High Prevalence of Diabetes in Adana, a Southern Province of Turkey

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OBJECTIVE — To determine the prevalence of diabetes and glucose intolerance and their relationship with risk factors in Adana, a southern province of Turkey, where risk factors are more prominent, probably because of social and economic reasons.

RESEARCH DESIGN AND METHODS — The study population included 1,637 randomly selected adults aged 20–79 years. Diagnosis of diabetes was based on plasma glucose values using the 1999 diagnostic criteria recommended by the World Health Organization.

RESULTS — The crude prevalence of diabetes was 12.9% in men and 10.9% in women ($P = 0.207$). Total prevalence of diabetes was 11.6%. The screening process identified previously undiagnosed diabetes in 4.2% of individuals and impaired glucose homeostasis (consisting of impaired glucose tolerance and impaired fasting glucose) in an additional 4.3% of subjects. The prevalence of hypertension was 26.4% among men and 36.6% among women ($P < 0.0001$). Total prevalence of hypertension was 32.9%, and prevalence of obesity was 43.4%. Age, sex, BMI, waist circumference, hypertension, family history of diabetes, and triglycerides were independently associated with diabetes.

CONCLUSIONS — The prevalence of diabetes in Adana is higher than expected in both urban and rural areas. Obesity and hypertension also seem to be common metabolic disorders in this area. Age, hypertension, obesity, high triglyceride level, and family history of diabetes are independently associated with diabetes. Therefore, primary prevention through lifestyle modifications may have a critical role in the control of diabetes.

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Type 2 diabetes is recognized as a major global health problem, and its prevalence has been rising around the world (1). Individuals with diabetes have an increased risk of developing significant end-organ damage such as retinopathy, nephropathy, neuropathy, and cardiovascular disease (2). Tight glucose control delays many of these complications in patients with diabetes. Typically, it has been an asymptomatic disease for many years and about half of diabetic individuals are unrecognized (3). Type 2 diabetes is usually only recognized 5–12 years after hyperglycemia develops (4).

The prevalence of diabetes varies widely between populations, reflecting differences in both environmental influences and genetic susceptibility (5). In Turkey, there have been a number of population-based studies of diabetes prevalence, and screening programs started in the 1940s. Nearly 1 million subjects have been screened to date, but because of different methodologies and lack of standardization between studies, considerable variations in diabetes prevalence have been reported, even in the same area (6–8).

The objective of this study was to determine the prevalence of diabetes and glucose intolerance and their relationship with risk factors in Adana, a southern province of Turkey, where risk factors are more prominent, probably because of social and economic reasons.

RESEARCH DESIGN AND METHODS

— The study was conducted in 18 (9 urban and 9 rural) areas in Adana. The study population included randomly selected nonpregnant adults 20–79 years of age. Areas and study subjects were randomly selected from the electoral roll, which was taken from the National Statistics Institute. A written invitation was sent ~2 weeks before the survey to officials of the villages or quarters. A total of 2,000 subjects (900 men and 1,100 women) were invited to participate in the study. Of those, 1,637 subjects (607 men and 1,030 women) participated. The response rate was 78.6% for men and 93.6% for women. All subjects gave informed consent, and the study protocol was approved by the Baskent University Internal Review Board.

Between 7:00 and 10:00 A.M. each day, ~100 individuals were invited to the health station after an overnight fast. Anthropometric and demographic data were obtained for each subject. Age, sex, and personal and family history of hypertension, coronary artery disease, and diabetes were recorded for all subjects. Weight, height, and waist circumference were measured for each subject; BMI and visceral obesity were determined from these parameters. Body weight and height were measured while subjects wore light cloth-

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Abbreviations: dBP, diastolic blood pressure; FPG, fasting plasma glucose; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; sBP, systolic blood pressure; TURDEP, Turkish Diabetes Epidemiology Study.

