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Original Research

Systematic and Comparative Analysis of the Burden of Alzheimer´s Disease and Other Dementias in Mexico. Results at the National and Subnational Levels, 1990-2019

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Abstract

INTRODUCTION: Dementias, including Alzheimer´s disease (AD), are one of the leading causes of disability and mortality in older people. It is a growing health problem in low- and middle-income countries, where epidemiological information is scarce and deficient. The aim of this study was to analyze the burden of AD and other dementias in Mexico from 1990 to 2019 by sex, subnational level, and age groups.

METHODS: A secondary analysis was conducted using data from the 2019 Global Burden of Disease, Injury, and Risk Factors Study (GBD). Data on prevalence, incidence, mortality, years of life lost (YLL), years lived with disability (YLD), and disability-adjusted life years (DALY) due to AD and other dementias were obtained. A joinpoint regression analysis was performed to describe the changes in the trend of age-standardized DALY rates by AD and other dementias during the analysis period.

RESULTS: AD and other dementias ranked second among neurological disorders producing the most DALY in Mexico. Between 1990 and 2019, prevalence and incidence increased by almost 203%. In 2019, the age-standardized rate per 100,000 inhabitants was: 512 for prevalence, 79.3 for incidence, 73.3 for YLD, 256.9 for YLL and 272.2 for DALY. Likewise, five states concentrated 39% of AD and other dementias cases: Ciudad de México, Estado de México, Veracruz, Jalisco and Puebla. Differences were also observed by sex and age groups.

DISCUSSION: Given that the number of older adults in Mexico will significantly rise over the next few decades, AD and other dementias represent one of the most important health challenges. The fact that epidemiological and demographic transformations take place in Mexico in a very diverse way makes it difficult for the country to adequately plan for the growing demands of both people with AD and other dementias and their families.

Key words: Alzheimer, dementias, prevalence, incidence, burden of disease, Mexico.

Introduction

Dementia, including Alzheimer´s Disease (AD), are considered a very important public health challenge (1, 2). It is a growing health problem in low- and middle-income countries (LMIC) (3), where epidemiological information is scarce and deficient. The number of dementia sufferers, currently numbering 50 million worldwide, is projected to triple to 152 million by 2050 (4), with LMIC nations seeing the largest increases, where it is estimated that 90% of dementia cases are undiagnosed (5). AD and other dementias resulted in 25,3 million of years of healthy life lost in 2019 and was responsible for 1.0% of total of these years (6). Women's global prevalence has been reported to be 1.17 times greater than men´s, age-standardized mortality rate is also higher in the female group (7). Particularly, in Latin America and the Caribbean there is a high prevalence and increase in dementias. In this region, about 1.6 million new cases occur each year (8), although the data varies widely among the countries that comprise it (9).

Dementias are one of the leading causes of death in older people due to the loss of years of healthy living, implying serious individual, familial, and social consequences, as well as the financial costs to healthcare systems (1, 4, 10). For example, the total social cost of dementia was $818 billion in 2015, accounting for 1.1% of global gross domestic product (GDP) (11), and this could rise to 1.6 billion by 2050 (10). In LMIC, the average national spending as a percentage of GDP is 0.45%, with indirect expenses accounting for 58% of that total (12). People with AD and other dementias are also subjected to emotional distress, physical, and financial stress, putting an added burden on healthcare systems (1,13) while also having direct consequences for caregivers, most of whom are family (1, 4, 14).

One of the most important risk factors for the onset of dementias is population aging. Currently, one in eleven individuals is 65 or older (15), and it is estimated that by 2050, there will be around 426 million individuals

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in this age group (16). Mexico is not exempt from the worldwide demographic trend of population aging (13, 17). According to the 2020 Population and Housing Census (18), Mexico´s population was 126 million people, up 10% from 2010, with 12% of the persons 60 years and older, a three-percentage-point rise from 2010. Likewise, by 2020, 1.8% of the total population was 80 years old or older (2.2 million). In the same year, Mexicans' life expectancy at birth was 75.2 years (78.1 for women and 72.4 for men) (19) however, 13.6% of these years are estimated to be spent in poor health conditions (12.1% for men versus 15.0% for women) (own calculations based on the GBD 2019) (20). Some reports indicate that AD and dementias in general are one of the causes that contribute most to the loss of healthy life years and dependence, mainly in older adults (21–26).

Few research has quantified the prevalence of dementia in Mexico to date. In a recent systematic review and meta-analysis on the prevalence of dementia in seven LMIC countries, including Mexico, only three sources of information on prevalence were identified (one with insufficient data), reporting prevalence´s of 8.5% to 9.5% for Mexico (27). In the three reports, however, different diagnostic criteria and study populations were utilized. On the other hand, the most recent national data available is from 2013, which estimated that approximately 800,000 people suffered from dementia (28).

Knowledge about the burden of that AD and other dementias represents in a nation is a critical input for defining health policies to address this condition (13, 14, 25, 29). In this sense, the aim of this study was to analyze the burden of AD and other dementias in Mexico from 1990 to 2019 by sex, subnational level, and age groups. AD and other dementias will probably be one of the most important epidemiological challenges that the country will have to face in the coming years (30). This study seeks to provide updated, detailed and complete information to serve as input for decision makers, so that concrete actions can be focused for their attention and thus contribute to the strengthening of the National Plan for Alzheimer´s and other dementias (13, 25).

