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ORIGINAL ARTICLE

# The prevalence of gestational diabetes mellitus and its related risk factors in Gorgan, north of Iran. Selective or universal screening test is cost-effective?

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**Abstract** Gestational diabetes mellitus (GDM) is the most prevalent metabolic disorder in pregnancy. GDM is defined in <1 % to 28 % of pregnancies, depending on the diagnostic criteria, the ethnic and racial characteristics. This study was performed to determine the prevalence of GDM and related risk factors among pregnant women in Gorgan, north of Iran. In a cross sectional study, 1276 pregnant women were recruited. All of women screened with glucose challenge test (GCT) in 24–28th wks of gestational age. Women with positive GCT underwent 100 g glucose tolerance test (OGTT). Diagnosis of GDM was according to Carpenter and Coustan's criteria. GCT was positive in 200 women (15.8 % with CI: 13.8 %–17.8 %) and GDM was diagnosed in 62 case (4.9 % with CI:3.7 %–6.8 %). In a multiple logistic regression, risk factors such as age, BMI, history of macrosomia, familial history of diabetes and impaired fasting glucose (IFG) were identified as independent risk factors for GDM ($p<0.05$). Among GDM cases, 3.2 %(2 women) had no risk factor. These results show moderate prevalence of GDM in north of Iran. It seems that a selective GDM screening method for women with some risk factors is more appropriate than general screening.

**Keywords** Gestational diabetes · Prevalence · Screening · Risk factors

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## Introduction

Gestational diabetes mellitus (GDM) is a metabolic disorder, defined as carbohydrate intolerance with first onset or diagnose in pregnancy. A resent systematic review on the prevalence of GDM with a focus on advanced economies reported the prevalence of GDM with a range of 1.7–11.6 %[1]. In another review, in 173 countries, GDM prevalence estimated range from <1 % to 28 %, depending on the diagnostic criteria used and the ethnic and racial characteristics [2]. GDM increases the risk of mortality and morbidity rate for both mother and child during pregnancy. The related complications of GDM include fetal macrosomia, birth trauma, intra-uterine fetal death (IUFD), neonatal hypoglycemia, risk of childhood obesity and type 2 diabetes [3, 4]. Pregnant women with GDM also are at increased risk of caesarean section, gestational hypertension, hydramnios, stillbirth and development of type 2 diabetes in future [5, 6]. Because of the lack of clinical signs and symptoms of GDM, screening tests are recommended during pregnancy to early detection [7]. The two major recommended methods for screening are universal and selective screening based on risk factors. However universal screening is more sensitive, selective screening is cost-effective [8].

There are only little data on the prevalence of GDM and its risk factors in Iranian population. The aim of this study is to estimate the GDM prevalence and its related risk factors in eastern north of Iran.

## Methodology

A cross-sectional study carried out in a teaching hospital and primary health centers in Gorgan City (Golestan state in east

of Caspian Sea, Iran) from March 2011 to September 2012. The screening and diagnosis of GDM have remained controversial. Since 2011 the ADA recommended single 75 gr OGTT at 24–28 weeks of pregnancy as screening and diagnostic test for GDM [9]. In the time that study was carried, in Iran, except some of research centers, Glucose Challenge Test (GCT) and OGTT 100 gr were used for universal screening.

### Data collection

A total of 1276 eligible pregnant women were randomly recruited into the study. Pregnant women with preexisting diabetes mellitus, twin pregnancies, miscarriage or termination before 24 weeks of gestational age and those on steroid therapy were excluded.

At the first antenatal visit, a structured questionnaire was administered to obtain baseline information data such as age, parity, gestational age. Participant's weight (before 12 weeks), height and blood pressure were measured, body mass index (BMI) was calculated. If the pregnant woman had at least one of the risk factors of GDM, early screening in the first visit was performed. Risk factors for GDM which we used as a guide for early screening were: age >35 years, BMI >30 kg/$m^2$, familial history of diabetes, macrosomia, congenital malformations, stillbirth or unexplained abortion, history of IFG, GDM and preeclampsia [9, 10]. Some of those who had negative GCT followed by repeated test in 24–28 weeks. For cases without risk factors, the screening test was done at 24–28 weeks. Serum glucose value >130 mg/dl on GCT, underwent a 100 g 3 h OGTT after an overnight 8 h fasting.

