International Journal for Equity in Health

RESEARCH

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Health system financing fragmentation and maternal mortality transition in Mexico, 2000–2022

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Abstract

Objective To analyze the temporal and territorial relationship between health system financing fragmentation and maternal mortality in the last two decades in Mexico.

Methods We conducted an ecological-longitudinal study of the maternal mortality ratio (MMR) in the 32 states of Mexico during the period 2000–2022. Annual MMRs were estimated at the national and state levels according to health insurance. We compared the distribution of individual attributes and place of residence between deceased women with and without social security to identify overrepresented demographic profiles. Finally, we mapped state disparities in MMR by health insurance for the last four political administrations.

Findings MMR in Mexico decreased from 59.3 maternal deaths per hundred thousand live births in 2000 to 47.3 in 2018. However, from 2019 onwards, MMR increased from 48.7 in 2019 to 72.4 in 2022. Seven out of ten maternal deaths occurred in the population without social security from 2000 to 2018, then decreasing to six out of ten from 2020. Maternal deaths in the population without social security were more frequent among younger women, with less schooling, unmarried, and residing in rural areas, with higher Indigenous presence and greater social marginalization. From 2019 onwards, the MMR was higher in the population with social security.

Conclusion The results of this study confirm the close relationship between maternal mortality and social inequalities, and suggest that affiliation with social security has ceased to be a differentiating factor in recent years. Understanding the evolution of maternal mortality between the population with and without social security in Mexico allows us to quantify the gap in maternal deaths attributed to inequalities in access to maternal health services, which can contribute to the design of policies that mitigate these gaps.

Keywords Maternal mortality, Financing fragmentation, Universal health coverage, Mexico

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Background

There is an ongoing debate on the performance of health systems in low- and middle-income countries (LMICs) related to their fragmented financial architecture, i.e., the coexistence of several subsystems financed by different funds and governed by heterogeneous rules of access to financial resources and health benefits [1]. Fragmentation affects health systems' functions, generates inefficiencies due to duplication of efforts and resources, inequities, and suboptimal health outcomes, and constraints progress towards universal health coverage (UHC) [2, 3]. Yet, some degree of fragmentation in health system financing may, in principle, be beneficial, for instance, by increasing choice and quality through enhanced competition. A better understanding of the consequences of fragmentation on the functioning of health systems can help strengthen them [4]. However, little attention has been paid to the relationship between fragmentation and health outcomes in LMICs [5].

Maternal mortality provides an opportunity to explore this relationship, given its high sensitivity to the performance of health systems and its close relation to a continuous supply of high-quality services during and after pregnancy [6, 7]. It is also a key indicator of inequality and social development [8, 9]. The literature is conclusive in that maternal mortality is preventable through adequate access to health services before, during, and after childbirth [9]. The most common approach to addressing maternal mortality has largely focused on directing investments towards the major biomedical causes of maternal death, particularly during the perinatal period [10]. However, there has been less attention to the underlying determinants of adverse outcomes during pregnancy and childbirth, and how health systems might be structured to implement effective interventions and mitigate the adverse effects of social factors on maternal health [10]. Specifically, little is known about how financial fragmentation may exacerbate the effects of the pandemic and other challenges on maternal mortality.

Despite the progress observed since the Millennium Development Goals (MDGs), inequities in maternal health outcomes persist, significantly affecting the most disadvantaged populations [11]. Notably, the maternal health policies and programmes implemented in Latin America and the Caribbean (LAC) over the last three decades have resulted in modest and heterogeneous progress in reducing the maternal mortality rate (MMR) [12–15], and this progress has been jeopardised by the Covid-19 pandemic [16].

