Characteristics of Patients With Type 2 Diabetes in México

Results from a large population-based nationwide survey

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OBJECTIVE — To describe the clinical characteristics of the diabetic population that formed part of a population-based survey conducted in México.

RESEARCH DESIGN AND METHODS — In 2000, information was obtained from 42,886 subjects aged ≥20 years using a multistage sampling procedure. Standardized questionnaires were used. Anthropometric measurements, blood pressure, and capillary glucose concentrations were taken.

RESULTS — Type 2 diabetes was found in 3,597 subjects (age-adjusted prevalence 8.18%), of which 2,878 (80%) had previously been diagnosed. The average age of the diabetic participants was 55.2 ± 13.5 years; 13% were <40 years of age. Nine percent had been diagnosed for >10 years. The average BMI was 29.2 ± 5.7 kg/m^2; three-quarters of the cases had BMI >25 kg/m^2. The average waist circumference was 102 ± 13.4 cm, and increased waist circumference was more common among women. Arterial hypertension was found in half of the cases and, of those on treatment, only one-third had a blood pressure <140/90 mmHg. Smoking was reported in 34% of the diabetic group, a higher rate than in the nondiabetic subjects. There was at least one modifiable coronary risk factor in 67.6% of the cases. Very few followed an exercise or dietary regimen and a small percentage used insulin.

CONCLUSIONS — Diabetes affects a large proportion of Mexican adults (8.18%). This figure may be underestimated. The majority of the subjects had modifiable risk factors for the chronic complications of diabetes. Only a few achieved adequate blood pressure control and other treatment goals.

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Diabetes is the most common cause of death in México (1). It is estimated that close to 11.7 million Mexicans will have diabetes by the year 2025 (2). This has important implications for every country with a significant number of Hispanic inhabitants. In the U.S., the Hispanic population is the fastest growing minority.

The clinical characteristics of the diabetic population and their comorbidities have been obtained mainly from hospitals or community-based surveys (3,4). Unbiased descriptions derived from nationwide, population-based surveys are scanty, especially for particular ethnic groups (5–8). Periodical assessments are necessary because the prevalence of certain factors may change over time (e.g., obesity), influencing treatment choices and the incidence of complications (9). Here, we describe the characteristics of the diabetic population forming part of a nationwide, population-based survey done in México during 2000. Our data demonstrate that Mexican adults with type 2 diabetes have a high prevalence of risk factors that contribute to the occurrence of macro- and microvascular complications.

RESEARCH DESIGN AND METHODS

Population sample

This is a cross-sectional study with participants from 400 cities. Up to 14 counties were selected in every state. Five basic administrative geographical units were selected in every county; up to 21 households from up to three blocks in every basic administrative geographical unit were visited and invited to participate. The households were randomly selected in these blocks; a randomly selected adult (≥20 years) was asked to participate from every selected home. The number of cases required from every basic geostatistic area was calculated based on the percentage of the Mexican population living in that region. The population of the survey was similar in distribution with regard to age, sex, and region as that reported in the 2000 population census (10). The sample size (n = 47,040) was capable of detecting conditions that have a prevalence of at least 6% with a relative error of estimation of 0.145 and a nonresponse rate of 35%. Information was obtained from 45,294 subjects; the response rate was 96.3%. The study was done in accordance with the Helsinki Declaration of Human Studies.

Methods

The demographic data and medical history were recorded using a standardized questionnaire utilized in previous nationwide Mexican surveys (11–14). It included questions on tobacco use, alcohol consumption, accidents, family history,

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Abbreviations: NHANES, National Health and Nutrition Examination Survey.

