



## The Incidence Rate of Gestational Diabetes and Relevant Factors on Pregnant Women in the City of Shahroud in 2014

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### Abstract

**Background:** The pregnant women suffering from gestational diabetes seem to face higher risks of pregnancy complications in spite of improvements in pregnancy outcomes during recent years. This study designed to define the incidence rate of gestational diabetes associated with its risk factors.

**Methods:** This was a longitudinal study, in which, we studied the pregnant women referred to 11 different urban health care centers in the city of Shahrud (Northeast of Iran) since April to September of 2014. Out of 1300 women with available medical care records, we studied 1098 pregnant women in the mentioned timespan. According to the results of fasting blood sugar (FBS) test, 7 mothers were diagnosed with diabetes at the beginning of the study. Using 75gr glucose, we conducted a 2-hour oral glucose tolerance test (OGTT) for all non-diabetic pregnant women (normal and pre-diabetic ones-1091 subjects) between the weeks 24 and 28 to screen the presence of gestational diabetes. The diagnosis of gestational diabetes was considered definite if one of the following criteria was met: Fasting blood sugar  $\geq 92$  mg/dl, 1-hour glucose  $\geq 180$  mg/dl or 2-hours glucose  $\geq 153$  mg/dl. We used the Log-binomial regression model to estimate the rate of diabetes incidence based on risk factors.

**Results:** The mean age of subjects was equal to 28.0 (SD=5.1) years. The rate of gestational diabetes occurrence was 7.8% (95% CI: 6.3-9.6 (Cases=85 pregnant women). In case of subject over 35 (RR=2.9), the factors of positive family history of diabetes (RR=1.8) and pre-diabetic condition (RR=1.6) increased the risk of gestational diabetes. The factors of BMI, smoking, education, and the pregnancy frequency were not considered in the model.

**Conclusions:** The incidence rate of diabetes in our population was higher compared to previous studies. However, due to variations made in the gestational diabetes screening guidelines, more studies are needed to do comparative research.

**Keywords:** Gestational diabetes mellitus, Pregnancy, Pre-diabetes, Incidence.

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## Introduction

By definition, gestational diabetes is any degree of carbohydrate intolerances initiated or diagnosed with onset or first recognition during pregnancy. Diabetes is the most common medical disorder during pregnancy, which occurs on average in 2-5% of cases. The patients can be divided into two groups: Those with diabetes before pregnancy (pre-gestational diabetes or known diabetes mellitus) and those whose disease is diagnosed during pregnancy (Gestational

diabetes).<sup>1</sup> According to reports, the prevalence of diabetes is between 1% and 14% in different parts of the world.<sup>2,3</sup> This rate varies between 1.3% and 8.9% in Iran according to 14 various research done in different cities.<sup>4</sup> The rate of diabetes in Iranian mothers was reported to be 4.8% by Keshavarz in 2005.<sup>5</sup> Based on studies conducted in Tehran, the diabetes prevalence was reported to be between 8.4 and 9.2%.<sup>4,6</sup>

The risk factors known for gestational diabetes include age, the overweight of mothers during childbirth and before pregnancy, diabetes family history, history of fetal macrosomia or babies with abnormality and previous records of pre-birth death without any rational reason.<sup>7,8</sup> The complications of gestational diabetes include preterm delivery, infectious complications, hydramenius, and hypertension. The complications may occur for neonates are intrauterine fetal death, congenital anomalies, affected fetal growth (macrosomia, intrauterine growth retardation), metabolic abnormalities (hypoglycemia, hypocalcaemia), polycythemia, hyperbilirubinemia, cardiomyopathy, respiratory distress syndrome, perinatal mortality due to abnormalities, as well as the occurrence of death among infants without any rational reason. Such complications and disorders may lead to childhood obesity, diabetes, and neuropsychiatric disorders in the long term.<sup>9</sup>

