"ASSOCIATION OF ELEVATED SERUM FERRITIN LEVELS WITH GESTATIONAL DIABETES MELLITUS IN PREGNANCY AND RISK OF GESTATIONAL DIABETES MELLITUS: A CROSS SECTIONAL STUDY"

By

Dr LAKSHMI NALLA M.B.B.S

Dissertation Submitted to the

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR – 563 101

In partial fulfilment of the requirements for the degree of

MASTER OF SURGERY (MS)

In

OBSTETRICS AND GYNECOLOGY

Under the Guidance of

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"ASSOCIATION OF ELEVATED SERUM FERRITIN LEVELS WITH GESTATIONAL DIABETES MELLITUS IN PREGNANCY AND RISK OF GESTATIONAL DIABETES MELLITUS: A CROSS SECTIONAL STUDY" ABSTRACT Background "Gestational Diabetes Mellitus (GDM) is a condition marked by pregnancy related carbohydrate intolerance". Its incidence increasing globally due to factors like lifestyle changes, maternal age, and obesity, posing risks to both mother and baby, including perinatal complications. Identified risk factors encompass 'advanced maternal age', 'high body mass index' (BMI), a history of 'gestational diabetes mellitus' (GDM), a' family history of diabetes,' and ethnic predisposition. Despite extensive research on GDM, the role of serum ferritin levels as a predictive marker remains largely unexplored. Addressing this gap,Our study aims to explore the relationship between elevated serum ferritin levels and development of gestational diabetes mellitus (GDM). This research could support early interventions, improving maternal and neonatal outcomes and guiding preventive measures. Materials and Methods In proposed study at RLJH Hospital, pregnant women at 16-24 weeks gestation, meeting eligibility criteria, were enrolled after informed consent. Demographic, obstetric, medical history, and examinations were recorded during OPD visits, along with relevant investigations. All 94 mothers underwent Oral Glucose Challenge Test (OGCT) between 16-24 weeks, and among them 47 mothers with values >140 mg/dL were classified as GDM, and equal number of subjects with normal OGCT were regarded as Non-GDM group. Serum ferritin was measured via vitros 5600 autoanalyzer method. Serum ferritin levels were grouped into four quantiles (<30, 30-60, 60-90, >90 ng/dL), assessing their association with GDM occurrence. This comprehensive approach aimed to evaluate serum ferritin's relevance in GDM diagnosis and management. Results The study enrolled 94 pregnant women, undergoing OGCT, with 50% classified as GDM and 50% as non-GDM controls, age-matched. GDM mothers showed significantly higher OGCT levels (mean: 167.77 ± 13.83 mg/dL) compared to non-GDM (mean: 111.17 ± 15.93 mg/dL). Age distribution, BMI, gravidity, and gestational age revealed no significant differences between 2 groups. Family history of GDM, previous GDM incidence, and previous big baby were associated in the GDM group. Serum ferritin levels were significantly elevated in GDM mothers (mean: 77.19 ± 32.88 ng/mL) compared to non-GDM (mean: 48.43 ± 26.93 ng/mL), with a positive correlation to OGCT levels. Insulin therapy corresponded to the highest serum ferritin levels, followed by oral hypoglycemics, then medical nutrition therapy. Conclusion The study indicates a significant difference in serum ferritin levels between GDM and non-GDM groups, suggesting a potential association. Correlations were found between serum ferritin and OGCT levels, particularly in individuals with poor sugar control. Treatment mode influenced serum ferritin levels, with insulin therapy correlating to higher levels. These findings highlight serum ferritin's potential as a GDM biomarker, warranting further investigation for personalized prevention and treatment strategies. Keywords Serum Ferritin , Gestational Diabetes Mellitus, Correlation, Cross-Sectional Study INTRODUCTION INTRODUCTION "Gestational Diabetes Mellitus (GDM) is defined by impaired carbohydrate metabolism during pregnancy, and its incidence is increasing due to lifestyle changes,maternal age, and rising obesity levels".1 GDM poses significant risks for both the mother and baby, including perinatal mortality and morbidity. Understanding its underlying mechanisms and identifying predictive markers is vital for early intervention and prevention of complications.2 The worldwide prevalence of GDM is increasing, reflecting the trends in obesity and maternal age.3 Risk factors include being over 35 years old, having a BMI over 30 kg/m², a previous history of GDM, a family history of diabetes, and certain ethnic backgrounds, particularly Indian ethnicity and PCOS. GDM significantly impacts maternal and neonatal health, making early detection and management crucial.4,5 Research has explored the links between GDM and factors like obesity and family diabetes history, but knowledge about the role of serum ferritin levels as a predictive marker for GDM is limited. Although iron overload and oxidative stress are linked to type 2 diabetes, few studies have investigated the connection between serum ferritin levels and GDM.6,7 This gap highlights the need for further research into serum ferritin as an early indicator of GDM. This study aims to address this gap by investigating the relationship between elevated maternal serum ferritin levels and the development of GDM. Given the association between 'iron overload', 'oxidative stress', and 'insulin resistance', exploring serum ferritin levels as predictor for GDM is clinically relevant.8 Early identification of women at risk through serum ferritin levels could help us in timely interventions, reducing complications and improving outcomes for both mother and child.9 Effective screening strategies are essential for early detection of GDM, as it often remains undetected until complications arise. Incorporating serum ferritin levels into current screening protocols could enhance accuracy of GDM diagnosis and facilitate tailored interventions. Investigating the link between serum ferritin levels and GDM pathogenesis can aid in developing targeted preventive strategies, potentially reducing GDM-related morbidity and mortality.10 In conclusion, investigating correlation between maternal serum ferritin levels and GDM development is a important step towards enhancing prenatal care and mitigating the adverse outcomes associated with GDM. By clarifying this relationship,study aims to provide valuable information that can guide clinical practice and tell us preventive interventions, enhancing maternal and neonatal health outcomes. OBJECTIVES OBJECTIVES OF THE STUDY Objectives To determine serum ferritin levels in GDM patients To determine serum ferritin levels in patients without GDM To compare association of serum ferritin levels with GDM and without GDM patients REVIEW OF LITERATURE REVIEW OF LITERATURE GESTATIONAL DIABETES MELLITUS According to the (WHO) World Health Organization and (ACOG) American College of Obstetricians and Gynecologists "Gestational Diabetes Mellitus (GDM) is characterized by any degree of glucose intolerance that either starts or is first detected during pregnancy".11 This condition includes women whose glucose tolerance returns to normal after pregnancy, as well as those who continue to experience glucose intolerance and are at risk of developing type 2 diabetes later on.12 HISTORY Gestational Diabetes Mellitus (GDM) is closely linked with the broader evolution of diabetes diagnosis and management. The concept of GDM has come to picture in the 20th century as medical professionals started to recognize that pregnancy could trigger a form of glucose intolerance.1 In 1950s, Dr. Jørgen Pedersen's work in Denmark contributed to understanding of carbohydrate metabolism during pregnancy significantly.It said that pregnancy induced hormones might cause '" insulin resistance", leading to elevated blood glucose levels.This study laid groundwork for distinguishing GDM from other forms of diabete.13 Initial diagnostic criteria for Gestational Diabetes Mellitus (GDM) were formulated in 1960's by Dr. John O'Sullivan with his team at Boston City Hospital conducted research that resulted in adoption of the oral glucose tolerance test (OGTT) for diagnosis.Findings showed women who experienced hyperglycemia during pregnancy were more likely to develop diabetes later, and their infants had a higher risk of 'macrosomia' and 'neonatal hypoglycemia'.14 Various studies formalized diagnostic criteria for GDM. These criteria later refined by the World Health Organization (WHO) and American College of Obstetricians and Gynecologists (ACOG), both of their findings underscore importance of early diagnosis and management to prevent

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ACOG	American College of Obstetricians and Gynecologists
ARDS	Acute Respiratory Distress Syndrome
BMI	Body Mass Index
CRP	C-Reactive Protein
DIPSI	Diabetes in Pregnancy Study Group India
FBS	Fasting Blood Sugar
GDM	Gestational Diabetes Mellitus
GFR	Glomerular Filtration Rate
HbA1c	Glycated Hemoglobin
HDL	High Density Lipoprotein
IL-6	Interleukin-6
IUD	Intrauterine Death
IUGR	Intrauterine Growth Restriction
MNT	Medical Nutrition Therapy
NAFLD	Non-Alcoholic Fatty Liver Disease
NDDG	National Diabetes Data Group
NST	Non-Stress Tests
OGCT	Oral Glucose Challenge Test
OGTT	Oral Glucose Tolerance Test
OHAs	Oral Hypoglycemic Agents
OR	Odds Ratio
PCOS	Polycystic Ovarian Syndrome

PPBS	Postprandial Blood Sugar
RBS	Random Blood Glucose
RDS	Respiratory Distress Syndrome
RIA	Radioimmunoassay
SLE	Systemic Lupus Erythematosus
TNF-α	Tumor Necrosis Factor-Alpha
WHO	World Health Organization

"ASSOCIATION OF ELEVATED SERUM FERRITIN LEVELS WITH GESTATIONAL DIABETES MELLITUS IN PREGNANCY AND RISK OF GESTATIONAL DIABETES MELLITUS: A CROSS SECTIONAL STUDY"

ABSTRACT

BACKGROUND: "Gestational Diabetes Mellitus (GDM) is a condition marked by pregnancy related carbohydrate intolerance". Its incidence increasing globally due to factors like lifestyle changes, maternal age, and obesity, posing risks to both mother and baby, including perinatal complications. Identified risk factors encompass 'advanced maternal age', 'high body mass index' (BMI), a history of 'gestational diabetes mellitus' (GDM), a' family history of diabetes,' and ethnic predisposition. Despite extensive research on GDM, the role of serum ferritin levels as a predictive marker remains largely unexplored. Addressing this gap,Our study aims to explore the relationship between elevated serum ferritin levels and development of gestational diabetes mellitus (GDM). This research could support early interventions, improving maternal and neonatal outcomes and guiding preventive measures.

MATERIALS AND METHODS: In proposed study at RLJH Hospital, pregnant women at 16-24 weeks gestation, meeting eligibility criteria, were enrolled after informed consent. Demographic, obstetric, medical history, and examinations were recorded during OPD visits, along with relevant investigations. All 94 mothers underwent Oral Glucose Challenge Test (OGCT) between 16-24 weeks, and among them 47 mothers with values >140 mg/dL were classified as GDM, and equal number of subjects with normal OGCT were regarded as Non-GDM group. Serum ferritin was measured via vitros 5600 autoanalyzer method. Serum ferritin levels were grouped into four quintiles (<30, 30-60, 60-90, >90 ng/dL), assessing their association with GDM

occurrence. This comprehensive approach aimed to evaluate serum ferritin's relevance in GDM diagnosis and management.

RESULTS: The study enrolled 94 pregnant women, undergoing OGCT, with 50% classified as GDM and 50% as non-GDM controls, age-matched. GDM mothers showed significantly higher OGCT levels (mean: 167.77 ± 13.83 mg/dL) compared to non-GDM (mean: 111.17 ± 15.93 mg/dL). Age distribution, BMI, gravidity, and gestational age revealed no significant differences between 2 groups. Family history of GDM, previous GDM incidence, and previous big baby were associated in the GDM group. Serum ferritin levels were significantly elevated in GDM mothers (mean: 77.19 ± 32.88 ng/mL) compared to non-GDM (mean: 48.43 ± 26.93 ng/mL), with a positive correlation to OGCT levels. Insulin therapy corresponded to the highest serum ferritin levels, followed by oral hypoglycemics, then medical nutrition therapy.

CONCLUSION: The study indicates a significant difference in serum ferritin levels between GDM and non-GDM groups, suggesting a potential association. Correlations were found between serum ferritin and OGCT levels, particularly in individuals with poor sugar control.Treatment mode influenced serum ferritin levels, with insulin therapy correlating to higher levels. These findings highlight serum ferritin's potential as a GDM biomarker, warranting further investigation for personalized prevention and treatment strategies.

Keywords

Serum Ferritin, Gestational Diabetes Mellitus, Correlation, Cross Sectional Study

INTRODUCTION

INTRODUCTION

"Gestational Diabetes Mellitus (GDM) is defined by impaired carbohydrate metabolism during pregnancy, and its incidence is increasing due to lifestyle changes,maternal age, and rising obesity levels".[1] GDM poses significant risks for both the mother and baby, including perinatal mortality and morbidity. Understanding its underlying mechanisms and identifying predictive markers is vital for early intervention and prevention of complications.[2]

The worldwide prevalence of GDM is increasing, reflecting the trends in obesity and maternal age.[3] Risk factors include being over 35 years old, having a BMI over 30 kg/m², a previous history of GDM, a family history of diabetes, and certain ethnic backgrounds, particularly Indian ethnicity and PCOS. GDM significantly impacts maternal and neonatal health, making early detection and management crucial.[4,5]

Research has explored the links between GDM and factors like obesity and family diabetes history, but Knowledge about the role of serum ferritin levels as a predictive marker for GDM is limited. Although iron overload and oxidative stress are linked to type 2 diabetes, few studies have investigated the connection between serum ferritin levels and GDM.[6,7] This gap highlights the need for further research into serum ferritin as an early indicator of GDM.

This study aims to address this gap by investigating the relationship between elevated maternal serum ferritin levels and the development of GDM. Given the association between 'iron overload', 'oxidative stress', and 'insulin resistance', exploring serum ferritin levels as predictor for GDM is clinically relevant.[8] Early identification of women at risk through serum ferritin levels could help us in timely interventions, reducing complications and improving outcomes for both mother and child.[9] Effective screening strategies are essential for early detection of GDM, as it often remains undetected until complications arise. Incorporating serum ferritin levels into current screening protocols could enhance accuracy of GDM diagnosis and facilitate tailored interventions. Investigating the link between serum ferritin levels and GDM

pathogenesis can aid in developing targeted preventive strategies, potentially reducing GDM-related morbidity and mortality.[10]

In conclusion, investigating correlation between maternal serum ferritin levels and GDM development is a important step towards enhancing prenatal care and mitigating the adverse outcomes associated with GDM. By clarifying this relationship,Study aims to provide valuable information that can guide clinical practice and tell us preventive interventions, enhancing maternal and neonatal health outcomes.

OBJECTIVES OF

THE STUDY

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- To determine serum ferritin levels in GDM patients
- To determine serum ferritin levels in patients without GDM
- To compare association of serum ferritin levels with GDM and without GDM patients

REVIEW OF LITERATURE

REVIEW OF LITERATURE

GESTATIONAL DIABETES MELLITUS

According to the (WHO) World Health Organization and (ACOG) American College of Obstetricians and Gynecologists "Gestational Diabetes Mellitus (GDM) is characterized by any degree of glucose intolerance that either starts or is first detected during pregnancy".[11] This condition includes women whose glucose tolerance returns to normal after pregnancy, as well as those who continue to experience glucose intolerance and are at risk of developing type 2 diabetes later on.[12]

HISTORY

Gestational Diabetes Mellitus (GDM) is closely linked with the broader evolution of diabetes diagnosis and management. The concept of GDM has come to picture in the 20th century as medical professionals started to recognize that pregnancy could trigger a form of glucose intolerance.[1]

In 1950s, Dr. Jørgen Pedersen's work in Denmark contributed to understanding of carbohydrate metabolism during pregnancy significantly.It said that pregnancy induced hormones might cause´" insulin resistance", leading to elevated blood glucose levels.This study laid groundwork for distinguishing GDM from other forms of diabetes.[13]

Initial diagnostic criteria for Gestational Diabetes Mellitus (GDM) were formulated in 1960's by Dr. John O'Sullivan with his team at Boston City Hospital conducted research that resulted in adoption of the oral glucose tolerance test (OGTT) for diagnosis.Findings showed women who experienced hyperglycemia during pregnancy were more likely to develop diabetes later, and their infants had a higher risk of 'macrosomia' and 'neonatal hypoglycemia'.[14]

Various studies formalized diagnostic criteria for GDM. These criteria later refined by the World Health Organization (WHO) and American College of Obstetricians and

Gynecologists (ACOG), both of their findings underscore importance of early diagnosis and management to prevent adverse complications.[11]

Advancements in medical technology helps us in understanding of GDM and knowing about pathophysiology have improved diagnostic accuracy and treatment options over decades.Research continues to investigate 'genetic', 'environmental', and 'lifestyle factors' contributing to GDM, aiming to enhance preventive strategies and therapeutic interventions.

EPIDEMIOLOGY

Prevalence of GDM varies significantly globally which is ranging from less than 1% to 28%, depending on factors such as 'diagnostic criteria' and 'population demographics'. It is estimated to complicate 5-14% of pregnancies in high-income countries.[15]

India faces particularly high burden. Studies report a national prevalence of GDM between 10% and 16%, with some regions exceeding 20%. This high prevalence is attributed to factors like rising obesity rates, sedentary lifestyles, and a growing population with a genetic predisposition for diabetes.[16]

ETIOLOGY [17,18]

The etiology of gestational diabetes appears to be associated with several key factors. One major cause is the dysfunction or delayed response of pancreatic beta cells to glucose levels.. Additionally, significant insulin resistance(IR) occurs due to the release of placental hormones, with human placental lactogen(Hpl) being the primary hormone linked to this increased resistance in GDM. Other hormones, such as growth hormone, prolactin, corticotropin-releasing hormone, and progesterone, also play roles in promoting insulin resistance and hyperglycemia during pregnancy.

The risk factors responsible for GDM include elevated body mass index (BMI) over 25, and reduced physical activity levels. A family history of (type 2 DM), especially in first-degree relatives, increases the risk, as does a previous history of GDM or

delivering a baby with macrosomia. Metabolic conditions like hypertension, low levels of high-density lipoprotein, triglycerides exceeding 250 mg/dl, and polycystic ovarian syndrome are also contributing factors. Additionally, a glycated hemoglobin level above 5.7, an abnormal OGTT, and markers of insulin resistance such as acanthosis nigricans are significant indicators. A history of cardiovascular diseases further increases the likelihood of developing gestational diabetes mellitus.

CARBOHYDRATE METABOLISM DURING PREGNANCY [19,20]

During pregnancy, carbohydrate metabolism undergoes significant adaptations to meet the heightened energy demands of both the mother and the developing fetus. These are orchestrated by hormonal fluctuations and alterations in maternal physiology to ensure an adequate supply of glucose to support fetal growth and maternal metabolism.

key hormone required in regulating carbohydrate metabolism during pregnancy is insulin. Insulin sensitivity generally decreases during pregnancy, particularly in 2nd and 3rd trimesters, due to hormonal influences such as elevated levels of estrogen,progesterone,human placental lactogen, and cortisol.Decreased sensitivity results in a state of insulin resistance, facilitating the efficient transfer of sugars to fetus while maintaining maternal blood sugar levels.

