PREVALENCE AND ASSOCIATED FACTORS OF GESTATIONAL DIABETES MELLITUS: A MULTICENTER, CROSS-SECTIONAL STUDY IN MEKONG DELTA REGION

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The purpose of this study was to determine the prevalence and associated factors of gestational diabetes mellitus (GDM) in the Mekong Delta region. A multicenter, cross-sectional descriptive study was conducted on 1727 pregnant women undergoing oral glucose tolerance testing (OGTT) at 4 major central hospitals of 4 provinces in the Mekong Delta region from 06/2017 to 06/2022. Results: Among 1727 pregnant women undergoing OGTT, the overall prevalence of GDM is 17.1% (296/1727), and the prevalence in 4 provinces ranges from 15.4 to 19.0%. Multivariate logistic regression analysis revealed 10 associated factors increasing the risk of GDM, including maternal age ≥ 25, Kinh ethnicity, urban residence, lower than high school education, family history of diabetes in the first generation, BMI ≥ 25 kg/m2, weight gain ≥ 12kg, history of miscarriage, history of delivering babies ≥ 4000g, and prior GDM history (p ≤ 0.05). Conclusion: The prevalence of GDM in the Mekong Delta region is nearly 1/5 of pregnant women, so screening for GDM should be routinely conducted for all pregnant women between 24 and 28 weeks of gestation, particularly those with risk factors associated with an increased risk of GDM.

Keywords: Gestational diabetes mellitus, prevalence, associated factors, oral glucose tolerance testing, 24-28 weeks of gestation.

I. INTRODUCTION

Gestational diabetes mellitus (GDM) is a subtype in the classification of diabetes mellitus. The prevalence of GDM varies from 1-14% in different epidemiological screening studies in countries worldwide.[1] A global overview system in 2021 by Wang H. and colleagues showed that the overall prevalence of GDM is around 14%.[2] In Vietnam, the prevalence of GDM has increased significantly. In the period from 2001-2004, the prevalence of gestational diabetes was about 3-4%, however, by 2012 onwards, this rate had risen to nearly 20%.[1] The development of GDM is related to several risk factors including age, ethnicity, family history of diabetes, dietary habits, physical activity, smoking and alcohol history, previous history of miscarriage, obesity, hypertension, parity, history of stillbirth, etc.[3-6] Early detection of GDM and appropriate management are crucial to prevent adverse outcomes. In this context, estimating the prevalence of GDM and reporting on its risk factors will facilitate the development of suitable medical interventions to improve the health outcomes of both mothers and children. In 2018, the Ministry of Health of Vietnam officially recommended the use of diagnostic standards for gestational diabetes using the 75g oral glucose tolerance test - 2 hours, as

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per the International Association of Diabetes and Pregnancy Study Groups, which has created uniformity in screening and diagnosing this condition.[1] Epidemiological studies on gestational diabetes have been conducted in some provinces of the Mekong Delta region. However, due to previous variations in GDM guidelines, the diagnostic standards in these studies often differ and lack consistency. Thus, with the new GDM diagnostic standards recommended by the Ministry of Health, the condition of GDM in the Mekong Delta region is an important issue of interest. The purpose of the current study is to assess the prevalence and identify risk factors of GDM in the Mekong Delta region, Vietnam, in the recent decade.

II. MATERIALS AND METHOD

1. Study population

Pregnant women attending antenatal care at the Obstetrics Departments of four Obstetric Hospitals in the Mekong Delta region, including Can Tho Obstetrics Hospital, An Giang Obstetric & Pediatric Hospital, Soc Trang Obstetric & Pediatric Specialized Hospital, and Ca Mau Obstetric & Pediatric Hospital, from June 2017 to June 2022.

Inclusion Criteria

Pregnant women with singleton pregnancies, clearly remembering the date of their last menstrual period and/or having ultrasound results within the first 3 months.

Gestational age between 24-28 weeks calculated from the first day of the last menstrual period or ultrasound results from the first 3 months of pregnancy. In cases where the calculated gestational age from the last menstrual period does not match the ultrasound results from the first 3 months, gestational age is determined based on ultrasound results.

