Trends and Effect of Marginalization on Diabetes Mellitus-Related Mortality in Mexico, 1990-2019

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Abstract

Globally, diabetes mellitus (DM) is one of the leading causes of mortality. However, this behavior may differ over time for countries given their intrinsic factors. The objective of the study is to characterize the trend and assess the potential effect of marginalization on DM mortality during 1990-2019 in Mexico. We analyzed death certificates where DM was listed as the underlying cause of death (N=1,907,173) and the extent to which DM mortality changes, were associated with marginalization from an age-period-cohort analysis. DM mortality has increased for Mexico in the 1990-2019 period, this change was faster in the first half of our study and slowed after 2004. The highest marginalization quintiles drove the changes in DM mortality trends during 1990-2019 in Mexico, with higher risk of dying in these quintiles with aging than the lowest. In the most recent cohorts, the highest marginalization quintiles showed twice the risk of dying from DM than the lowest. Renal complications were the leading cause of death in persons with DM during 1990-2019, with a marked increase since 1999-2001. In conclusion, Mexico continues with a very high DM mortality, but this has slowed over time, and subnational differences in the marginalization can partially explain this trend.

Introduction

Around 451 million adults lived with diabetes mellitus (DM) worldwide in 2017, a 8.7% increase compared to 2015. [1–2] These numbers are expected to increase by 53.7% by 2045.[2] In 2017, there were 5 million deaths from DM around the world, of which a third occurred in people under the age of 60.[2] According to the International Diabetes Federation 2019, Mexico is one of the countries with the highest prevalence of DM and is expected to remain high for the next 3 decades.[3–4] Another worrisome feature is the high and increasing diabetes mortality in Mexico, in 2016 DM ranked the top cause of death for women and the second cause for men in Mexico, especially in the northern states of Mexico.[5–6] Furthermore, DM has great economic repercussions. In 2019, Mexico was the sixth country with the highest total spending on health due to DM with ~\$17 billion USD.[3]

The prevalence of DM in Mexico has increased steadily over the last few decades. According to the National Health and Nutrition Surveys of Mexico (ENSANUT), the prevalence of diagnosed DM has gone from 7.5% in 2000 to 10.3% in 2018.[7–10] Data on diabetes incidence in Mexico is scarce,[11] still, due to the relationship between incidence, prevalence, and mortality, the increasing mortality and prevalence, suggest that incidence is increasing concurrently. Since the increase in mortality and prevalence has been constant and significant, it suggests that longevity in people with diabetes mellitus is not enough to maintain these trends, being necessary the involvement of a marked incidence.

Previous characterizations of the national trends in DM mortality in Mexico are limited to short periods, did not explore the potential drivers of these trends, and did not examine sub-national variations. Mexico is a very heterogeneous nation, with different levels of development and urbanization (marginalization).[12–13] Given the importance of these factors in determining diabetes and the prognosis, understanding the sub-national DM mortality trends in Mexico, should inform policies and resource allocation, and warrants further research.

We aimed to examine the extent to which DM mortality rates and changes, were associated with population-level characteristics through marginalization.

Results

There were 1,907,173 deaths due to DM between 1990-2019. Of those, 24,461 (1.28%) were excluded for a mismatch between the reported and calculated age (most [82.64%] excluded deaths occurred from 1990 to 1995). Of the 1,882,712 included DM deaths (1990-2019), 26.66% were of people younger than 60; with a mean age of death of 67.55 years (standard deviation [SD] $\pm$ 13.55).

At the national level, from 1990-92 to 2017-19, the age-adjusted DM mortality rate increased from 49.80 (95% confidence interval [CI] 49.42-50.17) to 88.23 (87.92-88.55) deaths / 100,000 inhabitants: a 77.17% increase in that period. There was an inflection point at 2002-04. The average percent increase was steeper from 1990 to 2004 (15.5%, 95% CI 10.2–21.1%) than from 2002 to 2019 (0.9%, -1.1–3.1%). Men had a higher burden age-adjusted DM mortality compared with women from 2017-19 (94.8 vs 82.3/100,000); Although, both sexes experienced similar rates of increased mortality over time with an slower increase after 2004 for women and 2007 for men. The highest burden of age-adjusted DM mortality as the first cause mentioned in the death certificates in 2017-19 was renal complications (25.7/100,000), followed by acute and circulatory complications (5.7 and 1.4/100,000 respectively). Only the renal complications shown a inflection point after 2001, with an average annual percentage change (AAPC) of 1.4% (95% CI -8.4–12.3%). While the acute complications experienced an decreased trend (-4.9%, -7.9% to -1.8%) and the circulatory an increased trend (6.6%, 0.8–12.8%) for the 1990-19. Table 1 and Figure 1.

