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Descriptive Finding

Estimating centenarians in Mexico: Trends, geographic distribution, and data quality challenges

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Abstract

BACKGROUND
The number of centenarians worldwide has increased considerably since 1950. However, most demographic research on population longevity has focused on high-income countries. As a result, little is known about centenarians in low- and middle-income countries, such as Mexico.

OBJECTIVE
This study assesses the quality of demographic data sources on centenarians in Mexico over time, estimates their population size in 2010, and analyzes their geographic distribution.

METHODS
We used individual-level data from the census and vital statistics records from 1990 to 2023. Using the extinct cohort method, we estimated the population of centenarians alive in the 2010 census. To examine spatial distribution, we computed centenarian rates by state.

RESULTS
Our findings suggest an increase in the number of deaths occurring at ages 100 and over after 2000. We estimate that in 2010 there were 6,300 female and 3,600 male centenarians in Mexico, which is half the number reported in the census. The female-to-male ratio is lower than that in low-mortality countries. Southern states show higher centenarian rates than northern states, which could be associated with differences in age reporting.

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CONCLUSIONS
The number of centenarians has increased in recent decades, with marked differences in longevity and data quality across the country.

CONTRIBUTION
We provide evidence of the increase in the number of centenarians and improvements in data quality for their study in a middle-income country such as Mexico. In contrast to high-income countries, we found a lower female-to-male ratio, highlighting the need to expand research on population longevity and age reporting worldwide to better understand their heterogeneity.

1. Introduction

The number of centenarians in low-mortality, high-income countries has increased since 1950, as supported by high-quality demographic data (Robine and Cubaynes 2017; Vaupel and Jeune 1995). However, little is known about centenarians in middle- and low-income countries, although in some cases, age misreporting has been observed, especially in censuses (Gomes and Turra 2009). Mexico is a middle-income country that has experienced an accelerated demographic transition. Between 1970 and 2025, the total population grew from 52 million to 133 million, life expectancy increased from 60 to 76 years, and the total fertility rate declined from 6.5 to 1.9 children per woman, despite sizeable differences among Mexican states (CONAPO 2023, 2024). Previous studies on centenarians in Mexico are either outdated (Ham Chande 2005) or do not consider the implications of age misreporting (Chávez-Lango and Hernández-Lara 2021). To our knowledge, only one study has verified the age of centenarians in Mexico City (Valdés-Corchado et al. 2017). This study examines the data quality, size, structure, and geographical distribution of Mexico's centenarian population from 1990 to 2023 using national censuses and vital statistics.

One of the major challenges in studying centenarians is the overestimation of this group due to age misreporting (Jeune and Vaupel 1999; Maier et al. 2010; Young et al. 2010). Age misreporting in older age groups has been associated with (1) illiteracy (Preston, Elo, and Stewart 1999), (2) living in places with lower human development (Coale and Kisker 1986), and (3) religion, socioeconomic status, and community hierarchy (Kannisto 1999; Young et al. 2010). Low-mortality countries have reliable demographic data owing to continuous age validation through administrative registers. Such high-quality data have made it possible to build datasets such as the Human Mortality Database (HMD) and the International Database on Longevity (Maier et al. 2010, Maier, Jeune, and Vaupel 2021). However, most middle- and low-income countries

do not have age validation processes for vital statistics or censuses. Previous studies in Brazil have identified a recurrent overestimation of centenarians in the censuses (Gomes and Turra 2009; Nepomuceno and Turra 2020). In Mexico, the National Institute of Statistics and Geography (INEGI [Spanish]) has adopted international recommendations by the United Nations (UN) and the World Health Organization (WHO) to collect, conceptualize, classify, and standardize death statistics.

The prevalence of centenarians depends on factors such as the rate of (1) increase in births 100 years ago, (2) decrease in the effects of emigration, and (3) improvement in survival at older ages (i.e., 65 or 80 years) (Vaupel and Jeune 1995). Regarding their spatial distribution, in certain regions of the world, higher centenarian rates have been associated with residing in rural areas with fewer Western diets, lower prevalence of obesity, reduced risk of cardiovascular diseases, and higher levels of physical activity (Gavrilova and Gavrilov 2012; Montesanto et al. 2017; Pes et al. 2015; Poulain et al. 2004; Poulain, Herm, and Pes 2013; Roli et al. 2012; Rosero-Bixby, Dow, and Rehkopf 2013).

