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PREVALENCE AND RISK FACTORS OF GESTATIONAL DIABETES MELLITUS AMONG PREGNANT WOMEN: A CROSS-SECTIONAL STUDY IN SOUTHERN IRAN

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Abstract

Background: Gestational diabetes mellitus has recently become a threatening public health issue that seriously affects the health of mother and her offspring. Conflicting results have been reported about the contributing factors of gestational diabetes mellitus.

Objective: We assessed the prevalence and associated factors of gestational diabetes mellitus among pregnant women received antenatal care at health centers in Yasuj city, the Southwest of Iran.

Material and methods: In this cross-sectional study, conducted between January 2021 and December 2022, we randomly selected 950 pregnant women attending all antenatal care clinics in Yasuj. The fasting plasma glucose test was used to screen and diagnose gestational diabetes mellitus. A structured questionnaire was devised to collect the necessary data. Univariate and multivariate logistic regression analysis and crud odds ratio/adjusted odds ratio were utilized to identify gestational diabetes mellitus associated factors.

Results: The estimated gestational diabetes mellitus prevalence among the studied women was 15.3% (95% CI = 14.1%-16.5%). Results from multivariate logistic regression analysis showed that pre-pregnancy obesity (adjusted odds ratio = 2.9; 95% CI = 1.15-7.11), gravidity 3-7 adjusted odds ratio = 2.3; 95% CI = 1.15-4.6), and previous history of gestational diabetes mellitus (adjusted odds ratio = 4.81; 95% CI = 1.42-16.24) increased the risk of gestational diabetes mellitus.

Conclusion: The prevalence of gestational diabetes mellitus among pregnant women in Yasuj was found to be high. Also, obesity, previous gestational diabetes mellitus history, and higher gravidity were identified as risk factors of this disease. Therefore, control of weight before and during pregnancy, management of gravidity at early ages, and intensive care of mothers with a history of gestational diabetes mellitus is essential for the target population.

Keywords: *gestational diabetes mellitus, pregnant women, risk factors, gestational age*

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Introduction

Gestational diabetes mellitus (GDM) is a prevalent metabolic condition defined as glucose intolerance with first recognition during pregnancy [*Hod M et al., 2019; Sweeting A et al., 2022; Zhou T et al., 2022*]. Over two recent decades, GDM has become a public health concern threatening the health of mother and offspring [*Liu B et al., 2020; Sadiya A et al., 2022*]. Maternal complications associated with GDM include risk of caesarean section delivery, spontaneous abortion, preeclampsia, third- to fourth-degree perineal tear, and subsequent development of type 2 diabetes mellitus (T2DM) [*Mdoe M et al., 2021; Wang X et al., 2021; Lendoye E et al., 2022; Ye W et al., 2022*]. Neonatal and fetal complications resulted from mothers with GDM entail increased risk of malformations, macrosomia, stillbirth, birth injuries, hypoglycemia, polycythemia, and hyperbilirubinemia [*Egan A et al., 2017; Farahvar S et al., 2019; Li G et al., 2020; Adam S et al., 2023*]. Furthermore, in the long term, children who born to mothers with GDM are prone to obesity and T2DM [*Zhu H et al., 2019; Sparks J et al., 2022; Dewi R et al., 2023*].

Literature reviews have suggested that GDM is escalating, affecting up to 25% of pregnant women across the globe [*Nguyen C et al., 2018; Li Z et al., 2020; Nigatu B et al., 2022; Orós M et al., 2023*]. However, the worldwide prevalence of GDM varies considering racial and ethnic backgrounds, population combinations, screening programs, and diagnostic tests [*Badakhsh M et al., 2019; Behboudi-Gandevani S et al., 2019; Kim H et al., 2021; Nigatu B et al., 2022*]. A cross-sectional study in the United States of Americ has reported the prevalence of 8.2% for GDM [*Zhou T et al., 2022*]. In Spain and Germany, the incidence of GDM has been stated to be 6.5% and 13.2%, respectively [*Melchior H et al., 2017; Orós M et al., 2023*]. In a recent study conducted in Tanzania, the prevalence of GDM was about 27.5% [*Mdoe M et al., 2021*]. According to the results of a former survey, the estimated prevalence rate of GDM among Chinese women was 21.8% [*Wu L et al., 2018*], and this rate was 24.2% among Saudi women [*Wahabi H et al., 2017*]. Overall, recent data on the i of GDM using the updated international diagnostic criteria in Iran is scarce [*Dewi R et al., 2023*], and rare research have investigated the subject of this study.

