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ORIGINAL RESEARCH

Sex disparities in the epidemic of type 2 diabetes in Mexico: national and state level results based on the Global Burden of Disease Study, 1990–2017

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Purpose: To analyze the type 2 diabetes (T2D) health burden in Mexico by sex at the national and state levels from 1990 to 2017.

Methods: This was a secondary analysis based on data from the Global Burden of Disease Study, 1990–2017. We used the indicators of mortality rates, years of life lost due to premature mortality (YLLs), years lived with disability (YLDs), and disability-adjusted life years (DALYs).

Results: At the national level, there was an increase in the standardized mortality rates, YLLs, YLDs and DALYs, especially in the male group. At the state level, the health impacts of T2D varied within the population and did not exhibit any clearly defined geographic pattern. However, the most pronounced increases in the various indicators occurred in the poorer states of the country.

Conclusion: T2D continues to have a dominant impact on Mexican public health, with marked disparities between the states. Working to reduce these health inequalities is necessary, and resources must be focused on the priority groups, for example, men, young and middle-aged adults, and individuals living in the states with the highest index of marginalization.

Keywords: type 2 diabetes, morbidity, mortality

Introduction

The incidence of type 2 diabetes (T2D) has been increasing for the last 30 years and is now the primary cause of morbidity and mortality worldwide.[1,2] Globally, it is estimated that 8.8% of those over 18 years old—more than 450 million people—live with diabetes. Of those, 80% live in middle- and low-income countries.[3] The number of people with T2D is expected to increase to over 693 million by 2045.[3] In 2012 alone, diabetes caused 1.5 million deaths worldwide, 43% of which occurred in individuals younger than 70 years of age.[4]

T2D is a complex chronic disorder that increases the risk of premature death and decreases the quality of life of those who suffer from it.[4] The impact of T2D is observed because of the high levels of associated mortality and disability and the medical costs of treating the disease and its complications.[5] Diabetes risk factors are divided into those that are modifiable (such as being overweight or obese, having poor eating habits, smoking and lacking physical exercise) and those that are

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nonmodifiable (such as ethnic origin, genetic predisposition and age).[3,4] The most frequent complications of T2D include heart attacks, strokes, kidney failure, lower limb amputations, loss of visual acuity, and neuropathy.[4] The annual global cost associated with diabetes is over US $827 billion dollars.[6]

In the Americas, the data indicate that close to 62 million people live with T2D. This figure has tripled in the last decade and now represents 15% of the entire Latin American population 18 years of age or older.[7] Among Latin American countries, Mexico has the highest T2D mortality rate.[8–10] The prevalence of diabetes has increased progressively,[11,12] and diabetes was the principal cause of death in 2017, with 106,508 deaths attributed to diabetes.[13] The prevalence of T2D in adults 20 and older increased from 7.2% in 2006 to 9.2% in 2012,[12,14] to 9.4% in 2016.[15] Healthcare costs associated with diabetes, including direct and indirect costs as well as those incurred as a result of T2D complications, in Mexico have increased to over US$3.43 billion dollars.[11]

While there are many studies of T2D in Mexico, there is little research about the behavior and dynamics of the epidemic at the state level, at which the demographic and epidemiological transitions have proceeded unevenly.[10] Other studies have offered general overviews of the situation by analyzing diabetes and other diseases without going deeper into the particularities that occur at the subnational level. The objective of this study is to analyze the T2D health burden in Mexico by sex at the national and state levels. The study analyzed all 32 Mexican states during the period from 1990 to 2017 and used the indicators of mortality rates, years of life lost due to premature mortality (YLLs), years lived with disability (YLDs), and disability-adjusted life years (DALYs).

Methods

We performed a secondary analysis based on data from the Global Burden of Disease Study 2017 (GBD), a project of the Institute for Health Metrics and Evaluation at the University of Washington.[9] The objective of the GBD is to quantify health loss caused by diseases, injuries and risk factors at a local, national, regional and global level.[16] The GBD uses a standardized, analytical approach that estimates incidence, prevalence and YLDs by year, sex, cause and location.[9,16] In 2017, the GBD included 195 countries and territories and subnational disaggregated data from 16 countries, using information beginning in 1990. The GBD included 359 diseases and injuries and 84 risks or combinations of risks.[17–19] The GBD makes use of many sources of information, including censuses, surveys, hospital and administrative registries, and verbal autopsies.[16] The GBD uses standardized and replicable methods that comply with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER).[17–19]

In the present analysis, only T2D is considered, so the data are restricted to people aged 15 or older, given that the evidence suggests that this type of diabetes is beginning to occur at younger ages.[18] The information, dating from 1990 to 2017, was disaggregated nationally, by state, and by sex and age groups. In this study, mortality, YLLs, YLDs and DALYs rates are presented. To describe the level of confidence for each indicator (given the uncertainty present in the initial data and subsequent calculations), the GBD derived 95% uncertainty intervals (UI). All rates reported here are age-standardized.