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

ing without shoes. BMI was calculated as weight (in kilograms) divided by the square of height (in meters). Subjects with a BMI ≥25 kg/m^2 but <30 kg/m^2 were classified as overweight, and those with a BMI ≥30 kg/m^2 were classified as obese. Waist circumference was measured with a soft tape on standing subjects midway between the lowest rib and the iliac crest. Visceral obesity was defined as a waist circumference >88 cm in women and >102 cm in men. Systolic blood pressure (sBP) and diastolic blood pressure (dBP) were measured twice in the sitting position after a 15-min rest, and the mean was taken in all cases. Hypertension was defined as sBP ≥140 mmHg, dBP ≥90 mmHg, or the use of antihypertensive agents.

Blood samples were drawn after 8–12 h fasting for the measurement of lipid profile (total cholesterol, HDL cholesterol, and triglycerides) and fasting glucose levels. A 75-g oral glucose tolerance test (OGTT) was performed in all nondiabetic subjects. Samples for the measurement of plasma glucose were drawn at 0 and 120 min during the OGTT. They were centrifuged, and plasma was transferred to separate tubes, transferred immediately to the laboratory in cold boxes filled with ice (2–8°C), and analyzed on the same day. Levels of plasma glucose, total cholesterol, HDL cholesterol, and triglycerides were determined by the enzymatic spectrophotometric method using an Aeroset autoanalyzer (Abbott Laboratories, Chicago, IL). Reagents were supplied by the same manufacturer. LDL cholesterol and VLDL cholesterol levels were calculated by the Friedewald formula.

Diagnosis of diabetes was based on plasma glucose values using the 1999 diagnostic criteria recommended by the World Health Organization (9). Subjects with a fasting plasma glucose (FPG) ≥7 mmol/l and/or a 2-h plasma glucose ≥11.1 mmol/l were classified as having diabetes. An FPG <7 mmol/l and a 2-h plasma glucose ≥7.8 mmol/l and <11.1 mmol/l indicated the presence of impaired glucose tolerance (IGT). Impaired fasting glucose (IFG) was defined as an FPG ≥6.1 but <7 mmol/l and a 2-h plasma glucose ≥7.8 mmol/l. Normoglycemia was considered to be an FPG <6.1 mmol/l and a 2-h plasma glucose <7.8 mmol/l. Subjects were also considered to have type 2 diabetes if they reported a previous history of diabetes diagnosed by a physician and had an FPG ≥7 mmol/l or if they used of antihyperglycemic drugs, regardless of their FPG concentrations.

SPSS for Windows (version 9.05; SPSS, Chicago, IL) was used for data management and statistical analysis. The categorical variables are given as percentages. Relations among different groups and variables were analyzed with the χ^2 test or Fisher's exact test where appropriate. Stepwise logistic regression analysis was performed to determine the association of independent risk factors with type 2 diabetes. Age, sex, history of smoking and alcohol intake, family history of diabetes, BMI, waist circumference, hypertension, and total cholesterol, HDL cholesterol, and triglyceride levels were included as covariates. A P value <0.05 was considered statistically significant.