Methods

Overview

A secondary analysis was conducted using data from the 2019 Global Burden of Disease, Injury, and Risk Factors Study (GBD), a project of the University of Washington´s Institute for Health Metrics and Evaluation (IHME). The GBD synthesizes existing knowledge on the levels and patterns of a variety of health outcomes, a wide collection of risk factors, and health system responses using a rules-based approach. This study provides data on incidence, prevalence, mortality, years of life lost (YLL), years lived with disability (YLD), and disability-adjusted life years (DALY) associated with 369 illnesses and injuries (27, 28). It covers 204 nations and territories from 1990 to 2019, as well as the first administrative level of disaggregation for 22 countries (including Mexico) (31). The information from the GBD comes mainly from censuses, surveys, hospital records, and administrative records. It follows the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) in a standard way that can be replicated (31–33).

GBD used case definitions from the Diagnostic and Statistical Manual of Mental Disorders (DSM; DSM-III, DSM-IV, or DSM V), which are used in surveys and cohort studies, as well as from the International Classification of Diseases (ICD; ICD-8, ICD-9, and ICD-10), which are used in vital registration and claims data sources (7). Dementia was defined as a "progressive, degenerative, and chronic neurological disorder characterized by cognitive dysfunctions that interfere with daily living" (6, 7, 30). In GBD 2019, AD and other dementias are identified according to ICD-10 with the codes F00-F03, G30 and G31, and ICD-9 with the codes 290,2901.2,291.8, 294 and, 331 (7, 30). For this article, level 3 of disaggregation of the cause was used, according to the hierarchies of the GBD (6).

Measures and analysis

Data on prevalence, incidence, mortality, YLL, YLD, and DALY due to AD and other dementias were obtained. The information was disaggregated by sex, states (32 in total) and age groups. YLD are estimated by multiplying the prevalence of a sequela by the disability weight for that sequela without using age weighting or discounting. The YLD associated with AD is the total of the YLD associated with each of the disease's sequelae. Information is displayed in terms of YLD numbers or age-standardized rates. For all age-standardized rates, GBD based a world population reference. For this, we used the non-weighted mean of 2019 age-specific proportional distributions population estimates for all locations, of the percentage of the population in each five-year age group, for the years 2010 to 2035 from the United Nations Population Division´s World Population Prospects, 2012 revision (GBD, 2020) (7, 31). In some cases, the percentages of change in the indicators between 1990 and 2019 are presented, and uncertainty intervals (UI) were generated for every metric using the 25th and 975th ordered 1000 draw values of the posterior distribution (7, 30).

The GBD 2019 study used DisMod-MR 2.1, a Bayesian meta-regression method designed to address important shortcomings in descriptive epidemiological data, such as missing data, inconsistency, and large methodological variance between data sources, for most sequelae (7, 30, 31). This method is more appropriate for estimating dementias because it considers and corrects for inconsistencies in cause-of-death data, prevalence data over time, and data between nations (7, 30, 31).

Finally, based on a log-linear model, a segmented

regression analysis (joinpoint regression) was also performed. This method describes the changes in the trend of rates in successive segments over time and the amount of change in each. The annual percentage change (APC) between each cut-off point is calculated using the slope of the line in that segment and the average annual percentage change (34). These models begin with the simplest trend (a straight line) and determine if the slope of the trend in each segment is statistically different from the preceding one. The statistical significance level was set at 5%. For goodness-of-fit measurements, the Bayesian information criterion (BIC) and degrees of freedom were used. The Joinpoint Regression, version 4.9.1.0 program was used to analyze the data (35).

Ethics considerations

The authors did not directly collect consent to participate because this study is a secondary data analyses research, but all research was carried out in accordance with relevant national and international guidelines and regulations. This study did not include any patients or the public at large in its recruitment or execution. All the data of GBD 2019 is publicly available and can be accessed at https://vizhub.healthdata.org/gbd-compare/. All data used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

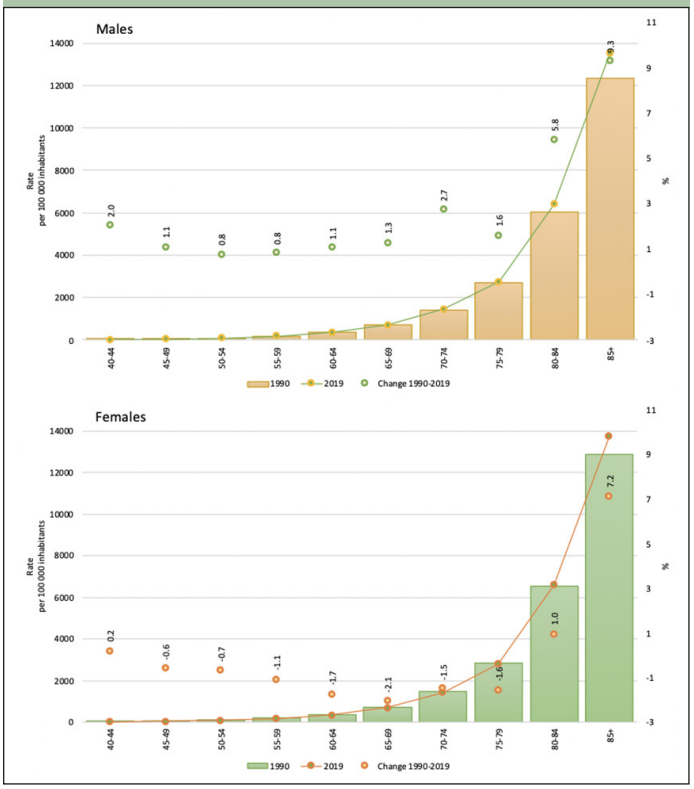
Results

National analysis

AD and other dementias ranked second among neurological disorders producing the most DALY in Mexico. It is, however, the leading cause of death for both men and women 70 years old and up. The prevalence of both disorders grew from 177,322 individuals (UI 150,816.2-205,650) in 1990 to 537,544 (UI 461,303-618,290) in 2019. During the same period, incidence increased from 27,332 individuals (UI 23,134-798) to 82,908 (UI 70,482.7-95,267.8). Between 1990 and 2019, both indicators increased by almost 203%. In 2019, the age-standardized prevalence rate was 512 (480.4 for males and 537.6 for women), while the incidence rate was 79.3 (75.5 for men and 82.5 for women). Total YLD in 2019 was 76,296.4 (UI 53,523.3-102,618.7), up 209.3% from 1990, while total YLL was 263,841.5 (UI 63,595.6-714,031.3) (224.6% more than 1990). The age-standardized YLD and YLL rates in 2019 were 73.5 and 256.9, respectively. Meanwhile, age-standardized YLD rates declined by 2.5% for men and 2.2% for women. Age-standardized YLL rates, on the other hand, increased in the male group (4.6%) and decreased in the female group (1.4%).