YLLs are a measure of premature death. We calculated the YLLs by multiplying the number of deaths from T2D in each age group by the average life expectancy at the age at which the death occurred.[18] The GBD in 2017 used a standard life expectancy taken from the lowest observed risk of death for each five-year age group in all populations greater than 5 million.[18] YLDs were calculated as the product of the estimated prevalence of diabetes and a comorbidity-adjusted disability weight.[17] The disability weights were obtained using DisMod-MR 2.1, a Bayesian meta-regression tool that produces estimates of incidence, prevalence, remission, excess mortality and the cooccurrence of different diseases and injuries. The DALYs quantify the health loss due to diabetes by measuring the difference between a current situation and an ideal situation in which everyone lives to the age of the standard life expectancy and in perfect health. The DALYs were calculated by adding the YLLs and the YLDs. Details on these indicators can be found in previous publications.[10,16–19]

Results

National overview

T2D has been among the leading causes of death in Mexico. In 1990, T2D deaths represented 5.8% (25,198) of the total deaths that year. By 2017, T2D deaths constituted 9.0% (64,067) of the total deaths (data not shown). This increase can also be seen in the mortality rates of both women and men (Figure 1).

Overall, the mortality rate (per 100,000 inhabitants) increased from 45.4 deaths (95%, UI 43.9–48.2) in 1990

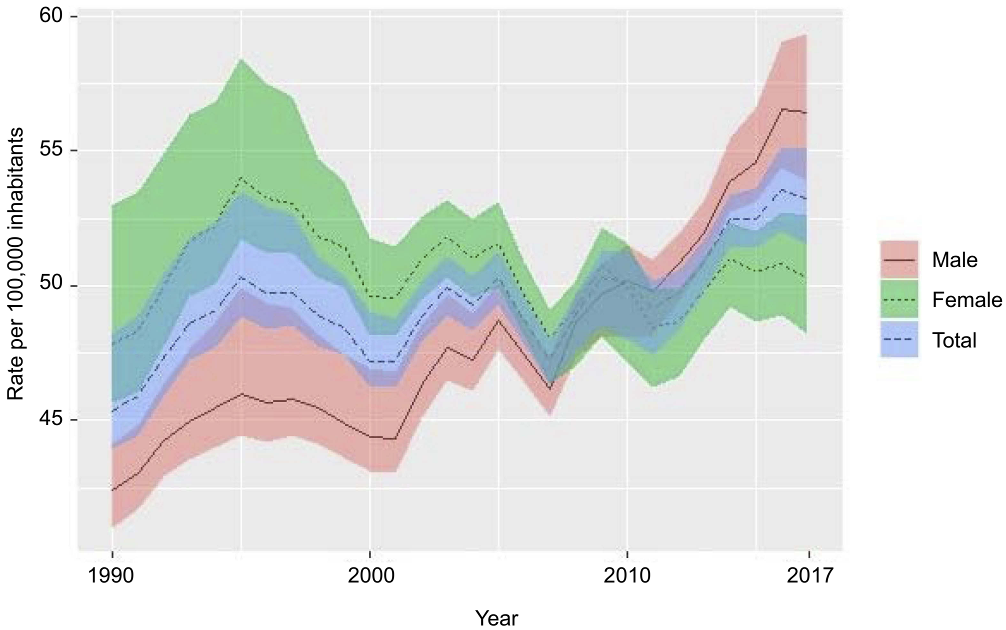

Figure 1 Age-standardized mortality rate due to type 2 diabetes, by sex; Mexico, 1990–2017. The shaded parts correspond to 95% uncertainty intervals.

to 53.2 (95%, UI 51.5–55.1) in 2017 (a relative change of 29.5%). However, the male mortality rate increased by a greater proportion than the female mortality rate (49.6% versus 9.7%). Although the T2D mortality rate was higher for women in 1990, from 2012 to 2017, this pattern was reversed. For males, the mortality rate increased in all age groups, especially in the groups between 20–29 and 35–44 years of age. Women between 20 and 44 years of age had significant increases in the mortality rate, while the mortality rate of women between 55 and 74 years of age was reduced (Figure 2).