The diagnosis of GDM was based on the criteria of Carpenter and Coustan [11], when at least two of the four values were raised: fasting >95 mg/dl, 1 h >180 mg/dl, 2 h >155 mg/dl and 3 h >140 mg/dl. If only one of four samples was impaired, OGTT was repeated 4 weeks later.

### Statistical Analysis

In this cross-sectional analysis, Mean ± SD are presented and compared using Students *T*-test for continuous, $\chi 2$ test or Fisher exact test for categorical variables. The binary logistic regression was used to assess the strength of association between dependent and independent variables. Odds ratio (OR) and CI were calculated in logistic regression analysis. Forward stepwise multiple logistic regression analysis was used to test several models for the association of gestational diabetes mellitus and other variables. All analyses were performed with the SPSS version16. Statistical level of significance was set at 0.05 and 95 % confidence interval (CI) was calculated.

**Table 1** The baseline characteristics of the study population ($n$=1,276)

| Max | Min | Mean ± SD | Variable |
|---|---|---|---|
| 51 | 16 | 27.3±5.5 | Age (year) |
| 157 | 38 | 64.4±13.3 | Weight (kg) |
| 63.6 | 15.5 | 25.3±4.9 | BMI (kg/m2) |
| 6 | 1 | 4.5±1.8 | Parity |
| 180 | 80 | 104.7±10.3 | Systolic BP (mmHg) |
| 90 | 45 | 66.2±8.0 | Diastolic BP (mmHg) |

### Ethical consideration

This study was approved by the "Research Deputy" and research ethics committee of the Golestan University of Medical sciences. A written consent form was signed by each participant. Women with GDM referred to endocrinologist and nutritionist for management and medical nutrition therapy.

## Results

The study included 1276 pregnant women aged 16–51 years. The 297 (23.3 %) and 965 (75.6 %) of them were from rural and urban population respectively and 14 (1.1 %) was data missing. Table 1 shows the baseline characteristics of the subjects.

Two hundred (15.7 % CI13.8–17.8 %) of the women had a positive GCT. GDM was diagnosed in 62 women or 4.9 % (CI 3.7–6.8 %). In rural and urban population, GDM defined in

**Table 2** Distribution of gestational diabetes cases according to demographic and medical variables

| *P*- value | non- GDM | GDM | Risk factors |
|---|---|---|---|
| 0.001 | 27.1±5.4 | 30.16±4.8 | Age (year) |
| NS | 159.8±5.9 | 158.7±5.5 | Height (Cm) |
| 0.0001 | 64.2±13.2 | 73±12.1 | Weight (kg) |
| 0.001 | 25.1±4.8 | 29±4.8 | BMI (kg/m2) |
| NS | 4.6±1.8 | 1.3±2.1 | Parity |
| 0.02 | 104.7±10.3 | 107.6±9.7 | Systolic BP (mmHg) |
| NS | 66.2±8 | 66.8±8 | Diastolic BP (mmHg) |
| 0.002 | 0.3 | 4.8 | History of GDM (%) |
| NS | 0.6 | 0 | History of gestational HTN |
| 0.001 | 16.9 | 35.5 | Family history of diabetes (%) |
| 0.001 | 0.9 | 9.7 | History of macrosomia (%) |
| NS | 14.2 | 21 | History of abortion and still birth (%) |
| NS | 0.3 | 0 | Previous congenital malformation (%) |

**Table 3** Most significant predictors associated with GDM using multiple logistic regression analysis

| *P*- value | CI | OR | Risk factors |
|---|---|---|---|
| 0.006 | 1.147–1.023 | 1.083 | Age |
| 0.001 | 1.145–1.044 | 1.093 | BMI |
| NS | 1.078–0.94 | 1.007 | Parity |
| NS | 1.059–0.992 | 1.025 | Systolic BP |
| NS | 1.019–0.933 | 0.975 | Diastolic BP |
| 0.01 | 33.454–1.624 | 7.371 | History of impaired fasting glucose |
| NS | 20.305–0.50 | 3.186 | History of GDM |
| 0.029 | 3.708–1.073 | 1.994 | Family history of diabetes |
| 0.001 | 33.906–2.581 | 9.355 | History of macrosomia |

4.4 % and 5.1 % respectively, that was not statistically significant ($P$=0.37).

