Performance and the Optimal Cut-Off Value of First-Trimester Fasting Plasma Glucose To Identify Gestational Diabetes Mellitus: A Retrospective Study From Southern China

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Abstract

Purpose

Previous studies have suggested that first-trimester fasting plasma glucose (FPG) is associated with gestational diabetes mellitus (GDM) and is a predictor of GDM. The aim of the present study was to explore whether first-trimester FPG levels can be used as a screening and diagnostic test for GDM in pregnant women.

Methods

This retrospective study included pregnant women who had their first-trimester FPG recorded at 9-13⁺⁶ weeks and underwent screening for GDM using the 2-hour 75 g oral glucose tolerance test (OGTT) between 24th and 28th gestational weeks. The cut-off values were calculated using a receiver operating characteristic (ROC) curve.

Results

The medical records of 28,030 pregnant women were analysed, and 4,669 (16.66%) of them were diagnosed with GDM. The mean first-trimester FPG was 4.62 ± 0.37 mmol/L. The total trend in the optimal cut-off value of first-trimester FPG in pregnant women was 4.735 mmol/L, with a sensitivity of 49%, a specificity of 67.6% and AUC of 0.608 (95% CI: 0.598-0.617, $p < 0.001$). Moreover, as the maternal age increased, the optimal cut-off values increased, respectively. The results suggest that first-trimester FPG can be considered a marker for identifying pregnant women with GDM.

Conclusion

The level of first-trimester FPG increased slightly with maternal age and, as maternal age increased, the optimal cut-off values increased, especially after age 30. The first-trimester FPG should be considered a screening marker when diagnosing GDM in pregnant women.

Introduction

Gestational diabetes mellitus (GDM) is one of the most common medical diseases related to pregnancy. It was previously defined as “hyperglycaemia first detected during pregnancy”¹. According to the WHO, approximately 16% of pregnant women worldwide are affected by GDM². GDM usually manifests in the second half of pregnancy and is caused by extreme physiological insulin resistance. Early diagnosis and treatment of GDM is extremely important because GDM can lead to several severe maternal-foetal complications, such as neonatal hypoglycaemia, birth injuries, macrosomia, shoulder dystocia,

respiratory distress syndrome, childhood obesity and perinatal mortality³. Despite the worldwide prevalence and severity of GDM, a universally accepted screening test is lacking. Screening tests and diagnostic criteria vary widely among clinicians and across geographic areas¹. Thus, the optimal method to screen for GDM in the first trimester remains unclear.

The ACOG and ADA recommend that all pregnant women, regardless of risk factors, should be screened for GDM by OGTT at 24 to 28 weeks of gestation^{4,5}. In 2010, IADPSG also recommended a 75-gram OGTT test at 24-28 weeks of gestation for the diagnosis of GDM in all pregnant women with no apparent history of diabetes⁶. However, some studies have pointed out that OGTTs cannot be widely implemented because of the complexity of the test, the need for a prior appointment, the long waiting time and the low cost-effectiveness⁷. Doctors are thus attempting to find a more acceptable alternative strategy for the diagnosis of GDM to reduce the number of pregnant women who need to undergo an OGTT.

In this regard, FPG has been reported to have good efficacy as a screening test for GDM, especially at low thresholds, which has a strong influence on the exclusion of GDM in women. High-precision FPG can reduce the burden on the laboratory and save resources because it may be very difficult to carry out 75-gram OGTTs with a large population and limited resources⁸. Previous studies have shown that FPG can be used to predict the risk of GDM in the third trimester, but there are significant differences among geographical regions of the world^{7,8}. Compared with the use of OGTTs, FPG is easy to manage, well-tolerated, reliable and has good repeatability; it also changes minimally throughout the entire pregnancy⁹. However, the usefulness of FPG in predicting GDM is not widely recognized because of the different diagnostic criteria, the choice of gestational age and differences related to race. There are no recognized diagnostic criteria for FPG in pregnant women^{9,10}. First-trimester FPG for screening GDM lacks related research with large samples in southern China, where the prevalence of GDM is different from that in northern China because of in cooking habits, flavour styles and so on^{11,12}. Southerners like sweets and are fed rice, whereas northerners prefer salty food. Therefore, it is necessary to establish some evidence for the use of first-trimester FPG and to delineate its optimal cut-off value for diagnosing GDM in southern China. In our study, we attempted to use the IADPSG standard⁶ to assess the sensitivity and specificity of FPG in the diagnosis of GDM to avoid the implementation of a large number of OGTT tests in southern China.