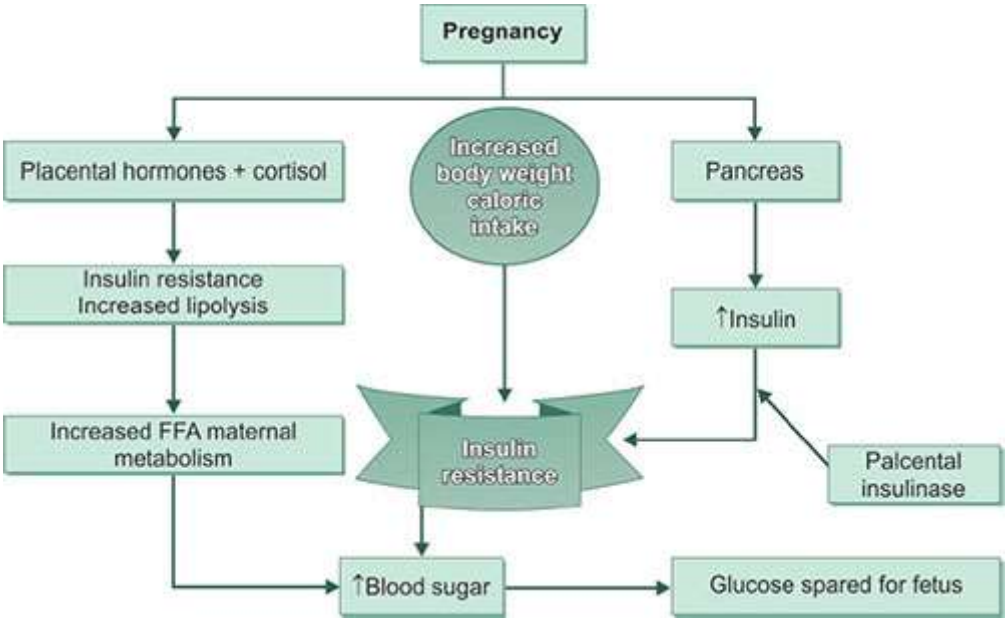

Figure 1: Carbohydrate metabolism in pregnancy [21]

The placenta plays a major role in transporting nutrients, including glucose, from the maternal to fetal circulation. It produces hormones such as(hPL,) which antagonize insulin's action, further contributing to insulin resistance. This mechanism ensures a steady supply of glucose to fetus for growth and development.

Maternal glycogen stores also undergo changes during pregnancy. Early in gestation, glycogen stores are built up primarily in the liver to meet increased energy demands later in pregnancy. As pregnancy progresses, these stores are gradually depleted, especially during fasting periods such as overnight or between meals, to ensure a continuous supply of glucose to fetus.

The adaptations in carbohydrate metabolism during pregnancy are refined to meet the energy needs of mother and fetus. Understanding these changes is important for improving maternal health and promoting optimal fetal development.

PATHOPHYSIOLOGY [22,23]

The pathophysiology of Gestational Diabetes Mellitus reflects the distinct physiological adaptations occurring during pregnancy, leading to "diabetogenic state" marked by gradually escalating insulin resistance.

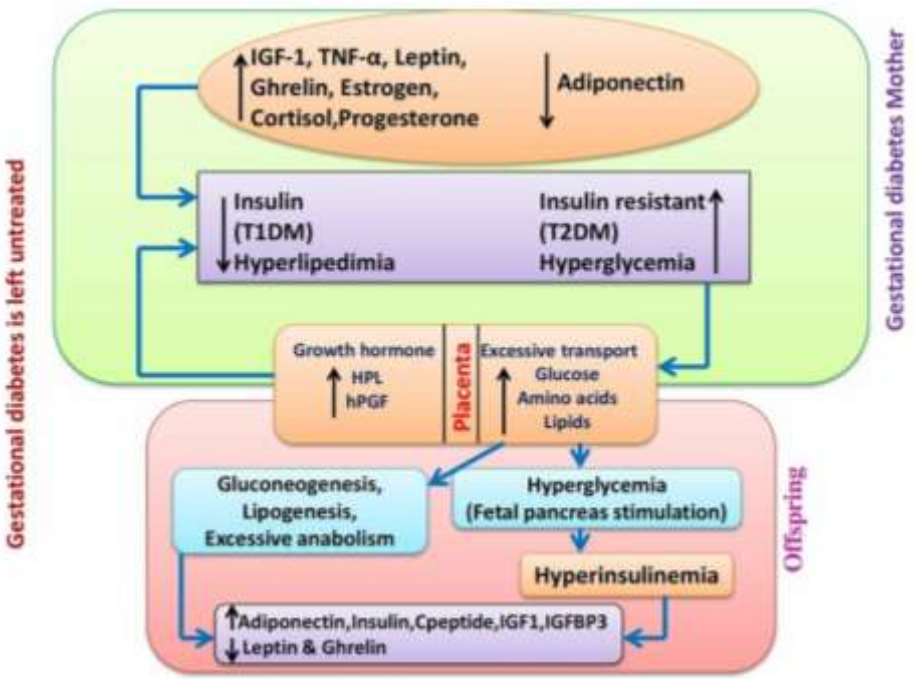

Figure 2: Pathophysiology of GDM [24]

Insulin Resistance

During pregnancy, several hormones contribute to heightened insulin resistance. Human placental lactogen, estrogen, progesterone, and cortisol possess “anti insulin properties”. Furthermore, prolactin, tumor necrosis factor-alpha, C-reactive protein, and interleukins further exacerbate “ insulin resistance”. The kidneys and placenta also enhance insulin degradation through the action of insulinase, reducing circulating insulin levels and increasing resistance.

Increased Lipolysis

To prioritize glucose availability for the fetus, the mother's body undergoes increased lipolysis, utilizing fatty acids to meet her caloric needs. This glucose-sparing mechanism ensures that the fetus receives adequate glucose, a critical energy source for development.

Gluconeogenesis Changes

Pregnancy alters gluconeogenesis, where major ‘gluconeogenic’ substrates like ‘alanine and other amino acid’s are preferentially used by the fetus. This process leads to an "accelerated starvation" state, where maternal amino acids and free fatty acids are utilized as substrates for glucose production, causing mild ketosis in the mother.

Increased Postprandial Glucose Levels

Postprandial glucose levels rise due to increased insulin resistance, lack of glucagon inhibition, and elevated placental diabetogenic hormones. This combination leads to a ‘diabetogenic state’ during pregnancy, as the body struggles to regulate glucose levels effectively.

Fasting Hypoglycemia

The continuous glucose consumption by the fetus, irrespective of the mother's glucose levels, can lead to a tendency for fasting hypoglycemia in the mother. The fetus's unrelenting demand for glucose ensures a constant drain on maternal glucose stores, even in fasting states.

Increased Hepatic Glucose Output

To compensate for the increased glucose demand by the fetus, the mother's liver ramps up glucose production, contributing to higher blood glucose levels.

Exaggerated Insulin secretion

Due to elevated glucose levels, there is an exaggerated insulin secretion, especially in the 2nd and 3rd trimesters. Initially, early pregnancy is marked by Insulin sensitivity, but as gestation advances, insulin resistance intensifies, peaking around 34-36 weeks. Basal and postprandial insulin secretion nearly doubles compared to non-pregnant levels to accommodate the growing glucose requirements of the fetus.

Overall, the interplay of hormonal changes, increased insulin resistance, and the fetus's glucose needs collectively shape the pathophysiology of GDM, underscoring the need for careful monitoring and management during pregnancy to ensure optimal maternal and fetal health.

FETAL GLUCOSE HOMEOSTASIS

Fetal glucose homeostasis is crucial for proper fetal development, with glucose entering the placenta via facilitated transport to ensure maternal and fetal glucose levels are closely aligned, typically within 10 mg/dl of each other. Maternal insulin cannot cross the placenta, so the fetus starts producing its own Insulin from the late 1st trimester, which is more important for growth than for blood sugar regulation.[25]

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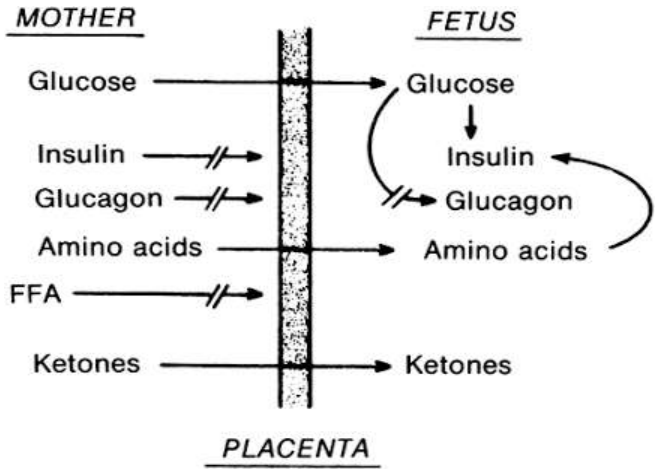

Figure 3: Fetal glucose homeostasis [26]

When maternal blood glucose levels exceed 200 mg/dl, transport of glucose to the fetus is inhibited as a protective measure. In response, the fetal pancreas increases insulin secretion to manage glucose levels independently of maternal fluctuations.

Pederson's "Hyperglycemic Hyperinsulinemia" theory describes - impact of maternal hyperglycemia on the fetus. Maternal hyperglycemia causes fetal hyperglycemia, prompting the secretion of insulin via pancreas through hypertrophy of beta cells of pancreas, leading to fetal hyperinsulinemia. This disease increases chances of delivery trauma, intra partum hypoxia, polycythemia, and respiratory distress in the baby due to greater fat deposition (macrosomia), higher erythropoietin production, and decreased surfactant production.[27]

EFFECT OF DIABETES ON THE MOTHER

Insulin resistance and normal or raised insulin levels are two characteristics of type 2 diabetes mellitus that are shared by GDM Diabetogenic hormones increased in pregnancy, can exacerbate the diabetic state, worsening an existing condition or triggering diabetes in previously undiagnosed cases. After delivery, some women may revert to normal glucose levels, while others may continue to experience glucose intolerance.[28]

Unlike type 2 diabetes, GDM typically does not increase the risk of congenital malformations, spontaneous miscarraige, nephropathy, or retinopathies. However,

pregnancy issues like preeclampsia, hydramnios, premature birth, and stillbirth are more common in women with GDM, hence close prenatal care and monitoring are essential.

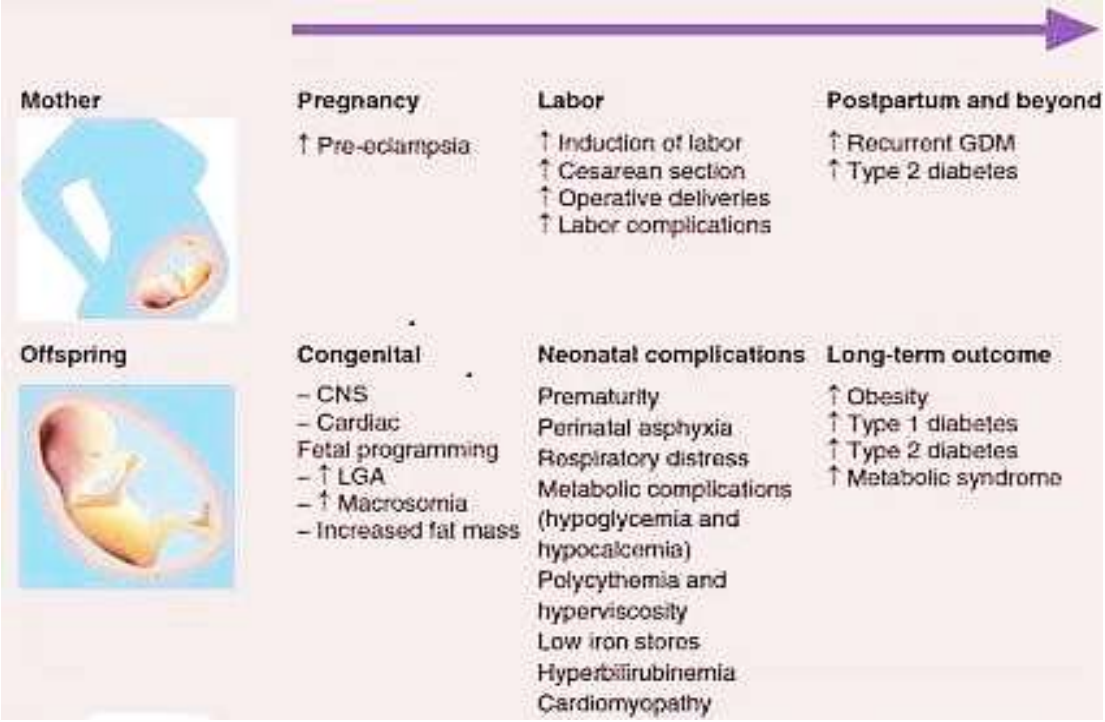

Figure 4: Effect of diabetes on mother and fetus [29]

Maternal hyperglycemia during pregnancy is a significant predictor of type 2 diabetes in future. A systematic review highlighted the progression of this risk.[28]

Cumulative incidence of type 2 Diabetes Mellitus

The risk of developing type 2 diabetes markedly elevated within the first five years following a GDM-affected pregnancy.

Plateau phase

After the initial five-year period, the incidence rate tends to plateau over the next ten years.

Fasting hyperglycemia

Elevated fasting blood sugar levels during pregnancy are a strong determinant of developing type 2 diabetes risk.

EFFECT OF DIABETES ON FETUS [30,31]

The effect of gestational diabetes mellitus on fetus is heavily influenced by the mother's glycemic control. Poorly managed GDM is related with several adverse events like perinatal death, morbidity, birth injuries, preterm births, macrosomia, and preeclampsia.

Macrosomia

Macrosomia, characterized by a birth weight above the 90th percentile or more than two standard deviations for gestational age, is a common outcome of poorly managed diabetes during pregnancy. These newborns often appear edematous and bloated, similar to postmature infants. This condition serves as an indicator of diabetic pregnancy outcomes, excluding cases influenced by high maternal BMI or ethnic factors. A significant correlation exists between macrosomia and maternal fasting blood glucose levels. Effective control of glucose levels can reduce the occurance of macrosomia, which is associated with a higher risk of intrauterine fetal demise. Early-onset GDM further increases the risk of perinatal and intrapartum complications.

Stillbirth

Maternal fasting hyperglycemia, especially with fasting glucose levels exceeding 105 mg/dl in the final 4 to 8 weeks of gestation, is linked to an increased chances of stillbirth. There is a positive correlation between mean glucose levels and stillbirth rates. Maternal hyperglycemia-induced fetal hyperinsulinemia results in chronic hypoxia, which increases oxygen demand and decreases arterial oxygenation, hence inducing the production of erythropoietin. Elevated erythropoietin levels in amniotic fluid indicate chronic hypoxia. Research by Russell et al. has demonstrated cardiac dysfunction and myocardial ischemia in fetuses, indicated by elevated levels of troponin-T in cord blood are linked to stillbirth.

Preterm Labor

A large cohort study by Hedderson et al., involving 46 thousand women screened for GDM at 24-28 weeks, found a 70% higher risk of preterm birth in those testing positive for GDM, independent of other preterm labor causes.

Spontaneous Abortions and Congenital Malformations

Pre-diabetic women face a higher risk of spontaneous abortions and congenital malformations compared to those with GDM . HbA1c levels at conception and during organogenesis are correlated with this risk, with levels below 6.5% deemed safe, while levels above 9.5% present a 28% risk. Common congenital malformations include cardiac anamolies and neural tube defects.

EFFECT OF DIABETES ON THE NEONATES [32,33]

Diabetes in pregnancy significantly affects neonatal outcomes, manifesting in a range of complications.

Neonatal Hypoglycemia

Neonatal hypoglycemia, affecting 30-50% of infants born to diabetic mothers, results from fetal hyperinsulinemia, leading to low blood sugar levels (< 30- 40mg/dl) within the first 12 hours postpartum. Preterm infants are particularly vulnerable, but good maternal glycemic control in the last trimester can reduce this risk.

Neonatal Hyperbilirubinemia

Neonatal hyperbilirubinemia usually appears on the second day post-birth and is closely linked to maternal glucose levels during pregnancy. Factors such as prematurity, an immature bilirubin conjugation system, and birth trauma contribute to its occurrence. Maintaining good glycemic control during pregnancy helps lower the incidence of hyperbilirubinemia.

Respiratory Distress Syndrome (RDS)

Inadequate glycemic control can delay lung maturity, increasing the risk of RDS. This risk reduces if the exceeds extends to 38 weeks. Administering corticosteroids with careful blood glucose monitoring can minimize the risk.

Neonatal Hypocalcemia and Hypomagnesemia

Neonatal hypocalcaemia, defined as serum calcium levels < 8 mg/dl in term infants and < 7 mg/dl in preterm infants, stems from neonatal hypoparathyroidism. It affects 7% of babies born to diabetes moms and usually manifests a few hours after birth, more often in preterm and infants with asphyxia.Hypocalcemia and hypomagnesemia frequently coexist in poorly managed diabetics because of increased renal losses.

Polycythemia

Polycythemia, defined by venous hematocrit levels above 65%, is driven by tissue hypoxia. The increased blood viscosity can lead to vascular sludging, poor circulation, and microthrombi, posing risks of infarction in vital organs.

Long-Term Complications

Neonates of diabetic mothers face long-term risks, including neurodevelopmental abnormalities such as cognitive defects and autism. Furthermore, these kids have a higher chance of growing up with metabolic syndrome and type 2 diabetes mellitus.

DIAGNOSIS

Early diagnosis of gestational diabetes mellitus (GDM) is necessary for identifying fetuses at risk of complications and women who may develop diabetes later. GDM may go unnoticed throughout pregnancy unless complications emerge, highlighting the need for effective screening to detect the condition early.

The debate continues on whether selective or universal screening for GDM is more effective. The ADA's 4th international workshop on GDM in 1977 advocated for selective screening, categorizing women into low and high-risk groups.Women with low-risk were under 25, had no family history of diabetes, a normal BMI, and did not belong to high-risk ethnic groups.[34]

However, this selective screening approach is unsuitable for Indian women, who belong to a high-risk ethnic group with greater prevalence of type 2 diabetes. Consequently, universal screening is recommended for Indian women.

Limitations of Screening Methods

Several common tests have limitations when used for GDM screening;

Random blood glucose (RBS), HbA1c, and serum fructosamine

Poor screening tests for Gestational Diabetes Mellitus.

Fasting glucose testing

False positive rates are high at set cut-off levels.

Normal fasting and postprandial blood sugar (FBS and PPBS) levels

Some women may still have an exaggerated response to Oral glucose challenge.

Milder forms of GDM

May be missed if OGCT are not conducted.

ACOG Recommendations [35]

The American College of Obstetricians and Gynecologists (ACOG) recommends universal screening involving;
Patient history and clinical risk factors assessment
Random blood glucose test at the booking visit
Oral glucose challenge test between 24-28 weeks during pregnancy

GDM is diagnosed based on a 100 g 3-hour oral glucose tolerance test if two or more values are positive.

