Prevalence of gestational diabetes mellitus and associated risk factors in Turkish women: the Trabzon GDM Study

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Abstract

Introduction: The aim of this study was to investigate the prevalence of gestational diabetes mellitus (GDM) in Turkish pregnant women in the Trabzon Region and further to identify population-specific risk factors for GDM.
Material and methods: In this prospective cross-sectional survey, universal screening for GDM was performed in 815 pregnant women. Screening was done with a 50-g oral glucose challenge test (GCT) with a 140 mg/dl cut-off point, then a diagnostic 100 g oral glucose tolerance test (OGTT) was performed according to Carpenter and Coustan (CC) criteria.
Results: The GCT was positive in 182 (22.3%) cases. The OGTT was performed on the 182 screen-positive pregnant women. Thirty-five were diagnosed with GDM on the basis of their results for a prevalence of 4.3% (35/815). Of the pregnancies with negative GCT but having high risk factors for GDM (n = 31), 4 were diagnosed with GDM (0.5%). Prevalence of GDM was found to be 4.8% (n = 39) for all pregnant women. Gestational diabetes mellitus was positively associated with advanced maternal age ($p < 0.001$), prepregnancy body mass index ($p < 0.001$), cessation of cigarette smoking ($p < 0.001$), excessive weight gain during pregnancy ($p = 0.003$), previous history of GDM ($p < 0.001$), history of selected medical conditions ($p = 0.018$), family history of diabetes (FHD) ($p < 0.001$), and existence of at least one high risk factor for GDM ($p < 0.001$). In multiple logistic regression analysis, independent predictors for GDM were maternal age, cessation of cigarette smoking, increasing prepregnancy body mass index, weight gain of more than 8 kg during pregnancy, GDM history in previous pregnancies and a history of diabetes in first-degree relatives of pregnant women.
Conclusions: The prevalence of GDM in Trabzon province was found as moderate. Commonly recognized risk factors including older age, prepregnancy obesity, FHD and past history of GDM, are valid for our urban Turkish population. Also, excessive weight gain in pregnancy and cigarette cessation were observed to be nontradional risk factors of GDM. It was concluded that all pregnant women should be screened for GDM if prevalence was not low.

Key words: gestational diabetes mellitus, prevalence, screening, associated risk factors, Turkish population, Trabzon.

Introduction

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance of variable severity, with an onset or first recognition during pregnancy [1–7]. It represents the most common metabolic complication of pregnancy, and is associated with maternal (hypertension, pre-eclampsia, caesarean section, infection, polyhydramnios) and fetal morbidity (macrosomia, birth trauma, hypoglycemia, hypocalcemia, hypomagnesemia, hyperbilirubinemia, respiratory distress syndrome, polycythemia) [8–11]. Moreover, women with GDM have a considerably elevated risk for impaired glucose tolerance (IGT) and type 2 diabetes in the years following pregnancy [11, 12]. Women with GDM are up to six times more likely to develop type 2 diabetes than women with normal glucose tolerance in pregnancy [13, 14]. Children of women with GDM are more likely to be obese and have IGT and diabetes in childhood and early adulthood [11, 15].

The prevalence of GDM, as reported in different studies, varies between 1% and 14% in all pregnancies depending on the genetic characteristics and environment of the population under study, screening and diagnostic methods employed as well as on prevalence of type 2 diabetes mellitus [3, 10, 16, 17]. The traditional and most often reported risk factors for GDM are older age (high maternal age), prepregnancy obesity, high parity, family history of diabetes (FHD) (especially in first-degree relatives), previous delivery of a macrosomic infant and previous obstetric outcome history (e.g. previous history of GDM, congenital malformation, caesarean section) [1, 2, 5, 10, 18–20]. Other potential risk factors are still controversial: low or high birth weight, short stature, smoking, multiparity, physical inactivity, excess weight gain in pregnancy and socioeconomic factors (education level, occupation and monthly household income) [1, 2, 5–7].

