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Disability and its impact on life expectancy: heterogeneity across Mexican states

Emerson Augusto Baptista^{1*}, Tianyu Shen² and Vladimir Canudas-Romo^{1,2}

Abstract

Background The percentage of the world's population with disabilities is estimated to be 16%, although its distribution and intensity varies within nations. We aim to disentangle the degree and types of disabilities, estimate the years spent with more severe disabilities, and analyze their distribution across states and between sexes in Mexico.

Methods The Mexican Census of 2020 includes information on disabilities, which allows the study of its national distribution. We used life tables and the Sullivan method to calculate the number of years spent with disability (NYS) and its percentage with respect to life expectancy for each state and each sex.

Results In Mexico, the population with disabilities is estimated to be 16.5%. Of this total, 69% have milder disabilities, while the remaining 31% have more severe disabilities. At age eighteen, there is a higher NYS from more severe disabilities for females with 5.67 years (95% CI 5.66 to 5.69) as opposed to males with 3.66 years (95% CI 3.65 to 3.67). Across states, a more homogeneous distribution with lower NYS is observed for men (between 2.44 and 5.69 years) than for women (4.14 and 8.08 years). A north-south division can also be observed, with particularly notorious disadvantages among coastal states, which is more distinctive among women.

Conclusions This study shows that comparing the number of years spent with disability and the total life expectancy between subpopulations is essential for monitoring the well-being of aging populations, guiding policy decisions, and promoting a society that values and supports all individuals, regardless of their abilities.

Keywords Disabled people, Life expectancy, Number of years spent with disability, Mexico

Introduction

According to the World Health Organization (WHO), 16% of the world population, or 1.3 billion people, currently have some form of disability and this number is increasing [1]. Population aging and an increase in the prevalence of non-communicable diseases and mental health disorders are two of the factors contributing to

the increase in disabilities [1]. Censuses are used in many countries to collect data on persons with disabilities, particularly in developing countries. In recent rounds of world population censuses, the United Nations has recommended using a consistent set of questions on disability. The United Nations defines persons with disabilities as those “who are at greater risk than the general population for experiencing restrictions in performing specific tasks or participating in role activities” [2]. The 2020 Mexican Census followed the recommendations of the United Nations to identify the prevalence of disabilities and counted 21 million people with disabilities (16.5% of the total population) [3], very close to the international level [1].

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Disability is a complex and diverse concept that encompasses a vast range of conditions and limitations that can vary widely in terms of their severity and impact on an individual's daily life. This population includes people with functional limitations on basic activities, such as vision, hearing, or walking, even if assistive devices reduce such limitations [2]. For instance, individuals with milder disabilities may experience limitations in certain areas but are generally able to function independently with minimal support. Individuals with moderate disabilities on the other hand, have significant limitations that often require support and care. Lastly, people with more severe disabilities may face profound challenges and need constant assistance to meet their basic needs.

In recent decades, Mexico has introduced a series of public health interventions, such as the Universal Health Coverage program (Seguro Popular), conditional cash transfer programs, and more recently, free medication and social security programs, to help poor families with education, health, and nutrition expenditures [4–6]. However, these initiatives have not been enough to eliminate disparities in health across Mexico. For instance, of the seven Mexican states with the lowest life expectancies in 2022, all are in the southern region, with Guerrero having the lowest life expectancy of 73.6 years (females and males combined), while Mexico City in the central region has the highest (76.8 years). Disparities are also found between sexes, with Mexican females living six years longer than their male counterparts (78.4 and 72.6 years, respectively) [7]. In this study, we hypothesized that this spatial and gender heterogeneity in survival could also be found amongst people with disabilities.

Healthy life expectancy is a summary measure of health and morbidity used by researchers and public health officials to measure and compare population health [8]. It is a measure that reflects the number of years an individual can expect to live in good health without experiencing significant illness or disability, considering not only the length of life but also the quality of life. Normally, this is calculated based on surveys that address disabilities in great detail. However, the representativeness of all areas in a country can be an important component missing in surveys. The results of the 2020 Mexican Census allow the study of disabilities across Mexican states without the issue of representativeness at the state level. Furthermore, studies carried out in Mexico show that after the age of 60 years, women live longer, but men spend fewer years without disability [9–13]. Assessing the disability heterogeneity between states and between sexes is necessary to scale-up targeted programs to reduce such gaps.