Methods

Subjects

This retrospective study included pregnant women who delivered between 1 June 2017 and 31 December 2019 at Shenzhen Maternal and Childcare Hospital in Shenzhen, southern China. Pregnant women younger than 18 years old, multiple pregnancies, pregnancies conceived by assisted reproductive technology, first-trimester FPG > 7.00 mmol/L and incomplete information, such as FPG in the first-trimester (FPG value between 9-13⁺6 weeks of gestation), 0-, 1- or 2-hour plasma glucose in a 2-hour 75 g

OGTT between 24-28 weeks' gestation, were excluded. Finally, only 28,030 pregnant women were included in our study (**Figure 1**). The study was reviewed and approved by the Ethical Review Boards of Shenzhen Maternal and Childcare Hospital (Approval number: Shenzhen Maternal and Child Ethics Review No. 23; Approval date: 2017-04-07).

Data Collection and Definitions

Demographic information and medical data, such as maternal age, pregestational body mass index (BMI), first-trimester FPG (collected the sample before 10 am every day), and 0-, 1- or 2-hour plasma glucose in a 2-hour 75 g OGTT between 24-28 weeks' gestation, were collected. The first-trimester FPG and OGTT results were measured using the enzyme electrode method (DXC800, Beckman). First-trimester FPG was measured using venous blood samples after at least 8 h at the first visit and divided into seven groups according to the HAPO study (≤ 4.2 mmol/L, 4.2-4.4 mmol/L, 4.5-4.7 mmol/L, 4.8-4.9 mmol/L, 5.0-5.2 mmol/L, 5.3-5.5 mmol/L, ≥ 5.6 mmol/L). GDM is defined as FPG, 1- or 2-hour plasma glucose of ≥ 5.1 , ≥ 10.0 , or ≥ 8.5 mmol/L, respectively, in 2-hour 75 g OGTT values between 24-28 weeks' gestation by IADPSG standard⁶. The study population was stratified according to GDM status: GDM (FPG, 1- or 2-hour plasma glucose of ≥ 5.1 , ≥ 10.0 , or ≥ 8.5 mmol/L, respectively) and non-GDM.

Statistical Methods

Data are presented as the mean $\pm$ standard deviation (SD) for continuous variables and numbers (percentages) for categorical variables. Differences between the GDM and non-GDM groups were assessed by the Student's t-test and the chi-squared test according to the nature of the variables. Cut-off values of the first-trimester FPG were determined using receiver operating characteristic (ROC) curves, and the area under the curve (AUC) and 95% confidence intervals (CIs), positive predictive value (PPV) and negative predictive value (NPV) were calculated. All statistical analyses were carried out using R software (version 4.0.3, <https://www.r-project.org/>). A two-tailed p-value < 0.05 was considered statistically significant.