With the growth of the economy and the transition to a more sedentary lifestyle in Turkey, the prevalence of diabetes, obesity and metabolic syndrome is rising dramatically [21–23]. The prevalence of diabetes has increased from 7.2% to 13.7% in the last 12 years [23]. In Turkey, there are not enough data about prevalence of GDM and associated risk factors. In the previous three studies [10, 24, 25], the prevalence of GDM has been investigated, but the risk factors for GDM have not been systematically researched in Turkey. To our knowledge, the present study is the first one about the relationships of GDM in Turkey.

The objective of this study is to assess the prevalence of GDM according to the Carpenter and Coustan (CC) criteria in the Trabzon Region and to examine its associations with a number of risk factors in a sample of the Turkish pregnant population.

Material and methods

The study was carried out in the central province of Trabzon city from May 2009 to April 2011. The central province of Trabzon city, located in the northeastern part of Turkey, includes a population of 230,399 people. The sample size was calculated based on a 5% prevalence of GDM with a 2% uncertainty level [26]. We estimated that this would require studying 788 subjects. In the present study, 815 pregnant women were included. This is an urban setting and patients were referred from the Trabzon Family Health Center of the Ministry of Health, Trabzon Gynecology, Obstetric and Child Disease Hospital, Farabi Hospital of the Faculty of Medicine, Karadeniz Technical University. At the first prenatal visit, anthropometric and demographic data for all pregnant women included in the study by educated surveyors were obtained by a structured questionnaire form. Pregnant women responded to a structured questionnaire about age, level of education, occupation, monthly household income, cigarette smoking (as smokers, nonsmokers and former smokers), their obstetric history, weight gain during pregnancy (< 8 kg and ≥ 8 kg) [8], FHD in first degree relatives, parity, number of pregnancies, family history of selected medical conditions (e.g. dyslipidemia, hypertension, or heart failure), and history of GDM in previous pregnancies. After questioning about risk factors for GDM, physical examinations of the pregnant women were performed. The measurements of arterial blood pressure, weight and height were recorded. Systolic (SBP) and diastolic blood pressures (DBP) were measured three times in a sitting position after 15 min rest, and the arithmetic mean was calculated for all cases. Hypertensive values of SBP and DBP in pregnant women were accepted as ≥ 140 mm Hg and ≥ 90 mm Hg, respectively [10, 21]. Participants were advised to avoid cigarette smoking, alcohol, caffeinated beverages, and exercise for at least 30 min before their blood pressure measurement. Each woman's prepregnancy body mass index (BMI) was calculated from the last height and most recent weight before conception. Also, it was calculated as weight (kilograms) divided by the square of height (meters squared). All subjects gave informed consent and the study protocol was approved by the Local Ethical Board (No: 2010/02). Study procedures were carried out in the local health centers in each town over an 18-month period.

In this prospective cross-sectional survey, all participants underwent universal screening for GDM by a standard 50-g glucose challenge test (GCT) during 24–28 weeks of gestation or earlier if they were at high risk for developing GDM. If the initial early screening was negative, partici-

pants were rescreened at 24–28 weeks' gestation. 1-h plasma glucose concentration was measured. A value of ≥ 140 mg/dl (7.8 mmol/l) was considered as positive (GCT (+)) both in earlier and later pregnancy according to American Diabetes Association (ADA) recommendations [27]. A GCT glucose value of ≥ 200 mg/dl allowed a direct diagnosis for GDM. In all women with positive GCT and those with negative GCT but with high risk factors (positive FHD, age > 35 years, prepregnancy obesity, personal previous history of GDM, previous macrosomia or glycosuria) for GDM, a 3-h oral glucose tolerance test (100-g OGTT) was performed after an 8–12 hour overnight fast. The diagnosis of GDM was made with the criteria of CC suggested by ADA [27, 28], i.e., when at least two of the four oral GTT values were raised: fasting > 95 mg/dl (5.3 mmol/l), 1 h > 180 mg/dl (10.0 mmol/l), 2 h > 155 mg/dl (8.6 mmol/l) and 3 h > 140 mg/dl (7.8 mmol/l). Obstetric outcomes (gender of newborn, presence of macrosomia, polyhydramnios and type of birth) were recorded. Twin pregnancies, miscarriages, terminations and women with preexisting diabetes were excluded from our study. Serum glucose concentration was measured by the glucose oxidase method in an autoanalyzer (Roche Diagnostics). All eligible pregnant women were followed up until delivery for poor obstetric and neonatal outcomes.

