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Research Article

Prevalence, Risk Factors, and Management of Gestational Diabetes Mellitus in Guelma City (East Algeria): A Cross-Sectional Study

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Abstract

Background: Gestational diabetes mellitus (GDM) is a common metabolic disorder occurring during pregnancy, characterized by glucose intolerance. It poses significant health risks for both mothers and children, increasing the likelihood of complications such as macrosomia, hypertension, and type 2 diabetes. ***Objectives***: To determine the prevalence of GDM and identify the associated risk factors among pregnant women in Guelma Province, located in northeastern Algeria. ***Methods***: A cross-sectional study was conducted on 180 pregnant women aged 17-47 years in Guelma, who were visiting 5 different local gynecology and obstetrics clinics. Data were collected through a structured questionnaire assessing demographic characteristics, medical history, lifestyle factors, and pregnancy outcomes. The prevalence of GDM was determined based on clinical diagnosis and the main significant risk factors identified. ***Results***: The prevalence of GDM among the study participants was 18.3% (95% CI 12.6–23.0). 9. Key risk factors significantly associated with GDM included maternal age (>30 years), obesity (pre-pregnancy BMI≥30 kg/m²), and multiparity (≥3 pregnancies). Additionally, women with GDM were significantly more likely to experience complications, including infants with high birth weight (3500±600 g) and the development of associated pathologies during gestation, especially hypertension, anemia, and hyperthyroidism. ***Conclusion***: The findings highlight the necessity for early screening and intervention strategies to manage GDM and mitigate its complications. Public health initiatives should focus on promoting healthy lifestyles, including balanced nutrition and regular physical activity, to reduce GDM risk. Further longitudinal studies are recommended to explore long-term maternal and fetal outcomes.

Keywords: Cross-sectional study; Gestational diabetes mellitus; Pregnancy; Prevalence; Risk factors.

الانتشار، عوامل الخطر، وإدارة مرض السكري الحملي في مدينة قالمة (شرق الجزائر): دراسة مقطعية

الخلاصة

الخلفية: مرض السكري الحملي (GDM) هو اضطراب أيضي شائع يحدث أثناء الحمل، ويتميز بعدم تحمل الجلوكوزوبشكل مخاطر صحية كبيرة على الأمهات والأطفال، مما يزيد من احتمالية حدوث مضاعفات مثل الماكروسوميا، وارتفاع ضغط الدم، والسكري من النوع الثاني. **الأهداف**: تحديد انتشار اضطراب GDM وتحديد عوامل الخطر المرتبطة بين النساء الحوامل في محافظة قالمة الواقعة في شمال شرق الجزائر. **الطرائق**: أجريت دراسة مقطعية على 180 امرأة حامل تتراوح أعمارهن بين 17 و48 عاما في قالمة حيث زارن 5 عيادات محلية مختلفة لأمراض النساء والتوليد المختلفة. تم جمع البيانات من خلال استبيان منظم يقيم الخصائص الديموغرافية، والتاريخ الطبي، وعوامل نمط الحياة، ونتائج الحمل. تم تحديد انتشار المرض بناء على التشخيص السريري، وتحديد عوامل الخطر الرئيسية ذات الدلالة. **النتائج**: كان انتشار GDM بين المشاركين في الدراسة 18.3٪ (95٪ CI=12.6–23.9). تشمل عوامل الخطر الرئيسية المرتبطة بشكل كبير باضطراب الحمل الجليدي الكبير عمر الأم (>30 سنة)، السمنة (مؤشر كتلة الجسم قبل الحمل≥30 كجم/م²)، والتعدد (≥3 حالات حمل). بالإضافة إلى ذلك، كانت النساء المصابات باضطراب GDM أكثر عرضة بشكل ملحوظ لمواجهة المضاعفات، بما في ذلك الرضع الذين لديهم وزن ولادة مرتفع (متوسط 3500±600 جرام) وتطور أمراض مرتبطة أثناء الحمل، خاصة ارتفاع ضغط الدم، فقر الدم، وقصور الغدة الدرقية. **الاستنتاجات**: تبرز النتائج ضرورة وجود استراتيجيات فحص مبكرة وتدخل لإدارة اضطراب GDM والتخفيف من مضاعفاته. يجب أن تركز المبادرات الصحية العامة على تعزيز أنماط الحياة الصحية، بما في ذلك التغذية المتوازنة والنشاط البدني المنتظم، لتقليل خطر الإصابة بمرض GDM. يوصى بإجراء دراسات طولية إضافية لاستكشاف النتائج طويلة الأم والجنين.

