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Original Article

Prevalence and Risk Factors of Carbohydrate Metabolism Disorders among Pregnant Women in Kyrgyzstan

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Abstract

Background: We aimed to determine the prevalence of carbohydrate metabolism disorders among pregnant women in Kyrgyzstan based on the 2013 WHO diagnostic criteria, to study their frequency, and to assess the influence of key risk factors on the likelihood of developing gestational diabetes mellitus (GDM) and overt diabetes.

Methods: A prospective cohort study was conducted, including 617 pregnant women between 2022 and 2024. All participants underwent an oral glucose tolerance test (OGTT) in the second half of pregnancy. Diagnosis of GDM and overt diabetes was carried out according to WHO criteria. Multivariate logistic regression was used to analyze risk factors. ROC analysis was performed to assess the diagnostic value of the number of risk factors in predicting carbohydrate metabolism disorders.

Results: The incidence of GDM was 18.8% (116/617), and overt diabetes — 6.96% (43/617). The main risk factors for GDM were: age over 35 years (P = 0.002), arterial hypertension (P = 0.001), second-degree family history of diabetes (P = 0.001), pre-pregnancy overweight or obesity (P = 0.002), and multiparity (P = 0.000). For overt diabetes, key risk factors included first-degree family history of diabetes (P = 0.034), second-degree family history (P = 0.001), and overweight or obesity (P = 0.018).

Conclusion: An increase in the number of risk factors correlates with the incidence of GDM and overt diabetes. However, for GDM, the number of risk factors is not a reliable predictor, highlighting the need for universal screening of all pregnant women. For overt diabetes, the number of risk factors showed satisfactory predictive value.

Keywords: Diabetes mellitus; Gestational diabetes mellitus; Prevalence; Risk factors

Introduction

Disturbances in carbohydrate metabolism during pregnancy are significant medical concerns, associated with a high risk of complications for both the mother and the fetus. According to the International Diabetes Federation (IDF), 21.1 million cases of hyperglycemia during pregnancy were identified in 2021, with 80.3% of these occurring in women with gestational diabetes mellitus

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(GDM) (1). GDM and diabetes mellitus (DM) can lead to serious complications, including fetal macrosomia (in up to 30–50% of cases), neonatal hypoglycemia (10–20%), preterm birth, and preeclampsia (2). Moreover, up to 50% of women with GDM are at risk of developing type 2 DM within 10 years after delivery (3). GDM and type 2 diabetes share significant pathogenetic mechanisms, making GDM a typical multifactorial disease influenced by various genetic, epigenetic, and environmental factors (4). Physicians from different specialties are particularly interested in modifiable risk factors that can be addressed during preconception planning and pregnancy, such as obesity, arterial hypertension (AH), polycystic ovary syndrome (PCOS), and physical inactivity.

Risk factors for the development of GDM, according to global literature reviews, include: maternal age over 35 years; overweight or obesity (or excessive weight gain during pregnancy); AH (blood pressure ≥140/90 mmHg or ongoing antihypertensive therapy); a history of GDM; previous delivery of a large-for-gestational-age infant (>4 kg); prediabetes (impaired glucose tolerance or impaired fasting glycemia); and any family history of type 2 diabetes (4, 5). The rising prevalence of carbohydrate metabolism disorders, the associated high risk of adverse pregnancy outcomes for both mother and child, and the potential long-term consequences of GDM represent a significant medical and public health concern. This underscores the importance of prevention through risk factor management, timely diagnosis, and effective treatment. We aimed to study the prevalence of carbohydrate metabolism disorders among pregnant women in Kyrgyzstan using the 2013 WHO diagnostic criteria (6), as well as the frequency and impact of key risk factors associated with the development of GDM and overt diabetes.

Materials and Methods

We conducted a prospective cohort study at the Bishkek Obstetrics and Gynecology Center, Kyrgyzstan, between 2022 and 2024. The study included 617 pregnant women. Inclusion criteria: gestational age up to and including 12 weeks; informed consent to participate in the study. Exclusion criteria: pregestational diabetes mellitus; fasting plasma glucose ≥5.1 mmol/L at enrollment. All pregnant women underwent a screening 75-g oral glucose tolerance test (OGTT) in the second half of pregnancy (up to 32 weeks of gestation), with plasma glucose levels measured while fasting, and at 1 and 2 hours post-glucose load. Diagnosis of GDM and overt diabetes was based on WHO 2013 criteria. Obesity was diagnosed using pre-pregnancy body mass index (BMI) values. Total weight gain (TWG) during pregnancy was assessed according to the recommendations of the U.S. National Academy of Medicine (7). Statistical analysis was performed using IBM SPSS Statistics 24.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as percentages and proportions. The significance of differences between independent proportions was evaluated using the z-test (vassarstats.net). Differences were considered statistically significant at $P < 0.05$. Multivariate logistic regression was used to assess risk factors for GDM and overt diabetes. ROC (receiver operating characteristic) analysis was conducted to evaluate the diagnostic value of the number of risk factors in predicting carbohydrate metabolism disorders.