This study has the following aims: (1) to disentangle the degree of different types of disability; (2) to estimate the years spent with more severe disabilities and their distribution across Mexican states; and (3) to compare the

years with more severe disabilities for Mexican females and males.

Methods

Data

Two sources of data are used in this study: the *Censo de Población y Vivienda 2020* and the statistics of deaths registered in 2020 [3, 14].

The Census recorded the following types of disabilities: vision, hearing, movement, remembering, bathing, and communicating. The population that replied positively to any of the disabilities was approximately 21 million, or 16.5% of the total population, with 1,110,969 women (53.3%) and 9,726,614 men (46.7%). Following the recommendations of the Washington Group for international reporting on dichotomous approaches [15], individuals with disabilities were classified by the degree of their impairment in a body structure as: (1) milder (“some difficulty”) and (2) more severe (“a lot of difficulty” and “cannot do at all”; see Supplementary Material 1 for the Census questionnaire). A category of “any disability” accounting for all six disabilities (vision, hearing, movement, remembering, bathing, and communicating) was created. Since an individual could have multiple disabilities, the degree of disability for “any disability” was determined by those having a more severe disability. For example, a person having milder hearing disability and a more severe disability in communicating would be classified as having a more severe disability in any disability. Data for Mexicans by age, sex, and location, as well as the type and degree of disability was extracted from the Census [3].

Additionally, the statistics of deaths registered in 2020 were obtained from the National Institute of Statistics and Geography [14]. All data was organized by single year of age up to age 99 and an open age-group 100 and more, sex, and state level (32 states).

Statistical analysis

Information on deaths and mid-year population by single year of age was used to calculate life tables for each Mexican state and each sex using standard demographic methods [16]. Number of years spent with disability (NYSD) were calculated using the Sullivan method, reflecting the combined effect of current levels of mortality and disability conditions [17–19]. NYSD is the average number of remaining years at a particular age that an individual can expect to live with disability.

The health-adjusted survival is defined as $l^*(x) = l(x) \pi(x)$, where $l(x)$ is the life table age-specific survivorship function at age x (or proportion being alive at this age from an initial birth cohort) and $\pi(x)$ denotes the corresponding proportion of those that are healthy. Similarly, the proportion of disabled people is

calculated as $1 - \pi(x)$. In this study, the focus is on calculating NYSD with more severe disability from any disability, as $NYSD = \int_0^\omega [l(x) - l^*(x)] dx$, with ω the last age attained in the population and the radix of the population as $l(x) = 1$.

Some of the disability census questions presented high levels of disability at early ages. This is likely an issue of interpretation, with those answering the census interpreting questions on abilities to move, bathe, and communicate. Thus, presentations of NYSD with more severe disabilities from any body structure were calculated for those aged eighteen and above. Finally, the percentage of NYSD with more severe disability with respect to the overall life expectancy at age eighteen were calculated for females and males across Mexican states. Confidence intervals were calculated for all life table measures by bootstrapping deaths, and for the years lived in more severe disabilities bootstrapping proportions disabled [20, 21]. All results presented were done in R [22].

Results

Figure 1 presents the age structures of the entire Mexican population as well as of people with disabilities (milder or more severe - black line) in 2020. The disabled population is concentrated at older ages, accounting for 42.0% of females and 39.3% of males among those aged 60 years and older. On the other hand, the pyramid of the general

population preserves its youthfulness, with 12.6% of females and 11.4% of males aged 60 years and older.

Figure 2 disentangles the population with disabilities into milder (yellow) and more severe (purple) categories by Mexican state and region. The three most prevalent disabilities: vision with 9.4% of the population, movement 6.6%, and hearing 3.8%; together with any disability (three above mentioned and remembering with 3.5%, bathing 1.7%, and communicating 1.5%) are presented in this Figure. In general, it is observed that milder represents 69% of all disabilities, while more severe disability corresponds to the remaining 31%. The highest percentage of people with more severe disabilities was observed in the southern region, followed by the northern region, and finally the central region. The southern region also contains the extremes of disability results: Oaxaca with the highest percentage of people with disabilities (19.2%), and Chiapas with the lowest (11.4%).