In 1990, deaths from T2D translated into 406,183 (95%, UI 392,005–440,054) YLLs, a number that tripled to 1,231,828 (95%, UI 1,189,260–1,275,772) in 2017. The highest number of YLLs from T2D occurred in adults and older adults from 50 to 74 years old. Of the total YLLs, 66.1% were concentrated in this age group. The YLLs increased throughout the entire period, with a greater

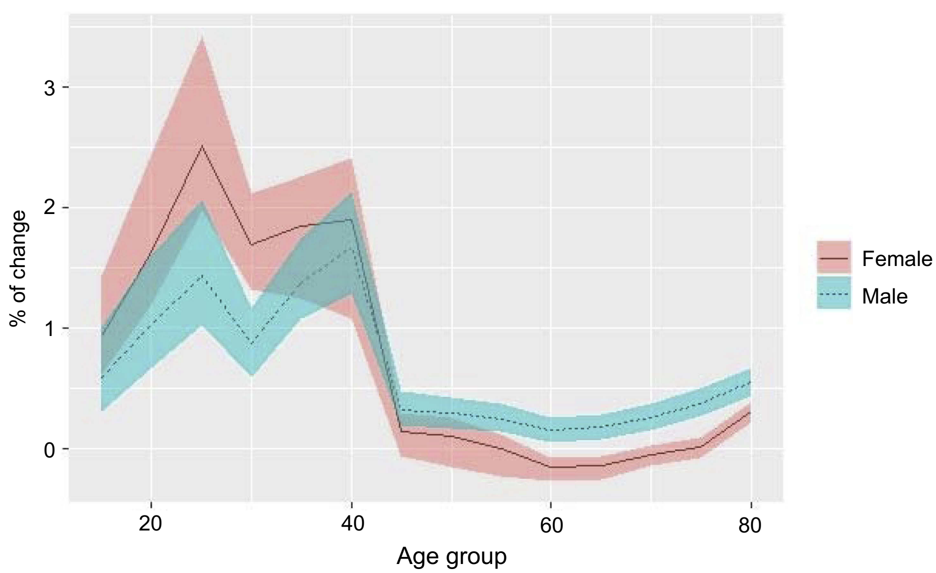

Figure 2 Percentage of change in age-standardized mortality rate due type 2 diabetes in Mexico, by sex and age group between 1990 and 2017. The shaded parts correspond to 95% uncertainty intervals.

increase in men (31.4%) than in women (2.5%). T2D is also one of the principal causes of disability in Mexico. By 2017, the YLDs had increased to 1,203,009 (95%, UI 814,567–-1,672,877) years, 2.7-times more than the 443,943 (95%, UI 301,391–610,852) years registered in 1990. Compared to the YLLs, the YLDs in 2017 originated mainly from younger age groups—67.8% were from individuals aged 40 to 69 years old. During the period examined in this study, the YLDs rate increased consistently, both for men (22.7%) and women (10.6%), and the DALYs rate was higher for men, except for three years (1995–1997). The YLLs, YLDs and DALYs rates by sex are shown in Table 1.

Subnational overview

In 1990 and 2017, Coahuila had the highest T2D mortality rate in men. However, the state with the highest female T2D mortality rate in 1990 was Colima, and in 2017, it was Quintana Roo. Although in the great majority of the states, the male mortality rate increased during the study period, in Aguascalientes, Baja California, Colima, Durango and Oaxaca, the rate decreased. However, in ten of the 32 states, the increase was greater than 50%, and even in Chiapas and Guerrero, the change was over 100%. These two areas, together with Quintana Roo, had a marked increase in the T2D mortality rate (greater than 50%) for women, which contrasts with thirteen states, mainly Baja California, Nuevo León, Colima and Sonora, in which the rate was reduced (Figure 3).

When considering premature deaths and disability jointly, we found that Tabasco and Mexico City were the regions that had the highest DALYs rate in 2017, while Sinaloa and Nuevo León had the lowest. The most pronounced increases in this rate occurred in Chiapas (67.8%), Quintana Roo (62.5%), Guerrero (60.8%), Tabasco (46.2%) and Oaxaca (42.9%)—all of them located in the southeastern and southern regions of the country. Likewise, in 2017, in two-thirds of the national territory, except for states such as Aguascalientes, Baja California Sur, Durango, Hidalgo, Nayarit, Nuevo Leon, Oaxaca, Querétaro, San Luis Potosí, Sinaloa and Yucatán, the YLLs rate was higher than the YLDs rate. However, in eleven states (Aguascalientes, Baja California, Baja California Sur, Chihuahua, Coahuila, Durango, Nayarit, Nuevo Leon, Sinaloa, Sonora and Tamaulipas) the YLL rate decreased, contrary to what happened with the YLDs rate that increased in all states, except Coahuila where it was reduced by only 0.5% (Figure 4).