Statistical analysis

Statistical analysis was performed using Student's test for unpaired data as appropriate, the χ^2 test or Fisher's exact test (SPSS/PC statistical program, version 13.01 for Windows). For associated risk factors of GDM, logistic regression analysis was done with a backward model. In this analysis, GDM was taken as the dependent variable. Associated risk factors for GDM were taken as independent variables. Results are shown as arithmetic mean ± standard deviation for quantitative data, and percentage for qualitative data. Odds ratio (OR) (95% CI) in logistic regression analysis was used. Value of $p < 0.05$ was considered as significant.

Results

The study included 815 consecutive pregnant women. Of the pregnancies screened, 182 (22.3%) had an initial oral GCT result of ≥ 140 mg/dl. Diagnostic testing with the OGTT was performed on the 182 screen-positive pregnant women. Of those tested, 35 were diagnosed with GDM on the basis of their results for a prevalence of 4.3% (35/815). Of the pregnancies with negative GCT but having high risk factors for GDM (n = 31), 4 were diagnosed with GDM (0.5%). Prevalence of GDM was found to be 4.8% for all pregnant women (Figure 1).

The clinical and metabolic characteristics of subjects with GDM and without GDM included in the study are given in Table I. The mean age, prepregnancy weight and BMI, weight during pregnancy, weight gain during pregnancy and diastolic blood pressure were found to be higher in pregnant women with GDM than those without GDM.

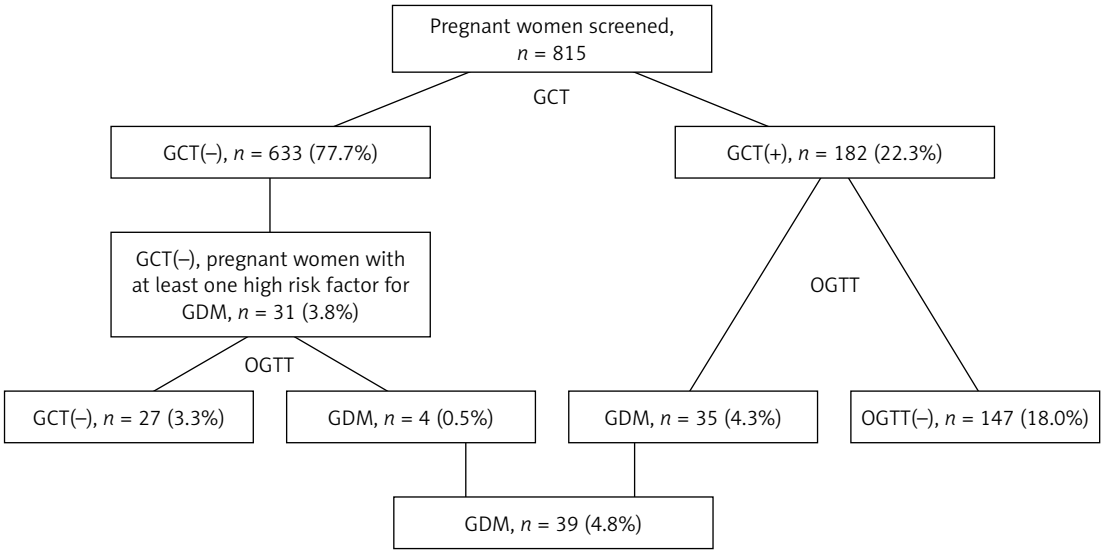

Figure 1. Flowchart of subjects who participated in the study

GCT – glucose challenge test (1 h 50 g), GCT(+) – positive glucose challenge test, GCT(–) – negative glucose challenge test, OGTT – oral glucose tolerance test (3 h 100 g), GDM – gestational diabetes mellitus. The GCT was performed in 815 women. OGTT was done in 182 GCT(+) women and GDM was diagnosed in 35 of them. OGTT was also performed in 31 randomly chosen women with GCT(–) but had at least one high risk factor for GDM. In this group 4 women had GDM. Therefore, the total number of subjects with diagnosis of GDM was 39, with a prevalence of 4.8%.