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

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Table 1—*Characteristics of the patients with diabetes*

	Total	Previously diagnosed	Detected during the survey	*P* value
n	3,597	2,878	719	
Sex (M/F)	1,090/2,507 (30.3/69.7)	859/2,019 (29.8/70.2)	231/488 (32.1/67.8)	0.23
Age (years)	55.2 ± 13.5	56.1 ± 13.2	51.3 ± 13.9	<0.05
20–29†	119 (3.3)	83 (2.9)	36 (5.0)	<0.05
30–39†	355 (9.8)	245 (8.5)	110 (15.3)	<0.05
40–49†	731 (20.3)	545 (18.9)	186 (25.9)	<0.05
50–59†	992 (27.6)	808 (28.1)	184 (25.6)	<0.05
60–69†	856 (23.8)	738 (25.6)	118 (16.4)	<0.05
70–79†	439 (12.2)	375 (13.0)	64 (8.9)	<0.05
≥80†	105 (2.9)	84 (2.9)	21 (2.9)	<0.05
Time since diagnosis (years)	8.8 ± 7.8	8.8 ± 7.8	—	—
BMI (kg/m^2)	29.2 ± 5.7	29.0 ± 5.7	29.9 ± 5.7	<0.05
BMI <25*	767 (21.3)	645 (22.4)	122 (17.0)	<0.001
BMI 25–30	1,400 (38.9)	1,139 (39.6)	261 (36.3)	<0.001
BMI >30	1,317 (36.8)	997 (34.6)	320 (44.5)	<0.001
Waist circumference (cm)	102 ± 13.4	101.7 ± 13.5	102.7 ± 14	<0.001
Women with waist >88 cm	2,104 (87.5)	1,688 (87.2)	416 (89.1)	0.155
Men with waist >102 cm	440 (42.5)	334 (41.0)	106 (48.0)	<0.05
Systolic blood pressure (mmHg)	133.5 ± 19.6	132.9 ± 19.6	133.7 ± 19	<0.01
Diastolic blood pressure (mmHg)	84.6 ± 12.6	83.9 ± 12.3	86.2 ± 12.9	<0.01
Arterial hypertension	1,795 (49.9)	1,466 (50.9)	329 (45.8)	<0.001
Undiagnosed high blood pressure	576 (16)	419 (14.6)	157 (21.8)	<0.001
Current treatment for high blood pressure	846 (23.5)	748 (26.0)	98 (13.6)	<0.001

Data are means ± SD of *n* (%). *Data were not available or wrong in 3% of the population (n = 113); †indicates percent value within group.

diabetes, hypertension, and other chronic disorders. Diabetes was explored in 11 questions, thus assessing age at diagnosis, method used for the detection, symptoms, time since the participant was diagnosed, and treatment-related issues. Personnel involved in the application of the questionnaire and the sampling attended a 30-day training course. These procedures were tested during a 10-day pilot test. Height and body weight were measured on a daily-calibrated balance. Waist circumference was measured at the midpoint between the highest point of the iliac crest and the lowest part of the costal margin in the mid-axillary line. Blood pressure was measured twice in those who had a blood pressure >120/80 mmHg. The second measurement was done after a 5-min rest, and the mean of both measurements was used in the database. Measurement of capillary glucose concentration was requested from all participants. The results are presented from the 42,886 subjects with a valid capillary glucose result. Samples were collected after a 9- to 12-h fasting period in 2,535 participants (5.9% of the population). These subjects were randomly distributed; no bias was detected for region or socioeconomic status. Accutrend sensor monitors (Roche Diagnostics) were used in this study. A random urine sample was requested from every patient. A commercially available strip test (Multistix; Bayer) was used to detect nitrates in the urine sample. Microalbuminuria was measured using the Micral test II (Boehringer, Mannheim, Germany).

Definitions

Diabetes was considered present in previously diagnosed cases or in subjects with a random glucose concentration of ≥11.1 mmol/l or a fasting glucose ≥7 mmol/l. Type 2 diabetes was diagnosed using the definition of the American Diabetes Association (15). Using BMI measurements, overweight was defined as 25–30 kg/m^2 and obese as ≥30 kg/m^2. Hypertension was diagnosed when the blood pressure was ≥140/90 mmHg or by a history of antihypertensive treatment (16). Isolated diastolic hypertension was diagnosed when the diastolic pressure was ≥90 mmHg and the systolic pressure was <140 mmHg. Isolated systolic hypertension was diagnosed if the systolic pressure was ≥140 mmHg and the diastolic pressure was <90 mmHg. Tobacco smoking was defined as the consumption of at least one cigarette during the previous month. Excess alcohol intake was defined as at least one episode of alcohol intoxication during the previous month. Microalbuminuria was defined as an albumin concentration ≥20 mg/l using the Micral-II test (17). A family history of coronary heart disease and urinary tract infection were considered present if referred to by the patient; specific questions explored these possibilities in the questionnaire.

