Prevalence of diabetes and glycemic control in Mexico: national results from 2018 and 2020

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Abstract

Objective. To estimate the prevalence of diabetes (diagnosed and undiagnosed), glycemic control in Mexico, and its associated factors. **Materials and methods.** We used data from Ensanut 2018 (n=12 648) and 2020 (n=2 309). We defined diabetes as fasting glucose ≥126 mg/dl or HbA1c≥6.5% or previously diagnosed; glycemic control was defined as HbA1c<7%. We fitted Poisson regression models to assess the association between diabetes, glycemic control, and potential associated factors. **Results.** The total prevalence of diabetes was 16.8% in 2018 and 15.7% in 2020. In 2018, 38% of adults with diabetes were unaware of their disease, while in 2020 this figure was 29%. Glycemic control was observed in 42% of participants in 2018 and 39% in 2020. Longer disease duration was associated with lower glycemic control, while older age, having a diet, and being affiliated to IMSS, Pemex, Sedena, or private healthcare were associated with better control. **Conclusion.** Mexico is among the countries with the highest diabetes prevalence. A high proportion of adults with diabetes did not have a previous diagnosis, and the proportion with

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Resumen

Objetivo. Estimar la prevalencia de diabetes total (diagnosticada y no diagnosticada), control glucémico en México y sus factores asociados. **Material y métodos.** Se analizó información de la Ensanut 2018 (n=12 648) y 2020 (n=2 309). Se definió diabetes como glucosa en ayunas ≥126 mg/dl o HbA1c≥6.5% o diagnóstico previo; se consideró control glucémico si HbA1c<7%. Usando modelos de regresión de Poisson, se estimaron los factores asociados con diabetes y control glucémico. **Resultados.** La prevalencia de diabetes fue de 16.8% en 2018 y 15.7% en 2020. En 2018, 38% de los adultos con diabetes desconocían su enfermedad, en 2020 fue 29%. El control glucémico se observó en 42% de los participantes en 2018 y en 39% en 2020. Mayor tiempo de diagnóstico se asoció con descontrol glucémico mientras que mayor edad, seguir una dieta y estar afiliado al IMSS, Pemex/Sedena o privados se asoció con control glucémico. **Conclusión.** México se encuentra entre los países con mayor prevalencia de diabetes. Una alta proporción de adultos con diabetes no tenía un diagnóstico previo y la proporción

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glycemic control is low. Strengthening screening to achieve a timely diagnosis, and improving glycemic control, should be key actions in the management of diabetes.

Keywords. Diabetes; prevalence; fasting blood glucose; epidemiologic surveys; HbA1c

con control glucémico es baja. Fortalecer la detección, el diagnóstico oportuno y el control glucémico es clave para el manejo de la diabetes.

Palabras clave: Diabetes; prevalencia; glucosa en ayunas; encuestas epidemiológicas; HbA1c

Over the last decades, the burden of type-2 diabetes mellitus has been increasing and it is now among the leading causes of death and disability worldwide.[1] In Mexico from 2006 to 2016 diagnosed diabetes increased from 7.3 to 9.5%,[2] while undiagnosed diabetes decreased from 7.1 to 4.1%, for a total diabetes prevalence of 14.4 in 2006 and 13.7% in 2016.[3] In contrast, the World Health Organization's (WHO) estimated prevalence of diabetes for the Americas region in 2014 was 8.3%,[4] making Mexico one of the countries in the region most affected by diabetes.

Prior studies have estimated that diabetes prevalence in Mexico will continue to increase.[5,6] Ageing is the primary driver of this increase,[6] yet dietary risk factors also represent fundamental causes of diabetes. In Mexico, 26% of the total caloric intake is linked to discretionary foods such as sugar-sweetened beverages and highly caloric non-essential food. In contrast, the contribution of legumes, fruits, and vegetables is low.[7] Also, obesity and overweight in Mexico are still increasing. Between 2000 and 2018, obesity prevalence increased 42%, particularly among women and people over 50 years of age.[8] Protective factors for diabetes, such as engaging in frequent and sufficiently intense physical activity, are still insufficient.[9] Overall, Mexico is still immersed in a highly diabetogenic environment, and it is reasonable to expect that the trends in diabetes prevalence will continue to rise.[5,6]

Generating updated estimates on the epidemiology of diabetes and its associated risk factors in the Mexican population is key to develop policies for disease prevention, management, and treatment. This is particularly important in the context of the Covid-19 pandemic, where usual healthcare services had to be reconverted to respond to the emergency.[10] We aimed to estimate the updated prevalence of total diabetes (diagnosed and undiagnosed), glycemic control, and its associated factors using two nationally representative surveys: *Encuesta Nacional de Saud y Nutrición* (Ensanut) 2018 and Ensanut 2020 Covid-19.