Table 1 presents the life expectancy and number of years spent with disability at different ages for Mexican females and males in 2020. The higher longevity for females than males is observed across the declining number of years of life expectancy over age. The NYSD declines with age, but their share of remaining life (%NYSD) increases over age. Apart from the country level life expectancy, Fig. 3 presents the geographic distribution of percentage of NYSD relative to life expectancy at age eighteen, %NYSD(18), by state and sex (NYSD

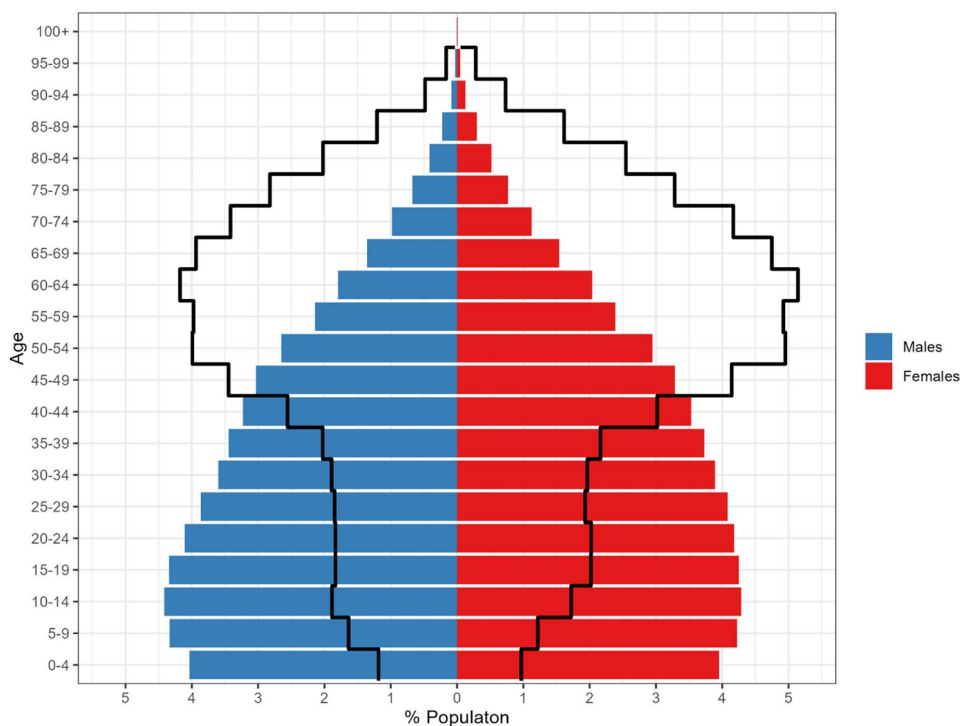


Fig. 1 Population pyramid for the Mexican general population and the population with disabilities (combining milder and more severe - black line) in 2020. Source: Mexican Census 2020 (INEGI, 2020a)

