"ASSESSMENT OF GESTATIONAL DIABETES MELLITUS AMONG FIRST TRIMESTER PREGNANT WOMEN – A COMMUNITY BASED LONGITUDINAL STUDY"

Submitted by

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LIST OF ABBREVIATIONS USED

SL.NO	ABBREVIATIONS	EXPANSION OF THE ABBREVIATIONS
1.	DM	Diabetes Mellitus
2.	LMICs	Low- And Middle-Income Countries
3.	T1DM	Type 1 Diabetes Mellitus
4.	T2DM	Type 2 Diabetes Mellitus
5.	GDM	Gestational Diabetes Mellitus
6.	cGDM	Conventional Gestational Diabetes Mellitus
7.	eGDM	Early Gestational Diabetes Mellitus
8.	IADPSG	International Association of Diabetes in Pregnancy Study Groups
9.	WHO	World Health Organization
10.	ADA	American Diabetes Association
11.	HbA1c	Glycated Hemoglobin
12.	LGA	Large-For-Gestational-Age
13.	FPG	Fasting Plasma Glucose
14.	OGTT	Oral Glucose Tolerance Test
15.	ADIPS	Australasian Diabetes in Pregnancy Society
16.	DIPSI	Diabetes in Pregnancy Study Group of India
17.	FOGSI	Federation of Obstetric and Gynecological Societies of
18.	GOD-POD	Glucose Oxidase-Peroxidase
19.	TFR	Total Fertility Rate
20.	NFHS	National Family Health Survey
21.	NCD	Non-Communicable Diseases
22.	MODY	Maturity-Onset Diabetes Of The Young

23.	NPCDCS	National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases, and Stroke
24.	NPNCD	National Programme for Prevention and Control of Non-communicable Diseases
25.	hPL	Human Placental Lactogen
26.	FFA	Free Fatty Acids
27.	TNF-α	Tumor Necrosis Factor- α
28.	IL-6	Interleukin-6
29.	DNA	Deoxyribonucleic acid
30.	PCOS	Polycystic Ovary Syndrome
31.	GLP-1	Glucagon-like peptide-1
32.	NICU	Neonatal Intensive Care Unit
33.	PE	Preeclampsia
34.	CD	Cesarean Delivery
35.	PPH	Postpartum Hemorrhage
36.	COVID - 19	Coronavirus disease 2019
37.	CVD	Cardiovascular Disease
38.	GGI	Gestational Glucose Intolerance
39.	ANC	Antenatal Clinic
40.	SDH	Sub-District Hospital
41.	WINGS	Women and Infants Integrated Interventions for Growth Study
42.	IGT	Impaired Glucose Tolerance
43.	OR	Odd's Ratio
44.	AUC	Area Under the Curve
45.	FCG	Fasting Capillary Blood Glucose
46.	ROC	Receiver Operating Characteristic

47.	FBS	Fasting Blood Sugar
48.	CBC	Complete Blood Count
49.	HB	Hemoglobin
50.	Hct	Hematocrit
51.	RBC	Red Blood Cell Count
52.	GWG	Gestational Weight Gain
53.	HAPO	Hyperglycemia and Adverse Pregnancy Outcome
54.	LTPA	Leisure-Time Physical Activity
55.	PRAMS	Pregnancy Risk Assessment Monitoring System
56.	IPAQ	International Physical Activity Questionnaire
57.	FinnGeDi	Finnish Gestational Diabetes
58.	NICE	The National Institute for Health and Care Excellence
59.	AOR	Adjusted Odds Ratio
60.	SD	Standard Deviation
61.	CI	Confidence Interval
62.	BMI	Body Mass Index
63.	SuPAR	Soluble Urokinase Plasminogen Activator Receptor
64.	IOM	Institute of Medicine
65.	eHEALS	Electronic Health Literacy Scale
66.	JNMC	Jawaharlal Nehru Medical College
67.	PHC	Primary Health Centre
68.	UHC	Urban Primary Health Centre
69.	GA	Gestational Age
70.	PPE	Personal Protective Equipment
71.	SPSS	Statistical Package for Social Sciences
72.	FBG	Fasting Blood Glucose
73.	PPV	Positive Predictive Value

74.	NPV	Negative Predictive Value
75.	CPI	Consumer Price Index
76.	CF	Correction Factor
77.	TB	Tuberculosis
78.	HIV	Human Immunodeficiency Virus
79.	HbsAg	hepatitis B surface antigen
80.	TSH	Thyroid-Stimulating Hormone
81.	IOTF	International Obesity Task Force
82.	BP	Blood Pressure
83.	PID	Pelvic Inflammatory Disease
84.	UTI	Urinary Tract Infection
85.	LSCS	Lower Segment Caesarean Section
86.	LBW	Low Birth Weight
87.	HBW	High Birth Weight
88.	BMV	Bag and Mask Ventilation
89.	PPV	Positive Pressure Ventilation
90.	CPAP	Continuous Positive Airway Pressure
91.	FHR	Fetal Heart Rate
92.	ASHA	Accredited Social Health Activists
93.	SES	Socio-Economic Status
94.	MNT	Medical Nutrition Therapy
95.	BOH	Bad Obstetric History
96.	LR	Likelihood Ratio
97.	APH	Antepartum Hemorrhage
98.	PROM	Premature Rupture Of Membrane

ABSTRACT

BACKGROUND AND OBJECTIVES

Gestational Diabetes Mellitus (GDM) is a significant metabolic disorder during pregnancy, associated with adverse maternal and neonatal outcomes. The prevalence of GDM has risen globally, particularly in low- and middle-income countries like India, where early detection and management remain challenging. This study aimed to determine the prevalence of GDM among first-trimester pregnant women in Belagavi district, Karnataka, and evaluate the predictive value of fasting blood glucose (FBG) compared to the oral glucose tolerance test (OGTT) and also to assess the risk factors associated with GDM.

METHODOLOGY

A community-based longitudinal study was conducted from 1st April 2023 to 31st January 2025 across four primary health centers in Belagavi. The study included 450 pregnant women aged 18–45 years in their first trimester (≤13 weeks). After obtaining the ethical clearance, pilot study was conducted. Written informed consent was obtained from every participant. Stratified proportionate sampling covered four health centers, with systematic random sampling selecting every third first-trimester registrant. Excluding those with diabetes or chronic illnesses. Data was collected using a structured questionnaire regarding the Sociodemographic characteristics, obstetric history, and biochemical assessments and pregnancy outcomes. Participants were screened using FBG and OGTT (75g anhydrous glucose) as per Diabetes in Pregnancy Study Group India (DIPSI) criteria (OGTT ≥140 mg/dL). Women with normal OGTT in 1st Trimester underwent repeat OGTT in the second trimester. Statistical analysis included chi square test, Fischer Exact test and 'P'value less than 0.05 considered significant and sensitivity, specificity, correlation, logistic regression, and ROC curve analysis was done.

RESULTS

This study found a prevalence of GDM, with 16.0% of first-trimester pregnant women testing positive by OGTT and 15.8% by FBG (≥92 mg/dL). In the second trimester, the prevalence was 6.3% by OGTT. For early detection, FBG demonstrated excellent predictive value with an optimal cutoff of 86 mg/dL, showing high sensitivity (97.22%) and specificity (82.80%), along with a strong positive likelihood ratio (9.55) and moderate correlation with OGTT (r=0.68). Significant risk factors for GDM included maternal age ≥25 years (AOR=1.82, p=0.042), excessive weight gain (>11 kg; AOR=4.27, p=0.013), and proteinuria (AOR=9.0, p=0.026), while family history of diabetes (AOR=1.41) and hypertension (AOR=1.60) showed non-significant trends. Importantly, GDM was strongly associated with adverse pregnancy outcomes, including polyhydramnios (47.2%), preterm labour (19.4%), and need for neonatal ventilatory support (73.6%), with p-values <0.001.

CONCLUSION AND INTERPRETATION

GDM prevalence in Belagavi is high, warranting universal screening in the first trimester, particularly targeting for high-risk groups, including older women and those with excessive weight gain, are recommended to improve maternal and neonatal health outcomes. Future research should focus on cost-effective management strategies validate FBG thresholds across diverse populations

Keywords: Gestational Diabetes Mellitus, first trimester screening, Fasting Blood Glucose, Oral Glucose Tolerance Test, Pregnancy Complications, Risk Factors.

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INTRODUCTION

Diabetes Mellitus (DM) is a chronic metabolic, inflammatory, vascular phenomenon characterized by persistently high blood sugar levels, resulting from insulin resistance, inadequate insulin production, or both. The complications arising due to inadequate management include heart disease, peripheral vascular diseases, kidney failure, nerve damage, and vision impairment. Beyond its health implications, diabetes significantly affects daily life and quality of life, imposing financial strain, reduced productivity and diminished overall well-being of individuals and their families. [2] Being a prevalent non-communicable disease of global concern, the prevalence of DM has risen sharply, from approximately 200 million in 1990 to 830 million by 2022, with low- and middle-income countries (LMICs) bearing the highest burden due to limited healthcare resources.[1] In 2021, diabetes and its related complications, particularly kidney disease, were responsible for over 2 million deaths worldwide. Additionally, elevated blood sugar levels contributed to approximately 11% of cardiovascular-related deaths, underscoring its widespread impact on public health. [3]

Diabetes Mellitus is a complex disease with multifactorial aetiology and can be classified into several types, including: Type 1 Diabetes Mellitus (T1DM), Type 2 Diabetes Mellitus (T2DM), Gestational Diabetes Mellitus (GDM), and other specific forms such as monogenic diabetes or secondary diabetes resulting from another disease or medication. Type 2 Diabetes Mellitus (T1DM) being the most prevalent type primarily characterized by insulin resistance, where the body's cells do not respond effectively to insulin, often accompanied by a gradual decline in insulin production and T1DM is an autoimmune disorder in which the immune system attacks and destroys insulin-producing beta cells in the pancreas, leading to insulin deficiency.

The Gestational Diabetes Mellitus is a significant metabolic condition leading to hyperglycemia that first appears during pregnancy. [4] Although it typically resolves after childbirth, its effects extend beyond immediate perinatal complications. Women with GDM have a higher risk of developing T2DM later in life. [5] The GDM is associated with several adverse maternal and neonatal outcomes, including macrosomia, neonatal hypoglycemia, and an increased likelihood of caesarean delivery. [6] Traditionally, GDM is diagnosed between the 24th and 28th weeks of pregnancy, a stage referred to as "conventional gestational diabetes mellitus" (cGDM). However, emerging research indicates that hyperglycemia can occur as early as the first trimester, leading to the recognition of a distinct condition known as early gestational diabetes mellitus (eGDM). [7]

A comprehensive review of 117 studies examining the incidence of GDM in India estimated an overall prevalence of 13% among pregnant women. However, the prevalence varied significantly across different region. The North zone reported the highest rate at 16.1%, followed by the South zone at 12.6%. The West zone had the lowest prevalence at 7%, while the East and North-east zones reported a prevalence of 11.5%. Additionally, GDM was found to be more common in urban areas (12%) compared to rural areas (10%).[8]

Differences in diagnostic criteria also influenced these prevalence estimates. Higher GDM prevalence was observed with use of International Association of Diabetes in Pregnancy Study Groups (IADPSG)/ World Health Organization (WHO) 2013 criteria at 17% as compared to the American Diabetes Association (ADA) criteria reported the lower prevalence at 7%. These variations in prevalence across regions, urban and rural settings, and diagnostic methods highlight the challenges in accurately assessing GDM rates and underscore the need for standardized diagnostic approaches. [8]

Aiming for early identification of GDM, some studies highlight the need for early screening of pregnant women in first trimester. The prevalence of early gestational diabetes mellitus varies widely, ranging from 0.7% to 36.8%, depending on the population studied and the diagnostic criteria used.[9] This broad range underscores the need for standardized screening protocols. Women with eGDM exhibit a distinct metabolic profile, characterized by a combination of beta-cell dysfunction and insulin resistance, differentiating them from those with conventional GDM. [10]

Recent studies suggest that early pregnancy glycosylated haemoglobin (HbA1c) levels can help predict eGDM. Elevated HbA1c levels, even within the normal range, have been linked to an increased risk of developing eGDM, indicating that subtle glucose dysregulation may be present before hyperglycemia becomes clinically detectable. [11] Furthermore, women with eGDM tend to have higher plasma-free fatty acid levels and lower insulin sensitivity compared to those with cGDM, reflecting a more severe metabolic impairment.[12]

Women diagnosed with eGDM face an increased risk of adverse pregnancy outcomes, including preterm birth, fetal macrosomia, and pregnancy-related hypertensive disorders.[13] They are also more likely to require insulin therapy and have a higher risk of postpartum dysglycemia, including prediabetes and type 2 diabetes.[9] Neonatal complications are also more frequent in eGDM, with an elevated risk of large-for-gestational-age (LGA) infants, neonatal hypoglycemia, and jaundice.[14] Fetal growth abnormalities in eGDM can be detected as early as 11–20 weeks of gestation. Among south Asian populations, fetal adiposity tends to increase even before the conventional GDM screening period, highlighting the critical need for early screening and diagnosis. Despite these findings, the optimal approach for screening and managing eGDM remains an area of ongoing research, particularly in high-risk populations such as South Asians, who experience a higher disease burden and worse pregnancy outcomes.[15] Screening for eGDM remains a topic of debate due to variations in diagnostic

criteria and screening timelines. While fasting plasma glucose (FPG) and the oral glucose tolerance test (OGTT) are widely used, there is growing interest in HbA1c as an early screening tool, as it reflects long-term glucose levels and may help identify at-risk women earlier in pregnancy.[11]

Different professional organizations recommend either universal or risk-based screening approaches. The International Association of Diabetes and Pregnancy Study Groups suggests diagnosing eGDM in early pregnancy if FPG levels range between 92 mg/dL (5.1 mmol/L) and 126 mg/dL (7.0 mmol/L)[16]. In contrast, the American Diabetes Association (ADA) and the Australasian Diabetes in Pregnancy Society (ADIPS) advocate for risk-based screening, recommending an early 75g OGTT at the first antenatal visit for high-risk women and ADIPS before 20 weeks of gestation.[17]

In India, the Diabetes in Pregnancy Study Group of India (DIPSI) supports universal screening in the first trimester, given the country's high burden of gestational diabetes.[18] Additionally, the Federation of Obstetric and Gynecological Societies of India (FOGSI) recommends a simplified, single-step screening and diagnostic approach for GDM in community settings.[19] This involves administering a 75g oral glucose load to pregnant women during their first antenatal visit, regardless of their last meal, followed by a plasma glucose measurement two hours later using the Glucose Oxidase-Peroxidase (GOD-POD) method.[19] A plasma glucose level of 140 mg/dL or higher confirms a diagnosis of GDM, aligning with WHO criteria. The single-step approach is not only clinically effective but also more feasible, affordable, and easier to implement, particularly in low-resource settings.[19]

As research on GDM screening has advanced, some studies have also explored the potential role of FPG in identifying GDM. Fasting plasma glucose and glycosuria were initially

used for screening pregnant women in anecdotal reports in 1985. The demand for FPG increased, when the ADA expert group favoured utilising FPG with lower thresholds than the OGTT for diagnosing DM in individuals who were not pregnant. After the WHO approved this ADA strategy in 1999, FPG gained much more acceptance and popularity. Later, while researching GDM screening, some studies unintentionally discovered that the FPG might be useful. A study conducted by Sacks, et al was the first in-depth study on FPG as a screening test.[20] Further studies have assessed the use of OGTT as the primary diagnostic tool while investigating FPG as a simpler alternative for screening. Early detection of GDM is critical for timely intervention, which can reduce complications for both mother and baby and lower long-term risks of type 2 diabetes, cardiovascular disease, and metabolic disorders.[21] The Treatment of Booking Gestational Diabetes Mellitus (TOBOGM) study, a large randomized controlled trial, emphasizes the benefits of diagnosing and managing eGDM at the earliest possible stage and early intervention significantly reduces the risk of neonatal complications. reinforcing the importance of timely screening and treatment during pregnancy.[22]

The burden of eGDM highlights the importance of continued research to better understand and manage the GDM. Our study aims at assessing prevalence of GDM among pregnant women during their first trimester using OGTT. Additionally, we also would assess the predictive value of using FBG as a single step approach in comparison with OGTT in early pregnancy. The early detection of GDM will complement effective management and improve pregnancy outcomes thereby improving the overall health and well-being of pregnant mothers and their offspring.

OBJECTIVES OF THE STUDY

Primary objective – To determine the prevalence of Gestational Diabetes Mellitus among first trimester pregnant women residing in field practice area of Belagavi district**.**

Secondary objectives

a. To predict Gestational Diabetes Mellitus using fasting blood glucose among pregnant women during their first trimester residing in field practice area of Belagavi.

b. To assess the risk factors for Gestational Diabetes Mellitus among pregnant women residing in field practice area.

REVIEW OF LITERATURE

Gestational diabetes mellitus (GDM) has emerged as a significant public health concern globally, with its prevalence steadily increasing over the past few decades. This rise can be attributed to shifts in epidemiological patterns driven by changing lifestyles, increasing maternal age, and the growing burden of obesity and metabolic disorders. Historically considered a condition primarily affecting high-income countries, GDM now poses a major concern in low- and middle-income nations like India, driven by urbanization and dietary shifts. The evolving diagnostic criteria and improved screening strategies have also influenced reported prevalence rates, highlighting the need for a deeper understanding of its risk factors and outcomes, for effective management and prevention. This review aims to synthesize existing literature on the epidemiological trends of GDM, its risk determinants, and its implications for maternal and neonatal health.

Demographic transition

India's population dynamics in 2024 are undergoing significant changes, marked by declining birth rates, a growing workforce, and increased life expectancy. The Total Fertility Rate (TFR) has dropped to 2, though states like Bihar and Uttar Pradesh continue to have higher birth rates. With a median age of 28, the expanding working-age population presents economic opportunities. Life expectancy has risen from 32 years in 1947 to 70 years in 2019, while infant mortality has declined substantially. However, regional disparities persist, particularly in northern states. Hunger remains a challenge, with India ranking 101st on the Global Hunger Index. Additionally, the absence of the 2021 Census raises concerns about demographic data accuracy, complicating planning for healthcare, education, and infrastructure.[23]

Epidemiological transition

India, often called the "Diabetes Capital of the World," is facing a sharp rise in diabetes cases, especially in urban areas. According to National Family Health Survey (NFHS)-5, 16.1% of adults aged 15 and above are affected by Diabetes in India; yet awareness, treatment, and control remain low only 27.5% know they have diabetes, 21.5% receive treatment, and just 7% manage to control their blood sugar.[23] Rural and economically disadvantaged populations face greater barriers due to limited healthcare access and socio-economic disparities. This rise is part of a larger shift towards non-communicable diseases (NCDs), fueled by urbanization, aging, and lifestyle changes. Poor diets, sedentary habits, and rising obesity affecting nearly a quarter of urban adults exacerbate the problem. While public health initiatives aim to improve prevention and treatment, challenges persist, especially in underserved areas. Strengthening healthcare infrastructure, raising awareness, and improving access to treatment are essential steps in tackling India's growing diabetes crisis.[23]

Definition of Diabetes Mellitus

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both.[24] Insulin is a hormone produced by the pancreas that helps regulate blood glucose levels. It is also characterized by vascular phenomenon and chronic inflammatory changes. Raised blood sugar due to impaired insulin function, leads to various complications if left untreated.[24]

Types of Diabetes Mellitus

1. **Type 1 Diabetes Mellitus (T1DM)**: A form of diabetes where the immune system attacks and destroys insulin-producing beta cells in the pancreas, leading to an absolute deficiency

of insulin. It is typically diagnosed in childhood or young adulthood and requires lifelong insulin therapy for blood sugar management.[25]

2. **Type 2 Diabetes Mellitus (T2DM)**: Characterized by insulin resistance, where the body's cells do not respond effectively to insulin, combined with a relative insulin deficiency. This type is more common in adults, especially in those with obesity, physical inactivity, and poor dietary habits. It can often be managed through lifestyle modifications, but many people will eventually require medications or insulin.[24]
3. **Gestational Diabetes Mellitus (GDM)**: A form of diabetes that develops during pregnancy and typically resolves after childbirth. Women diagnosed with GDM are at higher risk of developing Type 2 diabetes later in life, and their children may be at increased risk of obesity and diabetes.[24]
4. **Monogenic Diabetes**: A rare form of diabetes caused by mutations in a single gene affecting insulin production. It includes conditions like neonatal diabetes and maturity-onset diabetes of the young (MODY).[26]
5. **Secondary Diabetes**: This type occurs as a result of other medical conditions or medications that impair insulin production or action. Conditions such as Cushing's syndrome, hormonal disorders, or long-term use of corticosteroids can lead to secondary diabetes.[25]

Diabetes is a leading cause of morbidity and mortality globally, and its prevalence is rising, particularly due to lifestyle factors. Early diagnosis and proper management are crucial to preventing long-term complications such as cardiovascular disease, kidney failure, and neuropathy.[25,26]

Global Burden of Diabetes Mellitus

DM is a major global health challenge, affecting 537 million adults (10.5% of the 20–79 age group) in 2021, with cases projected to rise to 783 million by 2045, marking a 46% increase.[26] In 2021, diabetes accounted for 6.7 million deaths approximately one every five seconds and global healthcare expenditures related to diabetes reached $966 billion, a 316% increase over the past 15 years.[26] The burden is particularly high in low- and middle-income countries, where 80% of diabetes cases are concentrated.[2] Urbanization, sedentary lifestyles, unhealthy diets, and population aging contribute to its rising prevalence, while limited healthcare infrastructure in these regions hinders timely diagnosis, management, and prevention efforts.[2] Furthermore, diabetes is closely linked to increasing obesity rates and other NCDs, exacerbating the global health crisis.[2]

Burden of Diabetes in India

India is at the epicenter of the diabetes epidemic, often referred to as the "Diabetes Capital of the World." As of 2021, India had approximately 101 million adults living with diabetes. Projections indicate that this number will reach 134 million by 2045.[26] The *National Family Health Survey-5 (NFHS-5)* reports a diabetes prevalence of 16.1% among adults aged 15 and above, is significantly higher in urban areas at 19.0% compared to rural regions, where it stands at 14.1%.[23]

India faces unique challenges in addressing diabetes, including significant disparities in healthcare access. Awareness, treatment, and control of diabetes are alarmingly low: only 27.5% of individuals with diabetes are aware of their condition, 21.5% receive treatment, and just 7% achieve adequate glycemic control. This highlights a major gap in diagnosis and care, particularly in rural and underserved areas.[23]

The burden of diabetes in India also imposes a considerable economic strain, with costs stemming from both direct medical expenses and indirect losses due to reduced productivity and premature deaths. The increasing prevalence of obesity, unhealthy dietary habits, and physical inactivity further exacerbates the problem. Effective public health interventions, such as those under the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases, and Stroke (NPCDCS) which has now been renamed as National Programme for Prevention and Control of Non-communicable Diseases (NPNCD), aim to address these issues through early detection and lifestyle modifications. However, significant efforts are needed to scale up these initiatives and tackle the diabetes crisis comprehensively.[27]

Pathophysiology of Gestational Diabetes Mellitus [9]

GDM is a condition characterized by the onset of abnormal glucose metabolism during pregnancy. This condition presents a unique challenge as it involves multiple systems in the body working together in a delicate balance of insulin resistance, β-cell dysfunction, and altered hormonal signalling. While the condition is typically diagnosed during pregnancy and often resolves post-delivery, the pathophysiology of GDM has long-term implications, as women who experience GDM have an increased risk of developing T2DM later in life. The complexity of GDM's pathogenesis arises from the interplay between genetic, environmental, and hormonal factors. This detailed analysis explores the underlying mechanisms that contribute to the development and progression of GDM.

1. **Insulin Resistance and the Role of Pregnancy Hormones**

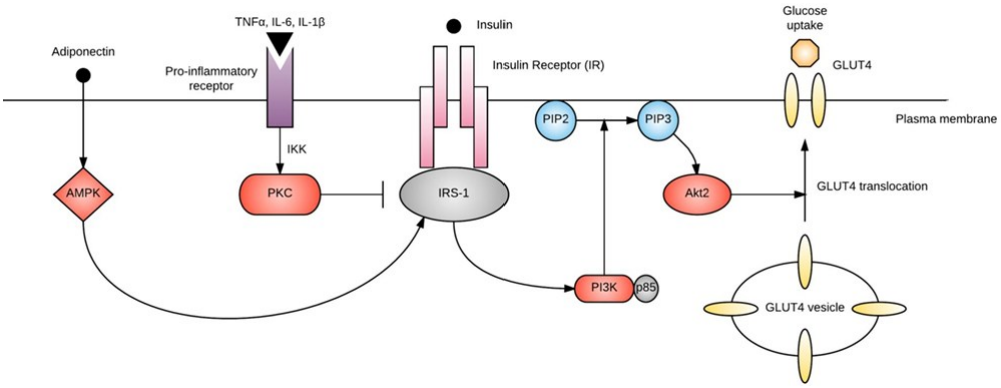


Figure 1 : Simplified insulin signalling.[28]

GDM is marked by insulin resistance, where the body's tissues respond less effectively to insulin, the hormone that helps move glucose from the bloodstream into cells for energy. During pregnancy, hormonal changes naturally increase insulin resistance to ensure adequate glucose for fetal growth. The placenta plays a key role by producing hormones essential for development, but some of these, like human placental lactogen, cortisol, and progesterone, also reduce insulin's effectiveness, making blood sugar regulation more challenging

- **Human Placental Lactogen (hPL)**: Produced by the placenta, hPL plays a crucial role in fetal growth by increasing the availability of glucose and free fatty acids to the developing fetus. However, it also antagonizes insulin, impairing insulin sensitivity in maternal tissues. The increased production of hPL is one of the most significant contributors to insulin resistance, particularly in the second and third trimesters of pregnancy.[28]

- **Estrogen and Progesterone**: Both of these hormones rise significantly during pregnancy. While estrogen promotes the growth and development of the fetal tissues, it also has a role in enhancing insulin resistance. Progesterone, produced by the placenta, further

contributes to the physiological increase in insulin resistance, particularly by influencing the mechanisms involved in glucose metabolism.[28]

- **Cortisol**: Elevated cortisol levels during pregnancy can lead to an increase in hepatic glucose production, thereby raising blood glucose levels. Cortisol also plays a role in inducing peripheral insulin resistance. High cortisol levels further exacerbate the insulin resistance seen in GDM.[28]

- **Prolactin**: While prolactin is known for its role in lactation, it also influences insulin resistance during pregnancy. Increased prolactin levels may contribute to impaired insulin action, particularly in the skeletal muscle and adipose tissue, both of which are crucial for glucose uptake.[28]

2. **Impaired β-cell Function**

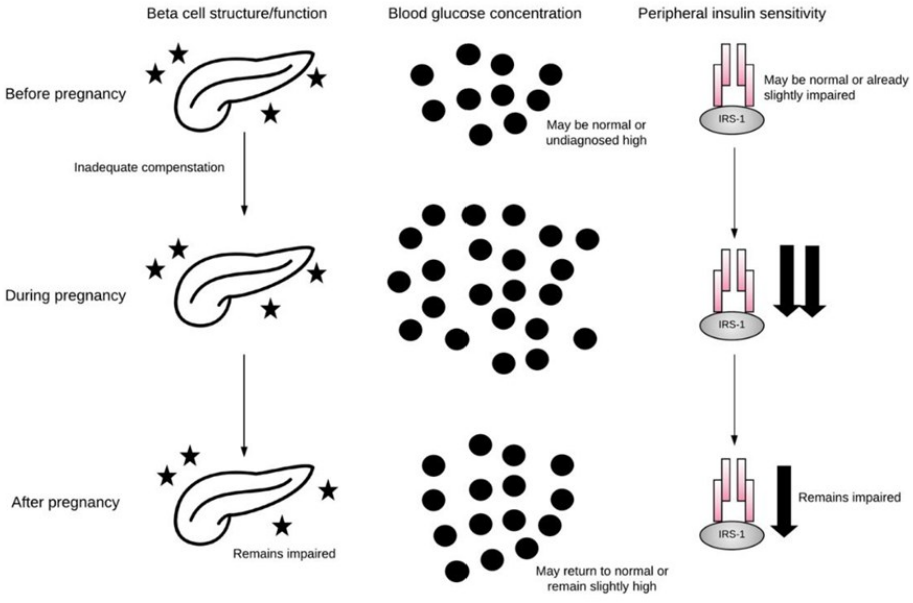


Figure 2: β-cell, blood glucose, and insulin sensitivity during normal pregnancy and GDM.[28]

While insulin resistance plays a central role in GDM, the ability of the pancreas to compensate for this resistance is also critical. β-cells, located in the islets of Langerhans in the pancreas, are responsible for the production and secretion of insulin in response to blood glucose levels. In a normal pregnancy, β-cells adapt to the increased insulin resistance by increasing insulin secretion to maintain normal glucose levels. This is a physiological response designed to ensure that both maternal and fetal glucose needs are met.

However, in women with GDM, the pancreatic β-cells are often unable to compensate for the increased insulin resistance. Several factors contribute to β-cell dysfunction in GDM:

- **Glucotoxicity:** Elevated blood glucose levels over time lead to glucotoxicity, which can damage the β-cells. The sustained high levels of glucose impair insulin secretion by β-cells and can also increase β-cell apoptosis (programmed cell death). This results in a further decline in insulin secretion capacity, exacerbating the hyperglycemia seen in GDM.[28]

- **Lipotoxicity:** Similar to glucotoxicity, elevated levels of free fatty acids (FFAs), which often accompany insulin resistance, can contribute to β-cell dysfunction. FFAs impair insulin secretion and promote β-cell death, thereby compounding the β-cell insufficiency seen in GDM.[28]

- **Genetic Predisposition:** Genetic variations can also play a role in β-cell dysfunction in GDM. Specific genes that affect insulin secretion, such as those related to the insulin receptor or β-cell signaling pathways, may predispose certain individuals to an impaired insulin response. Women with a family history of Type 2 diabetes are more likely to develop GDM, which underscores the genetic component in the disease.[28]

- **Inflammatory Cytokines:** Inflammation plays a significant role in β-cell dysfunction in GDM. Elevated levels of pro-inflammatory cytokines, such as Tumor Necrosis Factor- α (TNF-α) and Interleukin-6 (IL-6), have been found in women with GDM. These cytokines interfere with insulin signalling and exacerbate insulin resistance. Additionally, inflammation has been shown to increase β-cell apoptosis, further reducing insulin secretion.[28]

3. **Alterations in Adipose Tissue and Muscle Function**

The regulation of glucose metabolism is not limited to the pancreas. Other tissues, particularly adipose tissue (fat) and skeletal muscle, play critical roles in maintaining normal glucose levels. In GDM, the altered function of these tissues significantly contributes to the development of the condition.[28]

- **Adipose Tissue Dysfunction:** Adipose tissue is a major site for glucose storage and is an important regulator of insulin sensitivity. In women with GDM, there is often an increase in the size of adipocytes (fat cells) and a change in the secretion profile of adipokines, which are signaling molecules produced by fat cells. For example, there is a reduction in the secretion of adiponectin, an adipokine that enhances insulin sensitivity, and an increase in resistin and leptin, both of which promote insulin resistance. These changes further contribute to the systemic insulin resistance that characterizes GDM.[28]

- **Skeletal Muscle Dysfunction:** Skeletal muscle is the major tissue responsible for glucose uptake in response to insulin. In GDM, muscle tissue becomes less responsive to insulin, limiting its ability to take in glucose. This impairment is thought to be mediated by alterations in the insulin signaling pathway, particularly the decreased activity of insulin receptor substrates. As a result, glucose remains in the bloodstream, contributing to hyperglycemia.[28]

4. **Genetic and Epigenetic Factors**[28]

- **Genetic Risk Factors:** Certain genetic variants are associated with an increased risk of developing GDM. These include polymorphisms in genes related to glucose metabolism, insulin signalling, and β-cell function. Women with a family history of Type 2 diabetes are at an increased risk of developing GDM, indicating a strong genetic predisposition.

- **Epigenetic Modifications:** Epigenetic factors refer to changes in gene expression that do not involve alterations in the underlying Deoxyribonucleic acid (DNA) sequence. Environmental factors, such as diet, physical activity, and stress, can influence the epigenome, leading to changes in the way genes related to glucose metabolism and insulin action are expressed. These changes can increase the risk of developing insulin resistance and GDM. The maternal environment, particularly during critical periods of fetal development, can have lasting effects on the health of the offspring, predisposing them to metabolic disorders later in life.

5. **Progression to Type 2 Diabetes**[28]

One of the most concerning aspects of GDM is that it is a strong predictor of the later development of Type 2 Diabetes. The underlying mechanisms of insulin resistance and β-cell dysfunction that led to GDM often persist after pregnancy, putting women at a higher risk of developing Type 2 diabetes in the years following childbirth. Studies have shown that women who have had GDM have a 7-fold higher risk of developing Type 2 diabetes compared to those who did not experience GDM.

The persistence of insulin resistance after pregnancy, coupled with β-cell dysfunction, contributes to the progression to T2DM. Additionally, lifestyle factors such as obesity, lack of physical activity, and poor diet further increase the risk of developing Type 2 diabetes.