Materials and methods

Ensanut surveys are probabilistic, multi-stage, stratified, and clustered, representative of the national, regional, and rural/urban levels. The Ensanut 2018 survey was conducted between August 2018 and February 2019, visiting 50 654 households, with a response rate of 87%.[11] The Ensanut 2020 Covid-19 survey was conducted between August and November 2020, visiting 10 216 households with a response rate of 73%.[12] This survey aimed to investigate multiple aspects of health and well-being after the emergence of the SARS-CoV-2 pandemic. The Ensanut 2018 and Ensanut 2020 protocols were approved by the ethics, research, and biosafety committee of the National Institute of Public Health. Details of the design and sampling procedures of the surveys are available elsewhere.[11,12]

For this study, a random subsample of adults aged 20 years and older (27 639 in 2018 and 5 299 in 2020) was selected to provide a 10 ml blood sample. From them 13 162 in 2018 and 2 373 in 2020 agreed to participate (47.6% in 2018 and 45% in 2020 response rate). Pregnant women (139 in 2018; 8 in 2020) with gestational diabetes (22 in 2018), with less than eight hours of fasting (352 in 2018; 56 in 2020), and with missing data on glucose (n=1 in 2018) were excluded. The final sample was 12 648 adults for 2018 and 2 309 for 2020, which expands to 79 026 000 and 81 507 000 adults, respectively.

Fasting blood glucose and glycated hemoglobin

Both surveys used similar methods to determine fasting blood glucose and glycated hemoglobin. Fasting blood glucose was estimated by centrifuging venous blood samples at 3 000 g, in situ, for 20 min. The serum was separated and stored in cryovials at -70° C in liquid nitrogen until received at the Endocrinology Department's laboratory of the National Institute of Medical Sciences and Nutrition. The samples were quantified using a Beckman-Coulter autoanalyzer (Brea, CA), using the glucose oxidase technique and the reference material NIST965 to ensure its precision (variation between assays<3%). High-performance liquid chromatography (HPLC, Variant II Turbo, BIORAD) was used to measure glycated hemoglobin (HbA1c), with an inter and intra-assay variation <0.01%.

Prevalence of diabetes

Participants were classified as having "diagnosed diabetes" if they answered "yes" to the question: "Has a physician ever told you that you have diabetes or high blood sugar?" In Ensanut 2018 it was asked to all adults participating in the survey; in Ensanut 2020, it was asked at the household level and responded by the head of the household. Participants were classified as having "undiagnosed diabetes" if they answered "no" to the previous question and had fasting blood glucose ≥126 mg/dl, or HbA1c ≥6.5% at the time of the survey, under the Mexican Diabetes guidelines and the American Diabetes Association recommendations.[13,14] We constructed a total diabetes variable to identify participants with diagnosed plus undiagnosed diabetes cases.

Glycemic control

Only individuals with diagnosed diabetes were included because they are aware of their disease and can make changes in diet, exercise, or pharmacologic treatment to control it. Following the recommendations of the American Diabetes Association and the Official Mexican Standard (NOM-015-SSA2-2010), we defined glycemic control as HbA1<7%.[15,16] The prevalence of glycemic control was estimated for all individuals with diagnosed diabetes.

Covariates for diabetes prevalence

Age in years at the time of the survey was categorized into decades: 20-29, 30-39, 40-49, 50-59, 60-69, 70 and older. The socioeconomic level was previously estimated for the Ensanut 2018 and 2020 using a principal component analysis with information on household construction materials, number of sleeping rooms, water disposal, car ownership, number of household goods (refrigerator, washing machine, microwave, stove, and boiler), and number of electrical appliances (TV, cable, radio, telephone, and computer). The socioeconomic index was divided into low, medium, and high levels, using tertiles as cut-off points.