Statistical analysis

Continuous variables were described using means and SDs. The one-way ANOVA test using the Bonferroni correction was applied to compare differences between groups. Categorical variables were compared by the χ^2 statistic with Yates' correction. Multiple logistic regression was used to assess the association of diabetes with several variables. Age and sex were included in every model. The statistical analysis was conducted with SPSS version 10.0 for Windows.

RESULTS — Table 1 shows the characteristics of the diabetic population (n = 3,597). All cases were considered to have

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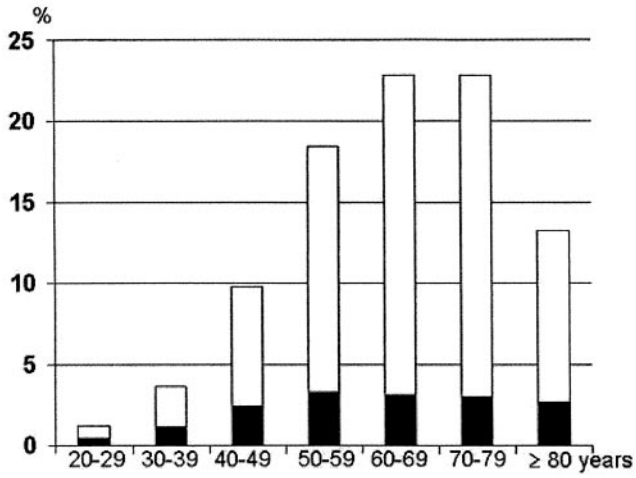

Figure 1—*Prevalence of diabetes in Mexican adults aged ≥20 years. □, previously diagnosed diabetes; ■, diabetes detected during survey.*

type 2 diabetes. The age-adjusted prevalence was 8.2% (men 7.7 and women 8.4%, $P = 0.001$). Diabetes affected 474 subjects <40 years of age and 546 individuals >70 years of age (13.2 and 15.2%, respectively). Newly diagnosed cases comprised one-fifth of the population ($n = 719$ [20%]); the majority of whom ($n = 688$) were diagnosed by means of a random glucose measurement. Figure 1 shows the prevalence of total, known, and newly detected diabetes stratified by 10-year intervals. The highest percentage of newly detected cases was found in the youngest group (38.2%).

Nearly half of the diabetic participants had been diagnosed for no more than 10 years ($n = 1,537$ [42.7%]) and only a few for more than 20 years ($n = 333$ [9.2%]). The mean age at diagnosis was 48 ± 12.5 years, and women were diagnosed at a younger age (47.6 ± 12.1 vs. 49.1 ± 13.6 years, $P < 0.01$).

Cardiovascular risk factors. Half of the diabetic subjects had high blood pressure, and one-third were diagnosed during the study. The coexistence of both systolic and diastolic hypertension was the most frequent finding ($n = 904$ [50.3%]). Isolated systolic or diastolic hypertension was less commonly found (17.1 and 32.6%, respectively). Tobacco smoking was more frequent in the diabetic group (34 vs. 29%, odds ratio [OR] 1.22, 95% CI 1.13–1.31, respectively). Family history of coronary heart disease in first-degree relatives was present in 1,032 cases (28.7%). Because of their age (≥45 years for men and ≥55 years for women), 857 men and 1,298 women may have an increased cardiovascular risk. Thus, a large percentage had, in addition to diabetes, at least one of the four cardiovascular risk factors described above ($n = 3,106$ [86.3%]). If only high blood pressure and tobacco smoking are considered, 67.6% ($n = 2,431$) had at least one treatable risk factor.