Results

Baseline characteristics of pregnant women between GDM and non-GDM

Table 1 displays the different characteristics of the pregnant women between GDM and non-GDM. Among 28,030 pregnant women, 4,669 (16.66%) were diagnosed with GDM. The mean maternal age was 31.01 ± 4.12 years, and the number of pregnant women with GDM was significantly higher than that of non-GDM women ($P < 0.001$). Among the GDM group, women aged 30-34 years occupied the largest number (42.13%), and in the non-GDM group, women aged less than 30 years occupied the largest number (42.87%). The mean first-trimester FPG level was 4.62 ± 0.37 mmol/L. The incidence of GDM increased with the first-trimester FPG level in the groups with first-trimester FPG levels < 4.2 mmol/L, between 4.2 mmol/L and 4.4 mmol/L, and between 4.5 mmol/L and 4.7 mmol/L was 6.47%, 17.95%, and 25.68% respectively ($P < 0.001$). The incidence of GDM decreased in the groups with first-trimester FPG

levels 4.8-4.9 mmol/L, 5.0-5.2 mmol/L, 5.3-5.5 mmol/L and ≥ 5.6 mmol/L, which was 23.82%, 15.40%, 6.83% and 3.86%, respectively ($P < 0.001$). The results of the OGTT at 24–28 gestational were also significantly different for pregnant women between GDM and non-GDM (all $P < 0.05$). According to the IADPSG diagnosis standard of GDM, the prevalence of GDM with 0 h, 1 h and 2 h of OGTT was 21.27%, 38.23% and 49.39%, respectively.

Predictive Performance and the Optimal first trimester FPG Cut-Off Points

Figure 2 showed the association between odds ratio (OR) of GDM and levels of first-trimester FPG (mmol/L), as first-trimester FPG increased, the OR for identifying GDM increased among pregnant women, with a value of first-trimester FPG at 4.6 mmol/L which OR equal to 1 (Chi-Square = 665.79, $p < 0.001$). The optimal cut-off value of maternal age-specific first-trimester FPG for identifying GDM were shown in **Table 2**. And **Figure 3** showed first-trimester FPG for identifying GDM in pregnant women among different maternal age. The optimal cut-off value of first-trimester FPG to distinguish GDM in pregnant woman was 4.735 mmol/L, with a sensitivity of 49% and a specificity of 67.6% and an AUC of 0.608 (95% CI: 0.598-0.617), the optimal cut-off value of first-trimester FPG for pregnant women for identifying GDM were higher with maternal age (Z test = 24.065, $p < 0.01$).

The incidence of GDM by different screening and diagnostic criteria

Set first-trimester FPG greater than or equal to 4.7 mmol/L (first trimester FPG ≥ 4.7 mmol/L) as a screening criterion. **Figure 4** showed the incidence of GDM by different screening and diagnostic criteria, it was indicated that 51.68% of the pregnant women can be diagnostic as GDM with first-trimester FPG, which overlapped 21.27%, 38.23% and 49.39% in OGTT 0 h, 1 h OGTT and 2 h OGTT at 24~28 gestational weeks, respectively.

Discussion

In 2008, the HAPO study was conducted with 25,505 pregnant women in 15 centres from nine countries who underwent 75 g OGTT at 24 to 32 gestation weeks and showed that an elevated FPG lower than the diagnosis level of diabetes in pregnant women was associated with adverse pregnancy outcomes, including GDM, LGA and/or macrosomia, as well as caesarean delivery, and was strongly and consistently associated with birth weight gain and elevated C-peptide levels in cord blood¹³. Another study of HAPO further noted that higher FPG levels in the first trimester, which are currently considered to be nondiabetic, increased the risk of adverse pregnancy outcomes¹⁴. Our data presented here showed that the prevalence of GDM was 16.66% in southern China, which was similar to that of the WHO². Interestingly, the results showed that the prevalence of GDM increased with the first-trimester FPG level increasing when it was lower than 4.7 mmol/L ($P < 0.001$). In particular, when the first-trimester FPG was between 4.2-4.4 mmol/L, the incidence of GDM sharply increased until the first-trimester FPG reached 4.5-4.7 mmol/L, and the incidence of GDM went to the peak. This trend is consistent with the HAPO study, in which $\text{FPG} \leq 4.4$ mmol/L (80 mg/dL) was associated with a lower risk of some adverse outcomes, to