Two-Step Approach for Screening [36]

ACOG endorses a two-step approach;

Step 1: A 50g oral glucose challenge test (O'Sullivan test). Blood glucose is measured one hour later. Sensitivity varies with the cut-off value;
130 mg/dl: 90% sensitivity
140 mg/dl: 80% sensitivity, reducing unnecessary OGTTs.

Step 2: If the OGCT is positive, confirm with a 100g 3-hour OGTT. GDM is diagnosed if two or more values exceed the following thresholds;
Fasting >95 mg/dl
1-hour >180 mg/dl
2-hour >155 mg/dl
3-hour >140 mg/dl

One-Step Approach [37]

To improve sensitivity and simplify testing, the ADA and IADPSG recommend a one-step diagnostic 75g 2-hour OGTT based on the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study:
Fasting >92 mg/dl
1-hour >180 mg/dl
2-hour >153 mg/dl

These cut-offs are lower than traditional values, aiming to detect complications at lower glucose levels.

Diabetes in Pregnancy Study Group India (DIPSI) [38]

In India, the Diabetes in Pregnancy Study Group India (DIPSI) recommends a single-step procedure during antenatal visits for GDM screening. Women receive 75g of glucose regardless of fasting status, and blood glucose levels are checked two hours

later. A result of ≥140 mg/dl indicates GDM. This method is endorsed by the WHO,Ministry of Health, Government of India.

Advantages of the DIPSI method include;

No overnight fasting required

Can be administered at the initial visit

Functions as both a screening and diagnostic tool

Can be repeated in the 2nd and 3rd trimesters

OGTT Protocol [39]

A traditional OGTT involves;

Conducting the test during morning atleast 8-12hours of fasting

An nonrestricted diet with at least 150g of carbohydrates per day

Avoiding physical activity restrictions and smoking during the test

The test uses 100 g of glucose, with blood drawn at hourly intervals, and the following cut-offs for diagnosing GDM;

Fasting > 95 mg/dl

1-hour >180 mg/dl

2-hour > 155 mg/dl

3-hour > 144 mg/dl

Urinary Glucose Test [40]

Physiological glycosuria results from elevated glomerular filtration rate during pregnancy, causing around 50% of women to have glucose in their urine at some point. Although it has low sensitivity (10%) and positive predictive value (20%), significant glycosuria (2+ or above) may indicate undiagnosed GDM and warrants further testing.

Effective screening along with early diagnosis of GDM are essential for reducing pregnancy adverse events and long-term maternal health risks. Universal screening, particularly in high-risk populations, and reliable diagnostic methods like the one-step OGTT or the DIPSI protocol, are vital for improving outcomes for both mother and child. Regular monitoring and appropriate management strategies can mitigate the adverse effects of GDM, ensuring healthier pregnancies and reducing the risk of later mothers developing diabetes

MANAGEMENT

Effective management of gestational diabetes mellitus is crucial to avoid complications for both mother and baby and to enhance their quality of life. The ACHOIS study by Crowther et al. (2005) underscores the importance of controlling blood glucose levels to achieve these outcomes.[41]

For women with GDM, daily blood glucose self-monitoring is essential, allowing timely adjustments to treatment plans to maintain recommended glucose levels. Regular ultrasounds are also important to detect macrosomia, where the fetus grows excessively large, complicating delivery.

The primary treatment involves lifestyle changes and Medical Nutrition Therapy (MNT). Dietary modifications and regular exercise can effectively manage blood glucose. Maintaining postprandial blood glucose is particularly crucial, as highlighted by the Study on Diabetes in Early Pregnancy by Boyd et al., which found third-trimester postprandial blood sugar levels are strong predictors of birth weight.[42]

If lifestyle adjustments and MNT are insufficient, insulin therapy is started. Insulin dosage should be based on postprandial blood sugar levels to better prevent complications, as suggested by Jovanovic et al.[43]

Avoiding hypoglycemia is essential, as it poses risks to both mother and fetus. Bi-weekly non-stress tests (NST) and ultrasound Doppler assessments are recommended to monitor fetal well-being and detect complications early.

Regular follow-up is important as women with GDM have a higher risk of ending in type 2 diabetes. A repeat OGTT is recommended two to four months after delivery to check for persistent glucose intolerance. Low-dose contraceptive pills can be recommended for family planning post-delivery.

The ACOG recommend maintaining preprandial glucose below 95mg/dl, 1-hour PPBS below 14mg/dl, and 2-hour postprandial glucose below 120mg/dl. Jovanovic et al.

suggest stricter targets: fasting glucose below 90mg/dl and postprandial glucose below 120mg/dl to prevent complications.[44]

Studies indicate that women with GDM and a mean blood glucose level of 87 mg/dl experienced higher rates of intrauterine growth restriction, while those with levels of 104 mg/dl had increased rates of large-for-gestational-age infants. This highlights the importance of controlling hyperglycemia without overtreatment, which can negatively impact fetal growth.[45]

A. MEDICAL NUTRITION THERAPY [46]

Medical Nutrition Therapy (MNT) plays a crucial role in managing gestational diabetes mellitus by improving the nutritional status of both the mother and the fetus while maintaining normoglycemia and preventing complications such as ketoacidosis.

Figure 5: Diet for GDM [47]

Nutritional Goals

The primary aim of MNT is to optimize the nutritional requirement of both the mother and the fetus. It helps in ensuring required weight gain during pregnancy while preventing excessive weight gain, which is often associated with GDM.

Caloric Intake

During the second and third trimesters of pregnancy, an additional 300 kilocalories per day are recommended. For GDM women with normal weight, a calorie intake of 30kcal/kg/day is advised. However, for obese women (BMI >30 kg/m2), a calorie restriction of approximately 33% of their estimated energy needs (around 25 kcal/kg/day) is recommended to prevent excessive weight gain without causing ketonuria.

Ketosis Monitoring

Careful monitoring of ketosis is essential, especially in GDM women undergoing calorie restriction. Ketonemia during pregnancy has been associated with long-term complications including poor psychomotor skills and low IQ in children. Pre-breakfast ketone levels should be measured in patients following low-calorie or carbohydrate-restricted diets.

Carbohydrate Management

GDM women are advised to consume low glycemic index foods and to distribute carbohydrate intake evenly throughout the dayIt is recommended to consume three small- to medium-sized meals and three snacks per day, with the goal of limiting carbohydrate intake to 40% of the total daily calorie requirement. Additionally, restricting carbohydrate intake at breakfast to 33% helps in managing postprandial glucose levels effectively, especially considering the high insulin resistance in the morning.

Individualized Approach

MNT for GDM should be tailored to each patient's specific nutritional needs, taking into account factors such as weight, metabolic status, and dietary preferences. Regular monitoring and adjustments to the meal plan may be necessary throughout pregnancy to maintain optimal glycemic control and ensure the well-being of both the mother and the fetus.

B. EXERCISE

Exercise is a cornerstone in the management of gestational diabetes mellitus (GDM). NICE 2015 recommends 30 minutes of brisk exercise daily. Research by Mottola MF found that GDM women who incorporated exercise into their management alongside diet experienced significant improvements.[48] In a randomized controlled trial, the diet along with exercise group showed a notable reduction in HbA1c levels, as well as reductions in fasting and post 1-hour glucose levels during oral glucose challenge tests compared to the diet-alone group over 6 weeks.[49] These findings highlight the importance of regular physical activity as an effective adjunct to dietary measures in controlling blood glucose levels and managing GDM.

ORAL HYPOGLYCEMIC AGENTS [50,51]

Oral hypoglycemic agents (OHAs) have emerged as potential options for managing gestational diabetes mellitus (GDM). Metformin and Glyburide are two OHAs recognized for their use in pregnancy, endorsed by the ADA. Initially, concerns regarding teratogenicity due to transplacental transfer limited their usage. However, Metformin, classified as category B drug by the FDA, has shown promise, especially in women with GDM and a history of PCOS or obesity. Studies, like one by Jamie et al, have highlighted Metformin's efficacy and safety, demonstrating no significant differences in birth weight compared to insulin-treated groups. Despite some concerns, retrospective cohort studies, including one by Pratap et al, have shown reassuring outcomes in pregnant women with PCOS or type 2 DM using Metformin.

Glyburide, a second-generation sulfonylurea, has also been considered. Although it exhibits minimal placental transfer in experimental models, its widespread use in GDM is not recommended by ADA and ACOG due to limited large-scale studies validating its safety and efficacy in pregnancy. Further research is required to establish its role and safety profile in managing GDM. Overall, while OHAs present potential alternatives to insulin therapy, careful consideration and larger studies are necessary to ensure their safety and effectiveness in pregnant women with GDM.

INSULIN THERAPY

Insulin therapy is the gold standard in managing gestational diabetes mellitus and pregestational diabetes due to its proven efficacy and safety. The most common insulin regimen includes short-acting Regular insulin and intermediate-acting NPH insulin, offering flexibility in controlling blood glucose levels. Initiation of Insulin therapy is typically recommended when medical nutrition therapy fails to achieve desired glucose levels.[52]

Studies, have demonstrated a reduced Incidence of macrosomia in GDM women treated with insulin.[53] Additionally, a large prospective study comparing intensive versus conventional management of GDM highlighted the benefits of intensive management, including decreased rates of macrosomia and neonatal complications.[54]

Tailoring the type and dose of insulin to individual patient requirements is essential for optimal management. Although human insulin is currently recommended, newer rapid-acting insulins such as lispro and aspart provide quicker onset of action. Lispro is categorized as pregnancy category B by the FDA

Insulin aspart, as pregnancy category C by the FDA, has shown effectiveness in lowering postprandial glucose concentrations. Although limited, there is evidence supporting the safety and efficacy of insulin glargine in pregnancy, despite being as pregnancy category C by the FDA.[55]

While insulin therapy remains essential in managing GDM, additional research is necessary to determine the most effective insulin regimens tailored to individual patient

requirements. Overall, insulin therapy plays a key role in achieving and maintaining tight glycemic control, thereby reducing the risk of adverse maternal and fetal outcomes associated with GDM.

SERUM FERRITIN

Serum ferritin serves as a crucial indicator of the body's iron status and plays a pivotal role in iron metabolism. As an iron storage protein, ferritin functions as a buffer between iron overload and deficiency, ensuring controlled release of iron when needed. Its production is ubiquitous across various organisms, including humans, where it acts as a cytosolic protein before being secreted into the serum in minimal quantities[56]

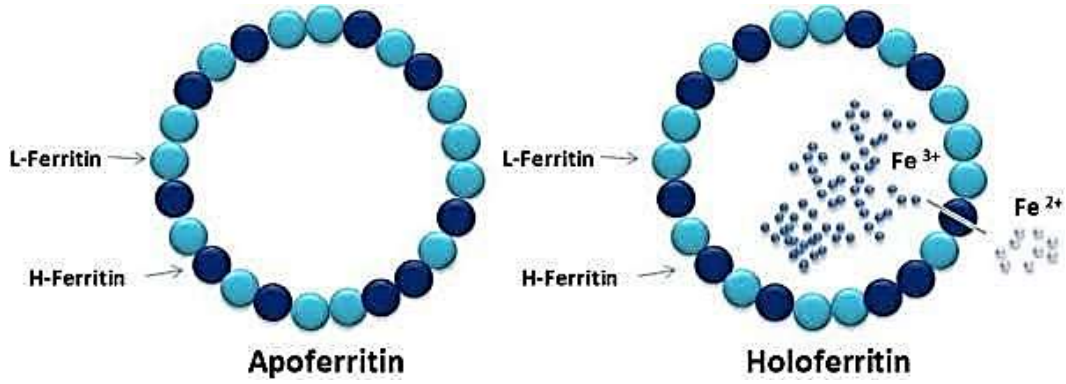

Figure 6: Structure of ferritin [57]

Comprising 24 protein subunits, ferritin forms a complex nanocage structure, iron is stored in a soluble and non-toxic form. Ferritin's ability to store iron safely makes it an essential component in preventing iron-related toxicity or deficiency.

Additionally, the discovery of mitochondrial ferritin, a protein precursor located within mitochondria, has shed light on its role as a metal-binding protein. Once processed into mature protein, mitochondrial ferritin contributes to the formation of ferritin shells.

further enhancing iron storage capacity.

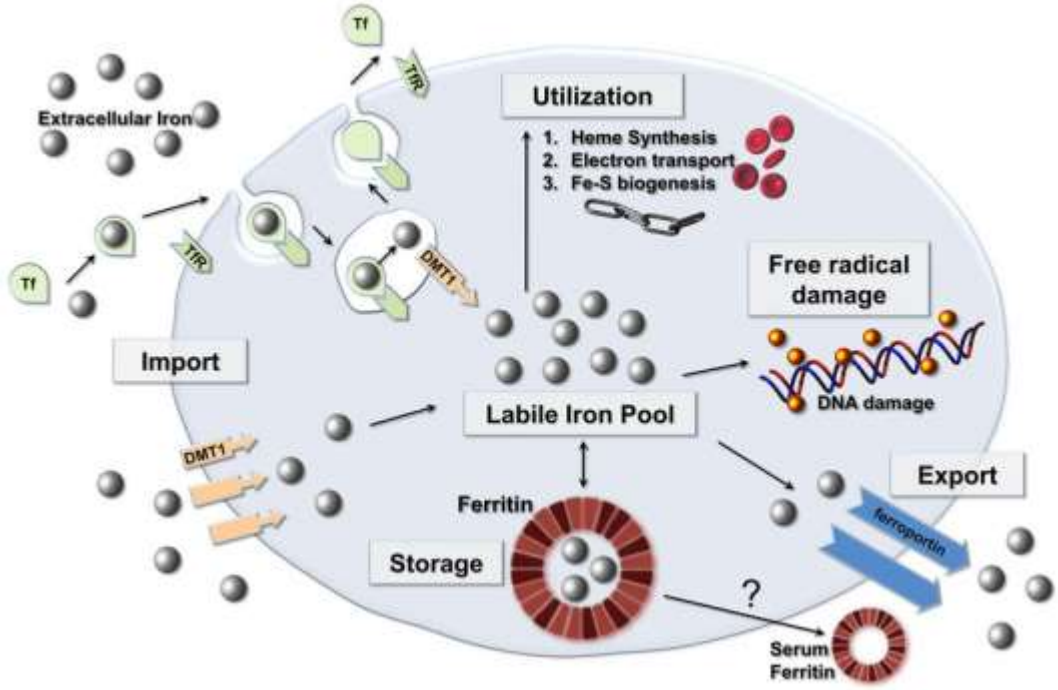

Figure 7: Intracellular homeostasis of serum iron [58]

Understanding the structural and functional intricacies of ferritin, including its interactions with other metal proteins, is crucial for comprehending its role in iron homeostasis. Moreover, advancements in research, contribute to unraveling the complexities of ferritin biology and its implications for health and disease.[56]

FUNCTIONS [59,60]

Serum ferritin serves multiple vital functions within the body, contributing significantly to iron metabolism, immune response, stress adaptation, and more.

Iron Storage

Ferritin acts as a storage protein for iron, holding it in a safe and non-toxic form until it's needed. This prevents the harmful effects of free iron, such as the generation of reactive oxygen species through the Fenton reaction. Production of ferritin is regulated by messenger RNA based on iron levels in the body,which ensures controlled storage and release of iron as and when required.

Immune and Stress Response

Serum ferritin serves a significant role as an inflammatory mediator. Ferritin levels rise in reaction to stressors such as anoxia and also in case of infections highlighting its role as both an acute phase reactant and an inflammatory marker. Elevated ferritin levels are seen in inflammatory conditions, including ”acute respiratory distress syndrome (ARDS), atherosclerosis, malignancies, liver cirrhosis, type 2 diabetes mellitus, metabolic syndrome, non-alcoholic fatty liver disease (NAFLD), preeclampsia, rheumatoid arthritis, and systemic lupus erythematosus (SLE)”.

Component of Yolk

Ferritin also serves as a component of egg yolk, which is neccesary for essential iron stores for embryonic development along with its intracellular action.

Cellular Molecular Functions

Apart from its roles in iron storage and immune response, ferritin also involves in various cellular and molecular activity, along with facilitating electron transfer across the protein cage through its light chain subunits.

SERUM FERRITIN AND INSULIN RESISTANCE

Raised serum ferritin levels have been associated with insulin resistance through various mechanisms, revealing the association between iron metabolism and glucose homeostasis.

Central obesity, often associated with elevated serum ferritin, correlates with insulin resistance and metabolic abnormalities, including elevated blood glucose and blood pressure. Addressing iron overload through decreased iron storage has emerged as a potential strategy in managing resistant hypertension.[61]

The pancreas, particularly sensitive to oxidative stress, relies on high ferritin concentrations for antioxidant protection. Mutations in genes like H63D and C282Y,

commonly found in hemochromatosis, are more prevalent in type 2 diabetes, suggesting a genetic link between iron overload and insulin resistance. Regular blood donation, reducing iron levels, has been linked with a lower risk of diabetes.

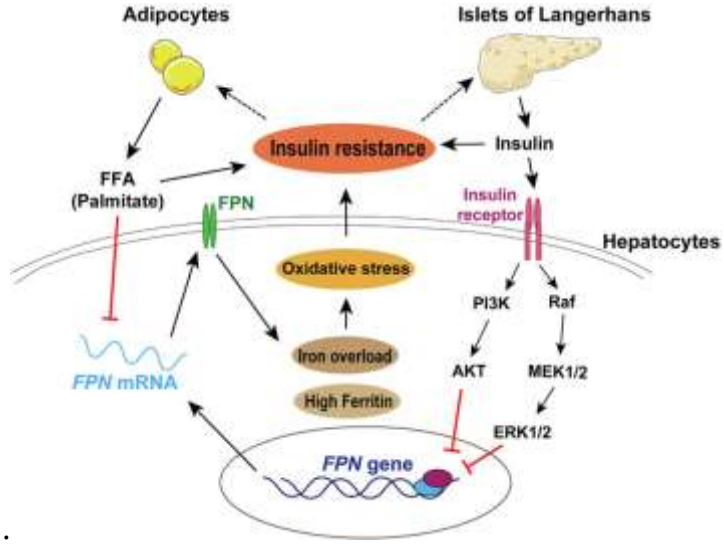

Figure 8: Serum ferritin and insulin resistance [62]

In liver iron overload conditions like ("insulin resistance-associated hepatic iron overload"), elevated ferritin levels, without increased transferrin saturation, indicate an imbalance in iron metabolism contributing to insulin resistance. Chronic "HCV" infection is also linked to insulin resistance, further complicating the association between iron status and glucose metabolism.

Insulin has a crucial role iron metabolism, affecting the distribution of transferrin receptors on cell surfaces. Increased iron levels inhibit insulin action in the liver, leading to hyperinsulinemia, which, in turn, promotes ferritin synthesis. Elevated iron levels and consequent ferritin synthesis are caused by hyperinsulinemia, which intensifies oxidative damage. Furthermore, reduced iron binding by glycated transferrin in diabetes results in elevated free iron levels and consequent ferritin accumulation.[63]

An understanding of iron homeostasis is crucial in the setting of metabolic diseases, as evidenced by the complex relationships among serum ferritin, insulin resistance, and glucose metabolism. To effectively treat insulin resistance and its related problems, more investigation into these interconnections may provide cutting-edge therapy strategies focusing on iron metabolism.