Table I. Clinical and metabolic characteristics of subjects with GDM and without GDM*

Parameter	Non-GDM (n = 776)	GDM (n = 39)	Value of p
	Mean ± SD	Mean ± SD	
Age [years]	28.8 ±5.2	32.4 ±3.9	< 0.001
Household income (TL)	1116 ±1010	1360 ±1181	0.312
Gestation week	25.9 ±1.5	26.1 ±1.6	0.422
Prepregnancy body weight [kg]	62.8 ±11.2	72.2 ±10.7	< 0.001
Weight during pregnancy [kg]	69.8 ±11.0	80.9 ±10.4	< 0.001
Weight gain during pregnancy [kg]	7.1 ±3.8	8.6 ±3.4	0.016
Prepregnancy BMI [kg/m^2]	24.2 ±3.9	28.1 ±4.6	< 0.001
Height [cm]	160.9 ±6.2	160.7 ±5.3	0.857
Number of pregnancies	2.1 ±1.2	2.5 ±1.4	0.074
Parity	0.9 ±0.9	1.0 ±1.1	0.309
SBP [mm Hg]	108.0 ±12.1	112.6 ±13.0	0.064
DBP [mm Hg]	68.0 ±9.9	71.6 ±9.4	0.025
Pulse [beats/min]	76.9 ±10.1	78.5 ±13.2	0.326
Fasting blood glucose on GCT [mg/dl]	116.4 ±27.9	162.3 ±21.5	< 0.001

**Variance analysis.*

Table II shows relationships of GDM with various associated risk factors. Prevalence of GDM increased with age (p < 0.001), with the highest prevalence in the ≥ 35-year-old age group (9.5%).

We observed an association between cigarette smoking and the prevalence of GDM (p < 0.001). Especially, there were a significant positive correlation between cessation of cigarette smoking and prevalence of GDM.

When prepregnancy BMI is considered, a positive relationship is observed between prepregnancy BMI and prevalence of GDM (p < 0.001). The prevalence of GDM increased with prepregnancy BMI. Prevalence was highest in the BMI ≥ 30 kg/m^2 group.

Gestational diabetes mellitus was more prevalent in women with greater weight gain (p = 0.003), with a history of GDM in previous pregnancies (p < 0.01), with a history of selected medical conditions in pregnant women (p < 0.05), with a positive FHD in first-degree relatives of pregnant women and with the existence of at least one high risk factor for GDM (p < 0.001). Gestational diabetes mellitus prevalence increased with SBP, but the relationship between SBP and GDM prevalence was only of borderline significance (p = 0.052).

In the χ^2 test, no relationship could be found between prevalence of GDM and other risk factors (education level, occupation, household income, height, number of pregnancies, parity, family history of GDM, and DBP).

To establish the independence of these variables we performed a multivariate analysis using a multiple logistic regression model. In this analysis, GDM was significantly and independently associated with older age (maternal age: 30–34 years; OR = 17.1; p < 0.01), cessation of cigarette smoking (OR = 3.1, p < 0.05), increasing prepregnancy BMI (BMI ≥ 30 kg/m^2, OR = 60, p < 0.001), weight gain of more than 8 kg during pregnancy (≥ 8 kg, OR = 4.7, p < 0.001), GDM history in previous pregnancies (OR = 84, p < 0.01) and a history of diabetes in first-degree relatives of the pregnant women (OR = 4.5, p < 0.001) (Table III). These risk factors were independent clinical predictors of GDM. Past history of GDM was the strongest independent predictor of GDM, followed by prepregnant BMI ≥ 30 kg/m^2 and maternal age = 30–34 years.

For poor obstetric outcome, rates for macrosomic infant, polyhydramnios, development of preeclampsia, cesarean delivery and the mean birth weights of delivered babies were significantly higher for pregnant women with GDM than those without GDM (Table IV). Moreover, birth weight of babies born to mothers with GDM was significantly higher as compared to mothers without GDM (3560 ±538 g vs. 3257.80 ±222 g; p < 0.001). There was no significant difference between women with and without GDM for gestational age at delivery time (week).