Therefore, it is essential for women with a history of GDM to undergo regular monitoring for diabetes and engage in preventative strategies, including weight management, physical activity, and dietary changes, to reduce their risk of future metabolic disorders.[28]

Risk Factors for GDM

Obesity is a major risk factor for GDM as it leads to insulin resistance, making blood sugar regulation difficult during pregnancy. Women with pre-pregnancy obesity have a significantly higher risk of developing GDM, with those requiring insulin therapy at greater risk than those managing it through diet. Surprisingly, gaining excess weight during pregnancy doesn't significantly add to this risk. Managing weight before conception can help reduce the chances of GDM and its complications, ensuring better health for both mother and baby.[29]

Age: Advanced Maternal Age and GDM Risk

As women age, their risk of developing GDM steadily increases. A large-scale study analyzing over 120 million pregnancies found that compared to women aged 20–24 years, the risk of GDM was 1.69 times higher for those aged 25–29, 2.73 times higher for those aged 30–34, and continued to rise, reaching nearly five times the risk for women aged 40 and above.[30]

Interestingly, ethnicity also plays a role in GDM risk. The study found that Asian women over the age of 25 were more likely to develop GDM than their Europid counterparts.[11] This difference may be due to genetic factors, body fat distribution, or lifestyle habits. Additionally, for each year a woman ages beyond 18, her overall risk of GDM increases by 7.9%, with Asian women experiencing a steeper rise (12.74%) compared to Europid women (6.52%). With more women delaying pregnancy, understanding the link between age and GDM is more important than ever.[30]

Family History of Diabetes: Genetic Predisposition to GDM

Having a family history of type 2 diabetes significantly increases a woman's risk of developing GDM, especially if both parents are affected. Women with first-degree relatives with diabetes are nearly twice as likely to develop GDM, while those with both first- and second-degree relatives face an even higher risk. This genetic predisposition is evident early in pregnancy, as these women often show signs of insulin resistance and higher glucose levels. Given these risks, early screening and lifestyle interventions are essential to help manage blood sugar levels and improve health outcomes for both mother and baby.[31]

Ethnicity: Racial and Ethnic Disparities in GDM Prevalence

Racial and ethnic differences play a key role in the risk of developing GDM. Women of South Asian, East Asian, and South-East Asian descent are more likely to develop GDM early in pregnancy, while South Asian women also have the highest rates of GDM later in pregnancy. In general, non-Europid women face a greater risk, especially if they have additional risk factors. Interestingly, glucose metabolism patterns vary by ethnicity East and South-East Asian women tend to have higher blood sugar levels after a glucose load, while other groups often have higher fasting glucose levels. These findings highlight the importance of tailored screening and management strategies to ensure early detection and better outcomes for all ethnic groups.[32]

Previous history of Gestational Diabetes: A history of GDM increases future risk

Women who have had GDM in a previous pregnancy are at a much higher risk of experiencing it again. The Mutaba'ah Study found that nearly 30% of pregnant women had a history of GDM, and those affected were less likely to plan their pregnancies and had shorter gaps between them. Many also reported higher levels of anxiety about childbirth. However, their

health behaviors such as physical activity and supplement use were similar to those without a history of GDM. These findings highlight the need for continued support, lifestyle counseling, and early intervention to help women manage their health and reduce the risk of GDM recurrence.[33]

Physical Inactivity: Role of sedentary lifestyle on GDM

A sedentary lifestyle is a key risk factor for GDM, even in women who engage in some form of routine physical activity. Studies show that prolonged sitting negatively affects glucose metabolism and insulin sensitivity, increasing the likelihood of GDM. Notably, women with both high physical activity and high sedentary behavior were at greater risk, especially if they had excessive gestational weight gain in the second trimester. This suggests that the benefits of exercise may be diminished by excessive sedentary time. Reducing prolonged sitting, alongside regular physical activity, is essential for lowering GDM risk and improving pregnancy outcomes.[34, 35]

Dietary Factors: Impact of nutrition on GDM

Maternal diet plays a crucial role in the development of GDM. A systematic review of observational studies found that a Western dietary pattern high in processed meats, refined carbohydrates, and unhealthy fats increases the risk of GDM, while a prudent or plant-based diet, rich in fruits, vegetables, legumes, and antioxidant nutrients, reduces it. Specific dietary components such as excessive iron intake and low carbohydrate diets were positively associated with GDM, whereas folic acid, fiber, and eggs were linked to a lower risk. These findings highlight the importance of a balanced, nutrient-rich diet before and during pregnancy to help prevent GDM.[36]

Polycystic Ovary Syndrome (PCOS) and GDM

Women with polycystic ovary syndrome (PCOS) are at a higher risk of developing GDM due to insulin resistance and hormonal imbalances. This risk extends beyond pregnancy, increasing the likelihood of type 2 diabetes later in life. Managing PCOS with a healthy lifestyle, including diet and exercise, can help reduce these risks, while medications like metformin and Glucagon-like peptide-1 (GLP-1) receptor agonists may offer additional benefits. Early screening and personalized care are essential to improving long-term health outcomes for women with PCOS.[37]

Multiple Pregnancies and risk of GDM

Multiple pregnancies, such as twins and triplets, increase the risk of developing GDM. The increased placental mass in multiple pregnancies leads to higher levels of insulin resistance, which can contribute to the development of GDM. Women carrying multiples also have a higher likelihood of adverse pregnancy outcomes, including preterm birth, macrosomia, neonatal intensive care unit (NICU) admissions, and cesarean delivery. GDM in multiple pregnancies further elevates the risk of complications like hypertensive disorders and neonatal metabolic issues.[38]

Others Medical Conditions and GDM

GDM is a significant risk factor for hypertension and cardiovascular disease in near future. Women with GDM have an increased risk of developing preeclampsia and gestational hypertension, conditions associated with endothelial dysfunction and insulin resistance. Additionally, GDM contributes to long-term cardiovascular complications, as it is linked to persistent metabolic disturbances such as dyslipidemia and chronic inflammation. The

increased risk of hypertension and cardiovascular disease highlights the need for postpartum monitoring and preventive interventions in women with a history of GDM.[38]

MATERNAL ADVERSE OUTCOMES OF GDM

Short-Term Maternal Outcomes

1. Preeclampsia

GDM significantly increases the risk of developing preeclampsia (PE), a severe hypertensive disorder of pregnancy. Both conditions share common risk factors, including obesity, insulin resistance, and endothelial dysfunction. Studies have shown that women with GDM have a higher likelihood of developing PE, even after adjusting for obesity and other confounders. GDM complicated by PE further elevates the risk of adverse pregnancy outcomes such as preterm birth, fetal growth restriction, and increased maternal cardiovascular risks.[39]

2. Increased Risk of Cesarean Section

Women with GDM face a higher risk of cesarean delivery (CD) due to complications such as fetal macrosomia, shoulder dystocia, and abnormal fetal heart rate patterns. Key factors contributing to this increased risk include nulliparity, excessive gestational weight gain, and insulin use. As these risk factors accumulate, the likelihood of requiring a CD rises, underscoring the need for careful prenatal monitoring and tailored management strategies. Optimizing maternal health and glucose control during pregnancy can help reduce the risk of CD and improve overall birth outcomes.[40]

3. **Postpartum Hemorrhage (PPH)**

GDM is associated with an increased risk of PPH, primarily due to complications such as macrosomia, labor dystocia, and the higher likelihood of cesarean delivery. Women with GDM often experience impaired uterine contractility, prolonged labor, and an increased need for obstetric interventions, all of which contribute to the risk of excessive postpartum bleeding. Additionally, the metabolic and vascular dysfunctions linked to GDM may further impact uterine tone and recovery after childbirth.[41]

4. **Risk of Infection**

Women with GDM are more prone to infections during pregnancy, including urinary tract infections, bacterial infections, and even increased susceptibility to Coronavirus disease 2019 (COVID-19). This heightened risk is likely due to poor blood sugar control, weakened immune function, and changes in the body's natural microbiome. While some infections, like gingivitis and vaginal candidiasis, do not show a strong link to GDM, the overall vulnerability to infections underscores the importance of close monitoring and preventive care for pregnant women with GDM. Proper glucose management and early detection can help reduce complications and improve maternal and fetal health.[42]

Long-Term Maternal Outcomes

1. Type 2 Diabetes Mellitus

T2DM, women with prior GDM also have a higher likelihood of developing metabolic syndrome, hypertension, and cardiovascular diseases due to prolonged glucose intolerance and vascular dysfunction. The increased risk underscores the importance of long-term follow-up, lifestyle modifications, and preventive interventions. Regular postpartum glucose screening, weight management, and physical activity are crucial in mitigating the progression to T2DM.[38]

2. Cardiovascular disease (CVD) & Mental Health

Women with GDM face an increased risk of long-term CVD and mental health issues. GDM is strongly linked to the development of hypertension, atherosclerosis, and ischemic heart disease due to persistent metabolic disturbances, including insulin resistance and dyslipidemia. The chronic inflammatory state associated with GDM further exacerbates cardiovascular risks, making long-term follow-up and lifestyle modifications essential for prevention.[43]

Additionally, GDM is associated with a higher likelihood of developing mental health disorders, particularly antenatal and postpartum depression. The stress of disease management, dietary restrictions, and fear of long-term complications contribute to psychological distress. Studies highlight the need for integrated care approaches that address both metabolic and mental health aspects to improve overall well-being in women with GDM.

Short-Term Neonatal Outcomes in GDM

Infants born to mothers with GDM are at increased risk of adverse neonatal outcomes. These include macrosomia (excessive birth weight), neonatal hypoglycemia, birth trauma (e.g., shoulder dystocia), hyperbilirubinemia, respiratory distress syndrome, and a higher likelihood of requiring NICU admission.[44] The severity of these outcomes varies with maternal glucose levels, with even mild untreated hyperglycemia contributing to higher birth weight and metabolic disturbances.[45] Additionally, preterm birth is more common in neonates of GDM mothers.[46]

Long-Term Neonatal Outcomes in GDM

Offspring of mothers with GDM face an increased risk of obesity, insulin resistance, and type 2 diabetes later in life.[44] The HAPO study demonstrated a strong association between maternal hyperglycemia and higher neonatal adiposity, which persists into childhood.[44] Additionally, in utero exposure to glucose-lowering drugs like metformin may have long-term metabolic consequences, increasing the risk of future cardiometabolic disorders.[44] Research highlights the importance of postnatal monitoring and preventive strategies for these children to mitigate long-term health risk.[46]

GDM Diagnosis Criteria

The **World Health Organization** (WHO) recommends a single-step approach using a 75g OGTT. This test is performed after an overnight fast. Blood sugar levels are checked at fasting and two hours after consuming the glucose solution. GDM is diagnosed if the fasting glucose is 92 mg/dL (5.1 mmol/L) or higher, or if the two-hour glucose level is 153 mg/dL (8.5 mmol/L) or higher. Screening is typically done between 24–28 weeks of pregnancy, but women at high risk may be tested earlier.[2]

The **American Diabetes Association** (ADA) offers two approaches for diagnosing GDM. The first is a one-step method using a 75g OGTT, where blood sugar is measured at fasting, one hour, and two hours after the glucose load. GDM is diagnosed if any of these values exceed the thresholds: fasting ≥ 92 mg/dL, one-hour ≥ 180 mg/dL, or two-hour ≥ 153 mg/dL. The second approach is a two-step method. Step one involves a non-fasting 50g glucose challenge test. If the result is 140 mg/dL or higher, a 100g OGTT is performed in step two. GDM is diagnosed if two or more values from the 100g OGTT exceed the thresholds: fasting ≥ 95 mg/dL, one-hour ≥ 180 mg/dL, two-hour ≥ 155 mg/dL, or three-hour ≥ 140 mg/dL.

Screening is recommended at the first prenatal visit for high-risk women and universally at 24–28 weeks.[25]

The **International Association of Diabetes and Pregnancy Study Groups** (IADPSG) also supports universal screening using a 75g OGTT. Blood sugar levels are checked at fasting, one hour, and two hours after the glucose load. GDM is diagnosed if any one of these values meets or exceeds the thresholds: fasting ≥ 92 mg/dL, one-hour ≥ 180 mg/dL, or two-hour ≥ 153 mg/dL. This approach aims to standardize diagnosis and improve outcomes for both mothers and babies.[16]

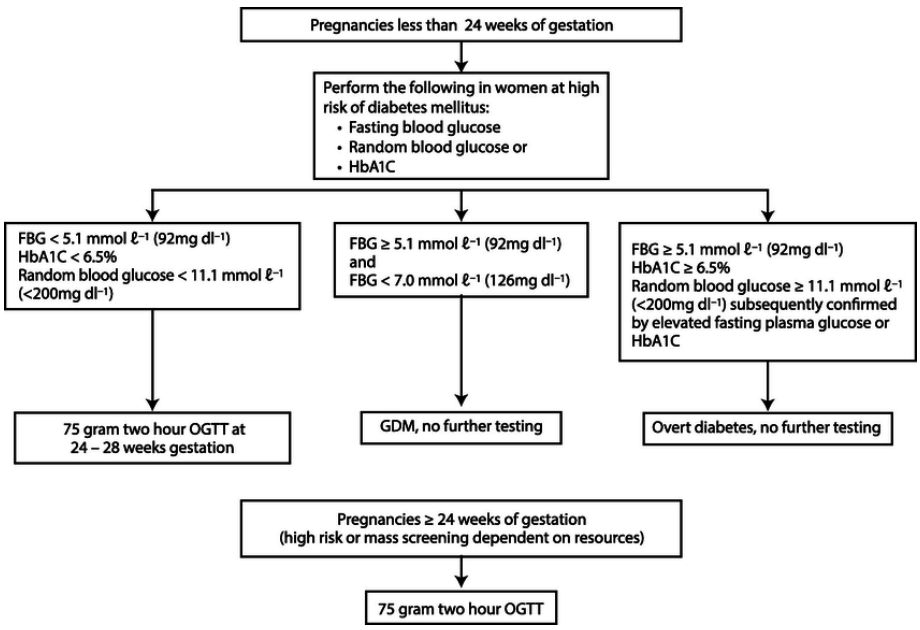


Figure3: **International Association of Diabetes and Pregnancy Study Groups criteria.**[16]

In India, the **Federation of Obstetric and Gynaecological Societies of India** (FOGSI) **and the Diabetes in Pregnancy Study Group of India** (DIPSI) recommend universal screening for GDM due to its high prevalence in the population. FOGSI suggests a single-step 75g OGTT, where blood sugar is checked two hours after the glucose load. A value of 140 mg/dL or higher indicates GDM, while values between 120–139 mg/dL are classified

as gestational glucose intolerance (GGI). Screening is ideally done early in pregnancy and repeated at 24–28 weeks and 32–34 weeks if initial results are normal. The DIPSI emphasizes a practical, single-step approach where a pregnant woman is given a 75g glucose load in a fasting state, and blood sugar is checked two hours later. This method is cost-effective and easy to implement in resource-limited settings.[19]

OGTT the gold standard for GDM diagnosis

As mentioned above, all the expert panels agree that the OGTT is the "gold standard" for GDM diagnosis. The OGTT has many drawbacks, the most serious flaw being that it is not reproducible.[47] It is expensive, time consuming and quite demanding for both the patient and the laboratory; furthermore, it is also not physiologic, quite unpleasant, uncorrected for body weight and its predictive value changes with ethnicity due to varying prevalence of GDM.[48] As a diagnostic test for DM in non-pregnant adults, many arguments have been made for keeping the OGTT [49] or avoiding it.[47] Due to the numerous problems of the OGTT, since 1997, the ADA favors the FPG with a lower threshold (7.0 mmol/L), rather than the OGTT for the diagnosis of DM in non-pregnant adults-even though this approach has its critics.[25] However, there has been no debate about the OGTT as a diagnostic test for GDM. Despite the potential of nausea and vomiting in pregnant women. the OGTT remains the cornerstone for diagnosis of GDM. Though many alternatives for screening of GDM have been explored, however, only the OGTT is currently acceptable as the diagnostic test.

Additional tests with OGTT may help to improve its performance. Measuring insulin with the 100 g OGTT may identify a subgroup of women who do not meet the ACOG criteria for GDM as they have only one abnormal glucose value. It has been found that women who have raised one hour serum glucose post oral glucose may need more intensive treatment.[50] The diagnosis of GDM using OGTT in pregnancy are further compounded by the variation in guidelines of

the various preeminent expert panels for the glucose load used (75 g *vs* 100 g) and, as mentioned earlier, in varying diagnostic glucose thresholds suggested for diagnosis.

FPG as a screening test

Over time, the definition of GDM, laboratory methods for glucose, and the screening and diagnostic criteria of GDM have evolved. Initially, in 1985, an anecdotal report,[51] first used fasting blood glucose (along with glycosuria) for screening pregnant women. In 1999, once the WHO approved this ADA approach, FPG became even more accepted and popular. Later, some studies while studying GDM screening, accidentally found that the FPG may have value.52 The first comprehensive study on FPG as a screening test was conducted by Sacks et al.[53]

As a screening test for GDM, the FPG is very appealing: It cheap, reliable, reproducible, does not produce vomiting as seen with the OGTT/Glucose challenge test (GCT). Thus, it can be administered in women unable to tolerate glucose drink and it takes less time than GCT. Using the FPG make GDM screening and diagnosis patient friendly.[54] However, the value of FPG for GDM screening remains uncertain. It is also not without problems. Incomplete fasting or an inability to fast for at least 8 h may not be easy for some pregnant women. In many poorer countries, multiple studies confirm that women find it hard to come to a clinic fasting. Often, the dropout rate is high when a pregnant woman is asked to come again for an OGTT after the clinic appointment. In some Asian populations, the FPG is inherently much lower but the postprandial is very high.[55] Thus, in India the authority on GDM, Diabetes in Pregnancy Study Group India advocates “a single-step procedure”, i.e., the 2-h glucose without fasting glucose for the screening and diagnosis of GDM.[56]

Challenges in diagnosing GDM

Gestational diabetes mellitus (GDM) presents significant challenges in screening, diagnosis, and management at global, national, and community levels. Screening inconsistencies arise due to varying guidelines and healthcare infrastructure, particularly in low- and middle-income countries (LMICs), where limited resources delay early detection. Nationally, differing policies on universal versus selective screening contribute to missed cases, with rural areas suffering from inadequate healthcare access. At the community level, lack of awareness and cultural beliefs prevent many women from seeking timely screening, leading to undiagnosed and untreated GDM.[57]

Managing GDM requires continuous glucose monitoring, lifestyle modifications, and medical support, yet financial constraints, inadequate healthcare systems, and inconsistent provider guidance make adherence difficult. In LMICs, shortages of trained professionals and conflicting recommendations further weaken care. Prevention strategies focusing on lifestyle changes are hindered by socio-economic barriers, misinformation, and cultural norms discouraging exercise during pregnancy. Without early intervention, many women with GDM progress to type 2 diabetes, and their children face an increased risk of obesity and metabolic disorders.[57]

The cost of treatment, including medical consultations, transport, and nutritious food, remains a major barrier, compounded by mental health challenges such as stress and depression. Stigma and community misconceptions further reduce treatment adherence. Long-term, women with a history of GDM are at elevated risk for type 2 diabetes, cardiovascular disease, and stroke, with over two-thirds developing diabetes within two decades. Additionally, fetal exposure to maternal hyperglycemia increases the likelihood of childhood obesity and metabolic disorders, making GDM a critical concern for both maternal and child health.[57]

Predicting GDM

Gestational Diabetes Mellitus is a condition that arises during pregnancy and is characterized by elevated blood glucose levels, which can lead to adverse maternal and neonatal outcomes if not properly managed. Early detection and effective management are key to minimizing these risks. Among the various diagnostic tools available, fasting glucose measurements (both capillary and venous) and the OGTT remain central in the diagnosis and prediction of GDM. Recent studies have explored the effectiveness and predictive value of these methods, providing insights into how best to identify women at risk for GDM.

Capillary glucose testing is emerging as a convenient alternative for diagnosing GDM, especially in settings where laboratory access is limited. A Swedish study evaluating capillary glucose levels found that adjusting the diagnostic cutoffs improved accuracy to 85% sensitivity, 95% specificity, and 90.3% accuracy. Corrected thresholds were 5.3 mmol/L for fasting, 11.1 mmol/L for 1-hour, and 9.4 mmol/L for 2-hour samples, making capillary sampling a reliable option when using validated point-of-care devices like the Accu-Chek Inform II. The study suggested that capillary glucose testing could replace venous sampling in GDM diagnosis without compromising accuracy.[58]

Despite its benefits, venous plasma glucose remains the gold standard for GDM screening due to its well-established diagnostic thresholds (≥5.1 mmol/L fasting, ≥10.0 mmol/L at 1-hour, and ≥8.5 mmol/L at 2-hours) as recommended by the IADPSG.[16] Comparative studies have shown that venous glucose readings are consistently lower than capillary values, with mean differences of 0.22 mmol/L (fasting), 1.12 mmol/L (1-hour), and 0.87 mmol/L (2-hour samples). While venous testing provides higher precision, capillary sampling offers a practical and immediate alternative, particularly in antenatal care settings with limited laboratory infrastructure.[58]

The GDM prediction and screening are transforming early detection and risk assessment. Machine learning (ML) models, such as XGBoost, logistic regression, and deep neural networks, are proving to be more effective than traditional screening methods by analyzing clinical, demographic, and biochemical factors. These models enable early identification of high-risk pregnancies, allowing for timely interventions that reduce complications for both mother and baby. Additionally, wearable devices and continuous glucose monitoring systems are improving real-time data collection, making screening more dynamic and personalized.[59]

Alongside technological advancements, refinements in traditional screening methods are enhancing GDM detection. Early pregnancy biomarkers, such as HbA1c and plasma proteins, are being incorporated into risk prediction models, helping to identify GDM earlier in pregnancy. Population-specific screening strategies are also being developed to account for ethnic and genetic differences, addressing disparities in diagnosis. These innovations mark a shift toward personalized and accessible care, ensuring that more women receive timely and effective screening, ultimately improving maternal and neonatal health outcomes.[60]

Studies measuring the prevalence of GDM

A study from the IDF Diabetes Atlas assessed the global burden of GDM, estimating that 16% of all pregnancies are affected by hyperglycemia, with 84% of these cases classified as GDM. Regional variations were noted, with the highest prevalence in the Middle East and North Africa (12.9%), followed by Southeast Asia (11.7%), the Western Pacific (11.7%), and South and Central America (11.2%). In contrast, lower prevalence was observed in Europe (5.8%), North America (7.0%), and the Caribbean (7.0%). The study emphasized the impact of ethnicity, lifestyle, and diagnostic criteria on GDM prevalence and highlighted the need for standardized global screening approaches.[61]

An eGDM, a condition diagnosed before 24 weeks of pregnancy. Prevalence varies widely, from 0.7% to 36.8%, depending on screening methods and criteria. Women with higher BMI, a history of GDM, or a family history of diabetes are at greater risk. eGDM is linked to complications like large babies, C-sections, preterm birth, and high blood pressure. It also raises the chances of postpartum diabetes and insulin dependence. The study calls for a standardized screening approach to ensure early detection and better outcomes for mothers and babies.[62]

The prevalence of Gestational Diabetes Mellitus in India has shown a noticeable increase between the National Family Health Survey (NFHS) rounds 4 and 5. According to NFHS-4 (2015-2016), the national prevalence of GDM showed an increase from 0.53% , to 0.80% in NFHS-5 (2019-2021), marking an increase of 0.27 percentage.[27] The rise in prevalence highlights a growing concern about GDM in the country, which can have significant implications for both maternal and neonatal health. The increase in GDM prevalence is seen across various states, with some states, such as Karnataka, witnessing more substantial increases. The data also indicates that the prevalence of GDM is higher among older age groups, with the highest prevalence observed in women aged 40-44 years. Additionally, urban areas tend to have a slightly higher prevalence of GDM compared to rural areas, though the difference is not large. This trend suggests that factors such as urbanization, lifestyle changes, and increasing obesity rates may contribute to the rising incidence of GDM. The national-level data underscores the need for improved screening and management of GDM, along with awareness campaigns targeting at-risk populations, to reduce the associated health risks for both mothers and their children. [63]

A systematic review and meta-analysis published in 2024 estimated the national prevalence of GDM in India at approximately 13%. The prevalence varied across regions, with the highest rates observed in the North zone (16.1%) and the South zone (12.6%). The West

zone had the lowest prevalence at 7%, while the East and North-eastern regions reported a prevalence of 11.5%. Urban areas exhibited a higher prevalence (12%) compared to rural areas (10%). These variations underscore the challenges in estimating GDM rates and the importance of considering regional differences when interpreting these results.[64]

A population-based study conducted between 2005 and 2007 in Tamil Nadu assessed the prevalence of GDM among 12,056 pregnant women across urban (Chennai), semi-urban (Saidapet), and rural (Thiruvallur) areas. The findings revealed a distinct urban-rural disparity, with the highest prevalence in urban areas (17.8%), followed by semi-urban (13.8%) and rural areas (9.9%). GDM was significantly associated with increasing age, higher BMI (≥25 kg/m²), and a family history of diabetes. Women aged 30–34 years in urban and semi-urban regions had the highest risk. These results highlight the need for region-specific screening and preventive interventions to address the rising burden of GDM.[65]

In a field-based cross-sectional study carried out in the rural parts of Assam state, India, by Chanda S, et al., 1410 pregnant women with gestational ages of 24-28 weeks took part. The oral glucose tolerance test was administered to a total of 1212 pregnant women. Due to pre-existing chronic conditions or extremely high blood glucose levels, 128 women were ineligible for the test. In Assam, the prevalence of GDM was 16.67% overall. A high prevalence of GDM in rural Assam warrants immediate government attention to safeguard the maternal and child health in the state. The mobile medical units may play a significant role in the implementation of GDM screening, diagnosis, treatment to ensure better maternal and foetal health outcomes in rural Assam.[66]

A cross-sectional study, conducted at three Urban Health Centers (UHCs) in Belagavi, aimed to determine the prevalence of GDM among pregnant women attending antenatal clinics. A total of 360 pregnant women were included, and GDM was diagnosed using a standardized

75gm oral glucose load and plasma glucose levels ≥ 140 mg/dl, as per the DIPSI criteria. The study found a prevalence of 12.2% for GDM among the participants. The mean age of the participants was 24.3±3.92 years, and the mean BMI was 22.48±3.05 kg/m². The study observed that the prevalence of GDM increased with age and higher parity. The findings emphasize the need for universal screening for GDM to identify the condition early and prevent potential maternal and fetal complications.[67]

A hospital-based cross-sectional study was conducted in the Faridabad district of Haryana, India, in an antenatal clinic (ANC) at a sub-district hospital (SDH) by Malhotra S, Kant S, et al. The study enrolled a total of 623 pregnant women out of 690, were screened to determine the prevalence of GDM and its associated factors. By modified The IADPSG criteria, the prevalence of GDM was 14.1%, and by DIPSI criteria, it was 6.7%. The prevalence of GDM is underreported using DIPSI criteria. The risk of GDM was found to be correlated with growing age, more years of schooling, and a positive family history of diabetes. Prospective maternal and neonatal outcomes in these women who have been diagnosed with GDM should also be monitored in future research. Malhotra et al. (2020)[68]

A hospital-based study by Rajput et al. (2011) in Rohtak, Haryana, found a 7.1% prevalence of GDM among 607 pregnant women (24–28 weeks gestation) using a 75 g OGTT. While bivariate analysis identified multiple risk factors, multivariate analysis showed significant associations with upper-middle-class socio-economic status and acanthosis nigricans. The study underscores the need for targeted screening and early interventions for high-risk women.[69]

Studies predicting GDM

A prospective study in Saudi Arabia examined glucose intolerance one year postpartum in 316 women with prior GDM at King Khalid University Hospital. Based on fasting blood glucose and HbA1c levels, 44% remained normoglycemic, 45% developed impaired glucose tolerance (IGT), and 11% were diagnosed with diabetes. Although requiring insulin during pregnancy [Odd's ratio (OR) 3.8, P=0.08] and having a family history of type 2 diabetes (OR 1.2, P=0.40) were linked to higher odds of glucose intolerance, these associations were not statistically significant. The study underscores the need for long-term monitoring and early intervention to prevent type 2 diabetes in women with prior GDM.[70]

Wu et al. (2020) aimed to develop an early prediction model for GDM using maternal risk factors from the first trimester. They analyzed data from 14,015 pregnant women in the Netherlands and 10,038 women in the USA. Their model performed well within the Dutch dataset [Area Under the Curve (AUC) 0.81] but showed reduced accuracy when tested on the U.S. dataset (AUC 0.69), highlighting the challenges of applying predictive models across different populations. The study reinforces the potential of early screening while emphasizing the need for region-specific adaptations.[71]

This study examined the reliability of capillary whole blood glucose testing compared to standard venous plasma glucose testing in screening for GDM. A total of 180 pregnant women at risk for GDM underwent both tests following a 50-g glucose challenge. The results showed a strong correlation ($r = 0.832$, $p < 0.001$) between the two methods. At a threshold of 140 mg/dL, capillary testing demonstrated high sensitivity (97.1%) with an accuracy of 73.9%, while a 165 mg/dL cutoff yielded 98.2% specificity and 82.8% accuracy. GDM was identified in 8.9% of participants. These findings indicate that capillary glucose testing may serve as a reliable alternative for GDM screening.[72]

Dhatt et al. in 2020 evaluated the Roche Accu-Chek Active glucose meter for GDM screening using fasting capillary blood glucose (FCG) levels. Among 1,465 pregnant women undergoing an OGTT, the study assessed the correlation between FCG and FPG using Passing and Bablok regression and estimated total error through Bland–Altman analysis, with the DXC-800 analyzer as the reference. GDM was diagnosed in 24.6% of participants using FPG and 23% via FCG. The Bland–Altman method showed a TE of -11.1% to 10.8%, and the receiver operating characteristic (ROC) curve analysis yielded an AUC of 0.953, indicating high diagnostic accuracy. The study concluded that the Roche Accu-Chek Active met analytical and clinical quality standards, making it a reliable tool for GDM screening in outpatient settings.[73]

A retrospective study by Mirzamoradi et al. in 2020 assessed the predictive value of first-trimester fasting blood sugar (FBS) levels for GDM. The study included 900 pregnant women enrolled between 2017 and 2019, who underwent FBS testing in the first trimester and a OGTT at 24–28 weeks of gestation. Results showed that 40.4% of women had FBS levels ≥ 92 mg/dL. ROC curve analysis identified an optimal FBS cutoff of 82.5 mg/dL, with 62.2% sensitivity and 45.1% specificity. The study concluded that while FBS may help in early screening, GTT remains essential for accurate diagnosis.[74]

A comprehensive review on the utility of FPG as a screening tool for GDM, tracing its evolution over three decades. Initially considered less reliable, recent studies have highlighted its potential as a simpler, cost-effective alternative to the OGTT. The review emphasized FPG's feasibility in resource-limited settings and its role in early pregnancy screening for timely interventions. While FPG offers advantages in ease of use and postpartum monitoring, the study cautioned about its limitations, including the need for appropriate cutoff values for accurate diagnosis.[75]

Cosson et al. examined the role of early FPG in detecting eGDM. While FPG screening in early pregnancy helps identify preexisting diabetes, intermediate hyperglycemia (5.1–6.9 mmol/L) is also linked to poor pregnancy outcomes. However, the study found that FPG ≥5.1 mmol/L alone is not a strong predictor of GDM diagnosed after 24 weeks. The authors suggest adjusting early screening thresholds based on factors like ethnicity and BMI. They highlight the need for early interventions, such as weight management, but emphasize that randomized trials are essential to refine management strategies.[76]

A prospective cohort study by Shaarbaf Eidgahi et al. in 2020 assessed the diagnostic accuracy of complete blood count (CBC) biomarkers for early prediction of GDM. The study included 600 pregnant women, utilizing repeated measurements of hemoglobin (Hb), hematocrit (Hct), FBS, and red blood cell count (RBC) during the first and early second trimesters. The findings indicated that women who later developed GDM had significantly higher levels of Hb, Hct, and FBS. The combined use of these biomarkers yielded a sensitivity of 87%, specificity of 70%, and an AUC of 83%, suggesting that these parameters could serve as an effective tool for early GDM detection.[77]

Studies assessing the risk factors for GDM

The study "Treatment of Gestational Diabetes Mellitus Diagnosed Early in Pregnancy" examined whether managing GDM before 20 weeks of gestation improves maternal and neonatal outcomes. Researchers randomly assigned 802 pregnant women with risk factors for hyperglycemia to either immediate treatment or a control group, where treatment was based on a repeat OGTT at 24–28 weeks. The findings showed that early treatment reduced the risk of adverse neonatal outcomes (24.9% vs. 30.5%) but had no significant effect on pregnancy-related hypertension or neonatal lean body mass. Importantly, no major safety concerns were

linked to early screening and treatment, suggesting that early intervention may benefit newborn health without increasing risks for mothers.[78]

A hospital-based study conducted at King Saud Medical City in Riyadh explored the risk factors associated with GDM among pregnant women attending antenatal care. The study found that 23.9% of participants were diagnosed with GDM, highlighting the condition's high prevalence. Women with a family history of diabetes had a significantly higher risk ($p=0.0218$), as did those with abnormal glucose tolerance test results ($p\leq0.001$). The risk was also greater in the last trimester of pregnancy ($p=0.0139$). However, factors like smoking, hypertension, and adherence to health advice were not significantly linked to GDM. These findings emphasize the importance of early screening and targeted interventions, particularly for high-risk women, to improve maternal and newborn health.[79]

A population-based study in South Delhi, part of the Women and Infants Integrated Interventions for Growth Study (WINGS), explored the burden, risk factors, and outcomes of gestational GDM among pregnant women from lower socio-economic backgrounds, finding a prevalence of 19.2% among those who underwent at least one OGTT. Older maternal age, higher BMI, and prediabetes at pregnancy confirmation were key risk factors, with prediabetes more than doubling the risk (RR 2.08, 95% CI: 1.45–2.97), while each additional year of age and each unit increase in BMI raised the risk by 10% and 4%, respectively. Interestingly, taller maternal height appeared protective. Despite the high GDM prevalence, women who received appropriate treatment did not experience increased risks of adverse pregnancy outcomes or higher cesarean section rates. These findings underscore the need for early screening, targeted antenatal care, and better management strategies, especially for high-risk women in disadvantaged communities.[80]

Ikoh et al. in 2021 conducted a review to examine the incidence and management of T2DM in women who previously experienced GDM. GDM is a transient form of impaired glucose tolerance during pregnancy, which significantly increases the risk of progressing to T2DM postpartum. The review highlights that women with a history of GDM are at a substantially higher risk of developing T2DM compared to those with normoglycemic pregnancies. The long-term impact of T2DM on the health of the mother and the potential risks to the offspring are of considerable concern. Key risk factors for the progression of GDM to T2DM include advanced maternal age, insulin use during pregnancy, and the delivery of an overweight baby. Given these risks, the review emphasizes the importance of effective management strategies to prevent the onset of T2DM in women with a history of GDM. These strategies include lifestyle modifications, postpartum care, breastfeeding, regular screening for diabetes, and raising awareness about the risks. This review serves as a guide for healthcare providers and women to understand the risks of T2DM following GDM and the necessary management approaches to mitigate these risks.[81]

A retrospective cohort study by Herath et al. examined the long-term risk of developing T2DM in Sri Lankan women with a history of GDM. The study followed 119 women with GDM and 240 without for over a decade. The incidence of diabetes was significantly higher in the GDM group (56.3 per 1000 person-years) compared to the non-GDM group (5.4 per 1000 person-years), with a rate ratio of 10.42. Key risk factors for T2DM development included maternal age over 30 years, insulin treatment during pregnancy, delivery of a baby weighing over 3.5 kg, and a family history of diabetes. [82]

A cohort study by Qi et al. explored whether excessive gestational weight gain (GWG) during the first and second trimesters increases the risk of GDM among women pregnant with singletons. The study included over 8,000 women who delivered in a Chinese hospital, with a

significant proportion diagnosed with GDM. GWG was categorized using standard guidelines and population-based measures. While initial analysis suggested a link between excessive GWG and GDM, further analysis did not confirm a strong association. However, when GWG exceeded higher percentiles, the risk of GDM was noticeably elevated.[83]

A prospective cohort study published in Diabetes Care examined how maternal hyperglycemia affects cardiometabolic risk in children. The study followed nearly 1,000 mother-child pairs from the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study, assessing children at age seven. Results showed that children of mothers with GDM were more likely to have abnormal glucose tolerance, higher body weight, and elevated blood pressure. Maternal glucose levels during pregnancy were linked to glucose abnormalities in children, even after accounting for other risk factors. The study also found that maternal hyperglycemia had a stronger impact on obesity in girls than in boys. These findings suggest that maternal blood sugar levels during pregnancy can have lasting effects on children's metabolic health.[84]

A cross-sectional study, conducted in Serbia, aimed to identify factors associated with insufficient leisure-time physical activity (LTPA) during the first trimester of pregnancy. The study included 162 pregnant women from the Clinic for Obstetrics and Gynecology at the Clinical Center of Serbia between January and June 2018. Data on social, pregnancy, and lifestyle characteristics were collected using questionnaires such as the Pregnancy Risk Assessment Monitoring System (PRAMS) and the International Physical Activity Questionnaire (IPAQ). The findings revealed that 27.2% of the women had insufficient LTPA. Multivariate logistic regression analysis showed that insufficient LTPA was significantly associated with having less than 12 years of education (OR: 2.3, 95% CI: 1.05–5.04), self-rated poor financial status (OR: 0.34, 95% CI: 0.14–0.79), and fewer hours spent walking before pregnancy (OR: 0.87, 95% CI: 0.77–0.99). The study concluded that these factors could guide

healthcare professionals in encouraging women planning pregnancy to engage in walking, as it is a sustainable form of physical activity that can improve maternal health outcomes.[85]

Finnish Gestational Diabetes (FinnGeDi) investigated neonatal outcomes associated with mild hyperglycemia in GDM using different OGTT thresholds. It included 4,939 singleton pregnant women who underwent a 75g 2-hour OGTT in six Finnish delivery hospitals in 2009. Women who did not meet Finnish diagnostic criteria (fasting glucose ≥ 5.3 mmol/L, 1-hour glucose ≥ 10.0 mmol/L, and 2-hour glucose ≥ 8.6 mmol/L) but met IADPSG or The National Institute for Health and Care Excellence (NICE) criteria were classified as having mild untreated hyperglycemia. The primary outcome was a composite of adverse neonatal outcomes, including hypoglycemia, hyperbilirubinemia, birth trauma, or perinatal mortality. Results showed no increased risk of adverse outcomes in untreated mild hyperglycemia compared to normoglycemic controls Adjusted Odds Ratio (aOR): 1.01 for IADPSG, 1.05 for NICE). The study concluded that current OGTT thresholds are sufficient for identifying clinically relevant GDM without excluding neonates at risk.[86]

A case-control study explored early first-trimester biomarkers to predict GDM development later in pregnancy. The study analyzed serum and plasma samples from 55 women who developed GDM and 55 controls from a cohort of 2,545 pregnant women in a Hungarian biobank. Women who developed GDM were older and had higher Body Mass Index (BMIs). Biomarkers such as fructosamine, total antioxidant capacity, testosterone, cortisone, and 21-deoxycortisol were significantly higher in GDM-affected women, while soluble urokinase plasminogen activator receptor (SuPAR) and cortisol were lower. A multivariate logistic regression model incorporating these biomarkers achieved 96.6% specificity and 97.5% sensitivity for predicting GDM. The study concluded that early risk estimation using these biomarkers could enable timely interventions, reducing long-term metabolic risks for mothers and offspring.[87]

Hillier et al. (2016) study evaluated the impact of early GDM diagnosis on GWG among 5,391 pregnant women in a diverse health maintenance organization. Women diagnosed with GDM early in pregnancy gained 2.4 kg less weight compared to those diagnosed later (Usual GDM), with an average GWG of 10.7 kg. Obese women diagnosed early had a mean GWG of 8.1 kg, within Institute of Medicine (IOM) guidelines, while 59% of obese women diagnosed later exceeded IOM recommendations. The study concluded that early GDM diagnosis in high-risk women, particularly those who are obese, helps optimize GWG, preventing excessive weight gain and improving maternal and fetal outcomes.[88]

A randomized controlled trial evaluated the effects of a preconception lifestyle intervention on maternal glucose tolerance and cardiometabolic outcomes in women at increased risk for GDM. The trial included 167 women aged 18–39 years, randomized into an intervention group (exercise and time-restricted eating) or a control group. The primary outcome was glucose tolerance at 28 weeks of gestation, with additional maternal and offspring health outcomes measured before and during pregnancy, at delivery, and postpartum. The study used linear mixed models for analysis and followed the 'intention to treat' principle. Approved by Norwegian ethics committees, the trial aimed to provide evidence for preconception interventions to improve maternal and offspring health.[89]

A mixed-methods study assessed electronic health literacy (eHealth literacy) among 235 pregnant women with GDM in China. Participants completed the Chinese version of the electronic Health Literacy Scale (eHEALS), with a median score of 29 (IQR: 26–32), indicating moderate eHealth literacy. Socioeconomic factors such as education level, age, and access to technology significantly influenced eHealth literacy. Semi-structured interviews with 11 women revealed challenges in understanding complex medical information and assessing the credibility of online sources. The study emphasized the need for clear, credible, and user-

friendly online health resources to improve GDM management and maternal-infant health outcomes. [90]

METHODLOGY

The present community-based longitudinal study was conducted to estimate the prevalence of Gestational Diabetes Mellitus (GDM) among pregnant women in their first-trimester residing across four primary health centres which are under the administrative control of Jawaharlal Nehru Medical College (JNMC), Belagavi, Karnataka, India, covering both rural and urban settings:

- Primary Health Centre (PHC), Kinaye,
- Primary Health Centre (PHC), Vantamuri,
- Urban Primary Health Centre (UHC), Rukmini Nagar, and
- Urban Primary Health Centre (UHC), Ashok Nagar.