The reasons for GDM development are intricate and not fully recognized [*Choudhury A, Devi Rajeswari V, 2021*]. However, screening physiological changes in pregnant women's body have revealed the association of GDM with insulin resistance and insufficient insulin secretion by pancreatic β-cells [*Choudhury A, Devi Rajeswari V, 2021; Fu J, Retnakaran R, 2022; Zakaria H et al., 2023*]. Numerous studies have also demonstrated that mediating factors, such as sociodemographic, economic, and behavioral characteristics, as well as pregnancy frequency, are involved in the incidence of GDM in pregnant women [*Bellamy L et al., 2009; Li G et al., 2020, Atlaw D et al., 2022; Dewi R et al., 2023*]. Among contributing factors of GDM investigated so far, conflicting results have been reported about age, number of pregnancies, and body mass index (BMI) of pregnant mothers [*Al-Rowaily M, Abolfotouh M, 2010; Abualhamael S et al., 2019; Li Z et al., 2020; Atlaw D et al., 2022*]. Furthermore, at present, the relationship between GDM and autoimmune diseases, especially coronavirus disease 2019 (COVID-19), remains unknown 90 [*Trotta F et al., 2014; Kachikis A et al., 2017*].

Providing an updated estimation of the prevalence of GDM and detecting its associated factors to mitigate the burden of the disease is necessary and unavoidable [*Larebo Y, Ermolo N, 2021*]. Therefore, this study was undertaken to assess the prevalence and associated factors of the GDM among pregnant women attending health centers in Yasuj city, the Southwest of Iran.

Material and methods

Study design and settings: This cross-sectional study was carried out among a cohort of pregnant women at all antenatal care (ANC) clinics in Yasuj city (Yasuj, Iran) from January 2021 to December 2022. The clinics were located in five health centers affiliated to Yasuj University of Medical Sciences. Yasuj city, the capital of the Kohgiluyeh and Boyer-Ahmad Province, is located in the southwest of the country and situated about 950 *km* distance from the capital city of Iran, Tehran.

Study sample, sample size, and sampling technique: Stratified random sample method was employed to select women who attended and received services from beginning and during pregnancy at ANC clinics and gave birth between January 1, 2021 and December 31, 2022. Women at age range of 18-49 years, without overt diabetes mellitus diagnosed before pregnancy, and with available data of fasting plasma glucose (FPG) level, were included in the study. However, diabetic women, women with current illness, and those with uncompleted data were excluded. The sample size was determined using single population proportion formula as follows:

$$n= \frac{Z^2_{1-0.5\alpha} \times p(1-p)}{d^2}$$

where, n is the desired sample size, p denotes the prevalence of GDM, which was considered as 0.10 based on a study conducted by Hosaini-Ganghorbani [*Niroomand M et al., 2019*] in Iran, α indicates the 0.05 type one error, z shows the percentile at 1-α/2 = 0.975 level of the standard normal variate obtained as 1.96, and d is the 0.02 margin error around the estimated p. Therefore, considering an attrition rate of 10%, the final sample size was determined as n = 950. Proportionate sampling method was used to allocate each ANC clinic's share of the total sample. Pregnant women were recruited based on their electronic medical records available in each health center, until required sample size was obtained.

Data source: All women of childbearing age who intended to become pregnant received maternity health care services in the gynecology and obstetrics divisions of the ANC clinics in the health centers. In these clinics, all sociodemographic, anthropometric, medical and biochemical measurements prior to pregnancy and during pregnancy, as well as outcomes and complications of pregnancy respective to both mother and offspring were measured by professional nurses. The obtained data were stored in an electronic database connected to the aforementioned centers.

Data collection: Data source was an existing electronic and computerized database in health centers where ANC was served. Two professional and well-trained nurses, in every center, prepared and/or recorded necessary data and entered them to the database. The data were comprised of sociodemographic and anthropometric measurements, results of laboratory tests, and pregnancy outcomes during ANC and at delivery state for both the mother and offspring. A structured questionnaire was used to collect women's data. Socioeconomic variables included age (years), education level (primary or below, secondary, college/ university or higher, and occupation status (household or employed). Data on the clinical history of the pregnant women, including gravidity, number of live births, stillbirth, and abortion or miscarriage, and history of COVID-2019 disease, were gathered. Measurements of the anthropometric characteristics before beginning pregnancy, in the first, second, and third trimesters were determined. For this purpose, the systolic and diastolic pressure of the mother, while seating, were measured using a mercury sphygmomanometer with small and normal cuffs measured on the left arm at the heart level. Weight in kilograms was determined by using a weighing scale machine, making sure that the mother had no heavy clothing or shoes; height was measured to the nearest 0.1 cm against a vertical wall. The mothers' BMI was calculated as weight in kilograms divided by the square height in meters. Using fasting blood sugar test, blood glucose levels of pregnant women were measured. Fasting blood sugar test was conducted by collecting a venous blood sample at morning within 6-10 weeks of gestation, while the mother was fasting for at least eight hours. Next, each blood sample was analyzed using a glucose meter, and FPG was then measured and recorded. According to the World Health Organization 2013 criteria (Organization 2013), at 6-10 weeks of gestation, pregnant women with FPG between 92 and 125 *mg/dL* were diagnosed as GDM, and those with FPG less than 92 *mg/dL* were determined non-GDM.