Education was divided into four categories according to the number of years studied: (1) primary school or less, (2) middle school, (3) high school, and (4) college or more. Affiliation to the health care system was obtained with the question "Are you affiliated or enrolled in medical services?" and divided into four categories: (1) Mexican Social Security Institute (*Instituto Mexicano del Seguro Social*, IMSS), (2) Institute of Social Security and Services for State Workers (*Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado*, ISSSTE), (3) other social security services (*Petróleos Mexicanos* [Pemex], *Secretaría de la Defensa Nacional* [Sedena]) and private health services, and (4) Institute of Health and Wellbeing (*Instituto de Salud para el Bienestar*, INSABI), which included all people without access or that previously had access to *Seguro Popular*. Urbanization was categorized as rural (areas <2 500 inhabitants), urban (areas ≥ 2 500&< 100 000 inhabitants), or metropolitan (>100 000 inhabitants). The geographic region was divided into four categories: North, Center, Metropolitan area of Mexico City, and South. Finally, body mass index (BMI) categories were built according to the WHO classification as normal or underweight (<25 kg/m^2), overweight (25-29.9 kg/m^2), and obesity (≥ 30 kg/m^2).[17]

Covariates for glycemic control

Additional to the variables above, we included extra variables that were only collected for Ensanut 2018. Time since diagnosis in years was assessed by asking "How long ago did your physician first told you that you had diabetes or high blood sugar?" and categorized into (1) five years or less and (2) more than five years. Pharmacological treatment was divided into three categories: (1) none, (2) only pills, (3) insulin or insulin combined with pills. Finally, diet and exercise were defined using the question "Do you currently use another treatment to control your sugar?" (yes/no).

Statistical analysis

We estimated the prevalence of diabetes and its 95% confidence interval (95%CI) for total, diagnosed, undiagnosed, and glycemic control, considering the complex sample design through the "svy" module of Stata 14.0 (StataCorp, Stata Statistical Software, Release 14, 2015). The prevalence of total, diagnosed, and undiagnosed diabetes was described by sex, age group, socioeconomic levels, education, rural and urban, and geographic region. The prevalence of glycemic control was described by sex, age (<50 and ≥ 50 years), and time since diagnosis to compare with previous studies and considering the sample limitations (restricted to adults with diagnosed diabetes).

As the prevalence of total diabetes and glycemic control in Mexico are not rare events (prevalence>10%), we estimated prevalence ratios (PR) using Poisson regression models.[18] We performed a bivariate model to estimate prevalence changes over time with survey wave as the independent variable.[18,19] We fitted a multivariate model to estimate the sociodemographic factors associated with diabetes prevalence and glycemic control, adjusting for survey wave (model 1). Finally,

we fitted a multivariate model to estimate the proximal variables associated with diabetes (BMI categories) and glycemic control (time since diagnosis, pharmacological treatment, exercise, and diet), adjusting for sociodemographic variables and survey wave (model 2). Model 2 for glycemic control included only Ensanut 2018, where proximal variables were collected. Models stratified for survey wave are presented in our appendix.[19]

Results

Table I shows the prevalence of diabetes in adults in Mexico in 2018 and 2020. The prevalence of total diabetes was 16.8% (95%CI 15.6, 18.1) for 2018 and 15.7% (95%CI 13.9, 17.6) for 2020. In absolute numbers, this prevalence translates into approximately 13.3 million adults with diabetes in 2018 (175 thousand (k) with 20-39 years, 638 k with 40-59 years and 514 k with 60+) and 12.8 million in 2020 (165 k with 20-39 years, 672 k with 40-59 years and 438 k with 60+). In 2018, 38% of the total diabetes cases were undiagnosed; this proportion decreased to 29% in 2020. The prevalence of diabetes was 18.7% (CI95% 17.0, 20.5) in females and 14.5% (CI 95%13.1, 16.2) in males in 2018; in 2020 the prevalence by sex was similar. The prevalence of total diabetes increased with age in both surveys. Diabetes prevalence was similar across socioeconomic levels in 2018, but in 2020 the prevalence in low socioeconomic level was 18.3% (CI95% 15.0, 22.1), while in high was 14.0% (CI95% 11.4, 17.1). We found that diabetes prevalence decreased as education increased. Finally, we found a higher diabetes prevalence in Mexico City in 2018 (22.8%; CI95% 17.6, 28.9), compared to the Central region (14.0%; CI95% 12.6, 15.5).