Table II. Prevalence of GDM in Turkish pregnant women by age group, level of education, occupation, household income, cigarette smoking, prepregnancy BMI, weight gain during pregnancy, height, number of pregnancies, parity, previous history of selected medical conditions, previous history of GDM, family history of DM and GDM, at least one high risk factor, SBP, and DBP

Parameter	Non-GDM		GDM	
	n	%	*n*	%
Age group [years]:	(χ^2 = 22.161, p < 0.001)			
< 25	157	99.3	1	0.7
25–29	293	97.6	7	2.3
30–34	202	91.8	18	8.2
≥ 35	124	90.5	13	9.5
Total	776	95.2	39	4.8
Level of education:	(χ^2 = 1.476, p = 0.831)			
Illiterate	9	100	0	0
Primary	280	94.6	16	5.4
Secondary	115	95.0	6	5.0
High school	203	94.9	11	5.1
University	169	96.6	6	3.4
Total	776	95.2	39	4.8
Occupation:	(χ^2 = 3.976, p = 0.625)			
Housewife	610	95.3	30	4.7
Official	116	95.9	5	4.1
Worker	50	92.6	4	7.4
Total	776	95.2	39	4.8
Household income [Euro/mo]:	(χ^2 = 1.389, p = 0.846)			
0–499	222	96.1	9	3.9
500–999	355	95.4	17	4.6
1000–1499	98	94.2	6	5.8
1500–1999	54	93.1	4	6.9
≥ 2000	47	94.0	3	6.0
Total	776	95.2	39	4.8
Cigarette use:	(χ^2 = 17.33, p < 0.001)			
Smoker	25	100	0	0
Nonsmoker	694	96.0	29	4.0
Former smoker	57	85.1	10	14.9
Total	776	95.2	39	4.8
Prepregnancy BMI [kg/m^2]:	(χ^2 = 66.77, p < 0.001)			
< 18.5	96	99.0	1	1.0
18.5–24.9	383	97.2	11	2.8
25–29.9	251	95.8	11	4.2
≥ 30	46	74.2	16	25.8
Total	776	95.2	39	4.8

Table II. Cont.

Parameter	Non-GDM		GDM	
	n	%	*n*	%
Weight gain during pregnancy [kg]:	(χ^2 = 8.948, p = 0.003)			
< 8	519	96.8	17	3.2
≥ 8	257	92.1	22	7.9
Total	776	95.2	39	4.8
Height [cm]:	(χ^2 = 2.690, p = 0.260)			
< 155	174	96.1	7	3.9
155–170	564	94.6	32	5.4
> 170	38	100	0	0
Total	776	95.2	39	4.8
Number of pregnancies:	(χ^2 = 3.374, p = 0.185)			
1	309	96.3	12	3.7
2–3	364	95.3	18	4.7
≥ 4	103	92.0	9	8.0
Total	776	95.2	39	4.8
Parity:	(χ^2 = 5.444, p = 0.364)			
0	336	96.0	14	4.0
1	240	94.5	14	5.5
2	149	94.9	8	5.1
≥ 3	151	94.5	3	5.5
Total	776	95.2	39	4.8
Previous history of selected medical conditions:	(χ^2 = 11.962, p = 0.018)			
No	721	95.9	31	4.1
Hypertension	10	83.3	2	16.7
Dyslipidemia	1	100	0	0
Heart failure	5	100	0	0
Total	737		33	
Previous history of GDM:	(χ^2 = 18.04, p < 0.001)			
No	774	95.4	37	4.6
Yes	2	50	2	50
Total	776	95.2	39	4.8
Family history of diabetes:	(χ^2 = 40.934, p < 0.001)			
No	561	97.9	12	2.1
First-degree relatives	129	85.4	22	14.6
Other relatives	86	94.5	5	5.5
Total	776	95.2	39	4.8

Table II. Cont.

