

Early-onset type 2 diabetes in a Mexican survey. Results from the National Health and Nutrition Survey 2006

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Abstract

Objective. To describe the characteristics of patients with type 2 diabetes diagnosed before age 40 (early-onset type 2 diabetes) identified in a nation-wide, population-based study. **Materials and Methods.** The survey was done in Mexico during 2006. Medical history, anthropometric and biochemical measurements were obtained in every subject. **Results.** Cases diagnosed before (n=181) and after age 40 (n=659) were included. Early-onset type 2 diabetes was present in 13.1% of the previously diagnosed, 30.3% of the cases identified during the survey and 21.5% of the whole population with diabetes. These individuals had a greater prevalence of obesity and hypertriglyceridemia compared to the cases diagnosed after age 40. **Conclusions.** Early-onset type 2 diabetes was present in 21.5% of patients with type 2 diabetes in Mexico. Close to 70% of them were obese or overweight and had the clinical profile of the metabolic syndrome.

Key words: diabetes mellitus; obesity; hyperglycemia; insulin; Mexico

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Resumen

Objetivo. Describir las características de los pacientes con diabetes diagnosticados antes de los 40 años en una encuesta representativa de la población mexicana. **Material y métodos.** La encuesta fue realizada en México durante 2006. Se registró la historia médica, mediciones antropométricas y bioquímicas de los participantes. **Resultados.** Se incluyeron casos diagnosticados antes (n=181) y después (n=659) de los 40 años. La diabetes tipo 2 de inicio temprano está presente en 13.1% de los casos previamente diagnosticados, 30.3% de los identificados durante la encuesta y en 21.5% de la población total con diabetes. En los casos diagnosticados antes de los 40 años hay una prevalencia mayor de obesidad e hipertrigliceridemia que en los diagnosticados después de los 40. **Conclusiones.** La diabetes de aparición temprana está presente en 21.5% de los casos con diabetes en México. Setenta por ciento de ellos tenían un peso mayor al saludable y tenían el perfil clínico del síndrome metabólico.

Palabras clave: diabetes mellitus; obesidad; hiperglicemia; insulina; México

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Type 2 diabetes has a remarkable social and economical impact in Mexico.¹ The large and growing number of cases, the complexity of therapy and the coexistence of several co-morbidities are major determinants of the burden imposed by this disorder to our health system. In countries, like Mexico, in which diabetes is highly prevalent, the onset of the disease happens at earlier ages.² This feature boosts the adverse consequences of diabetes. The longer exposure to hyperglycemia and other diabetes-related abnormalities increase the likelihood that patients will develop chronic complications.³ This characteristic results in a large number of incapacitated before the age of 50. Also, these subjects frequently exhibit a more severe form of the disease and require insulin treatment at an earlier time.⁴ In addition, they have different needs and obstacles to achieve adherence to therapy. This subset of patients, referred, as early-onset type 2 diabetes, is a heterogeneous group. Analysis of the 1994 National Survey of Chronic Diseases (ENEC) showed that early-onset type 2 diabetes occurred in 14% of the Mexican population with diabetes.⁵ The majority of the cases (78%) had one or more traits of the metabolic syndrome and were either obese or overweight. The remaining cases (22%) had a clinical profile seen in insulin deficient states (i.e., maturity onset diabetes of the young or late-onset autoimmune diabetes).

Few papers have described the characteristics and the consequences of diabetes diagnosed between ages 20 and 40.⁶⁻¹¹ Nation wide, population-based studies are required to describe the unbiased prevalence and the characteristics of the patients with early-onset type 2 diabetes. The objective of this report is to update the information provided by the National Survey of Chronic Diseases (ENEC), using data of the Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006).

