnant women and evaluate the prevalence of abnormal flow patterns in the umbilical paired artery.

Results: The study involved 72 anemic pregnant women with a mean gestational age of 26.44 weeks, indicating mid-pregnancy. The average Body Mass Index was 26.39. Haemoglobin levels averaged 10.29 g/dL, reflecting mild anaemia. In terms of Doppler ultrasound parameters, 65.3% of participants (47 cases) had a normal systolic/diastolic ratio, indicating stable placental perfusion. However, 26.4% (19 cases) showed moderate abnormalities, and 8.3% (6 cases) exhibited severe abnormalities. Regarding the Resistance Index (RI), 70.8% (51 cases) had normal values, suggesting good vascular conditions, while 27.8% (20 cases) showed moderate changes, and 1.4% (1 case) had severe abnormalities. For the PI, 41.7% (30 cases) of participants had normal values, while 48.6% (35 cases) showed moderate changes, and 9.7% (7 cases) had severe abnormalities, indicating a need for clinical intervention in some cases.

Conclusion: The results underscore the clinical significance of monitoring Doppler parameters in anemic pregnant women, as Doppler abnormalities were more prevalent despite the absence of significant statistical associations. These findings suggest the need for further research with larger sample sizes to explore potential causal relationships and refine management strategies for anaemia in pregnancy, emphasizing the importance of clinical observation in managing placental perfusion and maternal-fetal health

CHAPTER 1

INTRODUCTION

1.1Background

The umbilical cord is visible throughout pregnancy and can be detected sonographically as soon as the fetal pole is visible. The umbilical cord is usually 50-60 cm long and can twist up to 40 times to the left. An understanding of development, normal sonographic appearance, and major umbilical cord anomalies is essential in fetal evaluation. The peduncle, omphalomesenteric, yolk sac, and allantois all help produce the umbilical cord between weeks 5 and 12 of pregnancy [1]. A double sac is one of the first signs of pregnancy on sonography. Wharton's jelly, which is mainly made up of mucopolysaccharides and forms a gelatinous substance, coats the vessels within umbilical cord. It has one vein that takes oxygenated and nutrient-rich blood to the fetus and two arteries carrying deoxygenated, nutrient-poor blood away from the fetus. All aspects-the size, coiling, attachment, and position-of the umbilical cord can impact on pregnancy prognosis [2].

1.1.1Anemia

Anaemia is a reduction in the RBCs or a drop in haemoglobin levels within blood. It can be diagnosed based on a cut-off value which is 2SD below the median of healthy populations, allowing for adjustments in age, sex, and pregnant status. Few of anaemias are IDA, aplastic anaemia, SCC and vitamin deficiency anaemia. Anaemia can be congenital, caused at birth, or it can occur due to several factors in life [3].

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1.1.2Anemia

Anaemia during pregnancy remains a prevalent health condition globally, particularly in developing countries. It is characterized by a reduction in haemoglobin levels below the normal threshold, leading to insufficient oxygen supply to both the mother and the developing fetus. This condition has been linked with numerous maternal and fetal complications, including pre-mature birth, abnormal birth weight, small for gestational

age (SGA) infants, and placental insufficiency. While the global prevalence of anaemia during pregnancy has decreased in recent decades due to better awareness and nutritional interventions, it remains a major society challenge, especially in low-resource settings. Most pregnant women around the world have been diagnosed with iron deficiency anaemia, especially since it usually originates from low intakes of other essential nutrients together with dietary shortages of iron. However, besides these reasons, anaemia might also stem from other sources; these include chronic diseases, haemoglobinopathies, and infections. This condition is particularly threatening in pregnancy since it not only affects the mother but also, through its complications, can impact the fetus by causing growth restriction, premature birth, and other neonatal complications. Hence, anaemia during pregnancy is a critical issue that needs timely identification, monitoring, and intervention to prevent bad outcomes. Iron deficiency is major nutritional disorders globally, in pregnant women mostly [4].

Parasitic infections including malaria, hookworms, and schistosomiasis; deficiency of micronutrients, including Vitamin B, vitamin A, and vitamin B12 complex and hereditary heamoglobin defects, such as thalassemia, are among the known causes of anaemia [5,6]. It is according to the CDC in describing anaemia as Hb level less than 11 g/dL during the start and end of pregnancy, while during the second trimester it is described as less than 10.5 g/dL. It is one of the big challenges in public health worldwide and mainly in developing countries. According to the latest prevalence rates reported, the prevalence rate of anaemia is high among Asian and African countries with percentages of 60% and 52%, respectively) [8,9]. It is during this period, women of child bearing age, women in time of pregnancy and premature babies which have low weight at birth as well as geriatric infants plus toddlers, female teenagers are under the greatest threats of suffering anaemia from a deficiency of iron. There are 80 percent of women having anaemia disease within South Asia; 56%, in developing and 18 % in developed countries [10].

Gestational anaemia is a condition characterized by hypoxia that might be the reason of recirculation of fetal blood flow; however, until now, there have been no reports on placental insufficiency [11]. It has been observed that if someone has anaemia during the 1st trimester of pregnancy then chances of abnormal or premature birth, i.e., before 37 weeks of gestation, are high. However, a large number of investigations have not found such an association [12,13]. In other clinical studies have been carried out in various regions of the world to assess the association between gestational anaemia

during pregnancy and premature birth condition. These studies had shown significant relations in some research but in other studies it was not. We conducted a meta-analysis to compile all the clinical data-based evidence side by side, allowing us to present a more accurate picture of this global issue. Such a method is more reliable because of certain meta-analysis conditions. Physiological changes occur in a normal pregnancy, and changes in the patient's hemodynamic status is one of them. Plasma volume increases 10% to 15% by 6 to 12 weeks of gestation and continues to expand more rapidly until reaching 30 to 34 weeks; after that only a slight increase is detected [14,15].Gestational anaemia, sometimes reaching very low levels (maternal haemoglobin level, 40-50 g/l), is often associated with prematurity, low birth weight, and iron deficiency in the infant. Physiological changes in pregnancy, such as increased blood volume, contribute to the development of anaemia. The increase in blood volume would lead to a relative dilution of red blood cells and hence lower haemoglobin levels. Below a certain level of haemoglobin. However, the oxygen-carrying capacity is reduced and maternal tissue and potentially the fetus become hypoxic. This can negatively impact fetal development, especially placental function, which is in charge of delivering oxygen and ingredients to the developing fetus. Poor delivery of O_2 to the fetus leads to a series of complications i.e placental insufficiency, fetal growth restriction, and premature birth. Research has shown that anemic women, especially those with iron deficiency anaemia, are at a higher risk of delivering premature and low birth weight infants. Poor maternal health outcomes, such as cardiovascular strain, increased chance of infections, and postpartum hemorrhage, have also been associated with anaemia.

1.1.3Doppler Sonography

Doppler sonography is the non-invasive procedure of blood flow assessment in the fetoplacental circulation along with the gold standard in assessment of fetal hemodynamics.Doppler velocimetry has become an important tool in monitoring fetal growth, especially in complicated pregnancies such as anaemia and premature birth. Doppler ultrasonography measures blood flow through various vessels, including the UA, MCA, and arteria uterina, which gives insight into placental blood flow. Doppler indices increased with S/D ration increased more or reversed end diastolic flow due to placental insufficiency, which may be related to bad outcomes as far as fetal growth restriction and premature birth. Many studies have found that poor fetal outcome may be produced through placental insufficiency associated with abnormal Doppler

findings. Reversed end-diastolic flow, in particular, is said to be a marker of severe placental insufficiency and is associated highly with the risk of premature birth and the small for gestational age infant. If Doppler velocimetry holds promise for predicting the outcomes it has been applied widely in clinical practice to evaluate at-risk pregnancies; however, its utility in the context of anaemia remains a subject of further research. The umbilical paired artery is used to assess placental function. The Doppler test is a clinical test that can differentiate between modest GA and IUGR [16.17]. The ratio of cerebral to umbilical paired artery resistance is used to quantify Doppler ultrasonography. This Doppler is affected very little by the length of pregnancy and is always more than 1.1 [18]. during a normal gravidity. However, in the case of hypoxia, it decreases due to aggravation of placental resistance and cerebral vasodilation and is highly correlated with fetal growth, hypoxia, and behavior especially before 34^{th} weeks of gestation [19].

The resistance index of the paired umbilical arteries has a statically significant relationship. Values of the resistance index between 0.50-0.68, in mild anaemia 0.54-0.71, in moderate anaemia 0.59-0.74 and in severe anaemia 0.60-0.77. There is also a statistically significant relationship in regards to the paired umbilical arteries PI. The PI of the umbilical paired artery ranges from 0.77-0.85, for mild anaemia it ranges from 0.60-0.88, for moderate anaemia it ranges from 0.67-0.90, for severe anaemia ranges from 0.77-1.80. There is a statistically relationship between the different study groups regarding the SD ratio of the umbilical paired artery. The range of umbilical paired artery SD ratio ranges from 2.09-2.2, in mild anaemia 2.13-2.23 with an intermediate value, in moderate anaemia 2.10-3.40 and in severe anaemia 2.15 -4.30. Time-averaged peak of the MCA used for the prediction and wellbeing of fetal anaemia in the clinical setups of fetal anaemia and Rhesus isoimmunization[8,9]. For this application, PSV refers to normative gestational data and has been used to predict the presence of fetal anaemia. Abnormal waveforms in many pregnancies complicated either by preeclampsia or by severe IUGR may prove valuable insights into their pathophysiology. Combined umbilical paired artery Doppler sonography and biometry has been the best tool to date in identifying small fetuses at risk of terrible outcome [20]. Several other studies have shown its importance in improving obstetric outcomes. Although Doppler velocimetry has appeared promising for the detection of placental insufficiency, its use in cases complicated by anaemia has not been well-characterized. The interaction between anaemia and adverse pregnancy outcomes, including

premature birth and SGA infants is complex and operative at multiple levels, including the trimester during which anaemia presents (early, mid- or late gestation), severity, and other more serious underlying conditions, such as hypertension or nutritional deficiencies in the mother.

The current study, conducted at Tehsil Head Quarters Hospital Pattoki, aims to investigate the radiological characteristics of 72 patients with confirmed anaemia during gravidity, with a particular focus on the utility of Doppler velocimetry in predicting fetal outcomes.

The study explore how anaemia and other forms of anaemia affect gravidity outcomes, particularly in the context of placental function. Additionally, the study seeks to assess the predictive value of Doppler velocimetry in this setting, providing valuable insights into its potential role in the early detection of complications.

Due to poor socio-economic status, mostly women in our society suffer from poor health as well as low HB levels. In this regard, pregnancy causes more suppression of HB levels and many women suffer from anaemia. Anaemia causes numerous complications in these women. Due to the lack of information and organized data, these patients have no idea how to manage this situation in time, which can reduce the severity of complications. This research will provide organized data about this problem prevalent in our society which will give awareness to people and doctors to deal with it properly and timely. The findings of this study used for prenatal care, particularly in settings where iron deficiency anaemia is prevalent. If Doppler velocimetry proves to be a useful tool in identifying at-risk pregnancies with anaemia, it could be incorporated into routine screening, leading to earlier interventions and improved outcomes. Furthermore, by clarifying the association between anaemia and adverse pregnancy outcomes, this research could guide better management strategies for pregnant women with anaemia, reducing the incidence of premature birth, SGA infants, and other complications.

AIMS AND OBJECTIVE

To evaluate umbilical artery doppler indices in anemic pregnant women for reducing adverse effects of anaemia on maternal and fetal health.

To evaluate umbilical artery flow pattern for significant effect of gestational anaemia on fetal health

CHAPTER 2
LITERATURE REVIEW

Kiridi Enefia Kelvin, *et.al*,2019. Using Doppler ultrasound estimation of fetal blood flow has widely been established and has greatly managed high-risk gravidity cases, in turn, increasing outcomes. Though the data base of standard parameters in Nigeria are not readily available, this article intends to contribute to an exploratory investigation in regard to characterizing the fetus's umbilical paired artery. This was a multicenter study carried out at the University of Niger Delta Teaching Hospital, Yhouagoa Silhouette Radio Diagnostics Specialists, and a government medical center involving 400 pregnant women aged 20 to 40 over one year. The assessments were conducted using a 2014 Philips HD 11 ultrasound machine with a 3.5 MHz colored curvilinear probe, pulsed wave, and Doppler power. The mean age and body mass index (BMI) of the participants were 30 ± 6 years and 29.9 ± 5.76 kg/m², respectively. Both velocities of the umbilical paired artery were recorded at 40.07 ± 8.99 m/s and 17.44 ± 6.37 m/s, respectively, with an average resistivity index (RI) of 0.57. There was a negative correlation between RI and the number of years of pregnancy ($P < 0.05$). Doppler limits for the fetal umbilical paired artery play a significant role in the management of high-risk pregnancies and enhancing outcomes. The present study acts as a premise for further studies with a more extensive sample size [21].

Batool Fatima, *et.al*, 2021, Electrochemical sensing mechanisms are considered very good for the tracing of biomolecules because they are specific, respond rapidly, are low-cost, and can be automated. Haemoglobin, a major protein of human body and is associated with many physiological activities, as blood levels correlate directly with anemic women. In this investigation, a non-enzymatic sensor made from nickel telluride nanorods for the detection and estimation of haemoglobin in anemic pregnant women is developed. The NiTe nanorods are assembled in one step. After the removal of the apparatus, sensory parameters such as scanning scale, pH, concentration, and potential disturbances were checked with standard haemoglobin samples. A linearity of 0.99698 was found to be associated with LOD and LOQ at 0.012 nM and 0.04 nM, respectively. Stability tests were performed on cyclic chronoamperometry over a period of twelve hours and voltammetry for 100 cycles. The recovery percentages of haemoglobin from the blood samples ranged from 63% to 90%. NiTe nanorods were observed to measure the blood samples of pregnant women afflicted with anaemia for

haemoglobin levels [22].