VARIATION IN SERUM FERRITIN

Serum ferritin levels and their corresponding symptoms offer important hints about the state of iron and its possible effects on health.

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Symptoms including weariness, joint discomfort, palpitations, and stomach ache can be indicators of elevated ferritin levels. Iron overload diseases and chronic inflammatory states with high ferritin levels are two underlying illnesses that may be reflected in these symptoms. A high ferritin-related disease can be identified and treated earlier by keeping an eye on these symptoms in addition to ferritin levels;L.[64]

On the other hand, symptoms including tinnitus, headache, cramping in the legs, and giddiness may result from low ferritin levels. The depletion of ferritin levels resulting from insufficient iron reserves is a common sign of iron deficiency anemia. When the underlying iron shortage is identified, more testing and therapy may be necessary

ASSESSMENT OF SERUM FERRITIN

Finding H-ferritin, which is present in the heart and kidney, and L-ferritin, which is present in the liver and spleen, is the test principle for measuring serum ferritin. More precise than serum iron levels, serum ferritin levels testing is essential for precisely determining one's iron status.

An innovative technique for determining ferritin levels is the QUANTIMUNE FERRITIN IRMA KIT. It is more expensive than conventional procedures, but having great sensitivity and speedy results. Polyacryl beads covered with ferritin-specific antibodies tagged with iodine-125 are used in this assay. A gamma counter is then used to quantify the levels, yielding accurate readings similar to radioimmunoassay (RIA).[65]

SERUM FERRITIN IN GDM

Serum ferritin levels may be used as ‘predictor’ of insulin resistance and onset of gestational diabetes mellitus. Since hyperinsulinemia, insulin resistance elevated ferritin levels are associated, tracking serum ferritin levels during pregnancy—especially prior to the onset of symptoms—may provide information about the likelihood of developing gestational diabetes mellitus. When increased ferritin levels

are detected early, proactive steps to lower the risk and morbidity of GDM may be taken.[66]

In conclusion, determining the iron status and potential health hazards requires an understanding of the symptoms connected to high and low ferritin levels as well as the fundamentals of serum ferritin testing. Serum ferritin monitoring during pregnancy may offer insightful information about the likelihood of developing GDM and direct preventative measures to support health of both the mother and the fetus.[67]

REVIEW OF PREVIOUS STUDIES

1. A study by Soheilykhah S et al[68] involved 1,384 pregnant women between 12-16 weeks of gestation. Blood samples were taken to measure ferritin levels in the first trimester, and GDM was diagnosed using a 75g oral glucose tolerance test at 24-28 weeks. Women who had GDM had elevated serum ferritin levels than those who did not (p=0.01). A ferritin concentration of 45(ng/ml), the 75th percentile for healthy pregnant women, was found in 32% of GDM group and 25.2% of normal subjects (p=0.01). The risk of GDM was 1.4 times higher with elevated ferritin levels, with an adjusted odds ratio of 1.3 (0.95-1.8) after considering age and BMI (p=0.09). High serum ferritin is thus a significant risk factor for GDM.

2. A study by Poonguzhalai S et al[69] divided pregnant women into two groups based on GDM status , determined by glucose challenge test. Fasting and postprandial blood sugar levels were measured to diagnose GDM. Serum ferritin levels compared between the groups. The mean rank of serum ferritin in women with GDM was 33.02, while it was 27.98 in those without GDM, indicating a positive correlation between high serum ferritin and GDM. The study suggests that routine iron supplementation in pregnancy requires further evaluation due to the link between increased serum ferritin and GDM.

3. A study by Moghaddam FF et al[70], serum ferritin, iron, and insulin resistance (IR) indices were assessed in 50 antenatal women with GDM and 350 without. The study found that serum ferritin in the GDM group was significantly associated with all (IR) indices, except (HOMA-B). There was no significant relationship between serum iron levels and IR indices, except for "HOMA-IR". The study concluded that raised serum iron and ferritin levels might contribute to increased insulin resistance and increased risk of developing GDM.

4. A prospective, observational study by Cheng Y et al[71] involved(851) pregnant women at 10 and 20 weeks , divided based on serum ferritin levels. Blood samples were collected for biochemical analysis, and a 75-g OGTT was conducted at 24–28 weeks . The average ferritin concentration was 65.67(microgram µg/L). GDM prevalence in the quartiles was 9.4(%), 14.6(%), 18.8(%), and 19.3(%) (P=0.016). The odds ratio for GDM in quartiles 2–4 compared to quartile 1 were 1.64, 2.23, and 2.31, respectively. Elevated early pregnancy serum ferritin levels were linked to a higher GDM risk, especially in women with high iron storage, no anemia and obese. Iron supplementation should be considered to reduce GDM risk.

5. In a study by Chauhan P et al[72], 50 GDM cases were compared to 50 age-matched normal pregnancies. Maternal blood samples measured 'hb',' iron levels', 'serum ferritin', and CRP, while 'cord blood' samples assessed newborn hemoglobin and iron levels. Results indicated significantly higher serum ferritin levels in GDM cases ($p < 0.001$) compared to non GDM at time of delivery. Cord blood hemoglobin was negatively correlated with serum ferritin levels in mother with GDM. The study concluded that elevated serum ferritin in GDM indicates inflammation from increased ROS production due to iron overload, potentially impacting placental iron transfer and fetal hemoglobin synthesis.

6. Sun C et al[73] conducted a comprehensive database search (Embase, PubMed, Cochrane Library, Web of Science) up to May 10, 2019, to explore link between ferritin levels and GDM risk. They used a random effects model to summarize relative risks and 95% confidence intervals. Ten studies with 4,690 participants were included. The analysis revealed that individuals in the highest ferritin concentration category had a 1.87 times higher risk of GDM compared to those

in the lowest category (95% CI: 1.50 to 2.34; I2 = 20.1%). A linear dose-response showed a 10 μg/L ferritin increase raised GDM risk by 8% (1.08, 95% ,CI: 1.05to 1.13; I2 equal to 55.1%). A non-linear dose-response also indicated a consistent rise in GDM risk with higher ferritin levels. No publication bias was found. This meta-analysis suggests that increase in ferritin levels are linked to increased GDM risk.

7. In a study by Li W et al[74] at Yinan Maternal and Child Health-Care Hospital, pregnant women undergoing routine prenatal examinations from December 2015 to March 2018 were selected. Based on GDM diagnostic criteria, 72 GDM patients formed case group, and 72 pregnant women were randomly chosen as the control group. Fasting venous blood collected during the 1st (11-13 weeks) and 2nd trimesters (24-28 weeks). Fasting plasma glucose and serum ferritin (SF) levels were determined electrochemically. The ROC curve evaluated SF's diagnostic value for GDM. SF level in case group were higher than in control group ($p < 0.05$). The AUC for SF in diagnosing GDM was 0.895, with sensitivity(97.8%) and specificity(67.3%). Elevated SF levels in early pregnancy are correlated with GDM, suggesting SF as a key indicator for GDM prevention and monitoring.

8. Zhang X et al[75] studied 2,117 pregnant females from the Tongji Maternal and Child Health Cohort in Wuhan, China. Ferritin levels at approximately 16 weeks gestation were measured by ELISA kits, and iron supplement usage data were gathered via questionnaires. GDM was diagnosed using a 75-g oral-glucose-tolerance test (OGTT) at 24–28 weeks. The median plasma ferritin was 52.1ng/mL. Among participants, 40.8% used iron supplements during 2nd trimester, and 10.3% developed GDM. Adjusted RR(relative risk) for GDM increased across plasma ferritin quartiles, with higher quartiles showing significantly higher risks. Additionally, taking ≥60 mg/dl of supplemental iron during the 2nd trimester was linked to a higher GDM risk (RR: 1.37; 95% CI: 1.02, 1.84). Elevated plasma ferritin levels and significant iron supplementation are independently associated with increased GDM risk.

9. In a prospective observational study by Pandey R et al[76], 302 non-anemic singleton antenatal women between 14 and 20 weeks were enrolled from antenatal OPD. Serum ferritin was measured at enrollment, and blood glucose levels were tested at 24–28 weeks using the DIPSI method. Of the participants, 92 of them had blood glucose levels ≥140 mg/dl(milligram/dl) and were diagnosed with GDM, while 210 women had levels <140 mg/dl and classified as non-GDM. The mean serum ferritin level in GDM women was significantly higher (56.44 ± 19.19 ng/ml) compared to non-GDM women (27.62 ± 12.11 ng/ml) ($p<0.001$). A serum ferritin cutoff of >37.55 ng/ml showed 85.9% sensitivity and 81.9% specificity. The study concluded that serum ferritin is associated with GDM development and can serve as a predictive marker.

10. In a prospective study by Anushree N et al[77], conducted at Department of OBG, ESIC-MC-PGIMSR, from January 2020 to June 2021, 388 pregnant women were enrolled after providing informed consent. Maternal serum ferritin measured between 24 and 28 weeks gestation and analyzed statistically. Both groups were matched for demographic characteristics and hemoglobin levels to eliminate anemia as confounding factor. The mean serum ferritin value was 46.4 ng/ml(nanogram/ml) in the GDM group and 37.3 ng/ml in the non-GDM group ($p<0.001$). ROC analysis identified a serum ferritin cutoff of 34.7 ng/ml with 71% sensitivity and 63% specificity, indicating a 63% risk of developing GDM with ferritin levels above this threshold. The study concluded that elevated serum ferritin serves as predictive marker of GDM.

MATERIALS & METHODS

MATERIALS & METHODS

Study Area

Department of Obstetrics and Gynaecology, Sri Devaraj Urs Medical College, Tamaka, Kolar.

Study Population

All the pregnant women who came to antenatal checkup in their 16-24 weeks of gestation, in RLJH hospital, in the department of O.B.G., SDUMC, Kolar, during the proposed study period.

Study Design-Cross Sectional Study

Study Duration-September 2022 to December 2023 for a duration of 16 months

Inclusion Criteria

All the pregnant women who attended to antenatal checkup in their 16-24 weeks of gestation, in RLJH hospital

Exclusion Criteria-

Pregnant women with history of diabetes mellitus,severe anaemia, preeclampsia, haemoglobinopathies, acute or chronic infections, renal diseases, liver diseases, thyroid disorder and autoimmune disorders

Refusal of consent

Methodology

Pregnant women attending antenatal checkups at RLJH hospital between 16-24 weeks gestation, who met inclusion criteria, were included in study group after providing informed consent.

During their outpatient department (OPD) visit, demographic information including age, education, occupation, and socio-economic status, along with obstetric and medical history, were collected. General and systemic examinations were performed

along with investigations including complete hemogram, random blood sugar, thyroid profile, HIV, HBsAg, VDRL, liver and renal function tests, electrocardiogram, and ultrasound.

Blood sugar was measured using the Vitos 5600 autoanalyzer with the enzymatic, kinetic glucose oxidase, and peroxidase method. An oral glucose challenge test (OGCT) - 75(g) glucose was conduct around 16 to 24 weeks of gestation, regardless of fasting status. Women with blood sugar levels over 140 mg/dL were categorized as GDM.[79]

Venous blood (5 mL) was drawn from the antecubital vein between 16-24 weeks of gestation to measure serum ferritin levels using Enzymatic,Kinetic Glucose oxidase and Peroxidase with Vitos 5600 autoanalyzer. Serum ferritin reference values during pregnancy are 12-150 ng/mL. Serum ferritin levels in the study population were divided into four quintiles: <30ng/dL, 30-60ng/dL, 60-90ng/dL, and >90ng/dL.[80] In each quantile the number of GDM cases was analyzed to assess the link between serum ferritin levels and GDM

Statistical analysis

Data entered into Microsoft Excel. Categorical data were represented as frequencies and proportions, while continuous data is tested for normality using the Kolmogorov–Smirnov and Shapiro–Wilk tests and represented as mean & standard deviation.

For qualitative data, the Chi-square test was used, and for 2x2 tables not meeting Chi-square criteria, Fisher's exact test and Yates correction were applied. The independent t-test identified mean differences between two quantitative variables, while the Mann-Whitney U test was used for skewed distributions. ANOVA determined mean differences among more than two groups, with the Post Hoc Bonferroni test for intergroup analysis. Pearson or Spearman's correlation measured relationships between quantitative and qualitative variables, respectively, with correlation coefficients indicating weak, moderate, or strong correlations.

Graphs, including bar diagrams and pie charts, were created using MS Excel. p-value of <0.05 considered statistically significant. MedCalc was used for sample size estimation, and data analysis was performed using MS Excel and SPSS software

SAMPLE SIZE ESTIMATION

The sample size was estimated using the findings from a study by Sumathy V et al[78], where the prevalence of GDM was found to be 37.0%. Accordingly, the proportion was regarded as 37.0% (p = 0.37), while the precision was kept at 10% (d = 0.10), with 95.0% confidence level (α = 0.05). The sample size formula used for calculation is mentioned below;

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

The sample size was estimated to be 94, and was considered as the final sample size.

Sampling Method

Simple random sampling

RESULTS

RESULTS

Table 1: Distribution of the mothers with respect to groups

Subjects (N=94)		Frequency (n)	Percentage (%)
Groups	**GDM**	47	50.0%
	Non-GDM	47	50.0%

All 94 participants underwent a standardized Oral Glucose Challenge Test (OGCT) regardless of fasting status. Those with a glucose level exceeding 140 mg/dL were classified into the GDM group, consisting of 47 mothers. The remaining 47 mothers formed the healthy control group, meticulously matched in age to the GDM cohort, mitigating potential selection bias. This method ensured a balanced representation of both groups, enhancing the study's reliability and validity in assessing the association between serum ferritin levels and GDM.

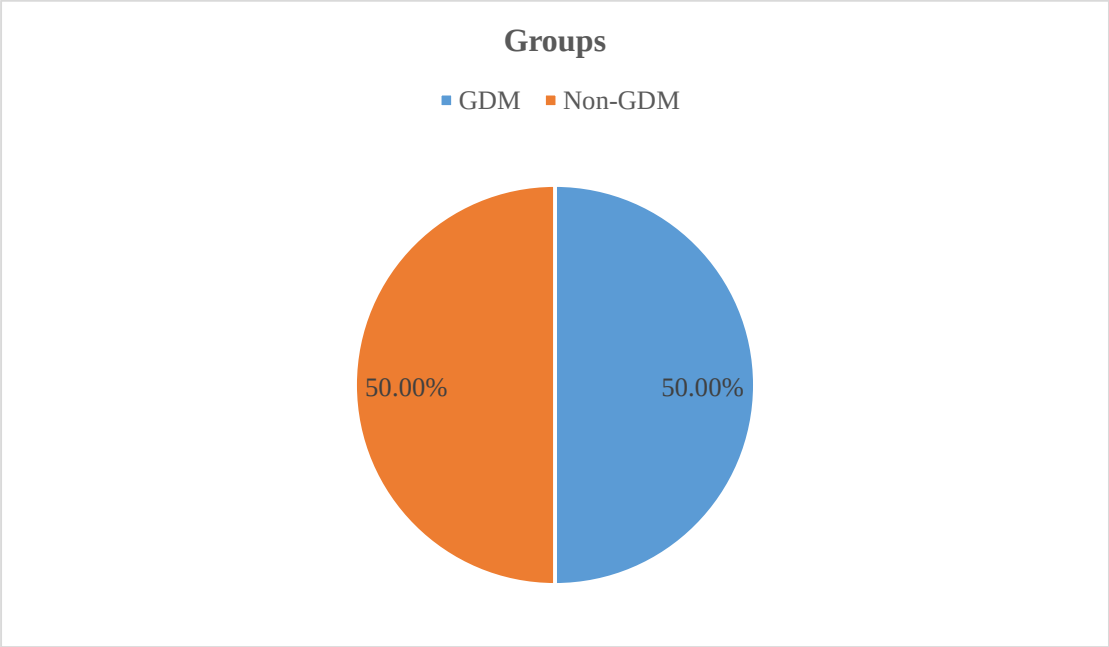

Figure 9: Distribution of the mothers with respect to groups

Table 2: Comparison of OGCT with respect to groups

Subjects (N=94)		Groups		p-value#
		GDM (n=47)	Non-GDM (n=47)	
OGCT (in mg/dL)	Mean ± SD	167.77 ± 13.83	111.17 ± 15.93	<0.001*
	Minimum	142.00	84.00	
	Median	167.00	113.00	
	Maximum	190.00	139.00	

Independent t-test
* Statistically significant

The OGCT levels of mothers in the GDM group exhibited a range of 142 mg/dL to 190 mg/dL, with a mean value of 167.77 ± 13.83 mg/dL, confirming their GDM status. Conversely, in the Non-GDM group, OGCT values ranged from 84 mg/dL to 139 mg/dL, with mean value -111.17 ± 15.93 mg/dL, indicating healthy maternal status. A comparative analysis showed statistically significant difference between the groups, substantiating distinction.

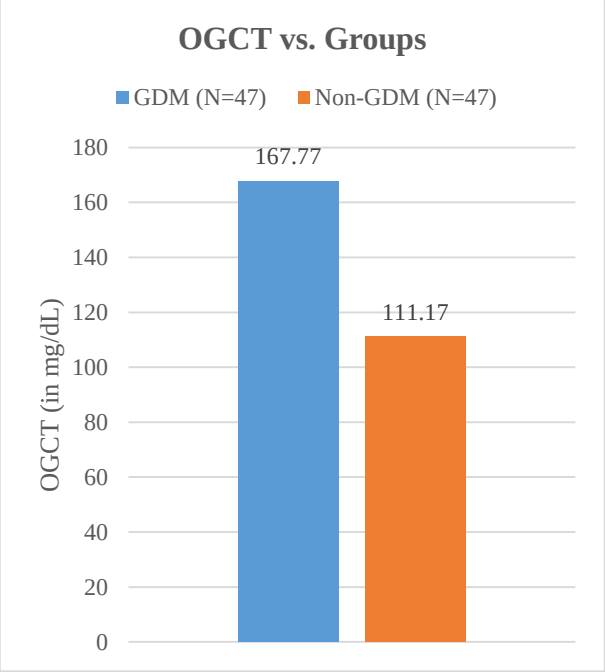

Figure 10: Comparison of OGCT with respect to groups

Table 3: Comparison of age distribution between the groups

Subjects (N=94)		Groups				p-value#
		GDM (n=47)		Non-GDM (n=47)		
		n	%	n	%	
Age group	21 to 24 years	15	31.9%	16	34.0%	0.979
	25 to 28 years	19	40.4%	17	36.2%	
	29 to 32 years	10	21.3%	11	23.4%	
	33 to 36 years	3	6.4%	3	6.4%	

Chi-square test

Subjects (N=94)		Groups		p-value#
		GDM (n=47)	Non-GDM (n=47)	
Age (in years)	Mean ± SD	26.45 ± 3.46	26.51 ± 3.75	0.932
	Minimum	21.00	21.00	
	Median	26.00	26.00	
	Maximum	35.00	33.00	

Independent t-test

In study, mothers mean age was 26.45 ± 3.46 years for GDM group and 26.51 ± 3.75 years for Non-GDM group. Participants in both groups were primarily between ages of 25 and 28 years, with next age groups being 21 to 24 years and 29 to 32 years. Mothers between ages of 33 and 36 years made up age group with the lowest representation.Statistical analysis revealed no significant difference in age distributions across 2 groups, confirming that selection bias was not present.This consistency in age distribution ensures a balanced representation of participants in both groups, thereby enhancing the study's reliability.

