Population-Based Study of Diabetes and Risk Characteristics in Turkey

Results of the Turkish Diabetes Epidemiology Study (TURDEP)

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OBJECTIVES — To investigate for the first time the prevalence of diabetes and impaired glucose tolerance (IGT) nationwide in Turkey; to assess regional variations and relationships between glucose intolerance and lifestyle and physical risk factors.

RESEARCH DESIGN AND METHODS — The Turkish Diabetes Epidemiology Study (TURDEP) is a cross-sectional, population-based survey that included 24,788 subjects (age ≥20 years, women 55%, response 85%). Glucose tolerance was classified according to World Health Organization recommendations on the basis of 2-h blood glucose values.

RESULTS — Crude prevalence of diabetes was 7.2% (previously undiagnosed, 2.3%) and of IGT, 6.7% (age-standardized to world and European populations, 7.9 and 7.0%). Both were more frequent in women than men ($P < 0.0001$) and in those living in urban rather than rural communities ($P < 0.001$). Prevalence rates of hypertension and obesity were 29 and 22%, respectively. Both were more common among women than men ($P < 0.0001$). Prevalence of diabetes and IGT increased with rising BMI, waist-to-hip ratio (WHR), and waist girth ($P < 0.0001$). Multiple logistic regression analysis revealed that age, BMI, WHR, familial diabetes, and hypertension were independently associated with diabetes, age, BMI, WHR, familial diabetes, and hypertension with IGT (except for familial diabetes in women with IGT). Education was related to diabetes in men but was protective for diabetes and IGT in women. Socioeconomic status appeared to decrease the risk of IGT in men while it increased the risk in women. Smoking had a protective effect for IGT in both sexes.

CONCLUSIONS — Diabetes and IGT are moderately common in Turkey by international standards. Associations with obesity and hypertension have been confirmed. Other lifestyle factors had a variable relationship with glucose tolerance.

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Abbreviations: dBP, diastolic blood pressure; FBG, fasting blood glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; sBP, systolic blood pressure; SES, socioeconomic status; TURDEP, Turkish Diabetes Epidemiology Study; WHO, World Health Organization; WHR, waist-to-hip ratio.

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

The prevalence of diabetes is increasing worldwide. According to the recent global estimates of the World Health Organization (WHO), there will be 300 million people with diabetes by the year 2025 (1,2). Turkey, with its large land area, growing economy, and more than 65 million inhabitants, is a country where awareness of diabetes is still poor. Screening programs date back to the 1940s, and nearly 1 million people have been screened to date, but because of differing methodology and lack of standardization between studies, considerable variations in diabetes prevalence have been reported from one area to another and even in the same area over time (3,4). The purpose of the present study was, for the first time, to determine the prevalence of diabetes and impaired glucose tolerance (IGT) throughout Turkey, to evaluate regional variations, and to examine the mediators and moderators of potential relationships of diabetes with social, demographic, lifestyle, and physical risk factors.

RESEARCH DESIGN AND METHODS

— The Turkish Diabetes Epidemiology Study (TURDEP) was carried out from September 1997 to March 1998. The Diabetes Division of the Istanbul Faculty of Medicine, Istanbul University, organized the survey in collaboration with the Ministry of Health, the State Institute of Statistics, and the WHO.

Study centers. Because of considerable differences in the factors of interest between geographic regions of Turkey (5) TURDEP included samples from both urban and rural populations in the northern, southern, western, eastern, and central regions of the country. Three provinces from each region, six towns from each province, and three urban districts and three rural villages near each town were randomly selected (6). In total, the survey was conducted in 540 centers across the nation.

Sample size. Sample size for each region was determined by allowing for 1% error

in prevalence with 95% CI (7). The number of people to be invited from each settlement was calculated on the basis of age and sex distributions of the urban and rural populations in Turkey. Residents who were aged ≥20 years and living in defined settlements were used as the target population.

In the Turkish health system, primary health care services are responsible for preventive and curative medicine. In rural areas, health care houses and public health centers serve 2,500–3,000 and 5,000–10,000 citizens, respectively. In cities, health care is delivered by public health centers which are linked to health care groups for 50,000–100,000 people (5). Every fifth family in the health registry was invited to participate. Taking into account the possibility of nonresponders, a sample equivalent to ~110% of the required size was invited. A written invitation was sent ~2 weeks before the survey. Participation was confirmed by telephone in the urban centers and by house visits in the rural areas. Approximately 4 weeks before the field survey, a media campaign was organized in each province by local television, radio, and newspapers.