Material and Methods

Population sample

The objectives and design of the survey are described in detail in another report of this issue. In brief, this is a cross sectional study that is representative of individuals living in metropolitan areas (state capitals or cities with a population above 100 000 people), urban (population 2 500 to 99 999 inhabitants) and rural settings (less than 2 500 inhabitants). A multistage, stratified and probabilistic sampling procedure was used. The country was divided in four regions (northeast, northwest, central and southern). All states of Mexico were included. A random sample of Basic Geographical Statistical Units was obtained in each state. Neighborhood blocks were randomly selected. In every home

one randomly selected adult, adolescent and infant and health service user were invited to participate. Military, religious, health and other institutions were excluded. A target of 4 731 individuals and 1 476 households per state was estimated for every state. The sample size was considered capable of detecting risk factors at the state level, that have at least a prevalence of 8.1% with a relative error of estimation of 0.25, a design effect of 1.7 and a non-response rate of 20%. The number of households was increased to 1 620 in 13 states to assure enough power to be representative for the communities participating in the "Oportunidades" federal program. The total amount of households was 48 600. This sample size allows the assessment of conditions with a prevalence equal or greater than 0.4%. The study was realized in accordance with the Helsinki Declaration of Human Studies. Informed consent was obtained of each participant. A separate consent form was signed by participants that provided blood samples. The research and ethics committees of the Instituto Nacional de Salud Pública approved the study protocol.

Personal interview

A general structured interview was conducted. A previously standardized questionnaire was used to obtain information on demographic and socioeconomic aspects, family health history, personal medical history, and lifestyle factors such as smoking. It includes questions about pre-diagnosed hypercholesterolemia and hypertriglyceridemia and the current use of hypolipidemic agents. In the same visit, anthropometric and blood pressure measurements were obtained. Systolic (1st-phase) and diastolic (5th-phase) blood pressures were measured to the nearest even digit with a sphygmomanometer with the subject in the supine position after a 5 minutes rest using a mercurial sphygmomanometer. Participants removed their shoes and upper garments. Height was measured to the nearest 0.5 cm using a stadiometer. Body weight was measured on a daily calibrated digital balance and recorded to the nearest 0.1 Kg. Body mass index (BMI) was calculated as weight (Kg) divided by height (m²) and was used as an index of overall adiposity.¹² The equipments were regularly calibrated using reference samples provided by the manufacturer.

Methods

Blood samples were obtained in approximately 30% of the adult population. A random sub-sample, with 8 or more hours of fasting, was obtained (n=6 006). These cases were randomly distributed between study

subjects from the total fasting cases, with statistical power to detect prevalence of DM2 and dyslipidemias $\geq 8\%$, and balanced by geographic region. All analytical measurements were done at the Instituto Nacional de Salud Pública. The sampling procedure was standardized during a two week training course. The subjects were sampled at their homes; they remained sited for five minutes before the blood was drawn.

Total cholesterol was determined using enzymatic hydrolysis and oxidation. Triglycerides concentration was measured after lipase hydrolysis in an automatic analyzer with a tungsten lamp. The interassay CV was 3.04 % for total cholesterol and 5.7% for triglycerides. HDL- cholesterol was measured by an enzymatic colorimetric direct method after eliminating chylomicrons, VLDL, and LDL by enzymatic digestion; the interassay C.V. was 5.02 %. To assure the precision and exactitude of the determinations, the concentrations of total cholesterol, HDL-cholesterol and triglycerides were adjusted to a standard curve constructed with the determinations of the NIST materials 909b and 1951b, levels I and II, using the standard material and a 1:1 dilution

Definitions

Diabetes was considered present in previously diagnosed cases or if a fasting plasma glucose was equal or greater than 126 mg/dl.¹³ In the early-onset type 2 diabetes group were included cases diagnosed between ages 20 and 40 years. The body mass index was used to define overweight (25-30 kg/m²) and obesity (≥ 30 kg/m²).

Hypertriglyceridemia was defined as a fasting plasma concentration ≥ 150 mg/dl. Cholesterol ≥ 200 mg/dl was considered to be hypercholesterolemia. High density lipoprotein cholesterol (HDL) concentration was considered to be abnormal if it was less than < 40 mg/dl for men and < 50 mg/dl for women. These cut-off points were selected based on the National Cholesterol Education Program recommendations.¹⁴ Hypertension was diagnosed when the systolic pressure was ≥ 140 mm Hg and/or diastolic pressure was ≥ 90 mm Hg and/or current use of antihypertensive medications. Blood pressure was measured twice in two different visits if the initial measurement was $\geq 120/80$. Regular alcohol consumption was defined as having 10 or more drinks per week during the previous month. Smoking was defined as having one or more cigarettes during the last thirty days.