Consent to participate in the study: agree to be interviewed, undergo the OGTT 75g test, and provide blood samples for testing as per the GDM screening guidelines of the Ministry of Health.[1]

Exclusion criteria

Refusal to participate in interviews.

Inability to undergo OGTT, unable to provide sufficient blood samples for testing.

Conception through assisted reproductive technology.

Previously diagnosed with diabetes before pregnancy, diagnosed with diabetes from elsewhere, diagnosed with conditions that may affect glucose metabolism: hyperthyroidism, hypothyroidism, Cushing's syndrome, polycystic ovary syndrome, liver disease, kidney failure, etc.

Currently diagnosed with malignant diseases, severe endocrine disorders, cardiovascular diseases, psychiatric disorders.

Currently using medications that affect glucose metabolism: corticosteroids, salbutamol, beta-blockers, thiazide diuretics, antipsychotic drugs, acetaminophen, phenytoin, nicotinic acid, etc

2. Study method

Study design

Cross-sectional descriptive study.

Sample size

The entire sample consisted of subjects who met the inclusion and exclusion criteria during the study period. In reality, we surveyed 1727 cases who underwent OGTT at 4 hospitals in the Mekong Delta region.

Study contents

General characteristics of study participants: age (mean ± SD; < 25/≥ 25), ethnicity (Kinh/ other), place of residence (rural/urban), education level (< high school/≥ high school),

BMI (< 25/≥ 25 kg/m2), and weight gain during pregnancy (< 12/≥ 12kg). [4,6-8]

Past medical and obstetric history of pregnant women: family history of diabetes (yes/no), family history of hypertension (yes/no), history of GDM (yes/no), history of pregnancy-induced hypertension [PIH] (yes/no), gravida (primigravida/multigravida), history of miscarriage (yes/no), and history of fetal macrosomia (yes/no).[6-8]

Determining the rate of GDM: Pregnant women were diagnosed with GDM (according to ADA 2019 diagnostic criteria and the national guidelines of the Ministry of Health of Vietnam 2018).[1,9] The diagnostic procedure of OGTT 75g - 2 hours was performed as follows:

Time: The procedure was carried out between 7 a.m. and 9 a.m., after the pregnant woman had fasted for at least 8 hours overnight.

Fasting blood glucose measurement using venous blood.

Pregnant women were given 75g of glucose - equivalent to 250 mL of 30% glucose solution, which they consumed within 5 minutes. During the procedure, pregnant women were strictly instructed not to smoke, eat, or drink sweetened beverages.

Blood glucose measurement 1 hour after glucose ingestion.

Blood glucose measurement 2 hour after glucose ingestion.

Pregnant women were considered to have GDM if they met or exceeded any of the following blood glucose values:

+ Fasting: 92 mg/dL (5.1 mmol/L).

+ 1-hour: 180 mg/dL (10.0 mmol/L).

+ 2-hour: 153 mg/dL (8.5 mmol/L).

The GDM prevalence (%) of the entire sample was calculated by dividing the number of pregnant women diagnosed with GDM by the total number of pregnant women surveyed. The GDM prevalence of each province was calculated by dividing the number of pregnant women diagnosed with GDM in the surveyed province by the total number of pregnant women surveyed in that province.

Analysis of factors related to GDM in the study population included general characteristics, medical history, and obstetric history.

Statistical analysis

Data were entered using EpiData software and analyzed using Stata 16.0. Categorical variables were presented as frequencies and percentages. Continuous variables were expressed as means and standard deviations. Univariate and multivariate logistic regression analyses were used to identify risk factors, represented by odds ratios (OR), 95% confidence intervals (CI), and p-values (significant when $p \leq 0.05$). Study results were presented in tables or graphs.

3. Ethics in research

The biomedical research ethics committee research of University of Medicine and Pharmacy, Hue University approved this study on April 20, 2016.