Survey teams. Each survey team included three local staff members (a general practitioner, a nurse, and a health technician or midwife). In total, ~1,800 team members were involved in the field work. At least 2 days before the survey, team members attended a training course covering specific local arrangements, completion of the questionnaire, and anthropometric, physical, and blood glucose measurements. A mobile core team was responsible for standardization and quality control between centers.

Study protocol. Subjects arrived at the survey center early in the morning after an overnight fast (8–16 h). After registration, they were requested to drink, within the space of 5 min, 75 g anhydrous glucose dissolved in 250 ml water. Subjects currently under regular oral antidiabetic medications or insulin were considered to have diabetes, and they underwent fasting blood glucose (FBG) measurement only. In those with a prior diagnosis of diabetes who were not on current treatment, FBG was checked. If results indicated diabetes, they were excluded from further testing; otherwise, they received an oral glucose tolerance test (OGTT).

A questionnaire covering social and demographic characteristics, medical history, lifestyle, and reproductive history (in women) was administered. Blood pressure, heart rate, weight, height, BMI, and waist-to-hip ratio (WHR) were measured according to standard methods (8,9).

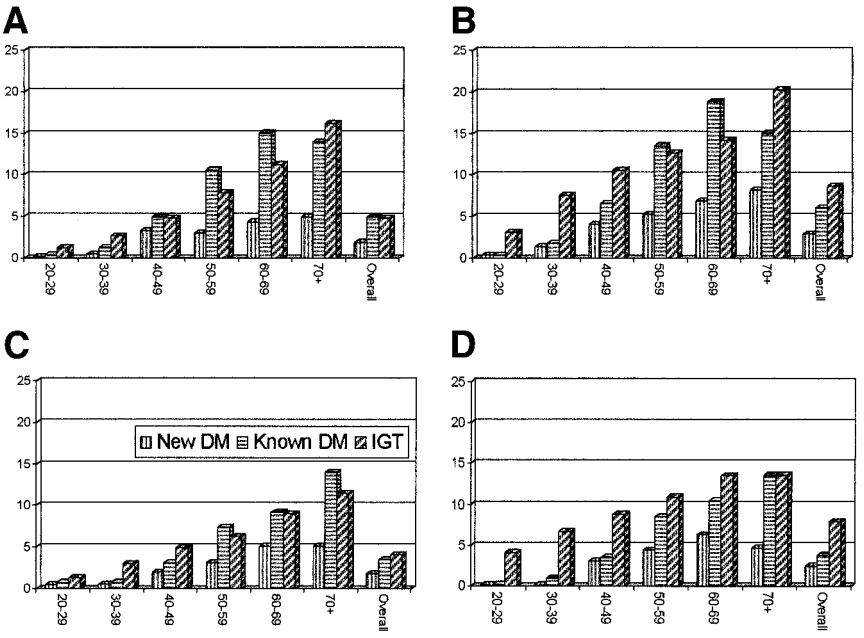

Figure 1—*Age- and sex-specific prevalence of new and known diabetes (DM) and IGT in the urban and rural areas of Turkey, 1997–1998.* A, *urban men;* B, *urban women;* C, *rural men;* D, *rural women.*

Blood glucose concentration was measured using a glucometer (Glucometer Elite; Bayer Corporation, Elkhart, IN), which uses a glucose oxidase method of estimation. Performance of the device was compared with a glucose autoanalyzer (APEC) in a small study and was found to be sufficiently reliable ($n = 110$; intra-assay coefficient of variation, 3.7%). During the field survey, instruments were checked every morning with standard solutions, and after every 20 measurements with check-strips. All control values were within recommended ranges.

The study protocol was approved by the local ethics board. Before starting the main survey, a pilot study was performed.

Assessment of glucose tolerance. Diabetes and IGT were diagnosed according to WHO recommendations: 2-h blood glucose ≥11.1 mmol/l for diabetes and 7.8–11.0 mmol/l for IGT (10). FBG was measured only in subjects who reported previous diabetes. If FBG results indicated diabetes, they were excluded from further testing; otherwise they received an OGTT. Because samples were of capillary whole blood, previously known but untreated diabetes was confirmed if FBG was ≥6.7 mmol/l. Diagnosis of type 1 diabetes was beyond the scope of this survey.

Definition of hypertension and obesity. Hypertension was diagnosed if systolic blood pressure (sBP) was ≥140 mmHg or diastolic blood pressure (dBP) was ≥90 mmHg. Subjects on regular antihypertensive treatment were considered to have hypertension. Diagnosis of general obesity was made if BMI was ≥30 kg/m^2. Based on the report of a WHO consultation (11), central obesity was defined as WHR ≥1.0 in men and ≥0.85 in women or waist girth ≥102 cm in men and ≥88 cm in women.