A new criterion for diagnosing gestational diabetes has been recently provided by American Diabetes Association (ADA). Based on this criterion, the pregnant women can be examined at their first care session using the conventional diabetes diagnosis method to screen the likelihood of developing diabetes; in case of positive diagnosis, they can be classified as the pre-pregnancy diabetes group. Other pregnant women between the weeks 24 and 25 of pregnancy may be screened with a 2-hour oral glucose tolerance test by taking 75gr of glucose (OGTT) for gestational diabetes. The definite diagnosis of gestational diabetes is called in case of meeting one of the following criteria: Fasting blood sugar  $\geq 92$  mg/dl, 1-hour glucose  $\geq 180$  mg/dl or 2-hour glucose  $\geq 153$  mg/dl.<sup>10</sup> Defining the risk factors is the major factor in the effectiveness of selective screening methods to limit the studied population. Thus, identifying the risk factors and their effect on developing the disease can assist in obtaining a better understanding of the disease and explaining the screening strategies. Hence, there is a need to focus on the incidence of the disease and its related factors in Iran due to the significance of the disease and its adverse effects on infants and mothers considering the limited economic resources and the young population size of our country. Also, it should be noted that about 11 million people of Iran are women at the age of fertility with a risk of

developing gestational diabetes, of which, most cases are asymptomatic but are followed by numerous complications for mothers and their babies.<sup>11</sup>

## Materials and Methods

In this longitudinal study, the population included pregnant women referred to 11 urban health centers of Shahroud in 2014 for routine medical and pregnancy cares. The information of all pregnant women included in the studied were reviewed since April to September of 2014 (1300 women) and their diabetes status was examined in the same period. All the participants signed an informed consent, allowing us to check their diabetes status as well as access to their medical information. In the end, 1098 subjects (84%) participated in the follow-up period.

This study was approved by the Institutional Review board (IRB) of Shahroud University of Medical Sciences in 09/06/2014 (930/86). All procedures in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All the participants signed an informed consent form upon inclusion in the study.

The pregnant women with a fasting blood sugar level  $\geq 126$  mg/dl at their first visit and/or in the second evaluation were categorized as the pre-pregnancy diabetes group, while those without pre-pregnancy diabetes were followed up for occurrence of gestational diabetes up to the week 28 of their pregnancy.

Trained midwifery experts at each center completed the data collection forms for pregnant women. These forms contained demographic information and some data regarding the gestational diabetes factors, including the gravidity, number of deliveries, history of stillbirth and abortions, birth history of a baby with a weight more than 4 kg, history of hypertension, gestational diabetes mellitus, diabetes in the first-degree relatives, cesarean delivery, date of the last delivery, date of the first day of the last menstruation, height and weight of the mother in the first trimester of pregnancy, and smoking. The mothers' weights were measured by a calibrated scale at health centers with minimum clothing and with no shoes. Using a standard meter fixed on the walls, their heights were also measured. The BMIs were then obtained by dividing the weights (Kg) by the square of the heights in metric scale ( $m^2$ ). The BMI greater or equal to  $25 \text{ kg}/m^2$  and less than  $30 \text{ kg}/m^2$  was defined as overweight, while obesity was seen as a BMI  $>30 \text{ kg}/m^2$ .<sup>12</sup> The gestational age was determined according to the first day of the last menstruation or based on the first trimester's ultrasonography. Using oral glucose tolerance test, we performed the GDM screening for all non-diabetic pregnant women (normal and pre-diabetic) between weeks 24 and 28 of their gestation by taking 75 g of glucose (OGTT).<sup>10</sup> The glucose levels were measured one hour before and two hours later after taking it. In case of meeting one of the following criteria, the diagnosis of gestational diabetes was considered definite: The fasting blood sugar  $\geq 92$  mg/dl, 1-hour glucose  $\geq 180$  mg/dl or 2-hour glucose  $\geq 153$  mg/dl.<sup>10</sup> The subjects were referred for further examination and treatment in the event of gestational diabetes diagnosis or blood sugar impairments.

Using Fisher and Chi-square tests, we analyzed the collected data. Also, we employed the log-binomial multiple regression model to determine the relationship between factors

associated with gestational diabetes mellitus (GDM). Accordingly, the relative risk of gestational diabetes was determined based on the risk factors with a confidence level of 95%. The data were analyzed using the STATA-12 software. The P-value less than 0.05 was considered significant.

