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ORIGINAL ARTICLE

Risk Factors for Gestational Diabetes; A Case Control Study

Nahla Ashraf, Nora Nabil Hussien[1], Zeinab Mohamed Omar Saqr[1*], Yousef Abo-Elwan[2], Zaitoun[1]

[1] Department of Family Medicine, Faculty of Medicine, Zagazig University, Egypt.
[2] Department of Obstetrics and Gynecology, Faculty of Medicine, Zagazig University, Egypt.

***Corresponding author**:
Zeinab Mohamed Omar Saqr
Email:
zmomer@medicine.zu.edu.eg

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ABSTRACT

Background: Gestational Diabetes Mellitus (GDM) is a common pregnancy complication, typically diagnosed between 24 and 28 weeks of gestation. It affects 10–15% of pregnancies worldwide and poses serious health risks to both mother and fetus. GDM is influenced by several risk factors such as obesity, advanced maternal age, family history of diabetes, and lifestyle factors. In Egypt, the rising prevalence of GDM has become a major public health concern. This study aims to identify risk factors for GDM among pregnant women attending prenatal care.

Methods: This case-control study was conducted over one year at Kafr Saqr family health centers in El Sharqia Governorate, Egypt. A total of 176 pregnant women in their third trimester were enrolled, including 88 women diagnosed with GDM (cases) and 88 healthy pregnant women without GDM (controls). Cases were identified as women who met the study's inclusion and exclusion criteria and tested positive on the oral glucose tolerance test (OGTT), while controls were women of similar age and gravidity who tested negative on the OGTT. Data were collected through structured interviews using validated tools, including the Pittsburgh Sleep Quality Index (PSQI) to assess sleep, the International Physical Activity Questionnaire (IPAQ), and the FIGO dietary checklist. The statistical analysis was done using SPSS software (version 26.0).

Results: Clinical, obstetric, and lifestyle factors were associated with increased risk of developing GDM, including obesity (OR = 5.02), smoking (OR = 4.58), low physical activity (OR = 3.26), poor dietary patterns (OR = 2.89), and family history of diabetes (OR = 3.91). These findings emphasize the influence of modifiable lifestyle factors in the development of GDM and support the need for integrated prevention strategies targeting high-risk pregnant women.

Conclusions: The study concludes that GDM is closely linked to a range of clinical, obstetric, and lifestyle risk factors, especially obesity, smoking, physical inactivity, unhealthy eating patterns, and a family history of diabetes. These results emphasize the need for early screening and targeted lifestyle modifications to help prevent GDM and enhance both maternal and fetal health outcomes.

Keywords:

INTRODUCTION

The term "gestational diabetes mellitus" (GDM) refers to carbohydrate intolerance that causes variable-severity hyperglycemia that initially appears or is diagnosed during pregnancy. The prevalence of GDM ranges from 1% to 20%, and it has been on the rise recently. Also, the effect of hyperglycemia on pregnancy is well known and can influence about 16.9% of pregnancies **[1]**.

According to the International Diabetes Federation (IDF), 1 in 6 pregnant women were diagnosed with GDM **[2].** In Egypt. According to the IDF 2021 Report, the prevalence of GDM is 14.2% of pregnant women, ranking it among the top 21 nations with a high incidence of GDM **[3].** High body mass index, advanced maternal age, physical inactivity, multiparity, family history of type II DM, GDM in prior pregnancy, ethnicity, history of macrosomia, and polycystic ovarian syndrome (PCOS) are common risk factors for GDM **[1].** Mother and her children may experience health issues as a result of GDM **[1],** so **c**linical diagnosis, adequate management, antepartum fetal surveillance, food and medication therapy, and other measures are important to reduce the related perinatal morbidity and death. Screening for gestational diabetes mellitus (GDM) is recommended for all pregnant women between weeks 24 and 28 and at the initial prenatal appointment using the oral glucose tolerance test (OGTT). **[4].**

The clinical significance of identifying risk factors for GDM is further highlighted by many studies that help in effective management of GDM to reduce negative outcomes **[4].** Therefore, this study's objective was to identify the risk factors associated with GDM among pregnant women, aiming to improve both maternal and fetal outcomes.