Tip Dergisi, Istanbul Kanuni Sultan Suleyman, *et.al*, 2017, This research was aimed to evaluate the impact of mortality, survival, and neurodevelopment in premature infants suffering from IUGR characterized by reversed diastolic flow detected in the umbilical paired artery by Doppler ultrasound. It was compared with various factors, such as population characteristics, timing of infant issues, and somatic and neurodevelopmental outcomes between the premature IUGR infants with abnormal umbilical paired artery flow and those with normal flow, monitored by our perinatology unit. Lubchenco and Neyzi curves were used in order to estimate the somatic growth, whereas the neurodevelopmental effects were checked through Bayley Scales III. In comprehension, language, and motor skills. There were 163 cases of infants diagnosed with abnormal umbilical paired artery flow within our perinatology department between 2002 and 2006. Of them, 117 had AREDF, while 46 had REDF. Within childbirth, there were 64 cases. For all infants surviving into 14 - 42 months, 38 were the control group, 30 the main group. However, there have been more serious differences between them in terms of gestational weeks, birth weight, and especially Apgar scores: from $p < 0.05$ upwards. Sex hospitalization time of stay mechanical support with ventilation degree of incidence, sepsis intracranial hemorrhages hypoglycemia states of respiratory failure, necrotizing enterocolitis didn't differ between study and control ones. While 2.6% of the study group fell below the third percentile for height at birth, this was also observed in the control group. Target weight loss was noted in 2.6% of the study group and 13.3% in the control group (p: 0.162). The Bayley Scales III scores for comprehension, language, and motor skills were comparable between both groups, indicating no significant growth restrictions in either cohort [23].

Yadav J, *et.al*, 2017, To assess the efficacy of umbilical artery Doppler indices in early detection of fetoplacental compromise and to determine the predictive value of each index in forecasting perinatal outcomes, thereby guiding timely interventions in hypertensive pregnancies.This prospective study involved 200 pregnant women diagnosed with hypertensive disorders. Doppler evaluations of the umbilical artery were conducted at gestational intervals of 28-32 weeks, 33-36 weeks, and 37-40 weeks, with increased frequency for those exhibiting abnormal Doppler results. Participants were categorized into two groups: those with normal Doppler indices (Group A) and those with abnormal indices (Group B). Perinatal outcomes between

the groups were compared and analyzed statistically using the Chi-square test. Exclusion criteria included multiple pregnancies, chronic hypertension, fetal congenital anomalies, systemic diseases, and loss to follow-up.Among the 200 participants, 64% were primigravida, and 36% exhibited abnormal umbilical artery indices. Group B experienced a significantly higher rate (88.88%) of adverse outcomes compared to Group A. Notably, Group B had increased incidences of cesarean sections, labor inductions, preterm deliveries, fetal growth restrictions, NICU admissions, and NICU stays exceeding 48 hours. Among the Doppler indices, the umbilical artery pulsatility index (PI) demonstrated the highest sensitivity (84.21%), positive predictive value (88.88%), and overall accuracy (90%) in predicting adverse perinatal outcomes.The umbilical artery PI is a reliable indicator for predicting adverse perinatal outcomes in hypertensive pregnancies. Its utilization can aid in the timely management and intervention, potentially improving perinatal outcomes [24].

Tamkeen N, *et.al, 2021*, To establish normative reference values for umbilical artery Doppler indices, including Resistive Index (RI), Pulsatility Index (PI), and Systolic/Diastolic (S/D) ratio, across gestational ages ranging from 18 to 40 weeks in healthy pregnancies.This cross-sectional study was conducted in the Radiology Department of Hayatabad Medical Complex from July to December 2018. A total of 260 normal singleton pregnancies between 18 and 40 weeks gestation were included. Doppler parameters—RI, PI, and S/D ratio—were recorded and analyzed to determine median values and percentile distributions across different gestational age groups.The study established that median PI values decreased from 1.23 at 18-20 weeks to 0.86 at 39-40 weeks. Similarly, median RI values declined from 0.70 to 0.52, and the S/D ratio reduced from 4.16 to 2.21 over the same gestational periods. These findings provide a baseline for normal umbilical artery Doppler indices in healthy pregnancies, which can be utilized for comparison in high-risk cases.Establishing normative Doppler indices is crucial for assessing fetoplacental blood flow and identifying potential risks in pregnancy. The reference values from this study can serve as a baseline for evaluating Doppler results in both routine and high-risk pregnancies, facilitating early detection and management of complications.

[25].

Muhammad Yousaf, *et.al*, 2018, The aim of analysis was to consider the indices in terms of both the SD ratio S/D and PI (PI) and assess them traditionally over time

within fetuses. Doppler ultrasonography is the arteria uterina broadly acknowledged as providing an important methodology for assessing high-risk pregnancies as well as investigating fetoplacental and uteroplacental blood flows. This is a study done on 100 traditionally monitored pregnant women at the Department of Radiology at Muhammadan Memorial Hospital (FMH) from August 3, 2012, to November 30, 2012. The age of gestation ranged from 37 to 40 weeks. A total of 100 Doppler assessments were conducted. The average S/D ratio was less than 3, and the median PI values were below 1 for participants between 37 and 40 weeks of gestation [27].

Alok Goyal, *et.al*, 2016, This study proposed to assess whether there was any correlation between umbilical paired artery Doppler sonographic findings with adverse perinatal outcomes of oligohydramnios among Indian females. It was understood that an umbilical paired artery Doppler is a direct independent predictor for complications at delivery and oligohydramnios is characterized by an elevated perinatal mortality and morbidity rate but few studies available are in literature that explains such factors' involvement among Indian groups. An observational study conducted in the Gynecology department of a tertiary care hospital where women who reported for prenatal care with oligohydramnios were recruited. Doppler ultrasound of the umbilical paired artery was performed, and patients were followed until delivery. Sociodemographic profile and other relevant predictive factors were recorded on a pre-designed form. Out of 946 women who were evaluated, 56.1% had normal Doppler results from umbilical arteries, that is, 41 out of 73. While 51% had abnormal results, which are 14 out of 27. The p-value is not statistically significant for the difference in outcomes ($p = 0.8$). Moreover, the Doppler result was not clinically different between the mild and severe oligohydramnios cases. The study concludes that there is no significant association between abnormal Doppler findings and adverse perinatal events in women with oligohydramnios. The inherent methodological limitations may account for these findings [28].

Murtala Yusuf, *et.al*,2021, The goal of this research was to describe the efficiency of cervical Doppler velocimetry as a predictive tool of preeclampsia in high-risk pregnancies. In particular, it tried to analyze the link between augmented impedance flow of blood in the arteries of uterine and the subsequent onset of preeclampsia. In an analysis of 138 pregnant women who visited the antenatal clinic. Doppler ultrasound assessments were conducted at second trimester of gestation. Tests were considered abnormal when the RI was equal to or greater than 0.58 in the arteria

uterina, regardless of the presence of a diastolic notch. The women then were followed for the development of preeclampsia. The frequency of preeclampsia in this cohort was found to be 12.3%. Of the participants, 21 patients (15.2%) showed high arteria uterina RI ≥ 0.58, whereas 117 (84.8%) had normal RI < 0.58. The incidence of preeclampsia was significantly higher in the group with elevated RI compared to those with normal RI (57.1% vs. 4.2%, $p < 0.05$). In addition, nine patients (6.5%) had DN, and the prevalence of preeclampsia was also significantly higher in this group compared to those without DN (55% vs. 9.3%, $p < 0.05$). According to the study, the abnormal RI has a good sensitivity (70.5%) and specificity (92.6%) in the prediction of preeclampsia. Findings are important to note the value of the Doppler ultrasound of the second trimester, especially with Doppler indicators derived from the arteria uterina and maternal studies [29].

Yingying Tian, *et.al*, 2022, The insertion of trophoblasts into the cervical decidua and the accompanying vascular structures is essential for appropriate placental formation. Placental abnormalities have been associated with conditions such as PE, fetal growth restriction, and small for gestational age in neonates. Arteria uterina Doppler ultrasound is an important tool in predicting major vascular events during gravidity. Monitoring the uterine and placental blood vessels from implantation through to the end of pregnancy can help diagnose potential complications. This review seeks to collate extant literature regarding the role of UAD in gravidity complications by reviewing articles in the English language from January 1, 1983, to October 30, 2021. Early diagnosis of complications would allow the providers to initiate interventions early in time, possibly averting or at least lessening damage both to mothers and babies. As a case in point, a daily dose of low-dose aspirin during pregnancy before the 16th week significantly reduced complications. UAD can be integrated with other maternal risk factors, biochemical markers, and fetal measurements throughout pregnancy to better identify high-risk populations. Recognition of these groups can also contribute to reducing maternal mortality rates. For women classified as intermediate risk, close monitoring can help decrease the incidence of complications [30].

Gerard Albaiges, *et.al*, 2010, To estimate the effectiveness of colour Doppler ultrasound in predicting preeclampsia and fetal growth restriction, the study was seen among singleton pregnant women undergoing routine ultrasound at 23 weeks of gestation. In this assessment, the arteria uterina bilaterally were assessed with regard

to PI. The presence of an elevated PI was above 1.45. There are 1,757 pregnant women were included in the study, and among them, 89 (5.1%) had PI levels that were elevated, while bilateral notches were observed in 77 (4.4%). Of the 65 pregnant women with elevated PI, 23 (35.3%; 95% CI 23.9, 48.2) developed preeclampsia subsequently. Moreover, among the 10 pregnant women who gets preeclampsia, 8 needed delivery before 34th weeks of gestation. The available analysis shows that from 65 women with bilateral notches, 21 (32.3%; 95% CI 21.2, 45.1) have exposed outcomes, which consist of preeclampsia and early delivery. The sensitivity for predicting low birth weight less than the 10th percentile was 30 out of 143 cases, or 21% (95% CI 14.6, 28.6), whereas it was higher at 70% for those delivering below the same percentile before 34 weeks. The program for screening at 23^{th} weeks effectively identified many women who would go on to experience significant complications before reaching term. Findings were consistent when assessing high-risk groups defined by either elevated PI or bilateral notches in the Doppler readings [31].

Khalil SE, *et.al*,2021, To investigate uterine and umbilical arterial Doppler indices in the early second trimester as predictors for late preeclampsia (PE) or intrauterine growth restriction (IUGR).

Methods: This prospective cohort clinical study was conducted at the Obstetrics and Gynecology Department, Faculty of Medicine, Tanta University Hospital, Egypt, from January 2020 to April 2021. The study included 150 pregnant women aged 18 to 30 years with gestational ages between 13 and 16 weeks. Doppler ultrasound assessments measured resistance index (RI) in both uterine and umbilical arteries.

Results: Significant differences were observed between groups regarding uterine and umbilical artery Doppler indices:Uterine Artery RI: Demonstrated a sensitivity of 62% and specificity of 88% for predicting IUGR, with a positive predictive value (PPV) of 37% and a negative predictive value (NPV) of 92%.Umbilical Artery RI: Achieved a sensitivity of 56% and specificity of 82%, with a PPV of 31% and an NPV of 30%; however, these results were not statistically significant.Conclusion: The combination of uterine and umbilical artery Doppler studies in early pregnancy serves as an effective indicator for predicting preeclampsia and IUGR. Implementing Doppler studies may aid in reducing maternal and perinatal morbidity and mortality associated with these conditions [32].

Amit Kumar Mani Tiwari, *et.al,* 2017; Iron deficiency anaemia is major cause of morbidity and mortality in pregnant females and their corresponding fetuses. Current

research includes the ongoing evaluation of the iron stores in the anemic pregnant women with regard to oral supplementation with iron. In this research study, 500 anemic women were followed who had either mild anaemia (200 cases), moderate anaemia (200 cases), and 100 had severe anaemia, while another group of 100 non-anemic women were put under follow-up. Standard protocol measurements included indices of blood as well as trace mineral levels in plasma. The results showed that Hb and ferritin were highly increased ($p < 0.001$) in both the anemic treatment group and the post-treatment controls. Serum transferrin receptor levels and TIBC were also decreased in many treatment groups. Oral iron supplementation increased the levels of iron (Fe), zinc (Zn), and copper (Cu) ($p < 0.01$),while the levels of selenium (Se) and manganese (Mn) decreased in all treatment groups. The findings indicate the restoration of some trace minerals required by the human body, other than manganese following iron and folic acid supplements, which poses numerous complications; such complications could range from increased oxidative stress on important body cells to increased susceptibility risks for the mother and fetus [33].

Niveditha Devasenapathy, *et.al*,2012 Anaemia in pregnancy is still a major public health problem in developing countries, especially in India. It is a direct cause of maternal mortality, accounting for 12-15% of deaths. Iron deficiency is the most common cause of anaemia in the Indian subcontinent, and though several preventive and treatment measures are available, challenges remain. Oral or intravenous routes can be employed for iron supplementation. Oral iron is non-invasive, less expensive, and generally safer but is usually ineffective due to the presence of dietary inhibitors and non-adherence on the part of the patient. In contrast, intravenous iron sucrose has recently become an important therapy in the treatment of pregnant women suffering from severe anaemia, with use over several years both in private and public healthcare systems. This article reviews the existing evidence on the safety and efficacy of intravenous iron sucrose in the treatment of anemic pregnant women, focusing on hematological and clinical outcomes. Although there is good evidence to support its efficacy in improving haemoglobin and serum ferritin levels, the effect on maternal and infant outcomes remains uncertain. The uncertainty mainly arises from a paucity of well-designed larger studies that would be able to differentiate between different clinical outcomes [34].

Mittal, *et.al*,2002, A series of randomized controlled trials were carried out at the All-India Institute of Medical Sciences in New Delhi, India. This research aimed to

explore the benefits of Doppler velocimetry studies in two fetal arteries: the umbilical vein and the central cerebral artery. There were 25 pregnant women with IUGR and developmental disabilities who were compared with 25 control pregnant women having normal fetal development matched for gestational age and without any risk factors for developmental disabilities. All study subjects were also followed up with fetal biometry, amniotic fluid index assessments, and Doppler flow studies of the medial and umbilical veins every week until delivery. The pregnant women in the intervention group were provided with additional monitoring of fetal activity, including daily kick counts, stress tests, and biophysical profiles. No pregnancies were terminated based on Doppler results. The two groups were matched for age and demographic factors, with most participants being primigravida. Hypertension associated with small-for-gestational-age pregnancies was common among the study group, with six cases recorded before 34 weeks of gestation. There is no statistical significance in the Doppler flow studies concerning the S/D ratio, RI, and PI concerning the study and the controls. Five instances of fetal bradycardia are documented during delivery for the study group versus one for the control group. Low Apgar scores at one minute postdelivery were documented in only two newborns of the study group. The values for both S/D values, RI values, and PI in both groups did not have statistical significance. This study cannot draw a solid conclusion in terms of the effectiveness of Doppler velocimetry in the prediction of outcome for pregnancies complicated with IUGR and developmental disabilities due to its small sample size [35].

