Clinical Value of Early-pregnancy Glycated Hemoglobin, Fasting Plasma Glucose, and Body Mass Index in Screening Gestational Diabetes Mellitus

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Research Article

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Abstract

Objective: To investigate the clinical value of early-pregnancy glycated hemoglobin (HbA1c), fasting plasma glucose (FPG), and body mass index (BMI) in screening gestational diabetes mellitus (GDM).

Methods: 216 pregnant women with GDM who underwent oral glucose tolerance test (OGTT) at 24-28 weeks were selected as the study (GDM) group, and 278 cases were randomly selected as the control group. FPG and glycated hemoglobin in early pregnancy were detected, and body mass index in early pregnancy was measured. The correlation between FPG, glycated hemoglobin and BMI in early pregnancy and the incidence of GDM was analyzed by binary Logistic regression, and the value of each index in predicting GDM alone or in combination was evaluated.

Results: FPG, glycated hemoglobin and BMI in early pregnancy in GDM group were higher than those in control group, and the differences were statistically significant ($P<0.05$). Binary logistic regression analysis showed that FPG, glycated hemoglobin and BMI were risk factors for GDM in early pregnancy [OR values were 3.374 ($P<0.05$), 4.644 ($P < 0.05$), and 1.077 ($P<0.05$), respectively]. The area under the ROC curve of FBG, glycated hemoglobin and BMI in early pregnancy for predicting the occurrence of GDM were 0.647, 0.661 and 0.608, respectively, while the area under the ROC curve of the combination of FBG, HBA1C and BMI for predicting GDM was 0.736, which showed higher diagnostic efficacy than that of the single indicator.

Conclusions: FPG, glycated hemoglobin and BMI in early pregnancy were risk factors for the occurrence of GDM, and their combination has certain clinical value of prediction.

Introduction

Gestational diabetes mellitus (GDM), defined as a metabolic disease in which abnormal blood glucose is first detected during, but not before, the pregnancy, can lead to adverse pregnancy outcomes such as ketoacidosis, gestational hypertension, fetal macrosomia, intrauterine growth restriction, fetal distress, etc., and is associated with the increased risk of developing type 2 diabetes after delivery [1, 2]. Due to the high incidence and multiple adverse effects of GDM, early screening and diagnosis can timely intervene in and reduce the occurrence of adverse pregnancy outcomes. At present, the OGTT test has been recommended home and abroad for screening and diagnosis of GDM at 24-28 weeks of gestation, but OGTT requires complicated operations and more time, resulting in poor acceptance and compliance of pregnant women [3, 4]. It is also susceptible to many objective factors. If there are more convenient, simple screening methods that can replace the previous and screen GDM at an earlier stage, it will be more promising to achieve earlier clinical intervention and less risk of adverse perinatal outcomes. The purpose of this study was to determine the clinical value of early-pregnancy glycated hemoglobin (HbA1c), fasting plasma glucose (FPG), and body mass index (BMI) in screening for GDM among gestational diabetics.

Materials And Methods

This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethic committee of The No. 1 Hospital of Wuhan. Written informed consent to publish the clinical details and images of the patient was obtained.

1.1 Participants

We selected 1120 cases of women with singleton pregnancy who had their records and regular maternity check-ups in our hospital from May 2017 to May 2019. The study group consisted of 216 pregnant women who had OGTT tests at 24-28 weeks of gestation and were diagnosed with GDM; the control group consisted of 278 pregnant women randomly selected. Exclusion Criteria: 1. multiple pregnancies; 2. patients with pre-pregnancy diabetes, hypertensive diseases, thyroid dysfunction, combined disease of the liver and kidney disease or tumor; 3. patients with gestational hypertensive disease during pregnancy.

1.2 Methods

All pregnant women had fasting blood glucose and glycated hemoglobin tests as well as their body mass index measured at the phase of early pregnancy (8-13 weeks) and took the OGTT test at 24-28 weeks. All pregnant women fasted for 12 hours before blood sampling and 5 ml of brachial venous blood was collected on the following morning to determine FPG, HbA1c, and BMI. BMI formula = weight/height squared (kg/m^2).