2. Data, measures, and methods

2.1 Data

We use individual-level data from censuses conducted in 1990, 2000, 2010, and 2020, along with death records from 1990 to 2023 (INEGI 2021, 2024). Censuses in Mexico are de jure and are collected every 10 years using face-to-face interviews with a key household informant who reports the characteristics of each household member, including age (in completed years). We use census microdata provided by INEGI (2022), particularly those prepared for this project. Individual-level mortality data were also published by INEGI. These data are generated from two complementary death certificates (*certificado de defunción* and *acta de defunción*), the issuance of which requires official photographic identification and the birth certificate (*acta de nacimiento*) of the deceased person. Vital statistics of deaths record the age (in completed years), month, and year of birth. Since 1998, these data have additionally included the day of birth. The *certificado de defunción*, provided by the Ministry of Health, contains epidemiological information on the deceased, including the cause of death determined by a physician, according to the ICD-10. The *acta de defunción* is the official document certifying death and is used to register the event in the civil registry. Of all analyzed deaths of the population aged ≥100 years between 1990 and 2023, 94% were certified and documented by a physician and 2% by civil or health authorities.

Finally, we compare our estimates with the latest official estimates published by the National Population Council of Mexico (CONAPO), also known as 'demographic conciliation,' which provides a historical reconstruction of the population dynamics from 1950 to the most recent census or intercensal count (CONAPO 2023, 2024). The strength of demographic conciliation lies in its comprehensive use of all available demographic data, including surveys, censuses, and vital statistics, combined with both direct and indirect methods to produce coherent estimates of mortality, fertility, and migration at the state and national levels, ensuring consistent and reliable population estimates. Although alternative methods for mortality estimation exist, demographic conciliation stands out for providing a complete reconstruction of Mexico's demographic dynamics since 1950, offering a robust foundation for analyzing long-term population trends.

2.2 Measures and methods

We described the size, age, and sex structure of the centenarian population using census and vital statistics data from 1990 to 2023. First, to assess age reporting among the oldest-old population and centenarians in the census, we used the Whipple index for the population aged 63 to 97 and 93 to 107 years, respectively. Based on Zeng and Vaupel (2003) and Wang et al. (1998), the Whipple indices for the oldest-old (W_O) and centenarian populations (W_C) are defined as follows:

$$W_O = 5 \cdot 100 \cdot \left(\frac{\sum_{k=0}^{6} N(65+5(k),t)}{\sum_{x=63}^{97} N(x,t)}\right) \quad (1)$$

$$W_C = 5 \cdot 100 \cdot \left(\frac{\sum_{k=0}^{2} N(95+5(k),t)}{\sum_{x=93}^{107} N(x,t)}\right), \quad (2)$$

where $N(x,t)$ denotes the population of age x at time $t = 1990, 2000, 2010, 2020$. A Whipple index less than 105 is considered highly accurate; 105 to 110, fairly accurate; 110 to 125, approximate; and greater than 125, rough or very rough.

Using vital statistics data on deaths from 2010 to 2020, we reconstructed the cohort of centenarians observed in the census using the extinct cohort method (ECM) (Vincent 1951; Wilson and Terblanche 2018).

The ECM reconstructs cohort populations by starting from the point of extinction (no survivors) and summing all recorded deaths backward to progressively younger ages. The cumulative sum of deaths at any given age was used to represent the cohort's population at that age. This approach is applicable only to cohorts that have completely died out and assumes that death records are complete and accurate, and that net migration is negligible. Mathematically, the population of a cohort c, that reached age x, is

calculated by $N_{x,c} = \sum_{i=x}^{\omega-1} D_{i,c}$, where $D_{i,c}$ are the number of deaths of the same cohort that occurred at each age i, for $i \in [x, \omega)$.

Because the year of birth is only universally available for deaths registered since 2009, we estimated the centenarian population only for the 2010 census, taking into account the exact age at death and census reference date. Based on the experience of other countries with exhaustive age validation processes (IDL 2025), we assume that this cohort virtually ceased to exist by 2020. To control for possible age misreporting in death statistics, we exclude records where the year of birth did not correspond to the age and year of death. To recover cases with missing months or days of birth, we assign a random date. We also compared this count estimation with the number of centenarians from the official demographic conciliation (CONAPO 2023).