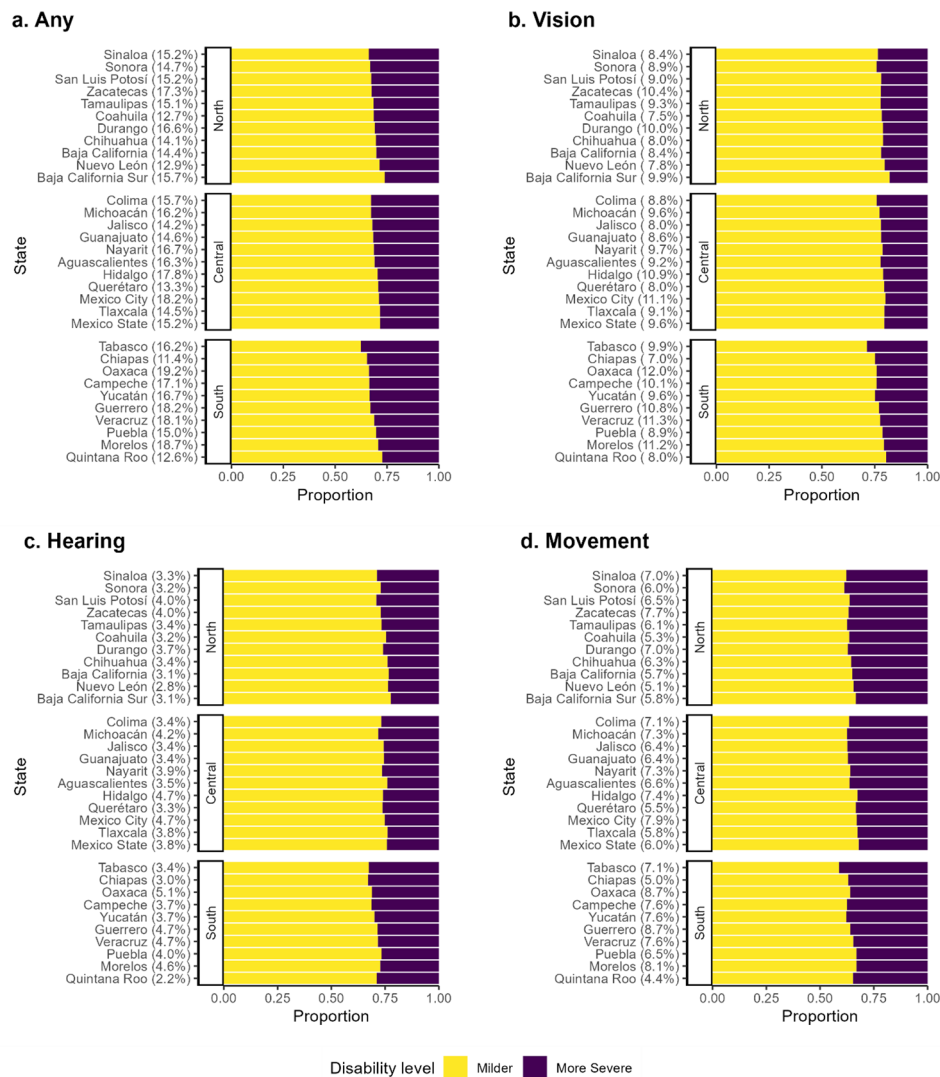


Fig. 2 Percentage of population with any disability (a), as well as with disabilities in vision (b), hearing (c) and movement (d), proportion of the population in parenthesis and subdivided by degree of disability (milder or more severe), for Mexican regions and states in 2020. Source: Mexican Census 2020 (INEGI, 2020a). Note: Ordered by “any disability” - panel (a), from the state with the highest more severe percentage to the lowest in each region

Table 1 Life expectancy - e(x), number of years spent with disability - NYSD(x), and percentage of life spent with any disability - % NYSD(x) - following the WG-SS recommended cutoff by age and sex, Mexico 2020

Age (x)	FEMALES			MALES		
	e(x)	NYSD(x)	% NYSD(x)	e(x)	NYSD(x)	% NYSD(x)
25	51.36 (51.33, 51.40)	5.57 (5.56, 5.59)	10.85 (10.83, 10.87)	44.02 (43.98, 44.05)	3.58 (3.57, 3.59)	8.13 (8.11, 8.15)
50	28.33 (28.30, 28.37)	5.25 (5.23, 5.26)	18.53 (18.49, 18.56)	23.38 (23.34, 23.41)	3.40 (3.39, 3.41)	14.54 (14.51, 14.57)
75	10.94 (10.91, 10.97)	4.35 (4.34, 4.37)	39.80 (39.73, 39.88)	9.08 (9.05, 9.11)	3.20 (3.18, 3.21)	35.21 (35.14, 35.29)
95	4.02 (3.98, 4.07)	2.98 (2.94, 3.01)	74.01 (73.68, 74.33)	3.77 (3.72, 3.82)	2.50 (2.46, 2.55)	66.45 (66.04, 66.89)

Source: Author's calculations based on Mexican Census 2020 (INEGI, 2020a) and statistics of deaths registered in 2020 (INEGI, 2020b)