When the data was analyzed by age group, it was found that males of all ages increased their rate of DALY for AD and other dementias during the study period. Women, on the other hand, exhibited this pattern in practically all age groups, with the exception of the oldest. The rate of DALY increased beyond the age of 70 for both sexes, notably for those above the age of 85 (Figure 1).

Figure 1. Age-standardized DALY rates of Alzheimer´s Disease and other dementias, by age groups and sex. Mexico, 1990 and 2019



The age-standardized DALY rate for males was 304.9 and 361.2 for females per 100,000 inhabitants in 2019. As shown in the joinpoint regression analysis (Figure 2), between 1990 and 2019, this rate increased by 0.2% on average for males and 0.1% on average for females ($p \leq 0.05$). However, the changes during this period were markedly different by sex. While men´s DALY rates showed four inflection points during the period, women´s rates changed only twice. Men have had a more consistent increase in the rate, which was especially prominent between 2001 and 2004 (although this change was not statistically significant). From 2004 to 2010, the rate rose by an annual average of 0.2% ($p \leq 0.05$). In the case of women, the age-standardized DALY rate has been stable since 2010, and it was not until 2019 that a minor decrease in the APC was seen (-0.01%).

Subnational analysis

In 2019, about 39% of the prevalent cases of AD and other dementias in Mexico were concentrated in five states: Ciudad de México (9.6%), Estado de México (9.5%), Veracruz (8.1%), Jalisco (6.6%), and Puebla (5.1%); in contrast, Baja California Sur, Colima, Quintana Roo,

Table 1. Age-standardized prevalence and incidence rates of Alzheimer´s Disease and other dementias by sex and states, and percentage of change. Mexico, 1990 and 2019

States	Prevalence						Incidence					
	Males		% change	Females		% change	Males		% change	Females		% change
	1990	2019		1990	2019		1990	2019		1990	2019	
Aguascalientes	503.7	492.4	-2.2	560.4	546.0	-2.6	79.1	76.9	-2.8	85.7	83.3	-2.8
Baja California	494.3	488.6	-1.2	558.8	546.2	-2.3	78.0	76.3	-2.2	85.6	83.2	-2.8
Baja California Sur	498.5	486.7	-2.4	573.0	553.1	-3.5	78.1	75.8	-2.9	87.2	84.1	-3.5
Campeche	506.7	495.9	-2.1	566.9	550.1	-3.0	80.0	77.4	-3.2	87.0	84.1	-3.3
Chiapas	510.4	493.7	-3.3	567.4	547.2	-3.6	81.3	78.0	-4.1	88.2	84.7	-4.0
Chihuahua	494.5	481.8	-2.6	558.3	538.0	-3.6	78.2	75.9	-3.0	85.9	82.8	-3.6
Ciudad de México	491.1	479.6	-2.3	563.5	543.1	-3.6	77.5	75.1	-3.0	86.3	83.1	-3.7
Coahuila	502.3	492.9	-1.9	561.9	545.0	-3.0	79.3	77.2	-2.7	86.4	83.5	-3.3
Colima	496.0	487.7	-1.7	561.0	548.1	-2.3	78.6	76.3	-2.9	86.3	83.7	-3.0
Durango	504.0	492.4	-2.3	569.9	553.1	-3.0	79.6	76.9	-3.4	87.4	84.4	-3.4
Estado de México	431.2	403.8	-6.3	482.2	455.1	-5.6	70.2	65.8	-6.2	76.2	72.1	-5.4
Guanajuato	508.0	496.0	-2.4	571.1	554.3	-2.9	80.1	77.4	-3.4	87.5	84.4	-3.5
Guerrero	516.2	500.1	-3.1	584.8	561.8	-3.9	81.4	78.2	-3.9	89.6	85.9	-4.1
Hidalgo	506.2	497.5	-1.7	570.5	554.6	-2.8	80.1	77.5	-3.2	87.5	84.5	-3.4
Jalisco	500.0	491.2	-1.8	563.9	549.9	-2.5	79.0	76.8	-2.8	86.4	84.0	-2.9
Michoacán	513.1	499.8	-2.6	570.8	554.0	-2.9	80.9	77.9	-3.7	87.4	84.4	-3.5
Morelos	439.7	412.7	-6.1	496.0	462.0	-6.9	71.5	67.4	-5.7	78.0	73.1	-6.2
Nayarit	506.6	494.3	-2.4	572.1	557.8	-2.5	79.8	77.1	-3.3	87.5	84.8	-3.1
Nuevo León	505.5	494.3	-2.2	569.5	553.7	-2.8	78.8	76.6	-2.8	86.4	83.9	-2.9
Oaxaca	503.1	489.9	-2.6	562.5	546.0	-2.9	80.2	77.2	-3.7	87.1	84.1	-3.5
Puebla	499.6	487.9	-2.3	559.8	542.6	-3.1	79.7	77.0	-3.4	86.7	83.6	-3.6
Querétaro	502.0	491.2	-2.1	563.6	549.0	-2.6	79.4	76.8	-3.3	86.5	83.8	-3.0
Quintana Roo	503.6	487.3	-3.2	569.1	547.3	-3.8	79.2	76.2	-3.8	87.0	83.6	-3.9
San Luis Potosí	505.8	494.9	-2.2	568.9	555.3	-2.4	79.8	77.2	-3.3	87.3	84.6	-3.0
Sinaloa	510.2	501.4	-1.7	573.4	559.7	-2.4	79.9	77.5	-2.9	87.1	84.4	-3.1
Sonora	495.0	484.6	-2.1	562.3	546.1	-2.9	78.0	75.9	-2.7	86.0	83.4	-3.1
Tabasco	505.8	493.3	-2.5	567.2	549.9	-3.0	79.8	77.2	-3.3	87.1	84.2	-3.4
Tamaulipas	501.5	493.4	-1.6	569.2	554.0	-2.7	78.8	76.6	-2.7	86.9	84.3	-3.1
Tlaxcala	505.4	494.2	-2.2	569.2	551.8	-3.1	79.7	77.1	-3.2	87.3	84.4	-3.4
Veracruz	503.8	490.6	-2.6	568.0	550.5	-3.1	79.8	76.9	-3.6	87.5	84.2	-3.7
Yucatán	499.1	487.2	-2.4	563.7	546.3	-3.1	78.6	76.2	-3.1	86.4	83.6	-3.3
Zacatecas	511.6	497.4	-2.8	573.8	553.6	-3.5	80.3	77.6	-3.3	87.6	84.3	-3.8
México	496.5	480.4	-3.2	558.9	537.6	-3.8	78.6	75.5	-4.0	85.9	82.5	-4.0