Previous studies, primarily conducted in high-income countries, have consistently shown that female centenarians significantly outnumber male centenarians (IDL 2025; HMD 2025; Kestenbaum and Ferguson 2010; Ouellette et al. 2021; Saito, Ishii, and Robine 2021). To examine this pattern in Mexico, we computed the sex ratios (SR) of the centenarian population using raw data from censuses, death records, and our estimates.

Finally, we analyzed the spatial distribution of centenarians within the country using the centenarian rate (CR). The CR compares the population aged 100 years at time *t* with the population aged 60 years in year *t* – 40 (i.e., 40 years earlier) (Robine and Caselli 2005). Given the study period and data availability, we compare the population aged 100 to 109 years with the population aged 80 to 89 years 20 years earlier. This approach is appropriate because the global rise in centenarians has been linked to improved survival rates after age 80 (Vaupel and Jeune 1995), and because the modal age at death in Mexico was 86 for females and 84 for males in 2019. This method does not account for the impact of migration, as this event is rare among the oldest-old population. In Mexico, between 2015 and 2020, only 1.6% of individuals aged 80 years and older migrated to another state or from another country (INEGI 2021).

To estimate the CR for each of Mexico's 32 states in 2010, we used the number of centenarians derived from extinct cohorts and the population aged 80 to 89 years in 1990, based on official estimates from CONAPO (2023). Therefore, we computed the centenarian rates as follows:

$$CR^t = \frac{{}_{10}N_{100}^{t}}{{}_{10}N_{80}^{t-20}} \tag{3}$$

for $t = 2010$.

To assess the differences in longevity at the subnational level, we estimated logistic regression models relating the centenarian rate to the percentage of illiteracy among the

population aged 60 years and older and the Whipple index (among the population aged 63 to 97 years) across states.

3. Results

Census results indicate a sustained increase in the population aged ≥90 years since 1990 but a decrease in the number of people reported as centenarians since 2000 (Figure 1). Death records show a sustained increase since 1999, and since 2010, virtually all records have included a consistent year of birth.

The Whipple index for the oldest population indicates an improvement in age reporting in census data. In 1990 and 2000, age reporting among individuals aged 63 and older was rough and very rough, respectively, but by 2020, it was fairly accurate among those aged 63 to 92 years and highly accurate among the population aged 93 to 107 years. The Whipple index values by sex for the last age group are presented in Figure 2. This improvement is also visible in the age structure of the centenarians in the census and vital statistics, where age heaping has progressively diminished, and the reporting of extreme ages beyond 105 has also decreased, especially in death records (Figure 2).

Estimation from extinct cohorts (Table 1) suggests that, in 2010, there were approximately 6,300 females and 3,600 males aged 100 years and older alive, instead of the 11,200 and 7,200 recorded in the census, respectively. The difference between the census and estimations from death records was higher among men (0.50) than among women (0.56). For 2010, we estimate 22% more centenarians of both sexes than in the official estimates (Table 1).