Shaikh Nasreen, *et.al*,2021, indicates that the morbidity and mortality rates of the mother and the child are at a very high level among those suffering from anaemia. WHO states that it is very common medical disorder during gravidity in the Southeast Asian region, ranging from 18-20% in developed countries to a surprising 40% to 75% in the Southeast Asian region. The CDC defines anaemia in pregnancy as being below 11 g/dL (with hematocrit <33%) during the first and third trimesters, and below 10.5 g/dL (with hematocrit <32%) during the second trimester. Physiological hemodilution is an established fact in pregnancy, putting women at an increased risk for anaemia, especially iron deficiency anaemia. This study compares the risk of PROM between non-anemic and anemic pregnant women. A follow-up study was conducted with 100 anemic pregnant women and 100 controls. Prevalence of PROM was at 64% in the anemic group. Different risk factors, including maternal health, socioeconomic status,

and age, were analyzed to determine anaemia. It was found that the rate of PROM among pregnant women with anaemia was higher than that of those without anaemia. There is an urgent need to include measures that prevent anaemia during pregnancy and strengthen anaemia treatment in order to avoid harmful effects on both mother and babies [36].

Ashutosh Kumar, *et.al*, 2015, Oxidative stress has been of immense interest to scientists for the last ten years or so, owing to its role in the pathogenesis of numerous diseases. Pregnancy appears to favor a pro-oxidant environment, mainly owing to the high mitochondrial content in the placenta. This oxidative stress is adverse not only to the mother but also to the fetus under development. Severer anaemia prevails among the women in the developing countries of India. Anaemia is further exacerbated by increased oxidative stress in gravidity. Rural women are under serious challenges owing to nutrient deficiency, which may include iron deficiency. This study examines the relationship of anaemia to oxidative stress among pregnant women from the rural setting in Rajasthan, India. Anaemia-positive pregnant women and the controls, namely, 25 pregnant women, not anemic were selected through Obstetrics and Gynecology outpatients in the NIMS Hospital in Jaipur. Blood samples were taken following informed consent, and blood parameters like haemoglobin percentage (Hb%), packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration were measured by a standard cell counter. Plasma samples from all the subjects and controls were assayed for the FRAP. There was a positive correlation ($R = 0.44$) of Hb% levels with oxidative stress both in the study and control groups. The association was significant between anaemia presence and low plasma ferric reduction ability at $p < 0.05$. Pregnancy-related anaemia disturbs the balance between oxidants and antioxidants, shifting it toward an oxidant-dominant state that significantly reduces antioxidant activity in the plasma of affected women. This condition compounds the existing pro-oxidant effects of gravidity. Since oxidative stress is implicated in both fetal and maternal complications during pregnancy, this increase is critical and warrants further investigation [37].

Nibal mohammed Hoobi, *et.al*,2021, Gravidity anaemia is a medical condition characterized by significant alterations in bodily functions and oral health, primarily as a result of the stressors that cause an imbalance between oxidants and antioxidants, such as decreased salivary antioxidants and increased oxidative stress. The study

comprised 90 women who were divided into three sections: 30 anemic pregnant women, 30 non-anemic pregnant women in their first and second trimesters, and a control group of 30 newlywed women who were not pregnant and matched for age. Participants were recruited from the maternity and infant health center in Baghdad. The ages included 20-25 years. Evaluation of oral health was done using Plaque Index, which measures the density of plaque on the teeth. Calculus Index assessed the presence of dental calculus, and Gingival Index measures the condition of the gingiva. Non-stimulated saliva was collected and analyzed for uric acid and salivary protein carbonyl content. There were statistically significant differences between the pregnant women who suffered from anaemia and both pregnant women who did not suffer from anaemia and controls, with no significant difference between the non-anemic pregnant women and controls ($P > 0.05$). The calculus index was also higher in non-anemic pregnant women in comparison to the anemic group and controls; however, were significant only between the anemic group and controls. The gingival index for anemic women during pregnancy was lower than that of non-anemic pregnant women, though both groups showed higher gingival indices than the control group, with significant differences noted. The salivary antioxidant level (uric acid) was greatly lower in the anemic group compared to both other anemic groups, while protein carbonyl content was greatly higher in the anemic group. Plaque index had a negative correlation with the salivary antioxidant levels and protein carbonyl content in the anemic pregnant females, but a positive correlation for non-anemic pregnant women. For calculus index, it had a positive relationship with the antioxidant levels in the saliva in the anemic females but not in the non-anemic counterparts. The trend was repeated with protein carbonyl level where the anemic females had a positive relationship but the non-anemic had a negative relationship. The study concluded that anaemia in pregnancy is related to decreased salivary antioxidants and increased oxidative stress, which complicates the oral health outcomes. This underlines the fact that further studies are needed in understanding how these factors affect the pregnancy outcomes regarding oral health [38].

Moe Iwata, *et.al*,1995, This study explains the predictive value of arteria uterina Doppler flow velocimetry in estimating the risk of adverse perinatal outcomes in growth-restricted fetuses. A prospective comparative study was carried out on pregnancies complicated by growth-restricted fetuses, focusing on both normal and abnormal arteria uterina blood flow. Ninety-three pregnancies were examined with

Doppler flow velocimetry to evaluate the resistance index between 27 and 36 weeks of gestation. The relative risks, with 95% Confidence Intervals, of several adverse outcomes were calculated from comparisons of 52 pregnancies that had abnormal arteria uterina blood flow and 41 that had normal blood flow. It emerged that the risks for the delivery conditions were the following: at 2.29 (1.32-3.97), premature birth; at 2.94 (1.74-4.97), less than 2,000g in weight at birth; at 2.57 (1.30-5.05), caesarean section due to fetal distress; and at 3.27 (1.60-6.69), admission to NICU. These results suggest that abnormal arteria uterina blood flow is significantly linked with an high risk of adverse perinatal indications in pregnancies complicated by growth restriction. Therefore, Doppler flow velocimetry of the maternal arteria uterina is a valuable tool for guiding clinical setups in such cases [39].

FitzGerald and Drumm and McCallum, *et. al*, 2017, Doppler techniques have generated widespread interest and scientific activity in obstetrics since the first reports by FitzGerald and Drumm of umbilical paired artery signals. For years, it has been recognized that poor uteroplacental and fetal perfusion contributes to adverse gravidity outcome, and it is increasingly feasible to diagnose this abnormality through Doppler ultrasonography. Abnormal UA velocimetry indicates increased impedance in placental blood flow, while the absence or reversal of end-diastolic flow in UA suggests poor fetal condition. A crucial examination with fetal Doppler involves the MCA for detection of cardiovascular disorders, fetal anaemia, or fetal hypoxia. The arteria uterina has a specific Doppler curve characterized by increased in both parameters (resistance to flow and a diastolic notch) that corresponds to high-risk pregnancies. This study was aimed at assessing the role of color Doppler imaging in predicting pregnancies of high-risk and their perinatal outcomes and demonstrating flow patterns and factors associated with adverse fetal outcomes in these high-risk cases [40].

J.M.A Texeira, K. Duncan, E. Letsky, N.M. Fisk, et.al, 23 December 2002. The fetal MCA peak systolic velocity may represent a test for determining levels of fetal HcT. We investigated the hypothesis that low fetal hct could be associated with increased MCA PSV in healthy and alloimmunized pregnancies using a prospective study. Values for fetal hematocrit and MCA PSV were obtained on twenty six alloimmunized fetuses, between 15 and 35 weeks of gestation, prior to any having received their first fetal blood transfusions. Values for MCA PSV obtained on 170 controls, at no risk to develop alloimmune anaemia, were obtained at gestational ages between 13 and 37

weeks. The study observed that MCA PSV changed with gestational age, fitting the equation: PSV = 0.56 - 0.032 GA + 0.00086 GA^2). A very strong correlation existed between MCA PSV and hematocrit Z scores, as evidenced by the Pearson correlation coefficient r = 0.69, P = 0.0001. Although the test showed only a sensitivity of 64% when using a PSV greater than 1 standard deviation to predict a fetal hematocrit level more than 2 standard deviations below the mean, it showed a specificity of 100%.. The sensitivity improved for predicting fetal hematocrit levels more than 3 standard deviations and 4 standard deviations below the mean to 73% and 83%, respectively, with good specificity at 93% and 80%. There is a high and very significant association between fetal hematocrit levels and MCA PSV. Considering that positive predictive value is very high whenever PSV is greater than 1SD, it is considered a reasonable predictor of fetal anaemia. In conclusion, MCA PSV test is an appropriate tool for diagnosing fetal anaemia in clinical environments [41].

G Acharya, T Wilsgaard, G.K.R.Bernsten, J.M.Maltau, T. Kiserud, *et.al*, 7 April 2007. The purpose of study was to formulate reference ranges for re peated measurements of absolute blood flow velocities in the umbilical paired artery during the second half of pregnancy and to assess the hypothesis that there are relevant correlations between the UA velocities and the volume of blood flow from the placenta, estimated using the velocities and diameter of the umbilical vein. It is a longitudinal prospective investigation concerning umbilical circulation. Altogether, 130 low-risk singleton fetuses underwent monitoring of absolute velocities of the UA and the blood flow within the umbilical vein in four-week periods between 19 and 42 weeks of gestation. For the derivation of reference ranges, data from 511 measurements was used, whereas multilevel modeling was conducted to assess how the absolute velocities of the UA are related with placental volume flow. Throughout the second half of pregnancy, both placental blood flow and UA absolute velocities showed a consistent increase. Notably, the rise in UA end-diastolic velocity (EDV) associated with gestational age was greater than the increase observed in PSV. The ratio of time-averaged intensity-weighted mean velocity (TAWMV) to time-averaged maximum velocity (TAMXV), which was found to be 0.6, suggests that the velocity profile is likely not entirely parabolic. The correlation between UA absolute velocities and placental volume blood flow was significantly positive at P = 0.00001, but gestational age affected this relationship. The intraobserver coefficients of variation for placental volume blood flow, as well as UA PSV, EDV, TAMXV, and TAWMV, were recorded at 10.17%,

16.29%, 11.46%, and 18.18%, respectively. From these longitudinal data, new reference ranges for UA absolute velocities have been established. Such findings are associated with a clinically significant correlation with fetoplacental volume blood flow, so these reference ranges may be very useful in assessing umbilical circulation during pregnancy.2005 ISUOG Copyright. John Wiley & Sons, Ltd. is the publisher [42].

Abdel Majeed Ismail, Amer Ahmad Mahmoud Riad, Shaimma Mehmoud Mohamad Morsi Elsherif, *et.al*, October 2018. The objective of study was to assess the impact of gestational anaemia on Doppler indices of the UA and MCA during the 3rd trimester of pregnancy. This prospective case-control clinical trial was conducted in the obstetric outpatient clinics and inpatient ward of Ain Shams University Maternity Hospital, and two hundred patients participated in the study. Inclusion criteria demanded that the fetuses must be viable and show normal ultrasound findings, with gestational ages of singleton pregnancies ranging from 28 to 40 weeks, as estimated by either the patients' last menstrual period or an earlier ultrasound. The umbilical paired artery resistance index, PI, and SD ratio were significantly increased in moderate to severe anemic patients compared to the control group. In addition, a notable increase in the cerebral/umbilical paired artery resistance ratio was observed in cases of severe anaemia compared to other groups. Gestational age at delivery was consistent across all groups, indicating no statistically significant difference ($P > 0.05$). Neonatal ICU admission rates differed among the groups, with rates of 2 (4%), 2 (4%), 4 (8%), and 9 (18%) respectively. A statistically significant difference in neonatal ICU admissions was noted between the various study groups ($P < 0.05$). Maternal anaemia is significantly impacting fetal Doppler indices in the third trimester for both the umbilical paired artery and the MCA. The effects are directly proportional to the degree of anaemia and are relevant in monitoring such parameters in pregnant women with anaemia to prevent Negative outcomes have been documented for both the mother and the fetusus [43].

Sonhaye Lantam, Kolou Beresa, Boube Abarchi Habibou, Gbande Pihau, *et.al* September 2018. This research was to explore whether the use of Doppler ultrasound in assessing the status of the umbilical paired artery can be useful in monitoring Lomé pregnancies exposed to vascular risk factors. In a Cross-sectional study, running for six months at the radiological department of the Campus Teaching Hospital; the focus was on the RI of the umbilical paired artery in women during pregnancy with vascular

risks as compared to those without risk factors. A total of 425 pregnant women without vascular risk and 209 women with such risks were included in the study. The average age of at-risk pregnant women was 26.31 years, while it was 25.38 years for those without vascular risks. The odds ratio for the association between a pathological RI and gestational diseases was found to be 1.57, with a 95% confidence interval of [1.07 - 2.20]. There was a positive correlation between pathological RI and a low Apgar score at birth for both at-risk and non-at-risk groups. The measurement of the resistance index is not routinely performed in the studied population; however, it may become a crucial tool for monitoring pregnancies at risk for conditions such as malaria, pre-eclampsia, and gestational anaemia. The findings suggest that umbilical paired artery Doppler ultrasound may enhance the assessment and management of high-risk pregnancies in the region [44].

Lasheen, G Mari, *et.al*, 2021. This study aimed at finding out if there is a statistically significant difference in haemoglobin levels at admission among three groups under study. MCA is also known for the prediction of fetal outcomes, depending on the direction and changes of cerebral blood flow. It has been proven that the fetal cerebral artery resists high resistance during the prenatal period; however, this can vary depending on threatening conditions, such as placental insufficiency and hypoxemia, that stimulate chemoreceptors in its sensitivity and increase the levels of vasodilators or vasoconstrictors. MCA Doppler measurements have been encouraged as a powerful tool in the diagnosis of fetal hypoxia, which can result in poor perinatal outcomes and fetal compromise. In the study, three groups compared for this study were taken in terms of MCA resistance index, PI, and SD ratio. A statistically significant correlation was established between the various study groups in relation to the MCA resistance index ($P < 0.05$) [45].