Table 2 shows the YLLs and YLDs rates disaggregated by sex and state. In general, the male YLLs rate decreased between 1990 and 2017 in some states, such as Aguascalientes, Baja California, Coahuila, Durango and Nuevo Leon, while the female YLLs rate decreased in slightly more than half of the states in that same period. In states such as Chiapas, Guerrero, Oaxaca and Quintana Roo, the YLLs rate increased for both sexes (by more than 85% in

Table 1 Age-standardized YLLs, YLDs and DALYs rates due type 2 diabetes in Mexico, 1990–2017, by sex

Year	Rate YLLs (95% UI)	Rate YLDs (95% UI)	Rate DALYs (95% UI)
	Male		
1990	893.63 (863.60–933.95)	865.73 (593.81–1194.36)	1759.37 (1474.31–2095.01)
1995	957.35 (924.18–1053.05)	916.44 (628.95–1270.61)	1873.80(1570.22–2227.15)
2000	928.78 (901.07–995.14)	908.85 (624.51–1264.12)	1837.65 (1541.25–2183.68)
2005	1013.58 (989.86–1050.67)	881.46 (599.66–1217.34)	1895.05 (1611.78–228.80)
2010	1040.11 (998.33–1066.99)	886.57 (604.22–1229.01)	1926.69 (1636.65–2274.61)
2017	1174.27 (1120.12–1237.63)	1062.53 (721.60–1475.29)	2236.81 (1893.14–2664.53)
% change 1990–2017 (UI)	31.4 (23.0–39.6)	27.7 (21.5–33.5)	22.7 (15.3–31.8)
	Female		
1990	929.94 (882.16–1055.74)	812.30 (557.26–1115.85)	1742.24 (1474.85–2036.79)
1995	1056.20 (1007.21–1169.07)	843.89 (574.21–1159.21)	1900.10 (1626.96–2206.21)
2000	963.58 (936.49–1015.06)	823.63 (558.85–1135.10)	1787.21 (1518.02–2093.48)
2005	985.01 (949.78–1016.59)	791.73 (535.74–1087.15)	1776.75 (1516.66–2073.25)
2010	937.22 (876.68–968.71)	877.59 (596.44–1206.37)	1814.82 (1533.35–2150.60)
2017	952.86 (910.21–997.27)	898.37 (607.05–1242.25)	1851.24 (1567.44–2195.78)
% change 1990–2017 (UI)	2.5 (−10.9–10.0)	6.3 (−2.1–12.1)	10.6 (3.4–18.2)

Abbreviations: YLLs, years of life lost due to premature mortality; YLDs, years lived with disability; UI, uncertainty intervals.