III. RESULTS

A total of 1727 pregnant women attended antenatal care at the Outpatient Departments of obstetric hospitals including Can Tho Obstetrics Hospital, An Giang Obstetric & Pediatric Hospital, Soc Trang Obstetric & Pediatric Specialized Hospital, and Ca Mau Obstetric & Pediatric Hospital, agreed to undergo OGTT 75g - 2 hours. The average age of the study sample was 28.78 ± 5.73 years, ranging from 15 to 47 years. The age group 25-34 accounted for the highest proportion at 57.6%. The majority of pregnant women were of the Kinh ethnicity (90.9%). Pregnant women residing in rural

areas accounted for 66.4%. The group with a high school education or below constituted the highest proportion at 36.1%. A total of 202 pregnant women were overweight or obese, with the prevalence of overweight at 10.77% and obesity at 0.93%. The majority of pregnant women met the standard weight gain criteria, accounting for 88.7%.

Table 1. General characteristics of study participants

Characteristics		Frequency (n)	Rate (%)
Family history of diabetes	Yes	171	9.9
	No	1556	90.1
Family history of hypertension	Yes	326	18.9
	No	1401	81.1
Gravida	Primigravida	764	44.2
	Multigravida	963	55.8
History of miscarriage	Yes	349	20.2
	No	1378	79.8
History of fetal macrosomia	Yes	41	2.4
	No	1686	97.6
History of GDM	Yes	12	0.7
	No	1715	99.3
History of PIH	Yes	33	1.9
	No	1694	98.1

Among the 1727 participants, 9.9% of pregnant women had a family history of diabetes mellitus, while 18.9% had a family history of hypertension. Pregnant women carrying multigravida accounted for 44.2%, while those carrying primigravida accounted for 55.8%. 20.2% of pregnant women had a history of miscarriage, and 2.4% had a history of giving birth to large babies. Regarding the medical history of previous pregnancies, 0.7% of pregnant women had a history of GDM, and 1.9% had a history of pregnancy-induced hypertension.

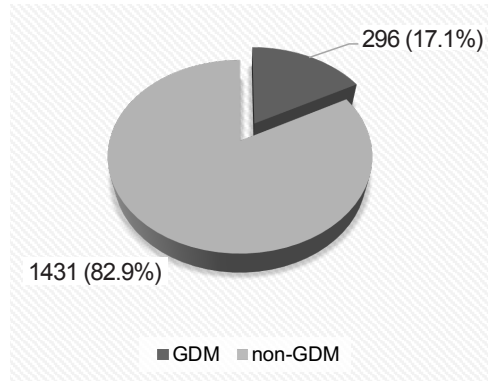

Figure 1. The prevalence of gestational diabetes mellitus

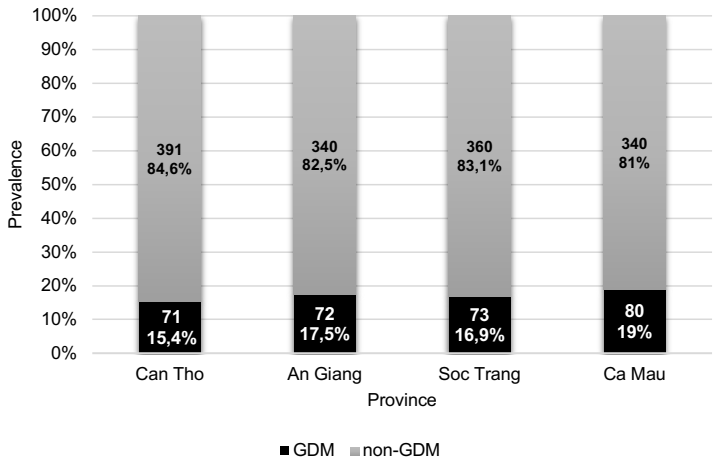

Figure 2. The prevalence of gestational diabetes mellitus of each province

Out of the 1727 pregnant women who underwent OGTT, 296 were diagnosed with GDM, accounting for 17.1%. The prevalence of GDM in Can Tho, An Giang, Soc Trang, and Ca Mau provinces is 15.4%, 17.5%, 16.9%, and 19.0%, respectively.