BMI and body fat distribution. Of the subjects with diabetes, 75% had a BMI ≥25 kg/m^2 ($n = 2,717$). The mean BMI was greater in women than in men (29.7 ± 5.8 vs. 28.1 ± 5.1 kg/m^2, $P < 0.001$, respectively). An increased waist circumference (>88 cm for women and >102 cm for men) was more common in diabetic subjects than in nondiabetic control subjects. This trend was clearer in women (women OR 4.2, 95% CI 3.73–4.79; men 2.2, 1.95–2.5).

Other comorbidities. Half of the patients with diabetes had a positive Micraltest ($n = 1,957$ [55.6%]); this finding was more common in the diabetic group (OR 1.32, 95% CI 1.23–1.41). Subjects diagnosed with diabetes for at least 10 years had an increased likelihood of a positive result (1.25, 1.05–1.48). The same trend was found for arterial hypertension (1.50, 1.29–1.74).

Subjects with diabetes had an increased prevalence of urinary tract infections (OR 1.5, 95% CI 1.38–1.63), and almost one-fifth had suffered at least one event ($n = 629$ [17.5%]). This observation is in concordance with the high prevalence of nitrates in urine ($n = 333$ [9.3%], $P < 0.05$ vs. nondiabetic subjects).

Treatment for hyperglycemia (Table 2). A large percentage of the subjects who had been diagnosed had received treatment ($n = 2,434$ [84.6%]). At the time of the survey, 1,997 (69.4%) took an oral glucose-lowering agent and 167 (5.8) took insulin. Insulin users were diagnosed at a younger age (44.0 ± 13 vs. 49 ± 11.8 years, $P < 0.001$) and tended to have had diabetes for a longer time (14 ± 8.9 vs. 9.1 ± 7.7 years, $P < 0.001$). Only 626 individuals (21.5%) appeared to be following a diet and an even lower number of subjects incorporated regular exercise into their treatment ($n = 114$ [5.8%]). Nontraditional medicine (including herbal products and homeopathy) was the chosen treatment in 328 cases (11.39%). Medication was paid for out-of-pocket in more than one-third of the diabetic population ($n = 1,047$ [36.4%]).

Antihypertensive treatment in the diabetic participants. Among the previously diagnosed hypertensive cases ($n = 1,219$), 80% had received antihypertensive treatment ($n = 981$). However, only 30% of those receiving treatment ($n = 373$) had a blood pressure <140/90 mmHg. Fewer still were able to achieve the goals proposed by the year 2000 recommendations of the American Diabetes Association (<130 mmHg for systolic [$n = 111$, 11.3%] and <85 mmHg for diastolic [$n = 261$, 26.6%]) (18).

Diabetes among cases <40 years of age (Table 3). These participants were different with respect to those aged 40–69 years (the age-group with the largest number of cases). Newly diagnosed diabetes was more common in this group, as was excess alcohol intake. Tobacco smoking was less frequent; however, a greater percent of those who smoked consumed ≥10 cigarettes daily (17.9 vs. 14.9%, $P < 0.001$). The majority of young diabetic subjects was either obese ($n = 204$ [43%]) or overweight (144 [30.4%]), with features of the metabolic syndrome. In addition, the percentage of cases with BMI <25 kg/m^2 (118 [24.8%]) was also greater in comparison with those aged 40–69 years. Of the young lean diabetic subjects, only a few remained without treatment after diagnosis and insulin use was more common, but this difference was not significant.

CONCLUSIONS — Our objective was to describe, based on a population-based survey, the characteristics of indi-

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Table 2—*Characteristics of the patients with diabetes: treatment of diabetes and other comorbidities*