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INTRODUCTION

Pregnancy is a critical period characterized by substantial physiological changes essential for fetal development and maternal well-being [1]. However, if maternal physiology does not adapt properly, complications such as gestational diabetes mellitus (GDM) may arise, posing risks to both maternal and fetal health [2]. Normally, pregnancy is characterized by insulin resistance and requires an increased pancreatic β-cell response to maintain normoglycemia. In contrast, GDM develops in women who are unable to mount a compensatory β-cells response, leading to hyperglycemia [3]. GDM is one of the most common metabolic disorders during pregnancy affecting 25% of pregnant women globally [4]. In fact, this condition does not only impact maternal and fetal outcomes during

pregnancy but also elevates the long-term risk of developing cardiovascular disease and type 2 diabetes for those women [5]. When it comes to newborns, in addition to macrosomia, neonatal hypoglycemia, hyperbilirubinemia, and neonatal respiratory distress syndrome, they are also at an increased risk of being obese in childhood and suffer from cardiovascular disease traits in adulthood [6]. Many studies focused on GDM in order to determine its main risk factors, therapeutic interventions, management and consequences on pregnant women [7-11]. Some risk factors were associated with an increased risk of developing GDM, including advanced maternal age, excess body weight expressed usually by a high body mass index (BMI>25), low physical activity, family history with diabetes and personal history of GDM, macrosomia or cardiovascular diseases [12]. Nevertheless, despite extensive studies examining GDM, its treatment and management remain a subject of debate [13]. According to the literature, only two studies are published on GDM in Algeria, with the last one being published 11 years ago [9,10]. To provide newer and updated information about GDM among Algerian women, the present study was conducted. The main objectives of this work are to determine the prevalence of GDM among pregnant women in the city of Guelma (East Algeria), identify the main risk factors influencing the appearance of GDM to facilitate early identification and the management of this complication and highlight the therapeutic plan followed by women with GDM in our population.

METHODS

Study design and population

A cross-sectional observational study was conducted between March and May 2024 in the city of Guelma (northeastern Algeria). The study population was recruited from five healthcare facilities representing both the public and private sectors. The public sector included three governmental hospitals: 1) the Mother and Child Hospital, which specializes in maternal and neonatal care; 2) the Public Foundation for the Heliopolis Centre, a general hospital providing multidisciplinary healthcare services; and 3) the Oumeddour Tunis Centre, which offers a wide range of outpatient and inpatient medical services. To ensure greater representativeness of the study population, two private gynecology and obstetrics clinics were also included, both of which agreed to participate voluntarily. Pregnant women attending routine antenatal consultations during their third trimester, as well as women attending postpartum follow-up visits, were consecutively invited to participate in the study during the data collection period. Recruitment was performed by trained members of the research team in collaboration with healthcare professionals at each participating facility. Before enrolment, all eligible women received detailed information about the objectives and procedures of the study, and those who agreed to participate provided written informed consent.

Sample size determination

In order to determine the minimum sample size required for this study, we applied the method described by Charan and Biswas [14].

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where n = required sample size, Z = Z-score for the desired confidence level (1.96 for 95% CI), P = expected prevalence, and d = absolute precision (margin of error). Assuming a prevalence p= 0.06 (6%), Z=1.96 (95% CI), and d= 0.04 (4%). Rounding up, the minimum sample size required was n=136. To account for anticipated non-response (<75% response rate), the number of questionnaires to distribute was adjusted as:

n *adjusted* = n/expected response rate = 136/0.75 =182

To account for potential non-response, 182 questionnaires were distributed across the selected healthcare facilities. Of these, 180 pregnant women completed the questionnaire, yielding a response rate of 98.9% and exceeding the minimum sample size required to ensure adequate statistical power.

Inclusion and exclusion criteria

Eligible participants were women aged 17 years or older who were either in the third trimester of pregnancy or attending a routine postpartum follow-up consultation during the study period. Women were recruited consecutively until the required sample size was achieved. Women with pre-existing type 1 or type 2 diabetes diagnosed before pregnancy, as well as those with chronic metabolic or endocrine disorders likely to influence glucose metabolism or pregnancy outcomes, were excluded from the study.

Diagnosis of GDM

GDM was diagnosed according to the International Association of Diabetes and Pregnancy Study Groups (IADPSG) 2010 criteria. During 24-28 weeks of pregnancy, 75-gram oral glucose tolerance test (OGTT) is made. The test was considered positive if the following venous plasma glucose thresholds were met or exceeded: Fasting ≥ 5.1 mmol/L (92 mg/dL), 1-hour ≥ 10.0 mmol/L (180 mg/dL), or 2-hour ≥ 8.5 mmol/L (153 mg/dL).