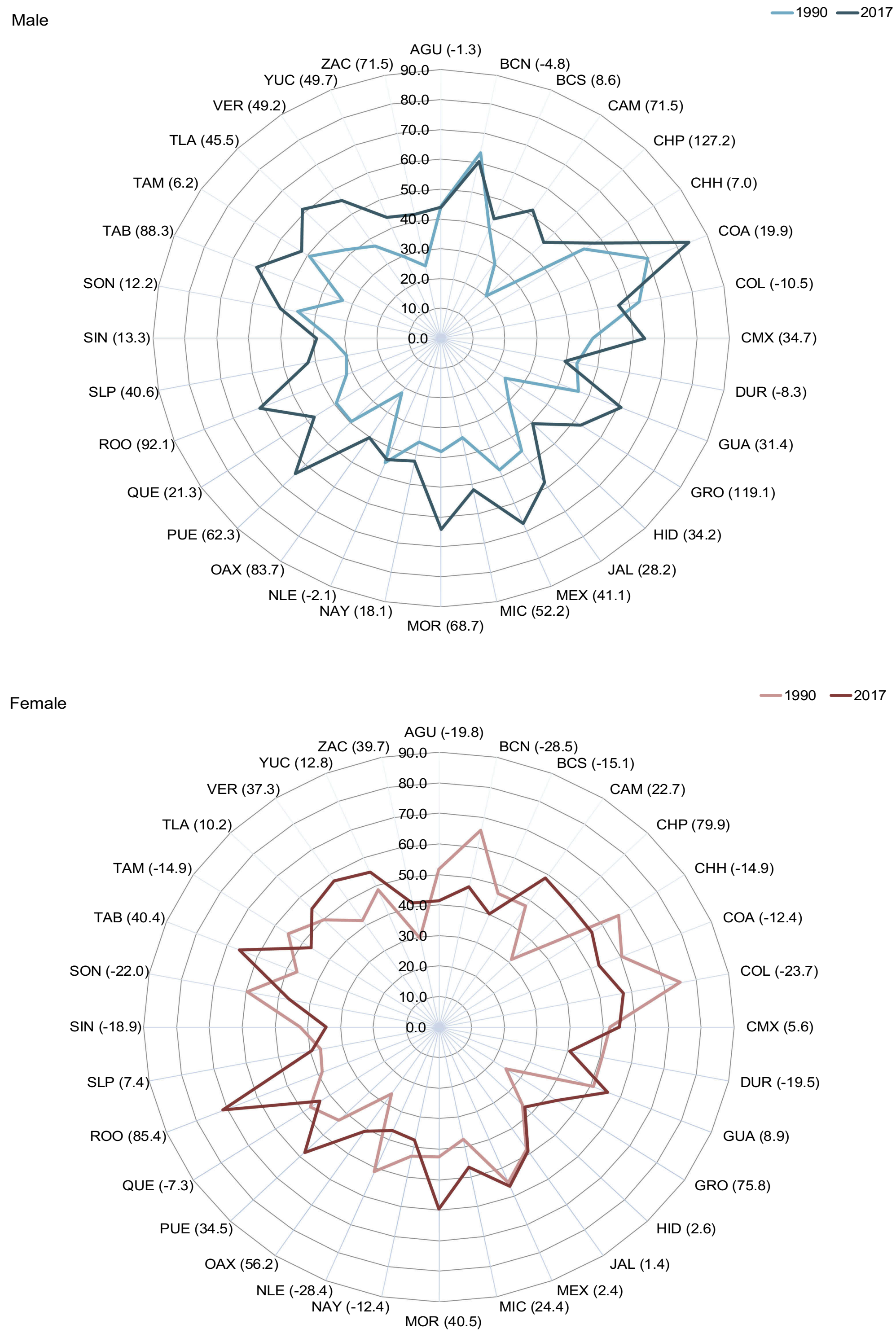

Figure 3 Age-standardized mortality rate due type 2 diabetes in Mexico, 1990 and 2017, by sex and states. Values in parentheses show the percentage change in the rate between 1990 and 2017.

Abbreviations: AGU, Aguascalientes; BCN, Baja California; BCS, Baja California Sur; CAM, Campeche; CHP, Chiapas; CHH, Chihuahua; COA, Coahuila; COL, Colima; CMX, Ciudad de México; DUR, Durango; GUA, Guanajuato; GRO, Guerrero; HID, Hidalgo; JAL, Jalisco; MEX, Estado de México; MIC, Michoacán; MOR, Morelos; NAY, Nayarit; NLE, Nuevo León; OAX, Oaxaca; PUE, Puebla; QUE, Querétaro; ROO, Quintana Roo; SLP, San Luis Potosí; SIN, Sinaloa; SON, Sonora; TAB, Tabasco; TAM, Tamaulipas; TLA, Tlaxcala; VER, Veracruz; YUC, Yucatán; ZAC, Zacatecas.

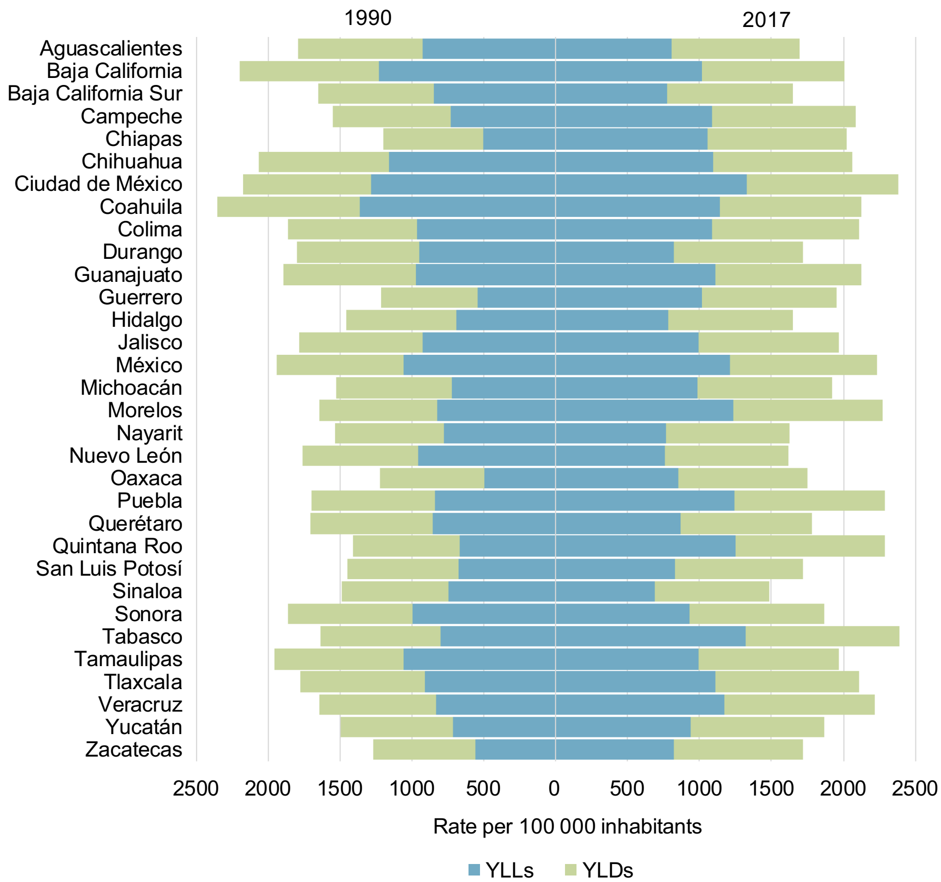

Figure 4 Age-standardized YLLs and YLDs rate due type 2 diabetes in Mexico, 1990 and 2017, by states.
Abbreviations: YLLs, years of life lost due to premature mortality; YLDs, years lived with disability.

men and 58% in women). On the other hand, the male YLDs rate increased in all states: a situation that occurred only in Aguascalientes, Baja California, Colima and Sonora for women. Again, Chiapas, Guerrero and Quintana Roo were the regions with the highest increase in this indicator (by more than 43% in men and 32% in women).