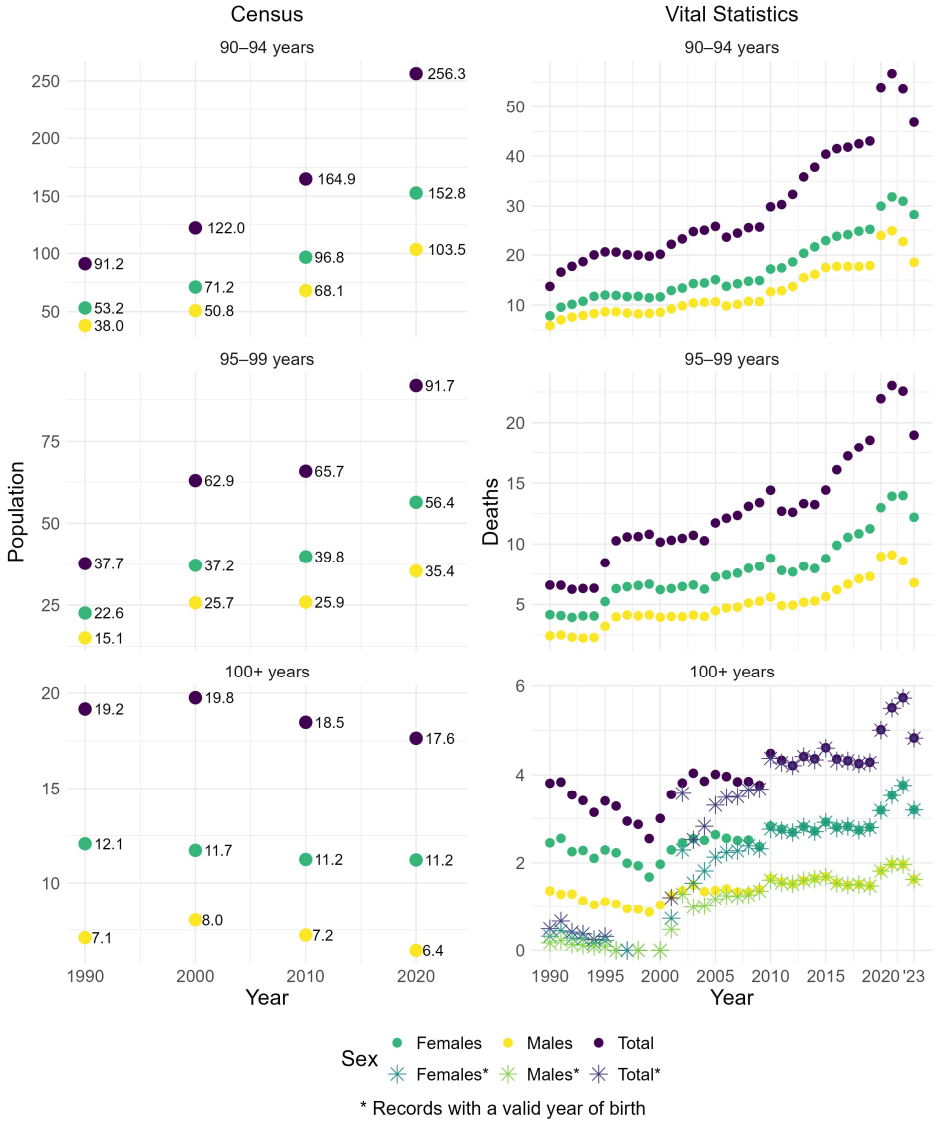
Table 1: Centenarian population: Census and estimates, Mexico, 2010

	Census (thousands) (1)	Estimates from deaths (thousands) (2)	CONAPO (thousands) (3)	(2)/(1)	(2)/(3)
Total	18.5	10.0	8.2	0.54	1.22
Female	11.2	6.3	5.2	0.56	1.22
Male	7.2	3.6	3.0	0.50	1.22

Sources: Census of Population and Housing 2010 (INEGI 2021); vital statistics of mortality (INEGI 2024); CONAPO (2023)

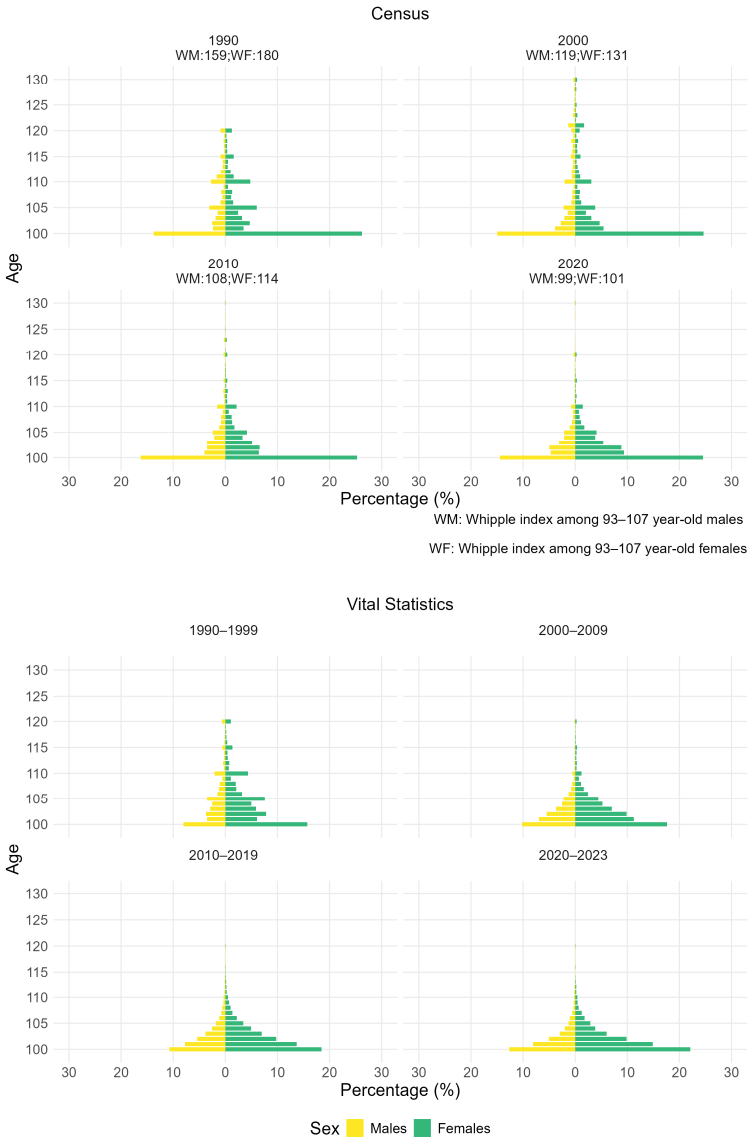
Regarding SRs, the data sources analyzed estimate nearly twice as many female centenarians as male centenarians, a pattern consistent across the different data sources. The SR in the census averaged 1.6, the average SR in the death records, including those with date-of-birth information, was 1.8, and the ratio from the extinct cohort was 1.7 females per male.