Table 1
Mortality rate and annual percentage change for diabetes mellitus in Mexico. *

Mortality Rate		First APC		Second APC		
	1990-92 [95% CI]	2017-19 [95% CI]	Period **	APC [95% CI]	Period **	APC [95% CI]
National	49.80 [49.42-50.17]	88.23 [87.92-88.55]	1990-2004	15.5 [10.2 to 21.1]	2002-2019	0.9 [-1.1 to 3.1]
By complication						
Acute	7.83 [7.68-7.98]	5.75 [5.67-5.83]	1990-2019	-4.9 [-7.9 to -1.8]	-	-
Renal	0.08 [0.06-0.09]	25.71 [25.54-25.88]	1990-2001	375.1 [-94.7 to 42300.1]	1999-2019	1.4 [-8.4 to 12.3]
Circulatory	1.06 [1.01-1.12]	1.39 [1.35-1.43]	1990-2019	6.6 [0.8 to 12.8]	-	-
Sex						
Men	47.16 [46.63-47.70]	94.81 [94.33-95.29]	1990-2007	14.2 [10.5 to 18.0]	2005-2019	1.4 [-1.4 to 4.3]
Woman	51.81 [51.29-52.33]	82.26 [81.85-82.67]	1990-2004	14.4 [9.5 to 19.5]	2002-2019	-0.8 [-2.8 to 1.1]
Marginalization	1990-94 [95% CI]	2015-19 [95% CI]	Period **	APC [95% CI]	Period **	APC [95% CI]
Very low	72.06 [71.23-72.89]	83.69 [83.14-84.24]	1990-2009	10.8 [8.5 to 13.2]	2005-2019	-8.7 [-11.4 to -6.0]
Low	56.78 [56.24-57.33]	89.64 [89.19-90.09]	1990-2004	26.1 [-40.6 to 167.9]	2000-2019	0.1 [-20.4 to 25.9]
Medium	40.70 [39.58-41.85]	92.67 [92.04-93.29]	1990-2019	9.6 [1.9 to 17.9]	-	-
High	43.60 [43.02-44.19]	97.04 [96.51-97.57]	1990-2004	37.0 [-19.9 to 134.3]	2000-2019	7.0 [-6.3 to 22.0]
Very High	38.61 [38.12-39.11]	91.01 [90.22-91.81]	1990-2019	16.6 [10.6 to 23.0]	-	-
Abbreviations: APC, Annual Percentage Change; CI, Confidence Interval						
* Because it was categorized into periods, the first and second APC is overlapped at the end and the beginning of the period where the inflection point was found. Since the start of the second APC is at the beginning of the period where the inflection point is found, and the first APC ends at the end of the period where the inflection point is found.						
** The two annual percentage changes are marked that mark the beginning and end of each period until presenting the turning point.						

There was wide heterogeneity in the mortality rates across states (Figure 2). We identified three different patterns in the mortality rate trends: 1) sustained increase (last annual percentage change [APC] CI was positive and $P<0.05$); 2) early increase, late decrease (last APC CI was negative and $P<0.05$); and 3) early increase, late plateau (last APC CI

include the zero value and $P \geq 0.05$). For the acute complications as the first cause in the age-adjusted DM mortality there are twenty and twelve states as second and third pattern; Although, the renal and the circulatory complications don't shown a states with the second pattern, they present three and seven states in the first pattern respectively. Finally, the renal complications shows a wide range in the AAPC for the whole period at state level.

At national level in the marginalization quintiles (Table 1 and Supplementary Figure S1) the highest burden of age-adjusted mortality due to DM was seen in very low quintile (72.1/100,000), and the lowest was the very high quintile (43.6/100,000) in the period 1990-94, but in the period 2015-19 the highest was the high quintile (97.0/100,000) and the lowest was the very low quintile (83.7/100,000). The marginalization trends have several important findings. Firstly, the medium and very high quintile don't showed a inflection point, the AAPC for the very high quintile (16.6%, 95% CI 10.6–23.0%) was greater than the medium quintile (9.6%, 1.9–17.9%). Secondly, the mortality in the high and low quintile experienced a stable ascend after 2004 (7.0, -6.3–22.0%; and 0.1%, -20.4–25.9% respectively). Thirdly, the very low quintile were the only quintile with an improvement in mortality, experiencing a consistent decrease of -8.7% (-11.4% to -6.0%).