Ethical approval

Research Protocol No. 4 dated September 16, 2022 was approved by the Ethics Committee of the Ministry of Health of the Kyrgyz Republic.

Results

Among the 617 pregnant women who underwent a 75-g oral glucose tolerance test (OGTT) in the second half of pregnancy (mean gestational age at testing: 26.8 ± 3.1 weeks), gestational diabetes mellitus (GDM) was diagnosed in 116 women (18.8%; 95% CI: 15.9%–22.1%) based on WHO criteria (group 2). In 43 women (6.96%; 95% CI: 5.2%–9.2%), the results were consistent with

overt diabetes mellitus (Group 3). A total of 458 women (74.2%; 95% CI: 70.6%–77.5%) had normal OGTT results and were assigned to group 1.

Among women in group 1, the average age was 28 (25; 32), while the age in groups 2 and 3 were 29 (26; 34) and 34 (29; 37), respectively, with the average age of women with normal carbohydrate metabolism being significantly lower than that of women with GDM and DM (*P*=0.01; *P*=0.000).

Table 1: Distribution of studied women by age groups

Age group(yr)	Group 1 N(%)	Group 2 N(%)	*P*- value	Group 3 N(%)	*P*-value
Under 25	126 (27.5)	15 (12.9)	*P*=0.001	4 (9.3)	0.023
25-35 years old	274 (59.8)	75 (64.6)	*P*=0.34	22 (51.2)	0.26
Over 35	58 (12.6)	26 (22.4)	*P*=0.008	17 (39.5)	0.001
Total	458	116		43	

As shown in Table 1, GDM and DM were more common among women in the middle age group (25–35 years) - 64.6% and 51.2% of cases, respectively. However, statistically significant differences compared to women in the main group (group 1) were observed in the age categories under 25 years and over 35 years, indicating that GDM and DM were significantly more prevalent among women over 35 years of age.

The gestational age at which the OGTT was performed ranged from 19 to 32 weeks, with a mean of 27.03 ± 3.0 weeks.

In the course of the study, we also assessed the frequency and significance of the most well-established and confirmed risk factors for GDM and DM in the study population (Table 2).

Table 2: Risk factors in the study groups

Risk factors	Control group N(%)	GDM N(%)	Odds Ratio (OR)	*P*-value	DM N(%)	Odds Ratio (OR)	*P*-value
Age over 35 yr	58 (12.6)	26 (22.4)	3.4 (1.59-7.28	0.002	17 (39.5)	1.84 (0.67-5.06)	0.232
1 degree heredity for DM	18 (3.9)	9 (7.7)	2.37 (0.73-7.63	0.148	7 (16.2)	4.72 (1.12-19.85	0.034
2 degree heredity for DM	79 (17.2)	44 (37.9)	3.57 (1.81-7.05)	0,001	17 (39.5)	6.13 (2.26-16.62)	0,001
Overweight and obesity	72 (15.7)	40 (34.4)	1.64 (1.14-2.35)	0.002	22 (51.2)	2.7 (1.18-6.16)	0,018
Excessive weight gain during pregnancy	102 (22.2)	32 (27.5)	1.36 (0.64-2.9)	0.416	12 (27.9)	2.02 (0.65-6.19)	0.219
Arterial hypertension (AH)	9 (1.9)	12 (10.3)	5.46 (2.24-13.30)	0,001	6 (13.9)	1.96 (0.89-7.53)	0.08
history of a large for gestational age fetus	31 (6.7)	14 (12)	2.06 (0.87-4.89)	0.098	6 (13.9)	1.16 (0.35-3.82)	0.803
Complicated obstetric history (COA)	125 (27.2)	47 (40.5)	1.47 (0.78-2.77)	0.234	21 (48.8)	0.9 (0.34-2.38)	0.844
Polycystic ovary syndrome (PCOS)	13 (2.8)	8 (6.8)	1.59 (0.33-7.66)	0,560	1 (2.3)	0.28 (0.12-6.88)	0.443
Multiparity	117 (25.5)	33 (28.4)	11.35 (4.62-27.89)	0,000	21 (48.8)	0.83 (0.28-3.1)	0.764