Data collection procedures

Data collection was conducted using a structured questionnaire, and designed to capture a comprehensive set of variables covering four main domains: 1) sociodemographic characteristics, including age, weight, height, and parity; 2) medical history, such as a previous diagnosis of gestational

diabetes, overweight or obesity prior to pregnancy, and the presence of other chronic conditions (e.g., hypertension, thyroid disorders, or cardiovascular disease); 3) lifestyle factors, including level of physical activity, dietary practices, and other relevant behaviors; 4) gestational diabetes management practices, such as regular blood glucose monitoring, consultations with nutritionists, adherence to dietary recommendations, and engagement in physical exercise, and 5) postpartum follow-up. To maximize accessibility and comprehension across participants with diverse educational backgrounds, the questionnaire was developed in Arabic, the native language of the study population. Furthermore, researchers assisted participants throughout the completion process, providing clarifications where necessary and ensuring the accuracy, reliability, and completeness of the responses.

Consent

All participants were approached individually and asked for their consent to participate in this observational study. Prior to enrollment, they were provided with detailed information regarding the study objectives, the procedures involved, and the potential benefits, ensuring that their decision to participate was based on a clear understanding. Participation was entirely voluntary, and written informed consent was obtained from each participant. To uphold ethical standards, strict confidentiality of all collected data was maintained. Information was anonymized through the removal of personal identifiers, and responses were coded to prevent the possibility of tracing data back to individual participants. The collected information will be used exclusively for scientific research purposes and will not be disclosed to any third party. Furthermore, participants were informed of their right to withdraw from the study at any stage without any consequences for their medical care.

Ethical considerations

The survey protocol received approval from the Scientific Advisory Board of the department of Biology at the University of 8 Mai 1945, Guelma on February 25, 2024 (Number: 311), as well as from the Public Health Administration of the city of Guelma and was conducted in accordance with internationally recognized ethical principles, including the Declaration of Helsinki.

Statistical analysis

The results are expressed as mean ± standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables. Categorical variables were compared using the Chi-square test. Continuous variables were analyzed using the independent Student's *t*-test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. Statistical significance was defined as $p < 0.05$, with all analyses conducted using SPSS Statistics software (IBM SPSS Statistics, Version 23.0, Armonk, NY, USA).

RESULTS

Of the total 182 questionnaires distributed, 180 participants completed the survey achieving a response rate of 98.90%. The average age of the participants was estimated at 32 ± 5.71 years (from 17 to 48 years). For the BMI of the total population, the average was 26.44 ± 3.7 (kg/m²). Regarding place of residence, 53% of participants were from urban areas, while 47% resided in rural areas. Additional characteristics on the number of pregnancies, fasting blood glucose, mode of delivery in addition to the basic characteristics of both groups: with and without GDM are presented in Table 1.

Table 1: Main characteristics of the total participants, with GDM and non-GDM groups

Characteristic		Result			*p*-value
		Total (n=180)	With GDM (n=33)	Non-GDM (n=147)	
Residence	Urban	95(53)	18(55)	77(52)	0.74*
	Rural	85(47)	15(45)	70(48)	
Age (year)		32±5.71	33.48±6.34	31.67±5.53	0.098†
BMI (kg/m²)		26.44±3.68	27.74±3.76	26.18±3.61	0.046†
Number of Pregnancies		2.7±1.4	3.1±1.5	2.5±1.2	0.0006‡
Fasting Blood Glucose (mg/dL)		102.4±18.9	130.5±28.7	96.3±12.4	<0.0001‡
Birth Weight (g)		3300±450	3500±600	3200±500	0.0038†
Mode of Delivery	Cesarean	65(36)	14(42)	51(35)	0.396*
	Natural	115(64)	19(58)	96(65)	
Family History of Diabetes	Yes	110(61)	22(66.66)	80(54.42)	0.19*
	No	70(39)	11(34)	67(45.58)	
Associated pathologies	Yes	31(17.22)	11(33.33)	20(13.60)	0.007*
	No	149(82.78)	22(66.67)	127(86.40)	

Values are presented as frequency, percentage, and mean±SD. *Chi-Square test; †T-students test; ‡ Mann-Whitney U test, values significantly different between GDM and non-GDM groups are in bold.

The prevalence of GDM in the study population was estimated at 18.3% (95% CI 12.6–23.9), with thirty-three women reporting a diagnosis of GDM. BMI, number of pregnancies, fasting blood glucose, birth weight, and the presence of other diseases showed statistically significant differences between the GDM and Non-GDM groups (p= 0.046; 0.0006; 6 × 10^{-8}; 0.0038 and 0.007, respectively). In contrast, no significant differences were observed between the two groups with respect to place of residence, maternal age, mode of delivery, or family history of diabetes (p= 0.47, 0.098, 0.396 and 0.19, respectively). The age of women with GDM varied from 20 to 45 years (33.48 ± 6.34). The majority

(60.6 %) were over 30 years old (p= 1× 10^{-1}0). In addition to the classification based on the age (≤ 30 years and >30 years), GDM women were classified into 3 groups based on their BMI: normal weight group (18.5 ≤ BMI ≤ 24.9), overweight group (25-29.9) and obesity group (≥ 30). Older women (> 30 years) had a significant higher BMI (Overweight (60%) and obese (30%); p= 0.031) than younger women (≤ 30 years) (Table 2).