Statistical methods. All analyses were performed using SPSS for Windows (version 8.0; SPSS, Chicago, IL). The significance of univariate differences was assessed by χ^2 and Student's t tests. Means were compared by ANCOVA. Variables found to be associated with diabetes or IGT in the univariate analysis were included in multiple logistic regression models. The backward elimination method was used. Odds ratios and 95% CIs were calculated. A P value <0.05 was considered significant. To generate international-comparable results, age-standardized prevalence was calculated

Table 1—*General characteristics of the survey population*

	Men	Women	*P* value
Age (years)	41.26 ± 14.43	40.88 ± 14.86	0.041
Height (m)	1.70 ± 0.18	1.57 ± 0.16	<0.001
Weight (kg)	74.33 ± 23.37	68.82 ± 21.48	<0.001
BMI (kg/m^2)	25.47 ± 4.58	27.45 ± 5.76	<0.001
Waist girth (cm)	90.03 ± 13.86	87.20 ± 14.61	<0.001
Hip circumference (cm)	101.47 ± 14.14	107.18 ± 16.19	<0.001
WHR	0.88 ± 0.10	0.81 ± 0.09	<0.001
sBP (mmHg)	119.41 ± 23.25	121.08 ± 22.66	<0.001
dBP (mmHg)	74.78 ± 14.42	75.12 ± 15.40	0.879
Pulse (beats/min)	77.36 ± 10.01	80.54 ± 9.66	<0.001
2-h BG (mmol/l)	5.46 ± 1.70	6.07 ± 2.36	<0.001
Smoking (%)			<0.001
Current smoker	50.9	10.9	
Ex-smoker	6.8	1.4	
Alcohol (%)			<0.001
Current user	18.1	0.5	
Ex-user	8.8	0.6	
Education (%)			<0.001
Illiterate	7.7	33.6	
Literate only	5.6	7.2	
Elementary school education	45.5	44.2	
Secondary school education	13.1	4.6	
High school graduate	18.2	7.6	
University education	9.9	2.8	

Data are means ± SD unless noted otherwise.

using both Segi's world and European populations as standards (12).

RESULTS — A total of 29,050 eligible subjects were invited to attend the survey. Of those, 24,788 (women 55.3%) completed the study, with an overall response of 85%; 15,669 subjects were from urban and 9,119 were from rural areas. Characteristics of the survey population are shown in Table 1. Generally, women had higher BMI, sBP, and 2-h blood glucose and similar dBP; men had higher WHR. Smoking and alcohol consumption were almost entirely confined to men. Women had a lower level of education than men.

The distribution of 2-h blood glucose was unimodal. Age- and sex-specific crude prevalence of glucose intolerance in the urban and rural communities is shown in Figure 1. Overall crude prevalence of diabetes was 7.2% (previously undiagnosed, 2.3%), and IGT, 6.7%. Prevalence of diabetes was 8.0% in women and 6.2% in men ($P < 0.0001$). IGT was also more common among women than men ($P < 0.0001$). Both were higher in urban than rural subjects ($P = 0.0002$). Glucose intolerance increased with age. Rate of increment in both sexes was greater in the younger age group (20–40 years) than in the middle-aged or elderly population and was more prominent for diabetes than for IGT. The treatment rate was higher in urban than rural areas (none, 26 vs. 45%; diet, 14 vs. 13%; oral antidiabetic medications, 55 vs. 39%; insulin, 4 vs. 3%; combined treatment, 0.8 vs. 0.5%) ($P < 0.001$).

Overall frequency of hypertension was 29%, and of obesity, 22%. Both were higher among women than men ($P < 0.0001$). The prevalence of central obesity based on WHR (19%) was comparable to that of general obesity based on BMI. When calculated according to waist girth, the prevalence of central obesity was higher (34%).

Subjects living in the eastern part of Turkey had the lowest prevalence of diabetes (6%), IGT (6%), and obesity (17%), whereas prevalence of hypertension was lowest in the western region (26%). The highest rates for diabetes (9%) and IGT (8%) were in the southern region, hypertension (32%) in the northern region, and obesity (27%) in the central region. Regional differences were more prominent among women than men for all disorders.

Both diabetes and IGT showed increasing trends in prevalence across tertiles of BMI, WHR, and waist girth ($P < 0.0001$). Above the highest tertile of BMI, prevalence of diabetes and IGT were 12 and 10%, respectively. The corresponding figures for WHR and waist girth were 10 and 13% for diabetes and 7 and 10% for IGT.