METHODS

This case-control study was conducted at the Kafr Saqr Family Health Centers in El Sharqia Governorate, Egypt. The study population consisted of pregnant women divided into two groups: a case group and a control group. The case group included pregnant women diagnosed with GDM during the third trimester, confirmed by the oral glucose tolerance test (OGTT). The control group comprised healthy pregnant women without GDM. Exclusion criteria for both groups included a history of type I or type II diabetes mellitus, chronic diseases (such as cardiac, hepatic, renal, collagen, or vascular disorders), respiratory syndromes, or the use of corticosteroids. Participants in both the case and control groups were selected using a systematic random sampling method. Specifically, every third pregnant woman in her third trimester who attended a health center or rural unit for a routine antenatal check-up was included in the study. Data collection occurred approximately three days per week. On average, 3 to 4 women were interviewed per day by the researcher, with assistance from the attending physician at the district center and selected rural units (chosen simply randomly). Each participant completed a structured interview questionnaire, which took approximately 30 minutes to administer.

For the case group, results of the initial OGTT conducted during antenatal care visits were recorded. GDM was diagnosed based on ADA 2022 criteria: fasting glucose ≥92 mg/dL, 1-hour ≥180 mg/dL, and 2-hour ≥153 mg/dL. Complete blood count (CBC) results, if previously performed, were also documented.

Anthropometric measurements included body mass index (BMI), with height measured barefoot using a validated stadiometer (to the nearest 0.1 cm) and weight recorded in light clothing (to the nearest 0.1 kg). Blood pressure was measured on both the left and right arms for all participants.

All pregnant women included in the study were interviewed for sociodemographic characteristics guided by **Fahmy et al. [5]**: age, socioeconomic class, level of education, income, occupation, and crowding index. A full clinical and obstetric history taken from participants using structured clinical history form designed by the researcher including; obstetric Factors focused on factors such as history of abortion, parity, birth weight, gestational age, history of cesarean section, and history of albuminuria and glucosuria) and clinical factors such as obesity by assessment of maternal body mass index (BMI), history of hypertension, history of anemia and family history of diabetes.

Lifestyle factors were assessed through structured interviews. Dietary habits were evaluated using the International Federation of Gynecology and Obstetrics (FIGO) Nutrition Checklist (Killeen et al. [6]. This checklist includes questions about special dietary requirements, overall diet quality, and folic acid supplementation during the preconception period and early pregnancy (first 12 weeks). Additionally, participants were asked about specific lifestyle behaviors, such as smoking and alcohol consumption.

Physical activity was assessed using the Arabic version of the International Physical Activity Questionnaire (IPAQ) [7]. Women were asked to recall their physical activity over the past three months. The assessment was conducted at the time of enrollment, between the 20th and 28th weeks of gestation, to optimize recall accuracy. This time frame represents a balance between minimizing recall bias (as it is not too far in the past) and ensuring that pregnancy is well established. The questionnaire covered four activity domains: household, occupational, sports, and exercise. Based on frequency, intensity, and duration, participants were classified into three activity levels: sedentary (<600 MET-min/week), moderate (600–<3000 MET-min/week), and vigorous (≥3000 MET-min/week).

The study protocol was approved by the Institutional Review Board (IRB) of the Faculty of Medicine, Zagazig University (Approval No. 10471-1-3-2023). Formal permission was also obtained from the head of the Kafr Saqr Health Department. Informed consent was obtained from all participants prior to their enrollment in the study.

Sample size: Assuming that the mean ±SD of maternal age in pregnant women with gestational diabetes (case group) is 31.95±5.01 and in healthy pregnant women (control group) is 29.97±4.3, the total sample size was 176 (88 in each group), calculated using OpenEpi, at a power of test of 80% and CL of 95% **[8].**

Statistical analysis:

The collected data were computerized and statistically analyzed using the Statistical Package for Social Sciences (SPSS) 26.0 for Windows (SPSS Inc., Chicago, IL, USA), applying statistical tests such as chi-square, t-test, Mann–Whitney U test, and binary logistic regression. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 176 pregnant women were included in this study, divided into a case group (88 pregnant women diagnosed with GDM) and a control group (88 healthy pregnant women) with no statistically significant difference regarding demographic factors such as age, educational, and socioeconomic status. While smoking, there is a statistically significant difference between the two groups; about 19% versus 2.3% of the GDM group versus the control group were smokers, with p = 0.001 (Table 1).

According to table (2), the GDM group showed a higher frequency of several risk variables compared to the control group. These included a greater incidence of large-sized babies (73.9% vs. 8%), stillbirths (13.6% vs. 0%), previous cesarean sections (61.4% vs. 27.3%), Rh positivity (75% vs. 58%), history of preeclampsia (56.8% vs. 13.6%), and family history of diabetes (47.7% vs. 27.3%) with statistically significant differences (P < 0.001 and 0.017, respectively).