Table 2: Characteristics of pregnant women diagnosed with GDM based on age and BMI

Variables	Total (n=33)	≤30 years (n=13)	>30 years (n=20)	*p*-value
Age (year)	33.48±6.34	27±2.92	37.7±3.84	<0.0001†
BMI (kg/m²)	27.74±3.76	25.72±2.93	29.05±3.71	0.0083 †
Normal [18.5 - 24.9]		6(46.15)	2(10)	
Overweight [25 - 29.9]		6(46.15)	12(60)	0.031*
Obese ≥ 30		1(7.7)	6(30)	

Data are presented as mean±SD or n(%). †Students t-test. *Chi-square test.

Among women with GDM, 66.7% reported a positive family history of diabetes (FHD); however, the difference compared with the non-GDM group was not statistically significant (p= 0.19). Maternal lineage accounted for the highest proportion of hereditary cases (27.3%), followed by paternal lineage (21.2%), both parents (9.1%), other relatives such as grandmothers and aunts (6.1%), and siblings (3.0%) (Figure 1).

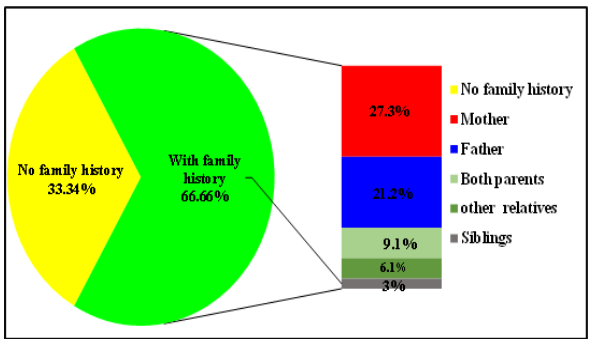

Figure 1: Family history of diabetes in women with GDM. Other relatives included grandmothers and aunts.

Among women with GDM, 33.3% developed at least one additional pathology (p= 0.007). The most frequently reported condition was hypertension (15.2%), followed by anemia (6.2%), and hypothyroidism, ulcerative colitis, osteoporosis, and hernia (3% each) (Figure 2). Hypertension, anemia, and hypothyroidism were observed in both GDM and non-GDM groups, whereas ulcerative colitis, osteoporosis, and hernia were reported exclusively in the GDM group. However, no significant association was observed between GDM status and the overall occurrence of comorbidities (p> 0.05) (Figure 2).

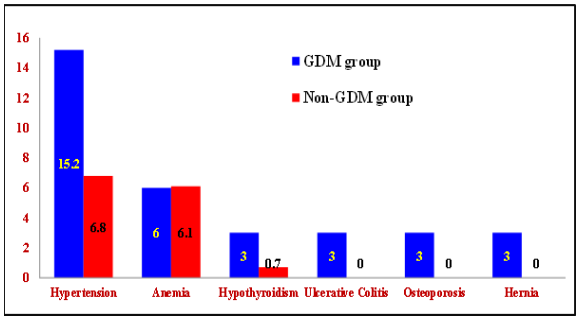

Figure 2: Associated pathologies reported during pregnancy.

Table 3 summarizes management and lifestyle among GDM women. A total of 76% reported consulting a nutritionist. Regarding treatment strategies, 51% were recommended to follow a healthy diet to regulate blood glucose, 40% needed a combination of insulin therapy dietary management, and 9% needed a combination of diet, insulin and oral medication to control their GDM. Dietary practices varied across participants: 55% adhered to a healthy diet suggested by a nutritionist, 42 % reported no changes in their dietary habits during pregnancy, and 3 % described their diet as unhealthy. With respect to physical activity, 39% of participants reported no engagement in any exercise, while 36% reported regular physical activity, and 24% exercised occasionally.