To better delineate the worsening trends in mortality from DM across the country and for the marginalization quintiles, we show in a series of heat maps (Figure 3) the death rate at state level due DM over the time. We also present the AAPCs by quintile of marginalization and state. The states with the greatest AAPCs as the same states in the very high quintile, Chiapas (15.2%, 10.5–20.0%), Oaxaca (13.4%, 11.5–15.3%) and Guerrero (13.2%, 9.9–16.6%). While, the three states with the smallest worsening are those in the low or very low quintile, Baja California Sur (1.50%, -1.60–4.80%), Sonora (1.30%, -2.10–4.90%) and Ciudad de México (0.80%, -0.80–2.50%). Finally, the increase in the AAPC experienced an almost perfect positive correlation with the marginalization index at the state level.

Age-period-cohort analysis for DM mortality by lowest (very low and low) and highest (medium, high and very high) quintiles of marginalization show the following findings (Figure 4). Firstly, with the increase in the age they following a greatest mortality by DM; the lowest quintiles reach the mortality value of 1/100,000 at youngest ages than highest quintiles (28 vs 32), for the 60 years the lowest had relatively higher mortality from DM than the highest quintiles (121.2 vs 99.3/100,000), but at the 80 years the mortality for the highest its more than the lowest quintiles (617.1 vs 519.8/100,000), Supplementary Table S1. Secondly, compared with the lowest the highest quintiles obtain a greatest rate ratio for the same birth cohorts in the time after the 1939 birth cohort (cohort in which the quintiles of marginalization equals one in rate ratios), e.g; birth cohort of 1950 (rate ratio 1.25, 95% CI 1.25-1.26 highest vs 1.08, 1.07-1.09 lowest), 1965 (1.86, 1.83-1.88 highest vs 1.26, 1.25-1.28 lowest), and 1980 (2.94, 2.86-3.02 highest vs 1.52, 1.48-1.56 lowest), Supplementary Table S2. Thirdly, the period effect don't show a wide differences in the rate ratios by marginalization quintiles, but after 1997 the mortality in the highest quintiles show a little mayor difference that persist until 2003 over the lowest quintiles. In the year 2002, where a inflection point finding at national level, the period effect are greatest for the highest quintiles compared with the lowest quintiles (1.12, 1.11-1.13 vs 1.08, 1.07-1.09), Supplementary Table S3.

Finally, the time-dependent mortality rates for the interaction highest and lowest quintiles of marginalization show a greatest mortality for the highest quintiles until the age of 78 years, reaching an mortality rate ratio for DM of 1.29 (95% CI 1.26-1.32) at the age of 98 years (Figure 4). However, highest quintiles of marginalization had about a 11% less mortality of DM than lowest quintiles across the 1990-2019 in Mexico when adjusting for age, birth cohort and period.

Discussion

DM mortality has increased dramatically over time the last 30 years in Mexico. However, these trends are temporally and geographically heterogeneous. First, while mortality has increased for Mexico in the 1990-2019 period, this change was faster in the first decades of our study and slowed after 2004, with the renal complications as the main cause reported in the death certificates. Second, both the rate of change and the temporal patterns themselves differ widely by geography. We found a discrepancy in the age-period-cohort analysis by marginalization quintiles with a poorest outcomes for the people in the highest quintiles, and a correlation between the marginalization index and the trends who can explain in part the change in geography and the high mortality for DM in Mexico.