Parameter	Non-GDM		GDM	
	n	%	*n*	%
Family history of GDM:	(χ^2 = 1.055, p = 0.304)			
No	769	95.3	38	4.7
Yes	7	87.5	1	12.5
Total	776	95.2	39	4.8
At least one high risk factor:	(χ^2 = 50.085, p < 0.001)			
No	617	98.1	12	2.9
Yes	159	85.5	27	14.5
Total	776	95.2	39	4.8
SBP [mm Hg]:	(χ^2 = 7.728, p = 0.052)			
< 100	94	97.9	2	2.1
100–119	458	95.2	23	4.8
120–139	210	95.0	11	5.0
≥ 140	14	82.4	3	17.6
DBP [mm Hg]:	(χ^2 = 60.080, p = 0.090)			
< 80	577	95.6	26	4.4
80–89	185	93.9	12	6.1
≥ 90	14	93.3	1	6.7

Discussion

This research represents a population-based study of GDM in which the prevalence of GDM and associated risk factors in Trabzon Region were analyzed for the first time. Also, the present study is the first study conducted in Trabzon Region according to CC criteria. In addition, in the present study, some risk factors associated with GDM (education level, occupation, household income, cigarette smoking, prepregnancy BMI, excessive weight gain in pregnancy, height, past history of GDM, number of pregnancies and births, past history of selected medical conditions, past history of GDM, and family history of diabetes mellitus type 2 and GDM) were investigated for the first time in Turkey.

Gestational diabetes mellitus is a common health problem and its prevalence is increasing globally. Gestational diabetes mellitus prevalence worldwide varies from 1% to 14% of all pregnancies [3, 10, 16, 29]. The prevalence may be variable in different regions of a country [8]. High prevalence rates have been reported in studies from Australia (Indian-born 15%, Chinese 13.9%) and the United States (Zuni Indians 14.3%) [30]. These differences may reflect the effects of dynamic interactions among genetic, demographic, sociocultural and economic factors. Statistical variations are partly due to differences in the screening methods and diagnostic criteria used [8, 30]. In previous reports about prevalence of GDM in Turkey between 1995 and 2007, the prevalence was found to be between 1.23% and 6.5% [10, 24, 25]. In a previous study performed by us from 1995 to 1997, we found that the prevalence of GDM in the central province of Trabzon city was 1.23% according to National Diabetes Data Group (NDDG) criteria [10]. In the present study, the prevalence of GDM was found to be 4.8%. The estimated prevalence of GDM was comparable, being moderately high by international standards. Also, in the present study, we detected that the GDM prevalence was 3.1% according to NDDG diagnostic criteria, indicating that GDM prevalence has prominently (approximately 3-fold) increased in the Trabzon region over the past 15 years.

Interestingly, in our study, GDM prevalence was found to be 12.3% for pregnant women with normal GCT but with high risk for GDM (a prevalence of 0.4% in all pregnant women). Therefore, we recommend screening to these pregnant women for GDM.

Maternal age is strongly associated with GDM. In many studies, it was reported that prevalence of GDM increased with maternal age [8, 16, 24,

Table III. Odds ratios of risk factors for GDM among 815 pregnant women in Trabzon city (logistic regression analysis)

Parameter	Odds ratio	95% Confidence interval	Value of *p*
Age group [years]:			
< 25	1		
25–29	5.8	0.5–59.7	0.13
30–34	17.1	1.6–175.0	0.01
≥ 35	10.7	1.0–113.3	0.04
Education level:			
Illiterate	1		
Primary	0.0007	0	0.99
Secondary	0.0008	0	0.99
High school	0.0007	0	0.99
University	0.0007	0	0.99
Occupation:			
Housewife	1		
Official	0.95	0.1–5.8	0.96
Worker	1.0	0.1–5.1	0.99
Household income [Euro]:			
0–499	1		
500–999	1.0	0.3–2.9	0.97
1000–1499	1.6	0.4–6.7	0.46
1500–1999	2.7	0.3–18.5	0.30
≥ 2000	1.8	0.2–14.8	0.54
Cigarette use:			
Nonsmoker	1		
Smoker	0	0	0.99
Former smoker	3.1	1.0–9.4	0.03
Prepregnancy BMI [kg/m^2]:			
< 18.5	1		
18.5–24.9	4.5	0.4–45.8	0.20
25–29.9	5.7	0.5–60.5	0.14
≥ 30	60.0	4.8–741.2	0.001
Weight gain during pregnancy [kg]:			
< 8	1		
≥ 8	4.7	1.9–11.5	< 0.001
Height [cm]:			
< 155	1		
155–170	1.2	0.4–3.5	0.68
> 170	0	0	0.99

Table III. Cont.