Source: Own elaboration based on GBD, 2019

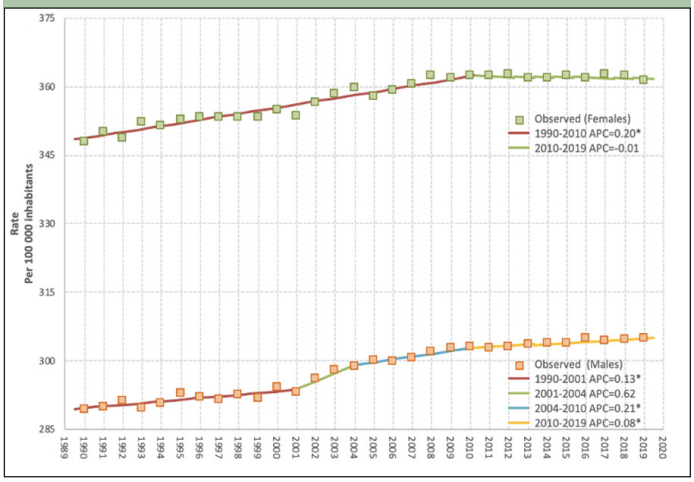
Campeche, and Aguascalientes accounted for 3.3% of the cases registered nationwide.

Between 1990 and 2019, the age-standardized prevalence and incidence rates of AD and other dementias dropped in all states and for both sexes, with variations between states. The states with the biggest reductions in prevalence and incidence rates were Estado de México and Morelos. Both rates were greater for women in all states. According to Table 1, prevalence and incidence rates were almost always greater than the national average rate by 2019.

Table 2 displays the age-standardized YLD and YLL rates owing to AD and other dementias by state and gender between 1990 and 2019, as well as the percentage change in rates over that time period. YLD rates fell in all states and for both sexes, as observed in the national trend. The states with the steepest declines were Estado de México, Morelos, and Querétaro. States such as Baja California and women in Colima, on the other hand, have seen no major changes in this rate over the last 30

years. The state of Sinaloa (72.0 per 100,000 inhabitants) and Estado de México (57.6 per 100,000 inhabitants) had the highest and lowest YLD rates in 2019. In women, the highest rate was for Guerrero (81.2 per 100,000 inhabitants) and the lowest for Estado de México (64.9 per 100,000 inhabitants).

Figure 2. Joinpoint analysis of age-standardized DALY rates of Alzheimer´s Disease and other dementias, by sex. Mexico, 1990-2019



Source: Own elaboration based on GBD, 2019.

In the case of men, the YLL age-standardized rates due to AD and other dementias decreased in six states (Baja California, Campeche, Coahuila, Guanajuato, Tabasco, and Yucatán), while they increased by more than 8% in seven states (Estado de México, Zacatecas, Michoacán, San Luis Potosí, Nayarit, Sinaloa, and Colima). In 2019, Hidalgo had the highest YLL rate for men (283.8 per 100,000 persons) and Durango had the lowest (232.8 per 100,000 inhabitants). The YLL rate was higher than the national average in 24 states. The situation was different for women, as the YLL rate increased only in Querétaro and Veracruz. Guerrero (7.8%), Coahuila (4.3%), Querétaro (3.8%), and Oaxaca (3.8%) had the most significant decreases (3.6%). In 2019, Ciudad de México and Querétaro had the lowest and highest YLL rates, respectively (Table 2).

The age-standardized DALY rate owing to AD and other dementias grew progressively from the 40–44 age group to 85 years and older in 2019, according to state, age group, and sex. While women had a higher DALY rate than men in general, the tendency was inverted for the 40–70 age groups in states including Coahuila, Guerrero, Michoacán, Nayarit, and Sinaloa. Similarly, in much of Estado de México, males 60 to 74 years old were more likely than women to surpass the DALY rate. In fact, in Aguascalientes, only women between the ages of 60 and 64 had a greater rate than men in the same age group. The disparities in rates by sex were particularly apparent in the older age groups (75 and up) (Table 3).