At the international level, different countries have reported a decrease in their mortality rates from DM, such as the United States, Brazil and Spain. Such decreases have been attributed to the improvement in the care systems of this population, and greater control of their disease and the different risk factors associated with it.[14–16] In contrast, in Mexico there are poor levels of DM control (only 22% of patients with glycated hemoglobin [HbA1c] <7%),[17–18] suggesting no improvement in DM management. Moreover, previous studies found that Mexicans with diabetes had higher HbA1c levels compared to other countries (9% in Mexico vs. 7.08% in the United Kingdom),[19–20] and the Mexican surveys using HbA1c have found little differences in DM control across states (e.g. Tabasco and Mexico City, 22.73 and 24.00% respectively, Supplementary Table S4).[18] On the other hand, data using longitudinal assessments of HbA1c in Mexico City has shown that diabetes control has improved over time, going from an average HbA1c of 8.3 to 7.2%, in 1998-2004 to 2015-2019.[21] These results can extrapolate to the other states in the very low and low marginalization quintiles, given the characteristics shared by these states, such as greater access to medical services, implying the decrease observed here for this states in the mortality by DM.

Our findings regarding monotonic increases in diabetes mortality in eight states are consistent with increasing prevalence of diabetes (e.g., Tabasco, a state with steady increase in DM mortality had a DM prevalence of 6.2%, 9.4% and 12.1%, in 2006, 2012, and 2018, respectively).[8–10] A potential explanation for this phenomenon is that the states that had increased mortality and prevalence, are those in the highest marginalization quintiles with a limited access to health systems and preventive education for diseases. On the other hand, states that had more stable mortality rates and prevalence (e.g., Mexico City: 8.9%, 12.3% and 12.7%, for 2006, 2012, and 2018, respectively)[8–10] are those in the lowest marginalization quintiles. In summary, the discrepancy between trends in mortality and prevalence, can be partially explained by different stages of the demographic conditions (e.g. education, incomes). Other potential explanations include differences in the prevalence of DM risk factors, leading to different incidence. However, studies to support these hypotheses are lacking.

The age-period-cohort analysis evidence that the recent birth cohorts compared with the reference cohort are a mayor risk of die for DM, and in this context the highest marginalization quintiles present two fold mayor risk of death than the lowest quintiles, likewise, the aging course has a significant effect on DM mortality regardless of marginalization quintile. This can be explained by the increase in life expectancy with a higher risk of developing DM and dying from it as one gets older; and the effect on birth cohorts for the increase in other diseases in recent years in Mexico that are considered important risk factors for the development of DM and death from it (e.g. obesity).[22]

Finally, it is important to mention that the main cause of death in people with DM in Mexico is the renal complications, coinciding with what was reported in the Mexican cohort study.[20] While, other countries report the cardiovascular complications as the first cause.[23] Therefore, it is necessary to conduct research in Mexico to discern whether deaths due to renal complications are really due to or with them in this population, since a constant increase in circulatory complications was found, and these may act as a indicator for a very likely greater presence of cardiac complications.

This is the first article showing evidence of a decrease in DM mortality in Mexico in recent years; however, it is worth noting the presence of eight states with a clear increase in their trend up to 2019. This has great implications for the health system. Decision-makers in these states should consider the application of screening at earlier ages and the strengthening of institutional programs focused on the management of DM. For states that experienced a decrease in DM mortality, we emphasize that such decrease might only reflect demographic measures, and other indicators should be identified when evaluating the state's DM control programs.

The main strength of this study is the richness of the data, with over 1.8 million DM deaths for 30 years, and the possibility of evaluating other variables of interest such as age and the marginalization. The reliability shown by death certificates in Mexico stands out. When performing a sub-analysis in the same period of the 15,527,101 deaths that occurred, only 1.71% were considered due to conditions not classified elsewhere (chapter R of the International Classification of Disease [ICD]). Moreover, the quality of mortality coverage in Mexico is very good.[24] The above implies that in general in Mexico it is possible to determine a cause of death and few DM deaths would be missed in our analyses.

Our study has some limitations. First, the potential misclassification of the underlying cause of death; despite death certificates being filled by trained personnel, there is the possibility that the underlying causes of death may not be properly recorded. We observed a drastic decrease in DM mortality in 2018-2019, this sharp decrease was not coherent with the trends we observed for the previous years. However, the decrease was consistent across all states. To smooth these potential year-to-year variations, we grouped deaths by triennia. Another reason behind the decline in DM deaths is the large number of violent deaths in Mexico (36,685 occurred in 2018 alone),[25] which may act as a competing risk. Second, despite considering that the marginalization shows an effect on the time trend obtained, it must be emphasized that this is based on statewide parameters, which may not be entirely accurate for all population in each one of the states. Last, this is an ecological study, which does not allow making inferences at the individual level. However, our key objective was assessing contextual trends at the national and state level.

