The Prevalence of Diabetes and Impaired Glucose Tolerance in Sivas, Central Anatolia, Turkey

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OBJECTIVE — The aim of this study was to determine type 2 diabetes, impaired glucose tolerance (IGT), and impaired fasting glucose (IFG) prevalence in Sivas, Turkey.

RESEARCH DESIGN AND METHODS — This cross-sectional study was conducted in the city center of Sivas. The study population of 771 subjects was selected by the cluster sampling method from 115,998 individuals aged ≥30 years. Participants with fasting venous plasma glucose concentrations <100 mg/dl were classified as "normal." Diabetes was diagnosed in participants if they had fasting blood glucose levels ≥126 mg/dl. An oral glucose tolerance test (OGTT) was performed in subjects with fasting blood glucose levels ≥100 mg/dl and <126 mg/dl.

RESULTS — According to the fasting blood glucose levels of the 771 subjects, 44 (5.7%) had diabetes. OGTTs were performed in 80 (10.4%) subjects. According to OGTT results, there were 5 subjects with diabetes, 20 subjects with IGT (2.6%), and 55 subjects with IFG (7.1%). The combined prevalence of IFG and IGT was 9.7%. After OGTT, the total number of diabetic subjects was determined to be 49 (6.4%). Twenty-four (3.1%) of the subjects had a previous diagnosis of diabetes. Multivariate analyses showed that age, sex, hypertension, cigarette smoking, obesity, and family history of diabetes were risk factors for type 2 diabetes ($P < 0.05$).

CONCLUSIONS — Diabetes incidence increases with changes in dietary habits and lifestyle. Education is particularly important for public health, as the community may then have required knowledge about the disease and its risk factors.

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Type 2 diabetes is recognized as a major global health problem, and its prevalence is increasing. The number of adults with diabetes is roughly estimated to be 135 million worldwide (1).

Turkey resembles a bridge in geographical aspects between Europe and Asia. This study was conducted in Sivas, Turkey, which is the largest city of Central Anatolia in terms of surface area. In this region, immigration to the city center from rural parts of the territory is still an ongoing event. Economical improvements and urbanization cause major changes in lifestyles and dietary habits. Consumption of carbohydrates and fat is also frequent in this area.

Previous studies reported diabetes prevalence of 1.0 and 1.5%, respectively, in Turkey's rural areas (2,3) and 4.5, 6.3, 6.9, and 6.0%, respectively, in Turkey's urban areas (4–7).

RESEARCH DESIGN AND METHODS

— We conducted this cross-sectional study in the city center of Sivas between November 2003 and February 2004. The study population of 773 subjects was selected by cluster sampling method among 115,998 individuals aged 30 years. We were able to contact 771 subjects ($\alpha = 0.05$, $d = 0.03$, $P = 0.05$, $q = 0.95$, $n = 115{,}998$), and we interviewed these individuals face to face. Participants were informed of the purpose of the study and the test; a patient information sheet that included a brief outline of the reason for the test and the procedure to be used was provided at least 3 days before the test. Participants were instructed to follow an unrestricted diet containing at least 150 g carbohydrate daily and continue usual physical activity for at least 3 days before the test. Participants were asked to fast for 10–16 h before the test with drinking water allowed. A current drug history was obtained, and any drugs known to affect glucose tolerance were noted.

Tests were performed in the morning. Smoking and strenuous activity were not allowed during the test. A comfortable waiting area was provided for the duration of the test. Blood samples were collected in fluoride/oxalate containers, and glucose levels were measured by fasting analyses of glucose oxidase using the IL-glucose kit (ILAB).

For the oral glucose tolerance test (OGTT), a glucose load equivalent to 75 g anhydrous glucose was given in a total water volume of 250–300 ml. The glucose solution was kept at room temperature (20–25°C). The glucose drink was consumed over 5 min. Timing for the rest of the test started at the beginning of ingestion. The test was invalid if the person vomited. A further blood sample was collected 2 h after the glucose load had been given and the glucose concentration measured.