Discussion

In Mexico, there is a lack of comprehensive and representative national research that may be used to track the progression of AD and other dementias. This is the first study to delve at the burden of AD and other dementias in Mexico in the last 30 years and by sociodemographic and geographic characteristics. The degree of particularity of the analysis from 1990 to 2019 is the main contribution. Using a highly standardized analytical approach, the GBD generates comparable and complete estimates of mortality, prevalence, incidence, risk factor exposure, and mortality and morbidity attributable to these risks by cause, age, and sex (31, 32, 36).

In general, our findings show that the overall number of YLD and YLL owing to AD grew by more than 200% between 1990 and 2019. The age-standardized YLD rate, on the other hand, showed a marginal decrease of just over 2% for both sexes, while the YLL rate increased by more than 4% for men and stayed almost unchanged for women (-1.4%). In terms of DALY rates, the male group showed the most pronounced and consistent rises across all age categories. Women 85 years old and over were the only age group that showed a significant increase. Overall, the female group had a higher age-standardized rate of DALY, with steady growth between 1990 and 2010 and a little decline from 2011 onwards. Men, on the other hand, grew at a faster rate, particularly in the early years of the twenty-first century.

There were significant differences between the results of this study and the global trend when compared (6, 7, 30). First, the increase in YLL and YLD years was significantly smaller at the worldwide level, with 35.1% for YLL and 39.3% for YLD for both sexes (30). Also, between 1990 and 2019, the age-standardized YLD rate decreased for both men and women in Mexico, whereas it increased by 2.4% for women and 3.2% for men globally (30).

On the other hand, analysis at the subnational level reflects a wide heterogeneity in the burden of AD and other dementias. It was found that five states account for nearly 40% of the prevalent cases in the state-by-state analysis. Although, at the national level, the prevalence, incidence and YLD age-standardized by age decreased in both sexes, there were notorious variations within the country. For example, in 2019, the age-standardized YLD rates for females in the state of Guerrero was 25% higher than in Estado de México. A similar situation was documented in China, where there were significant subnational contrasts in the burden of AD and other dementias (37).

The disparities found between states are mostly attributable to the distinct stages of demographic and epidemiological transformation that each state is currently experiencing. Both the aging profile and the causes of illness and mortality exhibit distinct gradients

Table 2. Age-standardized YLD and YLL rates of Alzheimer´s Disease and other dementias by sex and states, and percentage of change. Mexico, 1990 and 2019

States	YLD						YLL					
	Males		% change	Females		% change	Males		% change	Females		% change
	1990	2019		1990	2019		1990	2019		1990	2019	
Aguascalientes	71.5	70.7	-1.2	78.9	78.2	-0.9	255.9	261.6	2.3	266.3	266.8	0.2
Baja California	69.7	69.8	0.2	78.6	78.4	-0.4	259.2	256.9	-0.9	258.4	256.2	-0.9
Baja California Sur	70.9	69.8	-1.7	80.6	79.2	-1.8	260.3	268.2	3.0	270.6	269.0	-0.6
Campeche	72.0	71.1	-1.3	79.4	78.6	-0.9	266.9	264.8	-0.8	267.7	263.1	-1.7
Chiapas	73.1	70.9	-3.0	80.5	78.3	-2.7	261.7	272.4	4.1	271.6	265.9	-2.1
Chihuahua	69.3	68.4	-1.2	78.1	76.8	-1.6	257.6	257.7	0.0	264.9	258.7	-2.3
Ciudad de México	69.8	68.5	-1.9	79.8	77.9	-2.3	255.0	261.6	2.6	237.7	229.5	-3.5
Coahuila	71.0	70.6	-0.6	78.6	78.2	-0.6	263.0	254.4	-3.3	268.0	256.3	-4.3
Colima	70.5	69.7	-1.1	78.5	78.3	-0.3	243.3	263.2	8.2	267.5	264.3	-1.2
Durango	71.5	70.8	-1.1	80.6	79.7	-1.1	222.2	232.8	4.8	268.4	260.1	-3.1
Estado de México	61.2	57.6	-5.8	67.5	64.9	-3.8	234.1	258.9	10.6	254.6	254.9	0.1
Guanajuato	72.0	71.0	-1.4	80.0	79.2	-1.0	264.6	257.9	-2.5	266.7	262.6	-1.5
Guerrero	73.8	71.8	-2.7	83.6	81.2	-2.9	236.4	249.9	5.7	284.8	262.7	-7.8
Hidalgo	72.2	71.6	-0.9	80.6	79.8	-1.1	278.0	283.8	2.1	266.7	261.3	-2.1
Jalisco	70.8	70.2	-0.8	79.4	78.9	-0.6	258.0	262.5	1.8	264.0	259.4	-1.7
Michoacán	73.0	71.8	-1.6	80.8	79.8	-1.1	243.1	266.7	9.7	267.0	261.5	-2.1
Morelos	62.6	59.2	-5.5	70.3	66.3	-5.6	237.3	251.7	6.1	248.5	247.2	-0.5
Nayarit	71.9	70.9	-1.4	80.8	80.3	-0.6	250.0	273.2	9.3	268.4	268.4	0.0
Nuevo León	72.0	71.0	-1.4	80.4	79.7	-0.8	252.0	258.4	2.6	262.9	260.8	-0.8
Oaxaca	71.5	70.4	-1.6	79.7	79.0	-1.0	249.9	262.3	5.0	273.0	263.1	-3.6
Puebla	71.1	69.9	-1.7	79.3	78.1	-1.6	243.2	257.4	5.8	267.9	260.6	-2.7
Querétaro	71.4	69.3	-2.9	80.5	77.8	-3.4	253.4	262.3	3.5	259.9	269.9	3.8
Quintana Roo	71.5	70.7	-1.2	79.6	79.0	-0.8	259.6	264.7	2.0	267.7	264.7	-1.1
San Luis Potosí	72.2	71.1	-1.5	80.6	80.0	-0.8	244.8	267.8	9.4	265.2	266.5	0.5
Sinaloa	72.8	72.0	-1.1	81.5	80.8	-0.8	249.3	271.7	9.0	262.5	261.5	-0.4
Sonora	70.4	69.6	-1.2	78.5	77.9	-0.9	254.9	259.7	1.9	259.6	257.1	-1.0
Tabasco	71.9	70.5	-2.0	79.7	78.3	-1.7	256.9	253.3	-1.4	263.9	257.7	-2.4
Tamaulipas	71.5	71.0	-0.7	79.9	79.3	-0.8	253.5	258.8	2.1	270.1	263.1	-2.6
Tlaxcala	72.1	71.0	-1.5	80.3	79.1	-1.6	246.0	260.0	5.7	266.8	258.0	-3.3
Veracruz	72.0	70.3	-2.3	80.5	78.8	-2.1	242.0	257.5	6.4	255.5	260.1	1.8
Yucatán	71.3	70.1	-1.7	78.9	77.9	-1.3	261.1	256.9	-1.6	262.1	257.5	-1.8
Zacatecas	73.1	71.6	-2.1	80.9	79.3	-2.0	245.8	271.0	10.2	266.5	266.3	-0.1
México	70.6	68.9	-2.5	78.9	77.2	-2.2	246.2	257.4	4.6	260.1	256.5	-1.4