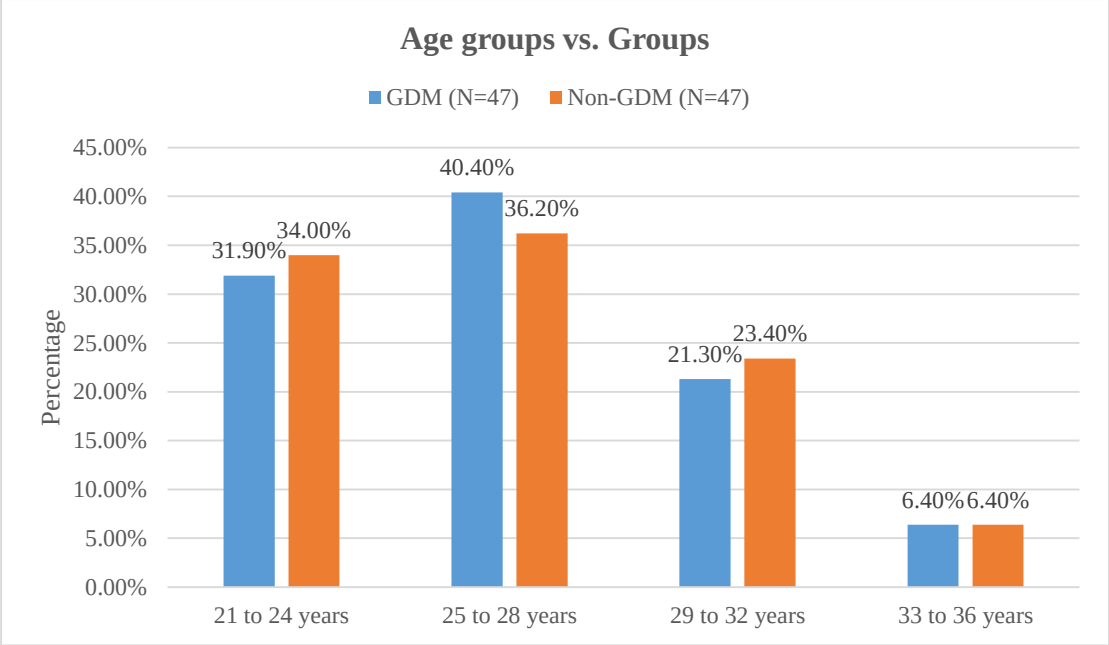

Figure 11: Comparison of age distribution between the groups

Table 4: Comparison of BMI distribution between the groups

Subjects (N=94)		Groups				p-value#
		GDM (n=47)		Non-GDM (n=47)		
		n	%	n	%	
Body Mass Index	Underweight	2	4.3%	5	10.6%	0.182
	Normal	10	21.3%	17	36.2%	
	Overweight	21	44.7%	16	34.0%	
	Obese	14	29.8%	9	19.1%	

Chi-square test

Subjects (N=94)		Groups		p-value#
		GDM (n=47)	Non-GDM (n=47)	
BMI (in kg/m^2)	Mean ± SD	27.08 ± 4.43	25.34 ± 4.69	0.068
	Minimum	18.20	17.50	
	Median	27.40	25.40	
	Maximum	34.60	34.60	

Independent t-test

In this study Body Mass Index (BMI) was calculating using height and weight in all women. Results were a mean BMI of 27.08 ± 4.43 kg/m2 in GDM group and 25.34 ± 4.69 kg/m2 in Non GDM group.Majority of participants in GDM group were overweight (44.7%) or obese (29.8%), while in Non-GDM group, a significant women had a normal BMI (36.2%) followed by overweight (34.0%).Inspite of these variations, statistical analysis showed no significant disparity in BMI distribution between the 2 groups. This indicates that participants had comparable BMI profiles, minimizing potential biases in study's findings.

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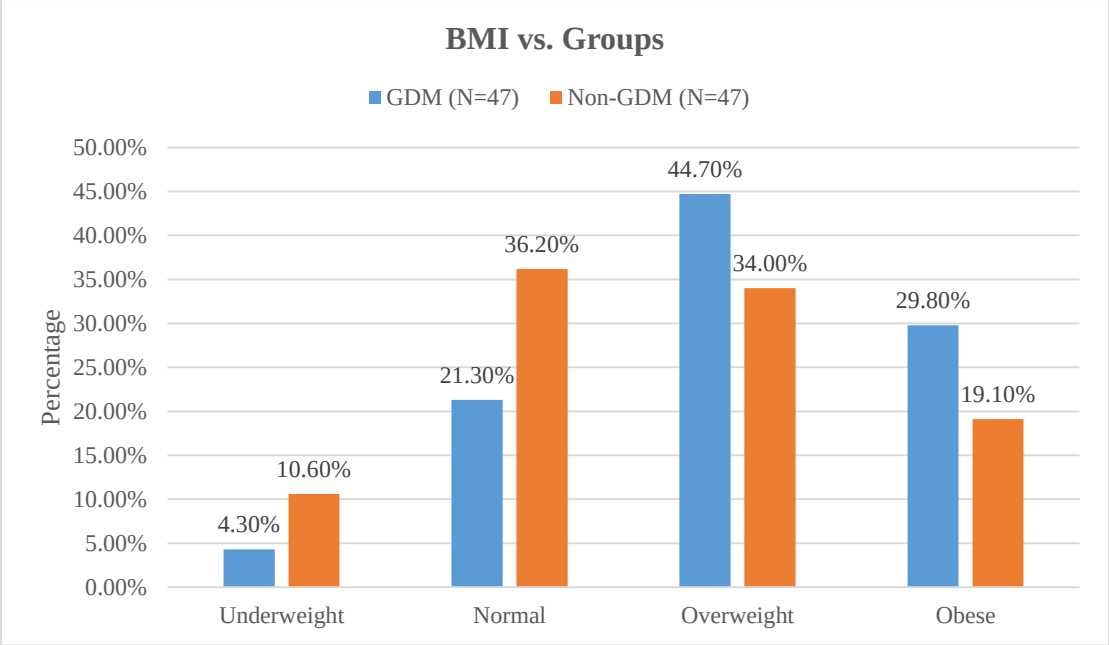

Figure 12: Comparison of BMI distribution between the groups

Table 5: Comparison of parity between the groups

Subjects (N=94)		Groups				p-value#
		GDM (n=47)		Non-GDM (n=47)		
		n	%	n	%	
Parity	Primigravida	13	27.7%	21	44.7%	0.086
	Multigravida	34	72.3%	26	55.3%	

Chi-square test

According to study in multigravida 72.3% of GDM group and 55.3% of Non GDM group. Primagravida, on other hand, made upto 44.7% of Non GDM group and 27.7% of GDM group. There was no discernible difference in the groups' parity distribution, according to statistical analysis. A fair representation of primigravida and multigravida is suggested by the parity uniformity across the groups, which strengthens the study's comparative validity.

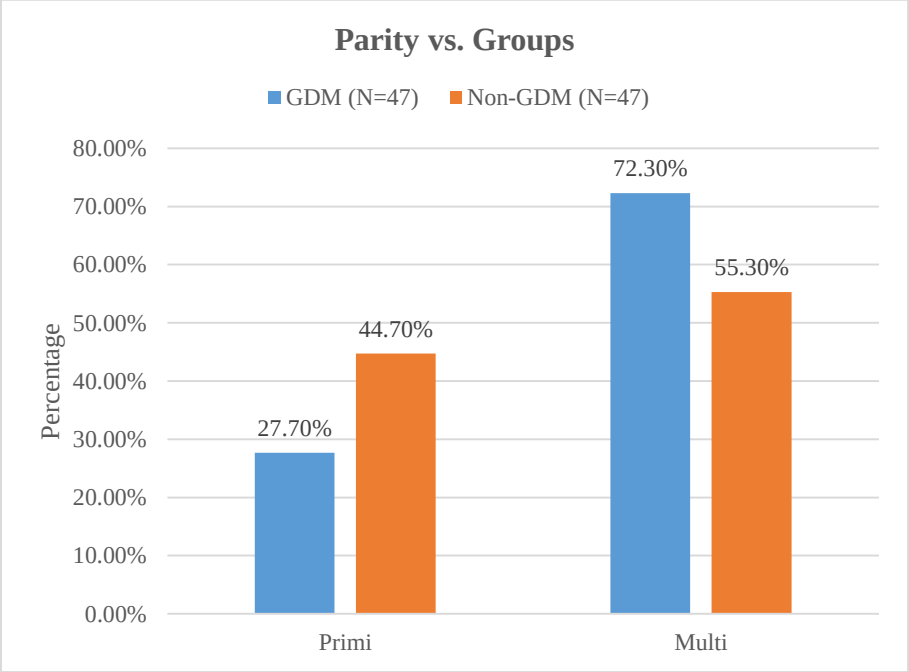

Figure 13: Comparison of parity between the groups

Table 6: Comparison of gestational age with respect to groups

Subjects (N=94)		Groups		p-value#
		GDM (n=47)	Non-GDM (n=47)	
Gestational age (in weeks)	Mean ± SD	19.72 ± 2.89	20.45 ± 2.75	0.217
	Minimum	16.00	16.00	
	Median	20.00	21.00	
	Maximum	24.00	24.00	

Independent t-test

During the study, obstetric history inquiries revealed a consistent gestational age range of 16 to 24 weeks in both groups. Mean gestational age among mothers was 19.72 ± 2.89 weeks in GDM group and 20.45 ± 2.75 weeks in Non-GDM group. Comparative analysis indicated no statistically significant difference in gestational age between 2 groups. This uniformity suggests comparable stages of pregnancy among participants, reinforcing the study's ability to draw meaningful conclusions across GDM and Non-GDM cohorts.

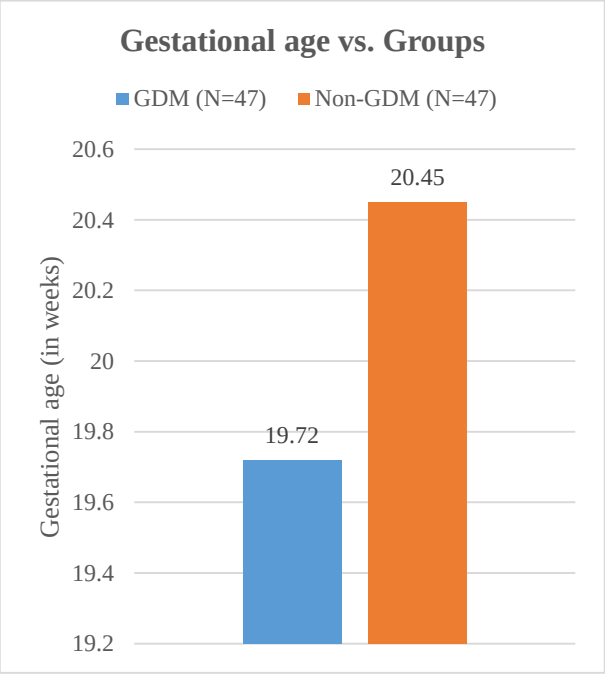

Figure 14: Comparison of gestational age with respect to groups

Table 7: Comparison of family history between the groups

Subjects (N=94)		Groups				p-value#
		GDM (n=47)		Non-GDM (n=47)		
		n	%	n	%	
Family History	Yes	25	53.2%	7	14.9%	<0.001*
	No	22	46.8%	40	85.1%	

Chi-square test
* Statistically significant

In the study, 53.2% mothers in GDM group had family history of GDM, notably higher than 14.9% observed in Non-GDM group. Comparative analysis revealed statistically significant difference between 2 groups regarding family history of GDM. This discrepancy highlights the potential hereditary influence on GDM predisposition and highlights the importance of familial medical history in assessing individual risk factors for gestational diabetes mellitus.

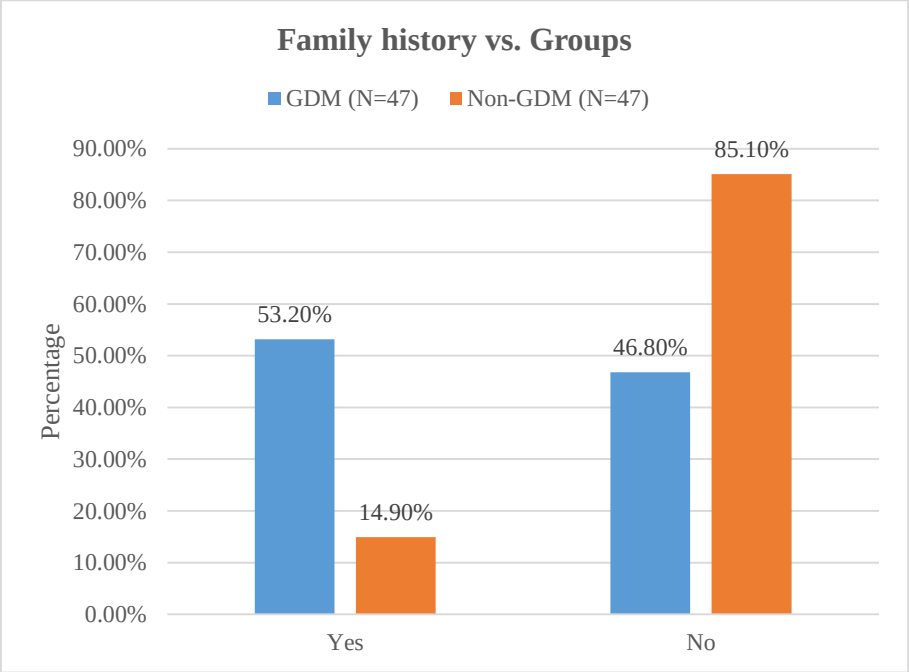

Figure 15: Comparison of family history between the groups

Table 8: Comparison of history of GDM in previous pregnancy between the groups

Subjects (N=60)		Groups				p-value#
		GDM (n=34)		Non-GDM (n=26)		
		n	%	n	%	
Previous GDM	Yes	15	44.1%	0	0.0%	<0.001*
	No	19	55.9%	26	100.0%	

Chi-square test
* Statistically significant

Compared to the Non-GDM group, which had no history of GDM, the GDM group's mothers had a 44.1% history of GDM in prior pregnancies. When comparing incidence of prior GDM between the two groups, comparative analysis showed a statistically significant difference. This research highlights the importance of past experiences with gestational diabetes mellitus in predicting the recurrence of the condition and may have an impact on management approaches and risk assessments in subsequent pregnancies..

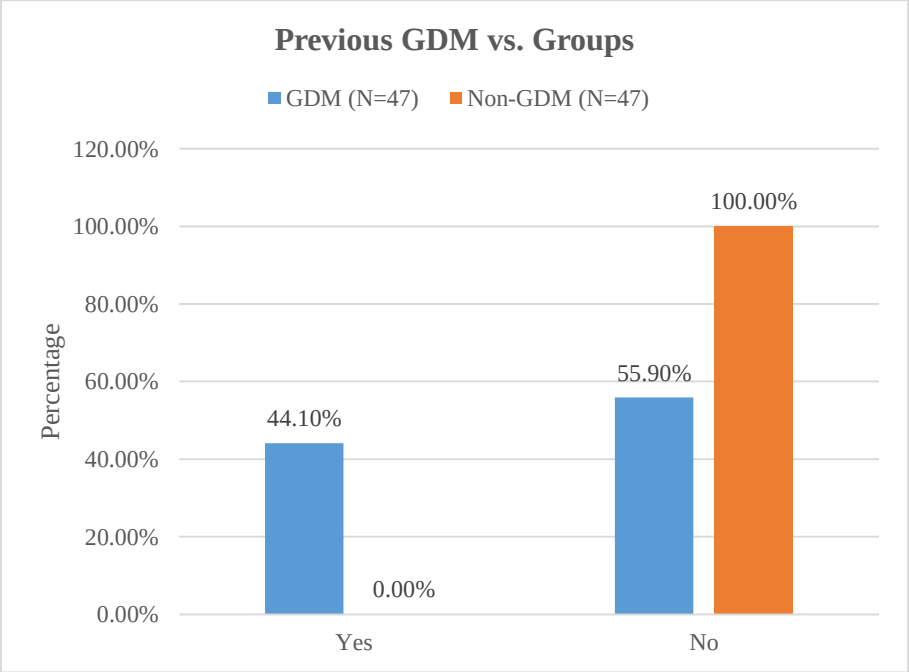

Figure 16: Comparison of history of GDM in previous pregnancy between the groups

Table 9: Comparison of history of big baby in previous pregnancy between the groups

Subjects (N=60)		Groups				p-value#
		GDM (n=34)		Non-GDM (n=26)		
		n	%	n	%	
Previous Big Baby	Yes	7	20.6%	1	3.8%	0.050*
	No	27	79.4%	25	96.2%	

Chi-square test
Statistically significant

In the GDM group, 20.6% mothers reported history of previous big babies, notably higher than 3.8% observed in Non-GDM group. Comparative analysis revealed a statistically significant difference between 2 groups regarding occurrence of big babies in previous pregnancies. This discrepancy highlights the potential association between gestational diabetes mellitus and fetal macrosomia, underscoring the importance of monitoring and managing maternal health to mitigate such risks in subsequent pregnancies.