The mean age was 30.1±4.82 years in women with GDM and 27.1±5.47 years in non GDM subjects ($p$=0.0001).

The mean BMI of GDM and normal subjects were 29.01± 4.80 and 25.09±4.83 kg/m$^2$ respectively ($p$=0.0001).

In univariate analysis of related risk factors maternal age, weight, systolic blood pressure and familial history of diabetes, history of IFG, fetal macrosomia, GDM in previous pregnancy were significantly associated with a higher likelihood for GDM ($P$<0.05). Table 2 shows the comparison of risk factors on binary logistic analysis in with GDM and non GDM women.

However in a multiple logistic regression history of fetal macrosomia, familial history of diabetes, IFG, maternal age and BMI were identified as independent risk factors for GDM ($p$<0.05) (Table 3) .

We also study the GDM prevalence in different age and BMI groups. In the age group less than 20 years GDM was not detected. The most prevalence of GDM (8.8 %) was seen in group of women equal or more than 35 years old (Table 4). We consider the 20–24 year age group as the reference group. Risk of GDM in age ≥35 years is 4.4 (95 % CI 1.7–11.4) times greater than 20–24 years. Instead of every one year increase for age, risk of GDM will raise 1.083 (95 % CI 1.023–1.147) fold.

We evaluate the prevalence of GDM in normal weight, overweight and obese women based on BMI. 669 (53.3 %) of our population had normal BMI (BMI <25) and rest of them were overweight (BMI between 25 to 29.99) or obese (BMI ≥30). In normal weight subjects, GDM was seen in 14 (2.1 %). In 392 overweight subjects, prevalence of GDM was 5.4 %. 195 subjects (15.5 %) were obese that 27 women (13.8 %) diagnosed as GDM. Risk of GDM in women with BMI ≥30 was 4.7 (CI 2.79–8.03) times greater than subjects with BMI <30. Every one unit rising in BMI increases risk of GDM 1.1 fold (CI: 1–1.15).

## Discussion

The prevalence of GDM was 4.9 % in our population, that is conformably to other parts of world [2]. In the another studies prevalence of GDM was 4 % in USA [12] and 2–6 % in Europe population with high prevalence in the south of Mediterranean [13]. The prevalence varies between racial and ethnic groups within the same country [14].

In a study in different parts of Iran, the prevalence was 1.3–8.9 %[15]. The highest prevalence (8.9 %) was reported from Bandar Abbas in south of Iran, screening and diagnostic criteria was performed as same as our method. This difference may be related to higher prevalence of type 2 diabetes in this area. [16]. Lowest prevalence reported from Ardebil in West North of Iran (1.7 %) [17] that may be due to upper level of cut off point for GCT (140 mg/dl).

A few study in Iran investigated GDM risk factors. In this study, we consider the risk factors for GDM.

According to greatest available evidence, the established risk factors for GDM are maternal age, increased body fat mass, race, family history of diabetes, history of IFG and macrosomia, about other risk factors such as parity, hypertension and history of poor obstetric outcomes, available data is controversial [12]. Our study shows that maternal age, BMI, familial history of diabetes, history of IFG and macrosomia were independent risk factors for GDM. The high relative risk was belong to history of macrosomia and IFG.