Table II shows the variables associated with total diabetes. Prevalence of diabetes did not significantly change between 2018 and 2020. Model 1, adjusting for sociodemographic factors, showed a 36% higher prevalence of diabetes for every 10-years increase in age. As education increased, the prevalence of diabetes decreased by 34% in people with high school and 32% in people with higher education, regarding people with primary school. Urban areas showed a 22% higher diabetes prevalence compared to rural areas, and being affiliated to ISSSTE showed 28% higher diabetes prevalence compared to the Institute of Health for Welfare. When BMI categories were included (model 2), previous associations remained. In addition, compared to people with normal weight, people with overweight had a 36% higher prevalence of diabetes, and people with obesity had a 74% higher prevalence of diabetes.

Table III shows the percentage of adults with glycemic control. A total of 42 and 39% of people with diabetes had their disease under control in 2018 and 2020, respectively. Table IV shows the variables associated with glycemic control. Differences in glycemic control by survey year were not statistically different.

In table IV, model 1, adjusting for sociodemographic factors, shows that older age is associated with glycemic control. The prevalence of glycemic control was 30% higher in individuals with high versus low socioeconomic levels, and 44% higher in adults with higher education than primary school. Also, adults affiliated to ISSSTE presented 32% lower glycemic control in comparison with INSABI. Model 2 presents the factors associated with glycemic control for 2018. Age was positively associated with glycemic control, as observed in model 2. The prevalence of glycemic control was 57% higher in adults affiliated to other public or private health systems relative to the prevalence in individuals with INSABI. People with longer disease duration presented lower glycemic control: 29% less in patients with more than five years since diagnosis. Taking pharmacologic treatment, either pill or insulin associated with worse glycemic control, while dietary treatment was associated with better glycemic control.

Discussion

This article aimed to estimate the prevalence of diabetes and glycemic control in 2018 and 2020. Diabetes currently affects one out of six Mexican adults, and remained unchanged between 2018 and 2020. In 2018, 38% of adults with diabetes were unaware of their disease; this proportion was 29% in 2020. Only 42 and 39% of individuals with diabetes presented adequate glycemic control in 2018 and 2020, respectively. Longer disease duration and taking pills or insulin were associated with lower control levels, while age, having a dietary treatment, and being affiliated to IMSS, Pemex, Sedena, or private healthcare systems were associated with better glycemic control.

The epidemiology of diabetes has changed over time. Diagnosed diabetes increased from 7.3 to 11.1% from 2006 to 2020, while undiagnosed diabetes decreased from 7.1 to 4.6% in the same period (figure 1). Ensuring a timely detection of diabetes is a major goal of the health care system, and it seems to have improved over time. As diabetes progression is slow, it can remain undetected until the first complications appear, increasing the likelihood of premature death and increasing healthcare costs.[20] With an increase in diagnosed but a decrease in undiagnosed cases, total diabetes has been relatively stable between 2006 and 2020, from 14.4 to 15.7% (figure 1). However, the number of people with diabetes increased from 7.3 million in 2006 to 12.8 million in 2020. Also, diabetes