Statistical analysis

The database was validated through recognition of missing values, outliers and inconsistencies between

variables. Prevalence of diabetes in indigenous and non-indigenous population according with several risk factors was estimated. The association between several risk factors and prevalence of diabetes was examined by multiple logistic regression. The model included age group ($>$ or $<$ 40 years), gender, ethnicity (classified as speaking any indigenous language, non-speaking indigenous language and non indigenous) and the variables under study. On the basis of the sample design of the survey, we used individual weighted factors in the statistical analysis and considered the survey's complex sampling design to obtain variances. Data from the 2005 National Population Counting was used to estimate the number of cases nationwide. All analyses were conducted using Stata 9.

Results

The clinical characteristics of the subsample with 8 or more hours of fasting (n=6 006) are shown in table I. Data are presented for subjects younger or older than age 40. The younger individuals had a higher education. However, they appertained more often to the lowest socioeconomic strata and a greater percentage of them had regular consumption of alcohol and smoking. Their mean body mass index was 27 kg/m². As expected, their prevalence of high blood pressure and dyslipidemia was lower compared to the older group.

The prevalence of diabetes in the study sample and in several subsets of the population is shown in table II. The national overall prevalence of diabetes was 14.42%. The coexistence of obesity, low HDL cholesterol, hypertriglyceridemia and arterial hypertension was associated with a higher prevalence of diabetes. The prevalence of diabetes in subjects aged 40 or younger was 5.8%. Early-onset type 2 diabetes was present in 13.1% of the previously diagnosed, 30.3% of the cases identified during the survey and 21.5% of the whole population with diabetes. Using expanding factors, we estimate that there are 1 662 870 Mexicans with early-onset type 2 diabetes.

The clinical profile of the early-onset type 2 diabetes group is shown in table III. The results are presented for cases previously diagnosed or identified as affected during the survey for both young and older patients with diabetes. All cases were considered as type 2 diabetes. Ethnicity was not different between the early- or late-onset groups. The early-onset group had a higher education compared to the older patients with diabetes, but this feature was not associated with a higher income. A large percentage live in urban centers and almost a third were in the lowest income groups. Current smoking and alcoholism were more common

Table I
DESCRIPTION OF THE STUDY POPULATION. MEXICO, ENSANUT 2006

	Aged 40 years and younger (n=3128)	Older than 40 years of age (n=2878)	p value
Sex (men), %	45.8	47.0	0.553
Age (mean, s.e.)	29.3 (0.2)	55.7 (0.3)	<0.001
Schooling, %			
None or basic school	33.1	70.5	<0.001
Middle	35.9	16.7	
High school or high	31.0	12.9	
Size of locality, %			
Rural	19.9	22.2	0.097
Urban	24.0	24.4	
Metropolitan area	56.1	53.4	
Socioeconomic income deciles, %			
1 – 2	40.9	31.6	0.001
3 – 4	22.4	27.1	
5 – 7	27.2	30.6	
8 – 10	9.5	10.7	
Ethnicity, %			
Speaking any indigenous language	5.3	6.3	0.922
Non-speaking indigenous language	13.5	13.1	
Non-indigenous	81.3	80.6	
Current smoking, %	21.1	16.4	0.004
Alcoholism, %	36.8	28.0	<0.001
Body mass index (kg/m ²)	27.0 (0.1)	28.8 (0.2)	<0.001
Systolic blood pressure, mmHg	117.4 (0.5)	129.1 (0.6)	<0.001
Diastolic blood pressure, mmHg	77.6 (0.5)	82.3 (0.6)	0.001
Cholesterol, mg/dl*	191.5 (1.5)	209.4 (1.7)	<0.001
HDL-C, mg/dl*			
Men	37.2 (0.4)	37.7 (0.4)	0.394
Women	40.0 (0.4)	41.8 (0.4)	0.002
LDL-C, mg/dl*	95.0 (1.0)	105.3 (1.1)	<0.001
LDL-C ≥ 100 mg*/dl, %	38.0	49.4	<0.001
VLDL-C, mg/dl*	22.2 (0.3)	25.3 (0.3)	<0.001
Triglycerides, mg/dl*	128.4 (1.8)	146.3 (2.0)	<0.001
Hypertension, %	20.5	46.9	<0.001

The study was done in Mexico during 2006

All values are means and standard error (s.e.), except when indicated

Weighted sample 50 759 142: 28 729 522 subjects aged 40 years and younger and 22 029 620 subjects older than 40 years of age

