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Maternal Factors and their impact on Gestational Diabetes Mellitus in the Maldives

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Abstract

Background: Gestational diabetes mellitus (GDM) is a significant public health concern globally, with a growing burden in South Asian countries, including the Maldives. South Asian women are genetically predisposed to insulin resistance and often experience GDM even at lower levels of adiposity. This study investigates maternal factors influencing the development of GDM among Maldivian women, aiming to inform risk stratification and preventive strategies.

Methods and Materials: A cross-sectional study was conducted among 137 postpartum Maldivian women within two years of delivery. Participants self-reported demographic, obstetric, and lifestyle information via an online survey. Key variables included maternal age, pre-pregnancy body mass index (BMI), gestational weight gain (GWG), parity, maternal birth weight, family history of diabetes, prior GDM history, nutrition, physical activity, and smoking. Statistical analysis, including logistic regression, was used to identify significant predictors of GDM.

Results: The prevalence of GDM in the sample was 34.3%. Statistically significant risk factors included maternal age ≥30 years ($p = 0.0026$), high pre-pregnancy BMI ($p < 0.001$), low maternal birth weight ($p = 0.0014$), family history of diabetes ($p = 0.0334$), and prior diagnosis of GDM ($p < 0.001$). Unhealthy eating patterns and lack of physical activity were also more common in the GDM group. Multivariate analysis confirmed previous GDM, family history, and low birth weight as the strongest predictors of GDM.

Conclusion: This study highlights the considerable influence of both modifiable (diet, BMI, physical activity) and non-modifiable (maternal age, birth weight, genetics) maternal factors on the development of GDM in the Maldivian population. These findings underscore the need for targeted public health interventions, preconception counselling, and culturally adapted prenatal education to reduce GDM incidence and its intergenerational consequences.

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Keywords: *Gestational Diabetes Mellitus (GDM)*, *Maternal Risk Factors*, *Pre-pregnancy BMI*, *South Asian Population, Maldives Maternal Health*

Introduction

Gestational Diabetes Mellitus (GDM) is a metabolic disorder characterized by any degree of glucose intolerance first recognized during pregnancy [1]. As one of the most common metabolic disorders complicating pregnancy in today's world, it certainly poses a significant public health concern. Affecting approximately 14% of pregnancies worldwide, with notably higher prevalence in South Asia due to rising rates parallel with increasing obesity, sedentary lifestyles and delayed childbearing [2]. GDM poses immediate risks to maternal and neonatal health, particularly in the absence of timely diagnosis and intervention, including macrosomia, neonatal hypoglycemia, preeclampsia and cesarean delivery, while also elevating long-term risks of developing type 2 diabetes (T2DM) and cardiovascular disease for both mother and child [3]. Hence, although glucose levels often return to normal postpartum, GDM is increasingly recognized as an early indicator of long-term metabolic dysfunction, particularly in the context of T2DM. As such, GDM serves as a "window" into the future health trajectories of two generations: both mother and child.

These complications, both short- and long-term, render GDM a significant public health issue. Importantly, South Asian ethnicity is acknowledged as a risk factor for GDM, being genetically predisposed to insulin resistance and having a higher likelihood of developing GDM at even lower levels of adiposity compared to Western populations [4], leading to countries in the South Asian region frequently experiencing disproportionately high GDM rates. Women in the Maldives, being South Asian, are similarly vulnerable and at a higher risk, with National health reports reflecting this risk: the Maldivian Maternal and Child Health Guidelines explicitly state that "being South Asian and pregnant puts Maldivian women at an increased risk for hyperglycemia during pregnancy," advocating for universal GDM screening in every pregnancy. [5]

Additionally, the Maldives is seeing an increase in obesity and diabetes among women: official statistics show that more than 12% of adult women in the Maldives suffer from diabetes. In contrast, almost two-thirds of women of childbearing age are either overweight or obese. According to the UNICEF Maldives health report, "increasing obesity rates are causing diabetes in expectant mothers, endangering both mothers and their babies." [6] In this context, comprehending the

Maternal factors that influence GDM are particularly critical for the Maldives maternal–child health policy.

Although known risk factors like maternal age and pre-pregnancy BMI are extensively recognized in literature, recent findings indicate that a wider variety of factors—both biological and behavioural—could greatly affect the likelihood of developing GDM. These factors include gestational weight gain (GWG), which can exacerbate insulin resistance in pregnancy [7]; maternal birth weight, since both low and high weights at birth are linked to negative glucose metabolism in adulthood [8]; and parity, with multiparous women possibly experiencing increased risk due to the cumulative metabolic strain from successive pregnancies [9].

A family history of diabetes, especially maternal GDM history, stands out as a significant non-modifiable risk factor, indicating both genetic predisposition and common environmental factors [10]. On the other hand, adjustable lifestyle factors such as dietary habits, exercise, and smoking are linked to metabolic control and may provide potential options for prevention [11,12]. Moreover, having a history of prior GDM significantly indicates the likelihood of recurrence in later pregnancies [13]. These maternal factors hold particular significance in South Asian populations, where insulin resistance often arises at reduced levels of adiposity, and culturally influenced behaviours may impact health-seeking and dietary habits [14].

In this context, the current study examines how these maternal factors— mother's age, pre-pregnancy Body Mass Index, Gestational Weight Gain, maternal birth weight, number of previous births, nutrition, physical activity, smoking habits, family diabetes history, past GDM occurrences, and maternal GDM background and more—relate to the onset of GDM among women in the Maldives. Although awareness of GDM is increasing in South Asia, data specific to individual countries are still scarce. In the Maldives, where antenatal care access can differ and culturally suitable dietary/lifestyle advice is limited, recognizing high-risk women via maternal risk factors is crucial for timely intervention and mitigating the intergenerational spread of metabolic disorders.

This study seeks to create context-specific evidence by surveying postpartum Maldivian women within two years of delivery, which may aid in risk stratification, screening, and intervention strategies in the Maldives, enhancing the

Understanding of GDM in South Asian communities is essential to create tailored management strategies to combat this condition, which is prevalent in many parts of the world.