Table I

PREVALENCE OF DIAGNOSED, UNDIAGNOSED, AND TOTAL DIABETES IN MEXICAN ADULTS. MEXICO, ENSANUT 2018-2020

	Diagnosed diabetes				*Undiagnosed diabetes*				*Total diabetes*			
	2018		*2020*		*2018*		*2020*		*2018*		*2020*	
	Prop (%)	*95%CI*	*Prop (%)*	*95%CI*	*Prop (%)*	*95%CI*	*Prop (%)*	*95%CI*	*Prop (%)*	*95%CI*	*Prop (%)*	*95%CI*
Total adults	10.4	(9.6-11.2]	11.1	(9.5-12.8]	6.4	(5.5-7.5]	4.6	(3.7-5.8)	16.8	(15.6-18.1)	15.7	(13.9-17.6)
Sex												
Males	9.0	(8.0-10.1)	9.4	(7.4-12.0)	5.6	(4.5-6.9)	6.1	(4.5-8.4)	14.5	(13.1-16.2)	15.6	(12.9-18.7)
Females	11.5	(10.3-12.8)	12.5	(10.5-14.9)	7.1	(5.9-8.6)	3.2	(2.3-4.5)	18.7	(17.0-20.5)	15.8	(13.5-18.4)
Age (years)												
20-29	0.5	(0.3-0.8)	0.5	(0.2-1.2)	2.8	(1.3-5.9)	1.7	(0.9-3.2)	3.2	(1.7-6.2)	2.2	(1.3-3.8)
30-39	3.5	(2.6-4.6)	4.7	(3.1-7.1)	4.2	(3.1-5.8)	2.9	(1.5-5.6)	7.7	(6.2-9.5)	7.6	(5.4-10.7)
40-49	7.8	(6.4-9.4)	10.7	(7.6-14.7)	8.4	(6.5-10.8)	7.9	(5.3-11.7)	16.2	(13.8-18.8)	18.6	(14.3-23.8)
50-59	18.3	(15.8-21.2)	22.0	(17.1-27.7)	10.6	(8.4-13.2)	6.7	(4.1-10.6)	28.9	(25.7-32.3)	28.6	(23.0-35.0)
60-69	26.5	(22.9-30.5)	23.2	(17.7-29.7)	7.4	(5.5-10.0)	5.0	(2.9-8.4)	34.0	(29.9-38.3)	28.1	(22.3-34.8)
70+	22.4	(19.0-26.1)	24.5	(18.3-32.0)	7.1	(4.9-10.1)	5.0	(2.1-11.5)	29.5	(25.5-33.7)	29.5	(22.6-37.6)
Socioeconomic level												
Low	10.1	(8.9-11.4)	11.3	(8.7-14.5)	6.8	(5.8-8.1)	7.0	(4.9-9.9)	16.9	(15.4-18.6)	18.3	(15.0-22.1)
Medium	10.9	(9.6-12.3)	10.5	(8.3-13.3)	6.0	(4.9-7.4)	4.6	(3.1-6.7)	16.9	(15.2-18.8)	15.1	(12.5-18.2)
High	10.1	(8.6-11.8)	11.3	(9.0-14.1)	6.4	(4.6-9.0)	2.7	(1.8-4.1)	16.5	(14.1-19.3)	14.0	(11.4-17.1)
Education level												
Primary school	18.0	(16.2-20.0)	19.8	(16.2-23.8)	9.0	(7.6-10.6)	6.0	(4.1-8.8)	27.0	(24.9-29.3)	25.8	(21.7-30.3)
Middle school	8.6	(7.3-10.0)	11.0	(8.4-14.4)	5.1	(4.0-6.4)	4.8	(3.1-7.3)	13.6	(12.0-15.4)	15.8	(12.5-19.8)
High school	6.3	(4.8-8.0)	5.0	(3.2-7.8)	4.4	(3.2-6.1)	3.9	(2.4-6.3)	10.6	(8.7-13.0)	8.9	(6.4-12.4)
College or more	4.9	(3.7-6.5)	6.4	(4.3-9.3)	6.3	(3.9-10.2)	3.4	(2.1-5.6)	11.3	(8.4-15.0)	9.8	(7.3-13.1)
Healthcare affiliation												
IMSS	12.7	(11.2-14.4)	12.2	(9.8-15.1)	5.4	(4.1-7.2)	3.5	(2.3-5.2)	18.1	(16.1-20.3)	15.7	(12.9-18.9)
ISSSTE	13.0	(10.0-16.8)	19.0	(12.9-27.2)	8.8	(5.0-14.9)	3.9	(1.8-8.1)	21.8	(16.9-27.6)	22.9	(16.3-31.2)
Other publics or privates	18.0	(11.8-26.5)	13.6	(6.5-26.2)	4.8	(1.8-12.2)	1.3	(0.2-9.2)	22.7	(15.5-32.1)	14.9	(7.4-27.8)
INSABI	8.1	(7.3-9.0)	8.9	(7.2-11.1)	6.8	(5.8-8.0)	5.7	(4.2-7.6)	14.9	(13.6-16.3)	14.6	(12.4-17.2)
Urbanization												
Rural	8.5	(7.5-9.7)	10.0	(7.4-13.5)	5.5	(4.6-6.5)	6.8	(4.2-10.6)	14.1	(12.7-15.6)	16.8	(13.2-21.1)
Urban	10.4	(9.1-11.8)	13.2	(10.1-17.1)	5.8	(4.7-7.0)	5.5	(3.8-7.8)	16.2	(14.6-17.9)	18.7	(15.2-22.8)
Metropolitan	11.1	(9.8-12.6)	10.2	(8.3-12.6)	7.2	(5.5-9.3)	3.3	(2.2-5.0)	18.3	(16.2-20.7)	13.6	(11.2-16.3)
Region												
North	11.7	(10.1-13.6)	11.1	(7.7-15.6)	4.7	(3.6-6.0)	5.2	(3.1-8.7)	16.4	(14.5-18.5)	16.3	(12.3-21.2)
Center	8.6	(7.5-9.8)	10.9	(8.5-13.8)	5.4	(4.5-6.6)	3.5	(2.2-5.5)	14.0	(12.6-15.5)	14.1	(11.8-16.6)
Mexico City	11.9	(9.0-15.5)	11.3	(8.1-15.5)	10.9	(6.8-17.0)	2.3	(1.3-4.1)	22.8	(17.6-28.9)	18.0	(14.5-22.2)
South	10.6	(9.4-11.9)	11.1	(8.5-14.5)	6.1	(5.1-7.3)	6.9	(4.8-9.8)	16.7	(15.2-18.4)	15.7	(13.9-17.6)