*N=5 660, 2 703 subjects aged ≤40 years and 2 957 subjects aged ≥40 years

Table II
PREVALENCE (%) OF DIABETES IN SUBJECTS AGED 40 YEARS AND YOUNGER AND SUBJECTS OLDER THAN 40 YEARS OF AGE. MEXICO, ENSANUT 2006

	Aged 40 years and younger (n=3128) Prevalence (95% CI)	Older than 40 years of age (n=2878) Prevalence (95% CI)	p value
Total prevalence	5.8 (4.4-7.1)	25.7 (23.0-28.3)	<0.001
Self-reported	1.6 (1.0-2.2)	14.8 (12.5-17.1)	<0.001
Diagnosed during the survey	4.2 (2.9-5.4)	10.9 (9.1-12.6)	<0.001
Sex			
Men	6.4 (4.0-8.8)	27.8 (23.7-32.0)	<0.001
Women	5.3 (3.9-6.7)	23.8 (20.4-27.1)	<0.01
BMI			
Normal	4.1 (1.9-6.4)	19.3 (14.5-24.1)	<0.001
Overweight	5.0 (3.2-6.8)	27.8 (23.5-32.1)	<0.001
Obesity	9.4 (6.1-12.6)	27.0 (22.4-31.7)	<0.001
Cholesterol mg/dl*			
≥200	4.7 (3.3-6.0)	22.2 (18.8-25.6)	<0.001
<200	4.7 (2.6-6.7)	23.8 (20.4-27.2)	<0.001
HDL-C mg/dl*			
<40 in men and <50 in women	5.6 (3.8-7.3)	25.7 (22.3-29.1)	<0.001
≥40 in men and ≥50 in women	3.2 (2.0-4.5)	19.3 (16.0-22.7)	<0.001
LDL-C mg/dl*			
≥100	4.5 (2.8-6.1)	21.1 (17.9-24.4)	<0.001
<100	4.8 (2.8-6.1)	24.8 (21.3-28.3)	<0.001
Triglycerides mg/dl*			
≥150	8.2 (4.7-11.8)	29.0 (24.5-33.4)	<0.001
<150	4.0 (2.5-4.5)	19.4 (16.6-22.2)	<0.001
Hypertension			
Yes	7.8 (4.8-10.4)	30.9 (27.1-34.7)	<0.001
No	5.2 (3.7-6.7)	21.0 (17.3-24.8)	<0.001

The study was done in Mexico during 2006
 N=5 660, 2 703 subjects aged ≤40 years and 2 957 subjects aged >40 years

in the early-onset group, but this difference did not reach statistical significance. Almost seventy percent (n=125) of the early-onset group were newly identified cases. The undiagnosed cases were remarkably young (mean age 31.4 years); they were the group in which obesity, smoking and alcoholism were more common. Some co-morbidities, such as arterial hypertension and hypercholesterolemia were more common in the older

cases. In contrast, the early-onset group had a higher prevalence of hypoalphalipoproteinemia.

More than two thirds of early-onset cases had a body mass index above 25 kg/m². Excess body weight (i.e., BMI >25 kg/m²) was associated with a higher prevalence of high blood pressure (32.5% vs. 18.9% respectively, *p*<0.05), low HDL cholesterol (79.3 vs. 61.7% respectively, *p*<0.05) and the coexistence of two or more