MAPS

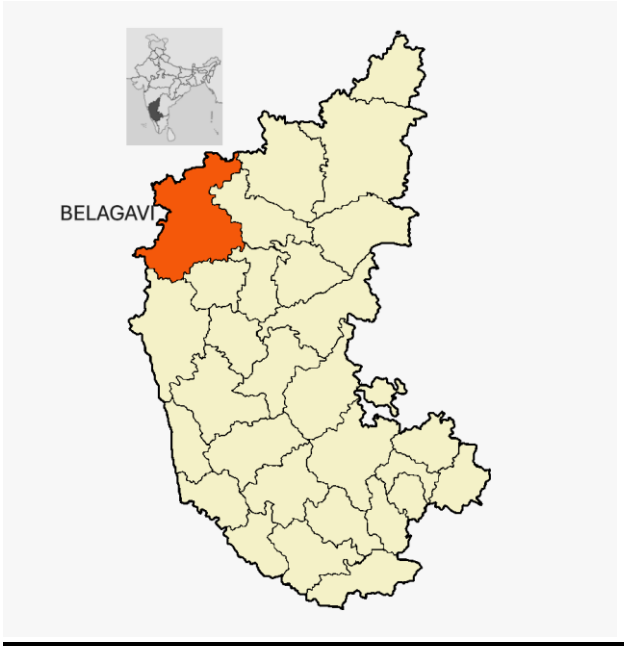


Figure 4. Map of Karnataka Highlighting Belagavi District

MAPS

Figure 5. Map of Primary Health Centre Vantamuri

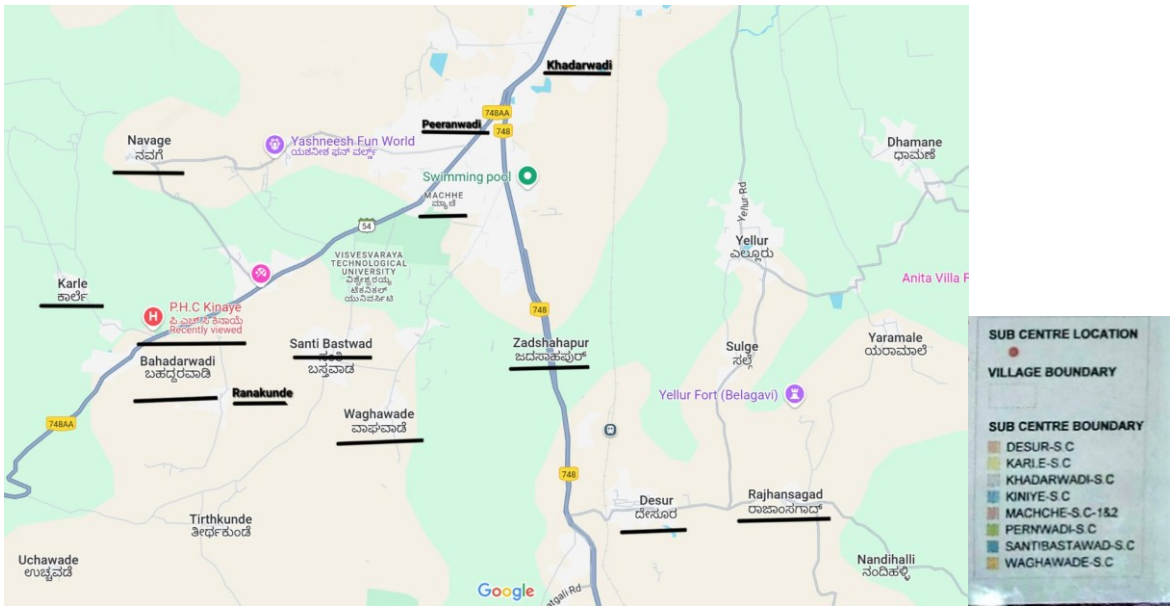


Figure 6. Map of Primary Health Centre Kinaye

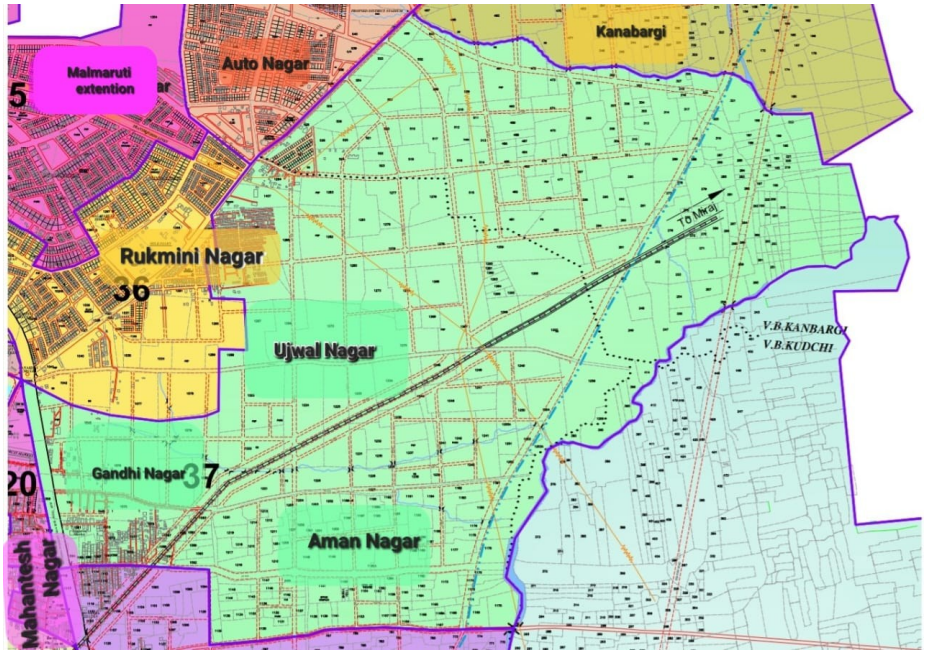


Figure 7. Map of Urban Health Centre Rukmini Nagar

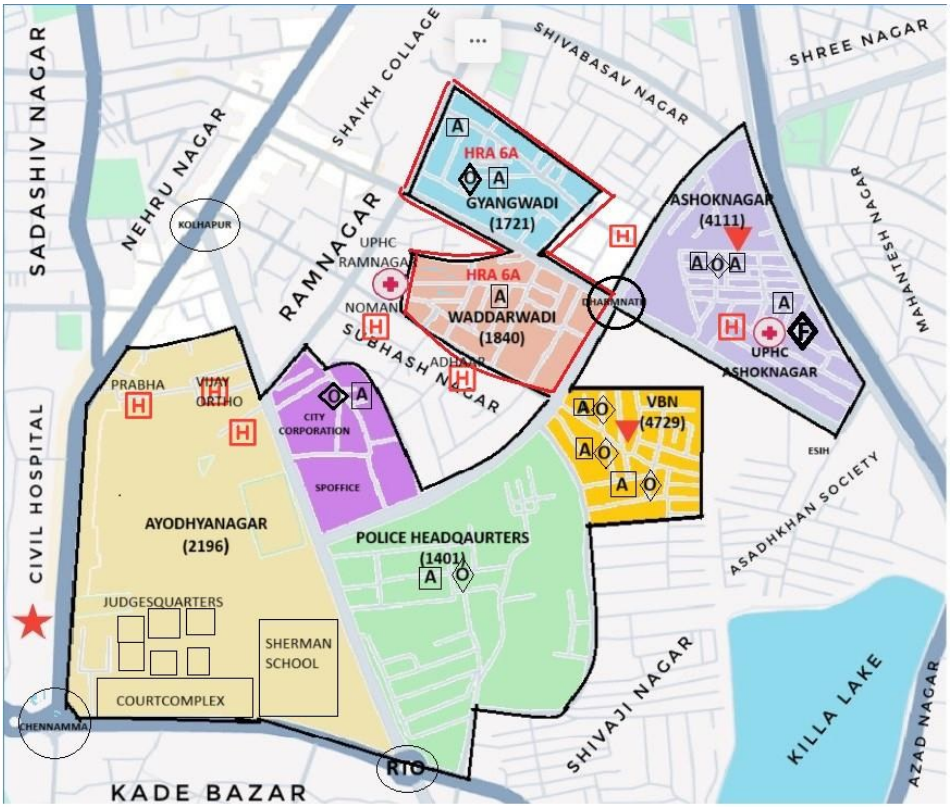


Figure 8. Map of Urban Health Centre Ashok Nagar

Design

The study design was community based longitudinal study.

Duration

22 months – conducted from 1st April 2023 to 31st January 2025.

Participants

Pregnant women aged between 18 and 45 years, residing in the field practice area of Jawaharlal Nehru Medical College (JNMC), Belagavi district, during their first trimester and residing in the following primary health care settings:

Primary Health Centers - Kinaye and Vantamuri (Rural);

Urban Primary Health Centers - Rukmini Nagar and Ashok Nagar (Urban)

Selection criteria

Inclusion

a. Pregnant women residing in the field practice area, who are willing to participate in the study and will be able to give informed consent.
b. Age between 18 to 45 years
c. Women with singleton pregnancy
d. Pregnancy registered before 13 weeks of gestational age

Exclusion

a. Known history of diabetes mellitus.
b. Known history of chronic kidney disease, chronic pancreatitis, and other severe illnesses
c. Women who are currently taking medications that may affect glucose metabolism (e.g. glucocorticoids, antipsychotics, etc.)

Sample Size:

The required sample size is calculated using the formula:

$$\mathbf{n} = \frac{\mathbf{N\ X\ z_{1-\alpha}^2\ X\ p\ (100-p)}}{\mathbf{d^2\ X\ (N-1)+\ z_{1-\alpha}^2\ X\ p\ X(\ 100-p)}}$$

Where, N = Population size,

p = prevalence of GDM,

d =Error (Relative),

$z_{1-\alpha} =$ critical value

By taking population size as 410, prevalence of Gestational Diabetes Mellitus as 14%* [19], and relative error as 10% of p = 0.1 x 14 = 1.4.

For 99% confidence, $z_{1-\alpha} =$ 2.58

$$n = \frac{410X\ 2.58^2X14X(100-14)}{1.4^2X\ (410-1)+\ 2.58^2X\ 14X\ (\ 100-14)}$$

$$n = \frac{410X6.6564X14X(86)}{1.96X\ (409)+\ 6.6564X\ 14X\ (86)}$$

$$n = \frac{3285865.296}{8815.94}$$

n = 372.75 ≅ **373**

n = **373** X Attrition

n = 373 X **1.2**

n = **447.6 ≅ 450**

Considering 20% drop outs from the study, the total sample size obtained was **450.**

Sampling method

We employed two step sampling:

- *For total study population*: **Stratified population proportionate sampling** was done to select the number of first trimester pregnant women below 13 weeks of gestation in each center and by taking the average data of first trimester registered ANC women for the past 3years residing in the field practice area, total study population is calculated.
- *For individual health centers*: **Systematic random sampling** was used for Data collection.

  Sampling interval (K) was calculated from No. of Pregnant women in the respective center with total number of ANC pregnant women in that field practice area.

  As per the table mentioned above, every **3**rd ANC registered mother was selected for the study after selecting the 1st ANC Mother using lottery method.

Total no. of ANC mothers below 13 weeks of gestational age registered in each health center in field practice area are as below:

Name of The Centers	Total No. of Anc Below 13 Weeks	Calculation for Proportionate Sampling	No. of ANC Mothers Selected for Study	Sampling Interval (K)
ASHOK NAGAR UHC	270	270/1643*450=74	**74**	270/74 ≅**3**
RUKMINI NAGAR UHC	719	719/1643*450=197	**197**	719/197 ≅**3**
VANTAMURI PHC	280	280/1643*450=77	**77**	280/77 ≅**3**
KINAYE PHC	374	374/1643*450=102	**102**	374/102 ≅**3**
			TOTAL =**450**	

Ethical Clearance

The study was approved from Institutional Ethics Committee for Human Subject's Research, Jawaharlal Nehru Medical College, Belagavi. **Ref No: MDC/JNMCIEC/47** (Annexure I)

Clinical Trials Registration No.: This study is registered under Clinical trial Registry, India at www.ctri.gov.in with Reg. No: CTRI/2023/05/053343

Informed consent

Based on the selection criteria, the study participants were selected and written informed consent (Annexure II) was obtained from all the participants, before collecting the data.

Data collection procedure

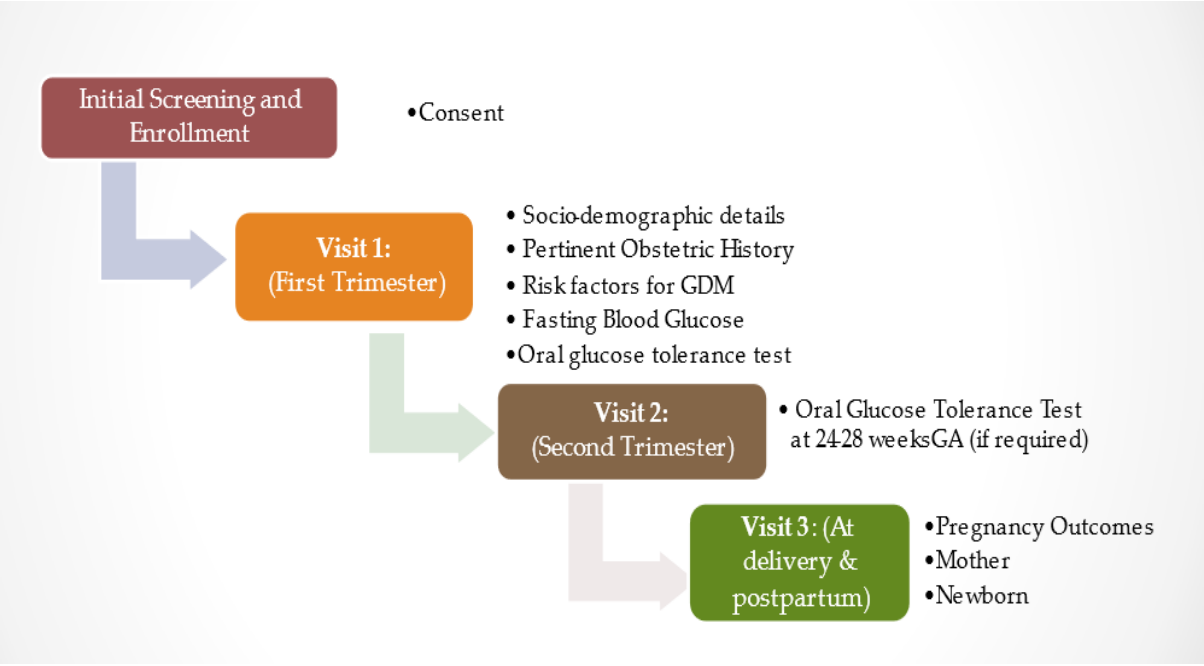


Figure 9: Data collection flowchart

- **Initial Screening & Enrollment:** Participants provide consent for the study.
- **Visit 1 (First Trimester):** Data collection includes socio-demographic details, obstetric history, GDM risk factors, fasting blood glucose, and an oral glucose tolerance test (OGTT).
- **Visit 2 (Second Trimester):** If needed, an OGTT is repeated at **24–28 weeks of gestation** to confirm GDM.
- **Visit 3 (Delivery & 1 week Postpartum):** Pregnancy outcomes for **both mother and newborn** are assessed.
- This stepwise approach ensures **early detection and management of GDM**, improving maternal and neonatal outcomes.

STEP 1:

Initially the eligible participants were screened for the inclusion and exclusion criteria and written informed consent was obtained after explaining the study procedures.

Data was collected using a structured questionnaire regarding the sociodemographic variables, family history of DM and other chronic conditions, current medical history, current and past obstetric history (as applicable), pertinent clinical data, maternal anthropometry including pre-pregnancy weight (clinical records and/or participants' self-assessment), present weight, height & body mass index (BMI); lifestyle factors viz. tobacco & alcohol consumption, physical activity, fruits and vegetables consumption and biochemical investigations details (as provided in the mother's card) and other risk factors of GDM.

STEP 2:

Participants in their first trimester (up to 13th week of gestation) tested for fasting blood glucose an early morning blood sample is measured using capillary blood glucose (minimum of 8hours of fasting was required).

The classification based on the FBG is as follows:[16] Normal glucose tolerance is defined as FBG below 92 mg/dL, indicating normal glucose metabolism during pregnancy. GDM is diagnosed when FBG is 92 mg/dL or higher, suggesting impaired glucose regulation

STEP 3:

All the study participants underwent an Oral glucose tolerance test (OGTT) with Uncanny's Check-75 ,75g anhydrous glucose powder in the same week [before 13 weeks 6 days gestational age (GA)] at their primary health centres. The procedure was explained to the participants. The glucose powder was dissolved in 250-300 ml of water and pregnant women

were asked to consume it in five minutes, regardless of whether she was fasting or not, or when she consumed her last meal.[91]

The results were assessed using Diabetes in pregnancy study group of India (DIPSI) Criteria[91] i.e., blood glucose level of ≥140 mg/dl two hours after the consumption of 75 mg of anhydrous glucose was considered GDM using capillary blood glucose method, under aseptic precautions.

STEP 4:

Participants who had normal blood glucose value in the first trimester were assessed for OGTT in the 24 -28 week of GA using capillary blood glucose method, under aseptic precautions.

The results were assessed using DIPSI criteria[91] (blood glucose level of ≥140 mg/dl two hours after the consumption of 75 mg of anhydrous glucose was considered GDM) using capillary blood glucose method, under aseptic precautions.

The diagnostic predictivity of GDM using FBG was compared with OGTT at First Trimester and Second Trimester.

STEP 5:

Final study outcomes were assessed during delivery and one week post-delivery based on the available hospital records. Pregnancy outcomes including complications during antenatal, intra-natal and postpartum period, mode of delivery, details of the delivery, and neonatal outcomes viz. birth weight, gender, requiring ventilatory support at birth, and details of admission at neonatal intensive care unit (NICU) were assessed until one-week post-delivery.

Instruments used for data collection

1. ACU-CHECK Analog Body Weight Scale, Mechanical Weighing scale for measuring body weight.
2. PAERIK INDIA Height measuring scale - Stadiometer - Precision Model, for height measurement (for BMI calculation)
3. Stethoscope
4. Omron - Validated digital sphygmomanometer with standard adult cuff (Style Name: HEM 7120 Fully Automatic Digital Blood Pressure Monitor)
5. Dr. Morepen's capillary blood glucometer to measure fasting blood glucose (FBG) and glucose levels during the OGTT.(Model Name BG-03 Gluco One Glucometer)
6. Uncanny's Check 75 - 75g anhydrous glucose sachets for preparing the glucose solution required for OGTT.
7. Measuring glass or container to dissolve glucose powder in 250–300 mL of water.
8. Stopwatch or timer to ensure accurate timing for the two-hour blood glucose measurement post-glucose consumption.
9. Personal protective equipment (PPE) such as gloves and masks to maintain aseptic precautions during sample collection.

   All the instruments were standardized.

Statistical analysis

The data was tabulated and master chart was prepared (Annexure IV). Data collected in the questionnaire (Annexure III) was coded and entered in Microsoft excel sheet. Random checks were done to ensure correctness of the data entered. Missing values were noted and recoded. The data was transferred and analyzed using Statistical Package for Social Sciences (SPSS),

version 26 [IBM Corp. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.; 2019.]

Descriptive statistics were used to summarize the sociodemographic characteristics, family and obstetric history, lifestyle factors, clinical data, and risk factors of the study population. Measures such as frequencies, percentages, means, and standard deviations were calculated as appropriate.

The Chi-square test was applied to assess the association between categorical variables, such as the presence of GDM (diagnosed using FBG and OGTT criteria) and other risk factors.

Multiple logistic regression analysis was performed to identify independent predictors of GDM, adjusting for potential confounding variables. The regression model estimated adjusted odds ratios (OR) with 95% confidence intervals.

The diagnostic accuracy of fasting blood glucose (FBG) in predicting GDM was compared to the first trimester OGTT results. The following metrics were calculated: sensitivity (ability of FBG to correctly identify true GDM cases), specificity (ability of FBG to correctly identify non-GDM cases), positive predictive value (PPV), negative predictive value (NPV), and area under the curve (AUC) of the Receiver Operating Characteristic (ROC) curve to evaluate the overall diagnostic performance of FBG compared to OGTT.

Funding information: This study is funded by the Research Society for the Study of Diabetes in India (RSSDI). Financial support is specifically allocated through the Central Division, New Delhi.

DEFINITION OF STUDY VARIABLES

SOCIO-DEMOGRAPHIC VARIABLES

Age: Age was documented to the nearest completed year according to the information provided by the study participants and/or verifying relevant documents (Aadhar card, etc.)

Religion: The subject's religion was noted and was grouped as "Hindu", "Islam", "Christian", "Sikh", "Jain" and "Others" (Buddhist, Parsi, Odia etc)

Educational status: The participants were asked to indicate their highest level of education completed, and based on their responses, they were grouped into five categories:

- **No formal education:** A person has not received or attended any formal school
- **Primary:** A person who had studied till or less than Seventh standard.
- **Secondary:** A person who had studied from eighth to tenth standard.
- **Collegiate & Graduate:** A person who has completed pre-university collegiate education or a diploma or person who has completed their education up to graduation and earned a degree.
- **Post graduate:** A person who has completed their education up to post-graduation and earned a master's degree.

Main work status

- **Homemaker:** An individual whose main activity involves performing household tasks without receiving payment.
- **Government employee:** An individual employed by a government office or agency and receiving a salary. This includes employees of the Central, State, or Municipal governments, as well as those working for government-owned agencies.
- **Non-Government employee:** An individual who is employed to work and receives a salary or wages. This includes employees who are not employed by the government.
- **Self-employed:** An individual who creates goods for sale or earns an income by providing services to others, and/or spends a significant amount of time working in a family business, farming, or similar activities.
- **Agriculture:** work related to the cultivation of crops, raising livestock, or other farming activities, including tasks like planting, harvesting, irrigation, and managing agricultural production.
- **Unemployed:** individuals who are actively seeking work but are not currently employed.

Socioeconomic status: The socio-economic status is assessed by per-capita income of the family. The total monthly income of the family in rupees was recorded along with the family size. The per capita monthly income was calculated by dividing the total family income by the no. of family members, and the family was then classified according to the modified B. G. Prasad's classification.

Modified B.G. Prasad's Classification (2024) [92]

Socioeconomic Class	Prasad's Classification (1961) per capita income in ₹/month	Per Capita Income in ₹/month (2024)
I	100 & above	₹9,098 and above
II	50 to 99	₹4,549 to ₹9,097
III	30 to 49	₹2,729 to ₹4,550
IV	15 to 29	₹1,365 to ₹2,728
V	Below 15	Below ₹1,365

- **Average Consumer Price Index for the year 2024** = INR 550.00 (estimated CPI-IW for the year).[93]
- **Calculation of Correction Factor (C.F.)**
- **C.F. =** (Average CPI for study period / 100) × 4.93

  C.F. = (1550.00 / 100) × 4.93

  C.F. = 15.50 × 4.93 ≈ **76**

Thus, the correction factor (C.F.) for 2024 is approximately **76**.

This C.F. will be used to adjust the original income values from Prasad's 1961 classification to reflect the economic conditions of 2024.

Family History: Family history of Diabetes Mellitus and Hypertension was assessed among parents and siblings of the participants.

- **Diabetes Mellitus** Assessed if any parent or sibling was diagnosed with diabetes, a known risk factor for developing the condition

- **Hypertension** Assessed if any parent or sibling had hypertension, which increases the risk of developing high blood pressure.[94]

MEDICAL CONDITIONS PRIOR TO PREGNANCY

- **Hypertension:** History of high blood pressure before conceiving and/or on regular treatment with anti-hypertensive medications.[95]
- **Cardiac Problems:** Prior cardiac issues, including heart attacks or arrhythmias diagnosed before pregnancy and/or on treatment for the same. [95]
- **Thyroid Disease:** Thyroid disorders diagnosed before pregnancy, such as hypothyroidism or hyperthyroidism and/or on treatment for the same.[96]
- **Tuberculosis (TB):** Prior TB diagnosis refers to a history of tuberculosis disease before pregnancy and/or on anti-Tb treatment.[97]
- **COVID-19:** COVID-19 diagnosed prior to pregnancy refers to individuals who have been infected with the SARS-CoV-2 virus before conception.[98]

CURRENT OBSTETRIC HISTORY

Gravida: Gravida refers to the total number of pregnancies a woman has had, regardless of the outcome. This includes all pregnancies, whether the outcome was a live birth, stillbirth, or miscarriage.[95]

Parity: Parity indicates the number of pregnancies a woman has carried to a viable gestational age (usually considered as 20 weeks of gestation or more). It is used to assess obstetric risk and outcomes.[95]

Last Menstrual Period (LMP): The LMP is the first day of the most recent menstrual period, which is used to calculate the estimated due date and gestational age of the pregnancy.[99]

Menstrual Cycle: The menstrual cycle is the interval from the first day of one period to the first day of the next, generally spanning 21 to 35 days. Regular cycles occur consistently within this range, while irregular cycles fluctuate in length.[95]

Oral Contraceptive Pills Use: Refers to the use of hormonal contraceptive methods to prevent pregnancy. The duration of oral contraceptive pill use may influence fertility and timing of conception.[95]

Ultrasound (USG) Date: The date when an ultrasound was performed to evaluate fetal development, gestational age, and any potential complications. Ultrasounds are vital for monitoring pregnancy health.[100]

LABORATORY PARAMETERS

Haemoglobin: Measures the amount of haemoglobin in the blood. Low levels can indicate anaemia, which may need treatment to avoid complications during pregnancy.

Normal Range: 11.0 - 14.0 g/dL for pregnant women. The categories of Anemia is as follows.[101]

Categories of Anemia for Pregnant women	Haemoglobin values
Mild	10.0 – 10.9 mg/dL
Moderate	7.0 – 9.9 mg/dL
Severe	< 7.0 mg/dL
Very severe	< 4.0 mg/dL

HIV Status: A test to determine whether a pregnant individual is infected with the human immunodeficiency virus (HIV). Early diagnosis allows for timely intervention to prevent transmission to the baby.[102]

HbsAg Status: The test for hepatitis B surface antigen (HbsAg) identifies whether an individual is infected with hepatitis B. This is important for preventing mother-to-child transmission of the virus during childbirth.[103]

Blood Group: The test identifies the individual's blood type (A, B, AB, or O) and Rh factor. It is important for managing potential Rh incompatibility and ensuring safe blood transfusions, if needed.[95]

Urine protein A test to check for protein in the urine, which can be a sign of preeclampsia, kidney disease, or other pregnancy complications. Proteinuria is commonly monitored throughout pregnancy to detect these conditions early. Normal Range: No detectable protein or < 30 mg/dL.[104]

Urine sugar A test to screen for diabetes by detecting excess sugar in the urine, which can be an indicator of glucose intolerance during pregnancy. Presence of urine sugar indicates the blood glucose level above the renal threshold.[105]

Thyroid test – TSH (Thyroid-Stimulating Hormone): A test to measure the level of TSH, which helps to assess thyroid function. Hypothyroidism or hyperthyroidism can affect pregnancy outcomes and fetal development. The TSH levels are categorized as <2.5, 2.5 – 5.0, >5.0 mIU/L.[96]

PAST OBSTETRIC HISTORY

Diabetes Mellitus: The history of DM was determined if the individual had been diagnosed by a physician or was using oral hypoglycemic agents, insulin, or both for treatment.[105]

Gestational hypertension: Presence of high blood pressure during pregnancy. Gestational hypertension is characterized by elevated blood pressure (≥140/90 mmHg) occurring after 20 weeks of gestation without proteinuria.[95]

Pre-eclampsia: Pre-eclampsia is a condition with blood pressure ≥140/90 mmHg with additional signs such as proteinuria and organ dysfunction, typically after 20 weeks of pregnancy. Diagnosis was made through routine prenatal blood pressure measurements and urinalysis.[95]

Previous LSCS: History of a prior cesarean section delivery, which may affect future pregnancy management.[95]

Neonatal death: Death of a newborn within the first 28 days of life, often due to prematurity or birth complications.[106]

Still birth: Fetal death after 20 weeks of gestation but before or during delivery. [106]

Previous difficult labor: Complications during a previous labor, such as prolonged labor or fetal distress, requiring intervention.[95]

Rh Incompatibility: Incompatibility between the Rh blood type of mother and fetus, potentially leading to fetal complications. [95]

Bad obstetric History A history of pregnancy complications such as recurrent miscarriage or preterm birth.[95]

Anxiety: History of anxiety disorders, affecting mental and physical health during pregnancy.[107]

Depression: History of depression, influencing both maternal well-being and pregnancy outcomes.[107]

ANTHROPOMETRIC MEASUREMENTS

Height: The subject was asked to stand straight without footwear, ensuring that the heels, buttocks, and back were aligned, with arms hanging by the sides. Height was measured from head to heel using a metallic measuring tape, with the measurement recorded to the nearest 0.1 cm. [108]

Weight: Body weight was recorded without footwear and minimal clothing using a standardized portable adult weighing machine, which was calibrated periodically throughout the study. The scale was adjusted to zero before each measurement, and weight was recorded in kilograms to the nearest 0.1 kg. [108]

Calculation of Body Mass Index (BMI):

BMI was calculated using the following formula:

$$\textbf{BMI} = \frac{\text{Weight in Kg}}{(\text{Height in Meter})^2}$$

As per the revised guidelines recommended by 2024 WHO guidelines,[109] persons with BMI values of less than 18.5 were classified as "Underweight", 18.5 to 24.99 were classified as "Normal weight", 25.0 to 29.99 were classified as "overweight / pre-obese" and 30.0 to 34.99 were classified as "Obese class I", 35.0 to 39.99 were classified as "Obese class II", ≥ 40.0 were classified as "Obese class III".

Category	**BMI range (Kg/m^2)**
Underweight	<18.5
Normal	18.5 – 24.99
Overweight	25 – 29.99
Obesity class I	30 – 34.99
Obesity class II	35 – 39.99
Obesity class III	≥ 40.0

For Asian populations, including India, the International Obesity Task Force (IOTF) has set the following BMI cut-offs: [110]

Category	**BMI range (Kg/m^2)**
Underweight	<18.5
Normal	18.5 - 22.99
Overweight	23.0 - 24.99
Obesity	>25

LIFESTYLE INFORMATION

Tobacco use: For the assessment of history of use of tobacco in any form (smoking or smokeless) period of recall was considered for the past one year and was based on WHO guidelines for tobacco use surveillance.[111]

Smoking tobacco:

Smokers: Subjects those who had smoked in the past or smoking at present were considered as "smokers".

Current smoker: The person who smoked beedis or cigarettes at least for the last one year.

Daily smoker: The person who smoked beedis or cigarettes daily for the last one year.

Past smoker: The person who smoked beedis or cigarettes earlier but left smoking for the last one year.

Non-smokers: Subjects who had never smoked any form of tobacco (Cigarettes/Beedi) are categorized as "non smokers".

Smokeless tobacco use:

Smokeless tobacco user: Subjects those who had used smokeless tobacco in the past or using at present were considered as "smokeless tobacco user".

Current use of smokeless tobacco: The person who used any form of smokeless tobacco products (Snuff, Gutka, Chewing tobacco, etc.,) at least for the last one year.

Past user of smokeless tobacco: The person who used smokeless tobacco earlier but left using it for the last one year.

Non user of smokeless tobacco: Subjects who had never used any form of smokeless tobacco were considered as “non users of smokeless tobacco”.

Alcohol Consumption: For the assessment of history of alcohol consumption period of recall was considered for the past one year.[112]

Alcoholics: Subjects who had consumed any drink containing alcohol either in the past or consuming at present were categorized as “alcoholics”

Present alcoholic: The person who consumed alcohol at least for the past one year.

Past alcoholic: The person who consumed alcohol earlier but left consuming alcohol for the last one year.

Non-alcoholics: Subjects who had never consumed alcohol.

Diet: Dietary assessment included frequency of fruits and vegetable consumption.[113]

Dietary assessment was conducted to evaluate the frequency of fruit and vegetable consumption among the study subjects. The frequency of fruit consumption was measured based on a typical week. Participants were categorized into four groups: those who never consumed fruit, those who consumed fruit 1–3 days per week, those who consumed fruit 4–6 days per week, and those who consumed fruit on all days of the week. A serving of fruit was defined as one medium-sized piece, approximately 80 grams, such as a banana, apple, or orange. These categorizations were based on guidelines provided by the.[112]

Similarly, vegetable consumption was assessed based on the frequency of consumption over the course of a typical week. Subjects were divided into four categories: those who never consumed vegetables, those who consumed vegetables 1–3 days per week, those who consumed vegetables 4–6 days per week, and those who consumed vegetables on all days of the week. A serving of vegetables was defined as one medium-sized cup of raw green leafy vegetables or half a cup of cooked vegetables, such as carrot, pumpkin, corn, tomatoes, or beans, weighing approximately 80 grams. The classification and methodology followed the recommendations of the.[113]

Physical Activity: Physical activity was assessed across three domains: work-related, leisure time, and travel-related. Each domain was classified into three categories: sedentary, moderate, and vigorous, based on the intensity and duration of the activities.[114]

1. **Work-Related Physical Activity:[109]**

   Sedentary work includes activities that involve mostly sitting or standing, with walking for less than 10 minutes at a time.

   Moderate work involves moderate-intensity activities, such as brisk walking or carrying light loads, for at least 10 minutes at a time.

   Vigorous work includes activities requiring vigorous physical exertion, such as heavy lifting or digging, for at least 10 minutes at a time.

   Individuals who reported engaging in all three types of activity were categorized as *vigorously active at work*. Those who reported both moderate and sedentary activities were classified as *moderately active at work*.[109]

2. **Leisure Time Physical Activity:**[109]

   Sedentary leisure includes activities such as sitting, reclining, or standing, with no physical activity lasting more than 10 minutes at a time.

   Moderate leisure involves moderate-intensity activities like brisk walking, cycling, or playing games for at least 10 minutes at a time.

   Vigorous leisure includes vigorous activities such as running, strenuous sports, or weight lifting for at least 10 minutes at a time.

   Individuals who reported engaging in all three types of leisure activities were classified as *vigorously active during leisure*. Those who reported moderate and sedentary activities were classified as *moderately active during leisure*.[109]

BIOCHEMICAL MEASUREMENTS

Fasting Plasma Glucose (FPG): Fasting plasma glucose is a diagnostic test used to measure blood glucose levels after an individual has fasted for at least 8 hours. It is commonly used to diagnose diabetes and assess glycaemic control. According to the World Health Organization (WHO) and American Diabetes Association (ADA) guidelines, a fasting plasma glucose level of:

- **Normal**: Less than 92 mg/dL (5.6 mmol/L)
- **Pre-diabetes**: 92–125 mg/dL (5.6–6.9 mmol/L)
- **Diabetes**: 126 mg/dL (7.0 mmol/L) or higher on two separate occasions.[105]

Oral Glucose Tolerance Test (OGTT): The OGTT is a diagnostic tool used to evaluate the body's ability to process glucose. After fasting overnight, a person drinks a glucose solution containing 75g of glucose, and blood glucose levels are measured at intervals, typically at 2 hours. The results are interpreted as follows:

- **Normal**: 2-hour blood glucose level less than 140 mg/dL (7.8 mmol/L)
- **Pre-diabetes**: 2-hour blood glucose between 140-199 mg/dL (7.8-11.0 mmol/L)
- **Diabetes**: 2-hour blood glucose level of 200 mg/dL (11.1 mmol/L) or higher.[105]
- **DIPSI Criteria (Diabetes in Pregnancy Study Group India):** The DIPSI criteria are used for diagnosing gestational diabetes mellitus (GDM). The test involves a 75g oral glucose load, and the blood glucose level is measured after two hours. A 2-hour plasma glucose level greater than or equal to 140 mg/dL (7.8 mmol/L) is considered diagnostic for gestational diabetes mellitus.[91]

Blood Pressure Measurement: Blood pressure is measured using a sphygmomanometer, typically through the brachial artery. The measurement is recorded in millimetres of mercury (mmHg) and consists of two numbers: systolic (the pressure when the heart beats) and diastolic (the pressure when the heart is at rest.[108]

During the course of interview, three measurements of blood pressure of each study participant were measured using mercury sphygmomanometer at an interval of 5 minutes in sitting position. The reading of blood pressure was obtained after the subject had rested for at least five minutes in the seated position. The first blood pressure measurement was recorded after obtaining socio-demographic information from study subject, while second and third was recorded during clinical examination.