1.3 Diagnosis

GDM is diagnosed by performing an OGTT test at 24-28 weeks of gestation to measure fasting blood glucose (5.1 mmol/L), blood glucose levels in 1 hour (10.0 mmol/L) and 2 hours (8.5 mmol/L) after glucose administration; any abnormality of blood glucose can determine the diagnosis [5].

1.4 Statistical methods

The data of the two groups were analyzed using SPSS 20. The mean ± standard deviation (X±s) was used to express the measurement data. Independent sample t test was used for comparison between groups if the variance was equal. Chi-square test was used to count the data. $P < 0.05$ indicated that the difference was statistically significant. The influencing factors were analyzed by binary logistic regression, and ROC curves were drawn to analyze the clinical value of BMI, FPG, HbA1c, and the combination of them all in predicting GDM.

Results

2.1 Comparison of general data of pregnant women between two groups

There was no statistically significant difference (P > 0.05) between the two groups in terms of maternal age, gravidity, and parity. The BMI of the study group was higher than that of the control group with a statistically significant difference (P < 0.05). See Table 1.

Table 1
Comparison of general data of pregnant women between two groups (X±s)

Groups	Cases (n)	Age (years old)	Gravidity (n)	Parity (n)	BMI (kg/m2)
Study (GDM) group	216	29.39±4.70	1.95±0.86	0.48±0.54	26.08±5.21
Control group	278	29.05±4.74	2.04±0.79	0.43±0.53	24.09±4.55
t	-	0.810	1.170	1.009	4.435
P	-	0.418	0.243	0.314	0.000

2.2 Comparison of FPG and HbA1c of pregnant women between two groups

The FPG and HbA1c levels in the study group were higher than those in the control group, with a statistically significant difference (P < 0.05). See Table 2.

Table 2
Comparison of FPG and HbA1c levels in early pregnancy between two groups (X±s)

Groups	Cases (n)	FPGm (mmol/L)	HbA1c (%)
Study (GDM) group	216	4.02±0.44	4.81±0.37
Control group	278	3.79±0.44	4.60±0.35
t	-	5.905	6.441
P	-	0.000	0.000

2.3 The correlation between GDM and serum FPG, HbA1c, and BMI in pregnant women

Logistic regression analysis showed that FPG, HbA1c, and BMI in early pregnancy were risk factors for the occurrence of GDM (P < 0.05), with OR values of 3.374, 4.644, and 1.077, respectively. See Table 3.

Table 3
The correlation between serum FPG, HbA1c levels, BMI and GDM

Items	*β*	S.E	Wals	*P*	OR (95%CI)
BMI	0.074	0.021	12.983	0.000	1.077(1.035-1.122)
FPG	1.216	0.235	26.667	0.010	3.374(2.127-5.353)
HbA1c	1.536	0.284	29.148	0.000	4.644(2.659-8.109)

2.4 Predictive value of combined tests for GDM

FPG, HbA1c, and BMI individually predicted GDM with sensitivities of 0.588, 0.505, and 0.634, and specificities of 0.633, 0.745, 0.554, while the combination of the three with the sensitivity of 0.689 and the specificity of 0.640. The AUC of the combination curve was 0.736, significantly higher than that of the individual test (FPG 0.647, HbA1c 0.661, BMI 0.608), as shown in Figure 1 and Table 4.

Table 4
Comparison of the efficacy of individual and combined tests for GDM diagnosis

Items	AUC	95%CI	*P*	Sensitivity	Specificity	Maximum Younden index
BMI	0.608	0.558-0.659	0.000	0.634	0.554	0.188
FPG	0.647	0.598-0.695	0.000	0.588	0.633	0.221
HbA1c	0.661	0.613-0.709	0.000	0.505	0.745	0.249
Combination	0.736	0.692-0.779	0.000	0.689	0.640	0.356

Discussion

The prevalence of GDM has gradually increased [6], accompanied by the improved living standard and constantly revised diagnostic criteria for GDM in recent years, threatening the mental and physical health of pregnant women and the safety of the fetus. Despite this, the cause of GDM remains unclear. The generally accepted explanation at the moment is insulin resistance and islet cell damage for various causes [7], and the exact mechanism is still in controversy [1]. The internationally recognized GDM diagnostic criterion is OGTT at 24-28 weeks of gestation, but as the gestational week is close to the

second trimester and earlier intervention is not available, many scholars have been investigating in recent years whether there are reliable screening or diagnostic indicators in early pregnancy.