Table 3: Management approaches among participants with GDM (n=33)

Category of management	Results n(%)
Consulting nutritionist	
Yes	25(76)
No	8(24)
Treatment	
Diet	17(51)
Diet + insulin	13(40)
Diet + Insulin + oral drugs	3(9)
Dietary habits	
Healthy diet	18(55)
Normal diet	14(42)
Unhealthy diet	1(3)
Physical activity	
No exercise	13(39)
Regular exercise	12(36)
Occasional exercise	8(25)

DISCUSSION

To our knowledge, this is the first cross-sectional observational study to investigate the prevalence of GDM in the city of Guelma, located in northeastern Algeria. A total of 182 questionnaires were randomly distributed to pregnant women across five healthcare facilities in Guelma over a three-month period. This study was undertaken in response to the scarcity of regional data on GDM prevalence in Algeria [15], with the aim of providing baseline evidence to inform prevention, screening, and management strategies in maternal healthcare. The prevalence of GDM in the present study was estimated at 18.3%. By comparison, a study conducted in 2014 in Constantine, eastern Algeria, reported a prevalence

of 6.3% based on WHO diagnostic criteria [10]. In similar international studies, the prevalence of GDM has been shown to vary widely, ranging from 8.4% to 24.5% in the Middle East and 6.8% in New Zealand, while Europe generally reported lower rates, with a median prevalence of 5.8% (range: 1.8–22.3%) [16,17]. Furthermore, the International Diabetes Federation (IDF) reported that in 2022 approximately 16.7% of live births were affected by some form of high blood glucose during pregnancy, with the highest burden observed in low- and middle-income countries [18]. Globally, the reported prevalence of GDM varies widely because of different diagnostic criteria and differences in screening procedures[19, 20]. For instance, in 2010, the International Association of the Diabetes and Pregnancy Study Group (IADPSG) set a one-step method for GDM diagnosis, based on findings from the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study, which uses a 75 g oral glucose tolerance tests [21,22]. These diagnosis recommendations were supported by other professional organizations like the American Diabetes Association (ADA), the International Federation of Gynecology and Obstetrics (FIGO) [23], and the WHO [24]. However, the American College of Obstetricians and Gynecologists (ACOG) adopted a two-step approach to GDM [25]. Moreover, several countries follow their own national guidelines with different diagnostic approaches and glucose thresholds [23]. This lack of consensus contributes to the wide variation in reported prevalence rates and complicates international comparisons of GDM burden. Regarding participants' place of residence, the prevalence of GDM was comparable between rural (45%) and urban (55%) areas, with no statistically significant difference observed (p= 0.74). Similar findings were reported in a prospective cohort study in China, which likewise demonstrated no significant difference in GDM incidence between pregnant women residing in urban and rural regions (p> 0.05) [26]. For the association between GDM and maternal age, the data indicate that GDM women tend to be older. More specifically, 60.6% of GDM women were over 30 years old. This strong significance suggests that maternal age above 30 years may represent an important risk factor despite the non-significant mean difference. These results are in accordance with studies from China and Malaysia, which also reported that increasing maternal age is a significant risk factor for GDM [26-28]. Women with GDM had a higher BMI compared to non-GDM women, reinforcing the well-established association between obesity and GDM. Combining both age and BMI, 90% of GDM women over 30 years old were mostly overweight or obese (60% and 30%, respectively). It has been reported that obesity reduces insulin sensitivity, leading to a rise of GDM risk by impairing insulin function and blood glucose control [29]. Furthermore, women with GDM had more pregnancies compared to those without GDM, indicating that multiparity may contribute to the risk of developing GDM. Similar findings have been documented in multiple studies, which reported that women with ≥ 3 pregnancies had a higher risk of developing GDM [30,31]. It is noteworthy to mention that these studies didn't follow the same criteria for GDM diagnosis, which could justify the variation of the results. Furthermore, these works focused only on the relationship between the number of live births and GDM, without taking into account abortions and stillbirth cases, which are also associated with metabolic alterations caused by pregnancy. The fasting blood glucose levels were significantly higher in the GDM group compared to the non-GDM group. This result underscores the significant metabolic disruption induced by GDM. In fact, according to the WHO criteria for GDM diagnosis, the fasting blood glucose should be 92-125 mg/dl [19]. However, the single-time-point measurement cannot fully capture the postprandial glucose exclusion, which makes it necessary to resort to oral glucose tolerance testing to provide a more comprehensive assessment of dysglycemia [25]. Additionally, the mean birth weight of neonates born to mothers with GDM was higher than those born to non-GDM mothers, contributing to an increased risk of macrosomia and its associated complications such as shoulder dystocia and neonatal hypoglycemia. This phenomenon is actually explained by the fetal hyperinsulinemia hypothesis, suggesting that maternal hyperglycemia provokes excess fetal insulin secretion leading to adiposity and growth [22]. Consequently, a high proportion of women with GDM (42%) underwent cesarean delivery compared to 35% in non-GDM women (p= 0.396). Although no statistical significance was found for the delivery mode between the two groups, GDM women had a 7.7% higher cesarean rate. Multiple studies highlighted that cesarean delivery is one of the most common adverse pregnancy outcomes induced by GDM [32]. This type of delivery is commonly adopted for GDM women to avoid other risks, such as shoulder dystocia and other birth traumas. It is related to multiple factors guided mostly by iatrogenic decisions to control the risks associated with fetal macrosomia [33]. According to our cohort, family history was not determined as a risk factor for GDM even with a high prevalence among the GDM group (66.66% of GDM women vs. 54.42% of non-GDM women) (p=0.19). In contradiction, a meta-analysis published in 2021, collecting articles from 2007 to 2020, presented that studies from Ethiopia, Cameroon, Peru, Iran, Pakistan, Malaysia, Kuwait, Saudi Arabia, and India found that family history of diabetes (FHD) significantly increased the risk of developing GDM [34]. In accordance with our findings, FHD and GDM can be influenced by ethnicity due to different genetic predispositions and environmental factors. FHD was a strong predictor of GDM in South Asian and Hispanic women and not a significant independent factor in Black or white women [31]. Actually, FHD reflects the influence of genetic and environmental conditions and highlights the multifactorial nature of the pathophysiology of GDM. However, it has not been established whether categories of the family history of diabetes can act as independent risk factors for GDM [35]. Therefore,