All blood pressure measurements were made on left arm of each subject, using an adult cuff of appropriate size covering 80% of the arm. The sphygmomanometer was kept at the level of the heart. The average of last two SBP and DBP reading in mm Hg were noted to describe the blood pressure of the participant.16

Categorization of subjects by blood pressure levels:

The subjects were divided into "Normotensive", "pre hypertensive "or "Hypertensive" on the basis of their blood pressure levels according to JNC VIII criteria.[114]

Category	**SBP (in mmHg)**		**DBP (in mmHg)**
Normotensives	≤ 120	and	≤ 80
Prehypertensive	121 – 139	or	81 – 89
Hypertension stage I	140 – 159	or	90 – 99
Hypertension stage II	≥ 160	or	≥ 100

POSTNATAL PARAMETERS

Polyhydramnios: An excessive amount of amniotic fluid in the uterus, often leading to complications like preterm labour, fetal malpresentation, or placental abruption. It can result from conditions such as gestational diabetes or fetal anomalies that affect swallowing or kidney function. Diagnosis is usually made through ultrasound examination.[95]

Antepartum Haemorrhage: Bleeding from the genital tract after the 20th week of pregnancy but before the onset of labour. It can result from placental abnormalities such as placenta previa, placental abruption, or other causes. Antepartum haemorrhage may pose significant risks to both the mother and fetus, requiring immediate medical evaluation and intervention.[95]

Abnormal Lie: A fetal lie that deviates from the normal longitudinal cephalic presentation, such as breech or transverse lie. These abnormal presentations can complicate labor and delivery, often requiring a cesarean delivery or other interventions.[95]

Anaemia: A condition characterized by a low red blood cell count or hemoglobin concentration in the blood, leading to decreased oxygen delivery to tissues. In pregnancy, iron deficiency anaemia is most common, but folate and vitamin B12 deficiencies can also contribute. Severe anaemia can lead to complications like preterm birth and low birth weight.[95]

Preterm Labour (< 37 weeks): Labor that begins before 37 weeks of gestation. Preterm labor is associated with an increased risk of neonatal morbidity and mortality, including respiratory distress syndrome and other complications.[95]

Premature Rupture of Membranes (PROM): The breaking of the amniotic sac before the onset of labor. If this occurs before 37 weeks, it is termed preterm PROM. This condition increases the risk of infection and preterm birth.[95]

Oligohydramnios:A condition of low amniotic fluid, defined by a deepest vertical pocket of less than 2 cm or an amniotic fluid index of less than 5 cm. It can lead to complications such as fetal growth restriction and umbilical cord compression.[95]

Cervical Incompetence: A condition where the cervix prematurely dilates, often leading to preterm birth or miscarriage, typically managed with cervical cerclage.[95]

Pelvic Inflammatory Disease (PID): An infection of the female reproductive organs, typically caused by sexually transmitted infections like Chlamydia or Gonorrhoea.[95]

Urinary Tract Infection (UTI): A bacterial infection of the urinary tract, commonly seen in pregnancy, that can lead to complications like preterm labor if untreated. Symptoms include dysuria and frequent urination.[95]

Types of delivery

- **Vaginal Delivery (Without Forceps/Vacuum):** A natural childbirth where the baby is delivered through the birth canal without the use of instruments. This method is preferred when there are no complications.[115]

- **Vaginal Delivery (With Forceps/Vacuum):** Assisted vaginal delivery using instruments like forceps or a vacuum extractor to help guide the baby out of the birth canal. This is typically done when there are difficulties during the second stage of labor, such as fetal distress or prolonged pushing.[115]

- **Lower Segment Caesarean Section (LSCS):** A surgical procedure in which an incision is made through the abdominal wall and uterus to deliver the baby. LSCS is typically performed when a vaginal delivery poses a risk to the mother or baby.[116]

Gender of the Baby : This variable denotes the biological sex of the newborn.

Birthweight: The weight of the newborn immediately after birth, measured in grams. Birthweight is a critical indicator of newborn health and can help assess the risk for neonatal complications.

A birthweight of less than 2500 grams is classified as low birth weight (LBW), while a birthweight over 4000 grams is considered high birth weight (HBW).[117]

Required Ventilatory Support: This variable refers to whether the newborn requires any form of respiratory support to aid in breathing after birth. The types of support include:[118]

- **Bag and Mask Ventilation (BMV):** A manual resuscitation device used to provide artificial ventilation.
- **Oxygen:** Administering pure oxygen to help the baby breathe.
- **Positive Pressure Ventilation (PPV):** A technique used to maintain airway pressure, often used when a baby requires more help to breathe than what can be provided by bag and mask alone.
- **Other:** Includes other forms of respiratory support such as Continuous Positive Airway Pressure (CPAP) or mechanical ventilation.[118]

NICU admission typically occurs when a newborn requires specialized care due to complications such as prematurity, respiratory distress, infections, or other critical conditions.[95]

Congenital Anomalies in Neonate refers to any structural or functional abnormality present in a neonate at birth, which may involve various body systems, such as the cardiovascular, nervous, or musculoskeletal systems. Congenital anomalies can either be detected immediately after birth or discovered later in the neonatal period. These anomalies can be classified as major or minor depending on their severity and potential impact on the newborn's health. [119]

Types of congenital anomalies might include:

- Cardiac defects (e.g., atrial septal defect, ventricular septal defect)

- Neural tube defects (e.g., spina bifida, anencephaly)
- Cleft lip/palate
- Genitourinary abnormalities (e.g., hypospadias, renal agenesis)
- Musculoskeletal abnormalities (e.g., clubfoot, polydactyly)[119]

Abnormal Fetal Heart Rate (FHR): Abnormal fetal heart rate during delivery refers to irregular patterns in the fetal heartbeat, which can indicate fetal distress and may require intervention such as a cesarean section or forceps delivery.[95]

Fever (>100.4°F / 38°C): A maternal fever exceeding 100.4°F (38°C) during delivery can be a sign of infection or inflammation, which may require management to prevent complications for both mother and baby. [95]

Shoulder Dystocia: Shoulder dystocia is a complication where the infant's shoulder becomes impacted behind the mother's pubic bone during delivery, potentially causing birth injuries or requiring specific maneuvers to resolve. National Institute for Health and Care Excellence.[104]

Retained Placenta: Retained placenta occurs when part of the placenta remains in the uterus after childbirth, which may lead to postpartum hemorrhage, infection, or other complications if not managed appropriately. [95]

Post-partum Hemorrhage: Postpartum hemorrhage refers to excessive bleeding after delivery, typically defined as blood loss greater than 500 mL after a vaginal birth or 1000 mL after a cesarean section, and is a leading cause of maternal morbidity and mortality. [120]

Sepsis: Sepsis in the postpartum period is a severe infection that can rapidly progress to life-threatening organ failure and requires immediate medical attention and treatment to prevent maternal morbidity and mortality. [95]

RESULTS

The present study was conducted among 450 pregnant women, at Two Primary Health Centers (PHCs) – Kinaye and Vantamuri and Two Urban PHCs – Ashok Nagar and Rukmini Nagar, Belagavi Taluka, Belagavi catering to an overall population of nearly 227,562 which are the field practice areas of the Department of Community Medicine, Jawaharlal Nehru Medical College, Belagavi between 1st April 2023 to 31st January 2025.

Most of the population can fluently speak and understand Kannada and Marathi languages. In rural area, majority were involved in agriculture and related activities whereas in urban predominantly were self-employed, working in small and medium scale industries for their living. The Accredited Social Health Activists (ASHA), Anganwadi Workers, Health Assistants, Health workers, Private Practitioners and Medical Officer of PHCs provided necessary health.

The data obtained was tabulated and analyzed under following headings as below:

Section I: Profile of study participants

Part A : Socio-demographic profile

Part B : Family History and Medical History

Part C : Current Obstetric profile of study participants

Part D : Past Obstetric History of study participants

Part E : Anthropometry

Part F : Intranatal and Postnatal Findings

Section II : Prevalence of Gestational Diabetes Mellitus

Section III : Fasting Blood Sugar as predictor of GDM

Section IV : Risk factors and its association with GDM status

Section V : Association of GDM with Socio-demographic Factors

Section I : PROFILE OF STUDY PARTICIPANTS

Part A: Sociodemographic Profile

Table 1: Age wise distribution of the study participants (n=450)

Age (Years)	Frequency (n)	Percentage (%)
18 – 20	83	18.4
20 - 24	192	42.7
25 - 29	120	26.7
≥ 30	55	12.2
Total	**450**	**100**

In our study, 83 (18.4%) participants were aged 18–20 years, 192 (42.7%) were between 20–24 years, 120 (26.7%) were between 25–29 years, and 55 (12.2%) were aged 30 years or older.

Mean Age of the study participants was **24.3** and with standard deviation **4.31**

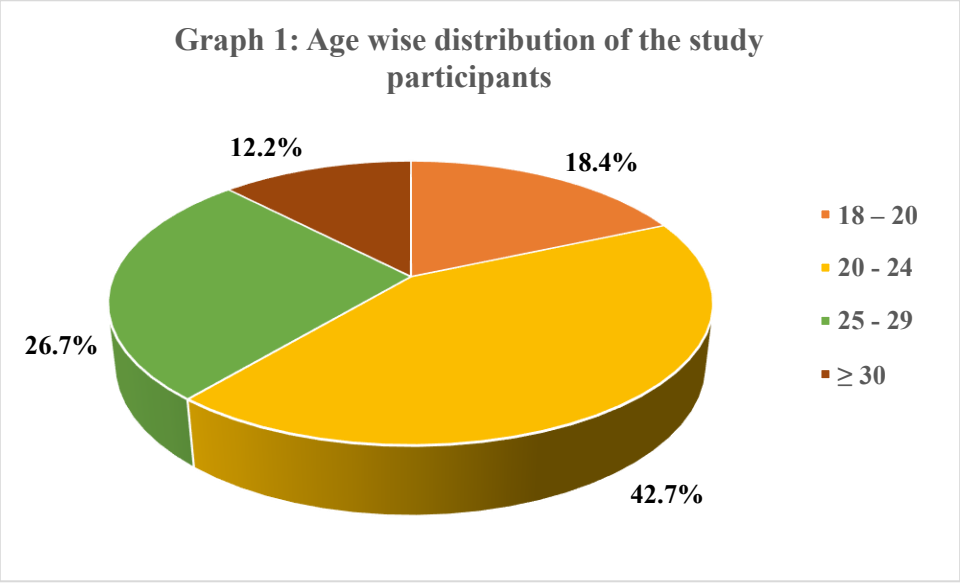


Table 2: Distribution of the study participants according to their Religion (n=450)

Religion	Frequency (n)	Percentage (%)
Hindu	210	46.7
Islam	225	50
Christian	2	0.4
Sikh	12	2.7
Others	1	0.2
Total	**450**	**100**

In our study, the majority of participants were Muslims 225 (50%), followed by Hindus 210 (46.7%). Sikhs accounted for 12 (2.7%), while Christians and others constituted 02 (0.4%) and 01 (0.2%) participant, respectively.

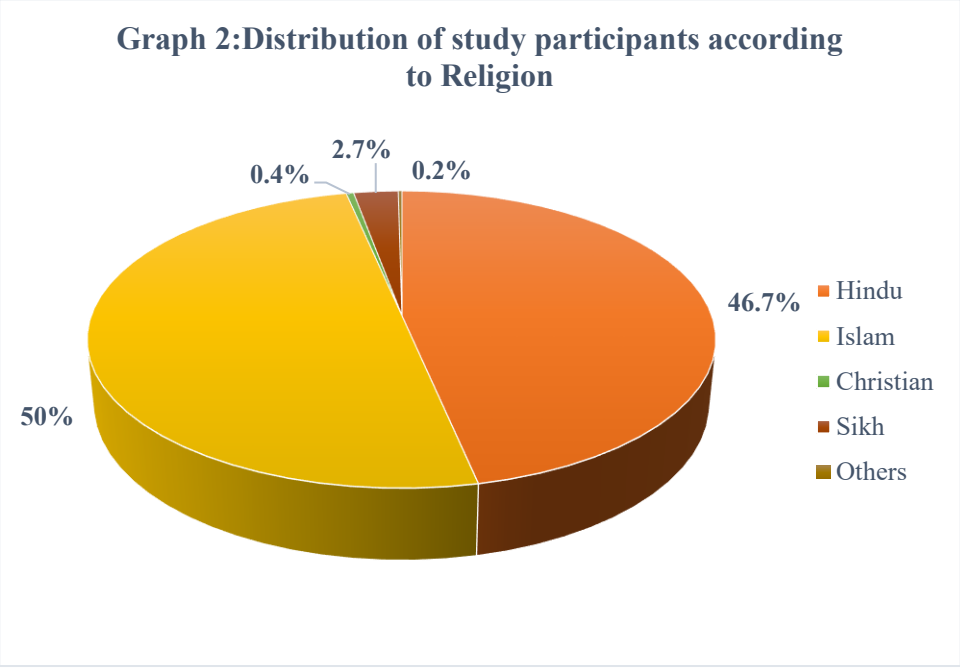


Table 3: Distribution of the study participants according to their education status (n=450)

Education	Frequency (n)	Percentage (%)
No formal education	7	1.6
Primary	63	14.0
Secondary	266	59.1
College	83	18.4
Post Graduate	31	6.9
Total	**450**	**100**

Most participants in our study had completed secondary education 266 (59.1%), while 83 (18.4%) had attended college and 63 (14%) had only primary education. A smaller group pursued postgraduate studies (6.9%), and a few (1.6%) had no formal education.

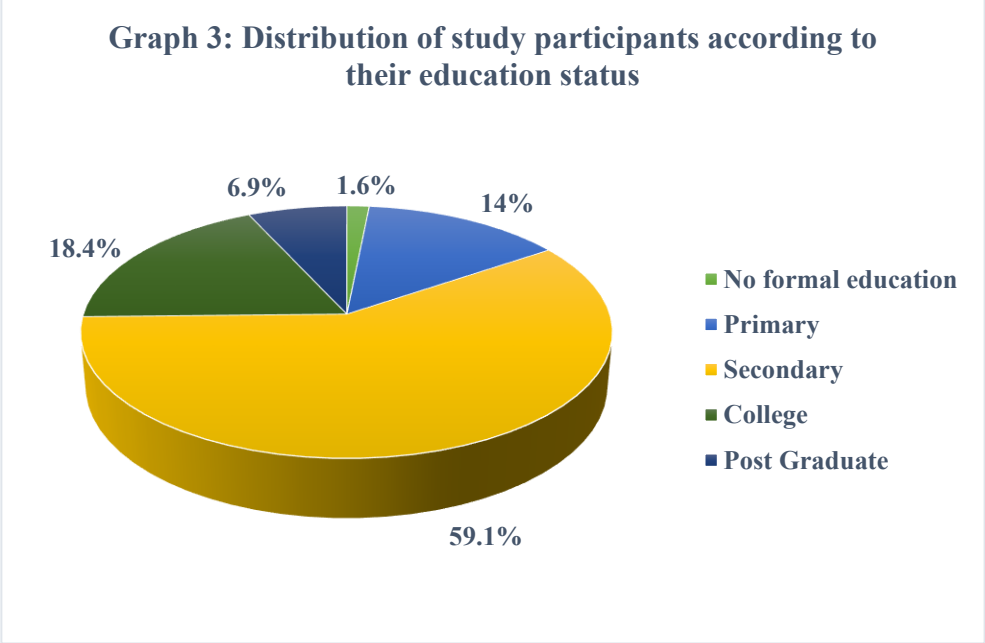


Table 4: Distribution of the study participants according to their main work status (n=450)

Occupation	Frequency (n)	Percentage (%)
Home maker	348	77.3
Govt. Employee	8	1.8
Non-govt employee	24	5.3
Self-employee	48	10.7
Agriculture	22	4.9
Total	**450**	**100**

In our study, the majority of participants were homemakers 348 (77.3%), while 48 (10.7%) were self-employed. Non-government employees accounted for 24 (5.3%), agricultural workers made up 22(4.9%) , and only 8 (1.8%) were government employees.

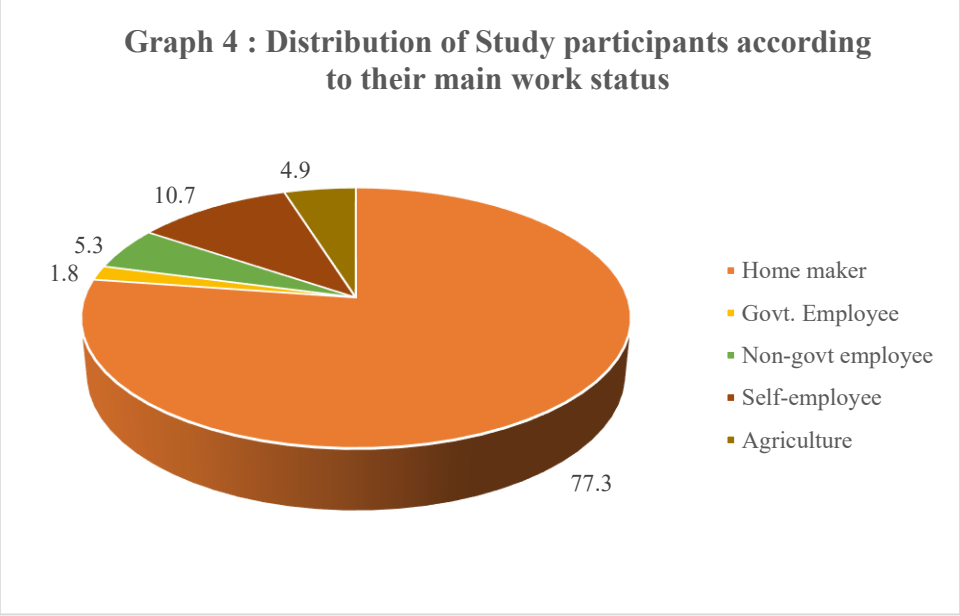
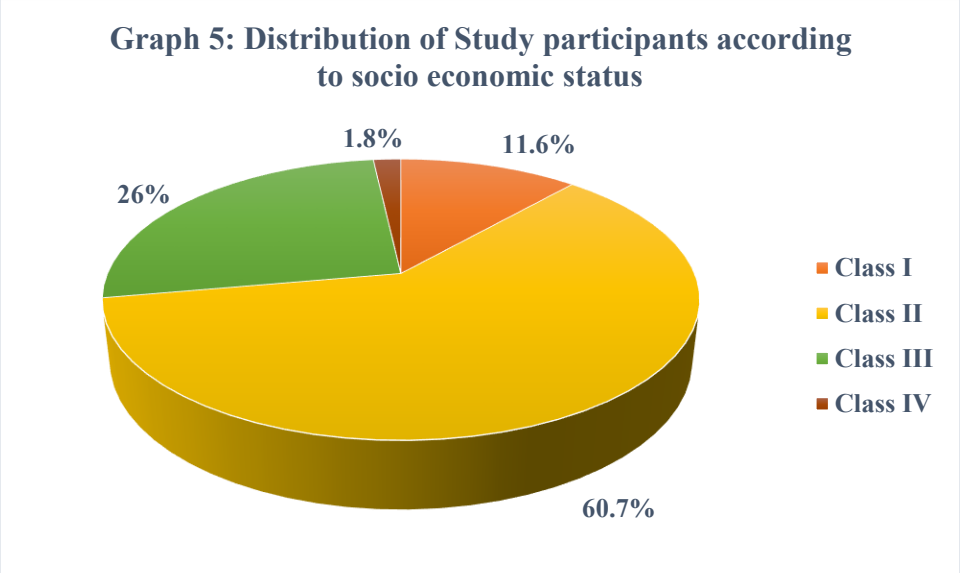


Table 5: Distribution of study participants according to socio economic status (Acc. to modified B.G. Prasad classification, 2024) (n= 450)

Socio-economic Status	Frequency (n)	Percentage (%)
Class I	52	11.6
Class II	273	60.7
Class III	117	26.0
Class IV	8	1.8
Total	**450**	**100**

In this study, most participants 273 (60.7%) were from Class II socio-economic status, while 117(26%) belonged to Class III. A smaller group 52 (11.6%) fell into Class I, and only a few 8 (1.8%) were in Class IV, based on the modified B.G. Prasad classification (2024).



Part B : Family History and Medical History

Table 6 (a): Distribution of study participants according to family history of Diabetes Mellitus (n=450)

Family history of Diabetes Mellitus	Frequency (n)	Percentage (%)
Yes	88	19.6
No	362	80.4
Total	**450**	**100**

In this study, 88 (19.6%) of participants reported a family history of diabetes mellitus, while the majority 362 (80.4%) had no such history.

Table 6 (b): Distribution of study participants according to family history of Diabetes Mellitus (n=88)

If Yes, Specify	Frequency (n)	Percentage (%)
Mother	34	38.6
Father	37	42.0
Both Parents	8	9.09
Siblings	9	10.2
Total	**88**	**100**

In this study, Among the 88 participants with a family history of diabetes, **37 (42.0%)** reported an affected father, **34 (38.6%)** had an affected mother, **8 (9.09%)** had both parents affected, and **9 (10.2%)** had diabetic siblings. A paternal history of diabetes was the most commonly reported.

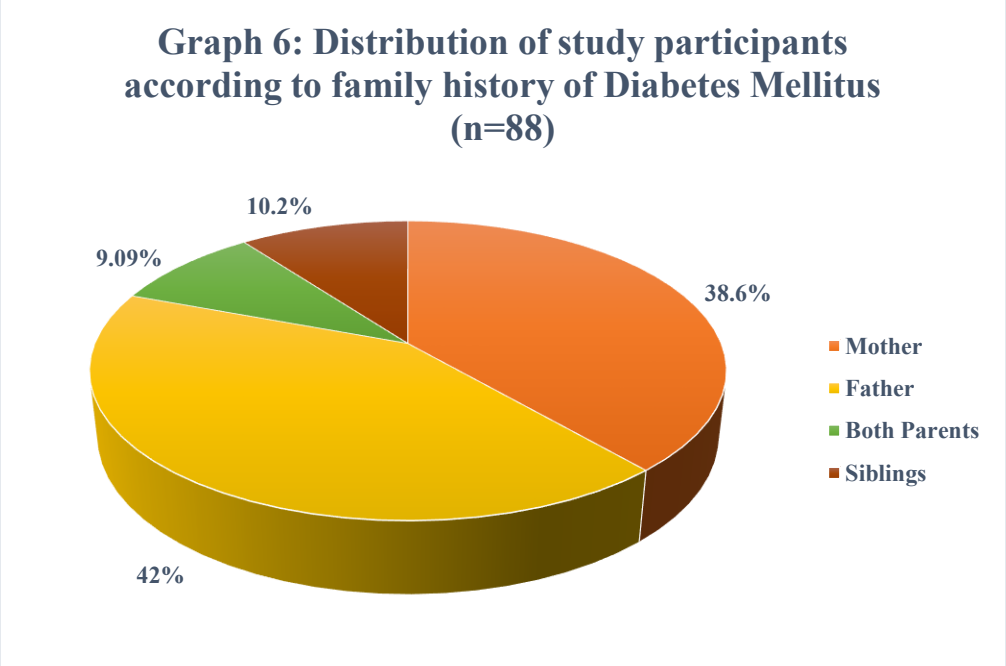


Table 7 (a): Distribution of study participants according to family history of Hypertension (n=450)

Family history of Hypertension	Frequency (n)	Percentage (%)
Yes	137	30.4
No	313	69.6
Total	**450**	**100**

In this study, 137 (30.4%) of participants had a family history of hypertension, while the majority 313 (69.6%) did not

Table 7 (b): Distribution of study participants according to family history of Hypertension (n=137)

If Yes, Specify	Frequency (n)	Percentage (%)
Mother	42	30.6
Father	74	54.0
Both Parents	16	11
Siblings	5	3.6
Total	**137**	**100**

Among those with a family history, 74 (54%) had a hypertensive father, 42 (30.6%) had a hypertensive mother, 16 (11%) reported both parents being affected, and 5 (3.6%) had siblings with hypertension.

Graph 7: Distribution of study participants according to family history of Hypertension (n=137)

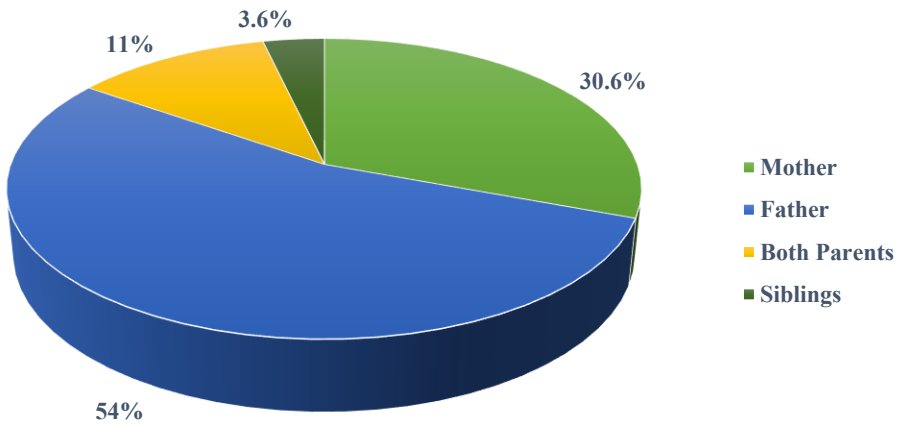


Table 8: Distribution of study participants according to their current medical condition prior to pregnancy (n=19)

Current medical conditions	Frequency (n)	Percentage (%)
Hypertension	7	36.8
Cardiac Problems	0	0
Thyroid disease	9	47.3
Tuberculosis	0	0
COVID-19	1	5.2
Psychiatric illness (Anxiety / Depression)	2	10.5
Total	**19**	**100**

In this study, 19 of them had some medical conditions prior to the current pregnancy. Among them, 9 (47.3%) had thyroid disease, followed by 7 (36.8%) with hypertension. Psychiatric illness (anxiety/depression) was reported by 2 (10.5%), while 1 (5.2%) had a history of COVID-19. No participants reported cardiac problems or tuberculosis. Thyroid disease was the most common pre-existing condition.

Part C : Current Obstetric profile of study participants (n=450)

Table 9: Distribution of study participants according to their gravida status (n=450)

Gravida	Frequency (n)	Percentage (%)
1	200	44.4
2	146	32.4
3	69	15.3
4	24	5.3
≥5	11	2.4
Total	**450**	**100**

In this study, among the 450 participants, 200 (44.4%) were primigravida, followed by 146 (32.4%) who were gravida 2, 69 (15.3%) gravida 3, 24 (5.3%) gravida 4, and 11 (2.4%) who were gravida 5 or more.

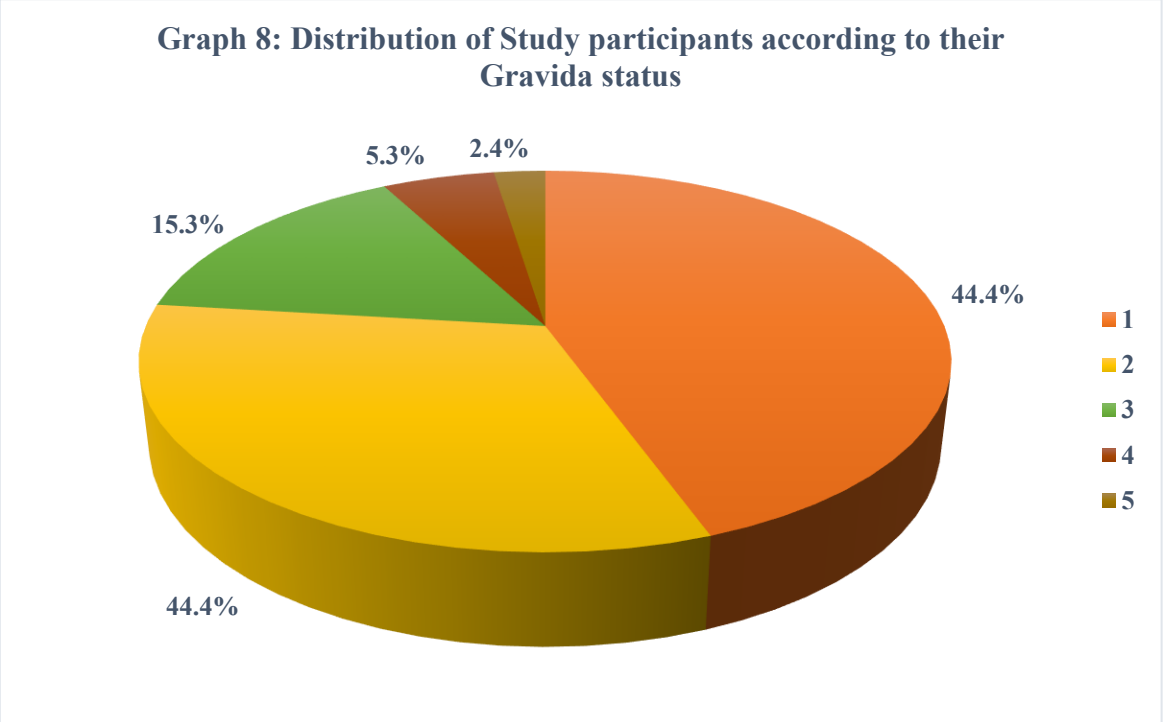
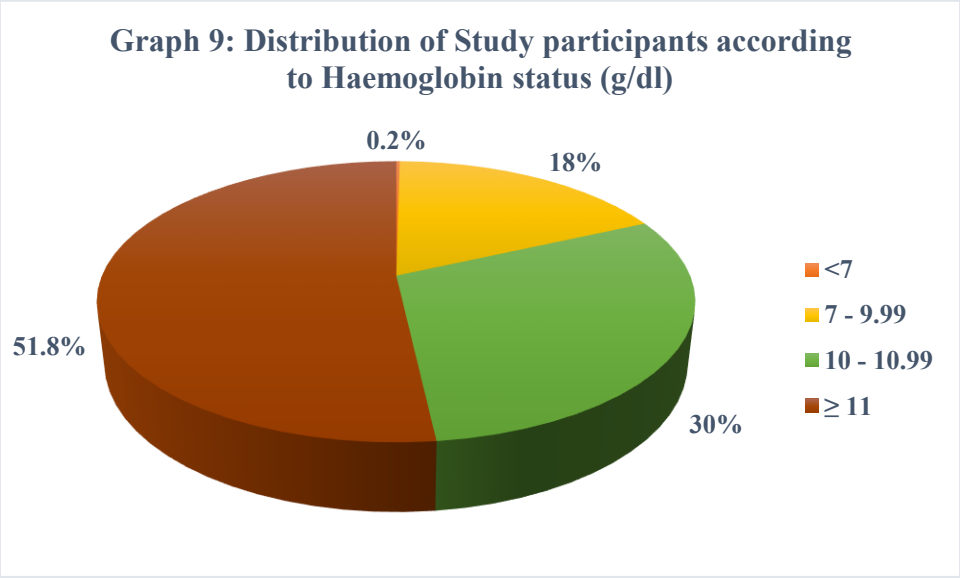


Table 10: Distribution of study participants according to their Hemoglobin Status (n=450)

Hemoglobin values (g/dl)	Frequency (n)	Percentage (%)
<7	1	0.2
7 - 9.9	81	18.0
10 - 10.9	135	30.0
≥ 11	233	51.8
Total	**450**	**100**

In this study, among the 450 participants, 233 (51.8%) had hemoglobin levels ≥11 g/dL, indicating normal hemoglobin status. 135 (30.0%) had hemoglobin levels between 10–10.9 g/dL, while 81 (18.0%) had levels between 7–9.9 g/dL, suggesting mild to moderate anemia. Only 1 (0.2%) participant had hemoglobin levels <7 g/dL, indicating severe anemia.



In this study, all 450 participants tested negative for HIV. For Hepatitis B (HBsAg), nearly everyone (99.8%) had a negative result, with just one participant (0.2%) testing positive for HBsAg.

Table 11: Distribution of study participants according to their Blood group category (n=450)

Blood group	Frequency (n)	Percentage (%)
A Positive	99	22
A Negative	11	2.4
B Positive	128	28.4
B Negative	9	2
AB Positive	43	9.6
AB Negative	4	0.9
O Positive	154	34.2
O Negative	2	0.4
Total	**450**	**100**

In our study, the most common blood group among participants was O Positive 154 (34.2%), followed by B Positive 128 (28.4%) and A Positive 99 (22%). AB Positive was found in 22(9.6%) of participants, while the negative blood groups were less common, with A Negative 11 (2.4%), B Negative 9 (2%), AB Negative 4 (0.9%), and O Negative 2 (0.4%) making up a smaller proportion.

Graph 10 : Distribution of Study participants according to their blood group category

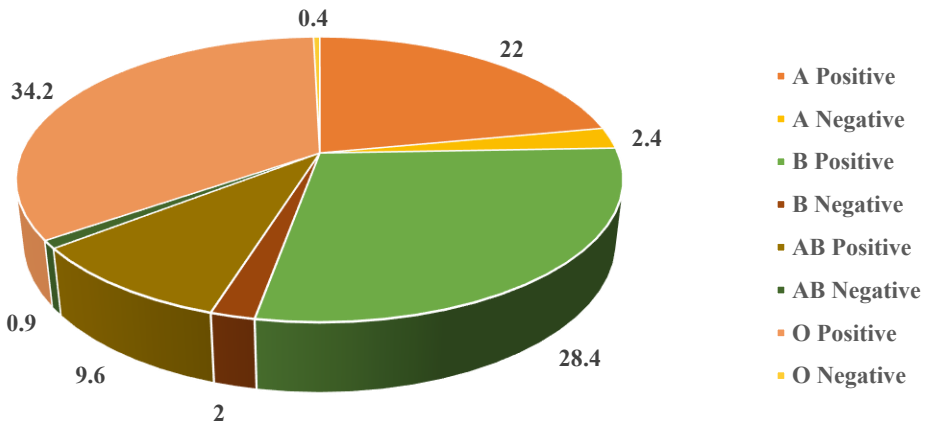


Table 12: Distribution of study participants according to their Urine protein status (n=450)

Urine protein	Frequency (n)	Percentage (%)
Present	6	1.3
Absent	444	98.7
Total	**450**	**100**

In this study, urine protein was present in 6 (1.3%) of participants, while the vast majority 444 (98.7%) had no detectable protein in their urine, indicating normal kidney function in most cases

Table 13: Distribution of study participants according to their Urine sugar status (n=450)

Urine sugar	Frequency (n)	Percentage (%)
Present	1	0.2
Absent	449	99.8
Total	**450**	**100**

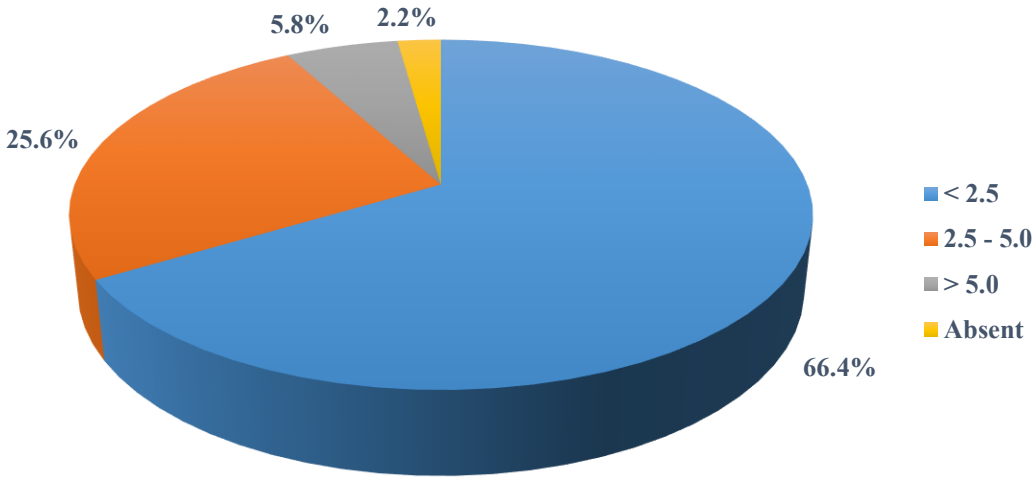
In this study, only 1 (0.2%) of participant had detectable urine sugar, while 449(99.8%) showed no presence of sugar in their urine.

Table 14: Distribution of study participants according to their TSH values (n=450)

TSH	Frequency (n)	Percentage (%)
< 2.5	299	66.4
2.5 - 5.0	115	25.6
> 5.0	26	5.8
Test not done	10	2.2
Total	**450**	**100**

In the present study, thyroid function tests were conducted for the majority of participants 440 (97.8%), while a small proportion 10 (2.2%) did not undergo testing. Among those tested, 299 (66.4%) had TSH levels below 2.5 mIU/L, 115 (25.6%) had levels ranging between 2.5 and 5.0 mIU/L, and 26 (5.8%) had TSH levels exceeding 5.0 mIU/L.

Graph 11: Distribution of Study participants according to TSH values



Part D : Past Obstetric History of study participants (n=250)

Table 15: Distribution of study participants according to their History of Diabetes Mellitus in Past pregnancy (n=250)

History of Diabetes Mellitus in Past pregnancy	Frequency (n)	Percentage (%)
Yes	3	1.2
No	247	98.8
Total	**250**	**100**

Among the participants, the vast majority 247 (98.8%) had no prior history of diabetes mellitus during pregnancy, while a small fraction 3 (1.2%) had experienced it in an earlier/past pregnancy. Among those with a history of GDM, 2 (0.8%) received medical nutrition therapy (MNT), 1 (0.4%) received a combination of treatments, and 247 (98.8%) did not require any treatment.