Sudhanshu Sekhar Mohanthy, *et.al,* January 2020. Biometric measurements and Doppler studies on the umbilical paired artery PI , MCA PI, and MCA PSV were done for each study. All measurements on MCA PSV were then converted to multiples of the median (MoM). Birth weight was then adjusted for gender. All pregnancies were delivered within two weeks after the studies. To evaluate levels of Hgb at delivery, a correlation of MCA PSV MoM with Hgb was assessed wherein level of Hgb in fetuses with normal values of MCA PSV versus abnormal values has been as compared to make use of 1.3 MoM as cut-off for mild anaemia; besides a multivariate linear regression analysis was undertaken wherein MCA PSV MoM was also included along

with other Doppler and clinical parameters.. Monitoring condition may lead to inappropriate escalations in labor induction and operative interventions [46].

Abdel-Megeed, *et.al*.,2021, the purpose of study was to compare different study groups in terms of MCA resistance index, PI, SD ratio, and peak systolic velocity. The findings revealed that the MCA resistance index in the control group ranged from 0.792 to 0.923, with a mean value of 0.821 ± 0.035. In the mild anaemia group, the index ranged from 0.78 to 0.98, with a mean of 0.734 ± 0.06. For the anaemia of moderate group, values grouped from 0.79 to 0.81, averaging 0.91 ± 0.06, while in the anaemia of severe group, it grouped from 0.56 to 0.80, with a mean of 0.70 ± 0.08.The umbilical paired artery resistance index in the control group was reported to range from 0.50 to 0.68; in the mild anaemia group, it ranged from 0.54 to 0.71; in the moderate anaemia group, it ranged from 0.59 to 0.74; and in the severe anaemia group, it was between 0.60 and 0.77. A statistically significant relationship was observed among the different study groups regarding the umbilical paired artery resistance index ($P < 0.05$). The umbilical paired artery PI varied from 0.77 to 0.85 in the control group, from 0.60 to 0.88 in the mild anaemia group, from 0.67 to 0.90 in the moderate anaemia group, and from 0.77 to 1.80 in the severe anaemia group. Again, there was a statistically significant relationship among the various groups concerning the umbilical paired artery PI ($P < 0.05$). The systolic / diastolic ratio of the umbilical paired artery was recorded as ranging from 2.09 to 2.20 in the control group, from 2.13 to 2.23 in the mild anaemia group, from 2.10 to 3.40 in the moderate anaemia group, and from 2.15 to 4.30 in the severe anaemia group. A statistically significant relationship was also found among the study groups relating the umbilical paired artery SD ratio ($P < 0.05$) [47].

Ali *et.al*.2021,The MCA/UA resistance ratio at 4 weeks and 6 weeks following admission was significantly higher in the anaemia group than admission values. Maternal anaemia leads to a hypoxic state in the fetus, provoking significant vasodilation in the fetal brain to ensure appropriate oxygenation of the brain, as demonstrated by the reduction seen in the resistance index of the MCA. Fetal cerebral edema and permanent damage can arise if cerebral vasodilation exists in the fetus over a protracted period of time. From Moiety & Ahmed research findings, groups B and C anemic state values for C/U ratio came within the critical abnormal range since, in a well-balanced physiological condition as portrayed in Group A, haemoglobin levels showed low but did not cross thresholds at which critical haemoglobin had diminished

significantly such that C/U value remained high to indicate within the normal scale despite low mother haemoglobin counts. The timing of gestational anaemia measurements varies across studies, which complicates meta-analyses. Existing literature indicates that the impact of maternal haemoglobin concentration on adverse birth outcomes is more pronounced when measured in detection of early pregnancy. A U-shaped curve has been observed regarding maternal haemoglobin levels and hazardous birth outcomes, with increased risks associated with both haemoglobin concentrations (Low and High). However, this relationship's consistency varies depending on when haemoglobin levels are determined during pregnancy. This study revealed differences among the three groups of studies on biparietal diameter, abdominal circumference, and femur length. The amniotic fluid index was also statistically different for 10 days and at delivery. The findings by Lasheen et al., however, differed where they noted that there was no significant effect on the amniotic fluid index by the presence or absence of the two conditions. However, they stated that preventing oligohydramnios may be more beneficial as pregnancy advances, especially in group C. [48].

Swain *et.al*.,2021, Qualitative variable analysis revealed clinically significant results. Low birth weight was recorded in both groups with little variation, and results were statistically non-significant during the initial six months, with only exception of last 12 weeks when mothers were found to be anaemic. Studies by Levy et al. demonstrated a strong correlation between decreased birth weight and gestational anaemia; however, a retrospective study revealed no association between first-trimester anaemia and low birth weight. Most studies concentrate on haemoglobin levels in the third trimester or at delivery, indicating that third-trimester haemoglobin levels are critical for determining birth weight. This aligns with the rapid fetal growth and peak iron and micronutrient accumulation occurring during this period. In contrast, the link between maternal anaemia and premature birth seems stronger. Anaemia during the second and third trimesters increased the rates of premature birth, especially in the third trimester [49].

Ozeren M, *et.al* 2017, The study reviewed 125 normal and 62 pre-eclamptic patients between the 31st and 40th weeks of gestation. The highest sensitivity of 88% and diagnostic accuracy of 94% in predicting adverse perinatal outcomes were associated with the systolic/diastolic UA ratio. The MCA PI/UA PI ratio has a higher predictive value for fetal growth restriction; 84% of the FGRs can be predicted and is highly

specific to an accuracy level of 87%. An abnormal cerebro-umbilical ratio is predictive of both the presence of fetal growth restriction as well as other adverse perinatal outcomes among patients diagnosed with preeclampsia; however, no significant change can be reported based on MCA PI values only. In this research, as depicted in Table 6, Doppler color was compared to conventional NST. When a comparison was performed between specificity alongwith sensitivity of Doppler and NST it was observed to be 82.6% and 63.0%, respectively, and diagnostic accuracy was 72%. The negative predictive value of the Doppler method was 80.95%, while the positive predictive value was 65.5%. The odds ratio was also significant at 2.23 [50].

Manoj Kumar Veerabathini, Sudhanshu Sekhar Mohanthy, *et.al,* March 2020. Intrauterine growth restriction which is also most observed complication of pregnency, also linked to perinatal mortality and morbidity, as well as impaired neurological development. Doppler assessments of the uterine, umbilical, and middle cerebral arteries, along with the cerebro-placental ratio, are commonly used for evaluating IUGR. In a study, the diagnostic performance of Doppler ultrasonography of the fetal MCA and umbilical paired artery in high-risk pregnancies and its correlation with perinatal outcomes. Prospective evaluation with Doppler ultrasound of the umbilical and middle cerebral arteries was performed on 50 singleton pregnancies beyond 7 months of gestation complicated by IUGR. Out of 50 cases, 40 had adverse outcome. Sensitivity of umbilical paired artery PI was at 82.5%, MCA PI was at 77.5%, and middle cerebral/umbilical paired artery PI ratio of 87.5% for predicting perinatal outcome. The PI of the middle cerebral/umbilical paired artery was the most sensitive predictor of adverse perinatal outcomes (87.5%); the most specific was the umbilical SD ratio (80.9%). Absent or reversed diastolic flow of the umbilical paired artery signified a bad prognosis and an increased risk for fetal mortality. Combining Doppler studies using the umbilical and the middle cerebral arteries, including the cerebroplacental ratio, enhances Doppler sensitivity to predict adverse outcomes of perinatal conditions [51].

Tannirandorn Y *et. al*,2017, determined outcomes in patients presenting with absent end-diastolic velocity and reversed end-diastolic velocity in umbilical paired artery flow velocity curves over a period of nineteen months. Over this period, 15 patients were identified. All the patients were in high-risk pregnancies, 9 presenting with AEDV and 6 with REDV. There were 12 deaths in the children, consisting of 3 fetal deaths, 4 stillbirths, and 5 neonatal deaths, thus bringing the perinatal mortality rate to

80% in this group. The time interval between the appearance of abnormal waveforms and fetal death or delivery ranged from 2 hours to 4 weeks. In three fetuses with abnormal diastolic flow, umbilical vein blood gas analysis showed severe acidosis and hypoxia. In the present study, 6 out of 50 (12%) fetuses were diagnosed to have AEDV in the umbilical paired artery, and out of them, 66.66% had both FGR and PE as maternal complications. The rate of cesarean section was found to be 83.33%, neonatal mortality rate 16.66%, ICU admission rate 83.33%, and neonatal complication rate 66.66% in this group. Meanwhile, 9 out of 50 (18%) fetuses presented with REDV, where 88.88% had both FGR and PE as maternal complications, similar cesarean section rates, neonatal mortality rate at 77.77%, 100% ICU admission, and neonatal complication rate at 66.66%. Such findings suggest that in the situation where the diastolic component of umbilical paired artery flow velocity curves is either reversed or not present, there is hypoxia and acidosis in the fetus, causing catastrophic perinatal outcomes. Fetuses have been known to be differentiated between healthy and sick fetuses by fetal Doppler, wherein deterioration can be monitored through serial measurements. Chronic changes are the Doppler changes which appear first; late indicators of fetal damage would be abnormal waveforms of fetal cardiac. This Doppler technique requires sophisticated equipment and a level of operator skill and expertise which may not be available at all centers. In contrast, non-stress tests (NST) are simple to use and interpret, inexpensive, and time-saving, thus being a valuable tool for the detection of at-risk fetuses in many hospitals [52].

RM *et al*, Garcia et al and Rai L *et.al*.2017, An analysis of the primigravida and multigravida respondents showed that the number of C-sections was lower than the number of vaginal deliveries, with fetal distress being the main cause of C-sections. The results are similar to those found in studies conducted by Rai L et al. and Garcia B et al. The mean birth weight was recorded at 2150 g in this study; however, this figure does not reflect the previous similar studies by Waldo RM et al., Garcia B et al., Peixoto et al., and Li H et al. The most common pregnancy complications found in the cases are listed as follows: Oligohydramnios Small for gestational age (SFGA) Preeclampsia Anaemia. Additionally, ultrasound Doppler screening shows a relatively poor detection rate for cases that started late in the second trimester. The present study thus established a statistical correlation between perinatal distress and the various factors like presence of a notch in the arteria uterina Doppler both bilaterally, the S/D ratio and end-diastolic velocity in the umbilical paired artery (UA), MCA PI, and the

ratio of MCA PI/UA PI. Hofstaetter et al. have suggested that arteria uterina notch is a better predictor of perinatal outcome than unilateral high PI. Contrarily, the study of Ghosh et al. shows that RI and PI were the best indicators of vascular impedance to predict adverse perinatal outcome [53].

Chanprapaph *et. al*.2015, The prevalence of IUGR at 50.9% was reported for singleton pregnancies with clinically suspected IUGR between 30 and 42 weeks gestation that were followed up for 30 months. Although this figure is slightly lower than the 53.6% prevalence observed in our study, due to the smaller sample size, definitive conclusions cannot be drawn. The follow-up period for patients in this study was also shorter compared to the aforementioned study. In a prospective study by Ghosh GS et al. conducted in Sweden involving 353 singleton pregnancies, abnormal flow in the umbilical paired artery was noted in 102 cases (28.4%). Our study reported a significantly higher incidence of abnormal umbilical paired artery flow at 79.2%. In our findings, sensitivity, specificity, positive predictive value, and negative predictive value for SD ratio of 3 or more are 76%, 76.9%, 79.2%, and 73.5%, respectively. This can be comparable with those results given by Chanprapaph et al. These included 66.7%, 78.85%, 74.42%, and 65.08% respectively [54].

Fleischer A *et. al*, 2015, Doppler velocimetry studies have shown that an S/D ratio of more than 3 has a sensitivity of 78% for predicting intrauterine growth restriction (IUGR), which is consistent with our study. In a study conducted on 118 high-risk singleton pregnancies in China, the umbilical arterial S/D ratio had a sensitivity of 80.0%, specificity of 83.7%, and a positive predictive value of 50.0%, with an IUGR rate of 16.9%. The mean gestational age based on the last menstrual period was 37 weeks and 4 days, and the mean birth weight was 2.1 kg. Of total neonates, 27 (19.3%) had perinatal asphyxia, while 26 of them (96.3%) had abnormal umbilical paired artery Doppler velocimetry. A total of 30 neonates were admitted to the NICU, out of whom 27 (90%) had abnormal umbilical paired artery Doppler findings before delivery. Among those thirty neonates, fifteen of them died immediately after birth. Another study published in Italy recruited 578 singleton pregnancies diagnosed with IUGR and referred for Doppler velocimetry. In this study, the mean delivery age was calculated to be 35 weeks and 5 days, with a mean birth weight of 1.85 kg. Of those, 547 live births were found while there were 28 (4.8%) intrauterine deaths, three elective terminations, and twenty-six neonatal deaths [55].

Abdel-Megeed Ismail Abdel-Megeed, *et.al,* 2019, In the study, the effects of

gestational anaemia on fetal Doppler indices, especially those concerning the UA and MCA during the 3rd trimester of gravidity. Results indicated a marked increase in the resistance index of the umbilical paired artery when moderately anemic patients were analyzed to the control group. In cases of severe anaemia, there was a marked increase in both the umbilical paired artery PI and the SD ratio. In addition, the cerebral/umbilical paired artery resistance ratio also increased significantly in those with severe anaemia. The results showed no difference in gestational age at delivery among the different groups ($P > 0.05$). However, the rates of NICU admissions differed significantly among groups, being 2 (4%), 2 (4%), 4 (8%), and 9 (18%) respectively ($P < 0.05$). 18 cases were included in Group 1, with levels of maternal haemoglobin above 60 g/L. Group 2 consisted of 14 cases with levels of haemoglobin less than this amount. The level of Doppler indices for brain and brain/umbilical cord, and the amniotic fluid index and biometry at admission was lower in Group 2 as compared to group 1. The uterine index stayed normal in all cases of groups 1 and 2. Abnormal fetal heart rates appeared only in cases of Group 2 (57.14%). By day 10, maternal haemoglobin levels and amniotic fluid indices had improved in group no 2 as compared to Group no 1, with increases noted in both the cerebral index and the ratio of cerebral to umbilical resistance. Notably, abnormal fetal heart rates were resolved in Group 2. Only severe maternal anaemia (haemoglobin level < 60 g/L) was associated with fetal cerebral vasodilation and a reduction in amniotic fluid volume [56].