Like most health systems in LAC [1, 3], the Mexican health system is financially fragmented: various service delivery subsystems coexist and operate uncoordinated, beyond the division between the private and public sectors [1, 3, 4, 17]. Mexico's public health system, which serves more than 90% of the population, includes two subsystems. The first is the contributory social security that provides comprehensive care to the salaried population, which is affiliated with the Mexican Social Security Institute (IMSS), the Institute of Security and Social Services for State Workers (ISSSTE) and the Health Services of the Defense, Navy and Petroleos Mexicanos (SEDENA, MARINA, and PEMEX). The second is the subsystem that provides care to the population without contributory social security. This subsystem was managed by the federal and state health ministries from 2000 to 2018. Between 2019 and 2021, it was under the responsibility of the Federal Ministry of Health, some state ministries, and the *Instituto de Salud para el Bienestar* (INSABI). Starting in 2022, the Federal Ministry of Health, some state ministries, and the *Servicios de Salud del IMSS para el Bienestar* (IMSS-Bienestar or IMSS-B) have been responsible for its administration.

This article examines the relationship between health system financing fragmentation and health outcomes in LMICs. We provide a temporal and geographic analysis of the relationship between health system fragmentation and maternal mortality during the last two decades in Mexico.

Methods

Study design

We conducted an ecological-longitudinal study [18] of the MMR in the 32 states of Mexico during the period 2000–2022. Following previous studies [19], the MMR was defined as the number of women aged 10–54 who died from causes directly (ICD-10 codes: O01-O99, A34, D392, F53, M830) or indirectly related to pregnancy (ICD-10 codes: A15-B49, C00-C96, D00-D48, D55-D89, E00-E90, F50-F59, G00-G99, I00-I99, J00-J99, K00-K93, L00-L08, M00-M99, N00-N99, Q00-Q99, R10-R19, R50-R69, R95-R99, U01-Y98) per hundred thousand live births [19, 20].

Data sources

The number of maternal deaths was calculated using mortality microdata produced by the National Institute of Statistics and Geography (INEGI) [21]. The number of live births came from the population projections made by the National Population Council (CONAPO) for 2000–2007 [22] and the Birth Information Subsystem (SINAC) administered by the Mexican Ministry of Health for 2008–2022 [23].

Variables

We focus on the potential association over time between maternal mortality and the fragmented financial

architecture of Mexico's public health care system, by analyzing MMR based on the deceased women's health insurance status (population with and without contributory social security) [24] and live births in each state and year. We also analyzed the following attributes of the deceased women: age, educational level, marital status, participation in the labor market, receipt of medical care before death and place of care; level of social marginalization of the municipality of residence [25] and the presence of Indigenous population [26], as well as the size of the locality of residence.

Analyses

We first present the annual and nationwide MMR estimates according to health insurance. Second, we compare the distribution of the individual and place of residence attributes between deceased women with and without social security. For this comparison, we calculated the population ratios (proportions with social security vs. without social security) for each attribute. Values greater than 1 indicate an overrepresentation of maternal mortality in the population without social security; values lower than 1 indicate underrepresentation; and values equal to 1 mean identical proportions. Third, state disparities in MMR by health insurance were mapped for four political administrations (2000–2006, 2007–2012, 2013–2018, and 2018–2022) to analyze the possible effects of changes in health policies on maternal mortality. These disparities were measured from the ratio (social security/no social security) of MMR in four categories: 0–0.5, >0.5–1, >1–1.5, and >1.5. The four categories were defined according to the values observed in the baseline period (2000–2006) to maintain comparability between all periods. Finally, the values of the MMR in the population with social security (in blue) and without social security (in red) are presented by state and period of the corresponding administration, as well as the percentage difference (marked in blue when it is higher in the former and red when it is higher in the latter).

Results

The MMR in Mexico decreased from 59.3 maternal deaths per hundred thousand live births in 2000 to 47.3 in 2018. This significant reduction in MMR gaps was accompanied by a narrowing of the gaps between the populations with and without social security (Fig. 1). However, from 2019 to 2022, the national MMR increased from 48.7 maternal deaths per hundred thousand live births to 72.7, primarily affecting the population with social security.