Aims, Materials and Methods

The main objective of this research was to explore the relationship between certain maternal factors and the occurrence of gestational diabetes mellitus (GDM) in Maldivian women. The study aimed to identify whether factors including maternal age, pre-pregnancy body mass index (BMI), gestational weight gain (GWG), maternal birth weight, parity, eating patterns, physical activity levels, smoking habits, a prior diagnosis of GDM, family diabetes history, and maternal GDM history were significantly linked to the incidence of GDM. This research also aimed to generate context-relevant insights to inform screening and prevention approaches for GDM in the Maldives.

This research employed a quantitative, analytical cross-sectional design to evaluate associations between maternal factors and the presence or absence of GDM during the most recent pregnancy. The cross-sectional nature of the study was appropriate for identifying potential risk factors and drawing associations based on retrospective data collected from postpartum women. Additionally, statistical analyses, including comparative analysis, descriptive statistics, and logistic regression models, were employed to assess any significant associations between maternal factors and GDM incidence.

The research was conducted with Maldivian women who had given birth within the past two years. Participants were gathered from across the country through an online method, ensuring wider geographical representation throughout the Maldives. Incorporating women up to two years after giving birth facilitated accurate recall of essential antenatal and perinatal details, while minimizing memory bias.

Eligibility criteria were defined as follows: Participants included Maldivian women aged 18 years or older who had delivered within the preceding 24 months and provided informed consent. Women with a pre-existing diagnosis of diabetes mellitus before pregnancy were excluded to ensure the study focused exclusively on gestational diabetes mellitus (GDM) cases first identified during pregnancy.

A total of 137 female participants took part in the study. The sample was split into two categories according to self-reported GDM status from their latest pregnancy: 47 women were identified

with GDM, while 90 women were not diagnosed with GDM. A convenience sampling technique was employed for participant recruitment through social media and various online platforms. Representing a pragmatic strategy in smaller population nations such as the Maldives.

Data were collected through a self-completed online survey specifically designed for the research. The survey consisted of both multiple-choice and open-ended questions addressing various related areas. The survey collected demographic details (age, number of children, education), obstetric background, and significant risk factors.

Maternal age was documented in years. The pre-pregnancy BMI was calculated using self-reported weight and height before pregnancy. Gestational weight gain was noted and assessed against the Institute of Medicine guidelines to categorize it as inadequate, adequate, or excessive. Participants provided their birth weight (maternal birth weight) in kilograms when known. Family history was characterized as having any first-degree relative diagnosed with type 2 diabetes.

Parity was documented as the count of prior live births. Diet was evaluated through inquiries about eating habits (e.g., frequency of fruits/vegetables, whole grains, red meat, and sweets) to measure overall diet quality. Exercise was defined as the self-reported frequency of moderate-to-vigorous physical activity (yes/no, with a minimum of 150 minutes per week). The smoking status was recorded (yes/no). Ultimately, participants indicated whether they had previously been diagnosed with GDM in a prior pregnancy.

Literature Review

3.1 Normal Metabolic Changes in Pregnancy

Pregnancy entails substantial physiological changes, including major alterations in maternal metabolism that are vital for facilitating fetal growth and development. A significant change occurs in glucose metabolism, which follows a biphasic pattern throughout pregnancy. During the initial stages of pregnancy (the anabolic phase), insulin sensitivity increases, leading to enhanced glucose absorption by maternal tissues and increased fat accumulation, primarily due to the hormones estrogen and progesterone. This stage equips the mother for the energy requirements of late pregnancy by accumulating nutritional reserves. [15]

As pregnancy progresses into the second and third trimesters, the metabolic state shifts to a catabolic phase, characterized by increasing insulin resistance. This physiological insulin

resistance is mainly influenced by placental hormones, including human placental lactogen (hPL), progesterone, estrogen, cortisol, and placental growth hormone. These hormones counteract the effects of insulin and have a diabetogenic effect, ensuring a steady supply of glucose to the fetus even when the mother is fasting. [16]

Insulin resistance in late pregnancy increases hepatic gluconeogenesis and decreases peripheral glucose uptake, resulting in elevated maternal blood glucose levels postprandially. In response, pancreatic β-cells are expected to augment insulin secretion to maintain euglycemia. In most pregnancies, this compensatory mechanism is sufficient. However, in some women—particularly those with predisposing genetic, environmental, or metabolic risks—this compensation fails, leading to the onset of gestational diabetes mellitus. [17]

Furthermore, adipokines such as adiponectin and leptin, released by maternal fat tissue, also influence insulin sensitivity during pregnancy. Low levels of adiponectin, frequently seen in obese people, are associated with decreased insulin sensitivity and can indicate GDM [18]. The interaction among maternal fat storage, placental hormones, and pancreatic activity is crucial in influencing glucose metabolism throughout pregnancy.

Comprehending these typical metabolic adjustments is essential for identifying how irregularities—especially deficiencies in insulin compensation—can lead to gestational diabetes. It is this fragile physiological balance that GDM interrupts, and numerous maternal risk factors examined in this study affect this insulin-glucose equilibrium.

3.2 Pathophysiology of Gestational Diabetes Mellitus

Gestational Diabetes Mellitus (GDM) results from a complex interplay of hormonal, metabolic, and inflammatory mechanisms throughout pregnancy. Two significant metabolic disorders, chronic insulin resistance and β-cell impairment, are presently associated with the development of GDM, although the exact cellular processes involved are still not fully grasped. This is then marked by a gradual reduction in insulin sensitivity paired with an insufficient compensatory insulin release response from pancreatic β-cells. This interplay leads to maternal hyperglycemia, especially during the second and third trimesters. Maternal genetic predisposition, combined with environmental and fetoplacental influences, sets off a sequence of events that impacts both the mother and fetus, in both the short and long term. [19]