Shoboo Rahmatia, *et. al* 2018: The leading cause of anaemia among pregnant women is iron deficiency anaemia while other causes are parasitic infections, micronutrient deficiency, and genetic disorders in hemoglobin. Anaemia during pregnancy is a public health issue since it incurs poor outcomes. A myriad of studies have differently highlighted the risk for premature birth and gestational anaemia across varied gestation periods. Based on the above analysis, this research is aimed to explain the correlation between maternal anaemia in pregnancy and the event of premature birth. There were 18 studies included in the meta-analysis, with 932,090 participants. It was found that the odds ratio for the correlation between maternal anaemia during pregnancy and premature birth was 1.56. Maternal anaemia during the 1st trimester was associated with an increased risk of premature birth; relative risk was 1.65. However, in the second trimester, the association was not statistically significant relative risk: 1.45, and in the 3rd trimester, relative risk: 1.43. That is why maternal

anaemia during pregnancy can be perceived as a predisposing factor to premature delivery in the 1st trimester [57].

Olubusayo Abimbola Agbajel *et.al*, Pubished in 2018, This study aimed at determining the UA Doppler indices at 26th weeks of gestation in women with no complicated pregnancies who are anemic. These indices will then be compared to obstetric outcomes. The design of this study was a cohort study with 60 cases and 60 controls recruited from a prenatal clinic. These pregnant women were then followed up to delivery. By 26 weeks, UA velocimetry, fetal biometric measurements, maternal hematocrit levels, and parity were observed. Fetomaternal outcomes were also documented. The study showed that UA Doppler indices and estimated fetal weights of anemic patients were lower than those in the control group at 26 weeks of gestation. Specific pathophysiological changes associated with anaemia enhances the effect of adverse maternal and fetal outcomes among pregnant anemic patients. In fact, there was a statistical rise among anemic patients for obstetric complications. Most importantly, there is no correlation for maternal hematocrit levels with vascular indices. Further studies would be needed in order to evaluate the proper cutoff values and optimum timing of an ultrasound assessment among anemic patients [58].

Solange Augusta American state militia , true heath Willner , *et.al*, 2015. The objective of this study was the assessment of how frequently maternal anaemia is detected in newborns and whether this anaemia relates to the newborn's growth status at birth. We collected information from pregnant women and their babies, including blood samples, for analysis of Hb, hematocrit, RDW, iron levels, protein, and transferrin saturation, all with automated devices. Results are provided as mean values and variances, and subjected to analysis of variance with the GraphPad InStat® version 3.0 at $p = 0.05$. The results showed that anaemia prevalence among mothers was 53.7%, and newborns were anemic at a prevalence of 32.6%. It is interesting to note that half of the anemic newborns were born to anemic mothers. Among the pregnant women who were anemic, 79.3% had mild anaemia and 20.7% had moderate anaemia. The mean Hb concentration and hematocrit levels were significantly lower in anemic mothers compared to non-anemic mothers: 9.7 ± 0.9 g/dL and 29.8 ± 3.2% respectively versus 11.9 ± 0.7 g/dL and 36.5 ± 2.7%. Maternal iron levels were positively correlated with umbilical cord protein ($r = 0.3889$, $p = 0.01$). The mean birth weight of babies born by anemic mothers was 3,375.9 ± 506.9 g, their length was 51.2 ± 1.7 cm and head circumference 34.5 ± 1.5 cm; newborns from non-anemic mothers

had a mean birth weight of 3,300.2 ± 458.3 g, length 50.3 cm, and head circumference of 34.2 ± 2.0 cm. However, no significant correlations were observed between maternal Hb levels, iron levels, or protein levels with infant weight, length, or head circumference. In conclusion, this study shows that maternal iron deficiency anaemia (mild to moderate) can affect the blood count and iron concentration in the umbilical cord blood of newborns without affecting their growth parameters at birth [59].

D. S. Makh,C. R. Harman,A. A. *et.al*, 2003, The study aimed to assess the predictive value of MCA and umbilical paired artery Doppler indices for anaemia in fetuses with intrauterine growth restriction (IUGR). Fetuses with abdominal circumference below the 5th percentile underwent UA and MCA Doppler studies before delivery. The parameters measured included the PI (PI) for the UA and MCA, the cerebroplacental ratio (CPR), and the peak systolic velocity (PSV) of the MCA. The complete blood counts were performed on peripheral blood samples collected at delivery. Calculations of MCA PSV z-scores were made by comparison with reference ranges of Mari et al. and Kurmanavicius et al., then the correlation of these z-scores with haemoglobin levels was explored through regression analysis. In addition, AEDV absence in the UA, brain sparing (MCA PI > 2 standard deviations below the mean for gestational age), low CPR (> 2 standard deviations below the mean), and elevated MCA PSV (> 2 standard deviations) were evaluated for their predictive value regarding anaemia. Results indicated that among 97 IUGR neonates, 23 were anemic, representing 23.7%. The MCA PSV in accordance with both mentioned standard values was highly correlated with haemoglobin levels. $F = 22.1577$ (Mari et al.) and $F = 21.8188$ (Kurmanavicius et al.), $P < 0.001$. When using categorical cut-offs, for multivariate analysis, no Doppler parameter could be found of clinical use to predict anaemia. In conclusion, parameters from the MCA and UA Doppler studies, combined with MCA PSV, significantly relate to anaemia in IUGR neonates, but their predictive accuracy is too low to be of value in clinical practice in this setting. The altered hemodynamics of the IUGR fetus could be one explanation for this fact [60].

CHAPTER 3

METHODOLOGY

3.1 Research Design

The This study follows a descriptive, cross-sectional research design, which is appropriate for evaluating and analyzing the umbilical paired artery flow patterns in pregnant women diagnosed with anaemia at a particular point in time. The study design aims to describe the relationship between anaemia severity and Doppler ultrasound findings in pregnant women and evaluate the prevalence of abnormal flow patterns in the umbilical paired artery.

3.2 Clinical Settings

This study was conducted at Tehsil Head Quarters Hospital Pattoki.The clinical settings provides an ideal environment for conducting this study, offering access to necessary diagnostic tools, a diverse patient population, and skilled healthcare providers for accurate data collection and analysis.

3.3 Sample Size

As selected according to expected prevalences and statistical power calculations, a minimum of 72 patients was chosen with confirmed anaemia.

$$n_0 = \frac{\hat{p} \times (1 - \hat{p}) \times z^2}{MOE^2}$$

$$n_0 = \frac{0.5 \times 0.5 \times 1.96^2}{0.05^2}$$

$$n = 385$$

$$\frac{1 + 385}{85}$$

n= 69.628 → which rounds up to 70

3.4 Sampling Technique

Non-probability sampling type sequential was the employed sampling technique. The sample used sequential sampling-another non-probability sampling technique-for the inclusion of all eligible patients meeting the criteria who turned up consecutively over the study period. Under this procedure, every individual satisfying the set criteria is included without randomization or even preselection.

3.5 Duration of Study

This period is the experimental program of this study between six months. Patients who were eligible and were thought to have anaemia during this period and came in for ultrasound examination were progressively included for the study protocol. This timeframe allowed systematic study of Doppler ultrasound imaging characteristics and clinical lab association while ensuring adequate data collection to arrive at the target sample size. The six-month period was designed to obtain a representative dataset while accounting for variations in patient flow.

3.6. Selection Criteria

3.6.1. Inclusion Criteria

This study was extended to those who fulfil the following standards:

- Pregnant women with Hb less than 11g/dl
- < 11 g/dl in the 1st and 3rd trimesters
- < 10.5 g/dl in the 2nd trimester
- Gestational age between 25weeks to 35weeeks

3.6.2. Exclusion Criteria

- Multigestational pregnancy
- Presence of Fetal anomalies detected by ultrasound
- Patients with pre-existing medical conditions such as hypertension, diabetes or renal disease.

3.7. Ethical Consideration

The study Doppler evaluation of umbilical paired artery flow pattern in anemic pregnant Women was carried out in compliance with local regulatory requirements and ethical standards. The Hospital in Lahore and the Faculty of Allied Health Sciences at The Superior University in Lahore examined and approved the research protocol. Strict attention to patient privacy and confidentiality was guaranteed by the study. To safeguard participant identities, all imaging data and health records were anonymised prior to analysis. All participants (or their legal guardians, if appropriate) provided written informed permission after being fully told about the study's goals, methods, possible risks, and rewards. There were no direct treatments that put the individuals at more danger, nor were there any invasive procedures carried out outside of standard clinical care

3.8. Data Collection Procedure

In conducting Doppler ultrasound of umbilical paired artery, ultrasound machine having a transducer of frequency range from3.5 to 6 Hz will be used. Then, the patient asks to lie on her back on an examination table. An abdominal ultrasound is done by a sonographer. A small amount of warm gel will be applied on the abdomen. The sonographer gently presses the transducer against the stomach area, moving it back and forth to capture black and white images and the measurements of images on the screen. When the umbilical paired artery seen near the pelvic region of fetus. The Doppler signal will be optimal with the probe placed at an angle of 45 – 60° to the

umbilical paired artery. The artery is not necessarily parallel to the skin; adjustment of the probe may be needed to obtain a good signal. Ultrasound examination typically takes about 30 minutes to complete. It is generally painless and non-invasive.

The ultrasound reports, patient history and their Ultraound imagesof all the included patients were collected from the radiology departments of the respective hospitals and with the help of those a performa was filled to evaluate different parameters regarding to this study.

Firstly, conversant permission was signed from participants for collecting information regarding to their Ultrasound examination and checkup. The data was collected with help of data collection tools (questionnaire and information assortment sheets). Information was obtained as per variable of questionnaire.

Body-mass index will be calculated from the weight measured to the nearest 0.1 kg and the standing height without shoes measured to the nearest 0.1 cm. Obesity was defined by a BMI 30 kg/m2

Measurement of blood pressure using mercury sphygmomanometer, the average of three measurements 5 minutes apart will be considered. Mean diastolic blood pressure of more than 90 mmHg and mean systolic blood pressure of more than 140 mmHg will be considered hypertension

A well-prepared questionnaire for the personal history, current medical history, menstrual history and family medical history will be administered to participants

Participant Information

1. MR No _____
2. Name _____
3. Age_____
5. BMI _____

Medical History

1. Are you currently taking any medications?

Yes

No

8. If yes, please list: _____

Sonographic Evaluation

1. Have you ever had a sonographic evaluation before?

Yes

No

2. Are you willing to undergo a sonographic evaluation as part of this study?

Yes

No

3.9. Data Analysis

The collected information was analyzed by using statistical analysis and Microsoft Excel. Different variables such age , gender,HB, Anema classifications (Mild, Modertae Severe), Doppler and their relations with anaemia find and their mean values and percentages were calculated numerically or quantitatively.

The SPSS (Statistical Package for the Social Sciences program version 25) used to analyze the study's data. Data collected from the hospital evaluated and analyzed using SPSS version 25 and Microsoft Excel 2016. Descriptive statistics were employed to examine the data distribution. Means and standard deviations (SD) were computed for continuous variables, while frequencies and percentages were determined for categorical variables. The data were stored using Microsoft Office. Additionally, summary of the clinical and demographic data, including frequencies for categorical variables and averages and standard deviations for continuous variables, will be provided using descriptive statistics. Chi-square test will evaluate the relationship between BMI state and categorical variables, while t-test will compare Hb levels with Umbilical Doppler indices in anemic women. Using multiple regression analysis, umbilical indices will be found for both the entire sample control group and anemic group mild, moderate and severe respectively.

CHAPTER 4

RESULTS

The demographic and clinical data that can be gleaned from the analysis of the Doppler evaluation of umbilical paired artery flow patterns in anemic pregnant women is insightful. In total, 72 participants were involved in the study, with a mean gestational age of 26.44 weeks (SD = 4.82), thus mid-pregnancy. The mean Body Mass Index was recorded as 26.39 (SD = 1.62), which means that most of the participants were slightly overweight. Haemoglobin levels averaged at 10.29 g/dL (SD = 1.21), indicating mild anaemia throughout the sample, with values ranging from 7.8 to 12.9 g/dL.

TABLE 4.1: Gestational Age

		Gestational Age	BMI	Hb
Sample (N)	**Valid**	72	72	72
	Missing	0	0	0
Mean		26.44	26.390	10.28889
Std. Deviation		4.820	1.6173	1.209418
Minimum		20	24.0	7.800
Maximum		35	29.2	12.900

This table presents the statistical summary of Gestational Age, BMI, and Hb levels. It includes the total number of valid cases (N=72) and no missing data for these variables. The mean gestational age is 26.44 weeks, BMI is 26.39, and haemoglobin (Hb) is 10.29 g/dL. The standard deviations indicate variability: 4.82 weeks for gestational age, 1.62 for BMI, and 1.21 g/dL for Hb.

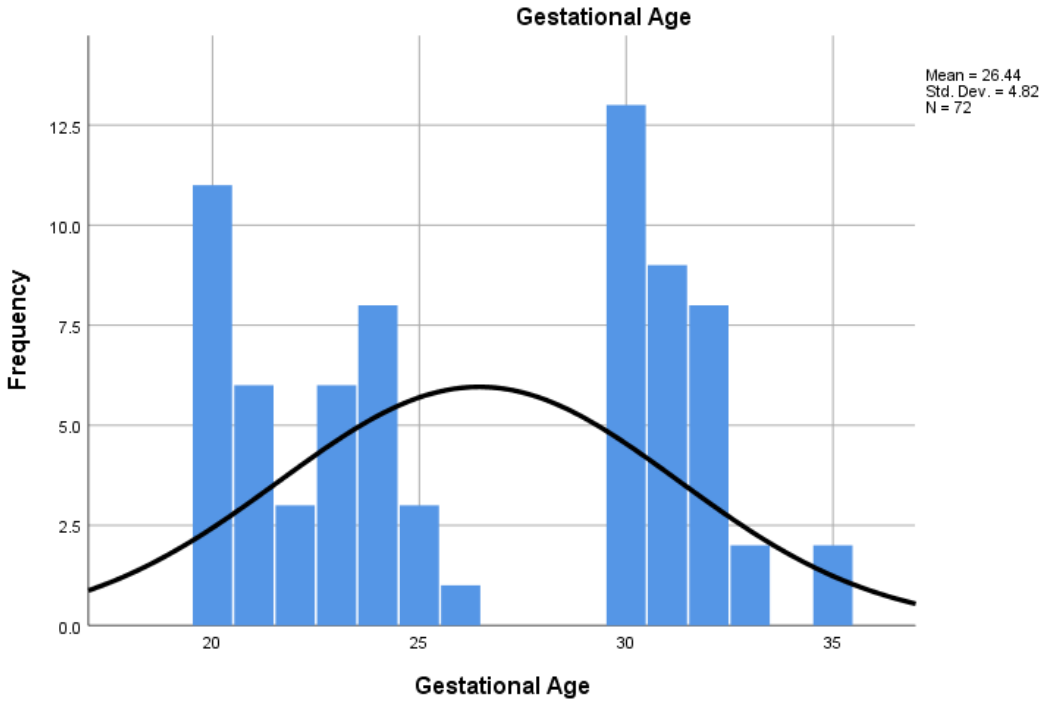

FIGURE 4.1.1: Histogram representation of Gestational Age of patients

Gestational Age has an average of 26.44 weeks, with a variability of 4.82 weeks, ranging from 20 to 35 weeks.