Source: Own elaboration based on GBD, 2019

(38), resulting in health disparities. Add to this the fragmentation and segmentation of health services (39), which are overwhelmed by the expanding and changing demands of the population in the context of infrastructure, supplies, and health personnel shortages (40). According to other study, dementia is directly connected with health and social vulnerabilities, such as inadequate health insurance and constrained living arrangements (41). However, it is suggested that future studies investigate the causes of dementia differences among federal entities in Mexico in greater depth.

In the context of Mexico´s changing demographics, these data are significant, mainly because the aging process also presents its own peculiarities. In contrast to other age groups, the older people have the steepest growth rate in the country (17). Between 2010 and 2020 alone, the growth rate was 3%, and it is expected that by 2050, one in five Mexicans will be 60 years old or

Table 3. Age-standardized DALY rates of Alzheimer´s Disease and other dementias, by states, age groups and sex. Mexico, 2019 (heatmap)

States	Age groups									
	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Males										
Aguascalientes	5.9	36.7	86.5	181.6	366.2	726.9	1463.7	2759.0	6484.0	13747.0
Baja California	5.0	32.3	78.1	168.1	344.9	692.2	1422.1	2691.3	6345.4	13262.5
Baja California Sur	6.4	38.8	89.3	181.7	363.6	728.8	1484.7	2818.0	6635.0	13889.1
Campeche	6.0	38.2	88.6	185.6	368.8	724.0	1473.9	2765.5	6427.5	13756.9
Chiapas	5.9	37.0	87.7	186.8	372.2	738.8	1492.2	2804.7	6463.1	13720.1
Chihuahua	5.5	35.2	83.3	176.8	359.3	727.1	1469.3	2778.6	6509.8	13855.6
Ciudad de México	5.7	34.8	81.3	171.2	346.7	698.6	1423.2	2659.5	6222.4	12928.7
Coahuila	6.3	38.1	87.8	181.1	359.1	702.2	1430.7	2698.9	6360.2	13519.7
Colima	5.1	33.4	82.2	176.8	363.3	730.4	1501.4	2843.8	6737.3	13896.5
Durango	6.5	39.7	91.1	189.2	371.5	740.0	1499.5	2806.9	6479.8	13438.7
Estado de México	5.2	32.3	74.8	157.4	319.9	641.5	1299.0	2437.7	5672.6	11827.6
Guanajuato	5.2	34.2	84.1	180.0	364.0	726.8	1488.0	2779.6	6507.9	13642.9
Guerrero	6.2	39.5	92.5	194.0	388.9	773.6	1559.5	2955.0	6951.3	13881.9
Hidalgo	5.9	37.2	86.1	182.2	369.6	739.5	1498.1	2831.5	6529.6	13791.0
Jalisco	5.6	35.7	85.2	179.8	361.8	724.7	1476.1	2779.8	6483.7	13599.9
Michoacán	5.8	36.7	88.7	188.1	378.6	754.3	1524.5	2867.4	6655.3	14347.6
Morelos	5.1	32.1	77.6	163.4	331.8	680.8	1379.1	2624.3	6083.4	12645.4
Nayarit	6.4	41.2	93.8	195.5	387.6	763.3	1543.6	2922.1	6777.7	14410.2
Nuevo León	5.9	36.9	86.8	181.6	359.5	721.7	1460.3	2748.3	6449.1	13615.1
Oaxaca	5.6	35.5	84.3	181.9	369.3	746.3	1504.5	2810.2	6499.0	13889.9
Puebla	5.5	34.7	81.7	174.6	354.5	714.8	1458.8	2753.1	6422.8	13637.6
Querétaro	5.8	36.3	84.0	180.2	363.5	725.7	1501.3	2795.0	6521.2	13091.2
Quintana Roo	4.7	31.7	79.1	171.7	356.3	720.8	1479.0	2763.7	6493.9	13509.9
San Luis Potosí	5.9	37.4	89.1	187.6	376.2	758.1	1530.5	2874.6	6587.7	13859.9
Sinaloa	6.8	42.2	98.3	198.9	387.1	758.4	1533.3	2875.0	6691.1	14552.1
Sonora	5.7	35.9	84.5	176.6	355.9	717.0	1447.6	2733.5	6432.3	13314.2
Tabasco	5.6	35.5	84.5	178.0	359.9	715.4	1453.6	2706.5	6316.7	13197.2
Tamaulipas	5.7	35.9	85.3	178.3	358.9	721.3	1476.5	2786.1	6481.1	13937.3
Tlaxcala	5.8	36.3	86.4	177.4	360.3	729.5	1487.8	2777.4	6503.9	13713.0
Veracruz	5.7	35.2	82.9	175.5	356.1	719.0	1461.1	2748.7	6410.3	13726.0
Yucatán	5.8	36.6	85.4	180.3	366.0	726.5	1453.1	2687.4	6318.5	12926.7
Zacatecas	5.8	37.7	91.9	193.4	383.5	762.1	1547.9	2892.6	6684.6	14372.7