	Total	Previously diagnosed	Detected during the survey	*P* value
n	3,597	2,878	719	
Treatment for diabetes	2,434 (67.7)	2,434 (84.6)	—	—
Diet	626 (17.4)	626 (21.7)	—	—
Regular exercise	114 (3.1)	114 (4.0)	—	—
Oral glucose-lowering agents	1,997 (55.5)	1,997 (69.4)	—	—
Insulin	167 (4.6)	167 (5.8)	—	—
Nontraditional medicine	328 (9.1)	328 (11.4)	—	—
Current hyperglycemia	2,283 (63.5)	1,558 (54.1)	719 (100)	<0.001
Fasting capillary glucose (mg/dl)	189 ± 88	196.2 ± 98	180 ± 72	<0.01
Non–fasting capillary glucose	244 ± 144	231 ± 115	302 ± 89	<0.001
Other comorbidities				
Tobacco smoking	1,222 (34.0)	1,007 (35.0)	215 (29.9)	<0.01
Family history of coronary heart disease	1,032 (28.7)	872 (30.3)	160 (22.2)	<0.001
Men aged ≥45 years	857 (78.6)	709 (82.5)	148 (64.1)	<0.001
Women aged ≥55 years	1,298 (51.8)	1,106 (54.8)	192 (39.4)	<0.001
Tobacco smoking and high blood pressure	586 (16.3)	481 (16.7)	105 (14.6)	<0.001
Excess alcohol intake†	390 (10.8)	285 (9.9)	105 (14.6)	<0.001
Nitrites in the urine	333 (9.2)	283 (9.8)	50 (7.0)	<0.001

Data are means ± SD or *n* (%). *Fasting glucose >126 mg/dl or random glucose >200 mg/dl; †at least one episode of alcohol intoxication during the previous month.

viduals affected by type 2 diabetes living in México. The results may help to clarify why diabetes has become the principle cause of death in Mexican adults (1).

One explanation is the large and growing number of affected individuals. Since the 1993 Mexican Survey of Chronic Diseases (11), using the same diagnostic tools and criteria, the prevalence of diabetes has changed from 6.7 to 8.2%, a 22% increase of in a 7-year period. This number includes known and newly diagnosed cases. The prevalence would be greater if the World Health Organization's criteria were used. In the coming years, the incidence of diabetes may be high, since 75% of the 97 million inhabitants of México are <40 years of age. These results reiterate the urgent need for nationwide diabetes prevention programs (19–21).

A second explanation is found by analyzing the characteristics of the diabetic population. The number of cases where diabetes was diagnosed before age 40 years was higher than expected. This finding is similar to that reported in the 1993 Mexican Survey of Chronic Diseases (14). A similar finding has been reported in Mexican Americans compared with non-Hispanic whites (6.2%) (22). Early appearance of the disease leads to a longer exposure to diabetes (23). Also, treatment

Table 3—*Characteristics of the cases with diabetes stratified by age-groups*

	Age <40 years	40–69 years	≥70 years	*P* value
n	474	2,577	646	
Sex (M/F)	130/344 (27.4/72.5)	766/1,811 (29.7/70.3)	194/352 (35.5/64.5)	<0.05
Age (years)	33.1 ± 5.1	54.9 ± 8.1	75.6 ± 5.2	<0.001
Undiagnosed diabetes	146 (30.8)	487 (18.9)	86 (15.8)	<0.001
BMI (kg/m^2)	29.3 ± 5.7	29.5 ± 5.7	27.3 ± 5.4	<0.001
BMI <25	118 (24.9)	479 (18.6)	170 (31.1)	<0.001
BMI 25–30	144 (30.4)	1,041 (40.4)	215 (39.4)	<0.001
BMI >30	204 (43.0)	1,004 (39.0)	109 (20.0)	<0.001
Treatment for diabetes	189 (39.9)	1,831 (71.1)	414 (75.8)	<0.001
Insulin treatment	17 (3.6)	122 (4.7)	28 (5.1)	0.16
Oral glucose-lowering agents	127 (26.8)	1,523 (59.1)	347 (63.6)	<0.001
Fasting capillary glucose (mmol/l) (% within group)	9.5 ± 4.2 (9.5)	11.2 ± 5.2 (5.3)	8.8 ± 3.8 (5.5)	<0.001
Random capillary glucose (mmol/l) (% within group)	12.4 ± 6.3 (90.5)	14 ± 6.3 (94.7)	12.4 ± 6.1 (94.5)	<0.001
Arterial hypertension	131 (27.6)	1,325 (51.4)	339 (62.1)	<0.001
Current tobacco smoking	139 (29.3)	874 (33.9)	209 (38.3)	<0.001
Positive Micraltest	171 (36.1)	952 (44.9)	191 (46.2)	<0.001
Excess alcohol intake†	65 (13.7)	291 (11.3)	34 (6.2)	0.001

Data are means ± SD or *n* (%). *Data were not available or wrong in 3% of the population ($n = 113$); †at least one episode of alcohol intoxication during the previous month.