the non-significant trend observed in our study may reflect a genuine association that our sample was underpowered to detect, or it may indicate that in our population, other factors like age, BMI, and parity are more primary drivers of GDM risk other factors like age, BMI, and parity are more primary drivers of GDM risks. Our findings indicated a high significance in terms of the overall prevalence of associated pathologies between GDM and healthy groups. However, when each pathology was examined separately—hypertension, anemia, hypothyroidism, ulcerative colitis, osteoporosis, and hernia—no significant differences were observed between the two groups. This suggests that even though GDM may increase the overall risk of comorbidities, the involvement of each condition may differ and might not be strong enough to appear as significant in this cohort. Furthermore, the limited sample size could reduce the precision of estimates and the statistical power to detect significant associations for rare conditions [36]. Effective management of GDM in pregnant women is crucial mainly to reduce short-term maternal and neonatal complications. Standard care includes glycemic monitoring, lifestyle adjustments, nutrition counseling, exercise, and insulin administration. According to our results, 76% of women consulted a nutritionist, indicating a relatively high adherence to dietary counseling, which is a crucial component of GDM management. For the dietary habits, 55% followed a healthy diet advised by their nutritionist, 24% didn't change their habits, describing their diet as normal, including moderate amounts of proteins, carbohydrates, vegetables, and healthy fats, and 3% admitted to having an unhealthy diet rich with fats and sugar. Despite GDM being highly responsive to dietary management, a substantial proportion may not be fully optimizing their nutritional intake. Concerning the treatment, the majority were instructed to follow a healthy diet to control blood glucose levels (51%), 40% combined both insulin and a healthy diet, and 9% combined dietary management, insulin, and oral medication to monitor their GDM. The intervention for GDM depends on the case of each patient, where it is conventional to start with lifestyle changes (nutritional counseling and exercise) and then the administration of medications (oral drugs and insulin) if needed [37]. Physical activity levels were low: 39% of respondents did not exercise at all, 24% exercised occasionally, and only 36% exercised regularly. Given the role of physical activity in glucose regulation, these findings suggest a need for targeted lifestyle interventions. In fact, in addition to considering low physical activity as a risk factor of GDM, lifestyle modifications, including diet and regular physical activity, have been shown to prevent GDM [15]. In summary, this study reveals a relatively high prevalence of GDM in Guelma and highlights maternal age, BMI, and multiparity as key contributing risk factors. While family history and comorbidities did not show significant associations, the findings point to a multifactorial nature of GDM where both modifiable and non-modifiable factors play a role. Although adherence to dietary counseling was encouraging, important gaps remain in nutrition and physical activity practices.

Study Limitations

Several limitations should be acknowledged. The study relied on a relatively small sample size from a single city, which may limit the generalizability of the findings. The cross-sectional design prevents establishing causal relationships between the identified risk factors and GDM. Furthermore, reliance on self-reported data for lifestyle habits such as diet and physical activity may have introduced recall or reporting bias. Finally, the lack of uniform diagnostic criteria across studies makes direct international comparisons challenging. Despite these limitations, this study provides valuable baseline evidence on GDM in northeastern Algeria and highlights the importance of early prevention, targeted screening, and comprehensive management strategies. Future large-scale, multicenter studies are warranted to strengthen national data and guide effective public health interventions.

Conclusion

GDM appears to be increasingly prevalent in this population, consistent with findings from international studies. These results underscore the importance of early screening and timely intervention to manage GDM and reduce adverse outcomes for both mothers and infants. GDM is associated with multiple interrelated factors; however, these associations may be influenced by confounding variables such as age, BMI, ethnicity, and the limited size of the GDM group. Larger and more diverse studies are needed to clarify the role of genetic predisposition in this population. Regarding management, women with GDM demonstrated strong awareness and responsibility, reflected in the high proportion who consulted a nutritionist and adopted a healthy diet. Nevertheless, targeted educational efforts remain necessary, particularly for high-risk women.