States	Age groups									
	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Females										
Aguascalientes	5.8	36.7	87.3	179.3	353.1	711.3	1478.2	2841.0	6765.9	13836.4
Baja California	5.4	35.4	85.3	176.8	347.3	694.6	1429.6	2793.5	6560.1	13329.2
Baja California Sur	5.9	37.9	89.8	184.8	361.0	710.9	1496.2	2904.2	6795.5	14256.2
Campeche	6.1	38.2	90.1	182.1	354.1	703.1	1476.4	2839.6	6741.8	13880.2
Chiapas	6.0	37.1	86.1	179.6	353.8	703.7	1478.5	2877.1	6802.0	14082.6
Chihuahua	5.7	36.0	84.7	175.9	347.2	697.6	1439.9	2806.3	6656.4	13863.1
Ciudad de México	5.9	37.2	88.0	180.0	351.6	697.6	1441.6	2797.9	6556.6	13608.6
Coahuila	5.9	36.7	85.0	175.3	343.4	689.0	1426.0	2800.9	6655.9	13977.6
Colima	5.4	35.2	86.2	180.6	358.7	711.6	1477.4	2864.0	6702.0	13466.4
Durango	6.1	38.6	91.1	185.6	362.9	717.7	1504.0	2917.0	6842.8	14582.2
Estado de México	5.2	32.4	75.6	154.5	305.4	612.9	1269.1	2457.7	5789.2	11816.9
Guanajuato	5.7	37.0	88.9	182.3	359.8	715.6	1472.4	2845.6	6705.7	13766.8
Guerrero	6.0	38.2	91.1	188.9	366.0	736.7	1522.0	2957.2	7037.4	14127.0
Hidalgo	6.0	37.9	89.9	185.2	363.1	723.3	1489.1	2885.0	6750.2	14333.5
Jalisco	5.8	37.3	88.4	180.6	357.0	707.4	1454.6	2816.1	6671.5	13704.2
Michoacán	5.8	36.7	88.4	182.2	358.6	712.5	1492.4	2875.9	6759.8	14445.7
Morelos	5.2	33.3	80.1	163.1	322.6	652.5	1362.1	2622.9	6179.0	12759.7
Nayarit	6.1	38.8	93.1	189.3	369.6	731.4	1527.3	2951.1	6942.3	14857.4
Nuevo León	6.0	38.2	91.0	184.5	362.8	718.2	1470.7	2850.9	6684.5	14018.2
Oaxaca	6.0	37.5	87.5	181.3	356.1	718.1	1492.1	2857.9	6740.9	14367.8
Puebla	5.8	36.7	85.8	175.8	349.3	704.1	1460.1	2835.4	6705.5	14061.8
Querétaro	5.9	37.2	89.6	183.1	361.3	718.9	1497.6	2865.0	6739.5	13317.3
Quintana Roo	5.4	35.9	86.8	181.7	357.7	714.6	1488.3	2865.4	6861.5	13359.0
San Luis Potosí	6.1	38.8	91.2	186.8	368.9	738.2	1511.8	2915.4	6853.3	14299.4
Sinaloa	6.0	39.0	93.6	190.8	373.7	731.7	1495.3	2889.2	6780.3	14401.2
Sonora	5.8	36.5	86.2	179.2	353.7	696.3	1441.6	2804.2	6572.6	13460.2
Tabasco	5.9	36.9	87.6	176.4	349.5	691.9	1427.3	2784.1	6610.3	13706.6
Tamaulipas	5.8	37.3	88.0	179.5	353.3	707.1	1465.5	2855.1	6722.6	14459.7
Tlaxcala	5.9	37.4	88.7	183.5	357.6	715.2	1474.0	2849.4	6745.7	14060.8
Veracruz	5.9	36.8	87.4	179.1	351.0	704.2	1455.3	2836.3	6692.1	14118.6
Yucatán	6.0	37.8	89.2	180.1	352.9	702.2	1438.3	2778.9	6592.3	13211.2
Zacatecas	6.0	38.4	91.0	189.2	366.8	728.4	1493.3	2901.0	6845.3	14428.2

Low rank — High rank

Source: Own elaboration based on GBD, 2019.

older. In 2020, the percentage of older adults ranged from 7.1% (Quintana Roo) to 16.2% (Mexico City) (17), which means that population aging is occurring at different rates and intensities. Although population aging is a global phenomenon, it is accelerating in LMIC (16, 22), posing complex challenges to health and social assistance systems that must adapt to the inherent health needs of this population group (24, 42, 43).