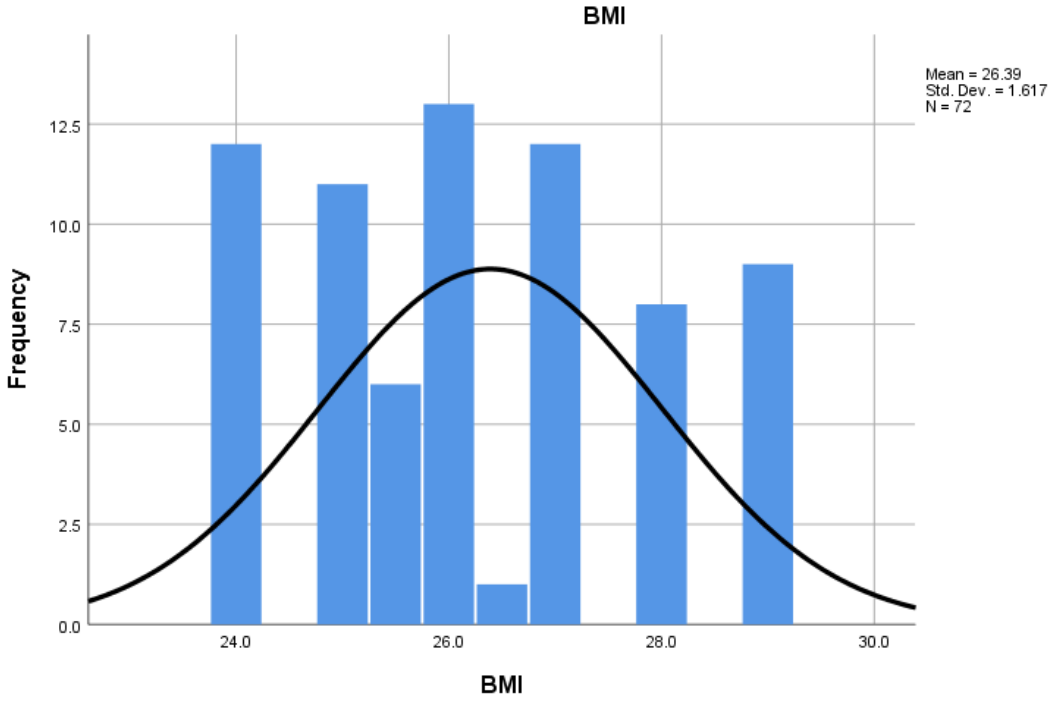

FIGURE 4.1.2: A Histogram representation of BMI of patinets

BMI shows a mean value of 26.39, indicating a slightly above-average body mass index among the participants, with a range from 24.0 to 29.2.

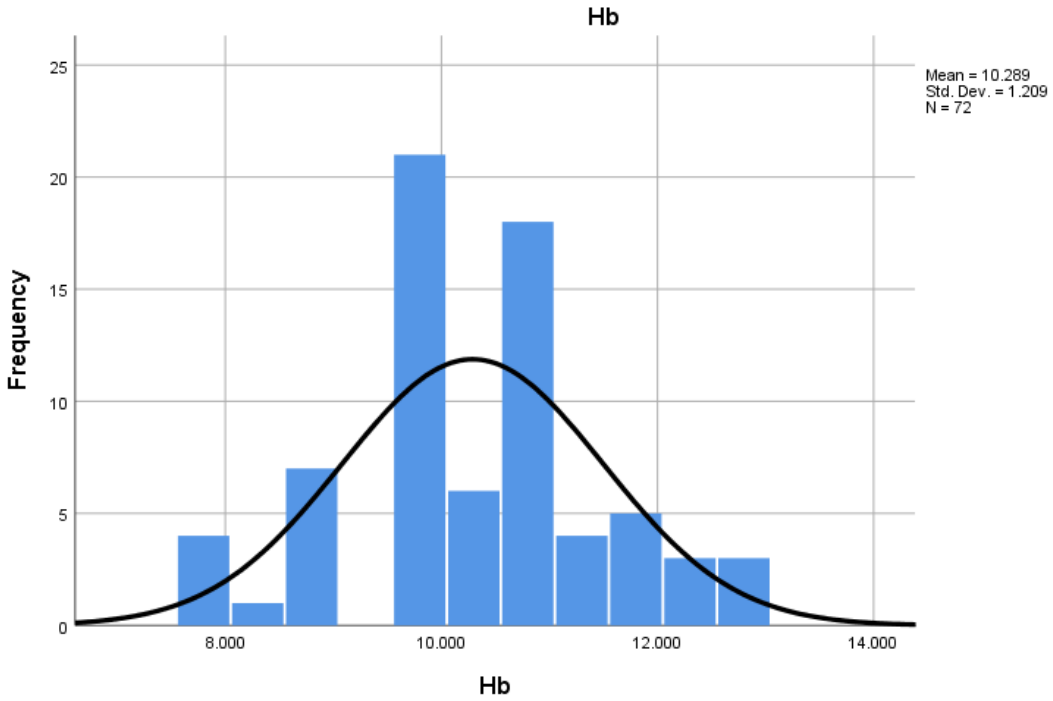

FIGURE 4.1.3: A Histogram representation of Hb of Patients

Haemoglobin (Hb) has an average level of 10.29 g/dL, suggesting mild anaemia on average, with levels varying from 7.8 to 12.9 g/dL. This range highlights the clinical diversity within the sample population.

TABLE 4.2: Distribution of different clinical parameters of the study participants

	S/D Ratio	Patient Age	RI	PI	Hb
	Frequency	Frequency	Frequency	Frequency	Frequency
Normal	47	32	51	30	30
Moderate	19	24	20	35	27
Severe	6	16	1	7	15
Total	72	72	72	72	72

ZZ

This table gives the distribution of different clinical parameters of the study participants: s/d Ratio, Patient Age, Resistance Index (RI), PI (PI), and haemoglobin levels (Hb_1). Here, 65.3% were within the normal category for s/d Ratio, thus representing stable placental perfusion. Moreover, 44.4% fell in the younger age category. The majority (70.8%) of them had normal RI values, which indicated that vascular conditions were good, although nearly half (48.6%) were classified under moderate PI levels, which is an area that requires clinical intervention.

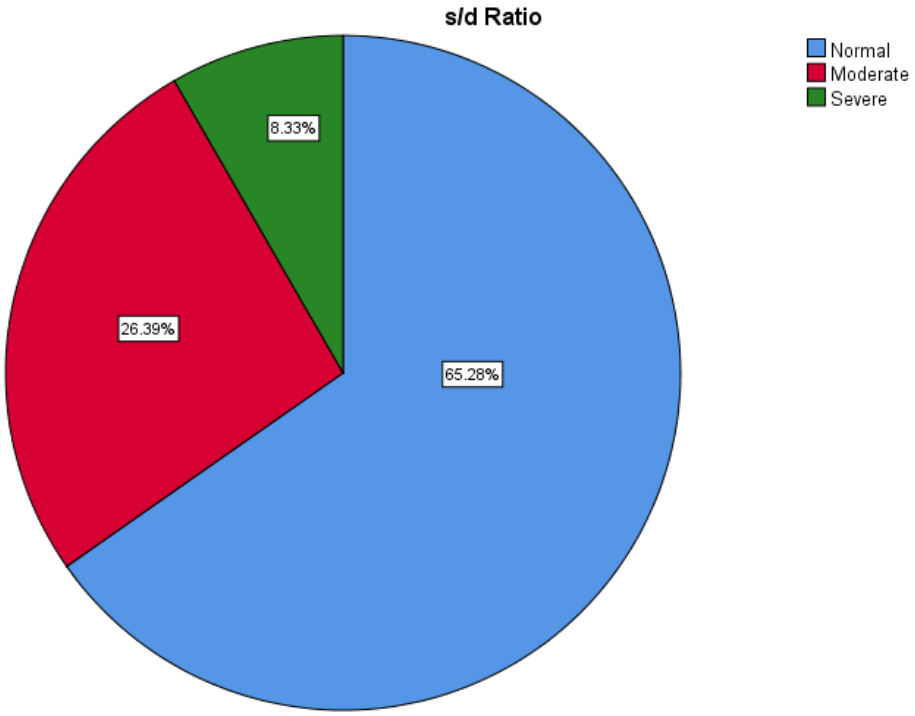

FIGURE 4.2.1: A Pie-Chart representation of s/d Ratio
Normal Category: Constituting 65.3%, it reflects stable conditions for the majority of patients.
Moderate Category: At 26.4%, this segment signifies patients at potential risk.
Severe Category: Making up 8.3%, this is the critical group requiring immediate attention

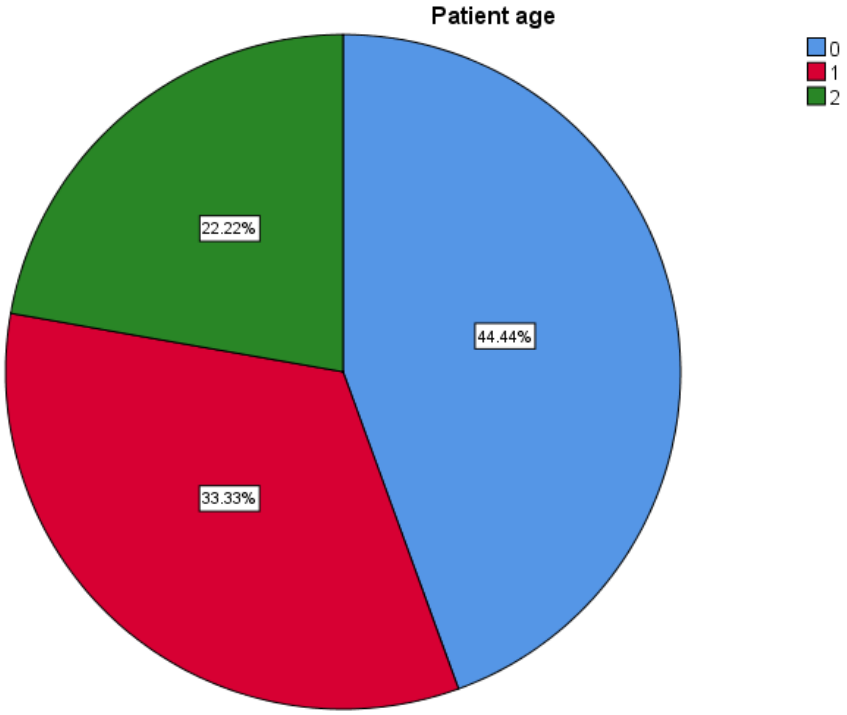

FIGURE 4.2.2: A Pie-Chart representation of Patient Age
Category 0 (Blue): Constitutes **44.44%** of the dataset, representing the largest single

proportion.
Category 1 (Red): Accounts for **33.33%** of the patients, indicating a significant portion of the sample.
Category 2 (Green): Makes up **22.22%**, the smallest segment in the dataset.
This segmentation suggests a balanced distribution, with **Category 0** being the most prevalent, followed by **Category 1** and **Category 2**. These categories could correspond to specific age ranges or classifications, which should be defined explicitly in the thesis to enhance clarity.

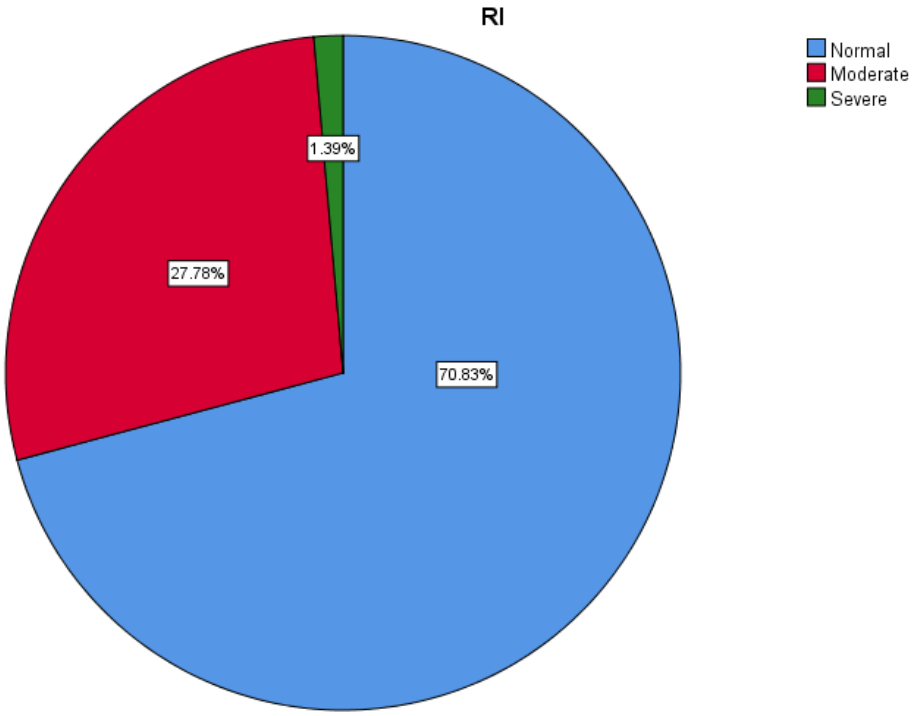

FIGURE 4.2.3: A Pie-Chart representation of Resistive Index of Umbilical paired artery
Normal (70.83%): Represented by the blue section, this category constitutes the majority of the dataset, indicating that a significant portion of the population falls under normal conditions as per the RI measurement.
Moderate (27.78%): The red section of the chart indicates the moderate category, comprising slightly over one-fourth of the total dataset. This suggests a notable prevalence of moderate conditions.
Severe (1.39%): Depicted by the green section, this category accounts for a very small percentage of the dataset. This suggests that severe conditions are relatively rare in the studied population.