Maternal age more than 25 years is an important risk factor of GDM [18]. In age group <20 years, we didn't see GDM. The most prevalence of GDM was seen in group of women ≥35 years old. In our sample, risk of GDM in age ≥35 years is 4.4 times greater than 20–24 years. In a study in Isfahan- Iran,

**Table 4** Odds ratio for Age-adjusted prevalence of GDM

| Age groups | GDM | Non GDM | Total | OR | CI | *P*-value |
|---|---|---|---|---|---|---|
| <20 | 0 (0) | 87 (100) | 87 (100) | – | – | – |
| 20–24 | 7 (2.1) | 322 (97.9) | 329 (100) | 1 | – | – |
| 25–29 | 24 (5.9) | 383 (94.1) | 407 (100) | 2.883 | 1.226–6.777 | .015 |
| 30–34 | 19 (6.5) | 275 (93.5) | 294 (100) | 3.178 | 1.316–7.673 | .010 |
| ≥ 35 | 12 (8.8) | 125 (91.2) | 137 (100) | 4.416 | 1.700–11.473 | .002 |
| Total | 62 (4.9) | 1192 (95.1) | 1254 (100) | — | | .020 |

the prevalence of GDM in age <20 year was zero. The relative risk of GDM in women ≥35 years was 10.2 times greater than women who had 20–24 years [18] and in another study in south of Iran, this was 15 fold [16]. 11.3 % women with GDM in our research were in group <25 years. Therefore, if we did selective screening based on age groups, we missed remarkable cases of GDM.

In many studies, BMI more than 30 kg/m$^2$ was related with incidence of GDM [16, 19, 20], in our study prevalence of GDM was 13.8 % in women with BMI ≥30 and 3.3 % in BMI <30 ($p$<0.001). Risk of GDM in women with BMI ≥30 was 4.7 times greater than subjects with BMI <30.

In normal weight subjects, GDM prevalence was 1.1 %. According to this finding, it's probable that screening based on BMI (BMI >25 kg/m$^2$) will be cost effective.

The association of positive familial history with GDM in our population was according to results in most previous studies [13, 21, 22], but some study such as a research in Nigeria and another in Seri- Lanka didn't find this relationship [19, 20]. Its discordant results were probably due to the shorter duration of the study and/or influenced by unknown confounding factors in the study population [20].

Although other risk factors such as parity, maternal hypertension and history of poor obstetric outcomes in our study were not statistically different in GDM and non GDM groups, this findings are consistent with those of Ardabil, in west north [17], Ahvaz, in the south [23], Tehran in the center [21] of Iran and in other countries such as Seri Lanca [19]. In our subjects with GDM, 2 women (3.2 %) were without any risk factors.

## Conclusion

The best approach to screen for GDM remains a controversy. The American Diabetes Association (2011), recommended universal screening, however selective screening is more cost-effective in low-prevalence populations. With due attention to moderate prevalence of GDM in our population, it seems that selective screening based on some risk factors such as BMI >25 is wisely approach and more cost effective.

### Limitations of our study

We didn't note the mother's weight gain during pregnancy and lipid profile that could be a risk factor for GDM. We also didn't follow the women to determine maternal and newborns pregnancy outcomes.