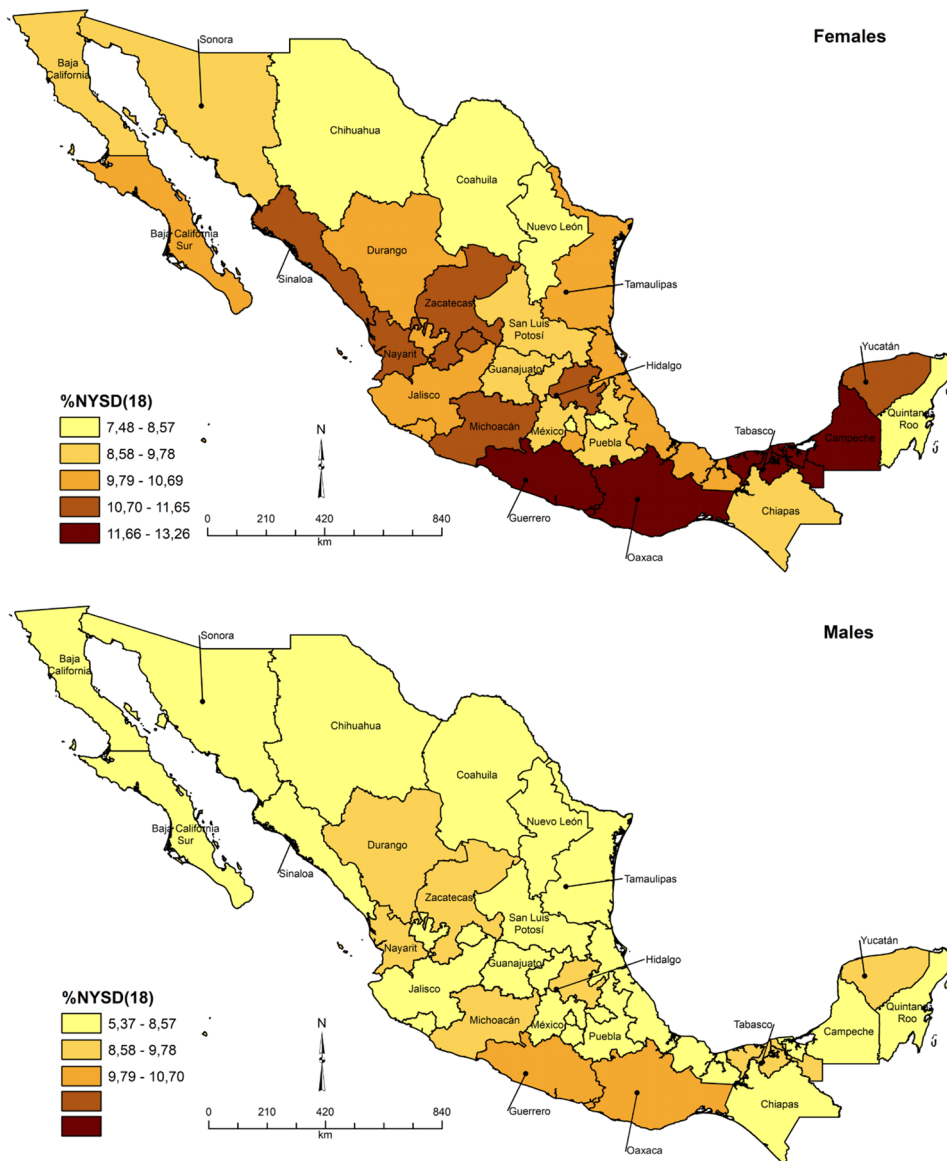


Fig. 3 Geographic distribution of the percentage of life years spent with more severe of any disability relative to life expectancy at age eighteen, %NYS(18), by sex for Mexican states in 2020. Source: Author’s calculations based on Mexican Census 2020 (INEGI, 2020a) and statistics of deaths registered in 2020 (INEGI, 2020b)

by sex, as well as other spatial results, are included in the Supplementary Materials 2 and 3). Males exhibit a more homogeneous distribution of NYSD, with much lower levels, than females. A north-south division can also be observed, with particularly notorious disadvantages among coastal states, with this being more distinctive among women. The gaps in life expectancy between females and males range from around 10 years in Mexico City to half of that in the southern state of Chiapas. However, the state of Guerrero and the southern state of Campeche have the largest female-to-male gaps in NYSD (2.72 years) and percentage of NYSD (3.43%), respectively.