The presence of a risk factor as multyparity demonstrates the highest risk of developing GDM, increasing the chance of GDM by more than 11 times (*P*=0.000). AH also significantly increases the likelihood of developing GDM, increasing its risk by more than 5 times (*P*=0.001). Pregnant women over 35 years of age have a 3.4-fold higher risk of developing GDM compared to

younger women (*P*=0.002). Despite the revealed two-fold increase in the risk of GDM in women with first degree heredity OG DM, this result was statistically insignificant (*P*=0.148), while the presence of diabetes in second-degree relatives is a strong and reliable risk factor for developing GDM (*P*=0.001).

Pre-pregnancy excess weight is also a significant predictor of GDM (*P*=0.002). The odds of developing the disease in obese women increase by 64%, indicating the need for weight control before and during pregnancy as an important preventive measure.

Excessive weight gain during pregnancy (*P*=0.416), history of large for geastational age fetus delivery (*P*=0.098), COA (*P*=0.234), PCOS (*P*=0.560) although demonstrated some increase in the odds of developing GDM, but in themselves are not predictors of GDM, and their influence is not statistically significant.

One of the significant risk factors for manifest DM among pregnant women is heredity for diabetes. Thus, 1-degree heredity for DM increases the chances of developing overt diabetes during pregnancy by 4.72 times (*P*=0.034) and is a statistically significant predictor of diabetes. A stronger effect was found for second -heredity: the chances of developing the disease increase by 6.13 times (*P*=0.001), which is also statistically significant.

Overweight and obesity are associated with a 2.7-fold increase in the risk of manifest diabetes (*P*=0.219) and have significant effect on the development of diabetes during pregnancy, while excessive weight gain during pregnancy is not a significant risk factor (*P*>0.05), although it increases the risk of diabetes by 2.02 times (*P*=0.219).

Age over 35 years, which was a significant predictor for GDM, did not show a statistically significant effect for overt DM (*P*=0.232).

We conducted a detailed analysis of the BMI levels among examined women, taking into account the relationship between obesity and insulin resistance, a key mechanism underlying the development of GDM and type 2 diabetes.

Table 3: BMI levels in the study groups of women

BMI	Stage	Control group N(%)	GDM N(%)	*P*-value	DM N(%)	*P*-value
16.5—18.49	Underweight	56 (12.2)	9 (7.7)	0.17	2 (4.6)	
18.5—24.99	Normal	330 (72)	67 (57.7)	0.002	19 (44.2)	0,0001
25-29,99	Overweight	52 (11.3)	30 (25.8)	0,0001	15 (34.8)	0,0001
30—34.99	First degree obesity	16 (3.5)	9 (7.7)	0.04	6 (13.9)	0,001
35-39.99	Second degree obesity	4 (0.8)	1 (0.86)		1 (2.3)	

Assessing the correlation between the variables "BMI" and "total weight gain during pregnancy (TWG)", an inverse moderate relationship was found (Pearson coefficient =-0.287, *P*=0.000).

We performed a detailed analysis of weight gain during pregnancy depending on the initial BMI in the study groups (Fig. 1).