Table III
CHARACTERISTICS OF FINDING AND SELF-REPORTED DIABETIC SUBJECTS BY AGE CATEGORY.
MEXICO, ENSANUT 2006

	Cases found during the survey (n=412)			Self-reported diabetic subjects (n=428)		
	Aged ≤40 years n=125	Aged >40 years n=287	p value	Aged ≤40 years n=56	Aged >40 years n=372	p value
Sex (men), %	58.3	57.4	0.916	30.4	46.1	0.114
Age (mean, s.e.)	31.4 (0.9)	56.8 (0.8)	<0.001	35.2 (0.7)	57.9 (0.9)	<0.001
Schooling, No. (%)						
None or basic school	60 (29.1)	208 (65.1)	<0.001	30 (50.0)	301 (77.0)	0.030
Middle	42 (46.4)	44 (20.7)		16 (33.4)	36 (9.6)	
High school or high	23 (24.4)	33 (14.2)		10 (16.6)	34 (13.4)	
Size of locality, No. (%)						
Rural	34 (17.7)	57 (12.6)	0.309	13 (17.5)	93 (15.5)	0.889
Urban	41 (30.0)	114 (28.2)		17 (17.4)	96 (23.3)	
Metropolitan area	50 (52.3)	116 (59.2)		26 (65.1)	183 (61.2)	
Socioeconomic income deciles, No. (%)						
1 – 2	56 (33.4)	90 (23.3)	0.283	22 (37.3)	123 (33.4)	0.480
3 – 4	19 (23.70)	76 (33.5)		9 (28.3)	93 (25.3)	
5 – 7	42 (35.6)	89 (31.6)		22 (30.5)	121 (32.0)	
8 – 10	8 (7.3)	32 (11.6)		3 (3.9)	35 (9.2)	
Ethnicity %						
Speaking any indigenous language	4.4	2.8	0.781	7.1	3.4	0.748
Non-speaking indigenous language	12.4	12.0		10.3	14.6	
Non-indigenous	83.2	85.2		82.6	82.1	
Current smoking, %	27.7	19.4	0.316	16.9	12.1	0.467
Current alcoholism, %	39.5	32.0	0.389	23.2	22.4	0.927
Body mass index (kg/m ²)	29.6 (1.0)	29.9 (0.4)	0.756	29.2 (1.0)	28.9 (0.4)	0.748
Body mass index (kg/m ²), No. (%)						
<25	23 (27.3)	43 (16.2)	0.655	16 (28.2)	63 (17.9)	0.387
25-29.9	45 (30.3)	118 (45.6)		21 (39.7)	151 (46.1)	
≥30	53 (42.5)	116 (38.2)		18 (32.2)	142 (36.0)	
SBP mm Hg	123.9 (2.1)	131.7 (1.4)	0.002	123.7 (2.6)	131.9 (1.3)	0.005
DBP, mm Hg	81.1 (2.5)	82.1 (1.0)	0.731	80.3 (2.1)	81.4 (0.8)	0.623
Hypertension, No. (%)	31 (24.9)	154 (56.7)	<0.001	19 (34.9)	228 (56.3)	0.052
Blood pressure ≥140/90 mm Hg, %	19.0	40.2	0.008	28.4	39.7	0.298
Cholesterol, mg/dl*	187.3 (5.1)	215.7 (6.3)	<0.001	198.3 (13.5)	200.5 (4.6)	0.877
HDL-C, mg/dl*						
Men	35.7 (1.2)	37.7 (1.3)	‡	34.8 (3.2)	36.2 (1.0)	0.663
Women	37.8 (1.3)	41.9 (1.5)	0.039	37.5 (2.4)	39.2 (1.1)	0.522

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	Cases found during the survey (n=412)			Self-reported diabetic subjects (n=428)		
	Aged ≤40 years	Aged >40 years	p value	Aged ≤40 years	Aged >40 years	p value
	n=125	n=287		n=56	n=372	
LDL-C, mg/dl†	91.7 (3.8)	107.2 (4.2)	0.006	96.5 (8.8)	97.5 (3.3)	0.913
LDL-C ≥100 mg*/dl, %	34.5	51.1	0.068	39.9	41.1	0.915
VLDL-C, mg/dl*	24.5 (0.9)	29.0 (1.3)	0.005	28.8 (2.4)	28.4 (1.4)	0.874
Triglycerides, mg/dl*	141.7 (5.3)	169.4 (7.7)	0.003	168.9 (14.7)	164.8 (8.0)	0.807
Fasting glucose, mg/dl*	176.8 (8.7)	196.7 (8.2)	0.098	185.7 (14.2)	190.2 (7.2)	0.777
HbA1c, % (n=236)	-	-	-	11.6 (1.0)	11.6 (0.3)	0.949
Health service utilization	14.0	13.1	0.869	18.1	22.2	0.594
Ophthalmologic examination	-	-	-	3.4	7.9	0.215
Renal function examination	-	-	-	0.0	0.8	-
Hypoglycemic medication, %	-	-	-	73.4	86.5	0.107
Type of hypoglycemic medication, No. (%)						
Oral hypoglycemic	-	-	-	37 (82.3)	302 (92.7)	0.745
Insulin	-	-	-	6 (9.1)	18 (5.5)	
Both	-	-	-	1 (8.6)	8 (1.8)	
Antihypertensive medication, No. (%)	1 (0.9)	56 (69.7)	<0.001	2 (45.7)	132 (82.5)	0.069
Aspirin use, No. (%)	-	-	-	1 (1.9)	24 (3.9)	0.456
Statins use, No. (%)	-	-	-	1 (2.8)	1 (0.2)	0.456
Diabetic complications						
Retinopathy	-	-	-	7.6	15.6	0.143
Neuropathy	-	-	-	3.0	14.9	0.076
Nephropathy (under dialysis)	-	-	-	1.9	1.1	0.665
Myocardial infarction	-	-	-	6.3	1.2	0.117