some degree⁶. We also found that the association between OR of GDM and levels of first-trimester FPG, as first-trimester FPG increased, the OR for identifying GDM increased among pregnant women, with a value of first-trimester FPG at 4.6 mmol/L which OR equal to 1 ($p < 0.001$). The optimal cut-off value of first-trimester FPG to distinguish GDM in pregnant woman was 4.735 mmol/L, with a sensitivity of 49% and a specificity of 67.6% and an AUC of 0.608, which was similar with some studies^{10,15}. The optimal cut-off value of first-trimester FPG for pregnant women for identifying GDM were higher with maternal age ($p < 0.01$), which trend was alike with Yang's¹. Furthermore, if we set first-trimester FPG greater than or equal to 4.7 mmol/L as a screening criterion, it was indicated that 51.68% of the pregnant women can be diagnostic as GDM with first-trimester FPG.

Early diagnosis of GDM is essential to prevent related pregnancy complications. A study in 2009 reported that higher first-trimester FPG increased the risk of some complications and implied that women with high risks would not receive appropriate attention if they were not diagnosed during the first trimester¹⁴. Mills et al. found a physiological decrease in FPG during normal pregnancy, which indicated that the standard of FPG in pregnancy should be different from that in nonpregnant individuals¹⁶. Our last research revealed a strong relationship between adverse pregnancy outcomes and GDM. The research also reported that the univariate analysis showed that first-trimester FPG was strongly associated with risks of outcomes, including GDM, caesarean section, macrosomia, GHD, primary caesarean section and LGA (all $OR > 1$, all $P < 0.05$). Furthermore, the risks of GDM, primary caesarean section and LGA increased with first-trimester FPG, as it was found to be at 4.19-4.63 mmol/L. After adjustments for multiple factors, every stage of first-trimester FPG was associated with the risk of GDM. With increasing first-trimester FPG, the risks of GDM increased¹⁷.

As the age of onset of diabetes declines, the risk that some young women may develop undiagnosed type 2 diabetes during pregnancy is quite real. The importance of screening for and properly managing GDM cannot be underestimated because GDM can cause severe maternal and infant complications^{1,11}. However, it is estimated that in some countries with limited health care resources, the lack of universal screening may miss up to 43% of people with GDM¹. Although the OGTT is the gold standard diagnostic test for GDM, it is associated with several potential limitations, such as high costs and laboratory requirements⁸. Therefore, screening all pregnancies with OGTTs can be difficult. Although FPG is not the gold standard for diagnosing GDM, measuring first-trimester FPG may be critical for screening for previously undiagnosed pre-existing diabetes. FPG has been proposed as a screening test for GDM because it is less time consuming and more user friendly and reduces the medical costs associated with universal oral glucose tolerance testing^{8,14,18}. Therefore, it is important to determine the diagnostic performance and optimal cut-off value of FPG for GDM screening, especially in the first trimester.

The optimal sensitive and specific cut-off value for FPG is still controversial¹⁰. The IADPSG and ADA have different views on the cut-off value at which the diagnosis is made. The IADPSG uses an FPG of 5.10 mmol/l during the first prenatal visit and throughout pregnancy as the diagnostic criterion for GDM, whereas the ADA recommends that first-trimester FPG can be used only to determine overt diabetes (7.00