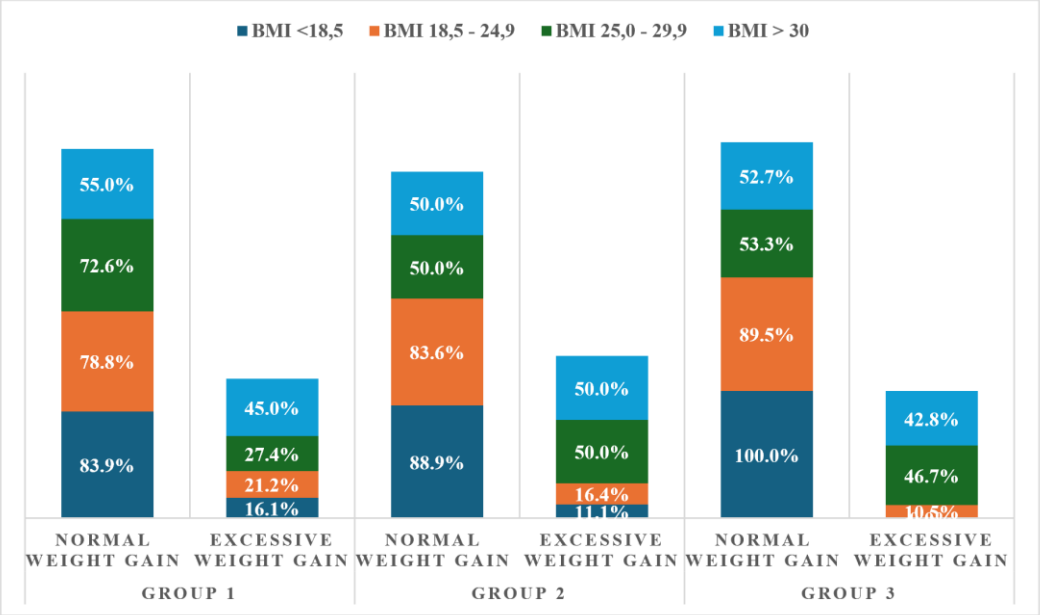

Fig. 1: Weight gain during pregnancy in study groups

In the all three groups, women with BMI <25 kg/m² mostly maintained normal weight gain. In contrast, those with BMI >25 kg/m², especially >30 kg/m², showed a sharp increase in excessive weight gain. This was most pronounced in women with normal carbohydrate metabolism. In GDM and DM groups, weight control in obese women was slightly better, but the risk of excess gain remains high.

When analyzing the total number of risk factors among the examined women (Table 4), it was found that in Group 1, most women had a minimum number of risk factors. Overall, 151 women (32.9%) did not have a single risk factor, which is the highest figure among all groups. One risk factor was identified in 148 women (32.3%), which also confirms the low risk level in this group.

Table 4: Total number of risk factors in the study groups

Number of risk factors	Control group (N =458) N(%)	GDM (N=116) N(%)	*P*-value	DM (N=43) N(%)	*P*-value
No risk factors	151 (32.9)	25 (21.5)	0.01	5 (11.6)	0.003
1 risk factor	148 (32.3)	33 28.4)	0.42	5 (11.6)	0.004
2 risk factors	78 (17)	30 (25.8)	0.02	11 (25.6)	0.16
3 risk factors	52 (11.3)	15 (12.9)	0.63	10 (23.3)	0.02
4 or more risk factors	21 (4.5)	13 (11.2)	0,007	12 (27.9)	0.0002

Among women with GDM, there was higher level of risk factors compared to group 1. There were 25 women (21.5%) without risk factors, which was significantly less than in the first group (P = 0.001). One risk factor was identified in 33 women (28.4%), which was also lower than in the group with normal carbohydrate metabolism, but close in value. Two risk factors were

observed in 30 women (25.8%), which is almost one and a half times higher than in women in group 1 (P = 0.002). Three risk factors were found in 15 women (12.9%), which is also slightly higher than in the first group (P = 0.063). The greatest differences are observed among women with four or more risk factors: 13 women (11.2 %) - this is two and a half times more than in the first group (P = 0.0007), which indicates a significant increase in the risk of GDM with an increase in the number of risk factors.

Group 3 had the highest rates of risk factors. Only 5 women (1.16%) were left without risk factors, which is significantly lower than in the first two groups (P=0.003), demonstrating a pronounced predisposition to complications in women with diabetes.

In order to determine the prognostic significance of the number of risk factors in the diagnosis of GDM and DM, ROC analysis was per% formed (Fig. 2). The analysis resulted in AUC (area under the curve)=0.589 (95% CI 0.53–0.65, P=0.003), which indicates a low prognostic ability of the variable "number of risk factors" for predicting GDM.