The study was done in Mexico during 2006. Number of subjects with information n=279, 32 subjects aged ≤40 years and 247 subjects aged >40 years

All values are means and standard error (s.e.), except when indicated

* 363 cases diagnosed during the survey and 371 self-reported diabetic subjects

† Due to stratum with single sampling unit in this category, it was not possible to estimate the means difference

cardiovascular risk factors (29.5% vs 19.9% respectively, $p<0.05$) as defined by the National Cholesterol Education Program.¹⁴ Minor differences were found in the fasting plasma glucose levels between undiagnosed and previously identified cases in both early- and late-onset groups. Among the previously diagnosed cases, the hemoglobin A1c concentrations were abnormally high in both age groups (11.9% vs. 11.4, $p=0.49$). The majority of cases in both groups were receiving glucose-lowering agents; very few were treated with insulin.

The use of preventive interventions against the diabetes-related chronic complications was low in both age groups. A very small percentage received a statin or low doses of acetyl salicylic acid or underwent regular

ophthalmologic or feet exams. In the early-onset group, 7.6% had retinopathy and 6.3% suffered a myocardial infarction (by self report). These percentages were not different from that reported by the older group.

Conditions associated with an increase likelihood for having early-onset type 2 diabetes are shown in table IV. Age, body mass index and hypertriglyceridemia were the variables associated with the early-onset phenotype. A 5 kg/m² difference in the body mass index was associated with a 37% increment in the risk for having diabetes. For the older group, hypoalbuminemia, living in urban areas and not being part of a Native American group were associated also with a higher risk for having diabetes.

Table IV
ASSOCIATED RISK FACTORS WITH THE PREVALENCE OF DIABETES IN SUBJECTS AGED 40 YEARS
AND YOUNGER AND SUBJECTS OLDER THAN 40 YEARS OF AGE. MEXICO, ENSANUT 2006

	Aged 40 years and younger (n=2881)		Older than 40 years of age (n=2623)		Both (n=5504)	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Age >40 years	-	-	-	-	5.87 (4.27-8.05)	<0.001
Age (per 5 years)	1.46 (1.14-1.86)	0.002	1.12 (1.06-1.18)	<0.001	-	-
Sex (women)	1.02 (0.58-1.82)	0.938	0.87 (0.64-1.18)	0.377	0.93 (0.71-1.21)	0.574
Ethnicity						
Speaking any indigenous language	1.0	-	1.0	-	1.0	-
Non-speaking indigenous language	1.02 (0.39-2.64)	0.972	2.03 (1.08-3.87)	0.029	1.64 (0.94-2.87)	0.083
Non-indigenous	1.08 (0.48-2.44)	0.852	1.93 (1.14-3.28)	0.015	1.64 (1.02-2.62)	0.039
Urban and metropolitan area	0.93 (0.48-1.79)	0.826	1.52 (1.11-2.10)	0.010	1.31 (0.97-1.76)	0.079
Body mass index (per 5 kg/m ²)	1.37 (1.11-1.70)	0.004	1.13 (0.99-1.29)	0.078	1.17 (1.04-1.32)	0.010
HDL-C (per 10 mg/dl)	0.86 (0.72-1.04)	0.113	0.83 (0.72-0.96)	0.011	0.83 (0.73-0.93)	0.002
Triglycerides (per 50 mg/dl)	1.19 (1.05-1.35)	0.005	1.37 (1.23-1.52)	<0.001	1.32 (1.22-1.43)	<0.001

The study was done in México during 2006

Discussion

Early-onset type 2 diabetes is a phenotype commonly seen in countries with a high prevalence of type 2 diabetes. It is characterized by a more severe form of the disease and an increased risk for suffering chronic complications.³ In México, the number of young adults (aged 20-40 years) with diabetes has increased during the past two decades. Now, early-onset type 2 diabetes is present in 21.5% of patients with type 2 diabetes. Based on the data reported here, it is estimated that there are 1 662 870 Mexicans with early-onset type 2 diabetes. The number of cases and their increased risk for having an adverse outcome are reasons for having special attention for this variant of the disease.