Statistical analysis: Categorical variables were described by frequencies (numbers and percentages). Mean and standard deviation were used to describe quantitative variables. Comparison of GDM prevalence among categories were accomplished via test. Univariate logistic regression analysis with crude odds ratio was performed to preliminary screen and determine potential factors associated with GDM prevalence among pregnant women. Multiple logistic regression analysis and Adjusted Odds Ratio (AOR) were employed to detect GDM risk factors. The Statistical Package for Social Sciences software version 26 was applied to conduct all statistical analyses. Statistically significant level was considered as p value (p) <5%.

RESULTS

A sample of 950 pregnant women were included in this study. The mean (SD) age of the participants was 30.8 (5.9) years. Among all the pregnant women, 22 (2.3%) were 15-19 years, and the majority (357/37.6%) were in the age groups of 20-29 years. Most of the pregnant mothers were housewife (713/75%), and more than half of them (481/50.6%) were university educated. The proportion (prevalence) of overweight and obese pregnant women were 39.4% and 36.6%, respectively. Among the studied women, 118 (12.4%) had a history of COVID-19 disease, and 33 (3.5%) had gestational diabetes in previous pregnancies. However, a notable proportion (80.6%) of the women had a gravidity 1 or 2 (Table 1).

In the evaluation of the blood glycemic status of the studied mothers, it was detected that 145 (15.3%) out of 950 pregnant women had a fasting blood sugar level in the range of 92-125 *mg/dL*. Therefore, the estimated prevalence of GDM among the studied population was 15.3% (95% CI = 14.1%-16.5%).

Bivariate analysis did not show statistically significant differences in maternal age, education level, and occupation between the non-GDM and GDM groups. However, among the investigated factors, the BMI (p = 0.01), history of COVID-19 (p = 0.001), history of GDM (p ≤ 0.00), and gravidity (p = 0.04) were significantly associated with the prevalence of GDM in the pregnant women (Table 2).

Based on univariate binary logistic regression analysis, overweight and obese mothers were respectively 1.26 times (95% CI = 0.76-2.06) and

TABLE 1

Socio-demographic, obstetric and clinical characteristics of the studied women (n=950)

Characteristics	n (%)
Age(years)	
15-19	22 (2.3)
20-29	357 (37.60
30-34	324 (34.1)
≥35	247 (26)
Occupation	
Housewife	713 (75)
Not a housewife	237 (25)
Education	
Under complete high school	182 (19.2)
Complete high school	287 (30.2)
University	481 (50.6)
Covid-19 history	
Yes	118 (12.4)
No	832 (87.6)
GDM history	
Yes	33 (3.5)
No	917 (96.5)
Gravidity number	
1-2	758 (79.8)
3-7	192 (20.2)
BMI	
Normal and lower	228 (24)
Over weight	374 (39.4)
obese	348 (36.6)

NOTES: *BMI: body mass index; GDM: gestational diabetes mellitus; covid-19: coronavirus disease 2019*

TABLE 2

Bivariate assessment of association of GDM and socio-demographic and clinical factors among studied pregnant women (n=950)

Variables	Women without GDM n, (%)	Women with GDM n, (%)	χ^2	p
Age (years)				
<35	602 (84.9)	107 (15.1)	1.04	0.31
≥35	198 (82)	43 (18)		
Education				
Under high school	149 (82.1)	33 (17.9)	0.97	0.62
Complete high school	251 (85.3)	43 (14.7)		
University	404 (85.2)	70 (14.8)		
Occupation				
House wife	604 (84.9)	107 (15.1)	0.6	0.44
Not a housewife	197 (82.6)	42 (17.4)		
BMI				
Normal and lower	207 (88.2)	28 (11.8)	8.9	0.01*
Overweight	323 (85.6)	54 (14.4)		
obese	269 (79.5)	69 (20.5)		
Covid-19 history				
yes	82 (71.3)	33 (28.7)	4.4	0.001*
no	714 (85.5)	121 (14.5)		
GDM history				
Yes	11 (42.3)	15 (57.7)	40.6	<0.001*
no	609 (87.1)	90 (12.9)		
Gravid number				
1-2	653 (85.3)	113 (14.7)	4.1	0.04*
3-7	145 (78.6)	39 (21.4)		