Table 16: Distribution of study participants according to their History of Gestational Hypertension/ Pre-eclampsia in Past pregnancy (n=250)

History of Gestational Hypertension/ Pre-eclampsia in Past pregnancy	Frequency (n)	Percentage (%)
Yes	9	3.6
No	241	96.4
Total	**250**	**100**

In the present study, 9 (3.6%) participants had a history of gestational hypertension or pre-eclampsia in a previous pregnancy, while 241 (96.4%) did not report any such history.

Table 17: Distribution of study participants according to their Previous LSCS (n=250)

Previous LSCS	Frequency (n)	Percentage (%)
Yes	68	27.2
No	182	72.8
Total	**250**	**100**

In the present study, 68 (27.2%) participants had a history of a lower segment cesarean section (LSCS) in a previous pregnancy, while 182 (72.8%) had not undergone LSCS.

Table 18: Distribution of study participants according to their History of Neonatal death/ Still Birth (n=250)

History of Neonatal death/ Still Birth	Frequency (n)	Percentage (%)
Yes	39	15.6
No	211	84.4
Total	**250**	**100**

In the present study, 39 participants (15.6%) had a history of neonatal death or stillbirth, whereas the majority, 211 participants (84.4%), had no such adverse obstetric outcomes in the past.

Table 19: Distribution of study participants according to their history of previous difficult labour (n=250)

History of previous difficult labour	Frequency (n)	Percentage (%)
Yes	22	8.8
No	228	91.2
Total	**250**	**100**

In the present study, 22 participants (8.8%) reported a history of previous difficult labor, while 228 participants (91.2%) had no such past history.

Table 20: Distribution of study participants according to their History of Bad obstetric history (n=250)

History of Bad obstetric history	Frequency (n)	Percentage (%)
Yes	59	23.6
No	191	76.4
Total	**250**	**100**

In the present study, 59 participants (23.6%) had a history of bad obstetric outcomes, while the majority, 191 participants (76.4%), did not report any such history. Among these, only 1 participant (0.4%) had a history of Rh incompatibility, while the majority, 249 participants (99.6%), did not report any history of Rh incompatibility and none of the participants had a history of delivering a baby weighing ≥ 4.5 kg.

Table 21: Distribution of study participants according to their History of Anxiety / Depression (n=250)

History of Anxiety / Depression	Frequency (n)	Percentage (%)
Yes	4	1.6
No	246	98.4
Total	**250**	**100**

In this study, 4 participants (1.6%) had a history of anxiety or depression, while the majority, 246 participants (98.4%), had no such past history.

Part E : Anthropometry

Table 22: Distribution of study participants according to their Pregnancy Weight Gain (n=450)

Pregnancy Weight Gain (Kg)	Frequency (n)	Percentage (%)
< 7	57	12.7
7 - 9	236	52.4
9 - 11	115	25.6
> 11	42	9.3
Total	**450**	**100**

In our study, pregnancy weight gain was less than 7 Kg in 12.7 (12.7%) of participants, while the majority 236 (52.4%) gained between 7–9 Kg. About 115 (25.6%) had a weight gain of 9–11 kg, and 42 (9.3%) gained more than 11 kg. Mean Weight Gain in the current pregnancy was 8.12 Kg and with standard deviation 1.81 Kg.

Graph 12: Distribution of Study participants according to their Pregnancy weight gain (Kg)

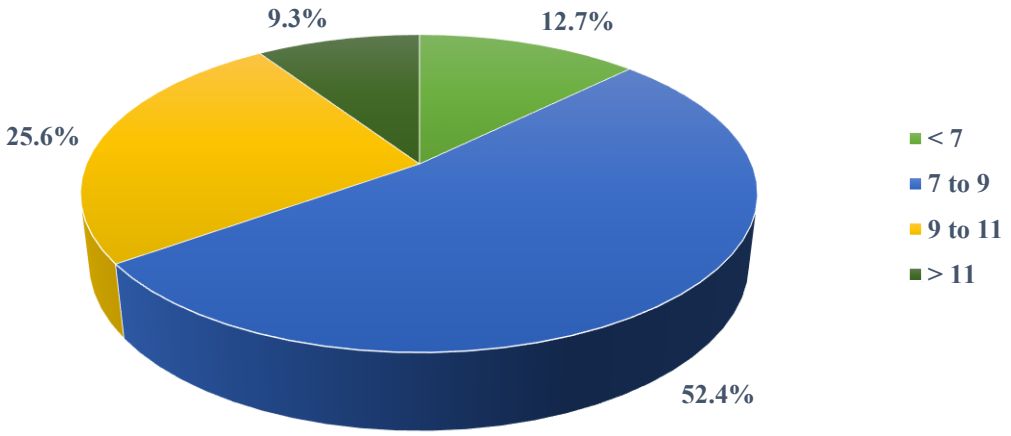
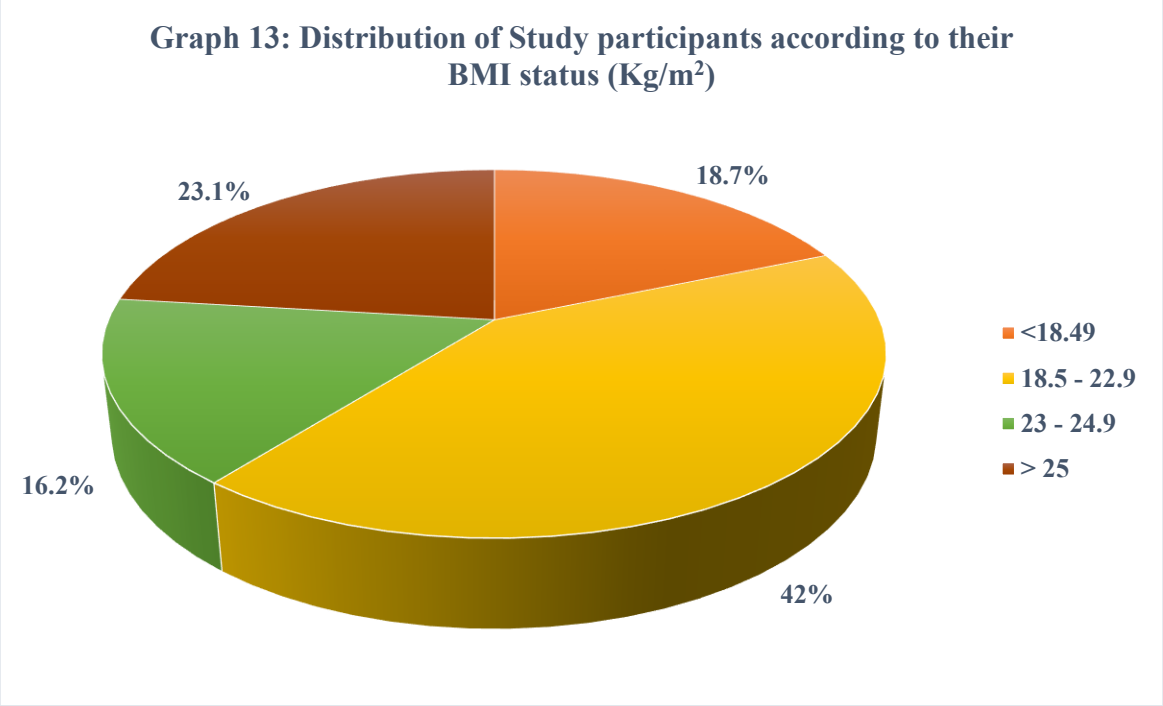


Table 23: Distribution of study participants according to their BMI status (n=450)

BMI (kg/m^2)	Frequency (n)	Percentage (%)
<18.49	84	18.7
18.5 - 22.9	189	42.0
23 - 24.9	73	16.2
> 25	104	23.1
Total	**450**	**100**

In our study, 84 participants (18.7%) had a BMI below 18.49, while 189 (42%) fell within the normal range of 18.5–22.9. A total of 73 (16.2%) participants had a BMI between 23–24.9, and 104 (23.1%) participants had a BMI greater than 25.

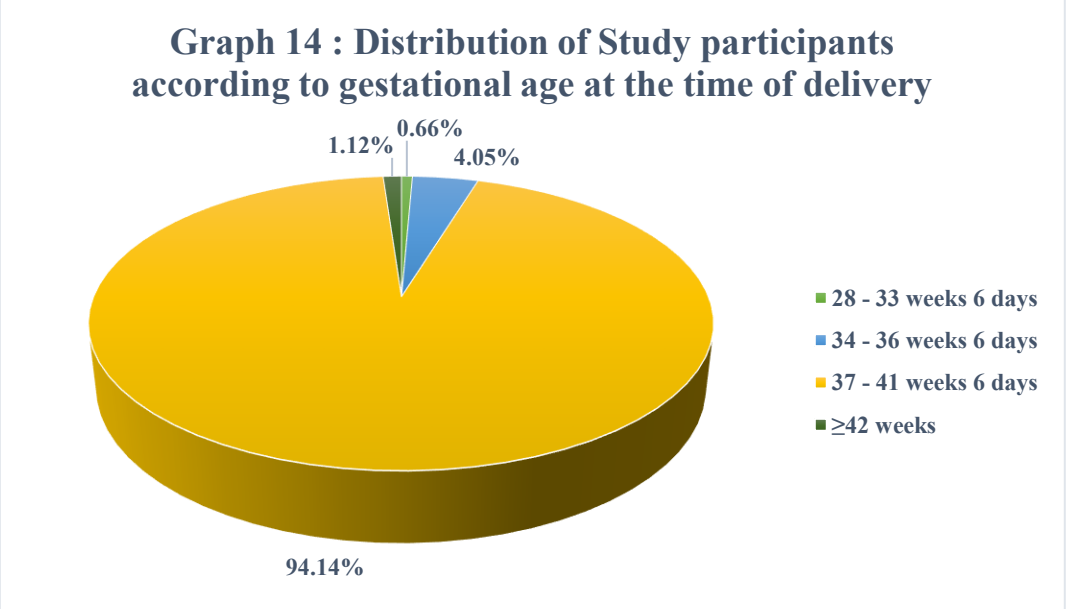


Part F : Intranatal and Postnatal Findings:

Table 24: Distribution of study participants according to Gestational Age at the time of delivery (n=444)

Gestational age at delivery	Frequency (n)	Percentage (%)
28 – 33 weeks 6 days	03	0.66
34 – 36 weeks 6 days	18	4.05
37 – 41 weeks 6 days	418	94.14
≥42 weeks	5	1.12
Total	**444**	**100**

In our study, 03 (0.66%) participants delivered early preterm (i.e., 28 - 33 weeks 6 days of gestation, while 18 (4.05%) participants had preterm deliveries between 34 and 36 weeks 6 days. The majority of participants, 418 (94.14%), delivered between 37 and 41 weeks 6 days, indicating that most pregnancies reached full-term gestation. A small proportion i.e. 5 (1.12%) participants, had post-term deliveries at or beyond 42 weeks.



Section II : Prevalence of Gestational Diabetes Mellitus

Table 25: Prevalence of GDM as per Oral Glucose Tolerance Test (OGTT) in 1st Trimester(T1) (n=450)

OGTT (T1) md/dl	Frequency (n)	Percentage (%)
≥140	72	16
≤140	378	84
Total	**450**	**100**

In the present study, the prevalence of Gestational Diabetes Mellitus in the first trimester, as determined by the OGTT, was 16.0% (72 out of 450 participants). The majority, 84.0% (378 participants), had normal OGTT results.

Table 26: Prevalence of GDM as per Fasting Blood Sugar (FBS) values in 1st Trimester (T1) (n=450)

FBS (mg/dl)	Frequency (n)	Percentage (%)
< 92	379	84.2
≥ 92	71	15.8
Total	**450**	**100**

In the present study, the prevalence of GDM based on FBS values in the first trimester was 15.8% (71 out of 450 participants) with FBS levels ≥ 92 mg/dL. The majority, 84.2% (379 participants), had FBS levels below 92 mg/dL, indicating normal glucose levels.

Table 27: Prevalence of GDM as per Oral Glucose Tolerance Test (OGTT) in 2nd Trimester (T2) (n=379)

OGTT (T2) mg/dl	Frequency (n)	Percentage (%)
≥140	24	6.3
≤140	354	93.7
Total	379	100

In the second trimester, the prevalence of GDM based on the OGTT was 6.3% (24 out of 379 participants). The majority, 93.7% (354 participants), had normal glucose tolerance, indicating a lower incidence of newly diagnosed GDM cases in the second trimester compared to the first trimester.

Section III : Fasting Blood Sugar as predictor of GDM

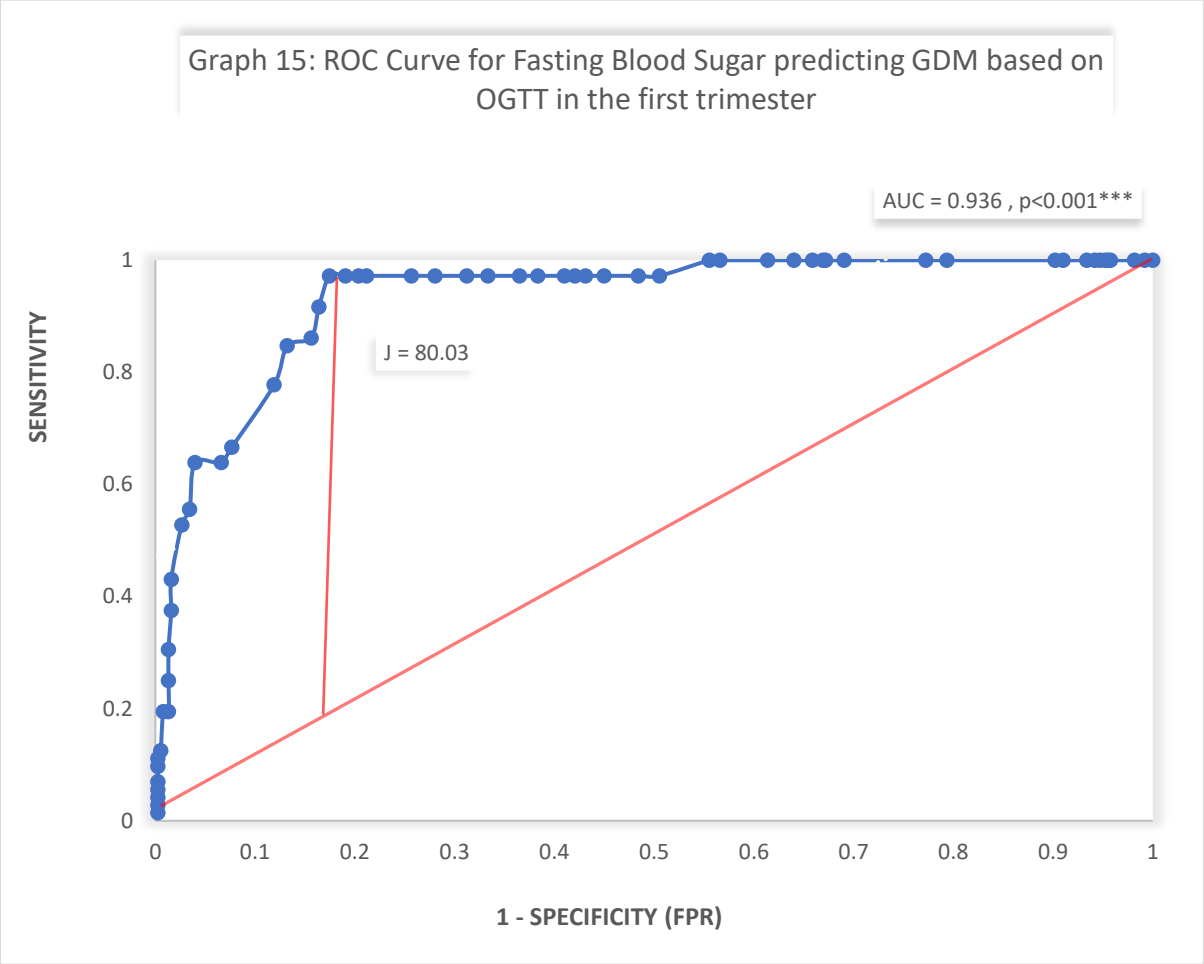
Table 28: Sensitivity, Specificity and Youden's Index for FBS In predicting GDM status

FBS Values	Sensitivity	Specificity	Youden's Index
50	100	0	0
51	100	0.79	0.79
52	100	1.85	1.85
53	100	4.23	4.23
54	100	4.50	4.50
55	100	4.76	4.76
56	100	5.29	5.29
57	100	5.82	5.82
58	100	6.61	6.61
59	100	8.99	8.99
60	100	9.79	9.79
61	100	20.90	20.90
62	100	23.02	23.02
63	100	31.22	31.22
64	100	33.07	33.07
65	100	33.33	33.33
66	100	34.39	34.39
67	100	36.24	36.24
68	100	38.89	38.89
69	100	43.65	43.65
70	100	44.71	44.71
71	97.22	49.74	46.96
72	97.22	51.85	49.07
73	97.22	55.29	52.51
74	97.22	57.14	54.37
75	97.22	58.20	55.42
76	97.22	59.26	56.48
77	97.22	61.90	59.13

78	97.22	63.76	60.98
79	97.22	66.93	64.15
80	97.22	69.05	66.27
81	97.22	72.22	69.44
82	97.22	74.60	71.83
83	97.22	79.10	76.32
84	97.22	79.89	77.12
85	97.22	81.22	78.44
86	**97.22**	**82.80**	**80.03**
87	91.67	83.86	75.53
88	86.11	84.66	70.77
89	84.72	87.04	71.76
90	77.78	88.36	66.14
91	66.67	92.59	59.26
92	63.89	93.65	57.54
93	63.89	96.30	60.19
95	55.56	96.83	52.38
96	52.78	97.62	50.40
97	43.06	98.68	41.73
98	37.50	98.68	36.18
99	30.56	98.94	29.50
100	25.00	98.94	23.94
101	19.44	98.94	18.39
102	19.44	99.47	18.92
104	12.50	99.74	12.24
106	11.11	100.00	11.11
107	9.72	100.00	9.72
108	6.94	100.00	6.94
110	5.56	100.00	5.56
112	4.17	100.00	4.17
122	2.78	100.00	2.78
126	1.39	100.00	1.39

Optimal Youden's Index

Graph 15: Receiver operating Characteristic Curve for FBS predicting GDM based on OGTT in the 1st Trimester pregnant women



The diagnostic ability of FBS to predict GDM status in first-trimester pregnant women was evaluated using sensitivity, specificity, and Youden's Index. The results indicate that an **optimal FBS cut-off value of 86 mg/dL provides a Youden's Index of 80.03**, with a **high sensitivity of 97.22% and specificity of 82.80%**. The Youden's Index**,** calculated as (Sensitivity + Specificity - 1), is a widely used measure for assessing the effectiveness of a diagnostic test. The highest Youden's Index observed in this study suggests that 86 mg/dL, which is 6 units lower than the high-risk threshold of 92 mg/dL, suggests that a lower cutoff may improve early detection of GDM while maintaining strong diagnostic performance.

Table 29: Diagnostic Performance of Fasting Blood Sugar in Detecting GDM Using OGTT in the 1st Trimester as the Reference Standard

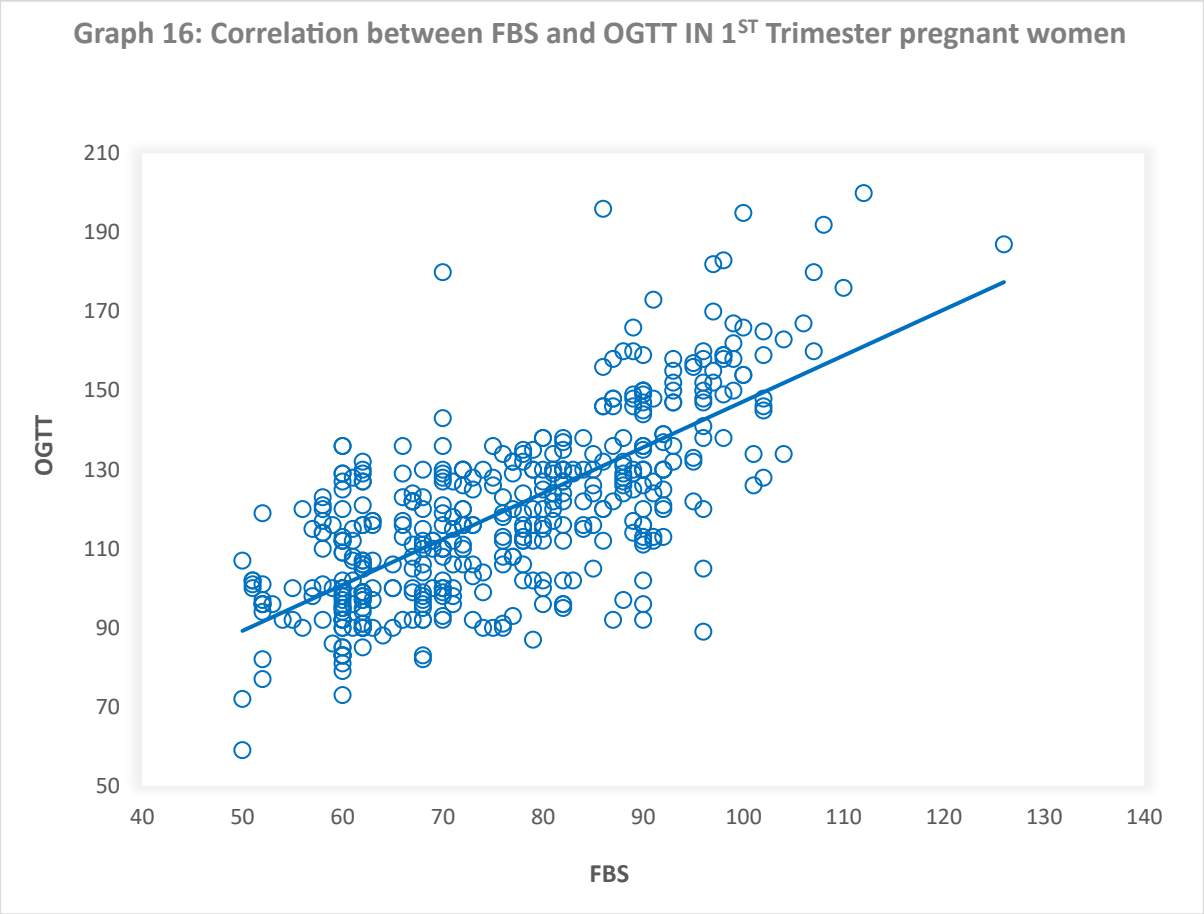
	OGTT 1st				
FBS	**≥140 mg/dl**	**%**	**≤140mg/dl**	**%**	**Total**
≥92 mg/dl	46 (TP)	64.80%	25 (FP)	35.20%	71
≤92 mg/d	26 (FN)	6.90%	353 (TN)	93.10%	379
Total	**72**	**16.00%**	**378**	**84.00%**	**450**

The diagnostic accuracy of FBS in detecting GDM using the OGTT as the reference was assessed as above. Among 450 participants, 72 (16.0%) had GDM as per the OGTT which is currently the gold standard. FBS correctly identified 46 cases (TP) but missed 26 (FN), while 353 (TN) were correctly classified as without GDM, with 25 false positives (FP).

The sensitivity of FBS for detecting GDM was found to be 63.9%, while the specificity was 93.3%. The positive predictive value (PPV) and negative predictive value (NPV) were 64.8% and 93.1%, respectively.

The **positive likelihood ratio (LR^+) was 9.55,** indicating a strong ability of FBS to confirm GDM when positive.The **negative likelihood ratio (LR^-) was 0.387**, suggesting limited effectiveness in ruling out GDM when negative.

Graph 16 : Correlation between FBS and OGTT in 1st trimester pregnant women



After excluding one of the extreme values of OGTT of 370, the correlation between FBS and OGTT for 449 patients was '**r' = 0.68** and the above graph was plotted.

A correlation coefficient of 0.68 indicates a moderate to strong positive correlation between FBS and OGTT values. This suggests that higher FBS values are generally associated with higher OGTT values. However, the correlation is not perfect, implying that while FBS can serve as an early indicator of glucose intolerance, OGTT remains essential for definitive diagnosis.

Section IV : Risk factors and its association with GDM status

Table 30: Association of Age and GDM status (n = 450)

Age (Years)	**GDM (n, %)**	**Non-GDM (n, %)**	**Total**
18 - 20	9 (10.8)	74 (89.2)	83
20 - 24	23 (12.0)	169 (88.0)	192
25 - 29	23 (19.2)	97 (80.8)	120
≥ 30	17 (30.9)	38 (69.1)	55
Total	**72 (16.0)**	**378 (84.0)**	**450**
$X^2 = 13.94$	df = 3	P=0.003*	

The prevalence of GDM increased with age, from 10.8% in the **18–20 years** group to 30.9% in women aged **30 years and above**. There is a significant association between maternal age and the risk of GDM (**p = 0.003**). The highest risk was observed in older age groups, highlighting the need for targeted screening and early intervention.

Linear Regression:

Table 31 : Linear Regression Between Age and OGTT Values

	OGTT	
	β (95% C.I.)	p- value
AGE	1.20 (0.66 -1.75)	<0.001***

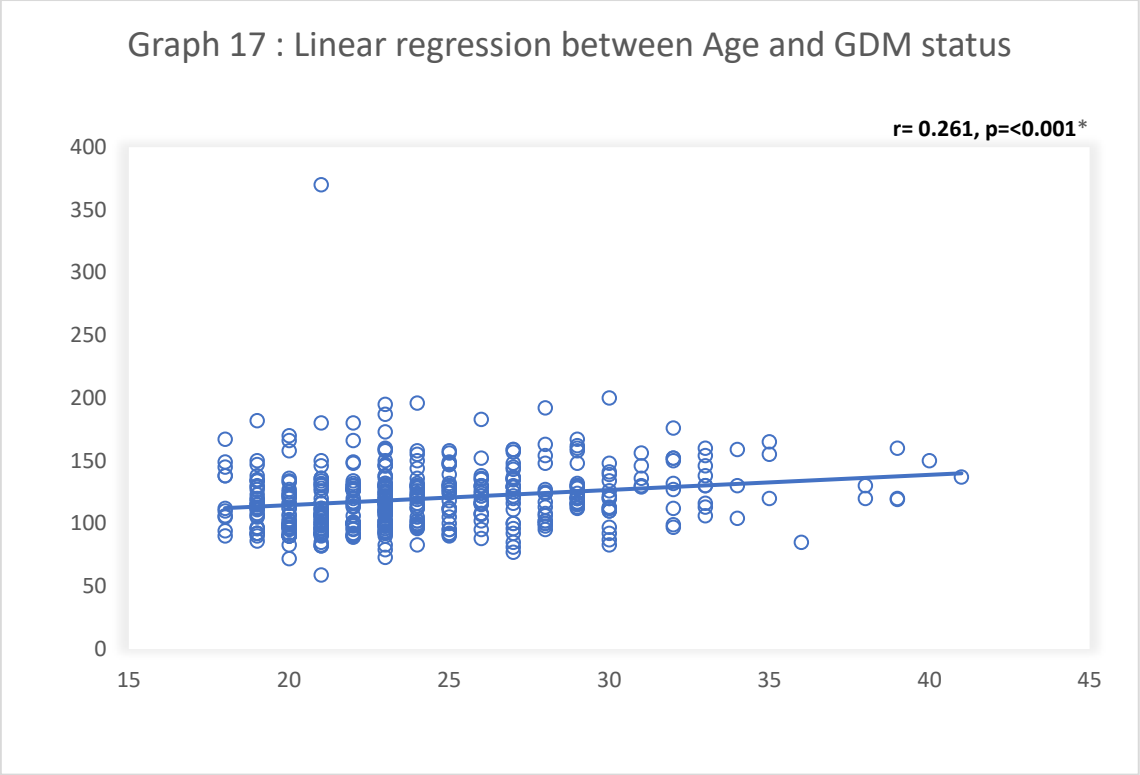
Linear regression analysis was conducted to examine the relationship between Age and OGTT values. Age was considered the independent variable, while OGTT was the dependent variable. The model showed Adjusted R^2 value of 0.04, indicating the FBS explains approximately 4.0% of the variance in OGTT values. This suggests low predictive relationship between Age and OGTT. The beta coefficient for FBS was 1.20, suggesting that for every one unit increase in age, OGTT on an average increase by 1.20 units.

Table 32: Linear Regression between Age and FBS values

	FBS	
	β (95% C.I.)	p- value
AGE	0.79 (0.48 -1.10)	<0.001***

Linear regression analysis was conducted to examine the relationship between FBS values. Age was considered the independent variable, while FBS was the dependent variable. The model showed Adjusted R^2 value of 0.04, indicating the Age explains approximately 5.0% of the variance in FBS values. This suggests low predictive relationship between Age and FBS. The beta coefficient for age was 0.79, suggesting that for every one unit increase in age, FBS on an average increase by 0.79 units.

Graph 17: Linear regression between Age and GDM status



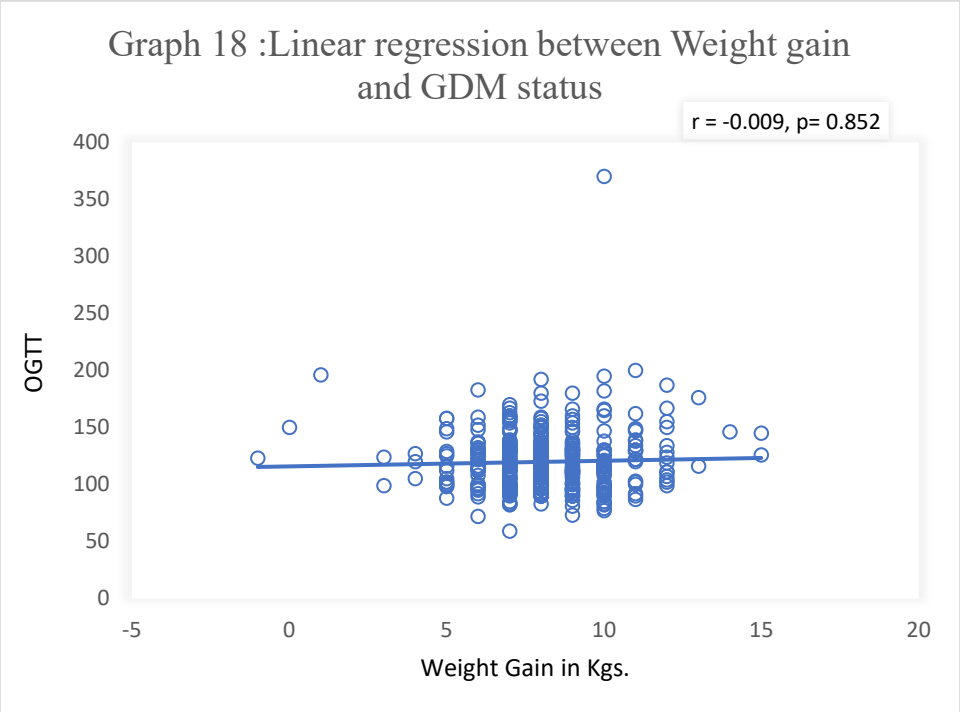
The scatterplot illustrates the linear regression between age and GDM status, showing a weak positive correlation ($r = 0.261$, $p < 0.001$). This indicates that as maternal age increases, the likelihood of developing GDM also slightly rises. Despite the weak correlation, the statistically significant ($p < 0.001$) suggests that maternal age plays a role in influencing GDM risk. This highlights the importance of age as a potential factor in screening and early detection of GDM in pregnant women.

Table 33: Association of Weight Gain during Pregnancy and GDM status (n = 450)

Pregnancy Weight Gain in kgs	**GDM (n, %)**	**Non-GDM (n, %)**	**Total**
<9	45 (15.3%)	250 (84.7%)	295 (65.6%)
9 - 11	20 (14.7%)	116 (85.3%)	136 (30.2%)
> 11	7 (36.8%)	12 (63.2%)	19 (4.2%)
$X^2 = 13.94$	df = 3	P=0.057 FT	

The prevalence of GDM was **15.3%** among women who gained **less than 9 kg**, **14.7%** in those who gained **9–11 kg**, and **36.8%** in those with weight gain exceeding **11 kg**. While the highest prevalence of GDM was observed in women with excessive weight gain, the association was not statistically significant (p = 0.057).

Graph 18 : Linear regression between Weight gain and GDM status



The scatter plot illustrates the linear regression between weight gain (in kilograms) and OGTT values to assess the association between weight gain and GDM status. The correlation coefficient (r = -0.009) suggests a negligible negative correlation between weight gain and OGTT values. The p-value (p = 0.852) indicates that this association is not statistically significant.

Table 34: Association of Various Risk Factors with GDM status (n = 450)

Factors	UOR (95% CI)	p-value	AOR (95% CI)	p-value
Maternal Age (years)				
<25 (Ref)	—	—	—	—
≥25	**2.25** (1.35–3.75)	0.002**	**1.82** (1.02–3.23)	**0.042***
Pregnancy Weight Gain (kg)				
9 - 11 (Ref)	—	—	—	—
<9	1.04 (0.59–1.85)	0.882	1.09 (0.60–2.05)	0.783
>11	**3.38** (1.20–9.63)	0.022*	**4.27** (1.36–13.44)	**0.013***
Family History of Diabetes				
No (Ref)	—	—	—	—
Yes	1.75 (0.98–3.13)	0.057	1.41 (0.72–2.76)	0.315
Family History of Hypertension				
No (Ref)	—	—	—	—
Yes	1.57 (0.93–2.65)	0.091	1.60 (0.90–2.84)	0.112
Urine Protein				
No (Ref)	—	—	—	—
Yes	**11.06** (1.99–61.57)	**0.006****	**9.0** (1.30–61.96)	**0.026***
Smoking Tobacco Consumption				
No (Ref)	—	—	—	—
Yes	2.65 (0.24–29.59)	0.429	—	—

Non-Smoking Tobacco Consumption				
No (Ref)	—	—	—	—
Yes	**2.50** (1.04–5.99)	**0.04***	2.07 (0.74–5.80)	0.165
Alcohol Consumption				
No (Ref)	—	—	—	—
Yes	0.87 (0.10–7.36)	0.901	—	—
Physical Activity				
Moderate/Vigorous (Ref)	—	—	—	—
Sedentary	0.77 (0.46–1.30)	0.327	—	—
Leisure Time Physical Activity				
No (Ref)	—	—	—	—
Yes	0.83 (0.49–1.39)	0.472	—	—
Fruit Consumption (times/week)				
≥4 (Ref)	—	—	—	—
≤3	**1.72** (1.04–2.85)	**0.036***	1.52 (0.86–2.68)	0.148
Vegetable Consumption				
No (Ref)	—	—	—	—
Yes	0.96 (0.45–2.05)	0.914	—	—

Legend:

- UOR = Unadjusted Odds Ratio
- AOR = Adjusted Odds Ratio
- CI = Confidence Interval
- p-value < 0.05 = Statistically significant*

- Women aged ≥25 years had 1.82 times higher odds of developing GDM compared to those <25 years (AOR = 1.82, 95% CI: 1.02–3.23, p = 0.042), indicating that advanced maternal age is a significant predictor of GDM.
- Excessive pregnancy weight gain (>11 kg) was strongly associated with GDM, with an adjusted odds ratio of 4.27 (95% CI: 1.36–13.44, p = 0.013), suggesting that higher weight gain increases the risk.
- Women with a family history of diabetes had 1.41 times higher odds of developing GDM (AOR = 1.41, 95% CI: 0.72–2.76, p = 0.315), though the association was not statistically significant. Similarly, a family history of hypertension showed a potential link to GDM (AOR = 1.60, 95% CI: 0.90–2.86, p = 0.112), but not statistically significant.
- The presence of protein in urine was a strong predictor, with 9.0 times higher odds of GDM (AOR = 9.0, 95% CI: 1.30–61.96, p = 0.026), highlighting its role as an important clinical marker.
- Non-smoking tobacco consumption was associated with increased GDM risk (AOR = 2.07, 95% CI: 0.74–5.80, p = 0.165), but the adjusted analysis did not confirm statistical significance.
- Women consuming fruits ≤3 times per week had 1.52 times higher odds of GDM (AOR = 1.52, 95% CI: 0.86–2.68, p = 0.148).
- Though association was not significant in the adjusted model. Other factors such as smoking, alcohol consumption, physical activity, leisure-time physical activity, and vegetable consumption did not show significant associations with GDM.

Table 35: Distribution of Study Participants according to Type of delivery (n=450)

Type of delivery	Frequency (n)	Percentage (%)
Vaginal (Without forceps/ Vacuum)	316	70.2
Vaginal (With forceps/ Vacuum)	5	1.2
LSCS	123	27.3
Abortion	06	1.3
Total	**450**	**100**

In present study, the majority of participants 316 (70.2%) had a vaginal delivery without the use of forceps or vacuum, while assisted vaginal deliveries accounted for only 5 (1.2%). Lower segment cesarean section (LSCS) was performed in 123 (27.3%) participants of cases, and 6 (1.3%) participants of pregnancies resulted in abortion.