Ensanut: *Encuesta Nacional de Salud y Nutrición*; IMSS: *Instituto Mexicano del Seguro Social*; ISSSTE: *Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado*; Other publics include *Petróleos Mexicanos* (Pemex), *Secretaría de la Defensa Nacional* (Sedena); INSABI: *Instituto de Salud para el Bienestar*. Individuals reporting no affiliation were included in INSABI. Prevalences are unadjusted.

Table II
Factors associated with total diabetes in Mexico over 2018 and 2020

	Model 1* n= 14 957		Model 2‡ n= 14 459	
	Prevalence Ratio (CI95%)	p value	Prevalence Ratio (CI95%)	p value
Survey wave				
2018				
2020	0.99 (0.86-1.13)	0.838	0.97 (0.85-1.12)	0.708
Sex				
Males				
Females	1.10 (0.97-1.25)	0.136	1.05 (0.92-1.20)	0.446
Age (10 years)	1.36 (1.31-1.41)	<0.001	1.37 (1.31-1.43)	<0.001
Socioeconomic level				
Low				
Medium	0.95 (0.81-1.11)	0.513	0.91 (0.77-1.06)	0.231
High	0.92 (0.77-1.10)	0.362	0.87 (0.72-1.05)	0.144
Education level				
Primary school				
Middle school	0.90 (0.75-1.07)	0.243	0.87 (0.73-1.05)	0.145
High school	0.66 (0.52-0.83)	<0.001	0.65 (0.51-0.83)	0.001
College or more	0.68 (0.53-0.87)	0.002	0.67 (0.52-0.86)	0.002
Healthcare affiliation				
INSABI				
IMSS	1.11 (0.97-1.27)	0.120	1.10 (0.96-1.26)	0.187
ISSSTE	1.28 (1.01-1.64)	0.044	1.31 (1.02-1.68)	0.033
Other publics or privates	1.22 (0.85-1.74)	0.281	1.18 (0.80-1.74)	0.396
Urbanization				
Rural				
Urban	1.22 (1.03-1.45)	0.023	1.25 (1.05-1.5)	0.015
Metropolitan	1.08 (0.89-1.31)	0.449	1.11 (0.91-1.36)	0.296
Region				
North				
Center	0.90 (0.75-1.08)	0.246	0.94 (0.78-1.14)	0.520
Mexico City	1.10 (0.86-1.40)	0.455	1.13 (0.87-1.45)	0.358
South	1.06 (0.88-1.29)	0.544	1.10 (0.90-1.35)	0.333
BMI categories				
Normal o underweight				
Overweight			1.36 (1.11-1.67)	0.004
Obesity			1.73 (1.43-2.10)	<0.001

* Model 1: Socioeconomic factors associated with diabetes using data from both Ensanut 2018 and 2020.
‡ Model 2 Proximal factors associated with diabetes using data from both Ensanut 2018 and 2020.
Ensanut: *Encuesta Nacional de Salud y Nutrición*; INSABI: *Instituto de Salud para el Bienestar*; IMSS: *Instituto Mexicano del Seguro Social*; ISSSTE: *Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado*; Other publics include *Petróleos Mexicanos* (Pemex), *Secretaría de la Defensa Nacional* (Sedena).