*Notes: BMI: body mass index; GDM: gestational diabetes mellitus; Covid-19: coronavirus disease 2019; *: significant*

1.93 times (95% CI = 1.19-3.13) more likely to have GDM compared to those with normal and lower weight. Also, mothers with a history of COVID-19 were 2.38 times (1.42-3.97) more likely to have GDM compared to those who had no history of this disease. Pregnant women with positive history of GDM, compared to those who had no history of this disorder, were 9.23 times (95% CI = 4.11-20.72) more at risk of being diagnosed with GDM. Mothers with gravidity 3-7 were 1.58 times (95%CI = 1.01-2.46) more likely to have GDM in comparison with those with gravidity 1-2 (Table 3).

Multivariate logistic regression analysis showed that pre-pregnancy obesity (AOR = 2.9; 95% CI = 1.15-7.11), gravidity 3-7 (AOR = 2.3; 95% CI = 1.15-4.6), and a history of GDM (AOR = 4.81; 95% CI = 1.42-16.24) increased the risk of GDM. However, the history of COVID-19 (AOR = 1.3; 95% CI = 0.56-3.01) was no longer significantly associated with GDM development in pregnant women (Table 3).

TABLE 3

Univariate and multivariate logistic regression analysis and associated factors of GDM Prevalence among the pregnant women

Variables	Univariate analysis			Multivariate analysis		
	COR	95% CI	p	AOR	95% CI	p
Age(years)						
<35	1.0			1.0		
≥35	1.23	0.83-1.83	0.31	1.13	0.58-2.2	0.72
Education						
Under complete high school	1.0			1.0		
Complete high school	0.79	0.46-1.35	0.39	0.7	0.3-1.64	0.41
University	0.80	0.49-1.3	0.36	0.85	0.38-1.9	0.70
Occupation						
A housewife	1.0			1.0		
Not a housewife	1.18	0.78-1.8	0.44	1.68	0.82-3.5	0.16
BMI						
Normal or lower	1.0			1.0		
Over weight	1.26	0.76-2.06	0.37	1.9	0.75-4.72	0.18
Obesity	1.93	1.19-3.13	0.007*	2.9	1.15-7.11	0.02*
Covid-19 history						
no	1.0			1.0		
yes	2.38	1.42-3.97	0.001*	1.3	0.56-3.01	0.53
GDM history						
no	1.0			1.0		
yes	9.23	4.11-20.72	<0.001*	4.81	1.42-16.24	0.01*
Gravid number						
1-2	1.0			1.0		
3-7	1.58	1.01-2.46	0.04*	2.3	1.15-4.6	0.02*

*NOTES: BMI: body mass index; GDM: gestational diabetes mellitus; Covid-19: coronavirus disease 2019; *: significant.*

DISCUSSION

Given the increased incidence of GDM among pregnant women and scant investigations on this matter, this study was conducted to evaluate the prevalence of GDM among pregnant women attending ANC centers in Yasuj city, Iran.

In the present study, 15.3% of pregnant women were diagnosed with GDM; however, this rate was lower (9.3%) in a national study conducted by Hosseini et al. (2018). The discrepancy between the results of the above-mentioned studies could be attributed to different diagnostic criteria used to diagnose GDM, study area, and participants' characteristics. Two recent systematic reviews and meta-analysis revealed the increased prevalence of GDM from 2015 to 2019 in Iran [*Jafari-Shobeiri M et al., 2015*]. In supporting our finding, Moradi et al. (2015) and Niroomand et al. (2019) reported a prevalence of 15.2% and 15.5% for GDM, respectively, and Wang et al. (2022) reported the global standardized prevalence of GDM as 14%. Inconsistent with the findings of the current study, Shahbazian et al. (2016) reported a prevalence rate of 29.9% for GDM in other regions of the country. A possible explanation for this disparity is that in the study of Shahbazian and co-authors conducted in Ahvaz city, only women referred to private clinics were investigated. These women probably had more risk factors and were in a younger age group (28.43 ± 5.52 versus 30.8±5.9 years). Another reason could be using different diagnostic criteria for GDM and FPG (in the trimester of pregnancy) in two studies. However, our results are comparable with those found in studies by Melchior et al. (2017), Larrabure-Torrealva et al,. 2018), Kiiza et al. (2020), Su et al. (2021), which was conducted in other countries. In the current study, we observed a lower prevalence rate of GDM than that reported by Mazumder et al. (2022), Bashir et al. (2018), Mdoe et al. (2021), and Dainelli et al. (2018), possibly because of difference in the diagnostic criteria, study area, socio-economic conditions, ethnic background, and the gestational age at which the FPG was tested.