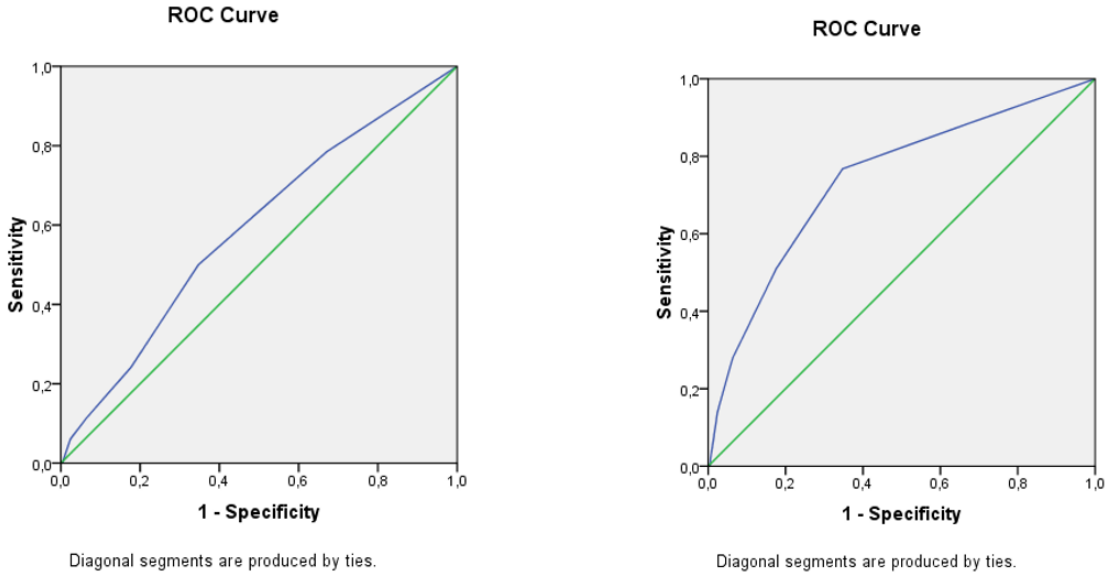

Fig. 2: ROC curve of the significance of the number of risk factors for GDM and overt DM

The AUC value as a result of the ROC analysis of the number of risk factors in predicting manifest FM was higher than in GDM and amounted to 0.741 (95% CI: 0.66–0.82; P=0.0001), indicating a good predictive ability of the number of risk factors for predicting diabetes. The AUC value in the range of 0.7–0.8 indicates satisfactory accuracy of the model. The obtained optimal threshold for the Youden index ≥1.5 shows that women with a number of risk factors of 1.5 or higher have an increased risk of developing diabetes. At the same time, a good balance is achieved between sensitivity (76.7%) and specificity (65.3%).

Discussion

The study examined the prevalence of GDM and overt diabetes among pregnant women in Kyrgyzstan, as well as the frequency and impact of major risk factors. A one-step OGTT with 75 g of glucose conducted in the second half of pregnancy revealed that 18.8% of women suffered from GDM, which was higher than the global standardized prevalence of GDM according to the criteria of the International Association of the Diabetes and Pregnancy Study Groups (IADPSG), accounting for 12.7%, 9.2% and

14.2% in low-, middle- and high-income countries, respectively (8).

The most significant risk factors for GDM were age over 35 years (*P*=0.002), AH (*P*=0.001), second-degree heredity for DM (*P*=0.001), overweight and obesity before pregnancy (*P*=0.002), and multyparity (*P*=0.000). These results are consistent with the data of the world literature, where maternal age over 35 years and obesity are noted as key risk factors (9, 10). Particular attention should be paid to the role of AH, which increases the risk of developing GDM by more than five times (*P*=0.001). This is consistent with the results of studies showing that hypertension and GDM have common pathophysiological mechanisms, including insulin resistance and chronic inflammation (11). For manifest diabetes, the most significant risk factors were first degree-heredity for diabetes (*P*=0.034) and the second degree-heredity (*P*=0.001). Pre-pregnancy overweight and obesity significantly increase the risk of overt diabetes, and excessive weight gain during pregnancy is not a significant predictor, however, women with a BMI greater than 25 kg/m² demonstrate a high probability of excessive weight gain, which may worsen the prognosis.

Interestingly, the number of risk factors showed low prognostic value for GDM (AUC=0.589; CI 0.53–0.65, *P*=0.003), which confirms the need for screening of all pregnant women, regardless of the presence of risk factors. For manifest diabetes, the number of risk factors turned out to be more informative (AUC=0.741; 95% CI: 0.66–0.82; *P*=0.0001), which can be used to identify high-risk groups and targeted monitoring.

Conclusion

The identified risk factors allow us to identify groups of women with an increased probability of developing carbohydrate metabolism disorders and to implement preventive and therapeutic measures in a timely manner. However, for GDM, the number of risk factors is not a reliable predictor and their absence does not exclude GDM, which emphasizes the importance of screening for all pregnant women.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare no obvious or potential conflicts of interest related to the publication of this article.

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