Table 36: Distribution of Study Participants according to gender of the baby delivered (n=450)

Gender of the baby	Frequency (n)	Percentage (%)
Male	232	51.6
Female	212	47.1
Abortion	6	1.3
Total	**450**	**100**

In present study, out of 450 study participants, 232 participants (51.6%) delivered male babies, while 212 participants (47.1%) delivered female babies. Additionally, 6 participants (1.3%) of cases resulted in abortion. The distribution shows a nearly equal proportion of male and female births, with no significant difference in birth outcomes based on gender.

Table 37: Distribution of Study Participants according to Birth weight of the baby (n=450)

Birth Weight (in grams)	Frequency (n)	Percentage (%)
<1000	7	1.6
1000 - 1500	0	0
1500 - 2500	10	2.2
≥ 2500	433	96.2
Total	**450**	**100**

Among the study participants, the highest proportion of newborns 433 (96.2%), had a birth weight of ≥2500 grams, followed by 10 (2.2%) participants belong to 1500–2500 gram category. A smaller proportion 7 (1.6%) of newborns weighed less than 1000 grams, while no cases were observed in the 1000–1500 gram category.

Table 38 : Distribution of Study Participants according to GDM Outcomes

Table 38(a): Association of Study Participants According to Maternal Outcomes and GDM Status

Maternal Outcome	GDM (Yes) n (%)	GDM (No) n (%)	Total n (%)	Chi-Square / Fisher's Exact Test	p-value
Decreased Fetal Movements	28 (40.0%)	39 (10.4%)	**67 (15.1%)**	40.24	<0.001***
Hypertensive Disorders	9 (12.9%)	20 (5.3%)	**29 (6.5%)**		0.031 *FET
Polyhydramnios	34 (47.2%)	6 (1.6%)	**40 (8.9%)**	158.67	<0.001***
Antepartum Haemorrhage	0 (0%)	2 (0.5%)	**2 (0.4%)**	---	1.00 (FET)
Abnormal Lie	30 (41.7%)	74 (19.6%)	**104 (23.1%)**	17.50	<0.001***
Anemia	20 (27.8%)	109 (28.8%)	**129 (28.7%)**	0.009	0.923
Preterm Labor (≤37 weeks)	14 (19.4%)	14 (3.7%)	**28 (6.2%)**	---	<0.001***
Premature Rupture of Membranes	5 (6.9%)	16 (4.2%)	**21 (4.7%)**	---	0.35 (FET)
Abnormal Fetal Heart Rate	16 (22.2%)	21 (5.6%)	**37 (8.2%)**	22.95	<0.001***
Fever (≥100.4°F / 38°C)	0 (0%)	1 (0.3%)	**1 (0.2%)**	---	1.00 (FET)
Retained Placenta	0 (0%)	2 (0.5%)	**2 (0.4%)**	---	1.00 (FET)
Postpartum Haemorrhage	1 (1.4%)	2 (0.5%)	**3 (0.7%)**	---	0.403 (FET)
Sepsis	---	---	**---**	---	---
df-1					

Abbreviations: FET – Fisher's Exact Test, ***p < 0.001, * p < 0.05*

Table 38(b): Association of Study Participants According to Neonatal Outcomes and GDM Status

Neonatal Outcome	GDM (Yes) n (%)	GDM (No) n (%)	Total n (%)	Chi-Square / Fisher's Exact Test	p-value
Required Ventilatory Support	53 (73.6%)	86 (22.8%)	139 (30.9%)	76.20	<0.001***
Required NICU Admission	22 (30.6%)	30 (7.9%)	52 (11.6%)	31.24	<0.001***
Congenital Anomalies	1 (1.4%)	1 (0.3%)	2 (0.4%)	---	0.291 (FET)
Shoulder Dystocia	---	---	---	---	---
df- 1					

- **Legend:**

  FET: Fisher's Exact Test

  CQ: Chi-Square Test

  *p-value < 0.001***: Highly significant association.

  NICU – Neonatal Intensive Care Unit

- A higher prevalence was observed in GDM pregnancies (40.0%) compared to non-GDM (10.4%), indicating a significant association (p<0.001)

- A statistically significant association was found between GDM and hypertensive disorders (p = 0.031). Hypertensive disorders were more common in GDM cases (12.9%) compared to non-GDM cases (5.3%), suggesting that GDM increases the risk of pregnancy-induced hypertension.

- Nearly half of GDM cases (47.2%) developed polyhydramnios versus only 1.6% of non-GDM cases, demonstrating a significant association ($p<0.001$), indicating that GDM is a major risk factor for excessive amniotic fluid accumulation.
- No significant association was found between GDM and antepartum haemorrhage (**p = 1.00**). Antepartum haemorrhage was not reported in any GDM cases, and it was very rare in non-GDM cases (**0.5%**).
- The prevalence of Abnormal fetal lie - malpresentations was significantly higher in GDM pregnancies (41.7% vs 19.6%, $p<0.001$)
- The study found no significant difference in anemia rates between GDM (27.8%) and non-GDM (28.8%) groups ($p=0.923$).
- GDM was associated with a substantially higher incidence of preterm delivery (19.4% vs 3.7%, $p<0.001$), indicating that GDM significantly increases the risk of preterm delivery.
- No statistically significant association was observed between GDM and PROM (6.9% vs 4.2%, $p=0.350$).
- Neonates of GDM mothers required significantly more ventilatory support (73.6% vs 22.8%, $p<0.001$), indicating greater respiratory compromise.
- A nearly 4-fold higher NICU admission rate was observed in GDM offsprings (30.6% vs 7.9%, $p<0.001$), reflecting increased neonatal morbidity.
- No significant association was found between GDM and congenital anomalies (**p = 0.291**). The occurrence was minimal in both groups (**1.4%** in GDM and **0.3%** in non-GDM cases).
- GDM pregnancies had 4 times higher rates of abnormal fetal heart rate patterns (22.2% vs 5.6%, $p<0.001$), emphasizing the need for continuous fetal heart rate monitoring in GDM pregnancies.

- No association was found between GDM and maternal fever (**p = 1.00**), with negligible occurrence in both groups. (**0%** in GDM and **0.3%** in non-GDM cases).
- No cases of shoulder dystocia were reported in the study, making statistical analysis impossible. However, given the well-established association between GDM and macrosomia, clinical vigilance is still warranted.
- The incidence of Retained placenta was extremely low in both groups (0% in GDM vs. 0.5% in non-GDM, p=1.000), showing no association with GDM
- No significant association was observed between GDM and PPH (**p = 0.403**). PPH occurred infrequently in both groups (**1.4%** in GDM and **0.5%** in non-GDM cases).
- No cases were reported in either group, though GDM remains a theoretical risk factor for infection-related complications.

Section V : Association of GDM with Socio-demographic Factors

Table 39: Association of Religion with GDM status (n = 450)

Religion	**GDM (n, %)**	**Non-GDM (n, %)**	**Total**
Hindu	44 (21.0%)	166 (79.0%)	210 (46.7%)
Islam	28 (12.4%)	197 (87.6%)	225 (50.0%)
Christian	0 (0.0%)	2 (100.0%)	2 (0.4%)
Sikh	0 (0.0%)	12 (100.0%)	12 (2.7%)
Others	0 (0.0%)	1 (100.0%)	1 (0.2%)
Total	**72 (16.0%)**	**378 (84.0%)**	**450 (100%)**
$X^2 = 8.8$, df = 4 P-Value=0.076 MC			

Among the study participants, the highest proportion of GDM cases was observed in Hindu women 44 (21.0%), followed by Muslim women 28 (12.4%). No cases of GDM were reported among Christian, Sikh, or other religious groups. The association between religion and GDM was not statistically significant (p = 0.076), indicating that religion may not be a major determinant.

Table 40: Association of Education with GDM status (n = 450)

Education Level	**GDM (n, %)**	**Non-GDM (n, %)**	**Total**
No formal education	2 (28.6)	5 (71.4)	7
Primary	13 (20.6)	50 (79.4)	63
Secondary	30 (11.3)	236 (88.7)	266
College	17 (20.5)	66 (79.5)	83
Post Graduate	10 (32.3)	21 (67.7)	31
Total	**72 (16.0%)**	**378 (84.0%)**	**450 (100%)**
df = 4, P-Value = 0.006** FT			

The association between education level and GDM status was found to be statistically significant (p = 0.006). The highest proportion of GDM cases was observed among women with postgraduate education 10 (32.3%) and those with no formal education (28.6%). Women with secondary education had the lowest prevalence of GDM 30 (11.3%).

Table 41: Association of Occupation with GDM status (n = 450)

Occupation	GDM (n, %)	Non-GDM (n, %)	Total
Home maker	51 (14.7)	297 (85.3)	348
Govt. Employee	2 (25.0)	6 (75.0)	8
Non-govt employee	5 (20.8)	19 (79.2)	24
Self-employee	5 (10.4)	43 (89.6)	48
Agriculture	9 (40.9)	13 (59.1)	22
Total	72 (16.0%)	378 (84.0%)	450 (100%)
df = 4, P-Value = 0.018** FT			

The prevalence of GDM was highest among women engaged in agriculture (40.9%) and lowest among self-employed women (10.4%). Homemakers, who constituted the majority of participants, had a GDM prevalence of 14.7%. The association between occupation and GDM status was statistically significant (p = 0.018).

Table 42: Association of Socioeconomic Status (BG Prasad Classification) with GDM status (n = 450)

SES	GDM (n, %)	Non-GDM (n, %)	Total
SES I	6 (11.5)	46 (88.5)	52
SES II	42 (15.4)	231 (84.6)	273
SES III	23 (19.7)	94 (80.3)	117
SES IV	1 (12.5)	7 (87.5)	8
Total	**72 (16.0%)**	**378 (84.0%)**	**8 (1.8%)**
df = 3, P-Value = 0.57** FT			

The association between socioeconomic status (SES) and GDM was not statistically significant (p = 0.57). The prevalence of GDM was highest in SES III (19.7%), followed by SES II (15.4%). In SES I and SES IV, the prevalence was lower at 11.5% and 12.5%, respectively. These findings suggest that while GDM occurrence varies across socioeconomic groups, no clear trend or significant association was observed in this study.

Table 43: Association of Family History of Diabetes Mellitus with GDM status (n = 450)

Family History	**GDM (n, %)**	**Non-GDM (n, %)**	**Total**
Yes	20 (22.7)	68 (77.3)	88
No	52 (14.4)	310 (85.6)	362
Total	**72 (16.0%)**	**378 (84.0%)**	**450 (100%)**
$X^2 = 3.684$, df = 1 P-Value=0.055 CQ			

A family history of diabetes was linked to a higher prevalence of GDM (22.7% vs. 14.4%**),** but this association was not statistically significant (p = 0.055). While women with a family history had a greater risk, the findings suggest that other factors may also play a role in developing GDM.

DISCUSSION

The present community-based longitudinal study was conducted to estimate the prevalence of Gestational Diabetes Mellitus (GDM) among pregnant women in their first-trimester residing across four primary health centers, which are under the administrative control of Jawaharlal Nehru Medical College (JNMC), Belagavi, Karnataka, India, covering both rural and urban settings and to assess their outcomes one-week post-partum.

- Primary Health Centre (PHC), Kinaye,
- Primary Health Centre (PHC), Vantamuri,
- Urban Primary Health Centre (UHC), Rukmini Nagar, and
- Urban Primary Health Centre (UHC), Ashok Nagar.

During the period 1st April 2023 to 31st January 2025.

Section I: Profile of study participants

Part A: Socio-demographic profile

In our study, a significant proportion of participants (42.7%) were aged between 20–24 years, followed by 26.7% in the 25–29 age group, 18.4% in the 18–20 age group, and 12.2% who were 30 years or older. The mean age of the participants was 24.3 ± 4.31 years. Similarly, a study conducted at a tertiary care hospital in Haryana reported that the majority of participants (58.2%) were aged 21–25 years,[72] while another study from Varanasi district, Uttar Pradesh, found a mean participant age of 24.39 ± 3.17 years.[121] Comparatively, in a study by Ennazhiyil et al, conducted in Palakkad, Kerala majority were 21–30 years (72.1%), with only 10.8% under 20 years.[122] (Table 1)

In our study, the majority of participants were Muslims, 225 (50.0%), followed by Hindus, 210 (46.7%). Sikhs accounted for 12 (2.7%), while Christians and others constituted 2 (0.4%) and 1 (0.2%) participant, respectively. Similarly, in a study by Ennazhiyil et al, Hindus were (57.66%), followed by Muslims (38.74%) and Christians (3.6%).[122] In contrast, a study conducted in Varanasi district, Uttar Pradesh, reported a higher proportion of Hindus, 91.9%, compared to Muslims, 8.1%.[121] (Table 2)

Our study found that most participants had completed secondary education (59.1%), followed by college (18.4%) and primary education (14%), with smaller proportions having postgraduate (6.9%) or no formal education (1.6%). In comparison, Jaiswal et al. reported 31.24% with secondary education, 27.6% with higher secondary, 8.76% with primary, and 10.74% with no formal education[121] (Table 3).

In our study, the majority of participants were homemakers (77.3%), whereas Muche's study, a larger proportion was unemployed (60.4%).[123] Employment rates were relatively similar between the two studies, with 39.6% employed in Muche's study,[123] while in our study, only 10.7% were self-employed, and smaller proportions were in non-government (5.3%) and government jobs (1.8%). (Table 4)

Our study found that the majority of participants belonged to Class II socio-economic status (60.7%), followed by Class III (26%), while a smaller proportion were in Class I (11.6%) and Class IV (1.8%), based on the modified B.G. Prasad classification (2024). In comparison, Jaiswal et al. also used the modified B.G. Prasad scale and reported that most pregnant women were from the lower middle class (44.3%), middle class (27.6%), upper class (3.47%).[121] (Table 5)

Part B: Family History and Medical History

Our study found that 19.6% of participants had a family history of diabetes mellitus, with the most commonly affected relative being the father (42%), followed by the mother (38.6%), both parents (9.09%), and siblings (10.2%). In comparison, Monod et al. in 2023 reported that 26.6% of pregnant women had a family history of T2DM and first-degree relatives was associated with a significantly increased risk of GDM (OR 1.91, 95% CI 1.16–3.16), with the highest risk observed when both parents were affected (OR 4.69, 95% CI 1.33–16.55, p = 0.009).[124] In a study by Ennazhiyil et al 42.35% had a family history of diabetes, with 19.8% maternal, 11.71% paternal, and 10.81% both parents.[122] (Table 6 a & b).

In our study, 30.4% of participants had a family history of hypertension, with paternal hypertension being the most commonly reported (54.0%), followed by maternal (30.6%), both parents (11.0%), and siblings (3.6%). This aligns with Kek et al.'s findings, which demonstrated that women with both GDM and pregnancy-induced hypertension had an 8-fold increased risk of postpartum hypertension (HR = 8.02, $p < 0.05$).[125] (Table 7 a & b).

Current medical conditions

In our study, 19 participants had pre-existing medical conditions before the current pregnancy, with thyroid disease (47.3%) and hypertension (36.8%) being the most common. This contrasts with Fong et al., who reported a lower prevalence of thyroid dysfunction in GDM (2.39%) and a higher prevalence of chronic hypertension in pre-GDM cases (8.03%) (AOR = 3.33, $p < 0.001$).[126] Additionally, 10.5% of our participants reported psychiatric illness (anxiety/depression), aligning with Thiele et al. (2023), who found a 15% increased risk of GDM in women with antenatal anxiety/depression (AOR = 1.15, 95% CI: 1.11–1.19).[127] One participant (5.2%) had a history of COVID-19, which may be relevant for future research on its impact on GDM and pregnancy outcomes. (Table 8).

Part C: Current Obstetric profile of study participants

In our study, 44.4% of participants were primigravida, followed by 32.4% gravida 2, 15.3% gravida 3, 5.3% gravida 4, and 2.4% gravida 5 or more. The Hillier study reported a different distribution, with 41.1% of women being nulliparous, 31.1% with one previous pregnancy, 16.5% with two, and 11.1% with three or more pregnancies ($p < 0.0001$).[88] While both studies observed that a substantial proportion of women were in their first or second pregnancy, the Belagavi study had a higher proportion of primigravida women (44.4%) compared to 30.7% in the Hillier study.[67,88] While the Lewandowska et al study identified multiparity as a protective factor against GDM (AOR = 0.57, $p = 0.007$) (Table 9).[128]

Our study found a higher prevalence of anemia (48.2%) compared to Muche et al.'s study, where only 12.9% of participants were classified as anemic.[123] While our study categorized anemia into mild (30%) and moderate (18%) cases, Muche et al. reported a significantly lower mean hemoglobin level in the GDM group (12.333 ± 1.7834 g/dL) than in the non-GDM group (12.735 ± 1.7455 g/dL) ($p = 0.024$).[123] (Table 10).

In our study, the most common blood groups among participants were O+ (34.2%), followed by B+ (28.4%) and A+ (22%). Similarly, in the study by Ennazhiyil et al., the most prevalent blood groups were O+ (37.83%), followed by A+ (27.02%) and B+ (27.02%).[122] (Table 11).

Our study found a very low prevalence of glycosuria (0.2%) and proteinuria (1.3%), with no significant associations between these markers and maternal complications during pregnancy. In contrast, Hosoya et al. reported a strong association between gestational glycosuria and future diabetes mellitus (aOR = 3.62, 95% CI: 1.21–10.9), as well as proteinuria and later kidney disease (aOR = 4.07, 95% CI: 1.29–12.9).[129] (Table 12 & 13)

In the present study, thyroid function tests were conducted for the majority of participants 440 (97.8%), while a small proportion 10 (2.2%) did not undergo testing. Among those tested, 299 (66.4%) had TSH levels below 2.5 mIU/L, 115 (25.6%) had levels ranging between 2.5 and 5.0 mIU/L, and 26 (5.8%) had TSH levels exceeding 5.0 mIU/L. Thyroid dysfunction was noted in 10.3% of GDM cases in Mirzamoradi et al study[130] (p = **.088**). (Table 14).

Part D: Past Obstetric History of study participants

In our study, the prevalence of prior GDM was low, with only 1.2% of participants reporting a history of GDM in a previous pregnancy. Among them, 0.8% were managed solely with medical nutrition therapy (MNT), while only 0.4% required a combination of treatments, including insulin. In contrast, the Hillier study reported a significantly higher proportion of GDM cases requiring insulin, particularly among those diagnosed in early pregnancy.[88] Among women diagnosed with GDM, 58.6% of those identified in the first trimester required insulin therapy, compared to only 24.8% of those diagnosed later ($p < 0.0001$).[88] (Table 15).

Our study found that 3.6% of participants had a history of gestational hypertension or pre-eclampsia in a previous pregnancy, while the majority (96.4%) did not report such a history. In comparison, Swaminathan et al. observed a higher prevalence of hypertension (6.3%) among women with GDM, with an increased but non-significant adjusted odds ratio (AOR = 1.7, 95% CI: 0.9–2.5),[131] Mirzamoradi et al. reported in 5.7% of women with history of hypertension with negative GTT results and 6.8% of those with positive GTT results. (P - 0.635)[130] (Table 16).

In our study, 27.2% of participants (68 out of 250) had a history of lower segment cesarean section (LSCS), while 72.8% (182 participants) had not undergone LSCS. Similarly, Bahl et al

reported C-section rates of 34.7% in GDM cases compared to 29.5% in non-GDM cases, but after adjusting for confounders, this association was not statistically significant (AOR 1.05, 95% CI 0.87–1.26).[80] The Women and Infants Integrated Growth Study (WINGS) also found a slightly higher likelihood of C-sections among women with GDM (34.7%) than in non-GDM pregnancies (29.5%), with a similarly non-significant adjusted association (AOR 1.05, 95% CI 0.87–1.26).[80] In contrast, Fong et al. observed a higher cesarean delivery rate in pre-GDM cases (52.4%) compared to GDM cases (44.05%), with a statistically significant association (AOR 1.31, $p < 0.001$).[126] (Table 17).

In our study, 39 out of 250 participants (15.6%) had a history of neonatal death or stillbirth in previous pregnancy, while 211 participants (84.4%) had no such adverse obstetric outcomes. In contrast, Bahl et al's study found no significant association between GDM and stillbirth.24 out of 1782 (1.3%) stillbirths in non-GDM pregnancies, 3 out of 430 (0.7%) stillbirths in GDM pregnancies.[80] (Table 18)

Our study reported a low prevalence of previous difficult labor (8.8%), suggesting fewer labor complications. Grabowska et al. found a 53% cesarean section rate in GDM pregnancies, with 70% being elective, mainly due to prior CS.[132] (Table 19)

In our study, 59 participants (23.6%) had a history of bad obstetric outcomes, while the majority, 191 participants (76.4%), did not report any such history. In comparison to Jali et al. identified a significant association between GDM and previous bad obstetric history (24.4%, $p = 0.000$).[133] (Table 20)

In our study, only 1.6% of participants reported a history of anxiety or depression, whereas Muche et al. found a higher prevalence of antenatal depression (10.1%) among their study population.[123] Additionally, their study demonstrated a significant association between

antenatal depression and GDM, with 25.6% of depressed participants diagnosed with GDM compared to 6.8% of non-depressed participants ($p < 0.001$).[123] (Table 21).

Part E : Anthropometry

In our study, pregnancy weight gain was <7 kg in 12.7% of participants, while the majority, 52.4%, gained between 7–9 kg. About 25.6% had a weight gain of 9–11 kg, and 9.3% gained more than 11 kg. The mean weight gain in the current pregnancy was 8.12 kg (SD: 1.81 kg) Similarly the Hillier study reported that women diagnosed with early GDM (<18 weeks) had a mean GWG of 8.1 kg, while those diagnosed with GDM at 24–28 weeks had a significantly higher GWG (10.7–11.4 kg).[88] Among obese women, 60% exceeded IOM guidelines, whereas early-diagnosed GDM cases were weight neutral in the first trimester (-0.2 kg).[88] In contrast to Lewandowska's study found lower median GWG in GDM pregnancies (10.0 kg, IQR 7.0–15.0) compared to non-GDM pregnancies (14.0 kg, IQR 11.0–17.0, $p < 0.001$)[128] (Table 22).

In our study, 18.7% of participants had a BMI <18.49, 42% were within the normal range (18.5–22.9), 16.2% had a BMI of 23–24.9, and 23.1% had a BMI ≥25. The Tamil Nadu study by V Sheshaih et al found that a BMI ≥25 kg/m² was a significant risk factor for GDM, with an AOR of 1.88 (95% CI: 1.63–2.16, $p < 0.001$).[18] Similarly, the Bahl S, et al study reported that higher early-pregnancy BMI was associated with an increased risk of GDM, with an AOR of 1.04 (95% CI: 1.01–1.07) per unit increase in BMI.[80] In terms of pre-pregnancy BMI, Lewandowska et al. study had 21.9% BMI in GDM cases and 8.6% in non-GDM ($p < 0.001$)[128] (Table 23)

Part F : Intranatal and Postnatal Findings:

In our study, 9 (2%) participants delivered early preterm (i.e., 28 - 33 weeks 6 days of gestation, while 18 (4%) participants had preterm deliveries between 34 and 36 weeks 6 days. The majority of participants, 418 (92.8%), delivered between 37 and 41 weeks 6 days, indicating that most pregnancies reached full-term gestation. A small proportion i.e 5 (1.2%) participants, had post-term deliveries at or beyond 42 weeks. This is in line with findings from the study by Erkamp et al., who noted that maternal glucose concentrations in early pregnancy were associated with altered placental blood flow and increased risk of hypertensive disorders.[134] Their study also reported a median gestational age at delivery of 40.1 weeks and a preterm birth rate of 5.1%.[134] Lewandowska et al (2021) found that GDM cases had a significantly lower gestational age at delivery (median 39.0 weeks, IQR: 38.0–39.8) compared to non-GDM cases (median 39.0 weeks, IQR: 38.0–40.0, p = 0.032).[128] (Table 24).

Section II : Prevalence of Gestational Diabetes Mellitus

In the present study, the prevalence of GDM in the first trimester, as determined by the OGTT, was 16.0% (72 out of 450 participants). The majority of participants, 84.0% (378 women), had normal OGTT results. Similar to our study, Lewandowska et al had identical prevalence of 16%.[128] And Our findings are consistent with previous studies conducted in India. Similarly, the in a study at Tamil Nadu study by V Sheshaih et al reported a slightly higher prevalence of 18.5% (IADPSG criteria) and a lesser prevalence of 14.6% (WHO 1999 criteria) as compared to our study.[18] However, the average prevalence closely matches our findings. Similarly, a secondary analysis from the Women and Infants Integrated Growth Study (WINGS), a population-based cohort study in South Delhi, found that 19.2% of pregnant women were diagnosed with GDM using the national guidelines (OGTT >140 mg/dL). In the WINGS study, 5.6% of women were diagnosed in the first trimester (early GDM), while 14.9% developed GDM in the second or third trimester (late GDM).[80] Hannah et al. (2022) conducted a systematic review on the global burden of early pregnancy GDM (eGDM) and reported a wide range of prevalence estimates (0.7% to 36.8%) across studies, A systematic review and meta-analysis published in 2024 estimated the national prevalence of GDM in India at approximately 13%.[9] The prevalence varied across regions, with the highest rates observed in the North zone (16.1%) and the South zone (12.6%). The West zone had the lowest prevalence at 7%, while the East and North-eastern regions reported a prevalence of 11.5%. Urban areas exhibited a higher prevalence (12%) compared to rural areas (10%).[64] In a field-based cross-sectional study carried out in the rural parts of Assam state, India, by Chanda S, et al showed prevalence of GDM was 16.67%.[66] A cross-sectional study in Belagavi showed a prevalence of 12.2%.[67] A hospital-based cross-sectional study in Faridabad, Haryana found a GDM prevalence of 14.1% (IADPSG criteria) and 6.7% (DIPSI criteria).[68] (Table 25).

In the present study, the prevalence of GDM based on FBS values in the first trimester was 15.8% (71 out of 450 participants) with FBS levels ≥ 92 mg/dL. The majority, 84.2% (379 participants), had FBS levels below 92 mg/dL, indicating normal glucose levels. (Table 26). Bhattacharya et al. (2024) conducted a meta-analysis and concluded that first-trimester FPG ≥92 mg/dL was strongly associated with GDM development at 24–28 weeks (RR 3.93, 95% CI: 2.67–5.77, P < 0.00001).[135] This aligns with our findings, reinforcing that an FBS cutoff of 92 mg/dL can effectively predict later GDM and serve as a useful screening threshold. (Table 26).

Our study found a 6.3% prevalence of GDM in the second trimester, with 93.7% of participants having normal glucose tolerance, indicating fewer newly diagnosed cases compared to the first trimester. This aligns with Donovan et al's review, which highlights the 50g-Oral Glucose Challenge Test (OGCT) as a primary screening method. At 7.8 mmol/L (140 mg/dL), the OGCT has moderate sensitivity (70%–88%) and specificity (69%–89%), while lowering the threshold to 7.2 mmol/L (130 mg/dL) increases sensitivity (88%–99%) but reduces specificity (66%–77%). Fasting plasma glucose (FPG) at 4.7 mmol/L (85 mg/dL) has comparable sensitivity (87%) but lower specificity (52%), making it less reliable.[136] The review by Virally and Laloi-Michelin highlights the advantages of the 75g-OGTT over the two-step approach for diagnosing GDM between 24-28 weeks of pregnancy, emphasizing its faster diagnosis, better tolerance, and ease of use. They also critique the use of alternative methods, particularly fasting glycemia, due to inconsistent study findings and lack of perinatal outcome data.[137] (Table 27).

Section III: Fasting Blood Sugar as predictor of GDM

Our study identified an optimal FBS cutoff of 86 mg/dL for predicting GDM in the first trimester, with a high sensitivity of 97.22% and specificity of 82.80% (Youden's Index: 80.03), suggesting that a lower threshold than 92 mg/dL may enhance early detection and the positive likelihood ratio (LR^+) was 9.55, indicating a strong ability of FBS to confirm GDM when positive. The negative likelihood ratio (LR^-) was 0.387. Similarly, Kashi Z, et al. study showed 10% GDM, with AUC was 0.853, high sensitivity of 80% and a specificity of 92%, with a cutoff threshold of 91.5 mg/dL for GDM.[138] In contrast, Li et al. (2019) proposed 81 mg/dL with lower sensitivity (64.29%) and specificity (56.45%),[139] while In comparison, Mirzamoradi et al. (2021) reported that 40.4% of pregnant women had an FBS ≥ 92 mg/dL, confirming a GDM diagnosis, while 27.6% of women with normal FBS developed GDM based on OGTT.[130] Their study found that the optimal FBS cutoff was 82.5 mg/dL, with lower sensitivity (62.2%) and specificity (45.1%), indicating limited predictive accuracy compared to our study. Additionally, the area under the ROC curve (AUC) for FBS in predicting GDM was only 0.571, suggesting that FBS alone had poor diagnostic performance in their cohort. Shlomit et al. (2020) found FPG ≥83 mg/dL predictive of GDM, though with varying diagnostic accuracy, and further linked FPG ≥ 4.67 mmol/L to adverse pregnancy outcomes.[140] (Table 28, 29).

Correlation FBS and OGTT

After excluding one of the extreme values of OGTT of 370, the correlation between FBS and OGTT for 449 patients was 'r' = 0.68 (Figure 10). A correlation coefficient of 0.68 indicates a moderate to strong positive correlation between FBS and OGTT values. This suggests that higher FBS values are generally associated with higher OGTT values. However, the correlation is not perfect, implying that while FBS can serve as an early indicator of glucose intolerance, OGTT remains essential for definitive diagnosis.

Section IV: Risk factors and its association with GDM status

In our study, the prevalence of GDM increased with maternal age, ranging from 10.8% in women aged 18–20 years to 30.9% in women aged 30 years and above. A significant association was observed between increasing maternal age and GDM risk ($p = 0.003$), with the highest risk noted in older age groups. Similarly, Muche et al found a significant association between increasing maternal age and GDM ($p < 0.001$). Older women (≥30 years) had a higher prevalence of GDM, while younger women (<25 years) had lower rates.[123] Similarly, Bahl et al's study identified advancing maternal age as a strong predictor of GDM, with the risk increasing for each additional year of maternal age (AOR 1.10, 95% CI 1.06–1.15).[80] Similarly, the Mysuru study (Sinha et al.) found a strong association between increasing maternal age and GDM ($p = 0.01$, mean difference = 2.54).[141] (Table 30)

Our study found a weak but significant positive correlation between maternal age and GDM ($r = 0.261$, $p < 0.001$). The risk of GDM slightly increases with maternal age, though the correlation remains modest. A meta-analysis by Li Y et al. showed a stronger association, with GDM risk rising by 7.90% per year.[30] (Graph 17)

In our study, the prevalence of GDM was 15.3% among women with a gestational weight gain (GWG) of less than 9 kg, 14.7% in those who gained between 9–11 kg, and 36.8% in those who gained more than 11 kg. Although the highest prevalence was observed in women with excessive weight gain, no statistically significant association was found between GWG and GDM ($p = 0.057$). In contrast, study by Lewandowska et al found that women with GDM had a significantly lower median GWG (10.0 kg, IQR 7.0–15.0) compared to those without GDM (14.0 kg, IQR 11.0–17.0, $p < 0.001$).[128] Furthermore, findings from Shan et al indicated that pre-pregnancy BMI was notably higher in women with GDM (22.65 ± 3.25 kg/m²) compared to controls (20.91 ± 2.35 kg/m², $p < 0.001$).[142] (Table 33).

Our study found no significant association between GWG and OGTT values ($r = -0.009$, $p = 0.852$), suggesting that GWG does not strongly predict GDM status. In contrast, the Panyakat et al. study reported a positive correlation between GWG and birth weight percentiles ($r = 0.437$, $p = 0.002$), indicating that GWG influences fetal growth outcomes rather than GDM risk.[143] (Graph 18)

In our study, women aged ≥25 years had 1.82 times higher odds of developing GDM compared to those <25 years (AOR = 1.82, 95% CI: 1.02–3.23, $p = 0.042$). Similarly, in the Tamil Nadu study (V Sheshiah et al), women aged ≥25 years had a slightly higher risk, with 2.1 times greater odds of developing GDM (95% CI: 1.87–2.37, $p < 0.001$) highlighting advanced maternal age as a significant predictor of GDM. Similarly, a cross-sectional study analyzing data from the fourth National Family Health Survey (NFHS-4) in India reported a gradual increase in GDM prevalence with age, with 1.0% among women aged 15–19 years, 1.1% among those aged 20–24 years, 1.6% in the 25–29 age group, 1.8% among those aged 30–34 years, and 2.4% in women aged ≥35 years.[144] Furthermore, women aged ≥35 years had 2.37 times higher odds of developing GDM compared to those aged 15–19 years. while the

Lewandowska et al study found an increased risk for women aged ≥40 years (AOR = 2.31, 95% CI: 0.99–5.34, p = 0.052).[128] (Table 34).

Our study did not find a significant association between sedentary behavior and GDM (AOR = 0.77, 95% CI: 0.46–1.30, p = 0.327). Similarly, Shan et al. reported no significant difference in walking time between GDM and non-GDM groups (p = 0.719), with comparable proportions of participants walking ≤20 minutes per day (66.7% vs. 69.2%) and >20 minutes per day (33.3% vs. 30.8%).[142] (Table 34).

In our study, leisure-time physical activity did not show a significant association with GDM (OR = 0.83, 95% CI: 0.49–1.39, p = 0.472). Similarly, Muche et al. categorized physical activity into high (30%), moderate (45.7%), and low levels (24.4%), with no significant difference observed between GDM and non-GDM groups (p = 0.387).[123] (Table 34).

In our study, alcohol consumption had an odds ratio of 0.87 (95% CI: 0.10–7.36, p = 0.901), Similarly, Muche et al. reported that 42.3% of GDM cases and 57.7% of non-GDM cases had no alcohol use (p = 0.430),[123] Swaminathan et al. reported that alcohol consumption was low (0.8% in controls and 1.4% in GDM cases), with an adjusted odds ratio of 2.1 (95% CI: 0.2–3.9).[131] (Table 34)

Our study did not find a significant association between smoking tobacco consumption and GDM (AOR = 2.65, 95% CI: 0.24–29.59, p = 0.429). However, non-smoking tobacco consumption showed a significant crude association (AOR = 2.50, 95% CI: 1.04–5.99, p = 0.04), though it became non-significant after adjustment (AOR = 2.07, 95% CI: 0.74–5.80, p = 0.165). In contrast, Shan et al. reported a significant association between passive smoking and GDM (p = 0.021), with a higher prevalence among exposed women (23.4%) compared to non-exposed women (10.3%).[142] Swaminathan et al. reported that current smoking was rare

among participants (0.2% in the control group and 0.1% in the GDM group), with no significant association observed (AOR = 0.4, 95% CI: 0.0–1.1)[131] (Table 34)

Our study women consuming fruits ≤3 times per week had 1.52 times higher odds of GDM (AOR = 1.52, 95% CI: 0.86–2.68, p = 0.148), found no significant association between fruit or vegetable consumption and GDM risk, whereas Shan et al reported a vegetables-fruits dietary pattern as protective (OR = 0.32, 95% CI: 0.17–0.61, p < 0.001).[142] In contrast, Muche et al. reported a significant association between inadequate dietary diversity 53.6 % and GDM (p < 0.001),[123] An intervention study incorporating blueberries and soluble fiber by Basu A et al showed differences in fruit and vegetable consumption between groups. The intervention group had a lower mean fruit intake (0.8 ± 0.6 to 1.1 ± 0.5 cups/day) compared to the control (1.0 ± 0.3 to 1.3 ± 0.7 cups/day).[145] Vegetable consumption in the intervention group (1.2 ± 0.7 to 1.0 ± 0.5 cups/day) was also lower than in the control group (1.1 ± 0.3 to 1.5 ± 0.8 cups/day). Despite these variations, the impact on GDM prevention remains inconclusive.[145] (Table 34).

Our study observed a higher rate of spontaneous vaginal delivery (70.2%) and a lower LSCS rate (27.3%) compared to Li Ping et al.'s study, where women with GDM had a significantly higher rate of assisted vaginal delivery or cesarean section (43.8%) than those without GDM (35%) (p = 0.010).[139] Additionally, Li Ping et al. found that elevated first-trimester FPG (≥4.67 mmol/L) was associated with a higher intervention rate (39.9%) compared to lower FPG levels (<4.19 mmol/L, 29.2%) (p = 0.000).[139] In contrast, Deng et al. reported a significant association between GDM and increased cesarean section rates (p < 0.001).[146] (Table 35)

In our study, the sex distribution of newborns was nearly equal, with 51.6% male and 47.1% female births, and no significant gender-based differences in birth outcomes. Additionally, 1.3% of cases resulted in abortion. In the Hillier study, the distribution of newborns by gender

was 50.7% male and 49.3% female, with no significant difference in the prevalence of GDM based on fetal sex (p = 0.9027).[88] In contrast, the study by Herath et al. found that 40.3% of babies born to mothers with GDM were male, compared to 46.7% in the non-GDM group (*p* = 0.25), indicating no statistically significant difference in sex distribution between groups.[82] (Table 36)

Our study found that most newborns (96.2%) had a birth weight of ≥2500g, with 2.2% in the 1500–2500g category and 1.6% having extremely low birth weight (<1000g). In contrast, Lewandowska's study reported a higher prevalence of macrosomia (>4000g) in the GDM group (14.4%) compared to the non-GDM group (9.9%) (p = 0.047).[128] While Lewandowska's study showed a lower proportion of low birth weight (<2500g) infants in the GDM group (4.1%) than in the non-GDM group (7.0%), our study did not report macrosomic births.[128] (Table 37)

Section V: GDM Outcomes

Maternal outcomes

Our study found significant associations between GDM and adverse pregnancy outcomes, including decreased fetal movements (40% vs. 10.4%, $p < 0.001$), hypertensive disorders (12.9% vs. 5.3%, $p = 0.031$), polyhydramnios (47.2% vs. 1.6%, $p < 0.001$), abnormal fetal lie (41.7% vs. 19.6%, $p < 0.001$), preterm labor (19.4% vs. 3.7%, $p < 0.001$), neonatal ventilatory support (73.6% vs. 22.8%, $p < 0.001$), NICU admission (30.6% vs. 7.9%, $p < 0.001$), and abnormal fetal heart rate (22.2% vs. 5.6%, $p < 0.001$). No significant associations were found with antepartum hemorrhage, anemia, PROM, congenital anomalies, maternal fever, retained placenta, PPH, or sepsis. according to Preterm Delivery. (Table 38 a).