Figure 1: Size and sex of the oldest-old population in censuses and vital statistics of mortality, Mexico, 1990–2023



Sources: Census of Population and Housing 1990, 2000, 2010, and 2020 (INEGI 2021) and vital statistics of mortality (INEGI 2024).

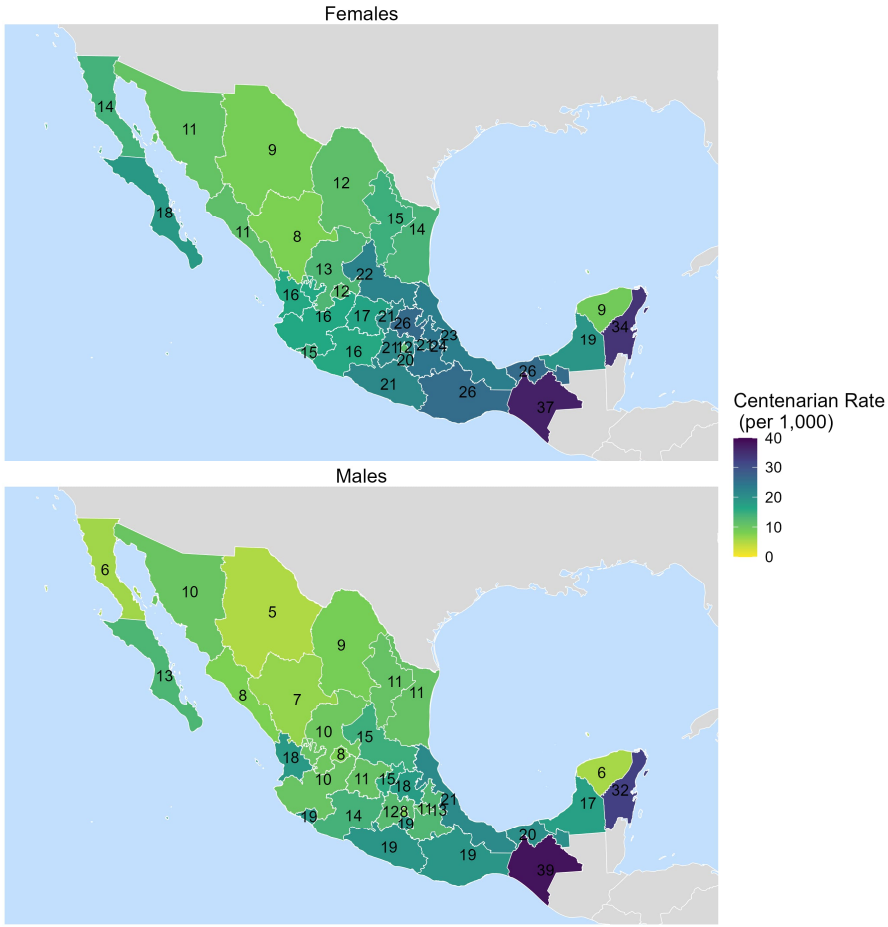
Figure 2: Sex and age structure of centenarians according to censuses and vital statistics, Mexico, 1990–2023



Sources: Census of Population and Housing 1990, 2000, 2010, and 2020 (INEGI 2021) and vital statistics of mortality (INEGI 2024).