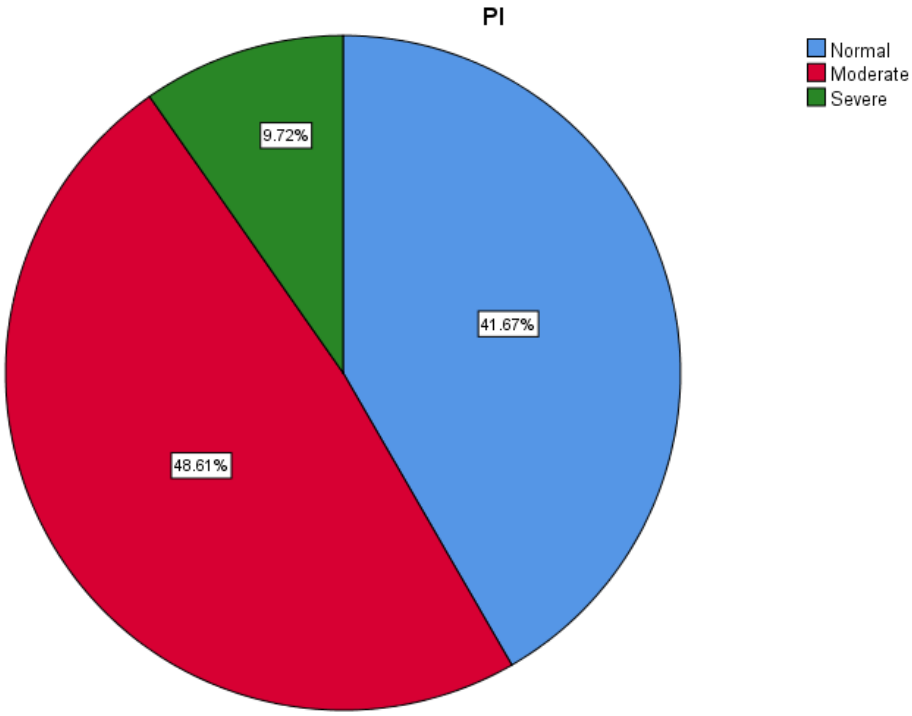

FIGURE 4.2.4: A Pie-Chart representation of PI of Umbilical paired artery

Normal PI: Accounting for 41.7%, these cases show standard PI levels.

Moderate PI: The largest segment at 48.6%, signaling potential concerns in nearly half the population.

Severe PI: Representing 9.7%, it identifies cases with critical PI levels requiring immediate follow-up.

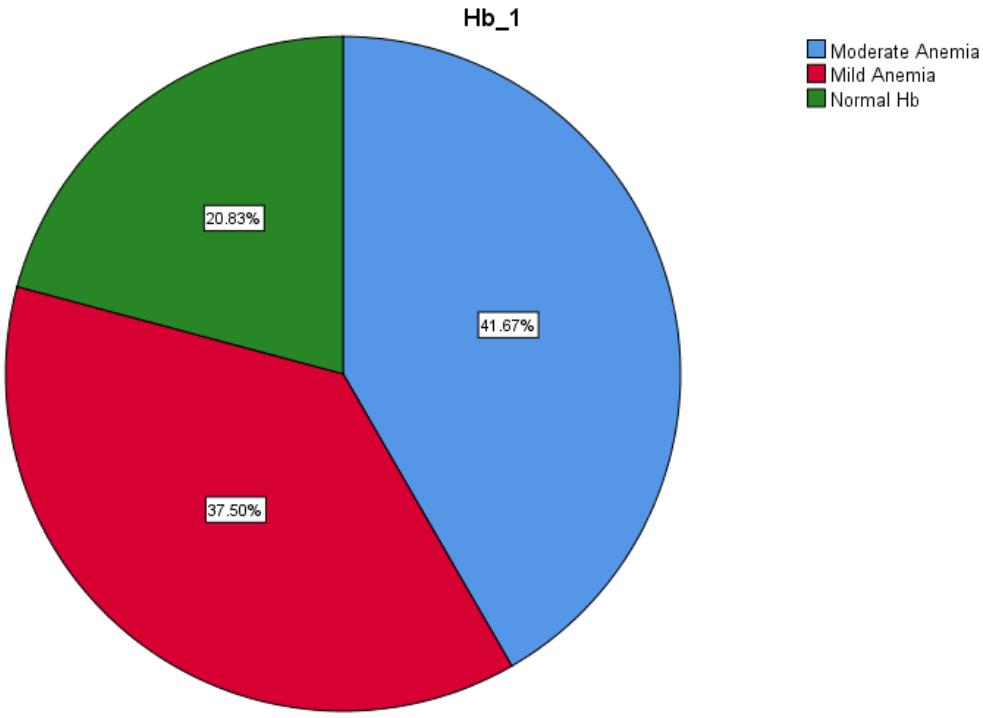

FIGURE 4.2.5: A Pie-Chart representation of Hb of Patients

Moderate Anaemia: Representing 41.7%, this segment forms the largest portion, highlighting its prevalence and the need for targeted interventions.
Mild Anaemia: At 37.5%, this group reflects a significant proportion of patients requiring moderate care.
Normal Hb: Comprising 20.8%, this category shows a smaller but healthy subset of the population.

Crosstabs of Haemoglobin Levels and Resistance Index

Crosstab analysis shows that the majority of patients classified with anaemia have normal RI, implying that anaemia can be present despite apparently normal RBC indices. The Chi-Square tests did not show any association between haemoglobin levels and the categories of RI ($p > 0.05$), and this implies that the observed frequencies are not significantly different from those expected under the null hypothesis. This further supports an investigation into why anaemia is somehow sustained despite normal RBC indices, which might influence clinical approaches to the treatment of anaemia in pregnant women. Many individuals with all types of anaemia reported have a normal RBC index (RI). This may suggest that anaemia is present even when RBC indices appear normal. - There are very few cases of severe RI across all categories, indicating that severe anaemia is rare among the sampled individuals. - Normal Hb levels are also present in individuals predominantly characterized by a normal RI, indicating that while they possess a normal Hb count, some may still experience mild or moderate anaemia.
Crosstab highlights that anaemia prevalence (both mild and moderate) is more common among individuals with normal RI, emphasizing the need for further investigation into why these individuals exhibit anaemia despite normal RBC indices. This could influence clinical approaches for diagnosing and managing anaemia in various populations

TABLE 4.3: Haemoglobin Levels and RI

Crosstab					
		RI			
		Normal	Moderate	Severe	Total
Hb_1	Moderate Anaemia	21	9	0	30
	Mild Anaemia	21	5	1	27
	Normal Hb	9	6	0	15
Total		51	20	1	72

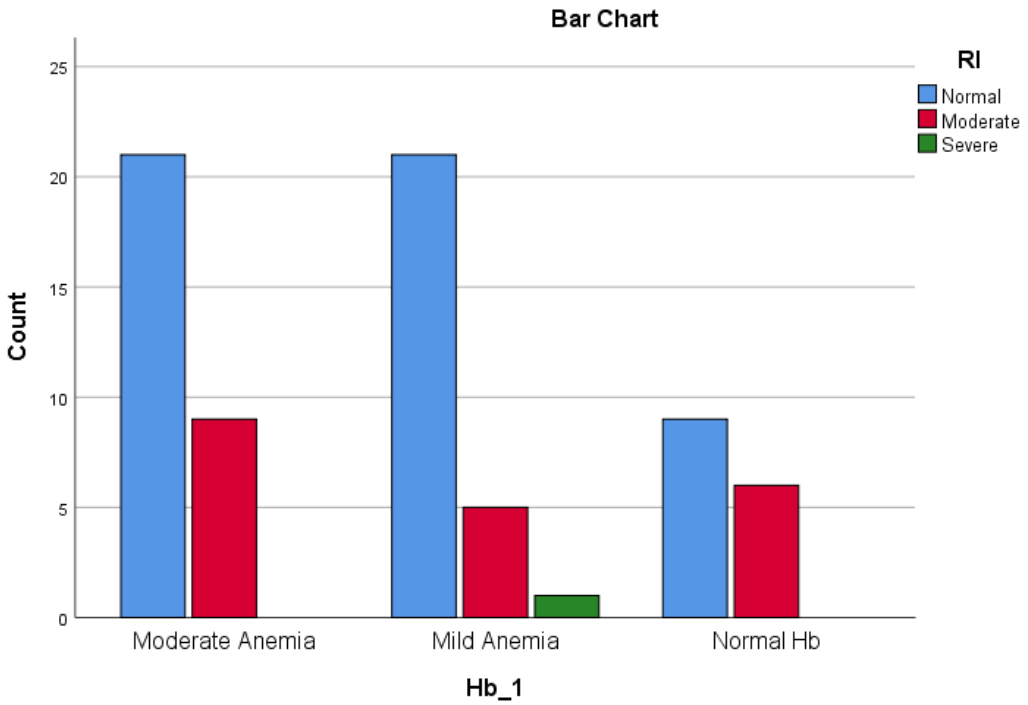

FIGURE 4.3.1: A bar chart representation of Data between Haemoglobin levels and RI catogory

The bar chart expresses the relationship of haemoglobin level with RI category, which displays that the predominant category is the Normal RI group in all of the Hb_1 groups, while categories of moderate and severe are comparatively less.
This structured analysis focuses on the most important findings concerning demographic data, within-group distributions, and inter-group relationships regarding the umbilical paired artery flow patterns in anemic pregnant women, underlining areas of potential clinical focus and further research.

TABLE 4.4:Haemoglobin Levels and s/d ratio

Crosstab					
		s/d Ratio			
		Normal	Moderate	Severe	Total
Hb_1	Moderate Anaemia	18	7	5	30
	Mild Anaemia	19	7	1	27
	Normal Hb	10	5	0	15
Total		47	19	6	72

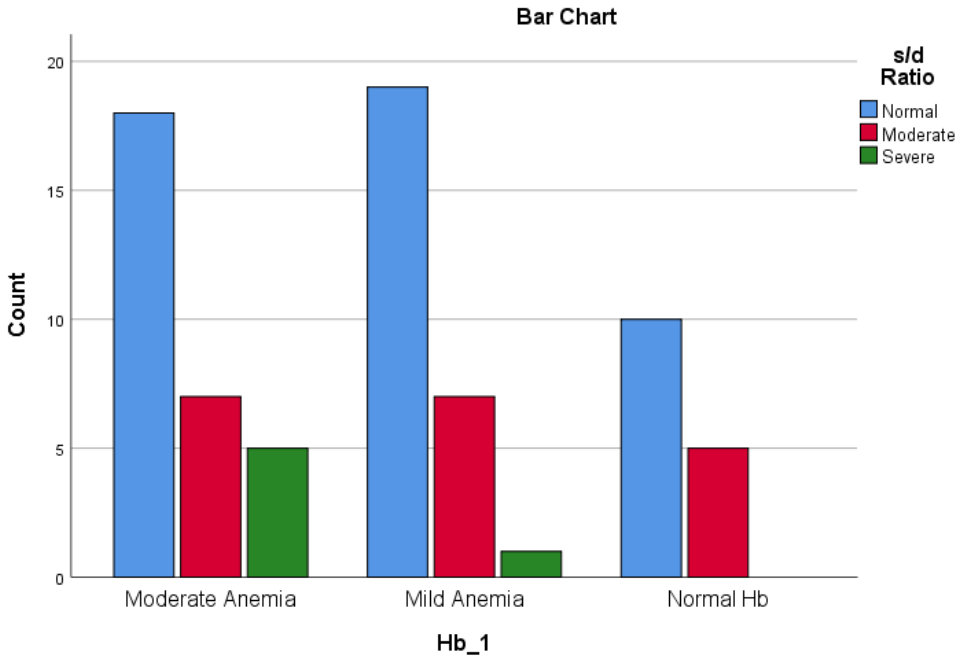

FIGURE 4.4.1 A bar chart representation of Data between Haemoglobin levels and s/d Ratio

Crosstab Analysis of Haemoglobin Levels and PI (PI)

Crosstab analysis revealed that Moderate PI was the predominant one among those who had both Moderate Anaemia and Mild Anaemia, and hence, a relationship between anaemia severity and placental perfusion as assessed by PI could be assumed. Results from Chi-Square test showed that haemoglobin level is not associated with PI categories at p-value > 0.05; this means variations in PI are not significantly related to haemoglobin classification in this population.