Conflict of interests

The authors declared no conflict of interest.

Funding source

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Data sharing statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

REFERENCES

1. Vinnars MT, Bixo M, Damdimopoulou P. Pregnancy-related maternal physiological adaptations and fetal chemical exposure. Mol Cell Endocrinol. 2023;578:112064. doi: 10.1016/j.mce.2023.112064.

2. Napso T, Yong HE, Lopez-Tello J, Sferruzzi-Perri AN. The role of placental hormones in mediating maternal adaptations to support pregnancy and lactation. *Front Physiol*. 2018;9:1091. doi: 10.3389/fphys.2018.01091.
3. Malaza N, Masete M, Adam S, Dias S, Nyawo T, Pheiffer C. A Systematic review to compare adverse pregnancy outcomes in women with pregestational diabetes and gestational diabetes. *Int J Environ Res Public Health*. 2022;19(17). doi: 10.3390/ijerph191710846.
4. Choudhury AA, Rajeswari VD. Gestational diabetes mellitus-A metabolic and reproductive disorder. *Biomed Pharmacother*. 2021;143:112183. doi: 10.1016/j.biopha.2021.112183.
5. Ugwudike B, Kwok M. Update on gestational diabetes and adverse pregnancy outcomes. *Curr Opin Obstet Gynecol*. 2023;35(5):453-9. doi: 10.1097/GCO.0000000000000901.
6. Juan J, Yang H. Prevalence, prevention, and lifestyle intervention of gestational diabetes mellitus in China. *Int J Environ Res Public Health*. 2020;17(24):9517. doi: 10.3390/ijerph17249517.
7. Mazumder T, Akter E, Rahman SM, Islam MT, Talukder MR. Prevalence and risk factors of gestational diabetes mellitus in Bangladesh: findings from demographic health survey 2017–2018. *Int J Environ Res Public Health*. 2022;19(5):2583. doi: 10.3390/ijerph19052583.
8. Tehrani FR, Naz MSG, Bidhendi-Yarandi R, Behboudi-Gandevani S. Effect of different types of diagnostic criteria for gestational diabetes mellitus on adverse neonatal outcomes: a systematic review, meta-analysis, and meta-regression. *Diabetes Metab J*. 2022;46(4):605-619. doi: 10.4093/dmj.2021.0178.
9. Mimouni-Zerguini S, Smail M, Boudiba A, Derguini M. Diabète gestationnel: facteurs de risque, évolution et conséquences périnatales: expérience du CHU Mustapha Bacha, Alger (Algérie). *Med Mal Metab*. 2009;3(6):626-633.
10. Bensalem S, Lakehal A, Roula D. Gestational diabetes in the commune of Constantine, Algeria: A prospective study. *Med Metab Dis*. 2014;8(2):216-220. doi: 10.1016/S1957-2557(14)70744-8.
11. Sagna Y, Abraham HWPB, Traoré S, Zoungrana L, Yanogo DRA, Bognounou R, et al. Prevalence and factors associated with gestational diabetes in urban hospitals in Burkina Faso. *Med Metab Dis. 2023*;17(1):76-80.
12. Quintanilla Rodriguez BS, Mahdy H. Gestational Diabetes. . StatPearls publishing copyright. Treasure Island (FL); 2024.
13. Mellitus GD. ACOG practice bulletin. ACOG: Washington, DC, USA 2018.
14. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Indian J Psychol Med*. 2013;35(2):121-126. doi: 10.4103/0253-7176.116232.
15. Al-Rifai RH, Abdo NM, Paulo MS, Saha S, Ahmed LA. Prevalence of gestational diabetes mellitus in the Middle East and North Africa, 2000-2019: A systematic review, meta-analysis, and meta-regression. *Front Endocrinol (Lausanne)*. 2021;12:668447. doi: 10.3389/fendo.2021.668447.
16. Zhu Y, Zhang C. Prevalence of gestational diabetes and risk of progression to type 2 diabetes: A global perspective. *Curr Diab Rep*. 2016;16(1):7. doi: 10.1007/s11892-015-0699-x.
17. Lawrence RL, Wall CR, Bloomfield FH. Prevalence of gestational diabetes according to commonly used data sources: an observational study. *BMC Pregnancy Childbirth*. 2019;19(1):349. doi: 10.1186/s12884-019-2521-2.
18. 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. doi: 10.1016/j.diabres.2021.
19. World Health Organization. Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy. 2013. p. 62. Available at: https://www.who.int/publications/i/item/WHO-NMH-MND-13.2