Figure 4 presents the percentage of NYSD with more severe disabilities relative to life expectancy at age eighteen for vision, hearing, and movement disabilities, as well as for any disability by state and sex. As observed in the spatial results (Fig. 3), there are lower, and smaller, variations in the percentage of NYSD for men than for women. This is confirmed in Figs. 4a and b for each disability: vision ranging 3.22-6.11% for females and 2.26-4.94% for males; hearing 1.49-3.36% for females and 1.33-3.39% for males; movement 4.35-8.39% for females and 2.38-5.61% for males; and any disability 7.48-13.26% for females and 5.37-10.70% for males.

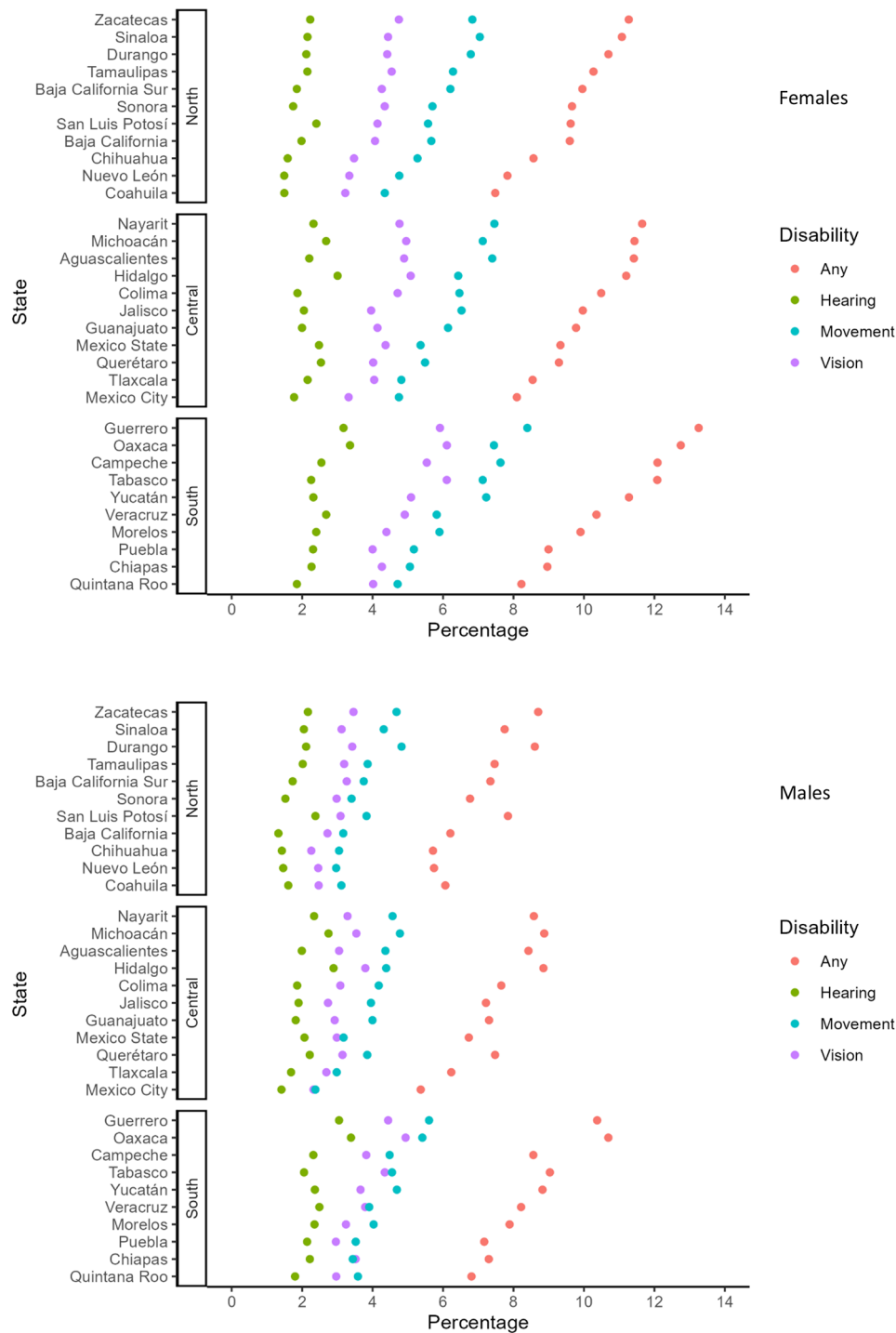


Fig. 4 Percentage of life years spent with more severe of any disability relative to life expectancy at age eighteen by sex, for Mexican regions and states in 2020. Note: States are ordered within each region from highest to lowest percentage of any type of disability for females. Source: Author's calculations based on Mexican Census 2020 (INEGI, 2020a) and statistics of deaths registered in 2020 (INEGI, 2020b)

Heterogeneity in NYSD and in its percentage relative to life expectancy at age eighteen is present in all regions. For women, the states of Zacatecas (NYSD 6.61 years with 95% CI 6.47 to 6.74) and Sinaloa (6.38 95% CI 6.29 to 6.48) in the north, Nayarit (7.06 95% CI 6.90 to 7.24) and

Michoacán (6.85 95% CI 6.77 to 6.93) in central Mexico, and Guerrero (8.08 95% CI 7.97 to 8.21) and Oaxaca (7.70 95% CI 7.61 to 7.79) in the south, are among the worst performers of percentage of NYSD with any disability. The same states, with Hidalgo (4.73 95% CI 4.66 to 4.81)

in central Mexico and Yucatán (4.69 95% CI 4.61 to 4.77) in the south, are among the worst performers for men. Among the best performers for women are Coahuila (4.14 95% CI 4.07 to 4.20) and Nuevo León (4.59 95% CI 4.54 to 4.65) in the north, Mexico City (4.49 95% CI 4.46 to 4.52) and Tlaxcala (4.86 95% CI 4.73 to 4.98) in central Mexico, and