Discussion

T2D remains an important public health problem in Mexico. However, because the available information has been limited, few studies have allowed for the kind of geographic and temporal disaggregation that this study was able to offer. To the best of our knowledge, this is the first time that information about the impact of T2D has been published that reflects the broad heterogeneity within Mexico, both premature deaths and disability, and data for men and women.

At a national level, the T2D mortality rates, YLLs and YLDs all increased consistently during the 28-year period studied. However, these changes occurred quickly in a short time. Overall mortality exhibited a dynamic behavior over time, with a constant rise since 2013. At the subnational level, the health impacts of T2D have varied within the population and have not exhibited any clearly defined geographic pattern, although it is systematically observable that the states with the highest YLLs rates also had the highest YLDs rates. Mexico City and Tabasco were the states with the highest DALYs in 2017, although states such as Chiapas, Guerrero, Oaxaca, and Quintana Roo had the most pronounced increases in all the indicators analyzed. These states also have the highest levels of poverty and marginalization in the country.

Our results show that since 2010, the male mortality rate has exceeded the female rate, inverting the epidemic's historical pattern. Although the reasons explaining this difference in T2D mortality by sex have not been deeply explored, it is possible that the change is due to the interaction of several physiological, behavioral and psychological factors that affect the course of the disease.[20,21] It has been reported that men with T2D often have a lower body

Table 2 Age-standardized YLLs and YLDs rate due type 2 diabetes in Mexico, 1990 and 2017, by sex and states

States	Male						Female					
	Rate YLLs		% change	Rate YLDs		% change	Rate YLLs		% change	Rate YLDs		% change
	1990	2017		1990	2017		1990	2017		1990	2017	
Aguascalientes	887.5	880.1	−0.8	893.3	969.3	8.5	960.4	743.8	−22.5	836.6	817.0	−2.4
Baja California	1249.9	1206.4	−3.5	1022.6	1096.2	7.2	1204.7	838.9	−30.4	925.3	879.5	−5.0
Baja California Sur	803.6	841.4	4.7	837.9	936.4	11.7	896.4	712.0	−20.6	760.3	808.8	6.4
Campeche	619.4	1062.5	71.5	789.3	1024.4	29.8	863.3	1114.0	29.0	852.2	965.0	13.2
Chiapas	422.6	988.4	133.9	676.5	976.8	44.4	602.0	1124.3	86.8	713.9	948.6	32.9
Chihuahua	1072.4	1146.4	6.9	912.4	1019.0	11.7	1240.9	1051.7	−15.2	905.9	915.0	1.0
Ciudad de México	1439.9	1766.2	22.7	983.3	1247.7	26.9	1161.0	977.9	−15.8	828.7	888.2	7.2
Coahuila	1268.7	1158.6	−8.7	989.0	1032.5	4.4	1453.1	1116.3	−23.2	988.7	939.9	−4.9
Colima	968.0	1226.8	26.7	932.7	1119.7	20.0	962.3	958.8	−0.4	867.0	928.1	7.1
Durango	897.3	819.6	−8.7	915.7	1013.1	10.6	1009.8	817.5	−19.0	783.9	804.5	2.6
Guanajuato	951.4	1215.8	27.8	950.7	1098.8	15.6	992.3	1011.4	1.9	899.7	948.1	5.4
Guerrero	552.7	1159.6	109.8	717.7	1031.4	43.7	531.0	893.7	68.3	630.4	847.4	34.4
Hidalgo	665.1	877.2	31.9	774.1	917.6	18.5	720.3	703.9	−2.3	758.4	821.6	8.3
Jalisco	940.8	1126.6	19.8	907.8	1070.4	17.9	914.9	869.0	−5.0	817.3	897.6	9.8
México	1030.9	1401.0	35.9	907.5	1135.1	25.1	1071.4	1047.9	−2.2	866.1	925.1	6.8
Michoacán	718.0	1092.6	52.2	824.0	1020.1	23.8	730.0	887.4	21.6	780.2	867.1	11.1
Morelos	817.3	1361.3	66.6	845.1	1147.6	35.8	830.1	1118.4	34.7	791.4	954.9	20.7
Nayarit	730.2	834.6	14.3	787.8	915.4	16.2	821.4	708.3	−13.8	736.3	792.8	7.7
Nuevo León	924.8	867.5	−6.2	819.3	924.2	12.8	981.5	661.0	−32.7	800.2	804.9	0.6
Oaxaca	482.6	894.2	85.3	739.1	974.9	31.9	517.9	822.3	58.8	707.5	822.3	16.2
Puebla	843.2	1384.3	64.2	896.5	1159.3	29.3	842.0	1120.3	33.1	817.0	955.7	17.0
Querétaro	814.5	954.6	17.2	854.0	1004.2	17.6	893.8	784.6	−12.2	838.7	843.9	0.6
Quintana Roo	632.8	1218.6	92.6	738.7	1057.1	43.1	713.4	1277.6	79.1	740.6	1023.3	38.2
San Luis Potosí	637.1	890.6	39.8	785.5	957.2	21.9	711.0	768.4	8.1	759.8	829.0	9.1
Sinaloa	677.9	757.9	11.8	777.3	855.5	10.1	813.0	629.8	−22.5	716.0	738.9	3.2
Sonora	896.3	1018.4	13.6	863.6	998.6	15.6	1088.8	850.8	−21.9	878.2	869.2	−1.0
Tabasco	703.7	1349.7	91.8	828.7	1126.0	35.9	906.3	1295.5	43.0	838.8	1010.8	20.5
Tamaulipas	1028.9	1076.5	4.6	966.8	1098.4	13.6	1085.2	916.4	−15.6	835.4	869.6	4.1