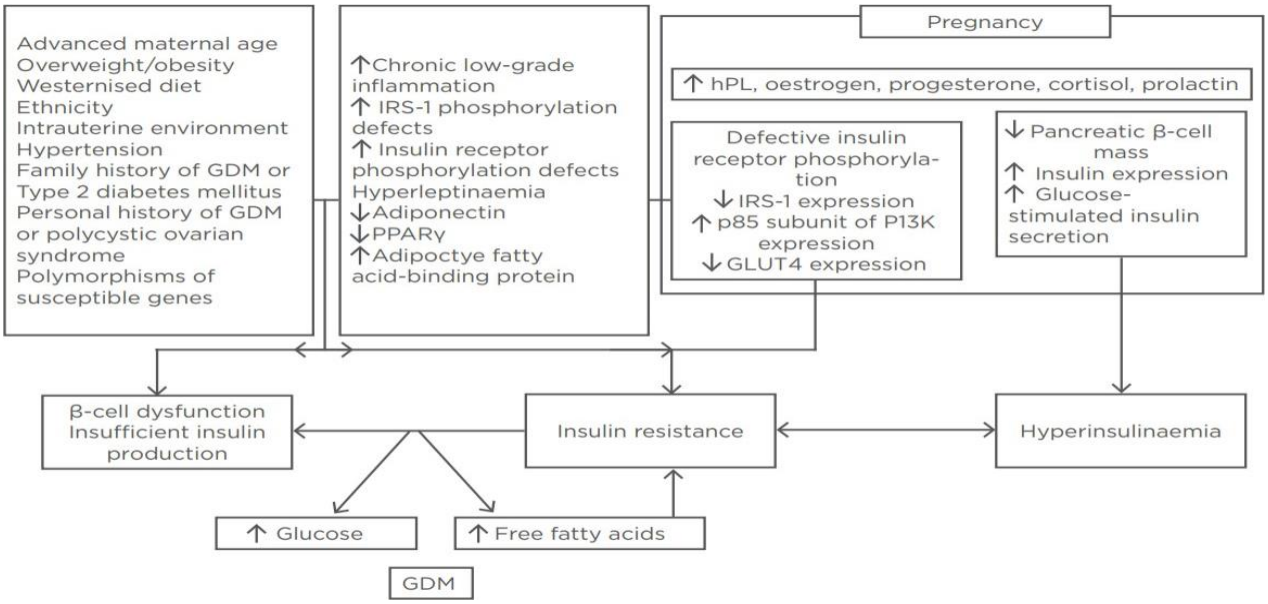

Figure 1: Mechanisms underlying insulin resistance in normal pregnancy and gestational diabetes mellitus [19]

Hormones specific to pregnancy, generated by the placenta, are essential in establishing the insulin-resistant condition. Human placental lactogen (hPL), placental growth hormone, progesterone, estrogen, cortisol, and tumour necrosis factor-alpha (TNF-α) are recognized as antagonists to insulin action.

These hormones reduce the sensitivity of insulin receptors, inhibit post-receptor signalling, and impair glucose transport in maternal peripheral tissues, such as skeletal muscle and adipose tissue [20,21]. Although this insulin resistance ensures adequate glucose transfer to the fetus, it also increases the demands on the maternal pancreatic β-cells to increase insulin production.

In normal pregnancies, the β-cell mass increases, and insulin production rises significantly to maintain glucose balance. Nonetheless, in women with GDM, this compensatory mechanism is compromised due to β-cell dysfunction—either existing beforehand or induced by pregnancy-related stress. This β-cell failure is associated with genetic predisposition, lipotoxicity, oxidative stress, and glucotoxicity [22].

Persistent low-level inflammation is increasingly recognized as a contributing factor to insulin resistance during pregnancy. Inflammatory indicators, such as interleukin-6 (IL-6), TNF-α, and

C-reactive protein (CRP), are elevated in females diagnosed with GDM [23]. These cytokines disrupt insulin signalling pathways, further hindering glucose absorption in insulin-sensitive tissues.

Additionally, adipokines—hormones released by fat tissue—play crucial roles in managing metabolic balance. Adiponectin enhances insulin sensitivity, and its concentrations are typically lower in GDM, particularly in overweight and obese females [18]. In comparison, leptin levels are higher in GDM and correlate with greater insulin resistance. The imbalance of adipokines in pregnant women with elevated adiposity plays a major role in the onset of GDM.

Pregnancy is also associated with hyperlipidemia, especially in the third trimester. Elevated levels of circulating free fatty acids (FFAs) lead to insulin resistance by impairing insulin's ability to promote glucose uptake and stimulate glucose production in the liver. Moreover, FFAs induce lipotoxicity in pancreatic

β-cells, reducing their capacity to release insulin [24]. The altered lipid metabolism

Seen in pregnancy is more evident in women with obesity or metabolic syndrome, increasing the likelihood of GDM.

3.3 Maternal Factors and their link to GDM

The age of mothers has been rising globally because of several reasons, including the increasing age at which people marry and advancements in assisted reproductive technology (ART). Maternal age over 35 years is linked to a higher likelihood of various negative perinatal outcomes, such as miscarriage, placental abruption, pregnancy-related hypertension, and preterm delivery. [25]

Increased maternal age was linked to a higher risk of developing both early and late GDM. Nonetheless, various factors may have contributed to the relationship between maternal age and GDM. The primary cause is the dysfunction of beta cells resulting from aging. The aging process reduces the proliferation and regeneration of beta cells. Another explanation might be adiponectin, an adipocytokine associated with glucose metabolism that is secreted by adipose tissue, which may clarify the link between maternal age and the onset of GDM. Levels of adiponectin are recognized to decline in pregnant women with gestational diabetes mellitus (GDM) and also decrease as one ages. [26,27]

Parity is also a significant obstetric factor that affects pregnancy outcomes. GDM is acknowledged as one of the most prevalent complications during pregnancy and has been associated with numerous previous studies. It is suggested that increased parity may be associated with a lower risk of GDM, possibly due to physiological adjustments such as changes in insulin resistance and hormone levels. Certain studies indicate that women who have never given birth (first pregnancy) face a lower risk compared to those who have had multiple pregnancies, likely due to the association of multiparity with age and weight increase across pregnancies.