Some studies have revealed a certain correlation between early-pregnancy FPG, HbA1c, BMI, and GDM [8]. FPG in early pregnancy is the initial screening of blood glucose during pregnancy. Han Wenli et al. [9] found that fasting blood glucose in early pregnancy has predictive value for GDM, which is consistent with this study. HbA1c is originally used to measure the level of glycemic control in recent months [10]. There has now been a heated debate at home and abroad on whether HbA1c can be used to screen GDM in early pregnancy. Some scholars believe that HbA1c is a stable reflection of blood glucose in the last 3 months. That it allows blood sampling at any time without fasting makes it easier to perform and more acceptable for patients, with better compliance of pregnant women and benefits to clinical work. Besides, HbA1c can not only detect abnormal blood glucose but also monitor the recent situation of blood glucose. In this study, early-pregnancy HbA1c and FPG of pregnant women with GDM were found to be higher than those in the normal control group, which is consistent with Zhao Ming's study [11]. Regression analysis showed that HbA1c and FPG were high-risk factors for GDM, and high levels of early-pregnancy HbA1c and FPG could predict the occurrence of GDM.

Studies have shown that obese patients have more severe insulin resistance and impaired pancreatic β-cell function, and BMI is an important indicator of obesity in humans. A meta-analysis [12] showed that overweight and obese pregnant women were 2.01 times more likely to develop GDM than those with a normal BMI. Therefore, diet, lifestyle intervention, and weight control are important part of GDM therapy [13]. Studies by Harper LM et al.[14] and Li et al.[15] suggested that early screening for GDM in obese women can prevent fetal overgrowth and reduce perinatal outcomes such as macrosomia. This study found that pregnant women who developed GDM also had a higher body mass index in early pregnancy than those in the control group. Logistic regression analysis suggested that pregnant women with a high BMI were 1.077 times more likely to develop GDM than those with a low BMI, which proved that BMI in early pregnancy might be a risk factor for GDM. The probability of developing GDM is also lower if some measures are taken in early pregnancy to improve dietary lifestyle and control weight, than that without interventions.

However, there are still some limitations in our study. This study has a relevant small sample size from a single center. Therefore, in the future study, we should do much deeper study on this topic using a large sample size from the multiple center.

In this study, we found that early-pregnancy FPG, HbA1c, and BMI of pregnant women with GDM were higher than those of the normal control group. ROC curve analysis showed that the AUCs of the three tests individually in predicting GDM were 0. 647, 0.661, and 0. 608, with respective sensitivity as 0.588, 0.505, and 0.634, specificity 0.633, 0.745, 0.554; the AUC of combined test 0.736, sensitivity 0.689, specificity 0.640, comprehensively higher than the three indexes that individually predict GDM. Therefore, it was inferred that the combination of BMI, FPG, and HbA1c in early pregnancy has higher diagnostic efficacy and can be used as a means of screening for GDM in early pregnancy. The combined application

of the three indicators has higher clinical value and a significantly improved accuracy of GDM screening. At present, a unified standard for early prediction of GDM has not yet come into being in clinical practice, and multicenter prospective randomized controlled trials with large sampling are necessary to provide a solid theoretical basis for early prediction of GDM, early intervention, and less incidence of adverse perinatal outcomes.

Abbreviations

glycated hemoglobin: HbA1c

fasting plasma glucose: FPG

body mass index: BMI

gestational diabetes mellitus: GDM

oral glucose tolerance test: OGTT

Declarations

Ethics approval and consent to participate: This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethic committee of The No. 1 Hospital of Wuhan.

Consent for publication: written informed consent to publish the clinical details and images of the patient was obtained.

Availability of data and materials: The datasets used and/or analysed during the current study available from the corresponding author on reasonable request. Competing interests: all authors declare they have no conflict of interests.