(Continued)

Table 2 (Continued).

States	Male						Female					
	Rate YLLs		% change	Rate YLDs		% change	Rate YLLs		% change	Rate YLDs		% change
	1990	2017		1990	2017		1990	2017		1990	2017	
Tlaxcala	876.6	1231.9	40.5	885.1	1082.7	22.3	951.0	1006.4	5.8	843.6	918.9	8.9
Veracruz	819.9	1193.7	45.6	830.6	1087.3	30.9	845.8	1152.0	36.2	785.8	1006.2	28.0
Yucatán	567.5	875.0	54.2	745.7	952.5	27.7	867.2	996.5	14.9	816.4	907.2	11.1
Zacatecas	516.1	862.8	67.2	722.4	959.7	32.8	598.3	779.6	30.3	703.9	841.9	19.6
	In respect to the national average[a]			Low (Q1)	Similar (Q2)	High (Q3)	% change		<20	20–49	≥50	

Note: [a]Calculated for every year and by sex.
Abbreviations: Q1, quartile 1; Q2, quartile 2; Q3, quartile 3; YLLs, years of life lost due to premature mortality; YLDs, years lived with disability DALYs, disability-adjusted life years.

mass index than women but a higher concentration of visceral adipose tissue, which in turn generates greater insulin resistance.[20,21] Men with T2D suffer more microvascular complications, while women tend to have a higher prevalence of depression, stress, and anxiety.[20,21] Data from the 2016 Halfway National Health and Nutrition Survey indicated that 3.4% of people with T2D in Mexico had macrovascular complications (such as myocardial infarction or stroke), and of these individuals, 69% were male.

All these aspects must be analyzed in specific studies to clarify the roles of sex and gender in the T2D disease burden.[21] In Mexico, a key element could be to understand health service access and use trajectories and the differential effects of various health interventions on lifestyles, treatment adherence and T2D complications to assess the impact of public policies. Regardless of the efforts carried out by the health system to reduce the adverse effects of T2D, the results continue to be below the minimum desired standards. For example, in 2016, 87.8% of Mexicans with T2D had some medical control of the disease, but only half took some preventive measure to avoid or delay any complication of the condition and even fewer individuals with T2D had modified their diet or increased their physical activity.[22] Additionally, only 8% of Mexican males, compared to 12.9% of females, with T2D received any information about the disease.[15]

It has also been reported that in Mexico, in contrast to other Latin American countries, the YLLs due to T2D begin at younger ages.[8] This characteristic of the epidemic could be explained by predisposing genetic factors of T2D and lifestyle risks present at a young age in the Mexican population. For example, it has been demonstrated that Mexicans have a genetic variant known as SLC16A (and other genetic variants) that increase the probability of developing T2D by 25% and explains 20% of the current prevalence.[23–25] Additionally, it has been shown that the intrauterine environment conditions the occurrence of T2D and that a lower birth weight or a weight higher than the adequate weight at a young age contributes to the development of different metabolic pathologies at later ages.[12] Another factor associated with the increase in T2D at younger ages is an increase in obesity and overweight in younger individuals. This increase has been related to increased urbanization and the globalization of food production, which paired with a failed policy in the regulation of the market, facilitates and promotes the consumption of foods with low nutritional value from an early age.[12] In