Consequently, parity is not a significant factor in GDM relative to others. [28]

An additional factor is the body mass index (BMI) before pregnancy, which is among the most extensively researched maternal factors linked to the onset of gestational diabetes mellitus (GDM). A robust collection of evidence backs the claim that a higher BMI before conception greatly raises the likelihood of GDM. Overweight women (BMI 25.0–29.9 kg/m²) or those who are obese (BMI ≥30 kg/m²) show

Insulin resistance, which is worsened by the hormonal environment during pregnancy, thus raising the risk of hyperglycemia and gestational diabetes mellitus [29]. In the Maldivian scenario, increasing obesity rates in women of reproductive age heighten the importance of pre-pregnancy BMI as an adjustable risk factor.

Gestational weight gain (GWG), which refers to the weight a woman gains throughout her pregnancy, has been acknowledged as a significant factor influencing the risk of GDM. Both excessive and insufficient GWG can negatively impact maternal metabolic results, but excessive GWG has been more regularly associated with a rise in GDM occurrence [30].

Excessive GWG leads to insulin resistance by enhancing adiposity, releasing pro-inflammatory cytokines, and increasing lipotoxicity, all of which disrupt insulin signalling and the function of pancreatic beta cells [16]. These metabolic changes can foster a diabetogenic environment during pregnancy, especially when GWG happens quickly in the first and early second trimesters—key periods for glucose regulation.

Maternal birth weight (MBW), an early indicator of intrauterine growth and nutritional health, has garnered increasing interest as a potential predictor of future pregnancy outcomes, such as

gestational diabetes mellitus (GDM). Research indicates that both low and high MBW are linked to a heightened risk of GDM, creating a
U- or J-shaped connection that suggests intrauterine programming plays a role in metabolic disease vulnerability throughout life [31].

From a developmental origins of health and disease (DOHaD) viewpoint, inadequate fetal growth — whether resulting from intrauterine growth restriction (IUGR) or excessive fetal nutrition — can lead to lasting changes in pancreatic β-cell mass, insulin sensitivity, and adipocyte functionality [32]. Low MBW is specifically believed to hinder β-cell development, making individuals more susceptible to insulin resistance and metabolic dysregulation later in life, particularly during periods of metabolic stress, such as pregnancy [33]. On the other hand, a high MBW, frequently caused by maternal hyperglycemia or excessive nutrition during pregnancy, may indicate early metabolic imprinting that heightens the risk of developing insulin resistance in later life [34].

Nutrition and diet play fundamental roles in the development of GDM. The intake of sugar-sweetened drinks, potatoes, and diets high in fats and carbohydrates is linked to a higher risk of GDM.

Dietary changes have been broadly acknowledged as beneficial for individuals with GDM. Enhancements in women's nutrition and health before and during pregnancy can aid fetal development. Imbalances in maternal micronutrients can lead to fetal stunting and chronic diseases by directly influencing hormonal adaptation and the regulation of genes through epigenetics. Therefore, mothers should not only focus on the intake of macronutrients such as carbohydrates and fats but also ensure adequate consumption of vitamins and minerals [35].

Exercise is essential in preventing and managing gestational diabetes mellitus (GDM). Physical activity enhances insulin sensitivity, reduces body fat, and improves glucose metabolism, serving as a vital lifestyle component in reducing the risk of GDM. In non-pregnant individuals, it is well established that physical activity reduces insulin resistance by stimulating glucose transporters on the surface of skeletal muscle cells, thereby improving glucose uptake. [36]

A dose–response connection exists between increased PA levels during the first and second trimesters and a lowered risk of GDM; this link is more pronounced in the first trimester.

Enhancing physical activity during pregnancy may help avert the onset of gestational diabetes mellitus.[37]

Smoking is another factor that is researched and known to increase the risks for many conditions, including GDM. Considering the well-documented dangers of smoking for both maternal and fetal health, it is highly advised to quit smoking during pregnancy. Research indicates that quitting at any stage during pregnancy lowers the likelihood of complications, such as GDM. Healthcare professionals ought to advise expectant mothers on the significance of quitting smoking and provide support initiatives to assist them in stopping. For women in the Maldives, where smoking prevalence is significant among those of reproductive age, these interventions are vital for diminishing the impact of GDM.

A family background of diabetes mellitus (DM) considerably increases the likelihood of gestational diabetes mellitus (GDM), influenced by genetic predisposition and common environmental factors. Genetic variations linked to insulin resistance (e.g., TCF7L2) and β-cell dysfunction, which are prevalent in type 2 diabetes, hinder the metabolic adjustment to insulin resistance caused by pregnancy. Even non-obese women who have diabetic family members show signs of metabolic dysregulation, although obesity significantly worsens the risk by increasing insulin resistance. Shared family habits, such as unhealthy eating or inactivity, can exacerbate genetic tendencies. [38].

Therefore, a family history of diabetes is a crucial indicator of gestational diabetes, requiring customized prenatal care and ongoing metabolic oversight to reduce negative maternal and fetal effects.

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Therefore, a family history of diabetes is a crucial indicator of gestational diabetes, requiring customized prenatal care and ongoing metabolic oversight to reduce negative maternal and fetal effects.

Results

This study comprised a final sample of 137 Maldivian postpartum women, who were surveyed within two years of giving birth. Participants were recruited through an online survey, and only women without a prior history of diabetes mellitus were included, ensuring that gestational diabetes mellitus (GDM) was initially recognized during pregnancy according to standard diagnostic criteria. The study employed a cross-sectional and descriptive design, intending to assess the relationship between different maternal factors and the onset of GDM.

The evaluated variables comprised maternal age, pre-pregnancy BMI, gestational weight gain (GWG), parity, history of previous GDM, maternal birth weight, family history of diabetes, maternal GDM history, smoking status, physical activity levels, and dietary practices during pregnancy.

Participants were divided into two categories: individuals who indicated they were diagnosed with GDM in their latest pregnancy (n = 47; 34.3%) and individuals who did not obtain a GDM diagnosis (n = 90; 65.7%).

This prevalence further confirms the importance of the study's goal: to determine and examine maternal predictors of GDM in a population increasingly affected by metabolic disorders, such as the Maldives. Given that over one in three participants is affected by GDM, the results could have significant implications for both public health strategies and clinical risk evaluations in comparable South Asian populations.