Table 1—*Prevalence of known and new diabetes, IGT, and IFG by age*

	Normal glucose tolerance	Known diabetes	New diabetes	IGT only	IFG only	IGT and IFG
Age 20–29 years						
Total	221 (98.2)	1 (0.4)	—	1 (0.4)	2 (0.9)	—
Men	82 (100)	—	—	—	—	—
Women	139 (92.7)	1 (0.7)	—	1 (0.7)	2 (1.4)	—
Age 30–39 years						
Total	280 (92.7)	10 (3.3)	6 (2.0)	4 (1.3)	1 (0.3)	1 (0.3)
Men	102 (87.9)	6 (5.2)	5 (4.3)	2 (1.7)	—	1 (0.9)
Women	178 (95.7)	4 (2.2)	1 (0.5)	2 (1.1)	1 (0.5)	—
Age 40–49 years						
Total	339 (86.0)	23 (5.8)	15 (3.8)	10 (2.5)	6 (1.5)	1 (0.3)
Men	136 (83.4)	13 (8.0)	6 (3.7)	4 (2.5)	3 (1.8)	1 (0.6)
Women	203 (87.9)	10 (4.3)	9 (3.9)	6 (2.6)	3 (1.3)	—
Age 50–59 years						
Total	244 (74.6)	35 (10.7)	24 (7.3)	13 (4.0)	8 (2.4)	3 (0.9)
Men	80 (70.8)	13 (11.5)	11 (9.7)	5 (4.4)	2 (1.8)	2 (1.8)
Women	164 (76.6)	22 (10.3)	13 (6.1)	8 (3.7)	6 (2.8)	1 (0.50)
Age 60–69 years						
Total	190 (74.8)	38 (15.0)	17 (6.7)	4 (1.6)	4 (1.6)	1 (0.4)
Men	59 (73.8)	13 (16.3)	6 (7.5)	1 (1.3)	—	1 (1.3)
Women	131 (75.3)	25 (14.4)	11 (6.3)	3 (1.7)	4 (2.3)	—
Age 70–79 years						
Total	102 (75.6)	14 (10.4)	7 (5.2)	5 (3.7)	4 (3.0)	3 (2.2)
Men	40 (75.5)	4 (7.5)	1 (1.9)	4 (7.5)	2 (3.8)	2 (3.8)
Women	62 (75.6)	10 (12.2)	6 (7.3)	1 (1.2)	2 (2.4)	1 (1.2)
Total	1,376 (84.1)	121 (7.4)	69 (4.2)	37 (2.3)	25 (1.5)	9 (0.5)
Men	499 (82.2)	49 (8.1)	29 (4.8)	16 (2.6)	7 (1.2)	7 (1.2)
Women	877 (85.1)	72 (7.0)	40 (3.9)	21 (2.0)	18 (1.7)	2 (0.3)

Data are *n* (%). $P < 0.0001$.

RESULTS — The crude prevalence of diabetes was 12.9% in men and 10.9% in women ($P = 0.207$). Total prevalence of diabetes was 11.6%. The screening process identified previously undiagnosed diabetes in 4.2% of individuals and newly diagnosed glucose intolerance (consisting of IGT and IFG) in an additional 4.3% of subjects. Frequencies of diabetes in urban and rural areas were similar (11.7 vs. 11.5%). Diabetes, IGT, and IFG increased with age. Their distribution according to age groups is shown in Table 1. The prevalence of diabetes showed significant association with increased age ($P < 0.0001$).

The prevalence of hypertension was 26.4% among men and 36.6% among women ($P < 0.0001$). Total prevalence of hypertension was 32.9% (21.0% previously known and 11.9% newly diagnosed). The frequency of hypertension was higher in diabetic subjects (Table 2). Subjects with hyperglycemia (IFG, IGT, and diabetes) had a higher prevalence of hypertension than subjects with normal glucose tolerance (52.1 vs. 29.1%; $P <$ 0.0001). In the present study, the prevalence of obesity was 43.4%. Of the sub-

Table 2—*Prevalence of previously known and new diagnosed hypertension in normal and glucose intolerant subjects*

	Normal glucose tolerance	Known diabetes	New diabetes	IGT	IFG
Normotensive	70.9	34.7	58.0	58.7	64.0
Known hypertension	18.8	41.3	23.2	21.7	32.0
New hypertension	10.3	24.0	18.8	19.6	4.0

Data are %. $P < 0.0001$.

jects with hyperglycemia, 27.2% were overweight and 61.3% were obese, and of the subjects with normal glucose tolerance, 36.3% were overweight and 40.0% were obese ($P < 0.0001$). In regression analyses, age ($P < 0.0001$), sex ($P < 0.002$), BMI ($P < 0.002$), waist circumference ($P < 0.0001$), hypertension ($P < 0.0001$), family history of diabetes ($P < 0.008$), and triglycerides ($P < 0.0001$) were independently associated with diabetes (Table 3).