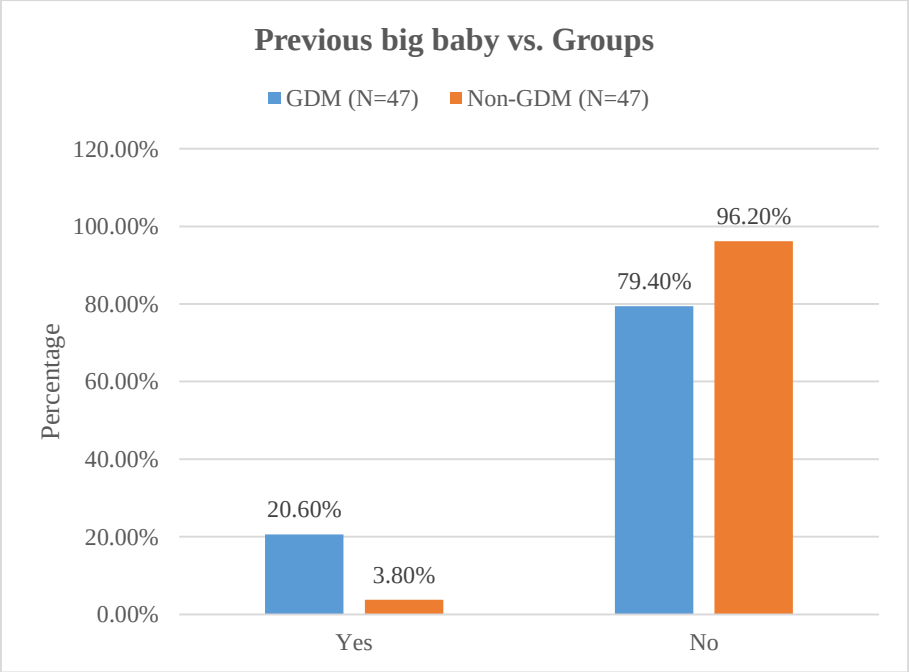

Figure 17: Comparison of history of big baby in previous pregnancy between the groups

Table 10: Comparison of history of IUD in previous pregnancy between the groups

Subjects (N=60)		Groups				p-value#
		GDM (n=34)		Non-GDM (n=26)		
		n	%	n	%	
Previous IUD	Yes	8	23.5%	2	7.7%	0.103
	No	26	76.5%	24	92.3%	

Chi-square test

In the GDM group, 23.5% of mothers reported a history of previous intrauterine deaths, whereas in the Non-GDM group, this proportion was 7.7%. However, upon comparative analysis,study found no statistically significant difference between 2 groups concerning the occurrence of previous intrauterine deaths. This suggests that while there is a disparity in the incidence rates between the groups, this factor may not significantly contribute to the development of gestational diabetes mellitus in subsequent pregnancies.

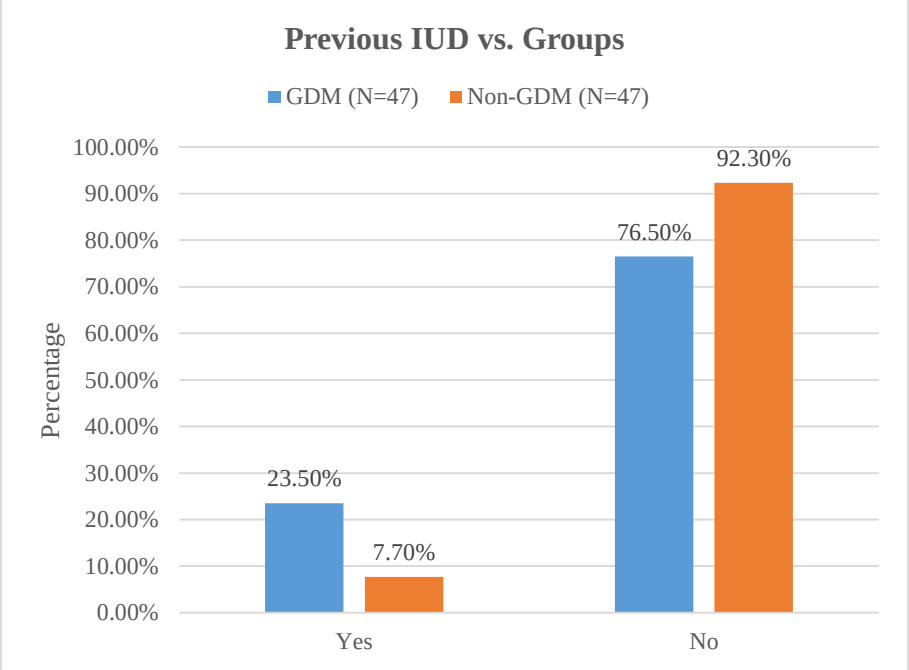

Figure 18: Comparison of history of IUD in previous pregnancy between the groups

Table 11: Comparison of serum ferritin levels between the groups

Subjects (N=94)		Groups				p-value#
		GDM (n=47)		Non-GDM (n=47)		
		n	%	n	%	
Serum Ferritin	<30 ng/mL	5	10.6%	17	36.2%	0.004*
	31 to 60 ng/mL	10	21.3%	14	29.8%	
	61 to 90 ng/mL	18	38.3%	12	25.5%	
	91 to 110 ng/mL	5	10.6%	4	8.5%	
	111 to 130 ng/mL	6	12.8%	0	0.0%	
	>130 ng/mL	3	6.4%	0	0.0%	

Chi-square test
* Statistically significant

Subjects (N=94)		Groups		p-value#
		GDM (n=47)	Non-GDM (n=47)	
Serum Ferritin (in ng/mL)	Mean ± SD	77.19 ± 32.88	48.43 ± 26.93	<0.001*
	Minimum	28.00	10.00	
	Median	77.00	43.00	
	Maximum	139.00	98.00	

Independent t-test
* Statistically significant

In the study, serum ferritin values were assessed in both groups of mothers. The mean serum ferritin level in GDM group was 77.19 ± 32.88 ng/mL, notably higher than the 48.43 ± 26.93 ng/mL observed in Non-GDM group. In GDM group, the majority of cases (38.3%) fell within 61 to 90 ng/mL range, while i Non-GDM group, most had less than 30 ng/mL of serum ferritin (36.2%). Comparative analysis showed a statistically significant difference between the groups regarding serum ferritin levels, indicating a potential association between elevated ferritin levels and gestational diabetes mellitus, warranting further investigation into underlying mechanisms.

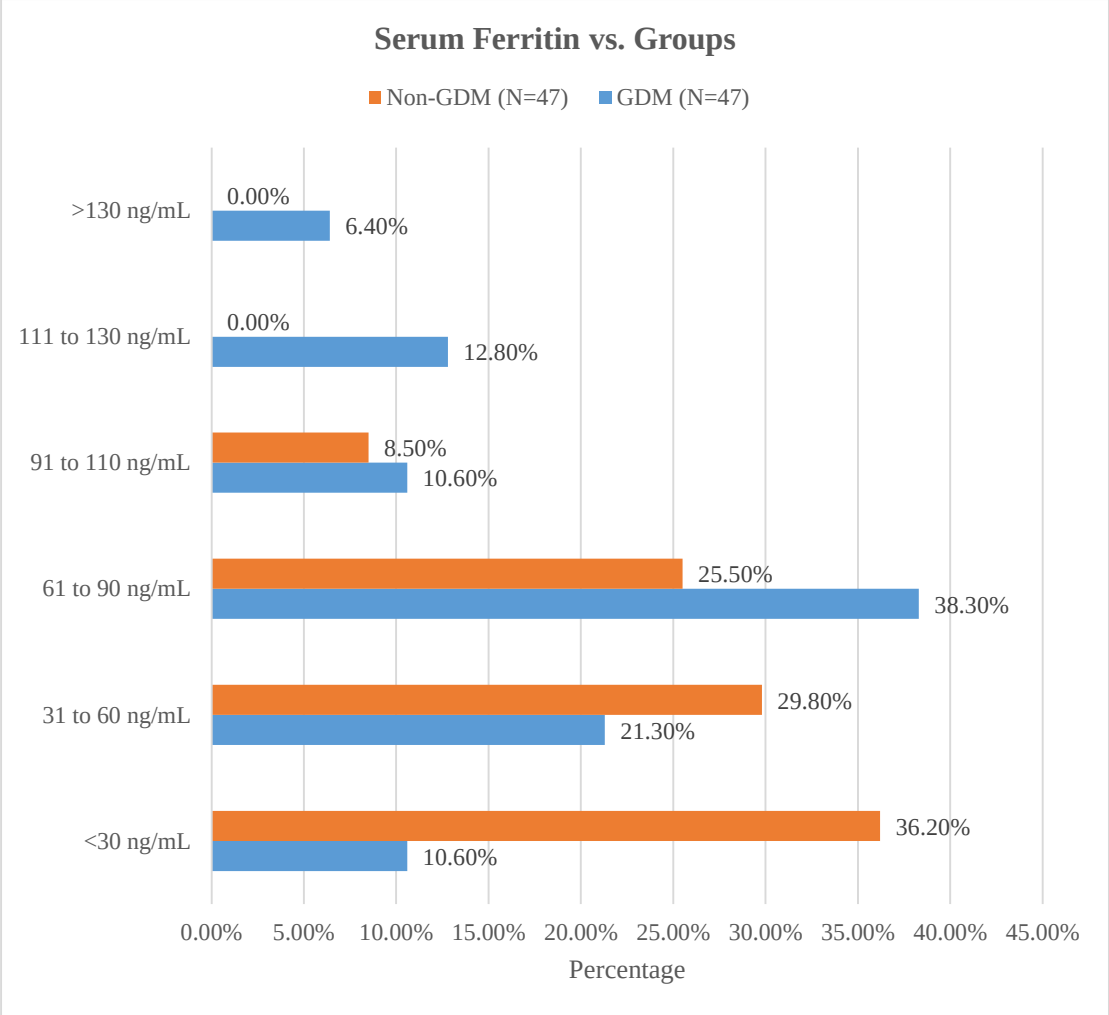

Figure 19: Comparison of serum ferritin levels between the groups

Table 12: Distribution of GDM cases based on the mode of treatment

Subjects (N=47)		Frequency (N)	Percentage (%)
Treatment	**MNT**	6	12.8%
	OHA	24	51.1%
	Insulin	17	36.2%

The predominant treatment modality among GDM mothers in the study was oral hypoglycemic agents (51.1%), followed by insulin therapy (36.2%). A smaller proportion of subjects were managed with medical nutrition therapy (12.8%). This distribution stresses the diverse approaches employed in managing gestational diabetes mellitus, with oral hypoglycemic agents and insulin therapy being the most frequently utilized strategies.

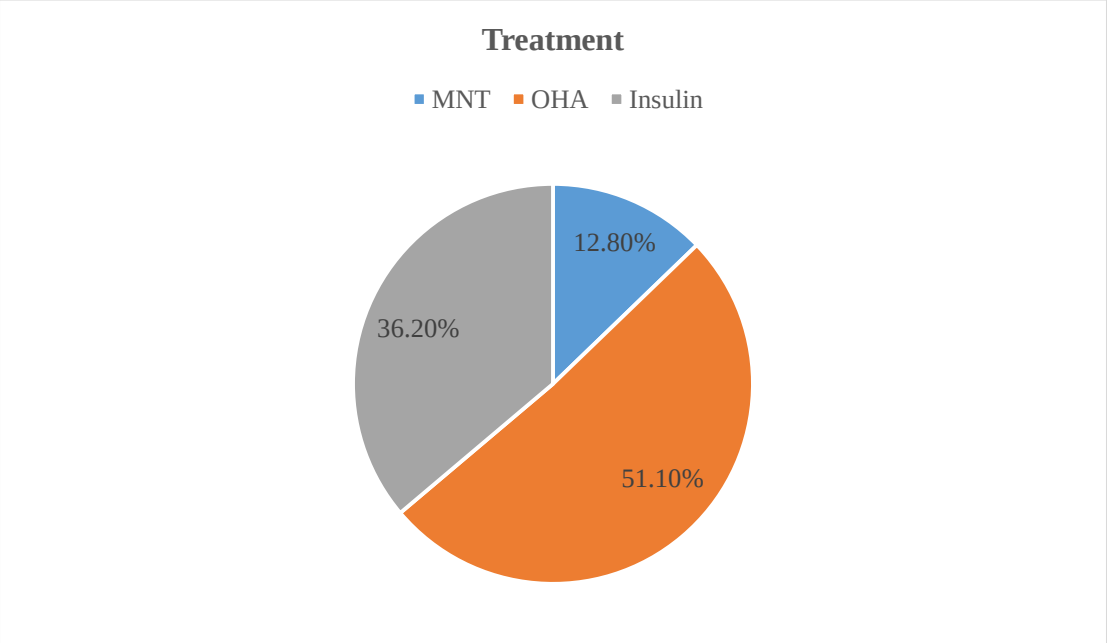

Figure 20: Distribution of GDM cases based on the mode of treatment

Table 13: Correlation between serum ferritin and OGCT levels

Subjects (N=94)		OGCT
Serum Ferritin (in ng/mL)	**Pearson Correlation**	0.787
	p-value	<0.001*

* Statistically significant

The study identified a positive correlation between serum ferritin levels and OGCT levels, demonstrating statistical significance. This implies that elevated OGCT levels significantly coincide with higher serum ferritin levels. Such findings suggest that individuals with poor sugar control exhibit increased serum ferritin levels. This correlation emphasizes the potential role of ferritin as a biomarker reflecting glycemic control, highlighting its relevance in monitoring and managing gestational diabetes mellitus.

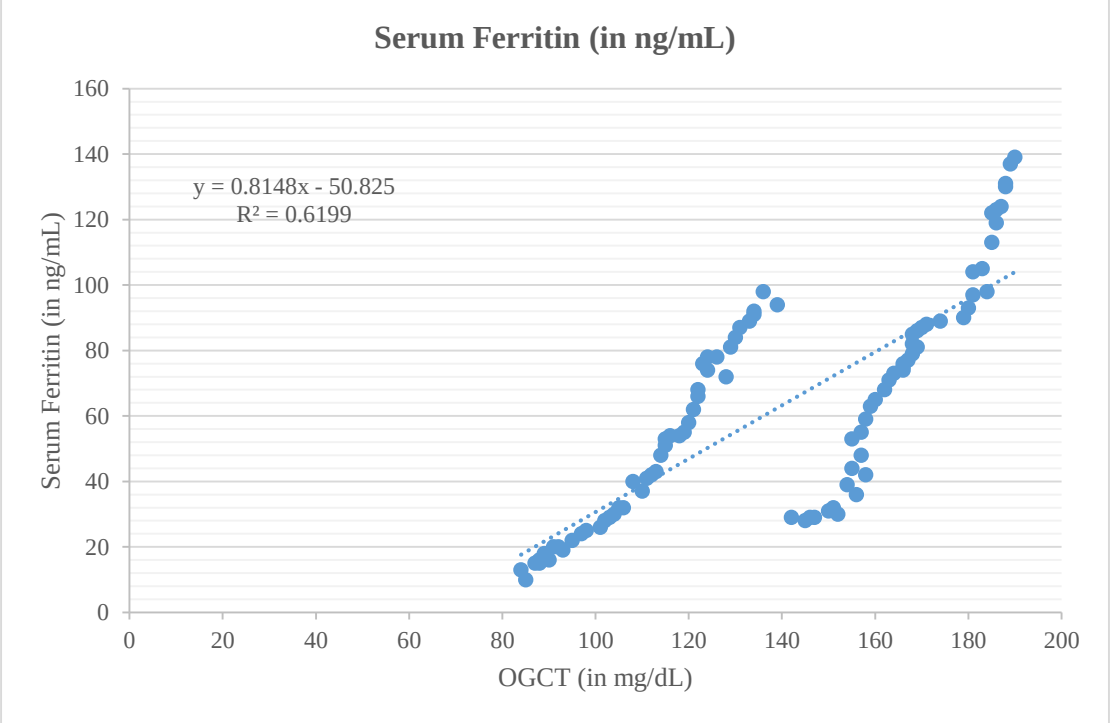

Figure 21: Correlation between serum ferritin and OGCT levels

Table 14: Comparison of serum ferritin levels with respect to mode of treatment

Subjects (N=47)		Groups			p-value#
		MNT (n=6)	OHA (=24)	Insulin (n=17)	
Serum Ferritin (in ng/mL)	Mean ± SD	29.33 ± 1.03	64.58 ± 17.15	111.88 ± 17.57	<0.001*
	Minimum	28.00	32.00	88.00	
	Median	29.00	69.50	113.00	
	Maximum	31.00	87.00	139.00	

One Way ANOVA
* Statistically significant

The study further analyzed serum ferritin levels among GDM mothers based on their treatment modalities. Results showed the highest mean serum ferritin level of 111.88 ± 17.57 ng/mL in mothers treated with insulin therapy, followed by 64.58 ± 17.15 ng/mL in those receiving OHA, and the lowest mean level of 29.33 ± 1.03 ng/mL in mothers managed with MNT. Statistical analysis revealed a significant difference between the groups concerning serum ferritin levels, suggesting a potential association between treatment regimen and ferritin levels in GDM management.

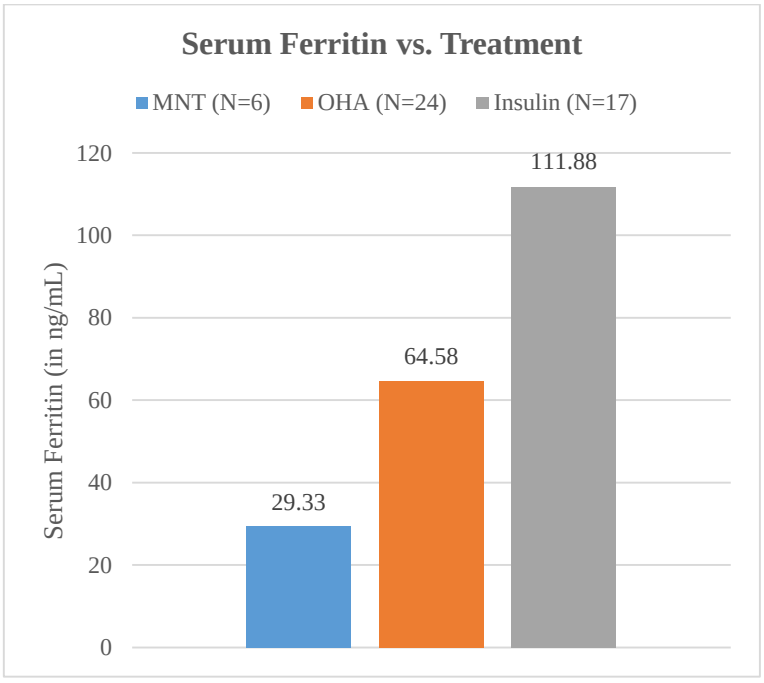

Figure 22: Comparison of serum ferritin levels with respect to mode of treatment

DISCUSSION

DISCUSSION

Pregnant women in their 16-24 weeks of gestation at RLJH Hospital participated after meeting eligibility criteria and providing informed consent. Upon antenatal check-up, demographic, obstetric, and medical histories were recorded, followed by comprehensive examinations and various tests, including OGCT.

OGCT levels in GDM group (142-190 mg/dL, mean: 167.77 ± 13.83 mg/dL) confirmed GDM, contrasting with Non-GDM group (84-139 mg/dL, mean: 111.17 ± 15.93 mg/dL) indicating healthy status. Statistical analysis showed a significant difference between groups. Serum ferritin levels were measured via vitros 5600 autoanalyser method. Additionally, serum ferritin levels were categorized into quintiles, correlated with GDM diagnosis.

GDM group comprised 47 (50.0%) mothers, while remaining 47 (50.0%) served as healthy controls, matched by age to minimize selection bias. These findings underscore OGCT's efficacy in diagnosing GDM and highlighting potential association between serum ferritin levels and GDM, suggesting its utility as a diagnostic marker warranting further investigation.

The present study primarily comprised mothers aged 25 to 28 in both groups, with the second largest age group being 21 to 24 years. This age distribution, detailed in the accompanying table, aligns with previous research findings, thereby validating the relevance of comparing our results with those of prior studies. The consistency in age demographics highlights the reliability of our conclusions and enhances the study's applicability to similar populations.