Quintana Roo (4.60 95% CI 4.49 to 4.71) and Chiapas (5.07 95% CI 5.00 to 5.14) in the south. Again, similar states, except for Chiapas, are found for men as the best performers, although the scale is lower. Added to these are Chihuahua (2.64 95% CI 2.60 to 2.68) and Baja California (2.89 95% CI 2.85 to 2.94) in the north.

Discussion

The 2020 Mexican Census reported 21 million people with disabilities (16.5% of the total population), which is very close to the international level [1], although very different from the 5.739 million (5.1%) recorded in the 2010 Census. This difference between Censuses likely arises from the questions used, with the former identifying whether individuals had disabilities, but not their degrees or magnitudes, unlike what is recommended by the United Nations [23]. In 2020, the Census followed the UN recommendations to identify the magnitudes of disability, therefore, instead of time trend analysis, our results focused on differentials across the magnitude of disability across Mexican states and between sexes.

The World Health Organization [24] Global report on health equity for persons with disabilities demonstrated that although some advances in terms of their rights have been made in recent years, people with disabilities are still neglected and disadvantaged. People with disabilities continue to die earlier [25, 26], experience more limitations in their daily activities, and have poorer health than the general population. Our results show that the disabled population in Mexico is concentrated at older ages, with 42.0% females and 39.3% males among those aged 60 years and older (Fig. 1). Disability and age are closely linked, in other words, aging leads to an increase in the prevalence of disability due to the lifespan accumulation of diseases, injuries, and chronic illness [27–29]. According to the United Nations [29], more than 46% of people aged 60 years and older have disabilities, compared to the lower prevalence in the Mexican results presented.