However, there was no significant difference observed between the groups in terms of history of anemia (46.6% vs. 36.4%), seven-day neonatal mortality (3.4% vs. 0%), or history of hypertension (22.7% vs. 12.5%).
There are statistically significant differences between the two studied groups in terms of systolic and diastolic blood pressure, weight, body mass index (BMI), glucosuria (77.3% in the GDM group versus 0% in the control group), and albuminuria (15% in the GDM group versus 0% in the control group) (p-value <0.001). All were higher in the GDM group than in the control group. While there is not a statistically significant difference in terms of hemoglobin and lower limb edema (Table 3).

There was a significant difference in physical activity levels between the GDM and control groups (p < 0.001). In the GDM group, 40.9% of participants reported high physical activity, 48.9% moderate activity, and 10.2% were classified as sedentary. In contrast, the control group demonstrated higher activity levels, with 64.8% classified as highly active, 35.2% moderately active, and no participants reporting sedentary behavior. Additionally, the median IPAQ score was lower in the GDM group (2800 MET-min/week) compared to the control group (3000 MET-min/week). (Table 4).
Regarding dietary data, the GDM and control groups showed statistically significant differences. A smaller percentage of women in the group with GDM reported adequate intake of fruits and vegetables (53.4% vs. 71.6%, p = 0.013), fish (51.1% vs. 85.2%, p < 0.001), dairy products (62.5% vs. 92%, p < 0.001), and whole grains (70.5% vs. 90.9%, p < 0.001) compared to the control group.
The overall dietary quality, defined by a score of ≥4, was considerably lower in the GDM group (38.6%) compared to the control group (90.9%, p < 0.001). As part of standard prenatal care, folic acid and iron supplements were given to every participant in both groups (Table 5).
The regression analysis identified several significant independent predictors of gestational diabetes mellitus (GDM). Poor dietary quality was the strongest predictor (OR = 10.85, p = 0.001), followed by smoking (OR = 10.30, p < 0.001), a history of preeclampsia (OR = 6.88, p = 0.002), higher parity (OR = 2.10, p = 0.002), and increased body weight (OR = 1.07 per kg, p = 0.005). A markedly elevated chance of getting GDM was linked to each of these conditions (Table 6).

Table (1): Comparison between the studied groups regarding age, education, socioeconomic and smoking status:

	GDM group n=88 (%)	Control group n=88 (%)	χ^2	p
Education				
Illiterate	**10 (11.4%)**	**3 (3.4%)**		
Read and write	**4 (4.5%)**	**3 (3.4%)**		
Preparatory	**3 (3.4%)**	**0 (0%)**	**3.457§**	**0.063**
Secondary	**18 (20.5)**	**25 (28.4%)**		
University	**32 (36.4%)**	**33 (37.5%)**		
Postgraduate	**21 (23.9%)**	**24 (27.3%)**		
Smoking				
Non-smokers	**71 (80.7%)**	**86 (97.7%)**	**Fisher**	**<0.001****
Smokers	**17 (19.3%)**	**2 (2.3%)**		
SES				
Low	**10 (11.4%)**	**3 (3.4%)**		
Middle	**52 (59.1%)**	**76 (86.4%)**	**3.107§**	**0.138**
High	**26 (29.5%)**	**9 (10.2%)**		
	Mean ± SD	**Mean ± SD**	**t**	**p**
Age (year)	**29.15 ± 4.35**	**28.8 ± 3.55**	**0.589**	**0.557**

χ^2Chi square test Fisher test §Chi square for trend test t independent sample t test *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table (2): Comparison between the studied groups regarding obstetric, family and past history:

	GDM group n=88 (%)	Control group n=88 (%)	χ^2	p
Abortion Present Absent	 18 (20.5%) 70 (79.5%)	 14 (15.9%) 74 (84.1%)	0.611	0.434
Parity Median (IQR)	2(2 – 3)	1(0 – 2)	Z= -5.385	<0.001**
Large size baby Present Absent	 65 (73.9%) 23 (26.1%)	 7 (8%) 81 (92%)	79.068	<0.001**
Still birth Present Absent	 12 (13.6%) 76 (86.4%)	 0 (0%) 88 (100%)	12.878	<0.001**
RH Positive Negative	 66 (75%) 22 (25%)	 51 (58%) 37 (42%)	5.737	0.017*
CS Present Absent	 54 (61.4%) 34 (38.6%)	 24 (27.3%) 64 (72.7%)	20.722	<0.001**
<7 days mortality Present Absent	 3 (3.4%) 85 (96.6%)	 0 (0%) 88 (100%)	Fisher	0.246
History of anemia Present Absent	25 (28.4%) 63 (71.6%)	24 (27.3%) 64 (72.7%)	0.028	0.866
History of preeclampsia Present Absent	50 (56.8%) 38 (43.2%)	12 (13.6%) 76 (86.4%)	35.957	<0.001**
History of hypertension Present Absent	20 (22.7%) 68 (77.3%)	11 (12.5%) 77 (87.5%)	3.172	0.075
Family History of diabetes Present Absent	42 (47.7%) 46 (52.3%)	24 (27.3%) 64 (72.7%)	7.855	0.005*

χ^2Chi square test Z Mann Whitney test IQR interquartile range *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table (3): Comparison between the studied groups regarding clinical and laboratory data:

	GDM group n=88 (%)	Control group n=88 (%)	χ^2	p
LL edema Present Absent	 38 (43.2%) 50 (56.8%)	 29 (33%) 59 (67%)	1.952	0.162
Albuminuria Present Absent	 15 (17%) 73 (83%)	 0 (0%) 88 (100%)	16.938	<0.001**
Glucosuria Present Absent	 68 (77.3%) 20 (22.7%)	 0 (0%) 88 (100%)	110.815	<0.001**
	Mean ± SD	**Mean ± SD**	t	p
Weight (kg)	79.25 ± 13.49	72.63 ± 11.63	3.489	<0.001**
BMI (kg/m^2)	29.53 ± 4.88	26.97 ± 4.92	3.466	<0.001**
Systolic blood pressure (mmHg)	119.15 ± 13.67	114.43 ± 13.72	2.284	0.024*
Diastolic blood pressure (mmHg)	77.84 ± 10.28	74.26 ± 10.33	2.305	0.022*
Hemoglobin (g/dl)	11.11 ± 1.22	11.41 ± 1.08	-1.678	0.095

χ^2Chi square test t independent sample t test *p<0.05 is statistically significant **p≤0.001 is statistically highly significant.

Table (4): Comparison between the studied groups regarding IPAQ score:

	GDM group n=88 (%)	Control group n=88 (%)	Z	p
	Median (IQR)	**Median (IQR)**		
IPAQ score	2800(820 – 3037.5)	3000(1200 – 3100)	-2.641	0.008*
Sedentary Moderate High	9 (10.2%) 43 (48.9%) 36 (40.9%)	0 (0%) 31 (35.2%) 57 (64.8%)	14.455§	<0.001**

§Chi square for trend test Z Mann Whitney test *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table (5): Comparison between the studied groups regarding dietary data (FIGO):

	GDM group n=88 (%)	Control group n=88 (%)	χ^2	p
Meat/poultry 2-3/w				
Yes	33 (37.5%)	42 (47.7%)	1.882	0.1701
No	55 (62.5%)	46 (52.3%)		
Fruit/vegetables 2-3/w				
Yes	47 (53.4%)	63 (71.6%)	6.206	0.013*
No	41 (46.6%)	25 (28.4%)		
Fish 1-2/w				
Yes	45 (51.1%)	81 (85.2%)	23.571	<0.001**
No	43 (48.9%)	7 (14.8%)		
Dairy products				
Yes	55 (62.5%)	75 (92%)	21.871	<0.001**
No	33 (37.5%)	13 (8%)		
Whole grains once/week				
Yes	62 (70.5%)	80 (90.9%)	11.811	<0.001**
No	26 (29.5%)	8 (9.1%)		
Snacks 5 daily				
Yes	61 (69.3%)	67 (76.1%)	1.031	0.31
No	27 (30.7%)	21 (23.9%)		
Total score				
Median (IQR)	4(3 – 5)	5 (5 – 6)	-5.037§	<0.001**
≥4	54 (61.4%)	80 (90.9%)	21.14	<0.001**
<4	34 (38.6%)	8 (9.1%)		
Iron intake (yes)	88 (100%)	88 (100%)	-	-
Folic acid intake (yes)	88 (100%)	88 (100%)	-	-