According to the univariate logistic

regression analysis, the history of COVID-19 disease increased the risk of GDM in women. However, in a study by Eskenazi et al. (2022), it was reported that this disease is associated with GDM incidence among pregnant women, and the history of COVID-19 disease was no longer associated with GDM, may be due to interactions between confounding variables when all were adjusted. Multivariate analysis also showed that among the potential risk factors, BMI, gravidity, and GDM history had a relationship with GDM prevalence among the pregnant women. The odds ratio of GDM among obese pregnant women was 2.9 times than that of women with normal weight because once the weight of pregnant women increases during pregnancy, the need for insulin secretion also increases. This condition also elevates the risk of insulin resistance, which in turn enhances the risk of GDM. In this regard, similar results have also been reported in several studies [*Bashir M et al., 2018; Lee K et al., 2018; Kiiza F et al., 2020; Liu B et al., 2020*].

Herein, we found that women with 3-7 pregnancies had a 2.3-fold higher risk of developing GDM compared to those with 1-2 pregnancies. A recent study reported that increased parity was associated with GDM development in women [*Collier A et al., 2017*]. In a systematic review and meta-analysis study, multiparity ≥2 was considered as a risk factor of GDM development in women [*Lee K et al. 2018*]. These two studies confirm the findings of our study, but contradict those of Kiiza et al.'s (2020) study in which prime parity was a significant risk factor for hyperglycemia in pregnancy. In another study, grand multigravida had a lower risk for GDM [*Abualhamael S et al., 2019*]. These contradictory results in the literature could be explained by difference in sample size, as well as subject's characteristics, including age group and ethnic and lifestyle conditions. Liu et al. (2020), in accordance with our result, displayed that there is a relationship between ≥3 pregnancies and a higher risk of GDM. The link between the number of pregnancies and GDM may be partially rooted in metabolic and lifestyle changes in the mother.

During pregnancy, glandular secretions necessary for the growth of the fetus lead to an elevation in insulin resistance in the mother's body tissue. Repetition of these conditions in multiple pregnancies gives rise to more metabolic destruction in the mother, which eventually causes GDM. Moreover, pregnant women tend to reduce their physical activity and increase their caloric diet during and after pregnancy. Following several pregnancies and as the age increases, mother gets excess weight, which can cause GDM [*Liu B et al., 2020*]. The risk of GDM in women with a history of GDM, compared to those with no history of GDM, was higher, as observed in some other studies [*Egan A et al., 2017; Kiani F et al., 2017; Kouhkan A et al., 2021; Dewi R et al., 2023*]. This variation seems to be related to the persistence of both insulin resistance and insufficient insulin secretion resulted from the previous pregnancies. In agreement with the results presented in the present study, Kiani et al. (2017) have reported that past GDM increases the likelihood of recurrence of the disease in future pregnancies.

A strong point of our study is the use of recent World Health Organization diagnostic criteria for GDM, which, in this study, we performed for all the pregnant women sampled. Also, as the studied women were prospectively selected from all ANC centers, they could be considered as a representative of the target population of pregnant women; therefore, the findings of our study could be generalized to real world settings, including the area studied herein. A limitation of study is that only some of the factors related to the prevalence of GDM among the women were investigated. Moreover, given the cross-sectional nature of the study, we could not establish an appropriate time order between the dependent and independent variables.

CONCLUSION

The present study found the high prevalence of GDM among pregnant women in Yasuj city, Iran. Moreover, obesity, prior history of GDM, and higher gravidity were detected as risk factors of GDM. In order to maintain and improve the health of mother and offspring, it is necessary to prepare and provide appropriate screening, treatment, and prevention programs for GDM. In future, priorities should be focused on managing and reducing weight before and during pregnancy for target population. In addition, a high number of pregnancies should occur at an early age, and mothers with a history of diabetes are recommended to be pregnant under high care.

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