Table 15: Comparison of mean ages with the previous literatures

Studies	GDM group	Non-GDM group
Present Study	26.45 ± 3.46 years	26.51 ± 3.75 years
Soheilykhah S et al[68]	29.40 ±5.40 years	27.10 ± 4.50 years
Li W et al[74]	29.86 ± 3.68 years	29.01 ± 4.12 years
Pandey R et al[76]	28.26 ± 4.27 years	27.33 ± 4.06 years
Anushree N et al[77]	28.00 ± 5.10 years	27.56 ± 4.78 years

In our present study, the majority of participants in GDM group were overweight (44.7%), followed by obese (29.8%). Conversely, in Non-GDM group, most participants had a normal BMI (36.2%), followed by those who were overweight (34.0%). This disparity in BMI distribution between the groups mirrors previous research findings, as illustrated in the accompanying table. Such observation supports the validity and relevance of comparing this study's results with prior studies, reinforcing the robustness and applicability of our findings to similar populations.

Table 16: Comparison of mean BMI with the previous literatures

Studies	GDM group	Non-GDM group
Present Study	27.08 ± 4.43 kg/m^2	25.34 ± 4.69 kg/m^2
Soheilykhah S et al[68]	26.40 ± 5.00 kg/m^2	24.70 ± 4.40 kg/m^2
Cheng Y et al[71]	21.17 ± 2.62 kg/m^2	20.64 ± 2.59 kg/m^2
Li W et al[74]	23.15 ± 7.28 kg/m^2	21.18 ± 5.21 kg/m^2
Pandey R et al[76]	26.59 ± 3.86 kg/m^2	24.16 ± 2.16 kg/m^2

In the present study, the majority of mothers in both groups were multigravida, with the remainder being primigravida. Comparative analysis revealed no statistically significant difference between the groups regarding parity. This finding aligns with previous studies, such as those by Poonguzhalai S et al[69], Moghaddam FF et al[70], Pandey R et al[76], and Anushree et al, which also reported a predominance of

multigravida mothers. This consistency with prior research stresses the strength of our study's findings and enhances their relevance to similar populations.

In present study, gestational age at the time of data collection ranged from 16 to 24 weeks in both groups. Comparative analysis indicated no statistically significant difference in gestational age between 2 groups. This finding diverges from previous studies, as detailed in the accompanying table, where variations in gestational age were noted depending on the study populations.

Table 17: Comparison of mean gestational age with the previous literatures

Studies	GDM group	Non-GDM group
Present Study	19.72 ± 2.89 weeks	20.45 ± 2.75 weeks
Cheng Y et al[71]	13.95 ± 2.15 weeks	14.54 ± 2.44 weeks
Li W et al[74]	12.56 ± 1.18 weeks	12.21 ± 1.25 weeks
Zhang X et al[75]	16.50 ± 1.20 weeks	16.40 ± 1.40 weeks
Anushree N et al[77]	27.10 ± 4.52 weeks	25.10 ± 5.35 weeks

In the study, 53.2% of mothers in GDM group had a family history of GDM, significantly higher than 14.9% observed in Non-GDM group. Comparative analysis revealed a statistically significant difference between the groups concerning family history of GDM. This finding is consistent with previous studies by Cheng Y et al[71], Sun C et al[73], Zhang X et al[75], and Pandey R et al[76], which also reported a higher prevalence of GDM among those with a family history. This stresses the importance of familial medical history in assessing individual risk factors for gestational diabetes mellitus, reinforcing relevance of these findings in clinical practice.

In the GDM group, 44.1% mothers had an history of GDM, compared to none in Non-GDM group. Comparative analysis revealed a statistically significant difference in incidence of previous GDM. Similar findings in studies by Soheilykhah S et al., Moghaddam FF et al., Chauhan P et al., and Li W et al., emphasize the importance of prior GDM experiences in predisposing individuals to recurrent gestational diabetes. This insight is crucial for informing management strategies and risk assessments in subsequent pregnancies

In GDM group, 20.6% of mothers reported a history of previous big babies, contrasting with 3.8% in Non-GDM group. Comparative analysis showed significant difference in previous big baby occurrences between 2 groups.Similar findings seen in studies by Poonguzhalai S et al[69], Cheng Y et al[71], Zhang X et al[75], and Pandey R et al[76] emphasizing the potential link between gestational diabetes mellitus and fetal macrosomia. This highlights the importance of monitoring and managing maternal health to reduce such risks in future pregnancies

In GDM group, 23.5% of mothers had previous intrauterine deaths, comparing with 7.7% in the Non-GDM group. However, analysis found no statistically significant difference with respect to previous intrauterine deaths between 2 groups. Findings in studies by Cheng Y et al[71], Chauhan P et al[72], Li W et al[74], and Anushree N et al[77]. suggest that while there's a disparity in incidence rates between groups, this factor may not significantly contribute to gestational diabetes mellitus development in subsequent pregnancies.

In the study, the majority of cases in the GDM group exhibited serum ferritin levels ranging from 61 to 90 ng/mL (38.3%), while in the Non-GDM group, most had levels

below 30 ng/mL (36.2%). Comparative analysis showed statistically significant difference existing between the groups regarding serum ferritin levels. This observation is consistent with the findings from previous studies, as detailed in the accompanying table. The significance of these results underlines the potential relevance of serum ferritin values in context of gestational diabetes mellitus, highlighting avenues for further research and potential implications for clinical management

Table 18: Comparison of mean serum ferritin levels with the previous literatures

Studies	GDM group	Non-GDM group
Present Study	77.19 ± 32.88 ng/mL	48.43 ± 26.93 ng/mL
Soheilykhah S et al[68]	41.00 ± 35.00 ng/mL	35.50 ± 30.73 ng/mL
Poonguzhalai S et al[69]	30.83 ± 20.61 ng/mL	23.48 ± 10.91 ng/mL
Cheng Y et al[71]	65.67 ± 39.66 ng/mL	46.83 ± 6.60 ng/mL
Chauhan P et al[72]	38.10 ± 4.60 ng/mL	33.50 ± 2.70 ng/mL
Pandey R et al[76]	56.44 ± 19.19 ng/mL	27.62 ± 12.11 ng/mL
Anushree N et al[77]	46.40 ± 11.92 ng/mL	37.30 ± 11.04 ng/mL

The study revealed positive correlation existing between serum ferritin levels & OGCT levels, with statistical significance. This implies that an increase in OGCT levels significantly elevates serum ferritin levels, indicating heightened levels among individuals with poor sugar control. Being consistent with our findings, previous studies done by Poonguzhalai S et al[69], Cheng Y et al[71], Pandey R et al[76], and Anushree N et al[77], have also identified this correlation. This association underscores the potential utility of serum ferritin levels as a biomarker for evaluating glycemic control, providing valuable insights into the interaction between iron metabolism and glucose regulation in gestational diabetes mellitus.

In our study, Among mothers with GDM, the majority were treated with oral hypoglycemic agents (51.1%), followed by insulin therapy (36.2%), and a smaller

group managed through medical nutrition therapy (12.8%). Serum ferritin levels were compared in treatment groups, revealing the highest average levels in those receiving insulin (111.88 ± 17.57 ng/mL), followed by on oral hypoglycemics (64.58 ± 17.15 ng/mL), and the lowest in those on medical nutrition therapy (29.33 ± 1.03 ng/mL). Statistical analysis showed a significant difference in serum ferritin levels between 2 groups.Similar findings in previous studies, including those by Poonguzhalai S et al., Cheng Y et al., Pandey R et al., and Anushree N et al., support these observations, telling the impact of treatment modalities on serum ferritin levels among mothers with GDM.

SUMMARY

SUMMARY

Present study at RLJH Hospital.All women included in the study had examinations and investigations, including OGCT, after basic demographic information, obstetrical history, and medical records were taken.They are classified into GDM and Non-GDM groups based on OGCT results, with each groups comprising 50% of the total.

OGCT levels confirmed GDM with a mean of 167.77 ± 13.83 mg/dL, compared to 111.17 15.93 mg/dL in Non GDM groupThe mean age of participants was similar in both groups (GDM: 26.45 ± 3.46years, Non GDM: 26.51 ± 3.75 years). BMI distribution showed more overweight and obese pregnant women in the GDM group, though difference was not statistically significant.

Most participants are multigravida, with no significant parity differences. Gestational age ranged from 16 to 24 weeks, with no statistical difference between groups.
A family history of GDM was significantly greater in the GDM group (53.2% compared to 14.9% in Non-GDM). Previous GDM incidence was also significantly higher in the GDM group (44.1% compared to none in Non-GDM). Similarly, the GDM group had a significantly higher incidence of delivering large babies.

Serum ferritin levels differed significantly between groups (GDM:77.19 ± 32.88ng/mL, Non-GDM: 48.43 ± 26.93 ng/mL), indicating an association with GDM. Majority in the GDM group had serum ferritin levels between 61-90 ng/mL, while in Non-GDM group, it was predominantly below 30 ng/mL.

The commonest treatment among GDM mothers was oral hypoglycemic agents (51.1%), followed by insulin therapy (36.2%), and medical nutrition therapy (12.8%).

Serum ferritin levels showed a positive association with OGCT levels, indicating elevated ferritin levels among those with poor sugar control. Further analysis revealed significant differences in serum ferritin levels among GDM mothers

based on treatment mode, with insulin therapy showing the highest mean serum ferritin levels followed by oral hypoglycemics and medical nutrition therapy.

- In summary, the study elucidates significant associations between GDM and factors such as family history, previous GDM incidence, serum ferritin levels, and treatment modalities, providing valuable insights into GDM management strategies.

CONCLUSION

CONCLUSION

The findings of present study reveal a significant difference in serum ferritin levels between pregnant women with gestational diabetes mellitus (GDM) and those without GDM. The GDM group had a markedly higher average serum ferritin level, indicating a possible link between elevated serum ferritin and the presence of GDM

The study recognised significant relation between serum ferritin and oral glucose challenge test (OGCT) values, suggesting that elevated OGCT levels may lead to increased serum ferritin,especially in individuals with poor glycemic control.Serum ferritin levels varied significantly based on the type of GDM treatment as in patients receiving insulin therapy showing the highest levels

These findings help us in understanding of the pathogenesis of GDM and enlightens the potential of serum ferritin as a biomarker for the diagnosis and treatment of GDM. Further research into the causes and clinical implications of these relationships is needed, which can help us to create personalized prevention and treatment strategies for GDM.

LIMITATIONS

One significant limitation of the study is the relatively small sample size of 94 pregnant women, which may affect the generalizability of the findings. A larger cohort would provide more robust data and enable more comprehensive statistical analysis. Additionally, the study's cross-sectional design limits the ability to establish causality between elevated serum ferritin levels and gestational diabetes mellitus (GDM). Longitudinal studies would be more effective in exploring the temporal relationship between these variables and the progression of GDM. The study also relied heavily on serum ferritin as a biomarker for iron status without considering other iron-related parameters, such as transferrin saturation or total iron-binding capacity, which could provide a more comprehensive understanding of iron metabolism in GDM. Furthermore, potential confounding factors such as dietary iron intake, supplementation, and inflammatory status were not adequately controlled or reported, potentially influencing serum ferritin levels and the study's outcomes.

Another limitation is the lack of ethnic diversity among the study participants, all of whom were from a specific geographic region in India. This homogeneity limits the applicability of the findings to broader populations with diverse genetic and environmental backgrounds. Additionally, the study did not account for other metabolic conditions or comorbidities that could affect serum ferritin levels and GDM risk, such as obesity, metabolic syndrome, or chronic inflammation. The exclusion of these factors may have led to an overestimation or underestimation of the association between serum ferritin and GDM.

RECOMMENDATIONS

To address these limitations, future research should aim to include a larger, more diverse sample size to enhance the generalizability of the findings. Longitudinal studies are recommended to explore the causal relationships between serum ferritin levels and the development of GDM over time. Including additional iron-related biomarkers and controlling for dietary iron intake, supplementation, and inflammatory markers would provide a more comprehensive assessment of iron metabolism in GDM. Moreover, expanding the study to include participants from various ethnic and geographical backgrounds would improve the applicability of the findings to a wider population.

It is also recommended to investigate the role of other metabolic conditions and comorbidities in the relationship between serum ferritin and GDM. This would involve detailed screening and stratification of participants based on the presence of obesity, metabolic syndrome, and other relevant conditions. Implementing standardized protocols for measuring and reporting these variables would enhance the comparability of results across different studies.

Lastly, integrating advanced statistical methods to adjust for potential confounders and interactions between variables would provide a more nuanced understanding of the relationship between serum ferritin and GDM. Collaborative multi-center studies could also be beneficial in pooling data to achieve more significant sample sizes and diverse participant groups, ultimately leading to more reliable and generalizable findings.

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ANNEXURES

PROFORMA

IP / OP NO:

NAME:

AGE:

ADDRESS:

OBSTETRIC SCORE:

MARITAL HISTORY:

MENSTRUAL HISTORY:

FAMILY HISTORY

H/o any family members having diabetes mellitus: Yes / No

PAST HISTORY

Diabetes mellitus: Yes / No

Hypertension: Yes / No

Thyroid disorder: Yes / No

OBSTETRIC HISTORY

LMP: **EDD:**

EXAMINATION

Height (in cm): **Weight (in kg):**

BMI (in kg/m^2):

INVESTIGATIONS

Test	Date	Results
Ferritin		
OGCT		

INFORMED CONSENT FORM

I Mr./Mrs. _____ have been explained in my own understandable language, that I will be included in a study which is Association of Elevated Serum Ferritin levels In Mid-Pregnancy and the risk of Gestational Diabetes Mellitus-Cross sectional study.

I have been explained that my clinical findings, investigations, postoperative findings will be assessed and documented for study purpose.

I have been explained my participation in this study is entirely voluntary, and I can withdraw from the study any time and this will not affect my relation with my doctor or the treatment for my ailment.

I have been explained about the interventions needed possible benefits and adversities due to interventions, in my own understandable language.

I have understood that all my details found during the study are kept confidential and while publishing or sharing of the findings, my details will be masked.

I have principal investigator mobile number for enquiries - 8296244129 I in my sound mind give full consent to be added in the part of this study.

Name of the patient

Signature of the patient

Date:

Place: Kolar

Name of the witness

Signature of the witness

Relation to the patient

Investigator signature

ಮಾಹಿತಿ ನೀಡಿದ ಒಪ್ಪಿಗೆ ನಮೂನೆ

ನಾನು ಶ್ರೀ/ಶ್ರೀಮತಿ. _____

ಎಲಿವೇಟೆಡ್ ಸೀರಮ್ ಫೆರಿಟಿನ್ ಮಟ್ಟಗಳ ಅಸೋಸಿಯೇಷನ್ ಮಧ್ಯ-ಗರ್ಭಾವಸ್ಥೆಯಲ್ಲಿ ಮತ್ತು ಗರ್ಭಾವಸ್ಥೆಯ ಮಧುಮೇಹ ಮೆಲ್ಲಿಟಸ್-ಕ್ರಾಸ್ ಸೆಕ್ಷನಲ್ ಅಧ್ಯಯನದ ಅಪಾಯದ ಅಧ್ಯಯನದಲ್ಲಿ ನನ್ನನ್ನು ಸೇರಿಸಲಾಗುವುದು.

ನನ್ನ ಕ್ಲಿನಿಕಲ್ ಸಂಶೋಧನೆಗಳು, ತನಿಖೆಗಳು, ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಯ ನಂತರದ ಸಂಶೋಧನೆಗಳನ್ನು ಮೌಲ್ಯಮಾಪನ ಮಾಡಲಾಗುತ್ತದೆ ಮತ್ತು ಅಧ್ಯಯನ ಉದ್ದೇಶಕ್ಕಾಗಿ ದಾಖಲಿಸಲಾಗುತ್ತದೆ ಎಂದು ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.

ಈ ಅಧ್ಯಯನದಲ್ಲಿ ನನ್ನ ಭಾಗವಹಿಸುವಿಕೆಯು ಸಂಪೂರ್ಣವಾಗಿ ಸ್ವಯಂಪ್ರೇರಿತವಾಗಿದೆ ಎಂದು ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ ಮತ್ತು ನಾನು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಅಧ್ಯಯನದಿಂದ ಹಿಂದೆ ಸರಿಯಬಹುದು ಮತ್ತು ಇದು ನನ್ನ ವೈದ್ಯರೊಂದಿಗಿನ ನನ್ನ ಸಂಬಂಧ ಅಥವಾ ನನ್ನ ಕಾಯಿಲೆಯ ಚಿಕಿತ್ಸೆಯ ಮೇಲೆ ಪರಿಣಾಮ ಬೀರುವುದಿಲ್ಲ.

ನನ್ನ ಸಂವ್ತ ಅರ್ಥವಾಗುವ ಭಾಷೆಯಲ್ಲಿ ಮಧ್ಯಸ್ಥಿಕೆಗಳಿಂದಾಗಬಹುದಾದ ಪ್ರಯೋಜನಗಳು ಮತ್ತು ಪ್ರತಿಕೂಲತೆಗಳ ಅಗತ್ಯವಿರುವ ಮಧ್ಯಸ್ಥಿಕೆಗಳ ಬಗ್ಗೆ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.

ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ಪತ್ತೆಯಾದ ನನ್ನ ಎಲ್ಲಾ ವಿವರಗಳನ್ನು ಗೌಪ್ಯವಾಗಿ ಇರಿಸಲಾಗಿದೆ ಮತ್ತು ಸಂಶೋಧನೆಗಳನ್ನು ಪ್ರಕಟಿಸುವಾಗ ಅಥವಾ ಹಂಚಿಕೊಳ್ಳುವಾಗ, ನನ್ನ ವಿವರಗಳನ್ನು ಮರೆಮಾಚಲಾಗುತ್ತದೆ ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

ವಿಚಾರಣೆಗಾಗಿ ನಾನು ಪ್ರಧಾನ ತನಿಖಾಧಿಕಾರಿಯ ಮೊಬೈಲ್ ಸಂಖ್ಯೆಯನ್ನು ಹೊಂದಿದ್ದೇನೆ - 8296244129 ಈ ಅಧ್ಯಯನದ ಭಾಗದಲ್ಲಿ ಸೇರಿಸಲು ನನ್ನ ಮನಸ್ಸಿನಲ್ಲಿ ನಾನು ಸಂಪೂರ್ಣ ಒಪ್ಪಿಗೆಯನ್ನು ನೀಡುತ್ತೇನೆ.