χ2Chi square test χ2Chi square test § Mann Whitney test IQR interquartile range *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table (6): Binary regression analysis of predictors of GDM:

	B	P	AOR	95% C.I.	
				Lower	Upper
Weight	0.072	0.005*	1.074	1.022	1.129
Parity	0.744	0.002*	2.104	1.302	3.400
Previous history of preeclampsia	1.928	0.002*	6.876	2.050	23.067
Smoking	4.110	<0.001**	10.30	16.142	229.893
Poor dietary quality	2.384	0.001**	10.850	2.544	46.281

AOR adjusted odds ratio CI Confidence interval *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

DISCUSSION

The increasing prevalence of GDM has become a growing health concern worldwide, promoting the need for deeper investigation of its causes, risk factors, and determinants contributing to its escalation. For this reason, this study aimed to assess the risk factors of gestational diabetes among pregnant women behind the growing incidence of GDM, particularly in Egyptian context **[3].** The study revealed several significant predictors of GDM. Poor dietary quality was the strongest predictor (OR=10.85, p=0.001), followed by smoking (OR=10.30, p<0.001), history of preeclampsia (OR=6.88, p=0.002), higher parity (OR=2.10, p=0.002) and increased body weight (OR=1.07 per Kg, p=0.005). Each of these factors was associated with a significantly increased risk of developing GDM.

Regarding demographic factors like age, education level, and social class, there is no statistically significant difference between the two collections in the current study, as it is a case-control study.

For age, a retrospective study by **Mirabelli et al. [9]** found that excess body weight prior to conception has a more significant association with GDM occurrence than maternal age in pregnant women, which is similar to this study. Also, a meta-analysis study by **Eades et al. [10]** found that maternal age alone is not a strong determinant; it's the clustering of metabolic risks that drives GDM. Briefly, all previous studies suggest that maternal age alone may not be a strong determinant of GDM when adjusting for other metabolic factors.

Regarding the relationship between education level, socioeconomic position (SES), and GDM, several studies suggested that lower SES and limited education increase GDM risk; others argue that this relationship is largely mediated by factors such as obesity, lifestyle, and healthcare access. For example, in the study done by **Rönö et al. [11],** no significant effect of education on GDM recurrence was found, suggesting that biological and metabolic factors may be more important in subsequent pregnancies than SES or education. Additionally, a study that was conducted by **Gnanasambanthan et al. [12]** indicated that although a greater percentage of women with GDM risk factors lived in the most impoverished postcodes, low SES did not raise the incidence of GDM.

Regarding obstetric factors, our analysis showed a significant correlation (p < 0.001) between a history of preeclampsia and gestational diabetes mellitus (GDM), aligning with previous studies. **[3]** reported a strong association between GDM and an increased risk of hypertensive disorders, including preeclampsia. Similarly, **Ahmed et al. [14]** found preeclampsia to be significantly more prevalent among women with GDM in a prospective cohort study (p = 0.04).

The current study found a correlation between multiparity and GDM, consistent with previous research. **Lee et al. [15]** identified multiparity as a risk factor for GDM (OR = 1.37), and **Mahmoud et al. [16]** also reported a significant association in a cross-sectional study of 250 pregnant women in Menoufia, Egypt.

In terms of stillbirth as a risk factor, the current study showed a significantly higher occurrence of GDM in women with a previous history of stillbirth in the case group compared to the control group (p < 0.001), which may be due to fetal macrosomia, placental insufficiency, and metabolic complications that can lead to insulin resistance and GDM occurrence that is in agreement with a study by **Azzam and El Sharkawy [17]**, who found that there's an association between perinatal complications and increased risk of GDM, including stillbirth.

Regarding large-size babies and GDM, the current study showed a significant association between a history of delivering large-size babies and GDM ($p < 0.001$), which is consistent with studies such as **Mahmoud et al. [16],** in which the history of delivering large-sized babies was significantly associated with the occurrence of GDM.

This study found that Rh-positive pregnant women had an increased risk of developing gestational diabetes mellitus (GDM). This finding aligns with **Haymont et al. [19]**, who reported a higher prevalence of GDM among Rh-positive women (27.6%) compared to controls (6.7%), suggesting a potential association. Similarly, **Lemaitre et al. [20]** observed that women with the Rh-positive AB blood group had a significantly higher risk of developing GDM (OR = 3.02, 95% CI: 1.69–5.39, $p < 0.001$), which they attributed to genetic predisposition.