CONCLUSIONS — This study provides the first representative, population-based estimates of the prevalence of diabetes and other categories of glucose intolerance in Adana using the 1999 diagnostic criteria recommended by the World Health Organization. Abnormal glucose tolerance affects nearly 16% of the population aged 20–79 years. Diabetes affects 11.6% of subjects, and the prevalence of diabetes increases by age in subjects aged 20–69 years. This rate is considerably higher than findings of the previous study conducted in Adana, Turkey, from September 1997 to March 1998 (10). In that study, they found the prevalence of diabetes in Adana was 8.8% (known 6.1% and previously undiagnosed 2.7%) and IGT as 5.6% (I. Satman, personal communication). The highest rates for diabetes and IGT were in the southern region (8). In our present study, we found previously undiagnosed diabetes in 4.2% of the subjects, which is higher than in the study mentioned above. In that study, they did not use fasting glucose to diagnose diabetes; in this respect they probably have underestimated the prevalence of diabetes. In our present study, we found previously undiagnosed diabetes in only 2% of the subjects according to 2-h blood glucose results alone (unpublished data). The results of previous studies (10–14) have clearly shown that fasting and 2-h glucose criteria do not identify the same group of individuals. Young and obese subjects and men are more likely to have diagnostic fasting glucose values than diagnostic 2-h glucose values (10–14).

Postload hyperglycemia mostly reflects impaired insulin response to glucose load; however, fasting glucose mostly reflects hepatic glucose production. In the Diabetes Epidemiology: Collaborative Analysis of Diagnostic Criteria in Europe study (13), 33% of subjects with a fasting glucose ≥7.0 mmol/l had nondiabetic 2-h glucose values. The prevalence of IGT was 2.8% in our study and 5.6% in the Adana section of the Turkish Diabetes Epidemiology Study (TURDEP) study; perhaps they had misdiagnosed some diabetic subjects as normal or IGT. These findings lead us to think that the TURDEP study underestimated the number of subjects with diabetes in Adana.

Table 3—*Multiple adjusted odds ratios of risk factors independently associated with diabetes*

	β-Coefficient	Odds ratio (95% CI)
Age (years)	0.04	1.04 (1.02–1.05)
Sex (female)	0.53	0.59 (0.41–0.85)
BMI (kg/m^2)	0.06	1.06 (1.02–1.10)
Waist circumference (cm)	0.03	0.97 (0.96–0.99)
Hypertension (mmHg)	0.18	0.72 (0.48–1.08)
Triglyceride (mmol/l)	0.01	1.01 (1.00–1.01)
No family history of diabetes	0.51	0.60 (0.42–0.85)

*Adjusted by age, sex, history of smoking and alcohol intake, family history of diabetes, BMI, waist circumference, hypertension, total cholesterol, HDL cholesterol, and triglycerides.

According to our study, 43.4% of subjects are obese and 32.9% are hypertensive. It appears that obesity, hypertension, and glucose intolerance have become very common in our region.

Because of geographical setting, Adana is influenced by the Middle East civilization for social, economic, and sociocultural views. A high prevalence of diabetes has also been noted among populations in the Middle East. Using the new criteria, 16.1% of adults in Oman, 10.6% of Kuwaitis, and 14.5% of Lebanese and 26.2% of Iraqis living in the U.S. have been diagnosed as diabetic (15–17). A high prevalence of diabetes has also been reported in Turkish Cypriots living in northern Cyprus and among Turks living in Germany (18,19).

The prevalence of undiagnosed diabetes in previous studies (3,7,17,20,21) has been shown to be nearly equal to that of diagnosed diabetes. Multiple factors, such as lack of access to and use of health care, physician practices, and culturally related health care practices and beliefs, may play a role. In the present study and some previous studies (6,8) conducted in Turkey, the prevalence of diagnosed diabetes was higher than undiagnosed diabetes. This difference might depend on the interest of participants or the effect of education programs carried out in our country.

In contrast to previous studies (15,22), frequencies of diabetes in urban and rural areas were similar. The similarity in urban and rural areas, as in the TURDEP study, may reflect the effects of lifestyle changes in rural areas in our region. Prevalence of obesity is increasing and being seen at younger ages than in the past (21,23,24). Obesity and lack of physical activity (results of modernization) are closely related to diabetes and have been observed to have increased in many countries (even in rural areas), including Turkey, over recent decades (15,21,25–27).