## Results

In this research, a follow-up study was performed on 1300 pregnant women regarding the incidence of gestational diabetes mellitus from the beginning of their pregnancy in 2014. Of all, 1098 (84%) of mothers completed their follow-up period. The average age of participants was 28.2 years (standard deviation =1.5) with an age range of 15 to 44 years old. Table 1 shows the demographic characteristics of participants.

Based on the results of fasting blood sugar test, a pre-pregnancy diabetes diagnosis was made seven mothers with a fasting blood glucose level greater than 126 mg at their first trimester visit. In this study, 1091 diabetes-free pregnant mothers were evaluated based on a gestational diabetes screening program between weeks 24 and 28 of their gestation by using a two-hour oral glucose tolerance test (OGTT). According to the glucose tolerance test results, 85 subjects had gestational diabetes (an incidence rate of 7.8% -95% CI: 6.3-9.6). The following factors were associated with increased risk of developing gestational diabetes based on the binomial log regression analysis results: Age over 35 years (RR=2.9), positive familial history of diabetes (RR=1.8), obesity (RR=1.82), and pre-diabetic prevalence (RR=1.6). The factors of smoking, education, and number of pregnancies were not considered in the model (Table 2).

## Discussion

This study was performed to assess the incidence rate of gestational diabetes and its risk factors in 1300 pregnant women in the city of Shahroud. Since 2013, a new criterion has been provided by ADA for diagnosis of gestational diabetes. Previous studies in different cities of Iran including Shahroud, were all done based on the Carpenter Coustan Criterion. But we used the new ADA criterion in this study to determine the incidence rate of gestational diabetes mellitus in Shahroud.

The study results showed an incidence rate of 7.8% for gestational diabetes in Shahroud. Based on the reports, the prevalence of gestational diabetes ranges from 1% to 14% in different parts of the world.<sup>13</sup> Review of studies in Iran revealed the highest prevalence of gestational diabetes mellitus as 11.9% in Urmia, while the lowest prevalence rate was found in Ardabil as 1.3%.<sup>14</sup> The prevalence rate of gestational diabetes was reported as 4.9% in Sayemiri et al. systematic review with the lowest rate in Kermanshah (0.7%), while the highest rate was seen in Karaj (18.6%).<sup>15</sup> In Keshavarz<sup>5</sup> study in 2000, the incidence rate of gestational diabetes mellitus in Shahroud was found equal to 4.8%, which appears to be lower than our results. Using a screening method based on the latest ADA guidelines (similar to the screening method of this study) in Razan, Dorostkar et al. did a research in 2013 and reported the incidence rate of gestational diabetes as 12.2%,<sup>16</sup> which was higher than the rate reported in the review of studies in 2008 ranging from 1.3 to 8.9.<sup>17</sup> This may explain the reported increased rate of gestational diabetes in Shahroud compared to the results of Keshavarz's study.<sup>5</sup> Keshavarz used the Carpenter-Coustan diagnostic criterion in gestational diabetes diagnosis, which may be the reason for different results in the