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## References

1. Schneider S, Bock C, Wetzel M, Maul H, Loerbroks A. The prevalence of gestational diabetes in advanced economies. J Perinat Med. 2012;12:1–10.
2. Jiwani A, Marseille E, Lohse N, Damm P, Hod M, Kahn JG. Gestational diabetes mellitus: results from a survey of country prevalence and practices. J Matern Fetal Neonatal Med. 2012;25:600–10.
3. Wendland EM, Torloni MR, Falavigna M, Trujillo J, Dode MA, Campos MA, et al. Gestational diabetes and pregnancy outcomes: a systematic review of the World Health Organization (WHO) and the International Association of Diabetes in Pregnancy Study Groups (IADPSG) diagnostic criteria. BMC Pregnancy Childbirth. 2012;31:12–23.
4. Vääräsmäki M, Pouta A, Elliot P, Tapanainen P, Sovio U, Ruokonen A, et al. Adolescent manifestations of metabolic syndrome among children born to women with gestational diabetes in a general-population birth cohort. Am J Epidemiol. 2009;169:1209–15.
5. Retnakaran R, Shah BR. Abnormal screening glucose challenge test in pregnancy and future risk of diabetes in young women. Diabet Med. 2009;26:474–7.
6. Landon MB, Spong CY, Thom E, Carpenter MW, Ramin SM, Casey B, et al. A multicenter, randomized trial of treatment for mild gestational diabetes. N Engl J Med. 2009;361:1339–48.
7. van Leeuwen M, Louwerse MD, Opmeer BC, Limpens J, Serlie MJ, Reitsma JB, et al. Glucose challenge test for detecting gestational diabetes mellitus: a systematic review. BJOG. 2012;119:393–401.
8. Kitzmiller JL. Cost analysis of diagnosis and treatment of gestational diabetes mellitus. Clin Obstet Gynecol. 2000;43:140–53.
9. ADA (2011) Testing in Asymptomatic Patients. Diabetes Care 34 (suppl 1):S14
10. Xiong X, Saunders LD, Wang FL, Demianzuk NN. Gestational diabetes mellitus: prevalence, risk factors, maternal and infant outcomes. Int J Gynaecol Obstet. 2001;75:221–8.
11. Carpenter MW, Coustan DR. Criteria for screening tests for gestational diabetes. Am J Obstet Gynecol. 1982;144:768–73.
12. Taber LC. Gestational Diabetes: Is It Preventable? Am Jof Lifestyle Med. 2012;6:395–406.
13. Buckley BS, Harreiter J, Damm P, Corcoy R, Chico A, Simmons D, et al. Gestational diabetes mellitus in Europe: prevalence, Current screening practice and barriers to screening. A review. Diabet Med. 2012;29:844–54.
14. Berkowitz GS, Lapinski RH, Wein R, Lee D. Race/ethnicity and other risk factors for gestational diabetes. Am J Epidemiol. 1992;135:965–73.
15. Khoshniatnikoo M, Sh A a, Larijani B. The review of GDM prevalence in different regions of Iran. Iran J Diabetes Lipid Disorders. 2008;8:1–10.
16. Hadaegh F, KheirAndish M, RahimiSh TM. Prevalence of gestational diabetes in pregnant women of Bandar Abbas. Iran J Endocrinol Metab. 2004;6:233–25.
17. Rahimi G. The Prevalence of Gestational Diabetes in Pregnant Women eferring to Ardabil Health Centers, 2003. J Ardabil Univ Med Sci Health Serv. 2004;4:32–8.
18. Tabatabaei A, Fallah Z, Haghighi S, Farmani M, Horri N, Eslamian Z, et al. Prevalence and Risk Factors for Gestational Diabetes Mellitus in Pregnant Women of Isfahan, Iran. Iran J Endocrinol Metab. 2007;9:251–9.
19. Siribaddana SH, Deshabandu R, Rajapakse D, Silva K, Fernando DJ. The prevalence of gestational diabetes in a sri Lankan Qntenatal Clinic. Ceylon Med J. 1998;43:88–91.
20. Anzaku AS, Musa J. Prevalence and associated risk factors for gestational diabetes in Jos, North-central, Nigeria. Arch GynecolObstet. 2013;287(5):859–63.

21. Hossein-Nezhad A, Maghbooli Z, Vassigh AR, Larijani B. Prevalence of gestational diabetes mellitus and pregnancy outcomes in Iranian women. Taiwan J Obstet Gynecol. 2007;46:236–41.
22. Keshavarz M, Cheung NW, Babaee GR, Kalalian Moghadam H, Ajami ME, Shariati M. Gestational diabetes in Iran: Incidence, risk factors and pregnancy outcomes. Diabetes Res Clin Pract. 2005;69: 279–86.
23. Shahbazian HB, Shahbazian N, Yarahmadi M, Saeidi S (2012) Prevalence of Gestational Diabetes Mellitus in Pregnant Women Referring to Gynecology and Obstetrics Clinics Scientific Medical Journal of Ahwaz University of Medical Sciences 11:113–121