Parameter	Odds ratio	95% Confidence interval	Value of *p*
Number of pregnancies:			
1	1		
2–3	2.2	0.6–7.5	0.17
≥ 4	2.8	0.5–16.5	0.23
Previous history of GDM:			
No	1		
Yes	84.0	4.7–1495.9	0.003
Family history of diabetes in first-degree relatives:			
No	1		
Yes	4.5	2.0–10.2	< 0.001
Family history of GDM:			
No	1		
Yes	0.05	0.01–2.1	0.12
SBP [mm Hg]:			
< 100	1		
100–119	1.6	0.3–8.0	0.54
120–139	1.5	0.2–8.8	0.63
≥ 140	5.3	0.3–94.4	0.25
DBP [mm Hg]:			
< 80	1		
80–89	0.8	0.3–2.1	0.65
≥ 90	0.4	0.02–9.5	0.61

Table IV. Obstetric outcomes of subjects with GDM and without GDM

Parameter	Non-GDM		GDM		All	
	n	%	*n*	%	*n*	%
Gender:	(χ^2 = 0.77, p = 0.379)					
Male	28	52.8	25	47.2	53	58.9
Female	23	62.2	14	37.8	37	41.1
Macrosomia:	(χ^2 = 8.451, p = 0.004)					
No	50	61.7	31	38.3	81	90.0
Yes	1	11.1	8	88.9	9	10.0
Polyhydramnios:	(χ^2 = 4.058, p = 0.044)					
No	51	58.6	36	41.4	87	96.7
Yes	0	0	3	100	3	3.3
Type of birth:	(χ^2 = 17.868, p < 0.001)					
Normal vaginal	36	78.3	10	21.7	46	51.1
Caesarean section	15	34.1	29	65.9	44	48.9

31, 32]. In our study, the prevalence of GDM increased markedly with maternal age, from about 0.7% among people in the < 25 year-old age group to 9.5% among people ≥ 35 years old. The OR for GDM significantly increased in > 30 year-old pregnant women (OR = 17.1 in the 30–34 year-old age group), indicating that the optimum pregnancy period for reducing risk of GDM is below the age of 30 years.

Although cigarette smoking is positively associated with hyperinsulinism and insulin resistance in some studies [1, 33, 34], the association between cigarette smoking and GDM has been little investigated [1]. Current smoking is a significant independent risk factor for GDM [35–37]. In other studies, a significant association between GDM and smoking has not been observed [32, 38]. In contrast to previous studies, in the present study, we found an inverse association between smoking and GDM. Gestational diabetes mellitus was significantly less frequent in current smokers than in former smokers and non-smokers. Logistic regression analysis indicated that the risk of GDM was significantly increased in former smokers (3.1-fold). This condition may be explained by the fact that cessation of smoking usually results in weight gain and alterations in adipocyte metabolism [39]. First, lipoprotein lipase activity, which is the most important lipolytic enzyme in the adipocyte, increases. In turn, body weight may increase. Also, this trend might be due to the effect of cigarettes on depressing the appetite. In the present study, our data revealed that Turkish pregnant former smokers were heavier and older than current smokers and nonsmokers. Also, weight gain in pregnancy in former smokers was higher than that in nonsmokers.