Additionally, this study identified a significant association between a history of cesarean section (CS) and the risk of GDM. This is supported by previous findings from **Ahmed et al. [21] and Eltoony et al. [22],** both of whom reported a similar correlation between prior CS and increased GDM risk. In contrast, no significant differences were observed between the GDM and control groups regarding the history of abortions or early neonatal mortality (within the first 7 days of life) ($p = 0.434$). These findings are in line with those of **Zhang et al. [23] and Simmons et al. [24],** who also found no significant association between GDM and these outcomes.

The current study found a significant association between a history of hypertension and the development of gestational diabetes mellitus (GDM), potentially due to shared pathophysiological mechanisms such as endothelial dysfunction, insulin resistance, and systemic inflammation. This aligns with findings from **Ye et al. [26] and Zhang et al. [27],** who identified prenatal and chronic hypertension as independent risk factors for GDM. Regarding anemia, although the association with GDM remains inconclusive, this study—along with research by **Wang et al. [28]**—suggests that low maternal hemoglobin levels, particularly moderate anemia (Hb <10 g/dL), may increase GDM risk due to iron dysregulation. However, contrasting evidence from **Tiongco et al. [29]** indicates a potentially protective effect of iron deficiency anemia.

It is commonly known that having a family history of DM increases the risk of developing gestational diabetes mellitus (GDM). While most studies support this association, some research suggests that the relationship may be mediated by lifestyle and metabolic factors rather than genetics alone. **Song et al. [30].**

In the current study, family history of DM is a strong contributing factor to GDM. Similarly, a study by **Cheung et al. [31]** discovered that women with a history of diabetes in their parents were 2.3 times more likely to develop GDM than women without parents with the disease.

This study found significant differences in clinical and laboratory parameters—such as weight, BMI, blood pressure, glucosuria, and albuminuria—all higher in the GDM group. These findings align with studies **[32] & [33]**, which linked GDM to elevated blood pressure, glycosuria, and BMI. However, no significant differences were observed in hemoglobin levels or lower limb edema, consistent with results from **Ahmadi et al. [14] and Hassan et al. [34].**

This study found significant differences in dietary habits between groups, with the control group demonstrating better overall nutrition quality and higher consumption of fruits, vegetables, fish, dairy products, and whole grains, and greater sun exposure. These findings are consistent with **Zareei et al. [35]**, who reported a higher risk of GDM among women following unhealthy dietary patterns (OR = 2.838), and **Filipovic et al. [36]**, who linked poor dietary intake to increased GDM risk. Additionally, a statistically significant difference was observed in physical activity levels between the groups, with 64.8% of the control group engaging in high physical activity compared to only 41% in the GDM group. This aligns with findings by **Ali et al. [37]** in Yemen, who noted a higher incidence of GDM among women with low to moderate physical activity, and **Aune et al. [38]**, who reported that regular moderate to vigorous exercise improves insulin sensitivity and reduces GDM risk.

In the current study the studied groups differ statistically significantly in terms of smoking, with a higher frequency in the GDM group (about 19.3% versus 2.3% were smokers), demonstrating that pregnant smokers had a substantial risk of developing GDM, which is consistent with the research done by **Bar-Zeev et al. [39], who** found that smoking is linked to insulin resistance and inflammation, which contribute to glucose dysregulation. Also, **Zhang et al. [23]** reported that smoking impairs β-cell function, leading to reduced insulin secretion and a higher risk of hyperglycemia.

Conclusion: This study found that GDM is strongly linked to clinical, obstetric, and lifestyle risk factors. Women with GDM were more likely to be obese, smoke, have hypertension or preeclampsia, have a history of undergoing cesarean sections, and have a history of delivering large babies. A family history of diabetes and unhealthy lifestyle habits, such as poor diet and low physical activity, were also more common, highlighting the role of modifiable factors in GDM risk.

Limitations: Limited Generalizability: Conducted only at Kafr Saqr family health centers, which may not represent other populations. Sample Size: Although statistically calculated, 176 participants may still be relatively small for detecting subtle associations. Study Design: Case-control design can show associations but not causality. Recall Bias: Data of lifestyle habits relied on self-report, which may introduce bias.

Recommendations: Implement early screening for GDM, especially in women with known risk factors like high BMI, smoking, low physical activity, and poor diet. Promote healthy eating habits and regular physical activity among pregnant women to reduce modifiable risks. Provide targeted health education on GDM prevention during antenatal care visits.

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