Glucose intolerance was more frequent among people with familial diabetes than those without (diabetes, 12.5 vs. 5.5%; IGT, 7.3 vs. 6.5%) ($P < 0.0001$). Diabetes and IGT were present in higher frequency among those with hypertension compared with normotensive subjects (diabetes, 16.1 vs. 3.6%; IGT, 11.6 vs. 4.7%) ($P < 0.0001$). The trend was not associated with treatment or grade of hypertension. The crude odds ratio for the association between diabetes and hypertension was 4.4, which fell to 1.8 when age, sex, and obesity were taken into account.

Because of substantial differences in terms of smoking and drinking habits and education between men and women in Turkey, multiple logistic regression was undertaken separately for each (Table 2). The models indicated that increasing age, BMI, WHR, hypertension, and familial diabetes in both sexes, education in men, and living in the south in women were positively associated with diabetes. Modest alcohol consumption and living in the central region in men and education and living in a rural area in women had a protective effect. Positive associations with IGT were age, BMI, and hypertension in both sexes; WHR, familial diabetes, and moderate alcohol consumption in men; and moderate to high socioeconomic status (SES) in women. Smoking in both sexes, SES in men, and education in women appeared protective.

CONCLUSIONS — This article reports one of the largest population-based studies of diabetes ever conducted, in which the prevalence of previously diagnosed and undiagnosed diabetes, IGT, and related risk factors were analyzed for the first time in Turkey. The frequency of diabetes and IGT were comparable, and both were moderately high by international standards (13). Compared to other surveys that used WHO diagnostic criteria in the Mediterranean, Central and

Table 2.—*Results of multiple logistic regression model of the association between diabetes, IGT, and selected factors*

	Men with diabetes		Women with diabetes		Men with IGT		Women with IGT	
Variable (unit entered)	*P*	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)
Age (1 year)	<0.001	1.08 (1.07–1.08)	<0.001	1.06 (1.05–1.07)	<0.001	1.04 (1.04–1.05)	<0.001	1.03 (1.02–1.03)
BMI (1 unit)	<0.001	1.05 (1.03–1.07)	<0.001	1.04 (1.03–1.05)	<0.001	1.04 (1.02–1.06)	<0.001	1.03 (1.02–1.04)
WHR (0.1 unit)	<0.001	4.51 (1.97–10.33)	<0.001	4.02 (2.16–7.47)	0.049	2.44 (1.00–5.96)	—	—
Familial diabetes (no)								
Yes	<0.001	3.30 (2.74–3.98)	<0.001	2.83 (2.44–3.27)	0.005	1.37 (1.10–1.71)	—	—
HT (no)								
Mild*	0.001	1.39 (1.14–1.69)	<0.001	1.82 (1.55–2.15)	<0.001	1.59 (1.28–1.98)	0.033	1.18 (1.01–1.37)
Severe†	<0.001	1.88 (1.47–2.41)	<0.001	2.15 (1.75–2.64)	<0.001	1.65 (1.24–2.21)	0.016	1.28 (1.05–1.57)
Smoking (no)								
Yes	—	—	—	—	0.003	0.73 (0.59–0.91)	0.0009	0.63 (0.48–0.83)
Alcohol (no)								
Moderate 1–3 /week)	0.004	0.63 (0.46–0.87)	—	—	0.029	1.38 (1.03–1.86)	—	—
Heavy (>3/week)	—	—	—	—	0.004	2.26 (1.29–3.97)	—	—
Education (Illiterate)								
Elementary education	<0.001	1.94 (1.43–2.62)	0.006	0.78 (0.66–0.93)	—	—	—	—
Secondary education	0.0067	1.75 (1.17–2.63)	0.015	0.54 (0.33–0.89)	—	—	0.014	0.59 (0.39–0.90)
High school graduate	0.0006	2.10 (1.37–3.21)	0.001	0.43 (0.26–0.71)	—	—	0.021	0.65 (0.45–0.94)
University education	0.0042	2.00 (1.24–3.21)	—	—	—	—	0.003	0.34 (0.16–0.69)
SES (Very poor)								
Poor	—	—	—	—	—	—	—	—
Moderate	—	—	—	—	0.009	0.69 (0.52–0.91)	0.005	1.30 (1.08–1.57)
High	—	—	—	—	0.004	0.48 (0.29–0.80)	0.024	1.44 (1.05–1.99)
Wealthy	—	—	—	—	—	—	—	—
Region (Northern)								
Southern	—	—	0.002	1.37 (1.12–1.68)	—	—	—	—
Western	—	—	—	—	—	—	—	—
Eastern	—	—	—	—	—	—	—	—
Central	0.010	0.70 (0.53–0.92)	—	—	—	—	—	—
Residence (Urban)								
Rural	—	—	<0.001	0.67 (0.57–0.78)	—	—	—	—

Variables entered in the model: age, sex, BMI, WHR, familial diabetes, HT, smoking, alcohol, social status, education, family size, SES, profession, geographical region, and residence. *Mild HT: sBP < 160 and/or dBP < 95 mmHg. †Severe HT: sBP ≥ 160 and/or dBP ≥ 95 mmHg.