In the present study, a statistically significant association was observed between GDM and hypertensive disorders ($p = 0.031$). The prevalence of hypertensive disorders was higher in GDM cases (12.9%) compared to non-GDM cases (5.3%). In contrast, Lewandowska et al.'s study found a higher overall prevalence of hypertensive disorders (17.1% in GDM vs. 14.6% in non-GDM cases) without statistically significant difference ($p = 0.438$).[128] And compared to Kek et al. (2.99% GDM vs. 2.12% non-GDM).[125] Wenrui Y et al reported that GDM increased the risk of pre-eclampsia by 39% (OR: 1.39; 95% CI: 0.99–1.96)[38] (Table 38 a).

In contrast to our study, which found no significant association between GDM and APH ($p = 1.00$) or PPH ($p = 0.403$), Muche et al. reported a twofold increased risk of APH (ARR = 2.10; 95% CI: 1.11–3.98) and a nearly fivefold increased risk of PPH (ARR = 4.85; 95% CI: 2.28–10.30) in GDM pregnancies.[123] (Table 38 a).

Neonatal outcomes

In our study, a significant association was observed between GDM and preterm labor ($p<0.001$). The incidence of preterm delivery was 19.4% in GDM cases, compared to 3.7% in non-GDM cases. Similarly, Deng et al. findings showed a significantly higher prevalence of preterm birth history in the GDM group (5.49%) compared to the non-GDM group (3.89%) ($\chi^2 = 921.557$, $P < 0.001$).[146] In contrast, Wenrui Y et al.'s meta-analysis demonstrated a 51% increased risk of preterm birth among GDM cases (OR: 1.51; 95% CI: 1.26–1.80).[38] In contrast, the study by Bahl S, et al. found that women with GDM did not have a significantly higher risk of preterm birth after adjusting for confounders (AOR 0.77, 95% CI 0.53–1.11)[80] and Riskin-Mashiah et al. found no significant association between first-trimester fasting glucose levels and preterm delivery or NICU admission (OR 0.73–1.35, P = 0.1).[140] (Table 38 b).

Our study reported a history of neonatal death or stillbirth in 15.6% of participants, we did not explicitly analyze NICU admissions. Wenrui Y et al study found that GDM doubled the risk of NICU admission (OR: 2.29; 95% Ci:1.59–3.31), highlighting the impact of GDM on neonatal health.[38] Additionally, their findings indicate that neonates born to GDM mothers had a higher risk of neonatal jaundice (OR: 1.28; 95% CI: 1.02–1.62) and respiratory distress syndrome (OR = 1.57; 95% CI: 1.19–2.08).[38] Muche et al found a higher risk of perinatal asphyxia (ARR = 3.58; 95% CI: 1.39–9.23), which aligns with our findings on neonatal respiratory distress.[123] (Table 38 b).

No cases of shoulder dystocia were reported in our study, in contrast to Nakshine & Jogdand report that 15%–45% of GDM pregnancies result in macrosomia, leading to an increased risk of shoulder dystocia and birth trauma.[147] (Table 38 b)

In our study found no significant association between GDM and congenital anomalies (p = 0.291), with minimal occurrence in both GDM (1.4%) and non-GDM (0.3%) cases. However,

in contrast Nakshine & Jogdand's review highlights an uncertain relationship between GDM and congenital anomalies, noting that while pre-existing diabetes is strongly linked to birth defects (Heart defects & neural tube defects), evidence for GDM remains inconsistent.[147] (Table 38 b)

Section VI: Association of GDM with Socio-demographic Factors

Our study found that GDM prevalence was highest among women with postgraduate education (32.3%) and no formal education (28.6%), while the lowest prevalence was observed among those with secondary education (11.3%) ($p = 0.006$). This contrasts with Muche et al., who reported a higher prevalence of GDM among women with lower education levels, particularly those without formal education (25.6%) and primary education (26.4%) ($p = 0.032$).[123] Similarly, Swaminathan et al. observed a slightly increased GDM prevalence among women with no schooling (26.0%) and those with higher education (Senior Secondary: 25.4%), though the associations were not statistically significant (AOR = 1.3–1.4, $p > 0.05$).[131] (Table 39).

Our study found a significant association between occupation and GDM ($p = 0.018$), with the highest prevalence among agricultural workers (40.9%) and the lowest among self-employed women 10.4%. Homemakers, who formed the majority, had a GDM prevalence of 14.7%. In contrast, Muche et al. categorized participants as employed or unemployed and reported a higher prevalence of GDM among employed women 51.2% compared to unemployed women 48.8% ($p = 0.004$).[123] (Table 40).

In our study, the prevalence of GDM varied across socioeconomic groups, with the highest occurrence in SES III (19.7%), followed by SES II (15.4%), while SES I and SES IV had lower rates (11.5% and 12.5%, respectively). However, this association was not statistically significant ($p = 0.57$). Similarly, Muche et al. found no significant association between monthly income and GDM status ($p = 0.808$), the average monthly income was 3169.22 ± 3167.78 birr.[123] Swaminathan et al. found that the prevalence of GDM increased with socioeconomic

status, with the highest prevalence observed in the wealthiest group (35.3%), and a significant association was noted (AOR = 1.7, 95% CI: 1.1–2.3).[131] (Table 42).

In the present study, women with a family history of diabetes had a higher prevalence of GDM (22.7%) compared to those without (14.4%), but this association was not statistically significant (p = 0.055). Comparatively, Lewandowska et al. (2021) found a significant association between family history and GDM risk, particularly when the father was affected (AOR = 3.68, 95% CI: 2.23–6.07, p < 0.001) or the mother was affected (AOR = 2.13, 95% CI: 1.1–4.14, p = 0.026).[128] Similarly, V Sheshiah et al. reported that women with a family history of diabetes had 1.58 times higher odds of developing GDM (AOR = 1.58, 95% CI: 1.39–1.79, p < 0.001).[18] In Muche et al study, GDM prevalence was significantly higher in women with a family history of diabetes (21.5%) compared to those without (only 4.2%) (p < 0.001).[123] (Table 43)

CONCLUSION

This community based longitudinal study underscores a significant burden of early Gestational Diabetes Mellitus (GDM) in both urban and rural settings of Belagavi, with approximately one in every six pregnant women diagnosed during the first trimester. Notably, the findings highlight the influence of socioeconomic and occupational factors on GDM prevalence. Women engaged in agriculture exhibited markedly higher rates up to two in every five suggesting that dietary practices, physical activity levels, and restricted healthcare access in this group warrant focused public health interventions.

Age emerged as a critical determinant, with women aged 30 years and above facing a substantially increased risk compared to their younger counterparts. Similarly, excessive gestational weight gain was positively correlated with GDM, where women gaining over 11 kg were found to have more than double the risk compared to those with lower weight gains. Furthermore, lifestyle factors, including low fruit consumption and the use of non-smoking tobacco, contributed to the elevated prevalence of GDM.

The study also identified overweight/obesity status and proteinuria as significant predictors, with the latter increasing GDM risk nearly ninefold. Although a positive family history of diabetes and hypertension was noted, these factors did not achieve statistical significance in this cohort.

Maternal GDM was strongly associated with adverse pregnancy outcomes. Pregnant women with GDM experienced a dramatically higher likelihood of complications such as polyhydramnios, hypertensive disorders, and preterm labor. Neonatal outcomes were similarly concerning, with a significantly higher proportion of infants requiring

ventilatory support and NICU admissions, thereby emphasizing the profound impact of maternal glycemic control on newborn health.

The identification of several modifiable risk factors—including older maternal age, excessive gestational weight gain, and suboptimal dietary habits—suggests that lifestyle interventions should be integrated into routine antenatal care. In addition, the U-shaped relationship observed between education level and GDM risk indicates that both lower and higher educational attainments are associated with increased prevalence, possibly reflecting complex underlying factors such as stress and lifestyle differences.

Overall, this study highlights the urgent need for early screening and tailored interventions for high-risk groups, particularly among agricultural workers and older mothers. Strengthening antenatal care services, promoting health awareness, and encouraging healthy weight management emerge as critical strategies to mitigate the burden of GDM and improve both maternal and neonatal health outcomes. These findings contribute to the understanding of the epidemiological transition in GDM prevalence and underscore the importance of targeted public health policies in addressing this growing concern.

RECOMMENDATIONS

Based on our study findings, we suggest the following recommendations to help prevent and manage GDM by addressing key risk factors:

1. Implement universal first-trimester screening with OGTT and consider lowering the FBS cut-off to 86 mg/dL for early detection.
2. Adopt two-step screening (FBG followed by OGTT for positives) to optimize resource utilization
3. Explore combined biomarkers (OGTT + HbA1c + clinical factors) for better prediction.
4. Prioritize screening for high-risk women (≥ 25 years, excessive weight gain, family history of diabetes, or proteinuria) and provide extra care for sedentary or physically demanding occupations.
5. Promote fiber-rich diets, reduce processed foods, and encourage physical activity to enhance insulin sensitivity.
6. Integrate GDM screening into routine antenatal care with regular glucose and blood pressure monitoring.
7. Advocate for routine screening policies, affordable diagnostic access, and further research on GDM interventions
8. Raise awareness through community programs and train healthcare workers to support lifestyle modifications.
9. Ensure postpartum follow-up to monitor glucose levels and prevent type 2 diabetes.

10. Long term cohorts studies are imperative to assess the impact of GDM on maternal and child health outcomes.

STRENGTHS

1. Study setting: A community based longitudinal study among 450 first trimester pregnant woman

2. Sampling technique: The study was conducted by using, stratified proportionate sampling across four health centers, followed by systematic random sampling within each center.

3. Optimal sample size (n=450) enhancing the statistical power and reliability of prevalence estimates

4. Research questionnaire: a structured questionnaire regarding the sociodemographic variables, family history of DM and other chronic conditions, current medical history, current and past obstetric history, pertinent clinical data, maternal anthropometry including pre-pregnancy weight, present weight, height & body mass index (BMI); lifestyle factors viz. tobacco & alcohol consumption, physical activity, fruits and vegetables consumption and biochemical investigations details and other risk factors of GDM.

5. Validated diagnostic tools like the Oral Glucose Tolerance Test (OGTT) and fasting blood glucose were used to ensure the accurate identification and diagnosis of GDM.

6. Validation of DIPSI criteria supports simplified, cost-effective diagnosis in primary care settings, enabled consistent classification of GDM cases

LIMITATIONS

The limitations of the study were:

1. Our study focused on pregnancy outcomes but did not include long-term follow-up of mothers and neonates to assess postpartum metabolic health or neonatal development.
2. As some questions were based on self-reported lifestyle habits, diet, and physical activity, pre-pregnancy weight, there was a potential for recall bias or inaccuracies in reporting these factors.
3. Our study did not account for factors like genetic predisposition or environmental exposures, which could have affected the results.
4. Variation in healthcare access among participants was not considered, which could have influenced the early detection and management of GDM.

SUMMARY

The present study was a community-based longitudinal study which was conducted to estimate the prevalence of Gestational Diabetes Mellitus among first-trimester pregnant women in Belagavi district, Karnataka, India. The study also assessed fasting blood glucose as a predictor of GDM and evaluated associated risk factors and maternal-neonatal outcomes. The data collection was carried out over 22 months (1st April 2023 to 31st January 2025) including the follow up of all the enrolled participants to one week postpartum and included 450 pregnant women from four primary health centers of Belagavi districts, covering both rural and urban populations.

The study participants had a mean age of 24.3 ± 4.31 years, with the majority (42.7%) aged 20–24 years. Nearly half (50%) were Muslim, followed by Hindus (46.7%). A significant proportion (59.1%) had completed secondary education, while 1.6% had no formal education. Most participants were homemakers (77.3%), followed by self-employed individuals (10.7%) and agricultural workers (4.9%). Socioeconomic status, assessed using the modified B.G. Prasad classification (2024), showed that 60.7% belonged to Class II, while only 1.8% were in Class IV.

The prevalence of GDM, diagnosed using the Oral Glucose Tolerance Test was 16% in the first trimester, with an additional 6.3% diagnosed in the second trimester. Fasting blood sugar levels ≥92 mg/dL identified 15.8% of women with GDM. The study determined an optimal FBS cut-off of 86 mg/dL, which had 97.22% sensitivity and 82.80% specificity for early GDM detection. A strong positive correlation (r = 0.68) was observed between FBS and OGTT values, reinforcing FBS as a viable screening tool in resource-limited settings.

Women aged ≥25 years had 1.82 times higher odds of developing GDM compared to younger women (p = 0.042), with the highest prevalence (30.9%) observed among those aged ≥30 years. Maternal age remains a significant risk factor, as increasing age is often associated with declining insulin sensitivity and metabolic changes during pregnancy. Women with a family history of diabetes (19.6%) and hypertension (30.4%) also demonstrated a trend toward increased GDM risk, although the association did not reach statistical significance.

Excessive pregnancy weight gain (>11 kg) showed a strong association with GDM (AOR = 4.27, p = 0.013). Excess weight gain during pregnancy contributes to insulin resistance, increasing the risk of developing glucose intolerance. Lifestyle factors also played a crucial role in GDM development. Low fruit consumption (≤3 times/week) was linked to an increased risk (AOR = 1.52), highlighting the importance of including diet rich in fruits and fibres in pregnancy. Additionally, non-smoking tobacco use, such as chewing tobacco, was associated with a higher GDM risk (AOR = 2.07), likely due to its effects on insulin resistance and vascular health. Proteinuria (1.3%) emerged as a strong predictor of GDM (AOR = 9.0, p = 0.026), indicating a possible link between kidney dysfunction and glucose intolerance. This also strengthens the potential association between pre-eclampsia and GDM.

Anthropometric measurements further reinforced the risk factors. BMI >25 kg/m² was observed in 23.1% of participants, aligning with existing evidence that overweight and obesity increase insulin resistance. Central obesity was more prevalent among women in the study but was not directly linked to GDM in adjusted models, suggesting that overall weight gain and metabolic factors may have a stronger impact than body fat distribution alone.

Women diagnosed with GDM experienced significantly higher risks of hypertensive disorders (12.9% vs. 5.3%, p = 0.031) and pregnancy complications such as polyhydramnios

(47.2% vs. 1.6%, $p < 0.001$), preterm labour (19.4% vs. 3.7%, $p < 0.001$), and abnormal fetal lie (41.7% vs. 19.6%, $p < 0.001$). These findings highlight the adverse maternal outcomes associated with GDM, underscoring the need for early diagnosis and management to prevent complications.

Neonatal complications were also more frequent among GDM pregnancies, with higher rates of ventilatory support requirements (73.6% vs. 22.8%, $p < 0.001$) and NICU admissions (30.6% vs. 7.9%, $p < 0.001$). Despite these significant risks, there was no notable difference in congenital anomalies (1.4% vs. 0.3%, $p = 0.291$) between GDM and non-GDM pregnancies. These findings reinforce the importance of timely intervention and glycaemic control during pregnancy to minimize adverse neonatal outcomes

Several modifiable risk factors were identified, including older maternal age, excessive weight gain, and poor dietary habits, suggesting that lifestyle interventions should be a cornerstone of antenatal care. The strikingly high prevalence of GDM among agricultural workers (40.9%) points to potential socioeconomic and occupational influences, possibly related to dietary patterns and limited healthcare access. Interestingly, education level showed a U-shaped relationship with GDM risk, with both postgraduate-educated and uneducated women exhibiting higher prevalence, possibly due to differing lifestyle factors or stress levels.

Thus, this study demonstrates a considerable burden of GDM among first-trimester pregnant women in Belagavi, with an overall prevalence of 16% initially, rising further in the second trimester. The findings validate fasting blood glucose as a robust screening tool, particularly with an optimal cut-off of 86 mg/dL. Notably, modifiable risk factors such as advanced maternal age, excessive weight gain, and poor dietary habits, along with socioeconomic and occupational influences especially among agricultural workers substantially contribute to

GDM risk. The significantly higher rates of maternal complications, including hypertensive disorders, polyhydramnios, and preterm labor, as well as adverse neonatal outcomes, underscore the urgent need for early screening and targeted antenatal interventions to mitigate these risks.

BIBLIOGRAPHY

1. WHO. Noncommunicable diseases. Geneva: World Health Organization; 2023 https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

2. Organization WHOJWH. Global report on diabetes. Geneva, Switzerland. 2016:1–88. https://www.who.int/publications/i/item/9789241565257

3. International Diabetes Federation. IDF Diabetes Atlas, 10th Edition. 2021

4. Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy: a World Health Organization Guideline. Diabetes Res Clin Pract 2014;103:341–63. https://doi.org/10.1016/j.diabres.2013.10.012

5. Ikoh Rph. C L, Tang Tinong R The Incidence and Management of Type 2 Diabetes Mellitus After Gestational Diabetes Mellitus. Cureus 15(8): e44468. DOI 10.7759/cureus.44468

6. Plows JF, Stanley JL, Baker PN, Reynolds CM, Vickers MH. The pathophysiology of gestational diabetes mellitus. Int J Mol Sci [Internet]. 2018;19(11):3342. Available from: http://dx.doi.org/10.3390/ijms19113342

7. Mohan V, Hannah W, Anjana RM. Early gestational diabetes mellitus: An update about its current status. Int J Diabetes Dev Ctries [Internet]. 2024;44(S1):22–6. Available from: http://dx.doi.org/10.1007/s13410-024-01370-0

8. Mantri, N., Goel, A.D., Patel, M. et al. National and regional prevalence of gestational diabetes mellitus in India: a systematic review and Meta-analysis. BMC Public Health **24**, 527 (2024). https://doi.org/10.1186/s12889-024-18024-9.

9. Hannah W, Bhavadharini B, Beks H, Deepa M, Anjana RM, Uma R, et al. Global burden of early pregnancy gestational diabetes mellitus (eGDM): A systematic review. Acta Diabetol. 2022;59(3):403–27. Available from: http://dx.doi.org/10.1007/s00592-021-01800-z

10. Thaweethai T, Soetan Z, James K, Florez JC, Powe CE. Distinct Insulin Physiology Trajectories in Euglycemic Pregnancy and Gestational Diabetes Mellitus. Diabetes Care. 2023;46(12):2137 46. https://doi.org/10.2337/dc22-2226.

11. Bozkurt L, Gobl CS, Leitner K, Pacini G, Kautzky-Willer A. HbA1c during early pregnancy reflects beta-cell dys function in women developing GDM. BMJ Open Diabe tes Res Care. 2020;8(2):e001751. https:// doi. org/ 10. 1136/ bmjdrc-2020-001751

12. Mittendorfer B, Patterson BW, Haire-Joshu D, Cahill AG, Cade WT, Stein RI, et al. Insulin Sensitivity and β-Cell Function During Early and Late Pregnancy in Women With and Without Gesta tional Diabetes Mellitus. Diabetes Care. 2023;46(12):2147–54. https://doi.org/10.2337/dc22-1894.

13. Benhalima K, Van Crombrugge P, Moyson C, Verhaeghe J, Van deginste S, Verlaenen H, et al. Women with Mild Fasting Hyper glycemia in Early Pregnancy Have More Neonatal Intensive Care Admissions. J Clin Endocrinol Metab. 2021;106(2):e836–54. https://doi.org/10.1210/clinem/dgaa831.

14. Immanuel J, Simmons D. Screening and Treatment for Early Onset Gestational Diabetes Mellitus: a Systematic Review and Meta-analysis. Curr Diab Rep. 2017;17(11):115. https://doi.org/ 10.1007/s11892-017-0943-7.

15. Venkataraman, H., Ram, U., Craik, S. *et al.* Increased fetal adiposity prior to diagnosis of gestational diabetes in South Asians: more evidence for the 'thin–fat' baby. *Diabetologia* **60**, 399–405 (2017). https://doi.org/10.1007/s00125-016-4166-2

16. International Association of Diabetes and Pregnancy Study Groups Consensus Panel, Metzger BE, Gabbe SG, Persson B, Buchanan TA, Catalano PA, et al. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diabetes Care. 2010;33(3):676–82. Available from: http://dx.doi.org/10.2337/dc09-1848

17. ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. 2. Classification and Diagnosis of Dia betes: Standards of Care in Diabetes-2023. Diabetes Care. 2023;46(Suppl 1):S19-s40. https://doi.org/10.2337/dc23-S002.

18. Seshiah V, Balaji V, Balaji MS, Paneerselvam A, Arthi T, Thamizharasi M, et al. Prevalence of gestational diabetes mellitus in South India (Tamil Nadu)--a community based study. J Assoc Physicians India. 2008;56:329–33.

19. Screening for gestational diabetes. FOGSI. 2015.https://www.fogsi.org/screening-for-gestational-diabetes/

20. Sacks DA, Greenspoon JS, Fotheringham N. Could the fasting plasma glucose assay be used to screen for gestational diabetes? J Reprod Med. 1992; 37:907-909.

21. Vinter CA, Tanvig MH, Christensen MH, Ovesen PG, Jorgensen JS, Andersen MS, et al. Lifestyle Intervention in Danish Obese Pregnant Women With Early Gestational Diabetes Mellitus According to WHO 2013 Criteria Does Not Change Pregnancy

Outcomes: Results From the LiP (Lifestyle in Pregnancy) Study. Diabetes Care. 2018;41(10):2079–85. https://doi. org/10. 2337/dc18-0808

22. Simmons D, Hague WM, Teede HJ, Cheung NW, Hibbert EJ, Nolan CJ, et al. Hyperglycaemia in early pregnancy: the Treat ment of Booking Gestational diabetes Mellitus (TOBOGM) study. A randomised controlled trial. Med J Aust. 2018;209(9):405–6. https://doi.org/10.5694/mja17.01129.

23. NFHS IT.Nfhsiips.in. 2019 [cited 2024 Dec 16]. http://www.nfhsiips.in/nfhsnew/nfhsuser/nfhs5.php

24. About diabetes. Diabetes.org. Available from: https://diabetes.org/about-diabetes.

25. Diabetes. Who.int. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes

26. Annual report 2023 Idf.org. Available from: https://idf.org/media/uploads/2024/06/IDF-Annual-Report-2023.pdf

27. Anjana, R.M., Deepa, M. & Pradeepa, R. The ICMR-INDIAB Study: Results from the National Study on Diabetes in India. *J Indian Inst Sci* **103**, 21–32 (2023). https://doi.org/10.1007/s41745-023-00359-8

28. Plows JF, Stanley JL, Baker PN, Reynolds CM, Vickers MH. The pathophysiology of gestational diabetes mellitus. Int J Mol Sci. 2018;19(11):3342. Available from: http://dx.doi.org/10.3390/ijms19113342

29. Lewandowska M, Więckowska B, Sajdak S. Pre-Pregnancy Obesity, Excessive Gestational Weight Gain, and the Risk of Pregnancy-Induced Hypertension and

Gestational Diabetes Mellitus. J Clin Med. 2020 Jun 24;9(6):1980. doi: 10.3390/jcm9061980. PMID: 32599847; PMCID: PMC7355601.

30. Li Y, Ren X, He L, Li J, Zhang S, Chen W. Maternal age and the risk of gestational diabetes mellitus: A systematic review and meta-analysis of over 120 million participants. Diabetes Res Clin Pract. 2020;162:108044.

31. Monod C, Kotzaeridi G, Linder T, Eppel D, Rosicky I, Filippi V, et al. Prevalence of gestational diabetes mellitus in women with a family history of type 2 diabetes in first- and second-degree relatives. Acta Diabetol. 2023;60(3):345–51. Available from: http://dx.doi.org/10.1007/s00592-022-02011-w

32. Yuen L, Wong V, Immanuel J, Hague WM, Cheung NW, Teede H, et al. Ethnic Differences in Characteristics of Women Diagnosed with Early Gestational Diabetes: Findings from the TOBOGM Study. J Clin Endocrinol Metab. 2024.

33. Ali N, Aldhaheri AS, Alneyadi HH, Alazeezi MH, Al Dhaheri SS, Loney T, et al. Effect of Gestational Diabetes Mellitus History on Future Pregnancy Behaviors: The Mutaba'ah Study. Int J Environ Res Public Health. 2021;18:58.

34. Yong HY, Shariff ZM, Yusof BNM, Rejali Z, Bindels J, Tee YYS, et al. High physical activity and high sedentary behavior increased the risk of gestational diabetes mellitus among women with excessive gestational weight gain: a prospective study. BMC Pregnancy Childbirth. 2020;20:597.

35. Taousani E, Papaioannou KG, Mintziori G, Grammatikopoulou MG, Antonakou A, Tzitiridou-Chatzopoulou M, et al. Lifestyle Behaviors and Gestational Diabetes Mellitus: A Narrative Review. Endocrines. 2025;6(6).

36. Lambert V, Muñoz SE, Gil C, Román MD. Maternal dietary components in the development of gestational diabetes mellitus: a systematic review of observational studies. *Nutr J*. 2023;22:15.

37. Livadas S, Anagnostis P, Bosdou JK, Bantouna D, Paparodis R. Polycystic ovary syndrome and type 2 diabetes mellitus: A state-of-the-art review. World J Diabetes. 2022 Jan 15;13(1):5-26. doi: 10.4239/wjd.v13.i1.5. PMID: 35070056; PMCID: PMC8771268.

38. Ye W, Luo C, Huang J, Li C, Liu Z, Liu F. Gestational diabetes mellitus and adverse pregnancy outcomes: systematic review and meta-analysis. *BMJ*. 2022;377:e067946.

39. Yang Y, Wu N. Gestational Diabetes Mellitus and Preeclampsia: Correlation and Influencing Factors. Front Cardiovasc Med. 2022;9:831297. doi: 10.3389/fcvm.2022.831297

40. Phaloprakarn C, Tangjitgamol S. Risk score for predicting primary cesarean delivery in women with gestational diabetes mellitus. *BMC Pregnancy Childbirth.* 2020;20:607.

41. Ye W, Luo C, Huang J, Li C, Liu Z, Liu F. Gestational diabetes mellitus and adverse pregnancy outcomes: systematic review and meta-analysis. BMJ. 2022;377:e067946.

42. Yefet E, Bejerano A, Iskander R, Zilberman Kimhi T, Nachum Z. The Association between Gestational Diabetes Mellitus and Infections in Pregnancy—Systematic Review and Meta-Analysis. Microorganisms. 2023;11:1956. https://doi.org/10.3390/microorganisms11081956

43. Kramer CK, Campbell S, Retnakaran R. Gestational diabetes and the risk of cardiovascular disease in women: a systematic review and meta-analysis. Diabetologia. 2019 Jun;62(6):905-914. doi: 10.1007/s00125-019-4840-2. Epub 2019 Mar 7. PMID: 30843102.

44. Murray SR, Reynolds RM. Short- and long-term outcomes of gestational diabetes and its treatment on fetal development. Prenatal Diagnosis. 2020;40:1085–1091. doi:10.1002/pd.5768

45. Kariniemi K, Vääräsmäki M, Männistö T, et al. Neonatal outcomes according to different glucose threshold values in gestational diabetes: A register-based study. BMC Pregnancy Childbirth. 2024;24:271. doi:10.1186/s12884-024-06473-4

46. Corcillo A, Quansah DY, Kosinski C, Benhalima K, Puder JJ. Impact of Risk Factors on Short- and Long-Term Maternal and Neonatal Outcomes in Women With Gestational Diabetes Mellitus: A Prospective Longitudinal Cohort Study. Front Endocrinol. 2022;13:866446. doi:10.3389/fendo.2022.866446

47. **Davidson MB**. Counterpoint: the oral glucose tolerance test is superfluous. *Diabetes Care* 2002; **25**: 1883-1885 [PMID: 12351497 DOI: 10.2337/diacare.25.10.1883]

48. 16. **Hanna FW**, Peters JR. Screening for gestational diabetes; past, present and future. *Diabet Med* 2002; **19**: 351-358 [PMID: 12027921 DOI: 10.1046/j.1464-5491.2002.00684.x]

49. 17.**Tuomilehto J**. Point: a glucose tolerance test is important for clinical practice. *Diabetes Care* 2002; **25**: 1880-1882 [PMID: 12351496 DOI: 10.2337/diacare.25.10.1880]

50. GestationalDiabetesMellitus.Acog.org.Availablefrom:https://www.acog.org/clinical/clinical-guidance/practicebulletin/articles/2018/02/gestational-diabetes-mellitus

51. **21. Mortensen HB**, Mølsted-Pedersen L, Kühl C, Backer P. A screening procedure for diabetes in pregnancy. *Diabete Metab* 1985; **11**: 249-253 [PMID: 4043492]

52. 22. **Atilano LC**, Lee-Parritz A, Lieberman E, Cohen AP, Barbieri RL. Alternative methods of diagnosing gestational diabetes mellitus. *Am J Obstet Gynecol* 1999; **181**: 1158-1161 [PMID: 10561637 DOI: 10.1016/S0002-9378(99)70100-6]

53. 23 **Sacks DA**, Greenspoon JS, Fotheringham N. Could the fasting plasma glucose assay be used to screen for gestational diabetes? *J Reprod Med* 1992; **37**: 907-909 [PMID: 1460607]

54. 24 **Rey E**. Screening for gestational diabetes mellitus. A simple test may make it easier to study whether screening is worthwhile. *BMJ* 1999; **319**: 798-799 [PMID: 10496805 DOI: 10.1136/bmj.319. 7213.798]

55. 25 **Wijeyaratne CN**, Ginige S, Arasalingam A, Egodage C, Wijewardhena K. Screening for gestational diabetes mellitus: the Sri Lankan experience. *Ceylon Med J* 2006; **51**: 53-58 [PMID: 17180809]

56. 26 **Anjalakshi C**, Balaji V, Balaji MS, Ashalata S, Suganthi S, Arthi T, Thamizharasi M, Seshiah V. A single test procedure to diagnose gestational diabetes melitus. *Acta Diabetol* 2009; **46**: 51-54 [PMID: 18830559 DOI: 10.1007/s00592-008-0060-9]

57. Ana, Y., Prafulla, S., Deepa, R., & Babu, G. R. (2021). Emerging and public health challenges existing in gestational diabetes mellitus and diabetes in

pregnancy. *Endocrinology and Metabolism Clinics of North America*, *50*(3), 513–530. https://doi.org/10.1016/j.ecl.2021.05.008

58. Nevander S, Landberg E, Blomberg M, Ekman B, Lilliecreutz C. Comparison of venous and capillary sampling in oral glucose testing for the diagnosis of gestational diabetes mellitus: A diagnostic accuracy study using Accu-Chek Inform II. *Diagnostics (Basel)*. 2020;10(12):1011

59. Kokori E, Olatunji G, Aderinto N, et al. The role of machine learning algorithms in detection of gestational diabetes: a narrative review of current evidence. *Clin Diabetes Endocrinol.* 2024;10:18. doi:10.1186/s40842-024-00176-7

60. Benhalima, K. (2021). Recent advances in gestational diabetes mellitus. Journal of Clinical Medicine, 10(10), 2202. https://doi.org/10.3390/jcm10102202

61. Wang H, Li N, Chivese T, Werfalli M, Sun H, Yuen L, et al. IDF diabetes atlas: Estimation of global and regional gestational diabetes mellitus prevalence for 2021 by International Association of diabetes in pregnancy study group's criteria. Diabetes Res Clin Pract. 2022;183(109050):109050. Available from: http://dx.doi.org/10.1016/j.diabres.2021.109050

62. Simmons D, Immanuel J, Hague WM, Teede H, Nolan CJ, Peek MJ, et al. Treatment of gestational diabetes mellitus diagnosed early in pregnancy. N Engl J Med. 2023;388(23):2132–44. Available from: http://dx.doi.org/10.1056/NEJMoa2214956

63. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for

2021 and projections for 2045. Diabetes Res Clin Pract .2022;183(109119):109119. Available from: http://dx.doi.org/10.1016/j.diabres.2021.109119

64. Mohan V, Hannah W, Anjana RM. Early gestational diabetes mellitus: An update about its current status. Int J Diabetes Dev Ctries. 2024;44(S1):22–6. Available from: http://dx.doi.org/10.1007/s13410-024-01370-0

65. Seshiah, Veeraswamy & Balaji, V. & Balaji, Sudharsan & Paneerselvam, Arunachalam & Arthi, T & Thamizharasi, M & Datta, Manjula. (2008). Prevalence of gestational diabetes mellitus in South India (Tamil Nadu) - A community based study. The Journal of the Association of Physicians of India. 56. 329-33

66. Chanda S, Dogra V, Hazarika N, Bambrah H, Sudke AK, Vig A, et al. Prevalence and predictors of gestational diabetes mellitus in rural Assam: a cross-sectional study using mobile medical units. BMJ Open [Internet]. 2020;10(11):e037836. Available from: https://bmjopen.bmj.com/content/bmjopen/10/11/e037836.full.pdf

67. Kansal D, Kambar S. Prevalence of gestational diabetes mellitus among pregnant women attending antenatal clinic at three urban health centres of Belagavi – a cross-sectional study. Int J Med Sci Public Health. 2019;8(3):169-173.

68. Malhotra S, Kant S, Kumar R, Ahamed F, Mandal S, M C A, Misra P, Gupta Y. Gestational Diabetes Mellitus Among Pregnant Women Attending Ante-natal Clinic at a Secondary Care Health Facility in Haryana, India. Cureus. 2022 May 29;14(5): e25452. doi: 10.7759/cureus.25452

69. Prevalence of gestational diabetes mellitus & associated risk factors at a tertiary care hospital in Haryana Rajesh Rajput, Yogesh Yadav, Smiti Nanda* & Meena Rajput**

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70. Wahabi H. Prevalence and risk factors for glucose intolerance among Saudi women with gestational diabetes. J Diabetes Res. 2018;2018:4282347. Available from: http://dx.doi.org/10.1155/2018/4282347

71. Wu Y, Hamelmann P, van der Ven M, Asvadi S, van der Hout-van der Jagt MB, Oei SG, et al. Early prediction of gestational diabetes mellitus using maternal demographic and clinical risk factors. BMC Res Notes. 2024;17(1):105. Available from: http://dx.doi.org/10.1186/s13104-024-06758-z

72. Rajput R, Yadav Y, Nanda S, Rajput M. Prevalence of gestational diabetes mellitus & associated risk factors at a tertiary care hospital in Haryana. Indian J Med Res. 2013 Apr;137(4):728-33. PMID: 23703340; PMCID: PMC3724253.

73. Dhatt GS, Agarwal MM, Othman Y, Nair SC. Performance of the Roche Accu-Chek active glucose meter to screen for gestational diabetes mellitus using fasting capillary blood. Diabetes Technol Ther . 2011;13(12):1229–33. Available from: http://dx.doi.org/10.1089/dia.2011.0097

74. Salehi* S, Shahabi V, Borumandnia N, Jamali R, Jamal M, editors. First Trimester Fasting Blood Sugar Level as a Predictor of Abnormal Results on Glucose Tolerance Test at 24 to 28 Weeks of Gestation Masoumeh Mirzamoradi.

75. Agarwal MM. Gestational diabetes mellitus: Screening with fasting plasma glucose. World J Diabetes. 2016;7(14):279–89. Available from: http://dx.doi.org/10.4239/wjd.v7.i14.279

76. Cosson E, Carbillon L, Valensi P. High Fasting Plasma Glucose during Early Pregnancy: A Review about Early Gestational Diabetes Mellitus. J Diabetes Res. 2017;2017:8921712. doi: 10.1155/2017/8921712. Epub 2017 Oct 18. PMID: 29181414; PMCID: PMC5664285.