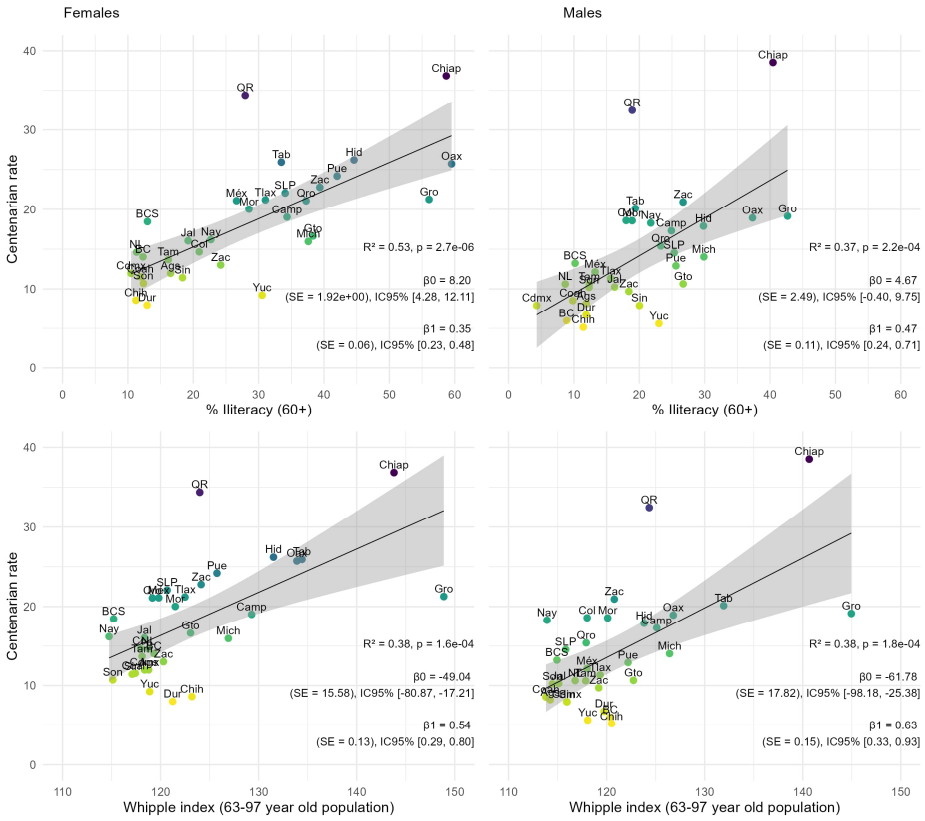
The spatial distribution of centenarians shows a clear distinction between the northern and southern regions of Mexico. Southern states have higher centenarian rates for both females and males, whereas northern states have the lowest rates. The central and western states show intermediate levels (Figure 3). Yucatán (eastern region) is the only southern state with very low centenarian rates. Regression analysis shows a positive association between centenarian rates, illiteracy, and the Whipple index.

Figure 3: Geographic distribution of centenarian rates by sex, Mexico, 2010



Sources: Vital statistics of mortality from INEGI (2024) and estimates of CONAPO (2023).

Figure 4: Centenarian rates against illiteracy rates and age misreporting by state, Mexico, 2010



Sources: Census of Population and Housing 1990, 2000, 2010, and 2020 (INEGI 2021); vital statistics of mortality (INEGI 2024) and CONAPO (2023).

4. Discussion

In this study, we analyze the main demographic data sources on centenarians in a middle-income country, such as Mexico, identifying an increased number of centenarians at the beginning of the 21st century. As in other Latin American countries, Mexican censuses may have overcounted the centenarians. Our estimate, derived by reconstructing extinct cohorts from death records with consistent birth-year information, indicates that the

number of centenarians alive in 2010 was approximately half (0.55) of that reported in the census. For 2010, we estimate 6,300 female and 3,600 male centenarians.

The evaluation of census and death records shows a consistent improvement in age reporting from 1990 to 2020 among older age groups, which translates into less digit preference in both data sources. In fact, the decline in the number of centenarians recorded in the census since 2000 can be explained by this improvement in age reporting.