2016, the combined prevalence of obesity and overweight in children aged 5 years or younger was 5.8% for females and 6.5% for males; in those aged 5 to 11 years, the prevalence was 32.8% and 33.7% for females and males, respectively; and in adolescents (12 to 19 years of age), the prevalence was 39.2% and 33.5% for females and males, respectively.[26]

In Mexico, the increase in the burden of T2D is a generalized phenomenon that is predicted to continue if immediate actions are not taken to halt it. Meza and collaborators calculated that by 2050, the prevalence of T2D diagnosed in adults older than 20 will be 13.7–22.5%.[27] Looking just at adults 50 and older, the prevalence could rise from 19.3% in 2012 to 34% in 2050.[28] This increase is critical since there are enormous challenges related to reducing T2D mortality in adults aged 50 to 69.[29] Mexico has a rapidly aging population, so it can be expected that T2D will continue to play a central role in the nation's epidemiological profile.[27] According to the 2015 Intercensal Survey, the total population of Mexico has grown to 119,530,753 people, of whom 10% are 60 or older.[30] This percentage is expected to rise to 25.1% by 2050.[31] T2D (along with homicides) is a primary culprit for the deceleration in life expectancy growth in Mexico, especially among men.[8,10,32,33] It has remained at approximately 75 years since the beginning of the 21st century, with a marginal increase of 0.3 years between 2000 and 2018.[31]

The gains made thus far have been insufficient. Broad, integrated policies are necessary to halt the T2D epidemic. Multidisciplinary and multisectoral work is imperative and should be directed at mitigating, decreasing and turning around the dynamic of T2D and its impacts on public health. Prevention and early identification are the most urgent challenges, as are controlling the disease and its complications.[10,12,27] In this respect, two critical lines of action can be discerned. The first has to do with the advancement of methods to promote and adopt healthy lifestyles. According to the most recent national health survey (2016), 72.5% of adults 20 and over in Mexico are overweight or obese[15]—one of the highest prevalence rates in the world.[34] Modifiable factors, such as lack of exercise and being overweight or obese, are those most closely associated with the risk of T2D[4,10,14,34–36] and are responsible for a large part of the burden of disease.[19] A second urgent line of action is to address the disparities in healthcare coverage, access and quality. These inequities are the likely cause of the broad differences in the distribution and impact of T2D among Mexican states. Although it has been documented that there have been positive advances in ensuring equal access to medical care for diabetes,[37,38] gaps remain. These disparities make the timely diagnosis and control of the disease and its comorbidities more difficult, and they raise issues related to the population's healthcare, above all for people at the lowest socioeconomic levels.[38,39] However, residents of states with the highest T2D rates have limited access to medical care. Although 60% of the total T2D mortality is concentrated in these states, they have the lowest concentration of health resources such as clinics, doctors, nurses, and medical equipment.[40] In Mexico, half the population does not have health insurance or is not enrolled in the Social Protection Health System known as *Seguro Popular* (49,018,903 people).[30] This is the poorest portion of the population and that with the greatest health challenges.

Finally, the information generated by using the GBD study is a useful tool to help target public policy and adequately assign resources. T2D is a potentially avoidable disease that relates to the Sustainable Development Objectives (SDO), which include the goal of using prevention and treatment methods to reduce premature deaths from non-transmissible diseases by one-third. This is a major task; a recent mortality rate projection exercise found that if current conditions do not change, Mexico will reduce premature deaths by only 25.9% by 2030, which is far below the proposed 40%.[29] Diabetes would be reduced by only 1.8%—the lowest projected decrease. It is even estimated that the number of deaths could be 1.6-times higher than the SDO targets for 2030.[29]

The strengths of this report's findings include the analysis of diabetes mortality and disability estimates in Mexico, at a national and subnational level, over the past 28 years using the GBD. The GBD is a crucial resource that can be used to define, describe and evaluate the consequences of diabetes. A limitation of this study is the possibility that information regarding diabetes may be underestimated because a high percentage of cases are not diagnosed.[27,41] However, the GBD methodology offers many new statistical approaches that can reduce the challenges of trying to estimate disease burdens in terms of mortality, YLLs or YLDs, diminishing potential biases.[16]

Conclusion

T2D continues to have a dominant impact on Mexican public health, with marked disparities by sex and state. Working to reduce these health inequalities is necessary, and resources must be focused on the priority groups, for example, men, young and middle-aged adults (20–44 years), and individuals in the states with the highest index of marginalization. Strategies behind any related actions should be rooted in the demographic and epidemiological transition phase occurring in each region and be appropriate to the local social and cultural context. It is also necessary to continue to strengthen health information systems to create precise health registries at the state level.

Disclosure

The authors report no conflicts of interest in this work.

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