Table 2. Logistic regression analysis of factors associated with gestational diabetes mellitus

Factors	Univariable analysis		Multivariable analysis	
	OR (95% CI)	p	OR (95% CI)	p
Age (≥ 25)	2.22 (1.56-3.16)	< 0.001	1.72 (1.17-2.55)	0.006
Ethnicity (Kinh)	1.79 (1.07-3.02)	0.027	1.81 (1.06-3.11)	0.031
Place of residence (urban area)	1.34 (1.04-1.74)	0.025	1.34 (1.02-1.77)	0.039
Education level (under high school)	1.36 (1.05-1.76)	0.018	1.46 (1.11-1.93)	0.007
Family history of diabetes (yes)	2.42 (1.70-3.46)	< 0.001	1.68 (1.13-2.50)	0.011
Family history of hypertension (yes)	1.67 (1.24-2.24)	< 0.001	1.22(0.87-1.70)	0.243
BMI (≥ 25 kg/m^2)	3.39 (2.45-4.70)	< 0.001	2.79 (1.98-3.93)	< 0.001
Weight gain (≥ 12 kg)	1.29 (0.89-1.87)	0.184	1.50 (1.01-2.23)	0.043
Pravida (multigravida)	1.58 (1.22-2.05)	< 0.001	0.98 (0.73-1.33)	0.903
History of miscarriage (yes)	1.67 (1.25-2.23)	< 0.001	1.36 (1.00-1.85)	0.049
History of macrosomia (yes)	5.39 (2.86-10.14)	< 0.001	4.08 (2.03-8.18)	< 0.001
History of GDM (yes)	14.9 (3.97-56.11)	< 0.001	5.66 (1.33-24.09)	0.019
History of PIH (yes)	3.24 (1.59-6.61)	< 0.001	1.72 (0.79-3.77)	0.172

The results of multivariate logistic regression analysis showed that there are 10 associated factors increasing the risk of GDM, including age ≥ 25, Kinh ethnicity, urban residence, education level lower than high school, family history of first-generation diabetes, BMI ≥ 25 kg/m^2, weight gain ≥ 12kg, history of miscarriage, history of giving birth to babies weighing ≥ 4000g, and history of GDM.

IV. DISCUSSION

The current study is a large-scale cross-sectional study conducted in the Mekong Delta region with 1727 pregnant women participating across 4 major hospitals in the area. We found the overall prevalence of GDM to be 17.1%, with specific rates ranging from 15.4% to 19.0% across the 4 provinces. These results are consistent with a study by Truong Thi Ai Hoa of Ho Chi Minh City, where the author reported a GDM prevalence of 18.9%.[8] Similarly, reports by Wang H. and colleagues indicated a global prevalence of 14.2%.[2] Conversely, data from a study by Nguyen Khoa Dieu Van at Bach Mai Hospital in 2015 showed a higher prevalence compared to our results, at 39%.[10] On the other hand, the GDM rate was only 7.4% in a study by Nguyen Thi Phuong Yen conducted at Can Tho University of Medicine and Pharmacy Hospital, lower than the current study.[7] The differences in GDM prevalence are mainly attributed to population characteristics, sample size, screening models, and diagnostic criteria. However, it is noteworthy that the increasing prevalence of GDM in recent studies, as well as changes in current diagnostic criteria towards earlier diagnosis, highlight the reality of this condition and the necessity of GDM screening.

The study also identified several risk factors associated with GDM through analysis. Age ≥ 25 significantly increases the risk of developing GDM compared to age < 25, a finding consistent with previous research by Nguyen Thi Phuong Yen, which showed that the ≥ 25 age group had a 2.42 times higher risk of GDM (95% CI: 1.96-6.23).[7] Mazumder T. and colleagues from Bangladesh also found that pregnant women aged ≥ 25 had a 2.02 times higher likelihood of developing GDM (95% CI: 1.13-3.62) compared to those under 25.[11] The majority of pregnant women were of the Kinh ethnicity, and both univariate and multivariate analyses showed that Kinh pregnant women had an increased risk of GDM compared to other ethnic groups. This association may be explained by different dietary habits or lifestyle behaviors among different ethnicities. Regarding residence, although urban pregnant women accounted for a small proportion of the study population, the risk of GDM was higher in urban areas compared to rural areas. This finding is similar to the study by Nguyen Thi Phuong Yen, where urban pregnant women had a 2.65 times higher risk of GDM (95% CI: 1.04-6.78) compared to rural areas.[7] Despite the narrowing gap between urban and rural areas, disparities still exist, with higher incomes in urban areas leading to dietary habits and structures that pose a higher risk of disease compared to rural areas. We noted that pregnant women with a high school education or below were more likely to develop GDM in both univariate and multivariate analyses. Similarly, Mazumder T. and colleagues found that pregnant women living in rural areas had a 2.74 times higher risk of GDM (95% CI: 1.43-5.28).[11] This could be due to lower educational attainment among pregnant women, resulting in less access to information and insufficient understanding of the risks and healthcare. Additionally, difficult living conditions may lead to less regular prenatal care, resulting in a higher risk of GDM. However, studies by Truong Thi Ai Hoa and Nguyen Thi Phuong Yen showed no significant difference between educational