The systematically lower number of centenarians estimated by CONAPO reflects methodological differences rather than data inconsistencies. CONAPO's demographic reconciliation is designed to produce internally consistent population estimates over long historical periods by jointly adjusting census data, vital statistics, and surveys using direct and indirect methods and model-based smoothing techniques, with particular emphasis on correcting age misreporting at older ages (CONAPO 2023). As part of this process, extreme ages are implicitly constrained through model-based smoothing, which tends to reduce the number of survivors at very old ages. In contrast, our extinct cohort estimates rely directly on individual death records with consistent birth-year information and are not subject to such regularization. Consequently, CONAPO's figures can be interpreted as conservative lower-bound estimates, while ECM-based counts may retain residual overstatement due to remaining age misreporting. This comparison delineates a plausible range for the centenarian population and highlights the sensitivity of extreme-age estimates to methodological choices.

The sex ratios in census data, vital statistics, and population estimates show a higher number of male than female centenarians compared with those reported for other countries in sources such as the Human Mortality Database and International Database on Longevity (2025). The comparatively low female-to-male ratio among Mexican centenarians could reflect differential patterns of age misreporting, potentially involving age exaggeration among men. However, our assessment of age heaping using the Whipple index at advanced ages suggests slightly better age reporting among men than among women. This pattern points to the alternative possibility that age underreporting among women may play a role, a hypothesis that warrants further investigation using data with individual-level age validation. Overall, differences in the reporting of deaths and ages by sex may affect the estimates of the number of centenarians in the country.

Age misreporting has been shown to contribute to underestimated mortality at older ages in Latin America, although no consistent evidence of sex differentials in age reporting has been documented (Dechter and Preston 1991). In addition, the levels of human development, particularly literacy, have improved over time in the region; therefore, other factors potentially associated with age reporting should be addressed. The consistency of sex ratios across different data sources in Mexico highlights the need for updated studies on sex differences in age reporting and survival in middle- and low-income countries.

Given that the number of centenarians depends on survival throughout the life course, especially after age 80, an alternative hypothesis is that the higher female-to-male ratios observed in other regions may not be universal. Instead, higher female mortality or lower male mortality may explain the lower ratio observed in Mexico. Evidence from Mexico and Costa Rica indicates that life expectancy among men aged 60 and older is higher than expected, given their socioeconomic and human development conditions (Rosero-Bixby 2018).

At the subnational level, the exploratory analysis correlating exceptional longevity with levels of illiteracy and age heaping may point in a similar direction to findings from other populations, where exceptional ages are associated with data quality issues (Coale and Kisker 1986; dos Reis and Turra 2015; Young et al. 2010). Despite improvements in death registration through the inclusion of birth certificates or official identification documents when recording deaths, further progress in the coverage and quality of these records is possible. For example, some individuals may obtain a birth certificate in adulthood or later in life, reporting an approximate date of birth that is difficult to verify.

Other possible explanations for the higher prevalence of people reporting exceptional ages should be addressed in the future. For example, in other regions of the world, lower levels of urbanization, lower prevalence of obesity, and higher levels of physical activity have been associated with greater longevity (Poulain, Herm, and Pes 2013; Rosero-Bixby 2018; Rosero-Bixby, Dow, and Rehkopf 2013). Indeed, some evidence suggests the existence of a reverse gradient, whereby higher life expectancy is associated with a lower socioeconomic status among older men in some Latin American countries (Rosero-Bixby 2018). Other factors, such as the higher concentration of Seventh-Day Adventists in the southern states and their association with healthy lifestyles and longevity, could also be explored (Butler et al. 2008; Gashugi et al. 2023).

We do not expect a single explanation for the differences in the distribution of centenarians; rather, we anticipate that different factors may explain these variations depending on the region. Therefore, we hope that this study of centenarians in Mexico will serve as a foundation for future multidisciplinary research that employs both quantitative and qualitative approaches to analyze the process of longevity and age reporting. Based on our findings, we believe that an in-depth validation process for a sample of centenarians is need, following the example of other countries (Kestenbaum 2021).

To our knowledge, this is the first study to analyze the size, structure, and spatial distribution of the centenarian population in Mexico while also assessing data quality. We highlight the improvement in demographic data on the centenarian population in a middle-income country and emphasize the importance of studying the oldest segments of the population. Reliable demographic data on the oldest individuals in Mexico would be especially valuable for studies of longevity, considering the potential size of the

centenarian population in a country with 131 million inhabitants. We hope that our findings will inspire future studies in middle- and low-income countries, helping to shed light on the different processes underlying population longevity.

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