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Abbreviations: IFG, impaired fasting glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Distribution of diabetes, IGT, and IFG prevalence by risk factor*

	Normal	Diabetic	IGT	IFG	*n*	Test results
Age-group (years)						
30–39	88.9	3.0	1.1	7.0	271	$\chi^2 = 44.85$
40–49	88.5	3.4	2.9	5.3	208	$P < 0.05$
50–59	80.5	9.7	2.6	7.1	154	
60–69	78.6	10.7	3.6	7.1	84	
≥70	59.3	18.5	7.4	14.8	54	
Sex						
Male	82.4	7.9	2.9	6.8	380	$\chi^2 = 3.36$
Female	85.4	4.8	2.3	7.4	391	$P > 0.05$
Smoking						
Smoker	88.2	3.3	3.3	5.3	246	$\chi^2 = 9.29$
Nonsmoker	81.9	7.8	2.3	8.0	525	$P > 0.05$
Family history of diabetes						
Yes	81.7	10.1	3.4	4.8	208	$\chi^2 = 9.91$
No	85.6	5.0	2.3	7.1	563	$P < 0.05$
Hypertension						
Yes	71.7	16.5	1.6	10.2	127	$\chi^2 = 32.29$
No	86.3	4.3	2.8	6.5	644	$P < 0.05$
BMI						
Normal	89.4	3.9	1.4	5.3	208	$\chi^2 = 17.38$
Overweight	83.9	4.9	2.6	8.6	348	$P < 0.05$
Obese	78.6	11.2	3.7	6.5	215	

Data are percent unless otherwise indicated.

Diagnostic criteria

We used the diagnostic criteria for epidemiological studies on diabetes and other categories of hyperglycemia, as recommended by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (8). According to the fasting glucose level, individuals with fasting venous plasma glucose concentrations of <100 mg/dl were classified as normal. An OGTT was not performed for this group. If the fasting venous plasma glucose concentration was ≥126 mg/dl, the test was repeated on another day. If test result remained high (≥126 mg/dl), a diagnosis of diabetes was made or an OGTT was performed if required.

An OGTT was performed in subjects with fasting glucose levels ≥100 and <126 mg/dl. According to the OGTT, a diagnosis of diabetes was considered if the 2-h post–glucose load venous plasma glucose concentration was ≥200 mg/dl. A diagnosis of impaired glucose tolerance (IGT) was considered if the venous plasma glucose concentration was ≥140 and <200 mg/dl. Impaired fasting glycemia or impaired fasting glucose (IFG) was diagnosed if venous plasma glucose concentration was <140 mg/dl.

BMI was calculated as weight in kilograms divided by height in meters squared. For adults, overweight was defined as BMI ≥25 kg/m^2 and obesity was defined as ≥30.0 kg/m^2 (9). At the end of the study, the diabetic subjects were sent to the Department of Internal Medicine for follow-up and treatment.

Statistical evaluation was done by χ^2 test and logistic regression analysis.

RESULTS — There were 380 male (49.3%) and 391 female (50.7%) subjects. Of the 771 subjects, 647 (83.9%) were normal and 44 (5.7%) were diabetic. An OGTT was performed for 80 (10.4%) subjects. According to OGTT results, 5 subjects were diabetic, 20 (2.6%) subjects had IGT, and 55 (7.1%) subjects had IFG. The combined prevalence of IFG and IGT was 9.7%. After an OGTT, the total number of diabetic subjects was 49 (6.4%). In 24 (3.1%) of the subjects, diabetes had been previously diagnosed.