TABLE 4.5:Haemoglobin Levels and PI

Crosstab					
		PI			
		Normal	Moderate	Severe	Total
Hb_1	Moderate Anaemia	12	12	6	30
	Mild Anaemia	11	15	1	27
	Normal Hb	7	8	0	15
Total		30	35	7	72

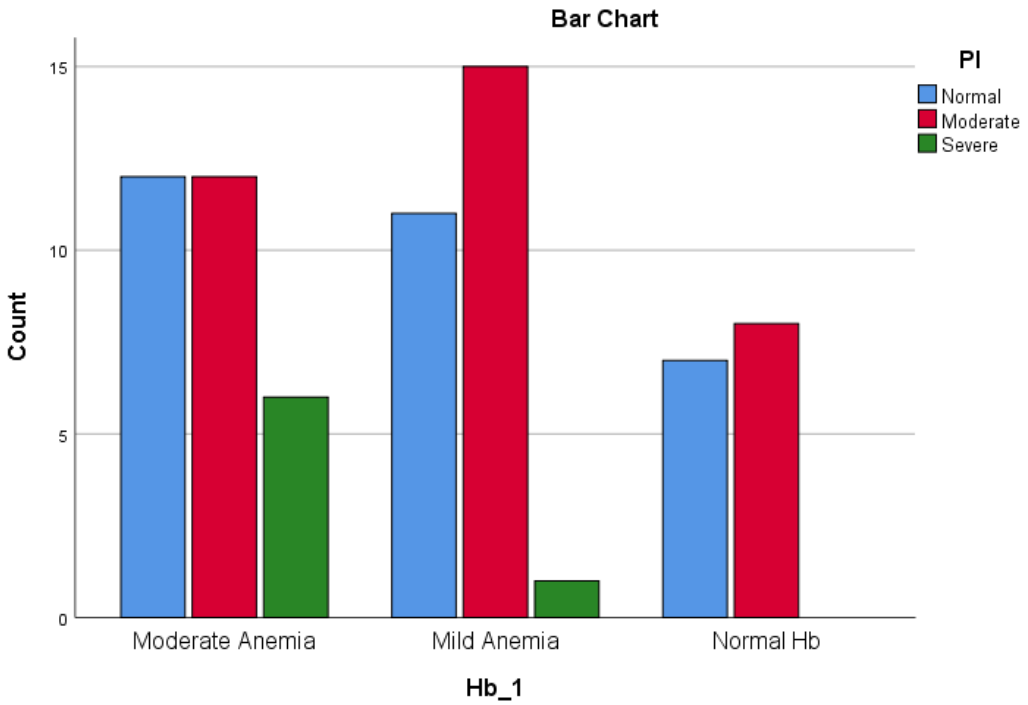

FIGURE 4.5.1: A bar chart representation of Data between Haemoglobin levels and PI

The bar chart expresses the relationship of haemoglobin level with PI category, which displays that the predominant category is the Moderate PI group in all of the Hb_1 groups, while categories of Mild and severe are comparatively less.
This structured analysis focuses on the most important findings concerning demographic data, within-group distributions, and inter-group relationships regarding the umbilical paired artery flow patterns in anemic pregnant women, underlining areas of potential clinical focus and further research.

CHAPTER 5

DISCUSSION

Maternal anaemia represents a major health challenge, especially in developing nations. Despite advancements in prenatal care, anaemia continues to be prevalent and is linked with adverse outcomes such as spontaneous premature birth (SPTB), low birth weight, and placental insufficiency. This chapter presents a comprehensive evaluation of the radiological and clinical data obtained from 72 patients with confirmed anaemia at Tehsil Head Quarters Hospital Pattoki. We aim to explore the relationship between anaemia and premature birth, with a particular focus on the role of Doppler velocimetry in predicting fetal outcomes.

Over the past few decades, the prevalence of anaemia in pregnancy has declined globally. However, anaemia remains a common condition in many low-resource settings, including Pakistan. Iron deficiency anaemia, in particular, is known to affect maternal health, leading to complications such as premature birth (PTB) and small-for-gestational-age infants. The relationship between maternal anaemia and adverse pregnancy outcomes is complex, with various factors, including nutritional status, socioeconomic conditions, and access to healthcare, influencing the outcomes.

Doppler velocimetry is a widely used diagnostic tool to assess placental blood flow and fetal well-being. It provides critical information on fetal growth, placental insufficiency, and potential complications such as SGA infants. Abnormal Doppler findings, such as increased S/D ratios or reversed end-diastolic flow, are typically associated with placental insufficiency, which can compromise fetal oxygenation

and growth.

In this study, we aimed to evaluate the use of Doppler velocimetry in predicting outcomes in patients with anaemia during pregnancy. Contrary to previous studies linking anaemia to placental vascular insufficiency, our findings did not show an increased incidence of placental insufficiency in the study population. This discrepancy may warrant a reevaluation of the established understanding of iron deficiency anaemia's role in causing placental complications.

The study focused on second- and third-trimester patients, a period during which Doppler velocimetry is known to have significant predictive value for fetal outcomes. Early pregnancy may not be a critical time for assessing placental insufficiency through Doppler velocimetry, as the placenta may not be fully formed or functioning at optimal capacity. This could explain why our study did not find the same predictive correlation between anaemia and placental insufficiency observed in earlier research.Previous studies have reported a doubling of the risk for premature birth in anemic women during the second trimester. However, no such correlation was found in our cohort, which was largely composed of second- and third-trimester patients. Klebanoff et al. highlighted that anaemia in the second trimester increases the risk of premature birth, but this association is not as evident in the third trimester. Our findings corroborate this view, suggesting that iron deficiency anaemia may not have a direct causal relationship with premature birth in the later stages of pregnancy.

The findings of this study offer critical insights into the relationship between anaemia, placental perfusion, and umbilical paired artery Doppler parameters in pregnant women. The mean haemoglobin level of 10.29 g/dL indicates that most participants had mild anaemia, aligning with the global prevalence of anaemia in pregnancy, which affects approximately 41.8% of pregnant women (World Health Organization, 2021). The average BMI of 26.39 suggests a slightly overweight population, reflecting a trend increasingly seen in obstetric populations due to lifestyle changes. A significant majority of participants (65.3%) exhibited normal systolic/diastolic (S/D) ratios, indicating stable placental perfusion, in line with previous studies which established a normal S/D ratio as a sign of adequate fetal blood flow and oxygenation. The moderate and severe S/D ratios (26.4% and 8.3%, respectively) observed in the study may suggest early placental insufficiency, which is a recognized complication in pregnancies complicated by anaemia (Khalil et al.,

2020).Despite these findings, no significant association was found ($p > 0.05$) between haemoglobin levels and RI, S/D ratio, or PI, suggesting that anaemia may not directly affect umbilical paired artery hemodynamics in the majority of cases. Additionally, a high proportion of participants with normal RI also exhibited anaemia, supporting findings by Akingbola et al. (2006), which proposed that systemic factors like nutritional deficiencies, inflammation, or chronic conditions contribute to anaemia independent of vascular indices.The high incidence of anaemia, even among those with normal RI and S/D ratios, highlights the multifactorial nature of anaemia in pregnancy, with studies by Kalaivani (2009) and Stoltzfus et al. (2001) emphasizing the role of nutritional deficiencies and systemic inflammation, which may not directly influence umbilical paired artery hemodynamics. The moderate PI levels observed in the study suggest that placental compromise might develop even without overt vascular abnormalities, underscoring the importance of early screening and intervention, as advocated by Baschat et al. (2007).This study highlights the necessity of evaluating both systemic and placental factors in the management of anaemia during pregnancy. Doppler studies should be combined with biochemical markers such as serum ferritin and transferrin saturation, as well as clinical assessments, to provide a comprehensive understanding of pregnancy health. Overall, the findings contribute to the growing body of evidence on the impact of anaemia on placental perfusion, underscoring the importance of early and multifactorial screening. Future research should explore the underlying mechanisms linking anaemia with Doppler abnormalities and include larger, more diverse populations, along with longitudinal studies, to assess causal relationships and long-term neonatal outcomes.The socioeconomic status and nutritional intake of the study population were similar across both the study and control groups. These factors, often implicated in both anaemia and premature birth, could have acted as confounding variables. For example, inadequate nutrition or poor socioeconomic conditions may contribute to both iron deficiency anaemia and premature birth independently of anaemia itself. This suggests that other factors—such as poor maternal nutrition—might play a more significant role in premature birth and SGA infants than anaemia alone.The hypothesis that iron deficiency anaemia leads to fetoplacental vascular compromise does not seem to hold in our study population. The absence of a strong correlation between anaemia and placental insufficiency implies that iron deficiency anaemia may not be the primary

cause of SGA or premature birth. This finding challenges the current understanding that anaemia directly affects placental blood flow, and instead, suggests that other underlying factors, such as maternal health and nutrition, might be more critical.Our findings raise important questions regarding the role of iron deficiency anaemia in pregnancy complications. Although anaemia remains an important risk factor for maternal and fetal health, our study suggests that Doppler velocimetry, a common tool for assessing placental insufficiency, may not be reliable for diagnosing anaemia-related complications. It may be more useful in identifying other factors contributing to adverse outcomes.Moreover, the lack of a direct link between anaemia and premature birth in our study emphasizes the need for a multifactorial approach to assessing premature birth risk. Nutritional deficiencies, socioeconomic status, and underlying maternal conditions should be considered in conjunction with anaemia when evaluating pregnancy risk.This study challenges some of the established assumptions regarding the relationship between iron deficiency anaemia and placental insufficiency in pregnancy. Our findings suggest that while anaemia remains an important concern, its direct role in causing premature birth or SGA infants may be overstated. Other factors, such as maternal nutrition, socioeconomic status, and possible underlying pathologies, may play a more significant role in these adverse outcomes.Further studies, particularly those including severe anaemia cases, are needed to fully understand the complex interaction between anaemia and pregnancy complications. Additionally, expanding the use of Doppler velocimetry to provide more detailed assessments of placental and fetal health could enhance prenatal care, but it is unlikely that it can serve as a sole diagnostic tool for anaemia-related complications in pregnancy.In future research, it would be beneficial to include severe anaemia cases to evaluate the full spectrum of anaemia severity and its impacts on pregnancy.Investigate the role of other maternal conditions (e.g., hypertension, diabetes, and infections) that may interact with anaemia to affect pregnancy outcomes.Assess the long-term outcomes for infants born to anemic mothers, including developmental and cognitive outcomes, which could provide a more comprehensive understanding of anaemia’s effects.

CHAPTER 6

CONCLUSION

Anaemia during pregnancy continues to be a major global health issue, with significant implications for maternal and fetal health. While the association between anaemia and its adverse results is well-documented, the exact mechanisms through which anaemia affects fetal development remain poorly understood. The current study seeks to provide insights into the association between anaemia, Doppler velocimetry findings, and pregnancy effects, ultimately contributing to better understanding and management of anaemia during pregnancy. By exploring these factors, the study aims to advance our knowledge of how anaemia influences pregnancy and to improve the clinical tools available for monitoring and managing high-risk pregnancies.A haemoglobin concentration of < 6.0 gram/L is notably associated with significant alterations in fetal hemodynamics, underscoring the importance of early detection and management of anaemia during pregnancy. This method of assessment is crucial for identifying potential risks and ensuring timely interventions to minimize adverse outcomes for both mother and fetus. Regular and comprehensive monitoring with Doppler velocimetry, combined with appropriate clinical management, could ultimately improve fetal well-being and pregnancy outcomes in anemic cases.Future studies could involve a wider demographic, including those with varying degrees of anaemia severity, to further explore the relationship between Doppler indices and fetal outcomes.Long-term follow-up of these pregnancies may help to determine the lasting effects of anaemia and the early fetal circulatory adaptations on infant health, birth weight, and development.Investigating the combined use of Doppler velocimetry with other diagnostic approaches could provide a more comprehensive understanding of anaemia's impact on pregnancy and fetal development.By enhancing our understanding of the hemodynamic changes associated with anaemia and their clinical implications, we can improve management strategies for affected pregnancies and

prevent complications like premature birth or intrauterine growth restriction.

CHAPTER 6

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APPENDICES

ENGLISH CONSENT FORM

The study you are about to participate is a randomized control trial survey titled as;

"**Doppler Evaluation of Umbilical Artery Flow Pattern in Anemic Pregnant Women**"

The study has no potential harm to participants. All data collected from you will be coded in order to protect your identity, and should not be disclosed to anyone. Following the study there will be no way to connect your name with your data. Your answers to the questions will not affect the quality of education given to you. Any additional information about the study results will be provided to you at its conclusion, upon your request.

You are free to withdraw from the study at any time. You agree to participate, indicating that you have read and understood the nature of the study, and that all your inquiries concerning the activities have been answered to your satisfaction.

NAME **Faiza Haq Nawaz**
SIGNATURE_____

DATE_____

DEMOGRAPHICS FORM & QUESTIONNAIRES

/ Doppler Evaluation of Umbilical Artery Flow Pattern in Anemic Pregnant Women /

Patient History

Participant Information

1. MR No _____

2. Name _____

3. Age_____

5. BMI _____

Medical History

1. Are you currently taking any medications?

- Yes
- No

8. If yes, please list: _____

Sonographic Evaluation

1. Have you ever had a sonographic evaluation before?

- Yes
- No

2. Are you willing to undergo a sonographic evaluation as part of this study?

- Yes
- No

Data Collection Sheet (Single Patient)

Topic: "Doppler evaluation of umbilical artery flow pattern in anemic pregnant women"

MR. No _____

Name _____

Patient History				**Doppler Indices**			**Anemia**			
Sr.No	Age	BMI	Gestational Age	RI	S/D Ratio	PI	Control group	Mild	Moderate	Severe

Data collection sheet (Ten patients)

Topic: "Doppler evaluation of umbilical artery flow pattern in anemic pregnant women"

Patient History				**Doppler Indices**			**Anemia**			
Sr.No	Age	BMI	Gestational Age	RI	S/D Ratio	PI	Control group	Mild	Moderate	Severe
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										

PERMISSION LETTER

SUPERIOR UNIVERSITY

OFFICE OF THE DEAN-FAHS

Ref.: IRB /FAHS/Allied-HS/10/24/MS/RS-3571

Date: 29th October 2024

Name: Faiza Haq Nawaz (MS Allied Health Sciences)

Registration: SU91-MSAHW-S23-091

Subject: Ethical Approval Letter

The Research Ethical Committee convened on Dated: **17th October, 2024** to discuss your protocol titled "**Doppler evaluation of umbilical artery flow pattern in anemic pregnant women**"

No further corrections and recommendations were suggested. The above-mentioned protocol has been approved after considering various research issues including ethical concerns with condition that the researcher will submit completion report at the end of his/her research.

Prof. Dr. Muhammad Naveed Babur
Dean/Convener REC
Faculty of Allied Health Sciences
Superior University, Lahore

ETHICS COMMITTEE LETTER

OFFICE OF THE DEAN-FAHS

SUPERIOR UNIVERSITY

Ref.: IRB /FAHS/Allied-HS/10/24/MS/RS-3571

Date: 29th October 2024

Name: Faiza Haq Nawaz (MS Allied Health Sciences)

Registration: SU91-MSAHW-S23-091

Subject: Ethical Approval Letter

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Prof. Dr. Muhammad Naveed Babur
Dean/Convener REC
Faculty of Allied Health Sciences
Superior University, Lahore

PLAGIARISM REPORT