**Table 1. Characteristics of pregnant women with diabetes and no diabetes women\***

Characteristic	Total (n=1091)	Mothers with gestational diabetes (n=85)	Mothers without gestational diabetes (n=1006)	P.V
Maternal weight (kg)	63.4±11.2	64.2±9.6	63.3±11.2	0.48
≤ 45	50 (4.6)	2 (2.3)	48 (4.77)	
46-90	1022 (93.1)	82(96.4)	934 (92.8)	0.44
≥ 90	26 (2.4)	1(1.18)	24 (2.3)	
Maternal height (cm)	159.91±6.0	158.4±6.4	160.0±5.9	0.02
Gravidity				
1	458 (41.7)	32 (37.65)	423 (42.05)	
2	381 (34.7)	27 (31.7)	351 (34.8)	0.29
≥3	259 (23.6)	26 (30.5)	232 (23.06)	
Parity				
Nulliparous	458 (41.7)	32(37.6)	423(42.1)	0.41
Multiparous	640 (58.3)	53(62.4)	583(57.9)	
Education (years)				
<8	206 (18.8)	12 (14.1)	187 (18.5)	
8-12	529 (48.2)	39 (45.8)	481 (47.8)	0.39
>12	363 (33.1)	40 (34)	338 (33.6)	
Maternal age (years)				
≤ 18	45 (4.1)	1 (1.1)	44 (4.3)	<0.001
19-34	930 (84.7)	60 (70.5)	864 (85.8)	
≥ 35	123 (11.2)	24 (28.2)	98 (9.7)	
BMI	24.83± 4.28	25.6±4.0	24.7±4.2	0.057
normal	574 (54.1)	36(44.4)	538 (54.8)	
overweight	365 (34.4)	34(41.9)	331 (33.7)	0.19
obese	123 (11.5)	11(13.5)	112 (11.4)	
Maternal smoking (Yes)	1079 (98.2)	0	7 (0.7)	0.44
History of abortion (Yes)	220 (20)	19 (21.1)	201 (19.9)	0.79
History of neonatal death (Yes)	20 (1.8)	2 (2.35)	18 (1.7)	0.71
History of Hypertension (Yes)	1080 (98.4)	3 (3.5)	14 (1.3)	0.12
History of cesarean section (Yes)	233 (21.2)	24 (28.2)	207 (20.5)	0.09
History of GDM (Yes)	13 (1.2)	2 (2.3)	9 (0.89)	0.19
Family history of diabetes (yes)	103(9.4)	15 (17.6)	88 (91.2)	0.007
Systolic Blood Pressure	105.11±10.70	106.4±10.5	104±10.5	0.23
Diastolic Blood Pressure	66.20±8.86	66.5±8.7	66.1±8.7	0.69
Hb (mg/dl)	12.68±1.18	12.7±1.05	12.6±1.1	0.84
Hct (%)	37.98±3.39	38.09±3.03	37.9±3.41	0.79

\* Table values are mean±SD for continuous variables and n (%) for categorical variables

**Table 2. Factors associated with gestational diabetes mellitus (GDM) using log binomial multiple regression model**

Variable	Adjusted Risk ratio	95% CI
Pre diabetic		
No	1	-
Yes	1.59	1.03-2.45
Maternal age		
≤18	0.42	0.059-3.03
19-34	1	-
>35	2.93	1.85-4.65
Family history of diabetes		
No	1	-
Yes	1.38	0.877-2.18
BMI		
<25	1	-
25-29	1.23	0.644-2.37
>=30	1.82	1.08-3.093

two studies. Changes in the lifestyle and food habits as well as using unhealthy diets and consumption of convenience and fast foods can be other causes of the increased rate of gestational diabetes in the last decade. The results of a systematic review in 2014 by Almasi and Salehiniya indicated an increased prevalence of gestational diabetes in comparison with the

previous years. However, this increase may be due the use of more accurate diagnostic methods and reporting system in their study.<sup>18</sup>

Demonstrated by previous studies, the prevalence of gestational diabetes in Shahroud seems to be similar with its prevalence in other parts of the Iran. The differences seen are due to using various screening methods in different studies. In addition, differences in race compared to European countries can be another reason for the relatively high incidence rate of gestational diabetes in our population. Using the recent criteria and Carpenter criterion on a same population in a study conducted by Kosus et al. in Ankara, the estimated rates of gestational diabetes appeared to be 8.1% and 15.7%, respectively. Based on the new ADA criteria, we may expect higher prevalence rates of gestational diabetes in the societies.<sup>19,20</sup>