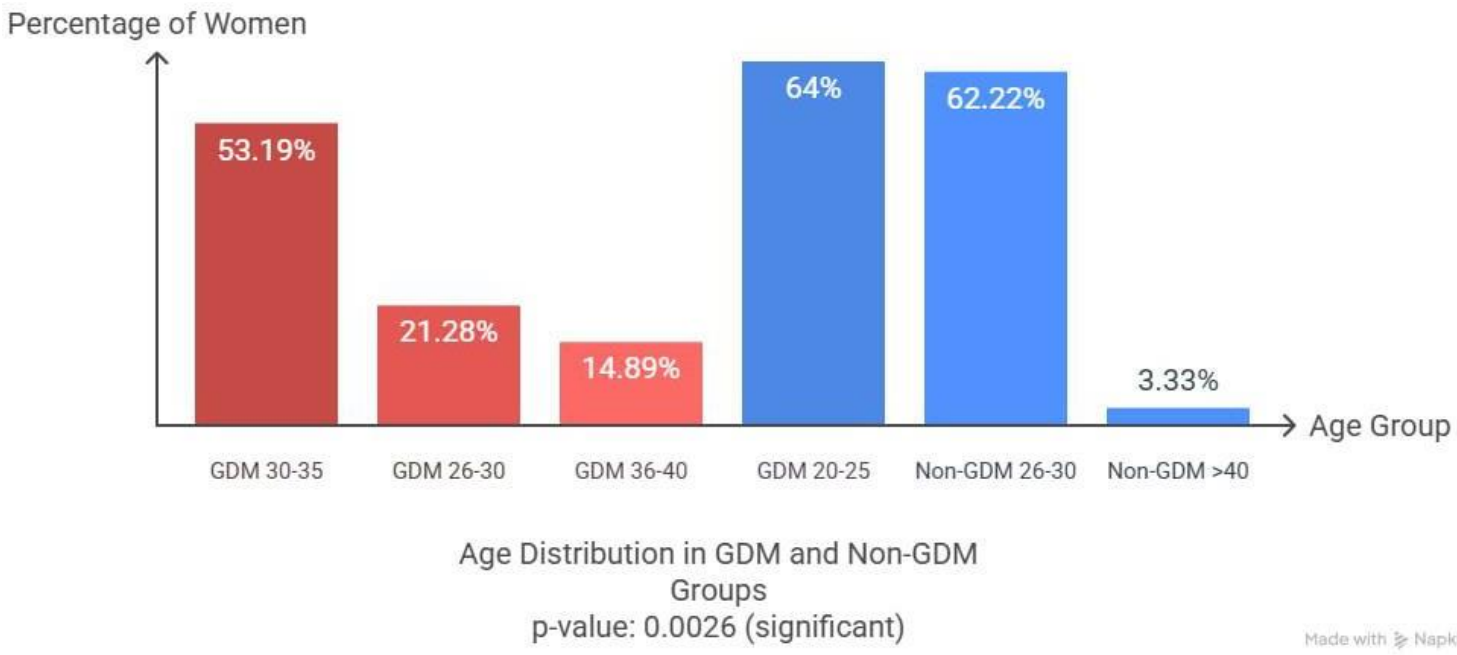
4.1 Maternal Age

The examination showed a notable correlation between maternal age and the diagnosis of GDM. The average age of participants diagnosed with GDM was greater than that of those without GDM. In particular, women with GDM were more often aged 30 years or older. In the GDM group, 53.2% were 30 years or older, whereas only 31.1% in the non-GDM group fell into this age category. This difference was statistically meaningful ($p = 0.0026$). (Figure 2)

These findings support the current literature, which recognizes older maternal age as a well-established risk factor for GDM. The decrease in insulin sensitivity with age and the increase in β-cell dysfunction contribute to this phenomenon. Advanced

Maternal age is frequently associated with higher adiposity and metabolic comorbidities, which also increase the risk of GDM [30].

Figure 2 Age Distribution in GDM and Non-GDM Groups



4.2 Pre-pregnancy Body Mass Index (BMI)

Pre-pregnancy BMI was also significantly associated with GDM in this cohort. Women diagnosed with GDM had a higher proportion of pre-pregnancy overweight and obesity. Specifically, 85.1% of GDM women were classified as overweight or obese before pregnancy, compared to 41.1% in the non-GDM group. The mean pre-pregnancy BMI of the GDM group was also notably higher at 28.41, compared to a mean of 24.7 in the non-GDM group. This difference is stark, and the association was statistically significant ($p < 0.001$).

This finding is consistent with a broad body of international and South Asian studies that demonstrate a clear link between increased adiposity and the risk of GDM.

Excess pre-pregnancy weight is known to heighten insulin resistance, thereby impairing glucose regulation during pregnancy. In South Asian women, this effect is compounded by a genetic predisposition to insulin resistance at lower BMI thresholds compared to Caucasian women [4].

Given that more than three-fourths of the GDM group were overweight or obese before conception, the need for preconception weight management programs is evident in the Maldivian context. These findings support the WHO and FIGO recommendations, which advocate for pre-pregnancy health optimization as a preventive strategy for GDM.

4.3 Gestational Weight Gain (GWG)

In this study, the average gestational weight gain (GWG) was 10.84 kg for non-GDM women, whereas it was 8.79 kg for women with GDM, indicating a mean difference of 2.05 kg. Nevertheless, this discrepancy was not statistically significant (p = 0.078), suggesting that GWG may not be an important contributing factor to GDM in the examined sample. (Figure 3)

Figure 3 Mean GWG comparison between GDM and non-GDM groups

The finding of reduced GWG in women with GDM is consistent with multiple studies. For example, Hedderson et al. (2010) discovered that high GWG

Before GDM diagnosis correlated with an increased likelihood of developing GDM, yet after diagnosis, women with GDM commonly experienced limited weight gain because of dietary changes and glucose control. Likewise, Bodnar et al. (2010) found that women with GDM experienced less total GWG than those without GDM, probably because of medical measures like dietary advice and insulin treatment. [30,40]

4.4 Parity

The findings revealed a favourable relationship between parity and GDM. Among women with GDM, 55.3% were multiparous, whereas just 36.6% of women in the non-GDM group were multiparous. However, this variation was not as statistically significant, suggesting that GWG

may not be the sole indicator of GDM, and other factors may have a greater impact on its occurrence in this cohort. ($p = 0.078$).