In each one of the nation wide population based surveys conducted in Mexico (1994, 2000 and 2006) it has been estimated the proportion of the population with diabetes diagnosed before age 40. The initial report was a sub-study of the 1994 National Survey of Chronic Diseases (ENEC).⁵ In 1994, the prevalence of diabetes was 6.7% nationwide and 1.8% for the age group 20-40 years. Early-onset type 2 diabetes was present in 14.8% of the population with diabetes. There were 318 400 cases nationwide. Later in 2000, the National Health Survey (ENSA) reported a diabetes national prevalence of 8.2% and 2.3% for the age group 20-40 years.¹⁵ Early-onset type 2 diabetes was present in 13.2% of the popu-

lation with diabetes. The data reported here updates the information and demonstrates a remarkable growth of the disease, affecting young adults also (national prevalence 14.4% and 5.8 % in the 20-40 years age group). Thus, in a 12 years period the national prevalence of diabetes have had a two-fold increment. The change is bigger for the 20-40 years group, which had a 3.22 fold increment. The number of early-onset type 2 diabetes cases increased from 318 400 to 1 662 870. As a result, this translates into a greater number of cases and a larger proportion of the affected subjects exposed to the disease for longer periods of time. The end result will be a growth in the incidence of diabetes related chronic complications and a greater number of cases that will retire prematurely due to physical limitations.

The contribution of early-onset type 2 diabetes is now similar in Mexico to the one reported in countries with the highest prevalence of diabetes worldwide. This form of the disease is present in 25% of the population with diabetes in India,¹⁶ 36% in the Middle East and 26% in Native Americans living in the US.¹⁷ Because obesity and unhealthy life styles are very prevalent in Mexican young adults,¹⁸ it is expected that the number of young adults will continue its growing trend in the years to come.

This population based, nation-wide study allows an unbiased description of the patients with early-onset type 2 diabetes. The clinical profile reported here is similar to that found in previous Mexican surveys.^{5,13} More

than two thirds of them had a body mass index above 25 kg/m². The quality of diabetes care that they received is far from acceptable. They were the group that had the highest prevalence of insulin or oral glucose-lowering treatment of all patients with diabetes. However, the majority of them were severely hyperglycemic. Their mean HDL cholesterol concentration was lower compared to that found in the older group. Nevertheless, they have a lower prevalence of hypercholesterolemia and arterial hypertension. Preventive strategies (i.e., low doses of acetylsalicylic acid, regular ophthalmologic or feet exams) were used in very few cases. All these characteristics contribute to the high rate of chronic complications.

The data reported here suggest that specific programs will be required to improve diabetes care in the early-onset group. They may have specific barriers to achieve the treatment goals. Their education level is higher compared to the older group, making possible to achieve a deeper knowledge about their disease. However, they are in the most productive time of their lives; environmental, economical and social factors may limit their adherence to a healthy lifestyle or to the medication. Our health system should design treatment programs that provide solutions to individuals with limited time to visit a medical unit and without the self-recognition of being at risk of having chronic complications. Translational research is urgently needed in this area.

A large percentage (70%) of the early-onset group ignored their condition. Several conditions were independently associated with early-onset type 2 diabetes. Obesity, age and hypertriglyceridemia increased the risk for having this entity. This information will be useful for clinicians to select young individuals in which diabetes screening is required.

In conclusion, early-onset type 2 diabetes is a form of diabetes with important public health implications. In México, the number of young adults (aged 20-40 years) with diabetes has increased five times during the past two decades. Now, early-onset type 2 diabetes is present in 21.5% of patients with type 2 diabetes. A great effort will be required to educate the public and primary care physicians in order to prevent the increase in the number of cases and provide them the best possible treatment.

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Conflicts of interest

We declare that we have no conflicts of interest.