77. Shaarbaf Eidgahi E, Nasiri M, Kariman N, Safavi Ardebili N, Salehi M, Kazemi M, et al. Diagnostic accuracy of first and early second trimester multiple biomarkers for prediction of gestational diabetes mellitus: a multivariate longitudinal approach. BMC Pregnancy Childbirth. 2022;22(1):13. Available from: http://dx.doi.org/10.1186/s12884-021-04348-6

78. Simmons D, Immanuel J, Hague WM, Teede H, Nolan CJ, Peek MJ, et al. Treatment of gestational diabetes mellitus diagnosed early in pregnancy. N Engl J Med. 2023;388(23):2132–44. Available from: http://dx.doi.org/10.1056/NEJMoa2214956

79. Mahha A, Maghrabi RI, Alshuhri M, Alqurashi RI. Risk factors of gestational diabetes mellitus among pregnant women attending antenatal care in King Saud Medical City, Riyadh, Saudi Arabia. Cureus.2024;16(8):e67701. Available from: http://dx.doi.org/10.7759/cureus.67701

80. Bahl S, Dhabhai N, Taneja S, Mittal P, Dewan R, Kaur J, et al. Burden, risk factors and outcomes associated with gestational diabetes in a population-based cohort of pregnant women from North India. BMC Pregnancy Childbirth. 2022;22(1):32. Available from: http://dx.doi.org/10.1186/s12884-022-04389-5

81. Ikoh Rph CL, Tang Tinong R. The Incidence and Management of Type 2 Diabetes Mellitus After Gestational Diabetes Mellitus. Cureus. 2023 Aug 31;15(8):e44468. doi: 10.7759/cureus.44468. PMID: 37664380; PMCID: PMC10471197.

82. Herath H, Herath R, Wickremasinghe R. Gestational diabetes mellitus and risk of type 2 diabetes 10 years after the index pregnancy in Sri Lankan women-A community based retrospective cohort study. PLoS One. 2017;12(6):e0179647. Available from: http://dx.doi.org/10.1371/journal.pone.0179647

83. Qi Y, Sun X, Tan J, Zhang G, Chen M, Xiong Y, Chen P, Liu C, Zou K, Liu X. Excessive gestational weight gain in the first and second trimester is a risk factor for gestational diabetes mellitus among women pregnant with singletons: A repeated measures analysis. J Diabetes Investig. 2020 Nov;11(6):1651-1660. doi: 10.1111/jdi.13280. Epub 2020 Jul 29. PMID: 32324966; PMCID: PMC7610133.

84. Diabetesjournals.org. Available from: https://diabetesjournals.org/care/article/40/5/679/36806/In-Utero-Exposure-to-Maternal-Hyperglycemia

85. Todorovic J, Terzic-Supic Z, Bjegovic-Mikanovic V, Piperac P, Dugalic S, Gojnic-Dugalic M. Factors associated with the leisure-time physical activity (LTPA) during the first trimester of the pregnancy: The cross-sectional study among pregnant women in Serbia. Int J Environ Res Public Health. 2020;17(4):1366. Available from: http://dx.doi.org/10.3390/ijerph17041366

86. Kariniemi K, Vääräsmäki M, Männistö T, Mustaniemi S, Kajantie E, Eteläinen S, Keikkala E; Finnish Gestational Diabetes [FinnGeDi] study group. Neonatal outcomes according to different glucose threshold values in gestational diabetes: a

register-based study. BMC Pregnancy Childbirth. 2024 Apr 12;24(1):271. doi: 10.1186/s12884-024-06473-4. PMID: 38609891; PMCID: PMC11010296.

87. Gerszi D, Orosz G, Török M, Szalay B, Karvaly G, Orosz L, Hetthéssy J, Vásárhelyi B, Török O, Horváth EM, Várbíró S. Risk Estimation of Gestational Diabetes Mellitus in the First Trimester. J Clin Endocrinol Metab. 2023 Oct 18;108(11):e1214-e1223. doi: 10.1210/clinem/dgad301. PMID: 37247379; PMCID: PMC10584002.

88. Hillier TA, Ogasawara KK, Pedula KL, Vesco KK, Oshiro CES, Van Marter JL. Timing of Gestational Diabetes Diagnosis by Maternal Obesity Status: Impact on Gestational Weight Gain in a Diverse Population. J Womens Health (Larchmt). 2020 Aug;29(8):1068-1076. doi: 10.1089/jwh.2019.7760. Epub 2020 Apr 24. PMID: 32330405; PMCID: PMC7461990.

89. Sujan MAJ, Skarstad HMS, Rosvold G, Fougner SL, Nyrnes SA, Iversen A-C, et al. Randomised controlled trial of preconception lifestyle intervention on maternal and offspring health in people with increased risk of gestational diabetes: study protocol for the BEFORE THE BEGINNING trial. BMJ Open. 2023;13(10):e073572. Available from: http://dx.doi.org/10.1136/bmjopen-2023-073572

90. Xu J, Chen Y, Zhao J, Wang J, Chen J, Pan X, Zhang W, Zheng J, Zou Z, Chen X, Zhang Y. Current status of electronic health literacy among pregnant women with gestational diabetes mellitus and their perceptions of online health information: a mixed-methods study. BMC Pregnancy Childbirth. 2024 May 28;24(1):392. doi: 10.1186/s12884-024-06594-w. PMID: 38807050; PMCID: PMC11134622.

91. Joshi S. Gestational diabetes mellitus--guidelines. The Journal of the Association of Physicians of India. 2006; Guidelines. Dipsi.in. Available from: https://dipsi.in/guidelines/

92. Javalkar, Sandhya Rani & Naveen H, Shalini & Davalgi, Shubha & G S, Vidya. (2024). Socio economic status assessment in India: history and updates for 2024. International Journal Of Community Medicine And Public Health. 11. 1369-1377. 10.18203/2394-6040.ijcmph20240648.

93. Consumer price index numbers on base 2012=100 for rural, urban and combined for the month of June 2024. Gov.in. Available from: https://pib.gov.in/PressReleasePage.aspx?PRID=2032780

94. American Heart Association, 2024; Heart.org. Available from: https://www.heart.org/en/

95. Acog.org.. Available from: https://www.acog.org/. (American College of Obstetricians and Gynecologists, 2024)

96. Guideline Central. Top thyroid guidelines in 2024 - guidelines rundown;Thyroid Awareness Month. Guideline Central. 2025. Available from: https://www.guidelinecentral.com/insights/2024-thyroid-guidelines-rundown/

97. Global tuberculosis report 2024. Who.int. Available from: https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2024

98. CDC. Coronavirus disease 2019 (COVID-19). COVID-19. 2025. Available from: https://www.cdc.gov/covid/index.html

99. Neupert B. American pregnancy association | expecting with confidence. 2021. https://americanpregnancy.org/

100. American Institute of ultrasound in Medicine - AIUM. www.aium.org.Available from: https://www.aium.org/

101. Sarojamma, Subiksha RA. Clinicopathological study of anemia during pregnancy. Int J Reprod Contracept Obstet Gynecol [Internet]. 2020;9(4):1545. Available from: http://dx.doi.org/10.18203/2320-1770.ijrcog20201220

102. National AIDS Control Organization. Gov.in.. Available from: https://naco.gov.in/

103. CDC. Centers for disease control and prevention. Cdc.gov. Available from: **https://www.cdc.gov/**

104. NICE website: The National Institute for Health and Care Excellence. NICE; Available from: https://www.nice.org.uk/

105. American diabetic association; Diatribe.org. Available from: https://diatribe.org/diabetes-management/your-guide-2023-ada-standards-care

106. Newborn mortality [Internet]. Who.int. [cited 2025 Mar 28]. Available from: https://www.who.int/news-room/fact-sheets/detail/newborn-mortality

107. Psychiatry.org. Available from: https://www.psychiatry.org/

108. Who.int. [cited 2025 Mar 28]. Available from: https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/steps/part3-section5.pdf?sfvrsn=a46653c7_2

109. WHO guidelines on physical activity and sedentary behaviour. Who.int. World Health Organization; 2020. Available from:https://www.who.int/publications/i/item/9789240015128

110. Misra A. Ethnic-specific criteria for classification of body mass index: A perspective for Asian Indians and American Diabetes Association position statement. Diabetes Technol Ther. 2015;17(9):667–71. Available from: http://dx.doi.org/10.1089/dia.2015.0007

111. Singh A, Ladusingh L. Prevalence and determinants of tobacco use in India: evidence from recent Global Adult Tobacco Survey data. PLoS One. 2014 Dec 4;9(12):e114073. doi: 10.1371/journal.pone.0114073. PMID: 25474196; PMCID: PMC4256395.

112. Alcohol [Internet]. Who.int. [cited 2025 Mar 28]. Available from: https://www.who.int/news-room/fact-sheets/detail/alcohol

113. World Health Organization. What are healthy diets? Joint statement by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO). Geneva: WHO; 2024. Available from: https://www.who.int/publications/i/item/9789240101876

114. Olin BR. June Twiggs, Pharm.D. Candidate 2015 [Internet]. Ymaws.com. [cited 2025 Mar 5]. Available from: https://cdn.ymaws.com/www.aparx.org/resource/resmgr/CEs/CE_Hypertension_The_Silent_K.pdf

115. Cunningham, F. Gary, et al. *Williams Obstetrics*. 26th ed., McGraw-Hill Education, 2021. Mhmedical.com.: Available from:https://obgyn.mhmedical.com/content.aspx?bookid=2977&sectionid=263812666

116. James D, Steer P, Weiner C, Gonik B, Robson S. High-Risk Pregnancy: Management options. In: High-Risk Pregnancy: Management Options. Cambridge, England: Cambridge University Press; 2017. p. i–ii.

117. Preterm and low birth weight Who.int. Available from: https://www.who.int/teams/maternal-newborn-child-adolescent-health-and-ageing/newborn-health/preterm-and-low-birth-weight/

118. Perlman JM, Wyllie J, Kattwinkel J, Wyckoff MH, Aziz K, Guinsburg R, et al. Part 7: Neonatal resuscitation: 2015 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations: 2015 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Circulation.2015;132(16 Suppl 1):S204-41. Available from: http://dx.doi.org/10.1161/CIR.0000000000000276

119. Congenital disorders. Who.int. Available from: https://www.who.int/news-room/fact-sheets/detail/birth-defects/

120. World health organization (WHO). Postpartum hemorrhage: A guide for management. WHO, 2018. Bing. Available from: https://www.bing.com/search?q=World%20Health%20Organization%20(WHO).%20Postpartum%20Hemorrhage%3A%20A%20Guide%20for%20Management.%20WH

O%2C%202018.&qs=n&form=QBRE&sp=-1&ghc=1&lq=0&pq=world%20health%20organization%20(who).%20postpartum%20hemorrhage%3A%20a%20guide%20for%20management.%20who%2C%202018.&sc=2-90&sk=&cvid=6246FEDE3C1C4C64B2B6DC94645DCFBD&ghsh=0&ghacc=0&ghpl=

121. Sudha Jaiswal, Ravi Shankar, Sandeep Kumar Jaiswal. Prevalence of gestational diabetes mellitus and associated risk factors among rural pregnant women attending antenatal care. Int J Clin Obstet Gynaecol 2022;6(4):20-26. DOI: 10.33545/gynae.2022.v6.i4a.1192

122. Ennazhiyil SV, Valsan SM, Rajeev AV, Srinivasan C, Kunnath RP. The socio-demographic determinants of gestational diabetes mellitus among postnatal women from Palakkad district, Kerala: comparative study. Int J Community Med Public Health [Internet]. 2019;6(6):2449. Available from: http://dx.doi.org/10.18203/2394-6040.ijcmph20192303

123. Muche, A.A., Olayemi, O.O. & Gete, Y.K. Effects of gestational diabetes mellitus on risk of adverse maternal outcomes: a prospective cohort study in Northwest Ethiopia. BMC Pregnancy Childbirth 20, 73 (2020). https://doi.org/10.1186/s12884-020-2759-8

124. Monod C, Kotzaeridi G, Linder T, Eppel D, Rosicky I, Filippi V, Tura A, Hösli I, Göbl CS. Prevalence of gestational diabetes mellitus in women with a family history of type 2 diabetes in first- and second-degree relatives. Acta Diabetol. 2023

Mar;60(3):345-351. doi: 10.1007/s00592-022-02011-w. Epub 2022 Dec 12. PMID: 36508047; PMCID: PMC9931850.

125. Kek, HP., Su, YT., Tey, SJ. et al. The joint effect of gestational diabetes mellitus and hypertension contribute to higher risk of diabetes mellitus after delivery: a nationwide population-based study. BMC Pregnancy Childbirth 23, 539 (2023). https://doi.org/10.1186/s12884-023-05829-6

126. Fong A, Serra A, Herrero T, Pan D, Ogunyemi D. Pre-gestational versus gestational diabetes: a population based study on clinical and demographic differences. J Diabetes Complications. 2014 Jan-Feb;28(1):29-34. doi: 10.1016/j.jdiacomp.2013.08.009. Epub 2013 Oct 4. PMID: 24094665; PMCID: PMC3887473.

127. Thiele GA, Ryan DM, Oberlander TF, Hanley GE. Preconception mental health and the relationship between antenatal depression or anxiety and gestational diabetes mellitus: a population-based cohort study. BMC Pregnancy Childbirth. 2022 Aug 31;22(1):670. doi: 10.1186/s12884-022-05002-5. PMID: 36045319; PMCID: PMC9429302.

128. Lewandowska M. Gestational Diabetes Mellitus (GDM) Risk for Declared Family History of Diabetes, in Combination with BMI Categories. Int J Environ Res Public Health. 2021 Jun 28;18(13):6936. doi: 10.3390/ijerph18136936. PMID: 34203509; PMCID: PMC8293805.

129. Hosoya S, Ogawa K, Morisaki N, Okamoto A, Arata N, Sago H. Gestational glycosuria, proteinuria, and borderline hypertension in pregnancy are predictors for

the later onset of maternal chronic disease. J Obstet Gynaecol Res. 2023 Feb;49(2):641-648. doi: 10.1111/jog.15497. Epub 2022 Nov 10. PMID: 36357346.

130. Mirzamoradi M, Salehi S, Shahabi V, Borumandnia N, Jamali R, Jamali M. First trimester fasting blood sugar level as a predictor of abnormal results on glucose tolerance test at 24 to 28 weeks of gestation. Perinatology. 2021;22(3):178-182.

131. Swaminathan G, Swaminathan A, Corsi DJ. Prevalence of Gestational Diabetes in India by Individual Socioeconomic, Demographic, and Clinical Factors. JAMA Netw Open. 2020;3(11):e2025074. doi:10.1001/jamanetworkopen.2020.25074

132. Grabowska K, Stapińska-Syniec A, Saletra A, Jarmużek P, Bomba-Opoń D. Labour in women with gestational diabetes mellitus. Ginekol Pol. 2017;88(2):81-86. doi: 10.5603/GP.a2017.0016. PMID: 28326517.

133. Jali MV, Desai BR, Gowda S, Kambar S, Jali SM. A hospital based study of prevalence of gestational diabetes mellitus in an urban population of India. Eur Rev Med Pharmacol Sci. 2011;15(11):1306–10.

134. Jan S Erkamp, Madelon L Geurtsen, Liesbeth Duijts, Irwin K M Reiss, Annemarie G M G J Mulders, Eric A P Steegers, Romy Gaillard, Vincent W V Jaddoe, Associations of Maternal Early-Pregnancy Glucose Concentrations With Placental Hemodynamics, Blood Pressure, and Gestational Hypertensive Disorders, American Journal of Hypertension, Volume 33, Issue 7, July 2020, Pages 660–669, https://doi.org/10.1093/ajh/hpaa070

135. Bhattacharya S, Nagendra L, Dutta D, Mondal S, Bhat S, Raj JM, Boro H, Kamrul-Hasan ABM, Kalra S. First-trimester fasting plasma glucose as a predictor of

subsequent gestational diabetes mellitus and adverse fetomaternal outcomes: A systematic review and meta-analysis. Diabetes Metab Syndr. 2024 Jun;18(6):103051. doi: 10.1016/j.dsx.2024.103051. Epub 2024 Jun 1. PMID: 38843646.

136. Donovan L, Hartling L, Muise M, Guthrie A, Vandermeer B, Dryden DM. Screening tests for gestational diabetes: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med 2013; 159: 115-122 [PMID: 23712349 DOI: 10.7326/0003-48 19-159-2-201307160-00657]

137. Virally M, Laloi-Michelin M. Methods for the screening and diag nosis of gestational diabetes mellitus between 24 and 28 weeks of pregnancy. Diabetes Metab 2010; 36: 549-565 [PMID: 21163420 DOI: 10.1016/j.diabet.2010.11.008]

138. Kashi Z, et al. Diagnostic value of fasting plasma glucose (FPG) in screening of gestational diabetes mellitus. IJDLD. 2006;6(1):67–72.

139. Li P, Lin S, Li L, Cui J, Zhou S, Fan J. First-trimester fasting plasma glucose as a predictor of gestational diabetes mellitus and the association with adverse pregnancy outcomes. Pak J Med Sci. 2019;35(1):95-100. doi: https://doi.org/10.12669/pjms.35.1.216

140. Riskin-Mashiah S, Younes G, Damti A, Auslender R. First-trimester fasting hyperglycemia and adverse pregnancy outcomes. Diabetes Care. 2009 Sep;32(9):1639-43. doi: 10.2337/dc09-0688. Epub 2009 Jun 23. PMID: 19549728; PMCID: PMC2732138.

141. Sinha AK, B. M, M. R. NM. A community based screening of gestational diabetes mellitus within 16 weeks of pregnancy: a study from Mysuru district, Karnataka. Int J

Community Med Public Health [Internet]. 2018;5(6):2266. Available from: http://dx.doi.org/10.18203/2394-6040.ijcmph20182038

142. Shan, X.; Peng, C.; Zou, H.; Pan, Y.; Wu, M.; Xie, Q.; Lin, Q. Association of Vegetables-Fruits Dietary Patterns with Gestational Diabetes Mellitus: Mediating Effects of Gut Microbiota. Nutrients 2024, 16, 2300. https://doi.org/10.3390/nu16142300

143. Panyakat WS, Phatihattakorn C, Sriwijitkamol A, Sunsaneevithayakul P, Phaophan A, Phichitkanka A. Correlation between third trimester glycemic variability in non-insulin-dependent gestational diabetes mellitus and adverse pregnancy and fetal outcomes. J Diabetes Sci Technol [Internet]. 2018;12(3):622–9. Available from: http://dx.doi.org/10.1177/1932296817752374

144. Chakraborty A, Yadav S. Prevalence and determinants of gestational diabetes mellitus among pregnant women in India: an analysis of National Family Health Survey Data. BMC Womens Health. 2024 Feb 29;24(1):147. doi: 10.1186/s12905-024-02936-0. PMID: 38424617; PMCID: PMC10902981.

145. Basu A, Feng D, Planinic P, Ebersole JL, Lyons TJ, Alexander JM. Dietary Blueberry and Soluble Fiber Supplementation Reduces Risk of Gestational Diabetes in Women with Obesity in a Randomized Controlled Trial. J Nutr. 2021 May 11;151(5):1128-1138. doi: 10.1093/jn/nxaa435. PMID: 33693835; PMCID: PMC8112774

146. Deng L, Ning B, Yang H. Association between gestational diabetes mellitus and adverse obstetric outcomes among women with advanced maternal age: A retrospective cohort study. Medicine 2022;101:40(e30588).

147. Nakshine V S, Jogdand S D (October 23, 2023) A Comprehensive Review of Gestational Diabetes Mellitus: Impacts on Maternal Health, Fetal Development, Childhood Outcomes, and Long-Term Treatment Strategies. Cureus 15(10): e47500. DOI 10.7759/cureus.47500

ANNEXURE – I

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed – to- be- University)
Accredited 'A+' Grade by NAAC in (3rd Cycle) Placed in Category 'A' by MHRD (GoI)
JNMC INSTITUTIONAL ETHICS COMMITTEE
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
Website: http//www.jnmc.edu
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Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref No.MDC/JNMCIEC/47 **Date: 31/03/2023**

To,
DR. **BD0122001**
PG Student in Community Medicine
J. N. Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"ASSESSMENT OF GESTATIONAL DIABETES MELLITUS AMONG FIRST TRIMESTER PREGNANT WOMEN- A COMMUNITY BASED LONGITUDINAL STUDY",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

(Dr. Smita Sonoli)
Member Secretary
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi.

(Dr. Harsha Hegde)
Chairman,
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi

ANNEXURE – I I

TITLE: "Assessment of Gestational Diabetes Mellitus among First Trimester Pregnant women – A Community-based Longitudinal Study**"**

Objective:

Primary objective – To determine the prevalence of Gestational Diabetes Mellitus among first trimester pregnant women residing in field practice area of Belagavi district**.**

Secondary objectives

c. To predict Gestational Diabetes Mellitus using fasting blood glucose among pregnant women during their first trimester residing in field practice area of Belagavi.

d. To assess the risk factors for Gestational Diabetes Mellitus among pregnant women residing in field practice area.

Introduction:

Globally Gestational diabetes Mellitus is emerged as serious health concern during pregnancy and childbirth, leading to both maternal and Fetal complications. The risk factors for GDM include, Age (the older a woman of reproductive age is, the greater her risk of GDM); overweight or obesity - excessive weight gain during pregnancy; a family history of diabetes; GDM during a previous pregnancy; a history of stillbirth or giving birth to an infant with congenital abnormalities; Diabetes during pregnancy and GDM increase the chance of future obesity and type 2 diabetes in offspring. Hence it is important that the susceptible population be educated about the impact of GDM and the benefits of Early detection and management of gestational diabetes mellitus thus decreasing the burden of GDM. These are the reasons for the present study to be undertaken. Participation in this study is completely voluntary

Explanation of procedure:

- In this study, you will have to answer a few prepared questions about Socio-demographic details, medical history, Obstetric history, lifestyle information.
- And participants in their first trimester (up to 13th week of gestation) tested for fasting blood glucose an early morning blood sample is measured using capillary blood glucose (minimum of 8hours of fasting is required).The classification based on the FBG is as follows: FBG Value: 70 – 92 mg/dL – Normal; 92 – 125 mg/dL – Early GDM; ≥ 126 – GDM
- All the study participants will undergo an Oral glucose tolerance test (OGTT) with 75-g anhydrous glucose powder. The glucose powder was dissolved in 250-300 ml of water and pregnant women will be asked to consume it in five minutes. The results are assessed using DIPSI (Diabetes in pregnancy study group of India) Criteria (A blood glucose level of ≥140 mg/dl two hours after the consumption of 75 mg of anhydrous glucose was considered GDM) using capillary blood glucose method under aseptic precautions.
- And the participants who had normal blood glucose value in the first trimester will be assessed for OGTT under aseptic conditions in the 24 -28 week of GA using capillary blood glucose method. The diagnostic performance of FPG in the will be compared with OGTT
- Final study outcomes will be obtained at delivery and one week post-delivery. If you agree to participate, then only questions will be asked to you and tests will be performed. At any moment, you can withdraw from the study.

Withdrawal from participation in the study: Participation in this study is voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. Even if you withdraw

from the study, care provided to you will not be halted. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: The benefits of participating in the study include contributing to the understanding of GDM prediction in the first trimester and the potential for early diagnosis and treatment of GDM.

Possible risks from participating in the study: The study procedures are safe and non-invasive. However, some women may feel nauseated, sweaty, or lightheaded after they drink the glucose solution. Serious side effects from this test are very uncommon.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purposes and or presented to scientific groups. However, your identity will never be revealed.

Legal rights: By signing this consent form, we are not waving any of your legal rights

CONSENT STATEMENT

I am making a voluntary decision to participate in the study "**Assessment of Gestational Diabetes Mellitus among First Trimester Pregnant women – a community based Longitudinal study**". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

Date:

Place:

ANNEXURE – III

PROFORMA / QUESTIONNAIRE

"Assessment of Gestational Diabetes Mellitus among First Trimester Pregnant women – a community based Longitudinal study"

(Note: The personal data provided by you will be kept confidential. Only aggregated results will be presented /published, without revealing your personal identity)

Participant ID: |___|___|___|___| Date:|____|____|_____|

PART 1: Socio-demographic details:

1. Name: _____
2. Age: (in completed years): _____
3. Religion: Hindu\ Islam\ Christian\ Sikh\ Jain\ Others (specify):_____
4. Education: Total years of Schooling: _____ Years

   No formal education/ Primary / Secondary / Collegiate / Post-graduate
5. Occupation: Home-maker / Govt. employee/ non-govt. employee/ Self employee / Agriculture /

   Unemployed
6. Total Family Income (Husband home): _____ INR
7. Total no. of Family Members: _____
8. Per capita income: _____ INR
9. Socio-economic Status (Mod. B G Prasad Classification): Class I / II / III / IV / V

PART 2: Family and Medical History

10. Family history of Diabetes Mellitus: Yes / No

    If Yes, Specify: Mother / Father / Both parents / Siblings

11. Family history of Hypertension: Yes / No

    If Yes, Specify: Mother / Father / Both parents / Siblings

12. Is she diagnosed with any medical condition prior to pregnancy?

a. Diabetes Mellitus – Yes / No

b. Hypertension – Yes / No

c. Cardiac Problems – Yes / No

d. Thyroid disease – Yes / No

e. Tuberculosis – Yes / No

f. COVID-19 – Yes / No

g. Psychiatric illness (Anxiety / Depression) – Yes / No

h. Others (Specify):_____

PART 3: Current Obstetric History

13. Gravida _____

14. Parity _____

15. LMP: _____|_____|_____

16. Is USG Date and GA Available? Yes / No

a. If Yes, Date of USG: ____|____|_____

b. GA at the time of USG: _____ weeks _____ days

17. Date of registration: _____|_____|_____

18. Haemoglobin (at registration): _____ g/ dL

19. HIV Status: Positive / Negative
20. HBSAg Status: Positive / Negative
21. Blood Group: _____
22. Urine Protein: Present / Absent
23. Urine Sugar: Present / Absent
24. Thyroid test done: Yes / No

    If Yes, TSH _____ mcg/L

PART 4: Past Obstetric History (if applicable)

25. History of Diabetes Mellitus in Past pregnancy: Yes / No

    If Yes, Treatment given: MNT / Insulin / Metformin / Combination of either
26. History of Gestational Hypertension/ Pre-eclampsia in Past pregnancy: Yes / No
27. Previous LSCS: Yes / No
28. History of Neonatal death/ Still Birth: Yes / No
29. History of previous difficult labour: Yes / No
30. History of Rh incompatibility: Yes / No
31. History of Bad obstetric history: Yes / No
32. History of delivering baby weighing > 4.5 Kg: Yes / No
33. History of Anxiety / Depression: Yes / No
34. Others (Specify): _____

PART 5: Anthropometry

35. Pre-pregnancy weight _____ (in Kg)
36. Present Weight: _____ (in Kg)
37. Weight at admission for delivery: _____ (in Kg)
38. Height: _____(in meters)
39. BMI: _____ (Kg/m^2)

PART 6: Lifestyle information:

40. Smoking Tobacco Consumption: Yes / No

    If Yes, Type: Cigarette / Bidi / Pipes / Others (Specify):_____

    If Yes, Frequency: Daily / Occasionally / Past smoker

41. Non-smoking Tobacco Consumption: Yes / No

    If Yes, Type: Snuff / Guthka / Chewing tobacco / Others (Specify):_____

    If Yes, Frequency: Daily / Occasionally / Past smoker

42. Alcohol Consumption: Yes / No

    If Yes, Type: Beer / Whisky / Rum / Brandy / Country liquor / Others (Specify): _____

    If Yes, Frequency: 5 or more days a week / 1-4 days a week / 1-3 days a month / < Once a month

43. Physical Activity assessment:

    Job related physical activity – Sedentary / Moderate / Vigorous / Not Applicable

    Leisure time physical activity – Yes / No

    If Yes, Frequency: Every day / 3 – 4 days a week / 1 – 2 days a week / Few days a month / Uncertain

44. In a typical week, no. of days of fruits consumption: _____ days

45. In a typical week, no. of days of vegetables consumption: _____ days

PART 7: Biochemical measurements: First trimester tests:

46. Fasting plasma glucose measurement:

a. Fasting blood glucose reading: _____mg/dL

47. OGTT measurement:

By DIPSI criteria capillary blood glucose at the end of 2hour of consumption of 75gm anhydrous glucose level: _____mg/Dl

48. Blood pressure measurement: _____/_____mm/Hg

PART 8: Biochemical measurements: Second trimester tests:

(Applicable for women with normal GTT in first trimester)

49. OGTT measurement:

By DIPSI criteria capillary blood glucose at the end of 2hour of consumption of 75gm anhydrous glucose level: _____mg/dL

PART 9: Postnatal (up to 7 days post-delivery)

50. Date of Delivery: _____/_____/_____

51. Did the mother have any of the following during present pregnancy? (Mark all that apply)

a. Gestational diabetes mellitus: Yes / No / Don't know

b. Hypertensive disorders in pregnancy: Yes / No / Don't know

c. Decreased Fetal movements: Yes / No / Don't know

d. Polyhydramnios: Yes / No / Don't know

e. Antepartum haemorrhage: Yes / No / Don't know

f. Abnormal lie: Yes / No / Don't know

g. Anaemia: Yes / No / Don't know

h. Preterm labour (< 37 weeks): Yes / No / Don't know

i. Premature rupture of membrane: Yes / No / Don't know

j. Others (specify): _____

52. Type of delivery: Vaginal (without forceps / vacuum) / Vaginal (with forceps / vacuum) / LSCS

53. Gender of the baby: Male / Female

54. Birthweight: _____ grams

55. Required ventilatory support (bag and mask/ oxygen / PPV / Etc.) – Yes / No

56. Required NICU Admission: Yes / No

If Yes, Reason for admission: _____

57. Congenital anomalies in Neonate: Yes / No

58. Did the mother have any of the following during delivery?

a. Abnormal Fetal heart rate (FHR): Yes / No

b. Fever (>100.4F / 38C): Yes / No

c. Shoulder dystocia: Yes / No

d. Retained placenta: Yes / No

e. post-partum haemorrhage: Yes / No

f. Sepsis: Yes / No

j. Others (specify): _____

ANNEXURE – IV

KEY TO MASTER CHART

A. Participant ID ___|___|___

B. Name: _____

C. **Age:** (in completed years): _____

D. Religion:

1. Hindu - 1
2. Islam - 2
3. Christian - 3
4. Sikh - 4
5. Jain - 5
6. Others (specify): _ - 6

E. Education: Total years of Schooling: _____ Years

F. Education

No formal education – 1

Primary -2

Secondary - 3

Collegiate - 4

Post-graduate -5

G. Occupation:

Home-maker – 1

Govt. employee – 2

Non-govt. employee – 3

Self-employee – 4

Agriculture – 5

Unemployed – 6

H. Total Family Income (Husband home): _____ INR

I. Total no. of Family Members: _____

J. Per capita income: _____ INR

K. Socio-economic Status (Mod. B G Prasad Classification):

Class I - 1

Class II -2

Class III - 3

Class IV - 4

Class V – 5

PART 2: Family and Medical History

L. Family history of Diabetes Mellitus:

Yes - 1

No – 2

M. If **Yes**, Specify:

Mother - 1

Father - 2

Both parents – 3

Siblings – 4

N. Family history of Hypertension:

Yes - 1

No – 2

O. If **Yes**, Specify:

Mother - 1

Father – 2

Both parents - 3

Siblings – 4

P. Is she diagnosed with any medical condition prior to pregnancy? Diabetes Mellitus – Yes -1, No - 2

Q. Hypertension – Yes- 1, No -2

R. Cardiac Problems – Yes- 1, No- 2

S. Thyroid disease – Yes – 1, No- 2

T. Tuberculosis – Yes -1, No - 2

U. COVID-19 – Yes – 1, No - 2

V. Psychiatric illness (Anxiety / Depression) – Yes – 1, No - 2

W. Others (Specify): _____

PART 3: Current Obstetric History

X. Gravida _____

Y. Parity _____

Z. LMP: _____|_____|_____,

AA. Cycles – Regular – 1, irregular – 2

AB. Oral contraceptive use -Yes – 1, No - 2

AC. Is USG Date and GA Available? Yes -1, No – 2

AD. If Yes, Date of USG: ____|____|_____

AE. AF. GA at the time of USG:

AE. _____ weeks

AF. _____ days

AG. Date of registration: _____|_____|_____

AH. Haemoglobin (at registration): _____ g/ dL

AI. HIV Status: Positive - 1, Negative -2

AJ. HBSAg Status: Positive – 1, Negative - 2

AK. Blood Group: _____

A Positive - 1

A Negative - 2

B Positive - 3

B Negative - 4

AB Positive - 5

AB Negative - 6

O Positive – 7

O Negative - 8

AL. Urine Protein: Present – 1, Absent – 2

AM. Urine Sugar: Present – 1, Absent -2

AN. Thyroid test done: Yes – 1, No - 2

AO. If Yes, TSH ___ mcg/L

PART 4: Past Obstetric History (if applicable)

AP. History of Diabetes Mellitus in Past pregnancy: Yes - 1, No – 2

AQ. If Yes, Treatment given:

MNT – 1

Insulin – 2

Metformin – 3

Combination of either – 4

AR. History of Gestational Hypertension/ Pre-eclampsia in Past pregnancy: Yes – 1, No – 2

AS. Previous LSCS: Yes – 1, No - 2

AT. History of Neonatal death/ Still Birth: Yes – 1, No – 2

AU. History of previous difficult labour: Yes – 1, No – 2

AV. History of Rh incompatibility: Yes – 1, No - 2

AW. History of Bad obstetric history: Yes – 1, No - 2

AX. History of delivering baby weighing > 4.5 Kg: Yes – 1, No - 2

AY. History of Anxiety / Depression: Yes – 1, No - 2

AZ. Others (Specify): _____

PART 5: Anthropometry

BA. Pre-pregnancy weight _____ (in Kg)

BB. Present Weight: _____ (in Kg)

BC. Weight at admission for delivery: _____ (in Kg)

BD. Height: _____ (in meters)

BE. BMI: _____ (Kg/m^2)

PART 6: Lifestyle information:

BF. Smoking Tobacco Consumption: Yes – 1, No – 2

BG. If Yes, Type: Cigarette -1, Bidi - 2, Pipes – 3, Others (Specify): _ - 4

BH. If Yes, Frequency: Daily - 1, Occasionally - 2, Past smoker – 3

BI. Non-smoking Tobacco Consumption: Yes – 1, No – 2

BJ. If Yes, Type: Snuff – 1, Guthka - 2, Chewing tobacco - 3, Others (Specify): _ - 4

BK. If Yes, Frequency: Daily -1, Occasionally -2, Past smoker - 3,

BL . Alcohol Consumption: Yes – 1, No – 2

BM. If Yes, Type:

Beer -1,

Whisky - 2,

Rum -3,

Brandy – 4,

Country liquor – 5,

Others (Specify): _ - 6

BN. If Yes, Frequency:

5 or more days a week - 1

1-4 days a week - 2

1-3 days a month -3

< Once a month - 4

BO. Physical Activity assessment: Job related physical activity –

Sedentary- 1

Moderate -2

Vigorous -3

Not Applicable -4

BP. Leisure time physical activity – Yes – 1, No – 2

BQ. If Yes, Frequency:

Every day – 1,

3 – 4 days a week – 2,

1 – 2 days a week – 3,

Few days a month – 4,

Uncertain -5

BR. In a typical week, no. of days of fruits consumption: _____ days

BS. In a typical week, no. of days of vegetables consumption: _____ days

PART 7: Biochemical measurements: First trimester tests:

BT. Fasting plasma glucose measurement:

a. Fasting blood glucose reading: _____mg/dL

BU. OGTT measurement:

By DIPSI criteria capillary blood glucose at the end of 2hour of consumption of 75gm anhydrous glucose level: _____mg/Dl

BV. Blood pressure measurement: _____/_____mm/Hg

PART 8: Biochemical measurements: Second trimester tests:

(Applicable for women with normal GTT in first trimester)

BW. OGTT measurement:

By DIPSI criteria capillary blood glucose at the end of 2hour of consumption of 75gm anhydrous glucose level: _____mg/dL

PART 9: Postnatal (up to 7 days post-delivery)

BX. Date of Delivery: _____/_____/_____

Did the mother have any of the following during present pregnancy? (Mark all that apply)

BY. Gestational diabetes mellitus: Yes - 1, No - 2, Don't know - 3

BZ. Hypertensive disorders in pregnancy: Yes - 1, No - 2, Don't know - 3

CA. Decreased Fetal movements: Yes - 1, No - 2, Don't know - 3

CB. Polyhydramnios: Yes - 1, No - 2, Don't know - 3

CC. Antepartum haemorrhage: Yes - 1, No - 2, Don't know - 3

CD. Abnormal lie: Yes - 1, No - 2, Don't know - 3

CE. Anaemia: Yes - 1, No - 2, Don't know - 3

CF. Preterm labour (< 37 weeks): Yes - 1, No - 2, Don't know - 3

CG. Premature rupture of membrane: Yes - 1, No - 2, Don't know - 3

CH. Others (specify): _____

CI. Type of delivery:

1. Vaginal (without forceps / vacuum) -1
2. Vaginal (with forceps / vacuum) -2
3. LSCS - 3

CJ. Gender of the baby: Male -1 / Female -2

CK. Birthweight: _____ grams

CL. Required ventilatory support (bag and mask/ oxygen / PPV / Etc.) – Yes – 1, No – 2

CM. Required NICU Admission: Yes – 1, No – 2

CN. If Yes, Reason for admission: _____

CO. Congenital anomalies in Neonate: Yes – 1, No – 2

Did the mother have any of the following during delivery?

CP. Abnormal Fetal heart rate (FHR): Yes – 1, No – 2

CQ. Fever (>100.4F / 38C): Yes – 1, No – 2

CR. Shoulder dystocia: Yes – 1, No – 2

CS. Retained placenta: Yes – 1, No – 2

CT. post-partum haemorrhage: Yes – 1, No – 2

CU. Sepsis: Yes – 1, No – 2

CV. Others (specify): _____