Many countries in Latin America and across the world have adopted the concepts of the Washington Group Short Set of Disability Questions in the census, developed to generate cross-national comparable disability data [15]. Hence, our results are in line with other studies, although proportions differ depending on the countries' aging level. The distribution of all disabilities for the Mexican population is 69% and 31% for milder and more severe disabilities. For Brazil, which has a population structure and health status comparable to Mexico, its

2010 Census showed that 77% of people with disabilities had milder severity, and 23% more severe [30]. However, for more developed populations and those that are more advanced in their aging process, the proportions change. In Canada, for example, among individuals with disabilities, 48% had milder disabilities, and 52% had more severe disabilities [31]. It is worth noting that milder disabilities are less clearly defined than more severe, which might justify the much higher percentages for these degrees of severity in some countries. This problem of comparability across populations can also be present within subnational populations in a country, thus, our selection of working only with more severe disability in the calculation of the number of years spent with disability.

Our research sheds light on the NYSD across Mexican states and between sexes. A north-south division is observed yet all regions show equal diversity in levels of NYSD and its percentage respect to life expectancy. Additionally, there is greater disparity between states for women. There is also a higher percentage of years without disability among males compared to females. Similar trends have been observed in studies on Activities of Daily Living (ADLs), with women having a greater number of problems and performing less well on health yet living longer (higher life expectancy) [12, 32–36]. For example, Beltrán-Sánchez and Andrade [12], focusing on older adults, estimated their total life expectancy and its decomposition into years spent disabled and disability-free for some sociodemographic-groups in São Paulo, Brazil, and urban areas in Mexico. They found that although women in São Paulo and urban Mexico showed higher life expectancy than their male counterparts, they were also expected to live a greater proportion of their lives with disabilities. Payne [33] estimated and compared current levels of disability-free life expectancy at age 65 for the U.S., Mexico, Costa Rica, and Puerto Rico. His results indicate that, across the four populations, men expect to spend about 10% more of their remaining life free of limitations in their ADL when compared with women. Additionally, Santosa and colleagues [34] describe the existence of gender inequality, with women enjoying longer lives than men, but with greater disabilities, a situation particularly stressed in Mexico.

Limitations of the study should be mentioned: (1) According to the WHO, “persons with disabilities die earlier ... than the rest of the population due to health inequities” [35]. However, the Sullivan method used in the study, assigns the same mortality for individuals with and without disabilities. A sensitivity analysis was carried out assigning higher mortality to individuals with disability compared to the rest of the Mexican population (see Supplementary Material 4). This increased mortality schedule for the disabled population reduced the NYSD. Thus, our results should be interpreted as an optimistic

scenario of reduced mortality for the disabled population which translates into increased NYSD. (2) Multiple disabilities are present in the Mexican population. However, in our estimates, each person is counted only once, and the degree of disability for any type of disability is determined by the most severe disability. Among Mexicans with total impairment in a body structure, 31.8% experience more than one disability. However, the different weights of each disability is an ongoing debate. As such, our results do not capture the NYSD with milder disabilities in the country, but accurately capture the NYSD for more severe disabilities. (3) We assumed homogeneity in types and degrees of disability by age, sex, and at the state level, but there may be important variations within states and among individuals, so this assumption can lead to specification errors [37]. Further research should investigate disabilities at the individual level (or for small geographical areas) to target proper interventions and close the existent disability-gaps still faced by this population. (4) Finally, this study does not incorporate risk factors associated with disability, such as genetics, lifestyle, diabetes, rural-urban residence, education, income, and other behavioral and socioeconomic characteristics.

Conclusion

In sum, this study has contributed to the knowledge of the demographics (sex and age) and geographic aspects of types and degrees of disability among Mexicans. This study shows that comparing the number of years spent with disability and total life expectancy between sub-populations is essential for monitoring the well-being of aging populations, guiding policy decisions, and promoting a society that values and supports individuals, regardless of their abilities.

Abbreviations

ADL	Activities of Daily Living
NYSD	Number of Years Spent with Disability
UN	United Nations
WG	SS-Washington Group Short Set of Disability Questions
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-20245-x>.

Supplementary Material 1

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Author contributions

EAB and VC-R contributed to the study design. EAB and TS performed the statistical analysis with advice from VC-R, and all authors helped interpret the results. EAB wrote the first draft, and all other authors revised the manuscript. All authors approved the final version of the manuscript.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to file size but are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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