References

1. Rull JA, Aguilar-Salinas CA, Rojas R, Rios-Torres JM, Gómez-Pérez FJ, Olaiz G. Epidemiology of type 2 diabetes in Mexico. *Arch Med Res* 2005; 36: 188-196.
2. García-García E, Aguilar-Salinas CA, Tusié-Luna MT, Rull-Rodrigo JA. Early-onset type 2 diabetes in México. *Isr Med Assoc J* 2002; 4:444-448.
3. Pavkov ME, Bennett PH, Knowler WC, Krakoff J, Sievers ML, Nelson RG. Effect of youth-onset type 2 diabetes mellitus on incidence of end-stage renal disease and mortality in young and middle-aged Pima Indians. *JAMA* 2006; 296:421-426.
4. O'Rahilly S, Spivey RS, Holman RR, Nugent Z, Clark A, Turner RC. Type II diabetes of early onset: A distinct clinical and genetic syndrome? *Br Med J* 1987; 294:923-928.
5. Aguilar-Salinas CA, Rojas R, Gómez-Pérez FJ, García E, Valles V, Rios-Torres JM, et al. Early-onset type 2 diabetes in a Mexican, population-based, nation-wide survey. *Am J Medicine* 2002; 113:569-574.
6. Rosenbloom AL, Young RS, Joe JR, Winter VE. Emerging epidemic of type 2 diabetes in youth. *Diabetes Care* 1999; 22:345-354.
7. Kadiki OA, Reddy MR, Marzouk AA. Incidence of insulin dependent diabetes and non insulin dependent diabetes (0-34 years at onset) in Benghazi, Libya. *Diabetes Res Clin Pract* 1996; 32:165-173.
8. Tan KC, Mackay IR, Zimmet PZ, Hawkins BR, Lam KS. Metabolic and immunologic features of Chinese patients with atypical diabetes mellitus. *Diabetes Care* 2000; 23:335-338.
9. Keenan H, el Deirawi K, Walsh M, Grover VV, Alva E, Onyemere K, et al. Are trends in diabetes incidence changing for minority children? *Ann Epidemiol* 2000; 10:459-463.
10. Pettiti DB, Imperatore G, Palla SL, Daniels SR, Dolan LM, Kershner AK, et al. SEARCH for Diabetes in Youth Study Group. Serum lipids and glucose control: the SEARCH for Diabetes in Youth study. *Arch Pediatr Adolesc Med* 2007; 161:159-165.
11. Lee SC, Ko GT, Li JK, Chow CC, Yeung VT, Critchley JA, et al. Factors predicting the age when type 2 diabetes is diagnosed in Hong Kong Chinese subjects. *Diabetes Care* 2001; 24:646-649.
12. Bessen Daniel H. Update on Obesity *J Clin Endocrinol Metab* 2008; 93:2027-2034.
13. Expert Committee on Diagnosis and Classification of Diabetes Mellitus. Report of the Expert Committee on Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care* 1997; 20:1183-1197.
14. Expert Panel on detection, evaluation and treatment of high blood cholesterol in adults. Executive summary of the third report of the national cholesterol education program (NCEP) expert panel on detection, evaluation and treatment of high blood cholesterol in adults (adult treatment panel III) *JAMA* 2001; 285:2486-2497
15. Aguilar-Salinas CA, Velazquez-Monroy O, Gómez-Pérez FJ, Gonzalez Chávez A, Lara-Esqueda A, Molina-Cuevas V, et al. Characteristics of the patients with type 2 diabetes in Mexico: results from a large population-based, nation-wide survey. *Diabetes Care* 2003; 26:2021-2026
16. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, Das AK, et al. Diabetes Epidemiology Study Group in India (DESI). High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. *Diabetologia* 2001; 44:1094-1101.
17. Rios-Burrows N, Geiss L, Engelgau M, Acton K. Prevalence of diabetes among native American and Alaska natives 1990-1997. *Diabetes Care* 2000; 23:1786-1790.
18. Córdova-Villalobos JA, Barriguete-Meléndez JA, Lara-Esqueda A, Barquera S, Rosas-Peralta M, Hernández-Avila M, et al. Chronic non-communicable diseases in Mexico: epidemiologic synopsis and integral prevention. *Salud Publica Mex* 2008; 50:419-427.