Between 2000 and 2022, three stages in the evolution of MMR in Mexico can be identified: (i) 2000–2006, a stage in which the MMR in the population without social security decreased by 40% (from 86.9 deaths per hundred thousand live births to 52.7), while in the population with social security, it remained practically unchanged (around 33); (ii) 2007–2018, in which the MMR in the population without social security continued to decrease to reach 48.5, while the MMR in the population with social security registered an increase of 35%, and reached 45.0, which caused the figures in both populations to be similar; and (iii) 2019–2022, a stage in which an increase of more than 40% was observed in the MMR in both populations, to reach levels of 71.8 and 74.3 per hundred thousand live births in women without social security and with social security, respectively. Appendices 3.1, 3.2 and 4 show the distribution of maternal deaths according to the ICD-10 causes used, distinguishing by the general population, without social security, and with social security, respectively [19, 20].

From 2000 to 2018, seven out of ten maternal deaths occurred in the population without social security, then declining to six out of ten from 2020 onwards (Fig. 2). Maternal deaths in the population without social security were more frequent in young (10 to 19 years), less educated, and unmarried women (Table 1.). These deaths were also overrepresented in rural areas, with a more significant Indigenous presence and greater social marginalization.

Between 2000 and 2006, in all of Mexico's states except Colima (located in the western part of the country), MMR was higher in the population without social security. In 29 states, the gap was greater than 50% (Fig. 3). From 2007 to 2018, a decrease in the MMR gap between the population with social security versus that without social security was observed, and only in five states was the gap greater than 50% in the population without social security. These years also saw an increase in the number of states with a higher MMR in the population with social security (nine states in 2007–2012 and eleven states in 2013–2018). Finally, between 2019 and 2022, only nine states maintained a higher MMR in population without social security; a ratio of 0.5 and 1 was observed (Fig. 3).

Figure 4 shows the MMR by state during the last four political administrations for the population with and without social security, and the percentage difference between the two ratios. Between 2000 and 2006, in most states, the MMR in the population without social security was more than 100% higher than that observed in those with social security. In states such as Nayarit- in the west of the country-, Yucatán, Tabasco, and Chiapas-in the southeast, the country's least developed region-, the difference was even higher than 200%. Between 2007 and 2018, that gap narrowed in most states due to a decline in MMR in the population without social security and an increase in MMR in the population with social security.