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of this subgroup seems to be more complex (24). Younger diabetic patients were more frequently using insulin or glucose-lowering agents. One reason for this phenomenon may be the presence of types of diabetes with impaired insulin secretion (e.g., maturity-onset diabetes of the young or latent-onset autoimmune diabetes). Such cases are typically lean and usually diagnosed before age 40 years (25). These characteristics were found in 118 individuals in this report (3.3% of the diabetic population, 24.8 of the young subjects). Furthermore, the younger diabetic subjects had the highest prevalence of excess alcohol consumption. Newly diagnosed diabetes was more common in this group. Thus, programs targeting young adults with diabetes must be included in diabetes clinics in México.

Further reasons for the high diabetes-related mortality rate include the prevalence of risk factors for the development of chronic complications. Half of our diabetes cases had arterial hypertension, and tobacco smoking was found in 34%. Previous reports (11) have also found a high prevalence of dyslipidemia in Mexican diabetic adults. Thus, modifiable cardiovascular risk factors are highly prevalent in this population, and the proper diagnosis and treatment of these factors has been shown to be effective in reducing diabetes-related mortality (26–28). With regard to diabetic nephropathy, microalbuminuria was evident in half of the diabetes cases, suggesting that diabetic renal complications may be present in a large proportion of the population. This is in agreement with the large number of diabetes-related renal insufficiency cases reported in this country (29). There was a high prevalence of urinary tract infections in our study; this is a contributing factor to the renal complications. Hence, we should screen for this treatable abnormality in every diabetic patient (30).

A lack of optimal treatment of type 2 diabetes is evident from our data. Among previously diagnosed subjects, hyperglycemia was found in 54%. In our study, the mean glucose concentration was similar to that reported in Mexican Americans (31). This value is lower than that found in Native Americans and higher than that observed in non-Hispanic whites. Diet and exercise were not part of the treatment in close to 80% of the subjects. Insulin treatment was limited to a small number of cases, many of whom had had the disease for >10 years. The number of insulin users was lower than that reported in U.S. cohorts (32 vs. 51%). With regard to antihypertensive treatment, goals were not reached by the majority of the population. The percentage of cases with blood pressure <140/90 mmHg (30%) was lower than that reported for Mexican Americans in the National Health and Nutrition Examination Survey (NHANES) III survey (34.7%) (33). In conclusion, educational programs for practitioners will be required for the proper treatment of diabetes and its comorbidities.

Limitations of our survey must be recognized. A capillary glucose measurement and a medical history are not enough for the accurate estimation of the prevalence of type 2 diabetes. A significant number of cases would be classified as having diabetes with complementary testing. This limitation may explain the lower than expected percent of undiagnosed cases found in this report (20 vs. ~50% found in the NHANES III). Among the nondiabetic population, 1,806 subjects had a random glucose ≥7.7 mmol/l. If further testing demonstrates that some of them are affected, the crude prevalence may move up to 12.6%. We limited our analysis to describing cases in which the diagnosis was certain. Also, comparisons between subjects with and without diabetes were limited to conditions where overt hyperglycemia plays a role (e.g., urinary tract infections). Some parameters were considered positive by the simple self-referral of the subjects. These limitations are common in large population-based studies. The number of subjects with diabetes reported here (n = 3,597) is greater than that included in the NHANES III survey or in the Hispanic Health and Nutrition Examination Survey (HHANES) study.

In conclusion, the growing number of individuals with type 2 diabetes, many of whom are <40 years of age, and the high prevalence of risk factors contributing to the development of chronic complications may explain why this disease has become the principle cause of death in México.

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