In conclusion, Mexico continues to be a country with a very high DM mortality, amongst the highest in the world (Supplementary Figure S2).[26] Given current trends, it seems plausible that diabetes mortality will decline in the following years, given current stagnation and even decline in some states. However, a number of states still show continued increases and have renal complications as the leading cause of death, representing an opportunity for population-level diabetes prevention strategies. We observed that marginalization drove these trends, but we could not rule out other aspects, including changes in diabetes control or incidence, warranting future studies.

Methods

Study design and Setting

Ecological epidemiological study of the temporal trends of DM mortality rates in Mexico from 1990 to 2019. The data were obtained from the vital registration system of the National Institute of Statistics, Geography and Informatics (INEGI).

Outcomes

The main outcome of our study was all registered deaths in which DM, or its complications, were listed as the underlying cause of death. From 1990-1998, Mexico used the ninth revision of the ICD; during this period code 250 was used to identify DM deaths, and for specific complications the following extended codes: 2501-2502 (acute), 2504 (renal) and 2507 (circulatory). For the period 1999-2019, Mexico used the ICD-10, and the following codes were

used: E10 to E14; and for the specific complications the following number was added to the previous codes: 0 and 1 (acute), 2 (renal) and 5 (circulatory).[27–28] The cause of death is determined by trained personnel (includes physician and government licensed personnel) at the community and hospital level at the time of death.

As a quality control strategy, we excluded deaths certificates if the age reported and the age calculated from their date of birth did not match (acceptable margin of ± 1 year of difference).

Marginalization index

To investigate the extent to which changes in demographic and economic characteristics were related to DM mortality rates and trends, we used a set of population measures representing level of marginalization.

The marginalization index at the state level were calculated in 1990, 1995, 2000, 2005, 2010 and 2015 by the Mexican National Population Council (CONAPO), obtaining quintiles of marginalization (very low, low, medium, high, and very high [states with less resources]). Briefly, the marginalization index is calculated based on the level of access to resources in four domains: education (% illiterate, %without primary education), housing (% of people living in houses without proper sewage system, electricity, potable water, overcrowding, dirt floor), population size (<5,000 residents), and income (% of employed residents with a daily income < \$140.20 MX pesos [$\sim$ \$9.63 USD]). In 2015, of the 32 Mexican states, 10 were in a very high and high, and 4 in very low marginalization quintile.[29]

We merged the INEGI's vital registry datasets with CONAPO's marginalization datasets using a common and unique identifier assigned to each state. The level of marginalization was assigned to each death according to the last state of residence. All deaths were linked correctly.

Statistical Methods

We conducted this analysis in four steps. First, we computed crude and age-adjusted mortality rate due to the specific and total causes of DM, with her respective 95% CI over 3-year periods from 1990 to 2019, for the whole country and by state using formulas developed by Tiwari, Clegg, and Zou.[30] As denominators, we used population projections and intercensal estimations of the total population by age, sex, and state from 1970 to 2050, published by CONAPO.[31] For the age-adjusted mortality rates, we used the 2000-2025 WHO world standard population.[32]

Second, to characterize changes in the age-adjusted mortality trends due to the specific and total causes of DM for the 32 states of Mexico, we pooled state trends into 3-year periods. We computed APC, AAPC, and their 95% CI using the Joinpoint Regression Program, version 4.7.0.0.[33] Findings in the joinpoint at $P < 0.05$ were considered significant.

Third, we compared the national and state level crude and age-adjusted DM mortality rate by marginalization quintiles. The mortality rate by marginalization quintiles was estimated by five-year periods for each state (e.g., 1990-1994) to match with the calculation of marginalization by the CONAPO. As the same in the previous step, they was estimated the APC and AAPC for the mortality trend by state and marginalization quintiles. Likewise, we evaluated the correlation with AAPC and marginalization index by state at national level.

Fourth, we performed an age-period-cohort analysis for the marginalization-stratified by lowest (low and very low quintiles) and highest (medium, high and very high quintiles). This analysis was performed using the method proposed by Carstensen, with the advantage to analyze the effects as continues variables avoiding the overparameterization and, consequently, the exclusion of one of the terms with the use of the Lexis diagram and restricted cubic splines to model the three variables, facilitating interpretation, estimation and forecasting.[34] The

outcomes were evaluated are mortality rates, rate ratios and mortality rate ratios due to DM, and their 95% CI were generated.