In addition to the foregoing, it is essential to note that the epidemiological profile of older persons is equally heterogeneous (22, 24, 43). Multiple chronic diseases coexist with mental disorders and geriatric syndromes, including falls, diseases of the sense organs, and dementias (22, 24). Regarding AD and other dementias, they increase with age to the extent that they are the 25th cause of disability in the 60-69 age group, the 7th in the 70-79 age group, the 5th cause in the 80-89 age group, and the 3rd cause in the 90 and older age group (24). In addition, the projected estimate for dementia in Mexico suggests that the number of cases will increase by 209% between 2019 and 2050, reaching a total of 1,843,049 persons (30). This is almost equivalent to the current population of the state of Durango, which was 1.5% of the country's overall population in 2020 (19).

The gender difference has remained pronounced throughout the time and appears likely to persist in the short and medium term (30), even though the standard rate of DALY for males in Mexico has been rising. This disparity may be due to the longer life expectancy of women, as well as specific biological mechanisms underlying AD and dementia that increase its risk and progression (7, 30, 44). However, the evidence is inconclusive, and, in some circumstances, the findings are inconsistent, therefore this hypothesis deserves additional investigation through clinical studies (44). Given the context of Mexico, it will be crucial to understand these differentials, considering, in addition, social and cultural determinants, as well as potential syndemic interactions between dementias and co-morbidities (chronic and mental), which often run in parallel (45–47).

Consequently, the effect of dementia, particularly AD, on the health indicators examined in this study offers a grim picture for the aging population. Evidence on the impact of plans and programs at the international level is scarce, making it more difficult to estimate the results and areas of opportunity for adapting strategies and using successful cases as a reference to assist other nations in implementing actions in the field of dementia. In contrast, organizations such as the WHO have a variety of models and tools (e.g. Mental Health Gap Action Programme) (48) that countries can use to develop strategies that are tailored to their political, economic, geographical, cultural, and social circumstances (13, 14, 25, 29).

According to this Organization, only a quarter of the world´s countries, half of which are in Europe, have policies, plans, or strategies to support people with dementia and their families. Many of these agreements, however, have expired or are soon to expire, and there are no clearly established methods to ensure their continuance or renewal (49). Meanwhile, dementia care initiatives in Mexico are scarce. Although the National Alzheimer Plan is available (13), not been prioritized in other national health programs, such as the Specific Action Program Mental Health and Addictions (50) and Specific Action Program for Aging Care (51), both from the 2020-2024 period.

Considering these findings, it is crucial to continue collecting statistical data at the national, state, and local levels to better understand and describe individuals with AD and other dementias. This requires standardizing, among other things, the criteria and methodologies used to obtain an accurate and comparable diagnosis (7, 9, 13, 30). In turn, this demands a national register of dementia patients that incorporate information on their social, clinical, and epidemiological situations and permits traceability in the use of health services, cost estimation, and longitudinal monitoring (13, 25).

This demands a strong commitment and cross-sectoral collaboration from the government, individuals with dementia, civil society, and families (3). Although there are no effective treatments for dementias yet, reducing risk factors such as body mass index (BMI), fasting plasma glucose, and smoking could have an influence on decreasing prevalence (30, 37, 52). In this sense, the promotion of healthy styles is key to promoting a life free of dementia, which could contribute to gains in life expectancy in older adults (21).

Study limitations

This study has limitations, some of which have been discussed previously (7, 30, 31, 36, 37). The most pertinent has direct bearing on the quality of the data used to calculate the various GBD indicators that may result from an underestimating of the illness burden, so the results should be interpreted with this consideration in mind since the GBD used information from diagnosed cases. McGrath et al. (53) found that only 1 in 10 older adults with cognitive impairment consistent with dementia (CICD) had been diagnosed with dementia.

According to GBD 2019 Dementia Forecasting Collaborators (30), major variations in the reporting of dementia prevalence and mortality between 1990 and 2019 can be linked to modifications in cause coding techniques (54). For example, Nichols and colleagues, identified 230 different ways to diagnose dementia through the evaluation of 237 studies that calculated the prevalence and incidence (7). Specifically, in Mexico, the prevalence of dementia also shows divergences according to the diagnostic criteria used (28). In their study, Farina et al. reported that the pooled DSM-IV prevalence was 4.7% overall, and 8.4% with the 10/66 pooled algorithm (27).

Another significant limitation of the GBD is that the category "other dementias" is not disaggregated, preventing us from determining the prevalence of causes

such as frontotemporal dementia, Huntington's disease, and Wernicke-Korsakoff syndrome, among others. More than one hundred subtypes of dementia have been found, both with and without cognitive impairment, and with a wide range of symptoms, making diagnosis even more challenging (55). Unfortunately, Latin America has much more knowledge gaps regarding these additional types of dementia (56).

Despite the above, the main strength of the study is that GBD offers up-to-date and standardized statistical data, which minimizes errors in calculations based on robust and reliable information. Additionally, GBD works on the permanent updating of dementia estimates in order to make them more robust, for which it includes the most recent available studies that meet the data quality criteria (7, 57).

Conclusion

Given that the number of older adults in the country will significantly rise over the next few decades, AD and other dementias represent one of the most important health challenges. The fact that epidemiological and demographic transformations take place in Mexico in a very diverse way makes it difficult for the country to adequately plan for the growing demands of both people with AD and other dementias and their families. Additionally, the health care system and social assistance programs are underfunded and underdeveloped, making it difficult to provide complete management of this conditions. Even though these issues are comparable to those encountered by high-income nations, the greatest obstacle for LMIC is the lack of human, material, and financial resources to sustain any long-term public policy. To lessen the burden of chronic diseases on future generations, there is a window of opportunity for action that must be taken.

Finally, more research on the policies implemented in various nations regarding AD and other dementias care is required to better understand which policies might work best in the national and local context. The funding of care and research, long-term services and support, health personnel training, health promotion and prevention, housing, community services like adult day care and senior centers, personnel policy and assistance for family caregivers, law enforcement, and protection of people with AD and other dementias should all be the subject of these research.

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