Using ADA diagnostic criterion in our study also suggested a higher incidence of gestational diabetes in Shahroud than Keshavarz study,<sup>5</sup> which seems consistent with the results of this study. We also evaluated the risk factors of gestational diabetes mellitus. According to other studies, the incidence rate of gestational diabetes is related to the risk factors such as age,

body fat growth, race, familial history of diabetes, the history of macrosomal birth, and previous history of maternal glucose impairment. However, more research is needed in case of other risk factors.<sup>21</sup> Our findings showed that the factors like age over 35 (RR=2.9), obesity (RR=1.82), and pre-diabetic status (RR=1.6) are followed by an increased risk of developing gestational diabetes. It should be noted that we did not consider the factors of smoking, education, number of pregnancies, and family history of diabetes in the model used. The factors of age, obesity, and familial diabetes history were reported as risk factors for diabetes in the study by Goli et al.<sup>22</sup> Keshavarz reported glycosuria, macrosomia history, obesity, and an uncertain history of neonatal death<sup>5</sup> in her study as the most important risk factors for gestational diabetes. The findings of Hedayati et al. suggested a significant relation between BMI, age, gestational diabetes history, and familial diabetes history with gestational diabetes.<sup>23</sup> The gestational diabetes history, age  $\geq 40$  years, and BMI greater than 35 were mentioned in another study in Australia as the most important risk factors. In a study in Isfahan by Tabatabaei et al., the rate of gestational diabetes was found to be higher in women with a history of diabetes in the first-degree family members.<sup>24</sup> The results of our study not consistent with these results. In addition, a study by Manafi et al. found that the incidence rate of gestational diabetes among women over 30 was four times higher than more women under 25 years at the time of gestation.<sup>3</sup> Several studies have indicated a relationship between maternal age and gestational diabetes.<sup>25</sup> The women with gestational diabetes were older<sup>20</sup> in Shahbaziyan's study. Dorostkaret al.<sup>16</sup> studied the prevalence of gestational diabetes in different age groups. According to their findings, as the maternal age increases, the rate of gestational diabetes will rise as well. The risk of gestational diabetes increases by age increasing according to Tabatabaei's study.<sup>24</sup> According to the results of this study, age higher than 35 will increase the risk of developing gestational diabetes by 2.9 times. The results of these studies seem to be consistent with our findings. The pre-diabetic status (fasting blood sugar test  $\geq 92$  mg/dl) was found to be a risk factor for gestational diabetes. Mohammadzadeh in his study in Gorgan (2013) found a significant relationship between impaired fasting blood glucose and the risk of developing gestational diabetes,<sup>26</sup> Which is consistent with our results.

We found a significant relationship between BMI over 30 and the rate of gestational diabetes that is consistent with the results of other studies. Ethnic-racial differences and obesity appear as two major risk factors for gestational diabetes; however, the demographic distribution of obesity is not an indication of demographic distribution of gestational diabetes (The highest rates of obesity are seen among African-Americans, while the lowest rate are observed in Asians; also, the highest GD rates are seen among Asians and the lowest among the African-Americans).<sup>27</sup> The mechanism of developing diabetes during pregnancy differs from the non-pregnancy period. The insulin resistance causes impaired fasting sugar during pregnancy, which leads to enhanced risk of diabetes. In addition, the BMI for pregnant women was calculated at their first visit to the pregnancy care unit. This led to inaccuracy in the BMI record since the same was not done for all the subjects at the same time. Thus, the discrepancy in the results can be

explained. Hence, due to the increasing shift of gestational diabetes mellitus incidence in Shahroud, it is recommended to design a screening and monitoring system for pregnant women.

In this longitudinal study, we used new diagnostic criteria for the first time to screen maternal diabetes in Shahroud. The acceptable response rate was another strength of this study. Evaluating the maternal diabetes in urban population seems to be a limitation of our study. Lack of accessibility for reviewing all laboratory tests was also another limitation.

Based on the results, the incidence rate of gestational diabetes mellitus has increased compared to the last year in Shahroud using ADA criteria. Some of the main risk factors leading to increased gestational diabetes rate include age over 35, being pre-diabetic, and obesity. According to the results, similar studies need to be done using the ADA diagnostic criteria in different provinces of Iran to be compared with these results. Shahroud seems to have a high level of gestational diabetes mellitus rate compared to other areas of Iran. Thus, it is recommended to perform diagnostic screening for gestational diabetes, train the mothers, and treat diabetic mothers based on the latest guidelines.

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### Conflict of Interest

The authors declared that they have no conflict of interest.

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