Interestingly, in contrast to our expectation, we did not find a statistically significant difference between the prevalence of diabetes in men and women. Regarding the prevalence of diabetes, Al-Lawati et al. (15) in Oman and Riste et al. (20) in different ethnic groups in Britain also did not find any significant difference between men and women. In the TURDEP study (8), prevalence of diabetes was higher in women than in men. However, as we mentioned above, they did not

measure FPG and isolated fasting hyperglycemia is more common in men than in women (13,14). The TURDEP study may have misdiagnosed some men with diabetes as normal or IGT.

In our region, risk factors independently associated with the high prevalence of type 2 diabetes are age, male sex, obesity, high triglyceride levels, and family history of diabetes. BMI and waist circumference indicated an android type of fat deposition. It is well known that obesity, especially visceral abdominal fat, increases the risk of developing type 2 diabetes and IGT (23,25). Age, BMI, android-type obesity, hypertension, triglycerides, and family history of diabetes were also independently associated with diabetes in previous studies (6–8,14,17,20, 21,23–25).

In conclusion, the prevalence of diabetes in Adana, a southern province of Turkey, is higher than expected in both urban and rural areas. Obesity and hypertension also seem to be common metabolic disorders in our region. Age, hypertension, obesity, high triglyceride levels, and family history of diabetes are independently associated with diabetes. Therefore, primary prevention through lifestyle modifications may have a critical role in the control of diabetes.