is increasing at younger ages. In 2016 3.2% (CI 2.1, 4.9) of the adults aged 30-39 years presented diabetes; this prevalence increased to 7.7% (CI 6.2,9.5) and 7.6% (5.4,10.7) in 2018 and 2020, respectively. The diabetes onset at younger ages is worrisome as the complications of diabetes will start earlier, decreasing quality of life, increasing mortality and costs.[21]

A major task of the health care systems is to promote a good glycemic control. Glycemic control in Mexico has been improving over time from 5.5% in 2006 to 31.8% in 2016 and 42.1% in 2018. However, in our analysis, no change from 2018 to 2020 was observed. The improvements in this indicator during the past 12 years could be explained by higher access to health services (e.g., increases in people affiliated to *Seguro Popular* that previously had no access), or better quality of services.[22-24] However, the Covid pandemic could have reduced the capacity of routinely managing diabetes, and access to pharmacologic treatments, or increased stress associated with confinement.[25] In 2018, a longer duration of diabetes and taking pharmacologic treatment was associated with lower control levels, in line with Ensanut's 2016 findings.[3] However, the association with pharmacologic treatment could be a result of reverse causality,

Table III

PREVALENCE OF GLYCEMIC CONTROL AMONG ADULTS WITH DIAGNOSED DIABETES. MEXICO, ENSANUT 2018-2020

	Glycemic control (HbA1c<7%)			
	2018 (n= 1 537)		*2020 (n= 324)*	
	Prop (%)	*95%CI*	*Prop (%)*	*95%CI*
Total adults	42.1	(38.4-45.9)	39.0	(32.5-45.8)
Sex				
Males	38.8	(33.3-44.5)	39.9	(29.9-50.8)
Females	44.2	(39.4-49.2)	38.3	(29.9-47.5)
Age (years)				
20-49	45.1	(37.8-52.7)	37.0	(25.7-49.9)
50 and older	41.1	(36.8-45.6)	39.8	(31.9-48.3)
Time since diagnosis				
≤5 years	52.2	(46.1-58.2)		
>5 years	36.5	(32.0-41.2)		

Ensanut: *Encuesta Nacional de Salud y Nutrición*

Table IV

FACTORS ASSOCIATED WITH GLYCEMIC CONTROL. MÉXICO, ENSANUT 2018-2020

	Model 1 (n=1 861)*		*Model 2‡ (n=1 397)*	
Survey wave	*Prevalence Ratio (95%CI)*	*p-value*	*Prevalence Ratio (95%CI)*	*p-value*
2018				
2020	0.95 (0.79-1.15)	0.605	-	-
Sex				
Males				
Females	1.12 (0.92-1.36)	0.276	1.10 (0.91-1.34)	0.307
Age (10 years)	1.13 (1.04-1.23)	0.003	1.12 (1.03-1.23)	0.010
Socioeconomic level				
Low				
Medium	1.13 (0.86-1.48)	0.388	1.05 (0.82-1.33)	0.723
High	1.30 (0.98-1.73)	0.070	1.21 (0.96-1.54)	0.111
Education level				
Primary school				
Middle school	1.14 (0.87-1.50)	0.342	0.95 (0.76-1.19)	0.657
High school	1.10 (0.78-1.56)	0.578	0.82 (0.59-1.14)	0.233
College or more	1.44 (1.01-2.06)	0.045	0.76 (0.48-1.19)	0.228
Healthcare affiliation				
INSABI				
IMSS	0.93 (0.73-1.19)	0.563	1.30 (1.04-1.62)	0.021
ISSSTE	0.68 (0.48-0.98)	0.041	1.06 (0.73-1.55)	0.765
Other publics or privates	0.89 (0.56-1.40)	0.602	1.55 (1.01-2.38)	0.044
Urbanization				
Rural				
Urban	0.79 (0.58-1.06)	0.119	1.12 (0.90-1.40)	0.321
Metropolitan	0.94 (0.69-1.27)	0.678	1.09 (0.83-1.43)	0.524
Region				
North				
Center	1.00 (0.78-1.29)	0.982	0.92 (0.73-1.15)	0.465
Mexico City	1.02 (0.79-1.33)	0.863	1.17 (0.87-1.56)	0.293
South	0.89 (0.68-1.16)	0.380	1.01 (0.78-1.32)	0.921
BMI categories				
Normal o underweight				
Overweight			1.01 (0.76-1.35)	0.943
Obesity			1.27 (0.96-1.67)	0.094
Time since diagnosis				
≤5 years				
>5 years			0.71 (0.59-0.86)	<0.001
Pharmacologic treatment				
No				
Pills			0.66 (0.55-0.80)	<0.001
Insulin			0.42 (0.28-0.63)	<0.001
Other treatments				
Diet			1.25 (1.03-1.52)	0.022
Exercise			1.12 (0.89-1.43)	0.337

* Model 1: Socioeconomic factors associated with diabetes using data from both Ensanut 2018 and 2020.