Analyses were conducted in Stata (StataCorp LLC, USA), version 15.1, or with the Joinpoint Regression Program, version 4.7.0.0. Joinpoint analysis (<https://surveillance.cancer.gov/joinpoint/>) determines the inflection points in the trends, from the APC or slope between three or more measurements using piecewise linear regression. A maximum of one joinpoint was stipulated for this study. The figures were elaborated with the following programs: Stata, version 15.1; Microsoft office Excel; and R, version 3.6.3.

The protocol was approved by the Ethics and Research Committees of the Faculty of Medicine at National Autonomous University of Mexico with project number: FM/DI/031/2020. Neither written informed consent nor patient consent was requested, since we worked with open mortality databases provided by the Mexican Government, with the consequent censorship of personal information in each record.

Declarations

Contributors: EGL carried out the analysis, and prepared the appendix. EGL, RAES, PMA, UB, ML and ROG drafted the initial manuscript. EGL and RAES oversaw database construction, assessed, compiled and updated the database. All authors interpreted and reviewed model results, edited the manuscript and agreed on the final version of the manuscript.

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Data availability statement: Data are available in a public, open access repository. All data relevant to the study are included in the article or uploaded as online supplemental information.

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Figures

Figure 1

Trends in age-adjusted mortality rates for diabetes mellitus and for specific complications recorded as primary cause in Mexico, 1990-2019.

The age-adjusted DM mortality rate for specific complications registered as a primary cause in Mexico from 1990-2019 is shown, with respect to the national rate (Panel A). Likewise, the age-adjusted mortality rate for deaths registered as a primary cause of renal complications (Panel B), acute complications (Panel C) and circulatory complications (Panel D) due to DM are presented in a smaller range of the Y-axis. Data markers represent observed rates by triennium; lines are fitted rates by triennium based on joinpoint analysis.

Abbreviations: DM, Diabetes Mellitus; AC, Acute Complications; RC, Renal Complications; CC, Circulatory Complications.

^a Age-adjusted mortality rates are shown per 100,000 population. ^b The dotted lines indicates the inflection point in the trend.

Figure 2

Trends and AAPC for diabetes mellitus specific complications recorded as primary cause at the state level in Mexico, 1990-2019.

We show the AAPC in each of the states of the Mexican Republic for DM mortality where the primary cause of recorded was renal complications (Panel A), acute complications (Panel B) and circulatory complications (Panel C) during 1990-2019. Trends in last APC are showed by colours for each state.

Abbreviations: DM, Diabetes Mellitus; APC, Annual Percentage Change; AAPC, Average Annual Percentage Change.

Figure 3

Age-adjusted mortality rates at the state level, and correlation for the AAPC of diabetes mellitus mortality and marginalization in Mexico, 1990-2019.

Panel A presents the age-adjusted mortality rate for DM by states of the Mexican Republic categorized by quartiles during the periods 1990-1992, 2002-2004 and 2017-2019. Likewise, it shows the AAPC by states categorized by marginalization quintiles (Panel B); and the scatter plot of the respective state AAPC with respect to the marginalization index of each one during the 1990-1994 period, states that showed a significant trend ($p < 0.05$) in their last APC were labeled with their name (Panel C).

* States that predominated in the very low marginalization quintile throughout the period; ☒ States that predominated in the very high marginalization quintile throughout the period.

Abbreviations: DM, Diabetes Mellitus; APC, Annual Percentage Change; AAPC, Average Annual Percentage Change.

Figure 4

Age-period-cohort analysis for diabetes mellitus mortality rate in the very low and low quintile of marginalization in relation to medium, high and very high in Mexico, 1990-2019.

The age-period-cohort model is shown for the population with lowest marginalization (very low and low quintile, Panel A), as well as the age-period-cohort model for the population with highest marginalization (medium, high and very high quintiles, Panel B) for the years 1990 to 2019. The leftmost solid line is the age effect, the longest of the solid lines on the rate ratio half of the graph is the cohort effect, and the shortest line is the period effect. Finally, we observe the time-dependent mortality rate ratio for the interaction highest marginalization quintiles with respect to lowest quintiles by age (Panel C). The shaded gray area indicates the 95% confidence interval.

Abbreviations: DM, Diabetes Mellitus; MRR, Mortality Rate Ratio.

Supplementary Files

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