Eastern Europe, and Middle East regions, prevalence of diabetes in Turkey is higher than in Malta (14), Tunisia (15), and Spain (16); lower than in Egypt (17), Oman (18), Sudan (19), and Bahrain (20); and similar to that in the Turkic population of Central Asia (21). In contrast, a high prevalence of diabetes in Turkish Cypriots living in Northern Cyprus (11% in both sexes aged ≥20 years) and second- or third-generation Turks living in Germany (10% in women and 8% in men aged 35–64 years) underlines the effect of changing lifestyle in these populations (22,23). As they live in a closed society, genetic influences may be influential as well.

We calculated age-standardized prevalence rates of diabetes and IGT based on standard populations of the world and of Europe. Due to the relatively younger population of Turkey, the figures were higher than crude rates (diagnosed diabetes, 5.4 and 6.1%; undiagnosed diabetes, 2.5 and 2.8%; and IGT, 7.0 and 7.6%).

An interesting finding was the relatively low ratio of undiagnosed diabetes (32%). Rates of undiagnosed diabetes as well as the proportions of diabetes and IGT in this survey were similar to those reported from the United States (Third National Health and Nutrition Examination Survey) and Cremona, Italy (24,25). However, publications from other countries present a rising prevalence of undiagnosed diabetes (17,26).

It appears that in Turkey, diabetes is more common in women than in men. In a recent survey in Uzbekistan, diabetes prevalence was slightly higher in men, although IGT was more common among women (27). In some Arab countries, both diabetes and IGT are more prevalent among women (2,28). The variation may be explained by differential distribution in risk factors between men and women across populations (1). Lack of employment outside the home may contribute to the higher frequency of obesity and glucose intolerance among Turkish women. Physical activity is restricted to house-

work, and women have no tradition for sporting activities. According to this survey, 29% of Turkish women are obese and an additional 27% are overweight. It appears that obesity, glucose intolerance, and hypertension become very common beyond childbearing age (29). In the survey of Turkish Cypriots, diabetes was inversely associated with physical activity (leisure time and professional) (30).

Prevalence of glucose intolerance is usually higher in urban than rural communities in countries experiencing economic transition (2). The relatively small difference between urban and rural areas shown in this survey may reflect the effects of extensive changes in lifestyle even in rural areas in Turkey, and in other countries as well (31–33). Low prevalence of diabetes, IGT, and obesity in the eastern part of the country could be attributed to the more traditional lifestyle of this region, in which the economy depends on animal husbandry and limited agriculture. Moreover, the public transport system is not well developed, and thus people are physically conditioned and less obese. Geographical features such as high altitude may also contribute to this effect. According to the National Nutrition and Health and Household Consumption Expenditure Surveys, carbohydrate consumption in the eastern region is higher, and protein and fat consumptions are lower than in general (31,34).

Glucose intolerance increased with body fat distribution, but after controlling for potential confounders, there was no association between female WHR and IGT, in contrast to other studies in the literature (35). According to the present study, smoking was inversely related to the risk of IGT but not diabetes. Moderate alcohol consumption is reported to be protective for or not associated with diabetes, in many studies (36–38); our findings confirmed this.

Extrapolating these results to the recent population census (39), nearly 2.6 million adults in Turkey may have diabetes, of whom 0.8 million may be unaware of their disease. An additional 2.4 million may have IGT. Persons with undiagnosed diabetes or IGT are at high risk of cardiovascular disease.

With respect to long-term complications, early identification would shift the focus of diabetes care toward a more preventive one (40). Therefore, this survey has important implications for public health in Turkey. Obese and hypertensive people and those with familial diabetes are at increased risk. Education is an important factor in protection from disease. This is just one of many reasons to encourage formal education for women. The results underline the need to increase public awareness and to emphasize the value of lifestyle modification toward traditional Mediterranean nutrition, increased physical activity, and weight reduction. The TURDEP is an important source of data on diabetes and risk factors, not only for this country but also for Europe as a whole.

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APPENDIX

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