mmol/L) and that the OGTT be used for GDM screening and diagnosis at 24-28 gestational weeks^{5,6}. A study of 6,520 pregnant women from India showed that a cut-off value of FPG of 76 mg/dL (4.2 mmol/L) had highly sensitive and negative predictive value (NPV) for the diagnosis of GDM, whereas a cut-off value of FPG of 92 mg/dL (5.1 mmol/L) had high specificity and positive predictive value (PPV) for the diagnosis¹⁴. In a meta-analysis, 8 of 29 studies used different cut-off values for diagnosing GDM, and two reported 91 mg/dl (5.05 mmol/L) as the optimal cut-off value for the diagnosis¹⁰. Other studies reported cut-off values of 81 mg/dl (4.5 mmol/L), 83 mg/dl (4.6 mmol/L), 84.5 mg/dl (4.69 mmol/L), 86.8 mmol/dl (4.82 mmol/L) and 89 mg/dl (4.94 mmol/L). In these studies, the sensitivity for most cut-off values was also in the range of 60-80%^{9,10,15}, similar to ours. Our study also suggests that first-trimester FPG may be an indicator of subsequent GDM. Riskin-Masiah, et al¹⁴ reported that mild hyperglycaemia in the first trimester may lead to adverse outcomes. Our research showed that the incidence of GDM increased with first-trimester FPG levels. If FPG levels in pregnancy are not well controlled, the opportunity to reduce the risk of adverse outcomes is likely to be missed¹¹. A cohort study of 361 healthy pregnant women by Mills et al. indicated that maternal age was independently associated with FPG¹⁶, which our study also supported. Our results indicated that the optimal cut-off value of first-trimester FPG for pregnant women for identifying GDM were higher with maternal age ($p < 0.01$). Impaired glucose tolerance usually occurs in the second trimester, only after that can treatment start. In fact, when these pregnancies were first assessed as having GDM, more than 20% of the foetuses showed signs of macrosomia, which may influence clinical decisions, such as the choice of delivery mode¹⁰. Screening for GDM in the first trimester can reduce the incidence of pregnancy complications, macrosomia, caesarean section and others^{10,14}. Therefore, early detection of GDM may reduce the risks and enable strict guidance from the beginning of pregnancy. Some studies found that despite treatment, patients diagnosed with GDM at an early stage had poorer outcomes, suggesting that first-trimester FPG may be a marker of glucose tolerance before pregnancy and poor pregnancy outcomes³.

In addition, lifestyle interventions to prevent GDM have been shown to be most effective in the first trimester¹⁹. In a meta-analysis of more than 11,000 pregnant women, Song et al. concluded that lifestyle interventions can prevent GDM only if implemented before the 15th week of gestation²⁰. Research on late intervention has been generally disappointing, which means that it would be useful to have early pregnancy markers of GDM risk to determine who could benefit from early intervention¹⁹. Prevention studies have shown the positive prevention effects of diet on the incidence of GDM, LGA, SGA and preterm birth^{21,22}. The two-step diagnosis of GDM in the second and third trimesters provides a narrow intervention window¹⁹. When receiving treatment, 20% of the foetuses showed signs of macrosomia and increased abdominal circumference, again emphasizing the need for early risk markers. In this regard, first-trimester FPG may be useful in selecting patients for early screening or LGA monitoring of GDM¹⁹. In addition, because metabolic changes during pregnancy result in a decrease in PG of approximately 2 mg/dl between six and ten gestational weeks, a specific threshold of PG for the gestational week or a narrow interval for the evaluation of first-trimester FPG should be determined²³.

Therefore, we recommend that all pregnant women have FPG assessed at their first visit in the first trimester to determine the risk of diabetes and GDM.

Limitations

The limitations of this study have to be acknowledged: the retrospective nature of this study makes it possible that some of the test conditions may not be optimal, for example, in terms of fasting, which may have influenced our results. In the absence of some missing data, we were unable to analyse the impact of some potential risk factors on the relationship between FPG and GDM. We did not have multiple data points from a single panel to indicate the most appropriate week for screening. In addition, the accuracy and repeatability of the measurements need to be guaranteed. Laboratory quality control is absolutely essential and can ensure that pregnant women are truly fasting, which has often proven to be challenging because pregnant women typically do not fast prior to the first-trimester visit, so doctors have to request that they return the next day. Some of these women do not return, especially those from rural areas; in addition, samples must be taken before 10 am to prevent prolonged fasting. Fagan's nomogram showed that FPG is clinically useful¹⁰; however, the diagnostic accuracy of any screening test for GDM may depend on several other factors, such as ethnicity, the timing of testing and the presence or absence of risk factors for GDM¹⁰. The effect of these variables cannot be determined in our analysis. Based on our study, we recommend that all pregnant women undergo FPG testing in the first trimester, particularly at the first antenatal visit. First-trimester FPG greater than 4.7 mmol/L will be considered a warning level. These data come from southern China, and the results may apply only to pregnant women in southern China. Despite these limitations, this study provided valuable insights into the accuracy of first-trimester FPG in the screening and diagnosis of GDM in southern China.