In literature, higher parity is increasingly recognized as a potential risk factor for GDM, likely due to cumulative metabolic stress and insulin resistance that develop across successive pregnancies [13]. Multiple pregnancies can lead to enduring alterations in pancreatic β-cell function and glucose metabolism, especially in women who have pre-existing tendencies like insulin resistance or central obesity [21].

These results highlight the importance of targeted screening and observation for multiparous women within the Maldivian antenatal care framework.

4.5 Prior Diagnosis of Gestational Diabetes Mellitus (GDM)

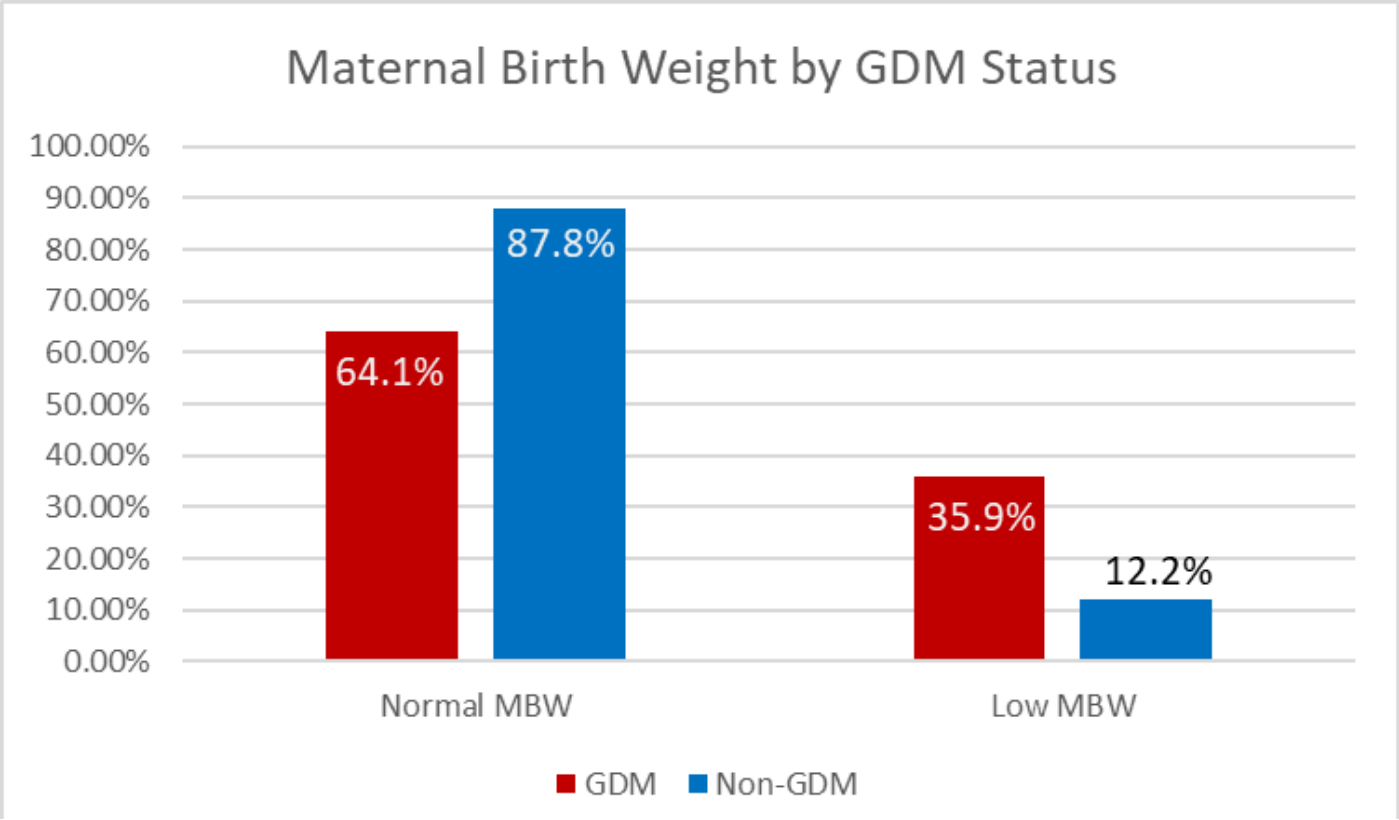
A statistically significant connection was found between a past occurrence of GDM and a present diagnosis among multiparous women. 95.5% of participants with a prior GDM diagnosis had a recurrence of GDM in their most recent pregnancy, while just 13.6% of women with no prior GDM diagnosis had GDM in their most recent pregnancy. ($p < 0.001$).

This aligns with strong global and regional results. Women who have had GDM in the past have up to a 50% chance of it recurring in later pregnancies [22].

This heightened risk is linked to ongoing β-cell impairment and enduring insulin resistance, which are not entirely resolved after childbirth, despite glucose levels returning to normal. In South Asia, the rates of recurrence may also be influenced by the ongoing presence of underlying risk factors, including obesity, inadequate postpartum follow-up, and poor metabolic control between pregnancies [41].

4.6 Maternal Birth Weight (MBW)

A low maternal birth weight (MBW) was significantly linked to an increased risk of GDM in adulthood. In the GDM group, 35.9% of individuals reported being born with a low birth weight (<2.5 kg), whereas this was true for only 12.2% in the non-GDM group. The correlation was statistically significant ($p = 0.0014$). (Figure 4)



This finding is consistent with the developmental origins of health and disease (DOHaD) hypothesis, which suggests that restricted growth in utero or inadequate fetal nutrition may lead to lasting changes in glucose-insulin metabolism, thereby elevating the lifelong risk of type 2 diabetes and gestational diabetes mellitus. A low birth weight often indicates inadequate fetal programming, which can potentially lead to decreased β-cell mass and changes in insulin sensitivity during adulthood [42].

In the context of the Maldives, the link between low MBW and GDM in later life highlights the necessity of enhancing maternal and fetal health for future generations.