According to risk factors, the distribution of prevalence for diabetes, IGT, and IFG is given in Table 1. There was a statistically significant association between age-groups and diabetes, IGT, and IFG prevalence. The frequencies of diabetes, IGT, and IFG in the 30- to 39-year age-group were 3.0, 1.1, and 7.0%, respectively. In the 60- to 69-year age-group, the respective frequencies were 10.7, 3.6, and 7.1%. In subjects aged ≥70 years, these frequencies were 18.5, 7.4, and 14.8%, respectively ($P < 0.05$). The frequencies of diabetes, IGT, and IFG were 7.9, 2.9, and 6.8% in the male subjects and 4.9, 2.9, and 7.4% in female subjects, respectively ($P > 0.05$). For participants who regularly smoked, the frequencies of diabetes, IGT, and IFG were 7.8, 2.3, and 8.0%, respectively. In the nonsmokers, these frequencies were 3.3, 3.3, and 5.3%, respectively ($P > 0.05$). The respective rates of diabetes, IGT, and IFG were 10.1, 3.4, and 4.8% for participants with a family history of diabetes and 5.0, 2.3, and 7.1% for those without family history ($P < 0.05$).

In hypertensive subjects, the frequencies of diabetes, IGT, and IFG were 16.5, 1.6, and 10.2%, respectively. In subjects without hypertension, the respective frequencies were 4.3, 2.8, and 6.5%. The differences were statistically significant ($P < 0.05$). The frequencies of diabetes, IGT, and IFG were 3.8, 1.4, and 5.3, respectively, for participants with normal BMIs and 11.7, 3.7, and 6.5% for those considered obese ($P < 0.05$).

By using multivariate analysis (logistic regression), age, sex (male), hypertension, cigarette smoking, obesity, and family history of diabetes were determined to be risk factors for type 2 diabetes ($P < 0.05$). Only age was determined to be a risk factor for IGT. None of the above characteristics were determined to be risk factors for IFG (Table 2).

CONCLUSIONS — In this study, the prevalence of diabetes, IGT, IFG, and IFG/IGT combined were determined to be 6.4, 2.6, 8.4, and 9.7%, respectively. Diabetes prevalence was higher in men. The prevalence of diabetes, IGT, and IFG increased with age. Age, family history of diabetes, and obesity were significantly associated with the prevalence of diabetes. Age, sex (male), hypertension, smoking status, obesity, and family history of diabetes were determined to be risk factors for type 2 diabetes. In our study, age was the only risk factor for IGT ($P < 0.05$).

Diabetes prevalence in developing countries has been reported in previous studies. King et al. (10) conducted a study in Sirdaria/Uzbekistan (ethnically resembling Turkey) and reported diabetes prevalence to be 4% in women and 11% in

Table 2—*Risk factors for diabetes, IGT, and IFG determined by multivariate analysis (logistic regression)*

Risk factor	*B* value	*P* value	Odds ratio	95% CI
Diabetes				
Age	0.046	0.001*	1.047	1.020–1.075
Sex (male)	0.988	0.004*	2.687	1.366–5.286
Hypertension	0.808	0.021†	2.244	1.130–4.458
Cigarette smoking	−0.936	0.032†	2.551	0.167–0.921
Obesity	−0.912	0.012†	2.487	0.197–0.817
Family history of diabetes	0.907	0.006*	2.477	1.301–4.715
IGT				
Age	0.061	0.001*	1.063	1.025–1.102
Sex (male)	0.148	0.784	1.159	0.404–3.326
Hypertension	−1.024	0.188	2.785	0.078–1.652
Cigarette smoking	0.613	0.274	1.846	0.616–5.538
Obesity	−0.456	0.381	1.577	0.228–1.758
Family history of diabetes	0.446	0.364	1.562	0.596–4.096
IGF				
Age	0.018	0.130	1.018	0.995–1.043
Sex (male)	0.035	0.911	1.035	0.564–1.900
Hypertension	0.372	0.311	1.451	0.707–2.977
Cigarette smoking	−0.392	0.280	1.479	0.332–1.376
Obesity	0.319	0.361	1.375	0.694–2.727
Family history of diabetes	0.185	0.565	1.204	0.565–1.204

*Significant at 0.01 level; †significant at 0.05 level.