Many studies have reported that prepregnancy BMI and obesity are associated with a higher prevalence of GDM and independent risk factors of GDM [6, 11, 13, 16, 18, 29, 30, 40–42]. Obesity also is strongly linked to the development of GDM [5, 7]. In a population-based cohort study of about 97,000 singleton births, obese women had a 3-fold higher risk of developing GDM than non-obese women [43]. The rate of obesity is rising dramatically worldwide, including in Turkey, consequently increasing the rate of GDM [7, 21]. In addition, an increasing prevalence of obesity in Trabzon city is likely to contribute to the increase in prevalence of GDM. In our study, prepregnancy BMI and obesity had a strong positive association with the prevalence of GDM. Prepregnancy obesity was found to be a significant risk factor for GDM. Multiple logistic regression analysis indicated that obese women (≥ 30 kg/m^2) were up to 60 times more likely to develop GDM than women with a BMI < 18.5 kg/m^2. These findings are in agreement with the results of many other authors.

Some studies showed a significant association between excessive weight gain in pregnancy (≥ 8 kg) and GDM [31, 35, 44]. Some other studies did not corroborate this association [45, 46]. The differences in the results might also be explained by the time interval in which weight gain was measured [1]. In the present study, we found an association between weight gain and GDM. The risk of GDM was significantly increased 4.7-fold in women with excessive weight gain in pregnancy.

Women with a previous (or past) history of GDM have increased risk of developing GDM in subsequent pregnancies [7, 47]. Previous GDM is also one of the strongest predictors for GDM [5, 48, 49]. In our study, we observed that the prevalence of GDM was strongly correlated with past history of GDM. Prevalence of GDM in women with a past history of GDM was 50%. We found that, as compared with women without a previous history of GDM, women with a previous history of GDM had 84-fold increased risk of developing GDM.

There is a positive relationship between FHD, especially in first-degree relatives, and prevalence of GDM [3, 8, 11, 16, 29, 30, 41, 42, 49]. Family history of diabetes is a strong independent risk factor for GDM [8, 11, 41, 49]. Di Cianni *et al.* reported that GDM was more prevalent in women with a positive FHD (14.5% vs. 7.3%; $p < 0.0001$) [8]. Yang *et al.* reported that pregnant women with a FHD in first-degree relatives had an approximately 2-fold increased risk for GDM as compared with whose without FHD in first-degree relatives [11]. In the present study, we found a higher prevalence of GDM in women with FHD in first-degree relatives ($p < 0.001$). In logistic regression analysis, women with FHD in first-degree relatives had a 4.5-fold increased risk of developing GDM, compared with women without FHD in first-degree relatives. Also, in our study, we found a higher prevalence of GDM in women with at least one high risk factor for GDM (14.5%), as compared with women having no risk factors. Our findings are consisted with some studies in the literature [16, 41, 50, 51].

Several studies have reported that GDM increases the fetal risk of macrosomia, maternal risk of pre-eclampsia and polyhydramnios [4, 10, 16, 29, 52]. In our study, rates for macrosomic infant, polyhydramnios, development of preeclampsia, the mean birth weights of delivered babies and cesarean delivery were significantly higher for pregnant women with GDM than those without GDM. Our findings were consistent with the findings in the literature.

The main disadvantage of the present study is that it is a local, regional study. Therefore, the number of participants was low. In addition, we

could not use other diagnostic criteria for GDM. Therefore, different GDM screening methods could not be compared with each other.

In conclusion, in this prospective study of pregnant women following a universal screening test which firstly examines various risk factors, we found that GDM is a moderate common pregnancy complication in Trabzon city. We found that the prevalence of GDM as defined by CC criteria is moderate (4.8%) in the Turkish pregnant women living in Trabzon province. The prevalence of GDM has obviously increased in the Trabzon region during the last 15 years. Commonly recognized risk factors including older age, prepregnancy obesity, FHD in first-degree relatives and past history of GDM are valid for our urban Turkish population. Also, excessive weight gain in pregnancy and cessation of cigarette smoking were observed to be nontraditional risk factors of GDM. In addition, the present study suggests that the increased prevalence may lead to poor obstetric and neonatal outcomes. This study demonstrates that our findings lead us to recommend universal screening for GDM in Trabzon city. Studies with large sample size and with long-term follow-up are needed to define health benefits of different screening methods in pregnancy. Required precautions including effective public health education, balanced nutrition and physical activity should be provided.

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Conflict of interest

The authors declare no conflict of interest.

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