levels.[7,8] Our study also found that a BMI ≥ 25 kg/m^2 increased the risk of GDM. Several previous studies have also noted a clear association between pre-pregnancy BMI and the occurrence of GDM.[12,13] Weight gain during pregnancy is an important factor to consider. Although the current study did not show significant differences in the GDM rate between the two groups of pregnant women with weight gain ≥ 12kg and < 12kg in univariate analysis (p = 0.184), multivariate analysis revealed that excessive weight gain during pregnancy was associated with GDM, with pregnant women gaining ≥ 12kg having a higher risk of GDM. Similarly, Nguyen Thi Phuong Yen's study found that pregnant women who gained excessive weight during pregnancy were 2.5 times more likely to develop GDM than those who gained weight within the normal range (p = 0.018).[7] Therefore, managing weight before pregnancy and controlling weight gain during pregnancy, especially in the early stages, may play an important role in preventing GDM.

We also analyzed some factors related to history, and the results showed a correlation between a family history of diabetes mellitus and the subsequent risk of developing GDM in pregnant women. This finding is consistent with a previous study by Truong Thi Ai Hoa at District 2 Hospital, which found that pregnant women with a family history of DM had a 3.22 times higher risk of GDM (95% CI: 1.93-5.38).[8] Additionally, the study found that pregnant women who had a history of GDM themselves were also associated with a higher risk of GDM in the future. Li G. and colleagues' previous report further supports our findings, as they found that pregnant women with a history of GDM were 7.74 times more likely to develop GDM compared to those without a history of GDM (95% CI: 6.42-9.32, p < 0.001).[14] Indeed, a history of GDM is considered the strongest risk factor for GDM and is one of the high-risk factors that require early screening. According to Garrison A., a history of GDM is an independent risk factor with an adjusted OR of 13.2, much higher than other independent risk factors with OR < 3.[15] We also noted that pregnant women with a history of giving birth to babies ≥ 4000g had a significantly higher risk of developing GDM in both univariate and multivariate analyses. Similarly, a history of miscarriage was also an independent risk factor for GDM. These findings are supported by numerous international reports.[12] Conversely, authors Truong Thi Ai Hoa and Nguyen Thi Phuong Yen did not find a statistically significant correlation between a history of miscarriage and GDM.[7,8] There are several reasons that may influence this relationship. When collecting data for assessment, we and other authors did not differentiate between spontaneous miscarriage and induced abortion. On the other hand, the practice of multiple abortions may be related to educational level, family economic status, and pre- and post-pregnancy healthcare.

The advantage of this study is its large sample size, multicenter nature, which highly represents the pregnant population, thereby contributing to an overall picture of the recent situation of GDM in Vietnam. We also proposed some hypotheses about the risk factors for GDM; however, as this is a cross-sectional descriptive study, causality cannot be demonstrated. Clearly, cohort studies need to be conducted in the future to fill the current gap.

V. CONCLUSION

The prevalence of GDM in our study is 17.1%. Screening for GDM should be routinely performed for all pregnant women with gestational age between 24-28 weeks, especially for those with risk factors associated with increased GDM risk, including maternal age ≥ 25, Kinh ethnicity, urban residence, education level lower than high school, family history of

diabetes mellitus, BMI ≥ 25, weight gain ≥ 12kg, history of miscarriage, history of giving birth to babies ≥ 4000g, and history of GDM.

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