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Figures

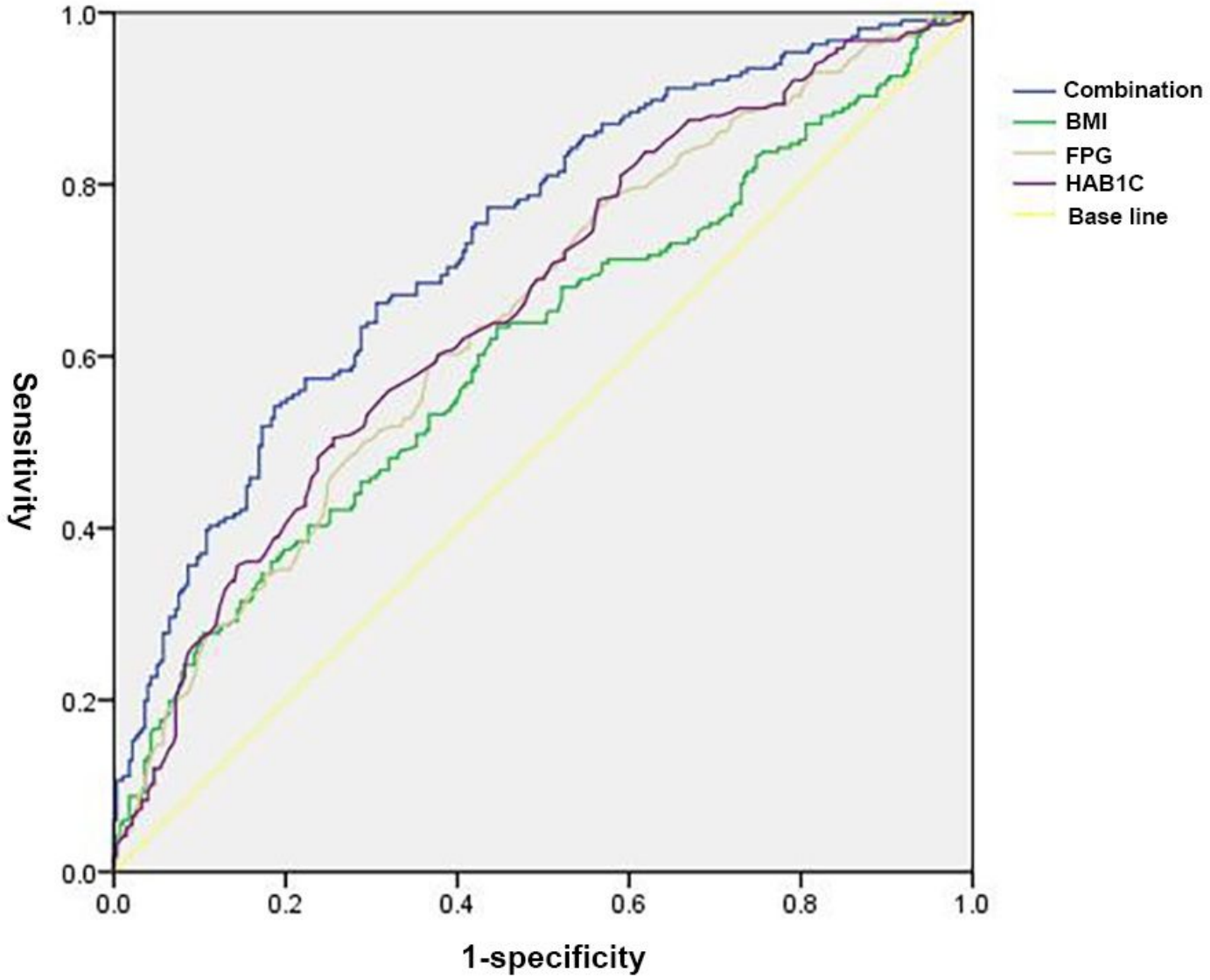

Figure 1

receiver operator characteristic (ROC) curves of glycated hemoglobin (HbA1c), fasting plasma glucose (FPG), and body mass index (BMI) individually predicting gestational diabetes mellitus (GDM), and the ROC curve of the three combined predicting GDM.