Conclusions

Based on our research, we found that the level of first-trimester FPG increased slightly with maternal age and, as maternal age increased, the optimal cut-off values increased, especially after age 30. We also suggest that the risks of GDM should be given increased attention and management as soon as the first-trimester FPG value is more than 4.7 mmol/L, even in the presence of a normal OGTT and regardless of the age at pregnancy. The first-trimester FPG should be considered a screening marker when diagnosing GDM in pregnant women. Further studies are needed to improve the accuracy of FPG in different ethnicities to strengthen the evidence.

Abbreviations

PG: Plasma Glucose

FPG: Fasting Plasma Glucose

GDM: Gestational Diabetes Mellitus

ACOG: The American College of Obstetricians and Gynaecologists

WHO: World Health Organization

ADA: American Diabetes Association

IADPSG: International Association of Diabetes and Pregnancy Study Groups

OGTT: Oral Glucose Tolerance Test

Declarations

Acknowledgments

Not applicable

Disclosure

Approval of the research protocol

This research was approved by the Review Board for Human Investigation and the Ethics Committee of Shenzhen Maternal and Children Hospital.

Informed Consent

Informed consent was obtained from every patient, and the investigations were performed in accordance with the principles of the Declaration of Helsinki.

Approval date of Registry and the Registration No. of the study/trial

Approval date: 2017-04-07;Shenzhen Maternal and Child Ethics Review No. 23;

Animal Studies

N/A

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Conflicts of interest

None

Author Contributions

JM Niu and LL Wu were responsible for the study conception and design, they contributed equally to the manuscript. JN Tong did the statistical analysis and wrote the script. YX Chen and XN Guan collected the data. HF Zhang gave help to the data interpretation. K Liu and AQ Yin helped to revise part of the script. All authors contributed to the study design, including data collection, data interpretation and manuscript revision, and gave final approval of the version to be published.

Availability of data and material

All data generated or analysed during this study were included in this published article

Code availability

The codes used during and/or analysed during the current study are available from the corresponding authors (JM Niu) on reasonable request.

Consent for publication

Not applicable

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Tables

Table 1 Clinical characteristics in pregnant women between GDM and Non-GDMPage 12/18