4.7 Family Background of Diabetes Mellitus & Maternal History of GDM

A statistically meaningful link was identified between having a family history of diabetes and the incidence of GDM. In the GDM group, 70.2% of women indicated having at least one first-

degree relative with diabetes, whereas only 47.7% of those in the non-GDM group reported the same (p= 0.0334).

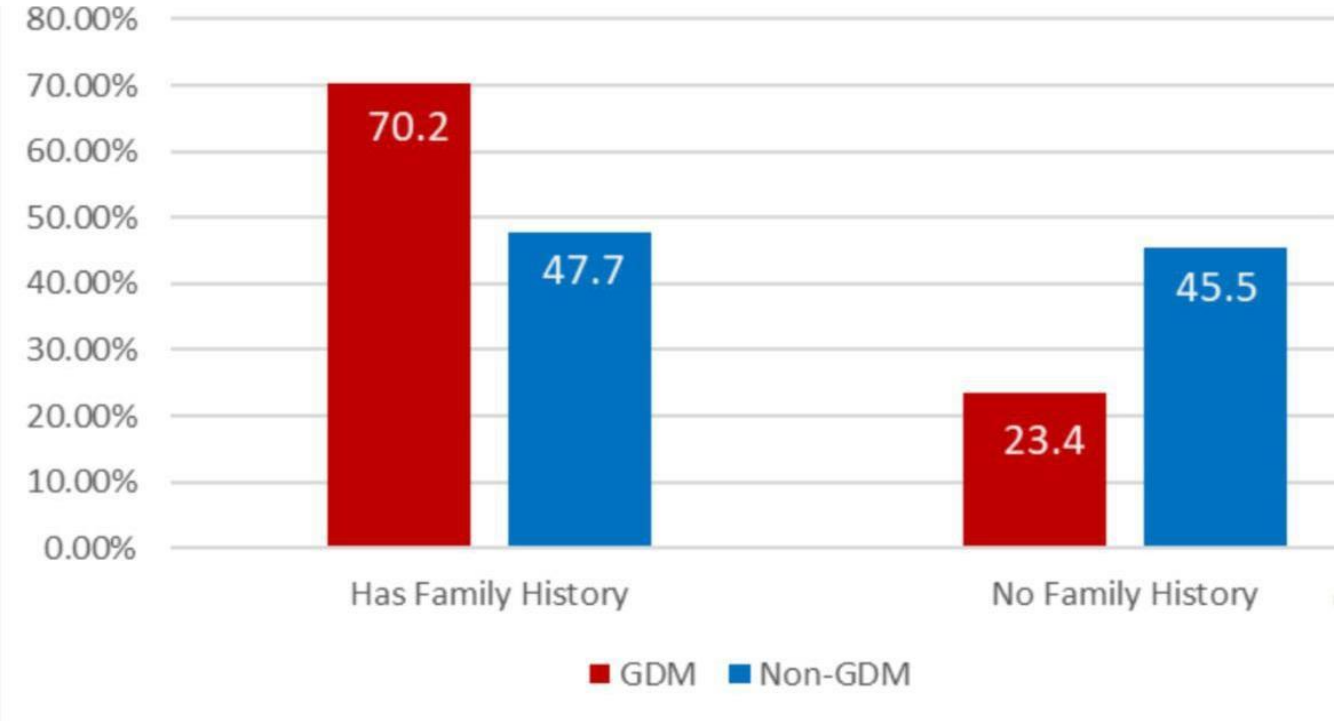


Figure 5 Family History amongst GDM and non-GDM groups

This is consistent with existing evidence indicating that a family background of type 2 diabetes mellitus (T2DM) serves as a significant, non-modifiable risk factor for GDM. Genetic factors, combined with common environmental and lifestyle influences, may increase the risk of glucose intolerance during pregnancy.

Research within South Asian communities has highlighted that the familial aggregation of T2DM and GDM is especially significant, likely stemming from a mix of insulin resistance, β-cell impairment, and genetic metabolic characteristics [14].

Due to the elevated diabetes prevalence in the Maldivian population—where more than 12% of adult women have T2DM—family history is a crucial resource for risk assessment in antenatal care. In practice, healthcare providers should be prompted to gather comprehensive family histories at the beginning of pregnancy, allowing for timely screening and preventive guidance for women at high risk.

In addition to general family history, the data also show that women whose mothers had GDM were significantly more likely to develop the condition themselves. Specifically, 21.3% of GDM participants had mothers who had GDM, compared to just 4.4% in the non-GDM group ($p = 0.002$).

A cohort study conducted by Dabelea and associates (2000) revealed that individuals who were exposed to maternal GDM during pregnancy exhibited notably higher fasting glucose levels and an increased risk of developing prediabetes and metabolic syndrome in adolescence and adulthood, in comparison to those born to non-diabetic mothers. These results indicate that exposure to hyperglycemia in utero not only leads to immediate perinatal issues but also causes long-term metabolic problems in children, establishing a harmful cycle across generations [43]. This intergenerational link has been increasingly studied, with research showing that maternal hyperglycemia during pregnancy may epigenetically program offspring toward insulin resistance, obesity, and glucose dysregulation later in life. Furthermore, exposure to a hyperglycemic intrauterine environment may lead to increased adiposity and impaired glucose tolerance, even in childhood, and persist into adult life. These findings underscore how maternal GDM status may function as both a genetic and an intrauterine environmental risk, thereby compounding future risk across generations [43].

For Maldivian health systems, this highlights the importance of tracking intergenerational risk and encouraging early testing for GDM among daughters of women who experienced hyperglycemia in pregnancy.

This section shows that a family history of diabetes—especially maternal GDM—is closely linked to a higher risk of developing GDM in Maldivian women. These results suggest that both genetic and environmental factors are involved and support the use of family history as an effective and affordable screening method to inform antenatal risk management.

4.8 Lifestyle: Nutrition, Physical Activity, and Smoking

Participants were requested to self-report their eating habits during pregnancy, focusing specifically on how often they consumed high-sugar, high-fat foods, as well as fruits, vegetables, and whole grains. The data indicated a statistically significant difference in dietary quality between the GDM and non-GDM groups. Women with GDM were more likely to report regular

consumption of sugary snacks and processed items (63.8% vs. 37.8%, p = 0.001), as well as reduced intake of fruits and vegetables (44.7% vs. 71.1%, p = 0.005).