20. Zheng AS, Morris G, Moses RG. The prevalence of gestational diabetes mellitus: The accuracy of the NSW perinatal data collection based on a private hospital experience. *Aust N Z J Obstet Gynaecol*. 2016;56(4):349-351. doi: 10.1111/ajo.12438.
21. Metzger BE, Gabbe SG, Persson B, Buchanan TA, Catalano PA, Damm P, 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):676-682. doi: 10.2337/dc09-1848.
22. Catalano PM, McIntyre HD, Cruickshank JK, McCance DR, Dyer AR, Metzger BE, et al. The hyperglycemia and adverse pregnancy outcome study: associations of GDM and obesity with pregnancy outcomes. *Diabetes Care*. 2012;35(4):780-786. doi: 10.2337/dc11-1790.
23. Tehrani FR, Naz MSG, Bidhendi-Yarandi R, Behboudi-Gandevani S. Effect of different types of diagnostic criteria for gestational diabetes mellitus on adverse neonatal outcomes: a systematic review, meta-analysis, and meta-regression. *Diabetes Metab J*. 2022;46(4):605-619. doi: 10.4093/dmj.2021.0178.
24. López Stewart G. Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy: A World Health Organization Guideline. 2014.
25. Singh S, Taneja B, Salvi SS, Agrawal A. Physical properties of intact proteins may predict allergenicity or lack thereof. *PLoS One*. 2009;4(7):e6273. doi: 10.1371/journal.pone.0006273.
26. Li G, Wei T, Ni W, Zhang A, Zhang J, Xing Y, et al. Incidence and risk factors of gestational diabetes mellitus: a prospective cohort study in Qingdao, China. *Front Endocrinol*. 2020;11:636. doi: 10.3389/fendo.2020.00636.
27. Zulkiply SH, Ratnam KKY, Liew SH. Prevalence and factors associated with gestational diabetes mellitus in Malaysia: a population-based study comparing 2016 and 2022. *BMC Public Health*. 2024;24(1):2703. doi: 10.1186/s12889-024-20215-3.
28. Han Y, Tong M, Jin L, Yu J, Meng W, Ren A. Maternal age at pregnancy and risk for gestational diabetes mellitus among Chinese women with singleton pregnancies. *Int J Diabetes Dev Ctries*. 2021;41(1):114-120.
29. Plows JF, Stanley JL, Baker PN, Reynolds CM, Vickers MH. The pathophysiology of gestational diabetes mellitus. *Int J Mol Sci*. 2018;19(11):3342. doi: 10.3390/ijms19113342.
30. Harris SB, Caulfield LE, Sugamori ME, Whalen EA, Henning B. The epidemiology of diabetes in pregnant Native Canadians: a risk profile. *Diabetes Care*. 1997;20(9):1422-1425. doi: 10.2337/diacare.20.9.1422.
31. Dornhorst A, Paterson C, Nicholls J, Wadsworth J, Chiu D, Elkeles R, et al. High prevalence of gestational diabetes in women from ethnic minority groups. *Diabet Med*. 1992;9(9):820-825. doi: 10.1111/j.1464-5491.1992.tb01900.x.
32. Xu X, Liu Y, Liu D, Li X, Rao Y, Sharma M, et al. Prevalence and determinants of gestational diabetes mellitus: a cross-sectional study in China. *Int J Environ Res Public Health*. 2017;14(12):1532. doi: 10.3390/ijerph14121532.
33. ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. Management of diabetes in pregnancy: Standards of care in diabetes—2023. *Diabetes Care*. 2023;46(Supplement_1):S254-S266. doi: 10.2337/dc23-S015.
34. Liu X, Janzen C, Zhu Y, Seamans M, Fei Z, Nianogo R, et al. Prevalence of maternal hyperglycemic subtypes by race/ethnicity and associations between these subtypes with adverse pregnancy outcomes: Findings from a large retrospective multi-ethnic cohort in the United States. *Diabetes Res Clin Pract*. 2024;209:111576. doi: 10.1016/j.diabres.2024.111576.
35. Lewandowska M. Gestational Diabetes Mellitus (GDM) Risk for Declared Family History of Diabetes, in Combination with BMI Categories. *Int J Environ Res Public Health*. 2021,28;18(13):6936. doi: 10.3390/ijerph18136936.
36. Suresh K, Chandrashekara S. Sample size estimation and power analysis for clinical research studies. *J Hum Reprod Sci*. 2012;5(1):7-13. doi: 10.4103/0974-1208.97779.
37. Diagnostic Criteria and Classification of Hyperglycaemia First Detected in Pregnancy [database on the Internet]. WHO Press. Available from: https://iris.who.int/bitstream/handle/10665/85975/WHO_NMH_MND_13.2_eng.pdf?sequence=1