Features	Overall(N=28030)	Non-GDM(N=23361)	GDM(N=4669)	P
Maternal age, years, mean (SD)	31.01 ± 4.12	30.71 ± 4.03	32.51 ± 4.25	<0.001
< 30, years, n (%)	11235 (40.08)	10016 (42.87)	1219 (26.11)	<0.001
30-34, years, n (%)	11155 (39.80)	9188 (39.33)	1967 (42.13)	
35-39, years, n (%)	4752 (16.95)	3567 (15.27)	1185 (25.38)	
≥ 40, years, n (%)	888 (3.17)	590 (2.53)	298 (6.38)	
Pregestational BMI, kg/m ² , mean (SD)	20.73 ± 2.41	20.62 ± 2.37	21.31 ± 2.52	<0.001
< 24 kg/m ² , n (%)	25485 (90.92)	21437 (91.76)	4048 (86.70)	<0.001
≥ 24 kg/m ² , n (%)	2545 (9.08)	1924 (8.24)	621 (13.30)	
first trimester FPG, mmol/L, mean (SD)	4.62 ± 0.37	4.59 ± 0.36	4.75 ± 0.43	<0.001
≤4.2 mmol/L,n(%)	2812 (10.03)	2510 (10.74)	302 (6.47)	<0.001
4.2-4.4mmol/L, n (%)	6306 (22.50)	5468 (23.41)	838 (17.95)	
4.5-4.7 mmol/L, n (%)	8802 (31.40)	7603 (32.55)	1199 (25.68)	
4.8-4.9 mmol/L, n (%)	6110 (21.80)	4998 (21.39)	1112 (23.82)	
5.0-5.2 mmol/L, n (%)	2773 (9.89)	2054 (8.79)	719 (15.40)	
5.3-5.5 mmol/L, n (%)	859 (3.06)	540 (2.31)	319 (6.83)	
≥5.6 mmol/L,n(%)	368 (1.31)	188 (0.80)	180 (3.86)	
OGTT at 24~28 gestational weeks				
0h OGTT, mmol/L, mean (SD)	4.35 ± 0.39	4.29 ± 0.32	4.64 ± 0.54	<0.001
FPG <5.1, mmol/L, n (%)	27037 (96.46)	23361 (100.00)	3676 (78.73)	<0.001
FPG ≥ 5.1, mmol/L, n (%)	993 (3.54)	0 (0.00)	993 (21.27)	
1h OGTT, mmol/L, mean (SD)	7.446± 1.59	7.11 ± 1.31	9.20 ± 1.73	<0.001
1h OGTT <10, mmol/L, n (%)	26245 (93.63)	23361 (100.00)	2884 (61.77)	<0.001
1h OGTT ≥ 10.0, mmol/L, n (%)	1785 (6.37)	0 (0.00)	1785 (38.23)	
2h OGTT, mmol/L, mean (SD)	6.62 ± 1.30	6.32 ± 1.00	8.12 ± 1.55	<0.001
2h OGTT < 8.5, mmol/L, n (%)	25724 (91.77)	23361 (100.00)	2363 (50.61)	<0.001

2h OGTT $\geq$ 8.5, mmol/L, n(%)	2306 (8.23)	0 (0.00)	2306 (49.39)
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*The category of the first-trimester FPG was according to the HAPO study.

Table 2 Optimal cut-off first-trimester FPG for pregnant women with GDM among different maternal age

Population	Optimal Cutoff	AUC	specificity	sensitivity	PPV	NPV
Total	4.735	0.608 (0.598 ~ 0.617)	0.676	0.490	0.232	0.869
< 30	4.775	0.597 (0.579 ~ 0.615)	0.752	0.408	0.167	0.913
30-34	4.735	0.601 (0.587 ~ 0.615)	0.656	0.505	0.239	0.861
35-39	4.915	0.587 (0.567 ~ 0.606)	0.801	0.346	0.366	0.787
$\geq$ 40	4.925	0.617 (0.577 ~ 0.658)	0.797	0.413	0.506	0.729

Figures

Figure 1

Flow chart of selecting process of the survey *: Complete data for outcomes refers to Gestational Diabetes Mellitus (GDM); Gestational hypertensive disorder (GHD); Macrosomia, Large for Gestational Age (LGA) and Low birth weight (LBW) and so on.

Figure 2

The association between odds ratio(OR) of GDM and levels of First-trimester FPG(mmol/L) . The X-axis represented levels of first-trimester FPG and Y-axis represents OR of GDM by each level of first-trimester FPG. When First-trimester FPG is about 4.6, the OR equal to 1, the risk of GDM increased as levels of First-trimester FPG increased.

Figure 3

ROC curves of first-trimester FPG for identifying GDM in pregnant women among different maternal age.

Figure 4

Incidence of GDM by different screening and diagnostic criteria. The X-axis showed different screening and diagnostic criteria-axis was rate of GDM by the x-axis screening and diagnostic criteria. *FPG at 24-28 gestational weeks refers to the results of 0h OGTT.