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References

1. World Health Organization: The Cost of Diabetes. Geneva, World Health Org., 1999 (Fact Sheet no. 236)
2. American Diabetes Association: Standards of medical care for patients with diabetes mellitus. *Diabetes Care* 26 (Suppl. 1):S33–S50, 2003
3. Roman SH, Harris MI: Management of diabetes mellitus from a public health perspective. *Endocrinol Metab Clin North Am* 26:443–474, 1997
4. Muggeo M: Accelerated complications in type 2 diabetes mellitus: the need for greater awareness and earlier detection. *Diabet Med* 15 (Suppl. 4):S60–S62, 1998
5. Amot A, McCarty D, Zimmet P: The rising global burden of diabetes and its complications: estimates and projections to the year 2010. *Diabet Med* 14 (Suppl. 5):S1–S85, 1997
6. Kelestimur F, Cetin M, Pasaoglu H, Coksevim B, Cetinkaya F, Unluhizarci K, Unal S, Koker AH: The prevalence and identification of risk factors for type 2 diabetes mellitus and impaired glucose tolerance in Kayseri, central Anatolia, Turkey. *Acta Diabetol* 36:85–91, 1999
7. Erem C, Yildiz R, Kavgaci H, Karahan C, Deger O, Can G, Telatar M: Prevalence of diabetes, obesity and hypertension in a Turkish population (Trabzon city). *Diabetes Res Clin Pract* 54:203–208, 2001
8. Satman I, Yilmaz T, Sengul A, Salman S, Salman F, Uygur S, Bastar I, Tutuncu Y, Sargin M, Dinccag N, Karsidag K, Kalaca S, Ozcan C, King H, the TURDEP Group: Population-based study of diabetes and risk characteristics in Turkey: results of the Turkish Diabetes Epidemiology Study. *Diabetes Care* 25:1551–1556, 2002
9. World Health Organization Department of Noncommunicable Disease Surveillance: Definition, diagnosis and classification of diabetes mellitus and its complications. Part I: Diagnosis and classification of diabetes mellitus: report of a WHO consultation. Geneva, World Health Org., 1999
10. Shaw JE, Boyko EJ, de Courten M, Zimmet PZ: Impact of new diagnostic criteria for diabetes on different populations. *Diabetes Care* 22:762–766, 1999
11. Wahl PW, Savage PJ, Psaty BM, Orchard TJ, Robbins JA, Tracy RP: Diabetes in older adults: comparison of 1997 American Diabetes Association classification of diabetes mellitus with 1985 WHO classification. *Lancet* 352:1012–1015, 1998
12. DECODE Study Group: Is fasting glucose sufficient to define diabetes? Epidemiological data from 20 European studies. *Diabetelogia* 42:647–654, 1999
13. Qiao Q, Nakagami T, Tuomilehto J, Borch-Johnsen K, Balkan B, Iwamoto Y, Tajima N: Comparison of the fasting and the 2-h glucose criteria for diabetes in different Asian cohorts. *Diabetologia* 43: 1470–1475, 2000
14. The DECODE Study Group: Age- and sex-specific prevalence of diabetes and impaired glucose regulation in 13 European cohorts. *Diabetes Care* 26:61–69, 2003
15. Al-Lawati JA, Al Riyami AM, Mohammed AJ, Jousilahti P: Increasing prevalence of diabetes mellitus in Oman. *Diabet Med* 19: 954–957, 2002
16. Abdella N, Al Nakhi A, Al Arouj M, Assoussi A, Moussa M: Impact of the 1997 American Diabetes Association criteria on classification of glucose intolerance among Kuwaitis below 50 years of age. *Acta Diabetol* 36:133–140, 1999
17. Jaber LA, Brown MB, Hammad A, Nowak SN, Zhu Q, Ghafoor A, Herman WH: Epidemiology of diabetes among Arab Americans. *Diabetes Care* 26:308–313, 2003
18. Satman I, Dinccag N, Yilmaz MT, Sengul AM, Yillar G, Salman S, Salman F, Tutuncu Y, Gedik S, Karsidag K, Karadeniz S, Tasyurek A, Sav H: Northern Cyprus: another high prevalence area of diabetes and impaired glucose tolerance in the Mediterranean (Abstract). *Diabetelogia* 40:A185, 1997
19. Porsch-Oezcueruemez M, Bilgin Y, Wollny M, Gediz A, Arat A, Karatay E, Akinci A, Sinterhauf K, Koch H, Siegfried I, von Georgi R, Brenner G, Kloer HU, the Giessen Study Group: Prevalence of risk factors of coronary artery disease in Turks living in Germany: the Giessen Study. *Atherosclerosis* 144:185–198, 1999
20. Riste L, Khan F, Cruickshank K: High prevalence of type 2 diabetes in all ethnic groups, including Europeans, in a British inner city. *Diabetes Care* 24:1377–1383, 2001
21. Dunstan DW, Zimmet PZ, Welborn TA, de Courten MP, Cameron AJ, Sicree RA, Dwyer T, Colagiuri S, Jolley D, Knuiman M, Atkins R, Shaw JE, the AUSDIAB Steering Committee: The rising prevalence of diabetes and impaired glucose tolerance. *Diabetes Care* 25:829–834, 2002
22. King H, Rewers M: Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults: the WHO AdHoc Diabetes Reporting Group. *Diabetes Care* 16:157–177, 1993
23. Troiano R, Flegal K, Kuczmarski R, Campbell S, Johnson C: Overweight prevalence and trends for children and adolescents: the National Health and Nutrition Examination Surveys, 1963 to 1991. *Arch Pediatr Adolesc Med* 149:1085–1091, 1995
24. Midthjell K, Kruger O, Holman J, Tverdal A, Claudi T, Bjorndal A, Magnus P: Rapid changes in the prevalence of obesity and known diabetes in an adult Norwegian population. *Diabetes Care* 22:1813–1820, 1999
25. Collins V, Dowse G, Toelupe P, Imo TT, Aloaina FL, Spark RA, Zimmet PZ: Increasing prevalence of NIDDM in the Pacific island population of Western Samoa over a 13-year period. *Diabetes Care* 17: 288–296, 1994
26. Prentice A, Jebb S: Obesity in Britain: gluttony or sloth? *BMJ* 311:437–439, 1995
27. Hillier TA, Pedula K: Characteristics of an adult population with newly diagnosed type 2 diabetes: the relation of obesity and age of onset. *Diabetes Care* 24:1522–1527, 2001