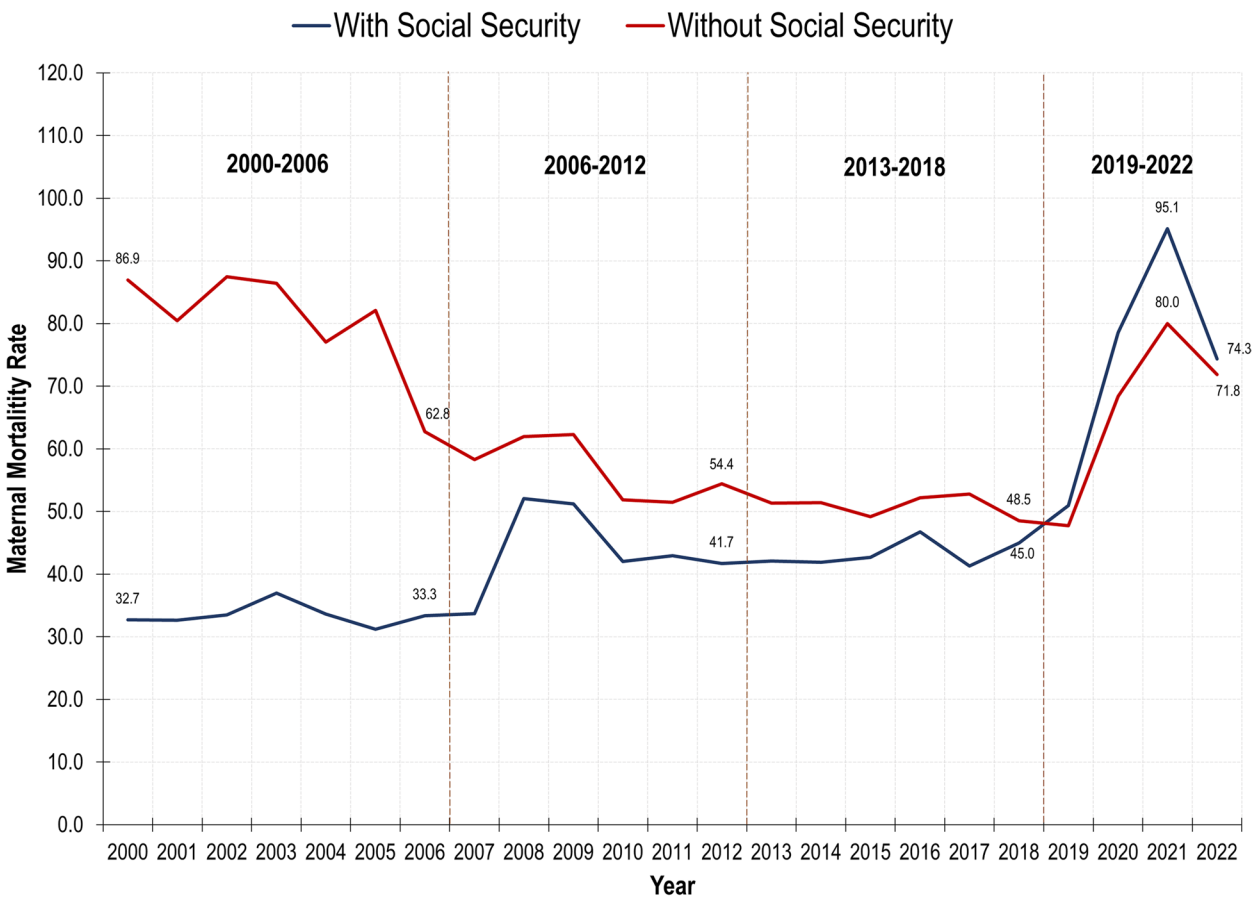

Fig. 1 Maternal mortality ratio according to Social Security affiliation. Mexico 2000–2022. The states where the MMR is higher in the population without social security are shown in red, and those in which the MMR is higher in the population with social security are shown in blue

For example, the MMR in the population with social security in Nayarit (first state in the list of both panels in Fig. 4) went from 18 between 2000 and 2006 to 55 between 2013 and 2018, while in the population without social security, it decreased from 98 to 58 in those same periods. Between 2019 and 2022, the MMR in Nayarit grew in the population with social security, eventually topping the MMR in the population without social security, whose MMR decreased over the period. The same happened in most states.

Discussion

Between 2000 and 2010, the MMR in Mexico decreased consistently, especially in the population without social security. This could be associated with the increase in access to healthcare due to the establishment of *Seguro Popular*, which offered comprehensive health services to the population without social security, and to the implementation in 2001 of the federal program "*Arranque Parejo en la Vida*," (Fair Start in Life) and its synergistic interactions with other programs such as the conditional cash transfer program *Progresa-Oportunidades-Prospera* [27], which had as one of its explicit objectives to improve maternal care to contribute to the fulfilment of the MDGs in this area [28]. In addition to this general decline, during this period, the gap in MMR between the population with and without social security started to narrow, a phenomenon that coincided with a notable decrease in the MMR in the latter mentioned above. In the second half of the decade, the MMR in the population without social security continued to decrease, while the MMR in the population with social security registered an increase, which caused the figures in both populations to equalize, a surprising fact given the differences in financial resources, services and quality of care between the institutions that covered these two populations. The good news that the gaps between these populations groups were narrowing, turned into an alarm when it was observed that this trend was now due both to an improvement in health care for pregnant women without social security, which continue to reduce the MMR in this sector of the