men. Age-standardized diabetes prevalence was 7.5% in women and 10% in men. The prevalence of IGT was 14% in women and 11% in men. Keleştimur et al. (11) studied 1,452 individuals in Kayseri and found the prevalence of type 2 diabetes and total glucose intolerance to be 6.9 and 15.9%, respectively. Baltazar et al. (12) studied 7,044 individuals in Luzon and reported diabetes prevalence to be 5.1% and IGT prevalence to be 8.1%. Gökcel et al. (13) conducted a study in Adana, Southern Anatolia, and determined diabetes prevalence to be 11.6% and impaired glucose homeostasis (consisting of IGT and IFG) prevalence to be 4.3%. Ramachadran et al. (14) conducted a study in India including six cities and reported the age-standardized prevalence of IFG, IGT, and newly detected diabetes to be 8.7, 8.1, and 13.9%, respectively, in the total group.

In developed countries, Sekikawa et al. (15) conducted a study in Japan and reported diabetes prevalence to be 10.1% and IGT prevalence to be 14.5%. Jaber et al. (16) conducted a study in Michigan that included Arab Americans. They found diabetes prevalence to be 15.5% and the prevalence of IGT/IFG to be higher in men (29.7%) than in women (16.8%). In the current study, we found diabetes prevalence to be 6.4% and IGT prevalence to be 2.6%. In men, the frequencies of diabetes and IGT were 7.9 and 2.9%, respectively. In women, the frequencies of diabetes and IGT were 4.9 and 2.9%, respectively.

The association of diabetes and sex has been the focus of many studies. In the study of Ramachandran et al. (14), the prevalences of IFG and diabetes were reportedly higher in women and the prevalence of IGT was higher in men. In that study, sex was not a significant differentiating factor in the study group. Sekikawa et al. (15) reported that prevalences of both diabetes and IGT were insignificantly higher in women. In the study conducted by Baltazar et al. (12), diabetes was more prevalent in women. In the study involving Arab Americans, prevalence of diabetes was higher in men; more men than women had a family history of diabetes in this study, possibly leading to that result (16). Gökçel et al. (13) and King et al. (10) also reported a greater prevalence of diabetes in men. In another study on the Turkish population, diabetes prevalence was reported to be nearly equal in men and women (11). In the current study, we found a greater prevalence of diabetes in men; however, the difference was not statistically significant. The women enrolled in this study were mainly housewives, whereas men were working outside the home; for this reason, men consumed more carbohydrate-rich "fast" foods. In Sivas, traditional foods such as döner kebap, köfte, and etli ekmek are rich in fat and carbohydrates and are heavily consumed by men. Also, professional dietary services are not available in this city. These factors may have influenced the unexpected difference in diabetes prevalence between sexes in our study.

In many studies, it was reported that the prevalence of diabetes increased with age (12,14–16). In our study, the prevalences of diabetes, IGT, and IFG were significantly different among age-groups and increased with age, particularly in those 50 years of age. The prevalence in participants aged ≥70 years is sixfold greater than that in the 30- to 39-year-old participants.

Diabetes and its risk factors have been investigated in many studies. Many studies report age (10,11,13,17) and sex (13) to be risk factors for diabetes. Hypertension was reported to be a risk factor (10,13), as well as family history of diabetes (13,16,17) and obesity (10,13,14,17). No association of diabetes with smoking was found in those studies. In our study, multivariate analysis (logistic regression) determined age, sex (male), hypertension, cigarette smoking, obesity, and family history of diabetes to be risk factors for type 2 diabetes ($P < 0.05$). Jorgensen et al. (17) reported that BMI and family history of diabetes are risk factors for IGT; in the current study, age was the only risk factor we found for IGT ($P < 0.05$). None of the above variables were determined to be risk factors for IFG.

Diabetes incidence tends to increase with changing dietary habits and lifestyle. Education is particularly important for public health, as the community may then have required knowledge about the disease and its risk factors.

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