ರೋಗಿಯ ಹೆಸರು

ರೋಗಿಯ ಸಹಿ

ದಿನಾಂಕ:

ಸ್ಥಳ: ಕೋಲಾರ

ಸಾಕ್ಷಿಯ ಹೆಸರು

ಸಾಕ್ಷಿಯ ಸಹಿ

ರೋಗಿಗೆ ಸಂಬಂಧ

ತನಿಖಾಧಿಕಾರಿ ಸಹಿ

PATIENT INFORMATION SHEET

Study title

Association of Elevated Serum Ferritin levels with Gestational Diabetes Mellitus In Pregnancy and the risk of Gestational Diabetes Mellitus

Name of the Investigator:

Dr. LAKSHMI NALLA

Name of the Participant:

Name of the Institution:

SRI DEVRAJ URS MEDICAL COLLEGE TAMAKA KOLAR, KARNATAKA

I am over 18 years of age and, exercising my free power of choice, hereby give my consent to be included as a participant in this study. I was free to ask any questions and they have been answered.

1. I have read and understood this consent form and the information provided to me. I have had the consent document explained to me. I have been explained about the nature of the study.
2. I have been explained about my rights and responsibilities by the investigator.
3. I have informed the investigator of all the treatments I am taking or have taken in the past months/years including any native (alternative) treatments.
4. I have been advised about the risks associated with my participation in the study.*

2. I have not participated in any research study within the past _____ month(s).*
3. I have been explained about the cost of the study and that is 600 Rs
4. I have been also explained about the cost and also the amount required to get serum ferritin levels will be taken care by the priniciple investigator.
5. I am aware of the fact that I can opt out of the study at any time without having to give any reasoned this will not affect my future treatment in this hospital.*
6. I am also aware that the investigators may terminate my participation in the study at any time, for any reason, without my consent.
7. I hereby give permission to the investigators to release the information obtained from me as result of participation in this study to the sponsors, regulatory authorities, Govt. agencies, and IEC if required\. I understand that my identity will be kept confidential if my data are publicly presented.
8. I have had my questions answered to my satisfaction

I consent voluntarily to participate in the research/study. I am aware that if I have any question during this study, I should contact the investigator. By signing this consent form, I attest that the information given in this document has been clearly explained to me and understood by me. I will be given a copy of this consent document.

For any further information contact

Dr LAKSHMI NALLA (Ph: 829624129)

Signature/thumb impression of the patient

ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆ

ಅಧ್ಯಯನದ ಶೀರ್ಷಿಕೆ

ಗರ್ಭಾವಸ್ಥೆಯಲ್ಲಿ ಗರ್ಭಾವಸ್ಥೆಯ ಮಧುಮೇಹ ಮೆಲ್ಲಿಟಸ್‌ನೊಂದಿಗೆ ಎಲಿವೇಟೆಡ್ ಸೀರಮ್ ಫೆರಿಟಿನ್ ಮಟ್ಟಗಳ ಅಸೋಸಿಯೇಷನ್ ಮತ್ತು ಗರ್ಭಾವಸ್ಥೆಯ ಮಧುಮೇಹ ಮೆಲ್ಲಿಟಸ್ ಅಪಾಯ

ತನಿಖಾಧಿಕಾರಿಯ ಹೆಸರು:

ಡಾ. ಲಕ್ಷ್ಮಿ ನಲ್ಲ

ಭಾಗವಹಿಸುವವರ ಹೆಸರು:

ಸಂಸ್ಥೆಯ ಹೆಸರು:

ಶ್ರೀ ದೇವರಾಜ್ ಯುಆರ್ಎಸ್ ವೈದ್ಯಕೀಯ ಕಾಲೇಜು ತಮಕ ಕೋಲಾರ, ಕರ್ನಾಟಕ

ನಾನು 18 ವರ್ಷಕ್ಕಿಂತ ಮೇಲ್ಪಟ್ಟವನಾಗಿದ್ದೇನೆ ಮತ್ತು ನನ್ನ ಆಯ್ಕೆಯ ಮುಕ್ತ ಅಧಿಕಾರವನ್ನು ಚಲಾಯಿಸುತ್ತಿದ್ದೇನೆ, ಈ ಮೂಲಕ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳುವವನಾಗಿ ಸೇರಿಸಿಕೊಳ್ಳಲು ನನ್ನ ಒಪ್ಪಿಗೆಯನ್ನು ನೀಡುತ್ತೇನೆ. ನಾನು ಯಾವುದೇ ಪ್ರಶ್ನೆಗಳನ್ನು ಕೇಳಲು ಸ್ವತಂತ್ರನಾಗಿದ್ದೆ ಮತ್ತು ಅವುಗಳಿಗೆ ಉತ್ತರಿಸಲಾಗಿದೆ.

1. ನಾನು ಈ ಒಪ್ಪಿಗೆ ನಮೂನೆ ಮತ್ತು ನನಗೆ ಒದಗಿಸಿದ ಮಾಹಿತಿಯನ್ನು ಓದಿದ್ದೇನೆ ಮತ್ತು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ. ನಾನು ಒಪ್ಪಿಗೆಯ ದಾಖಲೆಯನ್ನು ನನಗೆ ವಿವರಿಸಿದ್ದೇನೆ. ಅಧ್ಯಯನದ ಸ್ವರೂಪದ ಬಗ್ಗೆ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.
2. ತನಿಖಾಧಿಕಾರಿಯಿಂದ ನನ್ನ ಹಕ್ಕುಗಳು ಮತ್ತು ಜವಾಬ್ದಾರಿಗಳ ಬಗ್ಗೆ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.

3. ಯಾವುದೇ ಸ್ಥಳೀಯ (ಪರ್ಯಾಯ) ಚಿಕಿತ್ಸೆಗಳನ್ನು ಒಳಗೊಂಡಂತೆ ಕಳೆದ ತಿಂಗಳು/ವರ್ಷಗಳಲ್ಲಿ ನಾನು ತೆಗೆದುಕೊಳ್ಳುತ್ತಿರುವ ಅಥವಾ ತೆಗೆದುಕೊಂಡಿರುವ ಎಲ್ಲಾ ಚಿಕಿತ್ಸೆಗಳ ಕುರಿತು ತನಿಖಾಧಿಕಾರಿಗೆ ತಿಳಿಸಿದ್ದೇನೆ.

4. ಅಧ್ಯಯನದಲ್ಲಿ ನನ್ನ ಭಾಗವಹಿಸುವಿಕೆಗೆ ಸಂಬಂಧಿಸಿದ ಅಪಾಯಗಳ ಕುರಿತು ನನಗೆ ಸಲಹೆ ನೀಡಲಾಗಿದೆ.*

5. ನಾನು ಕಳೆದ _____ ತಿಂಗಳು(ಗಳು) ಒಳಗೆ ಯಾವುದೇ ಸಂಶೋಧನಾ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಿಲ್ಲ.*

6. ಅಧ್ಯಯನದ ವೆಚ್ಚದ ಬಗ್ಗೆ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ ಮತ್ತು ಅದು 600 ರೂ

7. ವೆಚ್ಚದ ಬಗ್ಗೆಯೂ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ ಮತ್ತು ಸೀರಮ್ ಫೆರಿಟಿನ್ ಮಟ್ಟವನ್ನು ಪಡೆಯಲು ಅಗತ್ಯವಿರುವ ಮೊತ್ತವನ್ನು ತತ್ವ ತನಿಖಾಧಿಕಾರಿಗಳು ನೋಡಿಕೊಳ್ಳುತ್ತಾರೆ.

8. ಯಾವುದೇ ಕಾರಣವನ್ನು ನೀಡದೆಯೇ ನಾನು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಅಧ್ಯಯನದಿಂದ ಹೊರಗುಳಿಯಬಹುದು ಎಂಬ ಸತ್ಯದ ಬಗ್ಗೆ ನನಗೆ ತಿಳಿದಿದೆ, ಇದು ಈ ಆಸ್ಪತ್ರೆಯಲ್ಲಿ ನನ್ನ ಭವಿಷ್ಯದ ಚಿಕಿತ್ಸೆಯ ಮೇಲೆ ಪರಿಣಾಮ ಬೀರುವುದಿಲ್ಲ.*

9. ತನಿಖಾಧಿಕಾರಿಗಳು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ, ಯಾವುದೇ ಕಾರಣಕ್ಕಾಗಿ, ನನ್ನ ಒಪ್ಪಿಗೆಯಿಲ್ಲದೆ ಅಧ್ಯಯನದಲ್ಲಿ ನನ್ನ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ಕೊನೆಗೊಳಿಸಬಹುದು ಎಂದು ನನಗೆ ತಿಳಿದಿದೆ.

10. ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಿದ ಪರಿಣಾಮವಾಗಿ ನನ್ನಿಂದ ಪಡೆದ ಮಾಹಿತಿಯನ್ನು ಪ್ರಾಯೋಜಕರು, ನಿಯಂತ್ರಣ ಪ್ರಾಧಿಕಾರಗಳು, ಸರ್ಕಾರಕ್ಕೆ ಬಿಡುಗಡೆ ಮಾಡಲು ತನಿಖಾಧಿಕಾರಿಗಳಿಗೆ ನಾನು ಈ ಮೂಲಕ ಅನುಮತಿ ನೀಡುತ್ತೇನೆ. ಏಜೆನ್ಸಿಗಳು, ಮತ್ತು ಅಗತ್ಯವಿದ್ದರೆ IEC\. ನನ್ನ ಡೇಟಾವನ್ನು

ಸಾರ್ವಜನಿಕವಾಗಿ ಪ್ರಸ್ತುತಪಡಿಸಿದರೆ ನನ್ನ ಗುರುತನ್ನು ಗೌಪ್ಯವಾಗಿ ಇರಿಸಲಾಗುವುದು ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

11. ನನ್ನ ಪ್ರಶ್ನೆಗಳಿಗೆ ನನ್ನ ತೃಪ್ತಿಗೆ ಉತ್ತರ ಸಿಕ್ಕಿದೆ

ಸಂಶೋಧನೆ/ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನಾನು ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಸಮ್ಮತಿಸುತ್ತೇನೆ. ಈ ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ನಾನು ಯಾವುದೇ ಪ್ರಶ್ನೆಗಳನ್ನು ಹೊಂದಿದ್ದರೆ, ನಾನು ತನಿಖಾಧಿಕಾರಿಯನ್ನು ಸಂಪರ್ಕಿಸಬೇಕು ಎಂದು ನನಗೆ ತಿಳಿದಿದೆ. ಈ ಸಮ್ಮತಿಯ ನಮೂನೆಗೆ ಸಹಿ ಮಾಡುವ ಮೂಲಕ, ಈ ಡಾಕ್ಯುಮೆಂಟ್‌ನಲ್ಲಿ ನೀಡಲಾದ ಮಾಹಿತಿಯನ್ನು ನನಗೆ ಸ್ಪಷ್ಟವಾಗಿ ವಿವರಿಸಲಾಗಿದೆ ಮತ್ತು ನನಗೆ ಅರ್ಥವಾಗಿದೆ ಎಂದು ನಾನು ದೃಢೀಕರಿಸುತ್ತೇನೆ. ಈ ಒಪ್ಪಿಗೆಯ ದಾಖಲೆಯ ಪ್ರತಿಯನ್ನು ನನಗೆ ನೀಡಲಾಗುವುದು.

ಯಾವುದೇ ಹೆಚ್ಚಿನ ಮಾಹಿತಿಗಾಗಿ ಸಂಪರ್ಕಿಸಿ

ಡಾ ಲಕ್ಷ್ಮಿ ನಲ್ಲ (Ph: 829624129)

ರೋಗಿಯ ಸಹಿ/ಹೆಬ್ಬೆರಳಿನ ಗುರುತು

MASTER CHART

Sl No	Group	OGCT	Age (in years)	GA (in weeks)	BMI (in kg/sqm)	Parity	Family History	Previous GDM	Previous Big Baby	Previous IUD	Treatment	Serum Ferritin (in ng/mL)
1	GDM	162	28	16	26.3	Multi	Yes	No	No	No	OHA	68
2	GDM	166	31	20	27.2	Multi	Yes	Yes	No	Yes	OHA	76
3	GDM	150	25	19	20.7	Multi	No	No	No	No	MNT	31
4	GDM	188	33	17	33.4	Primi	Yes				Insulin	131
5	GDM	168	26	23	28.2	Multi	No	Yes	No	No	OHA	85
6	GDM	163	29	16	26.4	Multi	No	Yes	No	No	OHA	71
7	GDM	189	26	24	34.4	Primi	Yes				Insulin	137
8	GDM	168	26	18	27.7	Multi	Yes	No	No	No	OHA	82
9	GDM	181	26	21	30.4	Multi	No	Yes	No	No	Insulin	104
10	GDM	155	22	19	23.7	Primi	No				OHA	44
11	GDM	154	30	17	21.6	Multi	No	No	No	No	OHA	39
12	GDM	186	27	21	32.1	Multi	Yes	Yes	No	No	Insulin	123
13	GDM	169	27	21	27.9	Multi	Yes	No	No	No	OHA	81
14	GDM	146	27	21	19.2	Multi	Yes	No	No	No	MNT	29
15	GDM	174	23	24	29.1	Multi	No	Yes	No	No	Insulin	89
16	GDM	184	23	24	30.5	Multi	Yes	Yes	Yes	No	Insulin	98
17	GDM	166	26	17	27.1	Multi	No	No	No	No	OHA	75
18	GDM	166	25	21	26.7	Primi	Yes				OHA	74
19	GDM	157	31	24	24.4	Multi	No	No	No	Yes	OHA	55
20	GDM	158	24	23	25.4	Multi	Yes	No	No	No	OHA	59
21	GDM	180	23	18	30.1	Primi	No				Insulin	93
22	GDM	142	25	19	18.3	Multi	Yes	No	No	No	MNT	29
23	GDM	168	27	24	27.6	Multi	No	Yes	Yes	No	OHA	79
24	GDM	170	24	17	28.7	Primi	No				OHA	87
25	GDM	188	23	18	34.2	Multi	No	Yes	Yes	No	Insulin	130
26	GDM	145	35	21	18.2	Multi	No	No	No	No	MNT	28
27	GDM	171	24	21	28.9	Multi	Yes	No	No	No	Insulin	88
28	GDM	147	29	24	19.8	Primi	No				MNT	29
29	GDM	151	30	16	21.3	Multi	Yes	No	No	No	OHA	32
30	GDM	187	29	20	32.8	Multi	Yes	No	No	Yes	Insulin	124
31	GDM	181	34	21	30.7	Multi	Yes	No	No	No	Insulin	97
32	GDM	183	26	18	30.8	Primi	Yes				Insulin	105
33	GDM	164	23	21	26.5	Multi	No	Yes	No	No	OHA	73
34	GDM	185	30	17	32.4	Multi	No	Yes	Yes	Yes	Insulin	122
35	GDM	179	28	24	29.4	Multi	Yes	Yes	Yes	Yes	Insulin	90

36	GDM	158	27	17	22.5	Multi	Yes	No	No	No	OHA	42
37	GDM	156	21	24	21.9	Primi	No				OHA	36
38	GDM	190	26	16	34.6	Multi	Yes	Yes	Yes	Yes	Insulin	139
39	GDM	159	21	17	25.9	Primi	No				OHA	63
40	GDM	186	21	16	31.7	Primi	Yes				Insulin	119
41	GDM	185	23	20	31.2	Multi	No	No	No	No	Insulin	113
42	GDM	155	25	17	25.3	Multi	Yes	No	No	No	OHA	53
43	GDM	152	22	16	20.4	Primi	Yes				MNT	30
44	GDM	157	27	22	25.1	Primi	No				OHA	48
45	GDM	167	29	17	27.4	Multi	Yes	No	No	Yes	OHA	77
46	GDM	169	24	16	28.4	Multi	Yes	Yes	Yes	Yes	OHA	86
47	GDM	160	32	24	26.2	Multi	No	Yes	No	No	OHA	65
48	Non-GDM	111	29	19	24.5	Multi	No	No	No	No		41
49	Non-GDM	84	27	21	17.5	Multi	No	No	No	No		13
50	Non-GDM	108	22	22	23.5	Primi	No					40
51	Non-GDM	102	33	23	22.3	Multi	No	No	No	No		28
52	Non-GDM	103	24	23	22.4	Primi	No					29
53	Non-GDM	88	31	21	18.2	Multi	No	No	No	No		16
54	Non-GDM	130	25	16	30.7	Primi	No					84
55	Non-GDM	89	31	19	19.9	Multi	No	No	No	No		18
56	Non-GDM	122	27	19	28.4	Multi	No	No	No	Yes		68
57	Non-GDM	133	23	18	31.2	Primi	No					89
58	Non-GDM	91	32	16	20.9	Multi	No	No	No	No		20
59	Non-GDM	116	30	19	26.8	Multi	No	No	No	No		54
60	Non-GDM	101	29	20	22.3	Multi	No	No	No	No		26
61	Non-GDM	136	28	17	34.6	Primi	No					98
62	Non-GDM	129	21	24	30.4	Primi	Yes					81
63	Non-GDM	92	23	16	20.5	Multi	No	No	No	No		20
64	Non-GDM	112	24	24	25.2	Multi	No	No	No	No		42
65	Non-GDM	87	25	22	18.1	Multi	No	No	No	No		15
66	Non-GDM	93	31	22	20.7	Multi	Yes	No	No	No		19
67	Non-GDM	90	25	22	19.5	Multi	No	No	No	No		16
68	Non-GDM	110	21	20	23.7	Primi	No					37
69	Non-GDM	85	28	16	17.7	Multi	No	No	No	No		10
70	Non-GDM	106	21	18	23.4	Primi	Yes					32
71	Non-GDM	115	22	21	26.3	Primi	No					53
72	Non-GDM	121	23	22	27.7	Primi	Yes					62
73	Non-GDM	123	21	24	29.4	Primi	No					76
74	Non-GDM	118	32	22	26.9	Primi	Yes					54
75	Non-GDM	124	28	17	29.1	Multi	No	No	Yes	No		74

76	Non-GDM	97	26	24	21.6	Multi	No	No	No	No		24
77	Non-GDM	134	33	24	33.8	Primi	Yes					92
78	Non-GDM	105	28	21	23.3	Multi	No	No	No	No		32
79	Non-GDM	95	21	24	21.3	Multi	No	No	No	No		22
80	Non-GDM	119	28	16	27.1	Multi	No	No	No	No		55
81	Non-GDM	126	28	18	30.2	Primi	No					78
82	Non-GDM	115	32	19	26.6	Multi	No	No	No	Yes		51
83	Non-GDM	120	26	16	27.2	Primi	No					58
84	Non-GDM	134	25	18	31.5	Primi	No					91
85	Non-GDM	113	26	24	25.4	Multi	No	No	No	No		43
86	Non-GDM	139	24	22	33.9	Primi	No					94
87	Non-GDM	114	30	22	25.9	Multi	No	No	No	No		48
88	Non-GDM	124	28	21	29.9	Primi	No					78
89	Non-GDM	122	33	23	28.1	Primi	No					66
90	Non-GDM	98	22	24	21.7	Multi	No	No	No	No		25
91	Non-GDM	104	26	17	22.7	Multi	No	No	No	No		30
92	Non-GDM	131	22	24	30.9	Primi	No					87
93	Non-GDM	128	29	19	29.8	Primi	Yes					72
94	Non-GDM	88	23	22	18.4	Multi	No	No	No	No		15