‡ Model 2: Proximal factors associated with diabetes using data from both Ensanut 2018.

Ensanut: *Encuesta Nacional de Salud y Nutrición*; INSABI: *Instituto de Salud para el Bienestar*; IMSS: *Instituto Mexicano del Seguro Social*; ISSSTE: *Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado*; Other publics include *Petróleos Mexicanos* (Pemex) and *Secretaría de la Defensa Nacional* (Sedena).

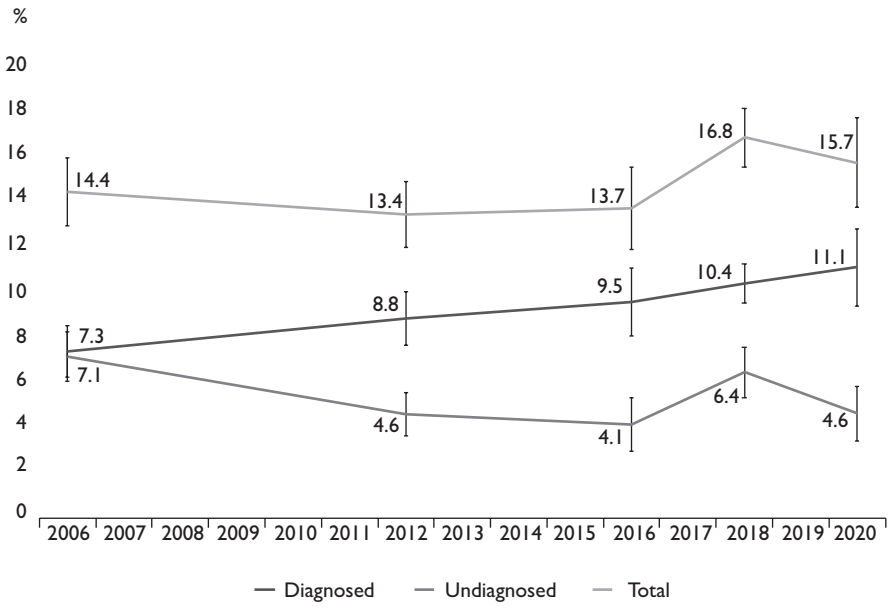

Figure 1. Diabetes prevalence in Mexico 2006-2020

as pharmacologic treatment is an indicator of severity and is recommended to individuals with uncontrolled glycemia.

Age was associated with glycemic control. The onset of diabetes at younger ages could be increasing the severity of the disease and explaining the worse glycemic control at younger ages.[21] In a multivariate regression model,[19] we included diagnostic age instead of time since diagnosis. We found that adults with diabetes onset age 60 had 45% better control levels than those with diabetes onset before age 40. Finally, following a diet was associated with better control levels, suggesting the importance of nutrition counseling as an opportunity area to reduce diabetes complications.

This work presents some limitations that should be mentioned. The statistical models of total diabetes and glycemic control are based on cross-sectional data, so we cannot make causal claims. This study may present reverse causality, as is probably the case of glycemic control and pharmacologic use. In 2020, the diabetes prevalence was estimated based on the same question used in 2018, but it was responded by the head of household instead of individually. This could lead to an underestimation of diagnosed diabetes in 2020. Also, in 2020, no information about time since diagnosis or treatment was included, so the model for the proximal factors associated with glycemic control was restricted to Ensanut 2018.

Diabetes is among the leading causes of morbidity and mortality in the country. In Mexico, diabetes affects 12.8 million people, of which 3.7 are unaware of their condition. Diabetes care and management should be done at the primary healthcare level, with nutritionists and a multidisciplinary group with a comprehensive approach to strengthen preventive services, timely detect diabetes, and establish individualized control levels.

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

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