Low dietary quality is generally recognized as an adjustable risk factor for GDM. Research has shown that diets rich in refined carbohydrates, saturated fats, and low in fibre are linked to heightened insulin resistance and a greater risk of developing GDM. Conversely, following healthy eating patterns—such as the Mediterranean diet or diets high in whole grains, legumes, and unsaturated fats—has been associated with a lower risk of GDM [12]. The connection observed in this Maldivian group mirrors these broader global trends and highlights the immediate need for culturally sensitive nutritional guidance in early antenatal care.

It was also discovered that physical activity had a notable correlation with GDM status. Among women without GDM, 67.8% indicated they participated in regular moderate exercise while pregnant (e.g., walking 30 minutes daily), whereas just 29.8% of women in the GDM group did the same ($p < 0.001$).

The safeguarding effect of physical activity against GDM is clearly recognized. Consistent exercise enhances insulin sensitivity and glucose absorption, thus lowering the likelihood of hyperglycemia (Tobias et al., 2011). Both physical activity before and during early pregnancy is linked to a reduced incidence of GDM, especially in women who have additional risk factors like a High BMI [11]. In the context of the Maldives, sociocultural influences, restricted availability of safe exercise spaces, and myths associated with pregnancy may hinder physical activity, necessitating more qualitative investigation and focused intervention.

A minimal percentage of women in the entire sample indicated smoking while pregnant (n = 5), and there was no significant statistical difference between the GDM and non-GDM groups (p = 0.642). Due to the low rate of smoking in Maldivian women, this factor likely did not significantly contribute to the onset of GDM in this group.

Nonetheless, on a global scale, smoking has been linked to heightened insulin resistance and negative metabolic effects, even though its relationship with GDM is still somewhat variable. Certain research indicates a higher risk of GDM among smokers, whereas other studies reveal no notable correlation, potentially due to confounding variables or low smoking rates in specific groups [44].

4.9 Multivariate findings

The logistic regression analysis revealed distinct maternal factors that were significantly associated with the risk of gestational diabetes (GDM) in the Maldivian cohort. The strongest predictor was a prior diagnosis of GDM, which increased the odds of developing GDM in the current pregnancy by 232-fold (OR = 232.028).

This underscores the persistent metabolic dysfunction and β-cell impairment in women with recurrent GDM, aligning with global studies that highlight recurrence risks due to unresolved insulin resistance. Similarly, a family history of diabetes significantly elevated GDM risk (OR = 4.759), reflecting genetic susceptibility and shared environmental or behavioural factors that exacerbate insulin resistance during pregnancy. Women whose mothers had GDM were observed to have a greater risk of developing GDM themselves (OR=8.597)

Maternal birth weight (MBW) emerged as a critical intergenerational risk factor. Women born with low birth weight (<2.5 kg) had 4.04 times higher odds of GD (95% CI = 1.56–10.48, p = 0.0014). This finding highlights the importance of addressing fetal undernutrition and its long-term metabolic consequences. Pre-pregnancy BMI showed a non-significant trend toward increased GD risk (OR = 1.366), likely due to the small sample size, though its clinical relevance remains notable in the context of high obesity rates in Maldivian women.

Lifestyle factors yielded nuanced insights. Regular exercise appeared protective (OR = 0.675), though its confidence interval overlapped 1, suggesting potential variability in its effect. Conversely, smoking exhibited an implausibly strong inverse association with GD (OR < 0.001), likely reflecting confounding variables (e.g., lower BMI among smokers) or data limitations. Gestational weight gain (GWG) and maternal age did not significantly predict GD risk in this cohort, contrasting with some literature but possibly indicating effective post-diagnosis dietary management in GD-positive women.

However, the study's cross-sectional design, reliance on self-reported data, and modest sample size limit the ability to make causal inferences. Future longitudinal studies with larger cohorts are essential to validate these associations and explore cultural or socioeconomic barriers to the prevention of GD.

Conclusion

Gestational diabetes mellitus (GDM) continues to be a significant public health issue in the Maldives, as this study shows a considerable prevalence (34.3%) among Maldivian women,

highlighting the need to tackle both modifiable and non-modifiable maternal risk factors. The results indicate that older maternal age (≥30 years), high pre-pregnancy BMI, previous GDM, a family history of diabetes (notably maternal GDM), and low maternal birth weight (MBW) are closely linked to the risk of GDM. These findings are consistent with international studies. Importantly, lifestyle elements—unhealthy eating patterns (excessive sugar/processed food consumption) and a lack of exercise—although not as statistically significant in this study due to limitations —highlight the importance of modifiable behaviours in the prevention of GDM.

The absence of statistical significance for gestational weight gain (GWG) and parity differs from certain studies but may indicate the success of dietary management after diagnosis in women with GDM. The distinct situation in the Maldives—elevated obesity levels, genetic tendencies for insulin resistance, and restricted availability of culturally relevant prenatal support—heightens the urgency for localized solutions. For example, the association between low MBW and GDM reinforces the developmental origins of health and disease (DOHaD) hypothesis, prompting policymakers to focus on maternal nutrition through generations.

The implications of this study are twofold. Clinically, it underscores the significance of preconception counselling, emphasizing weight management and assessment for high-risk women. Public health initiatives must encourage prenatal education on nutrition and physical activity, addressing obstacles such as limited safe exercise areas and cultural misunderstandings. Nonetheless, constraints—such as cross-sectional design, self-reported information, and a small sample size—warn against making broad generalizations. Future studies should employ longitudinal methodologies to investigate causal links and integrate qualitative perspectives on cultural and socioeconomic barriers to GDM management.

In summary, this research offers essential proof for the development of maternal health policies in the Maldives. Through the incorporation of risk factor assessments, lifestyle changes, and health initiatives across generations, the Maldives can mitigate the increasing prevalence of GDM and its long-term metabolic effects, thereby protecting both current and future populations.

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