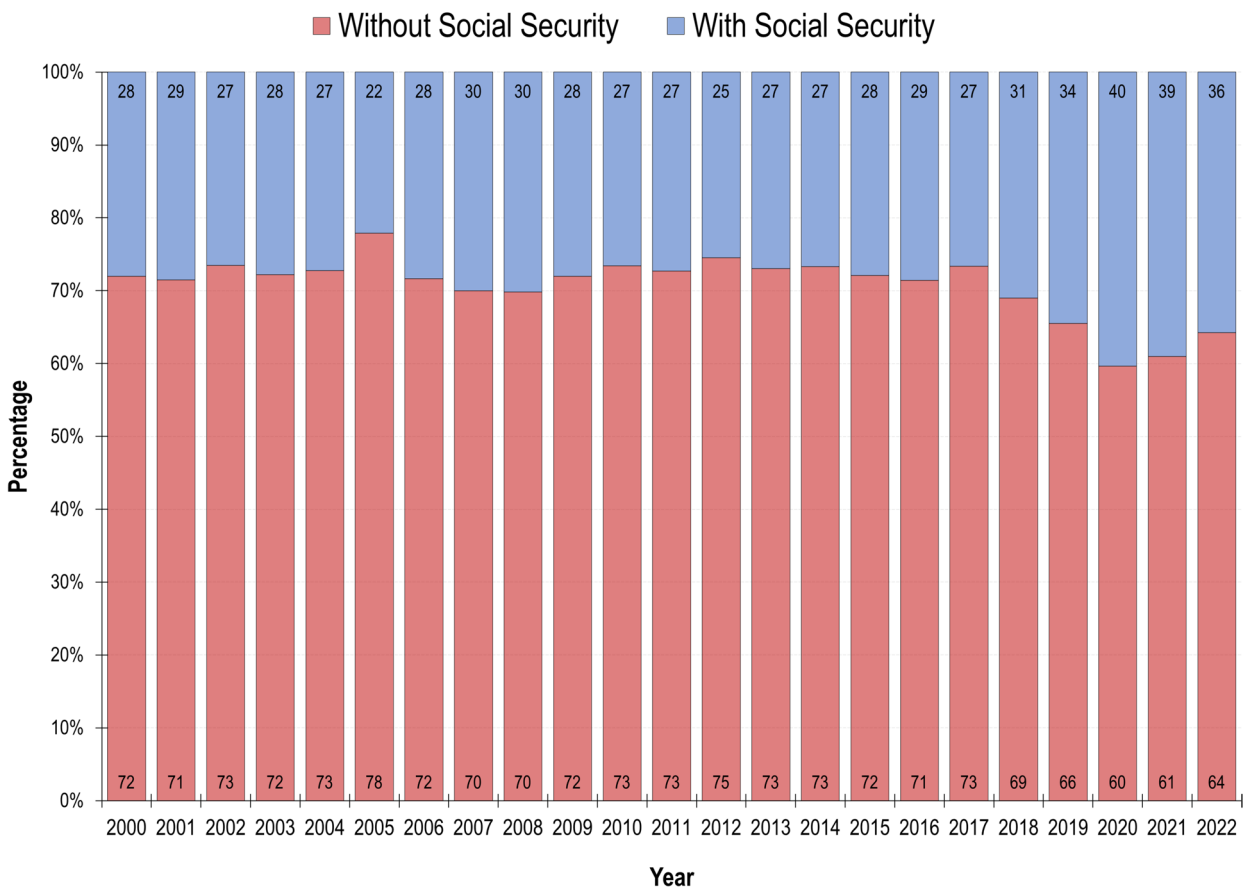

Fig. 2 Percentage distribution of maternal deaths and maternal mortality by Social Security affiliation. Mexico 2000–2022

population, and disruptions in maternal health services for the population with social security, which affected its MMR Fig. [29].

During the second decade of this century, the MMR stagnated at around 40 in the insured population and around 50 in the population without social security, possibly as a result of the fact that maternal initiatives had overcome the easier obstacles and were now facing more challenging conditions. It could also be due to a relative neglect of maternal health programs once the effort linked to meeting the MDGs targets was concluded. This stagnation phenomenon has been observed in all regions of the world, especially since 2015 [30].

In 2019, the MMR in the population without social security decreased slightly, while the MMR in the population with social security increased. This caused the values of this indicator in both populations to cross.

Finally, during the two years of the pandemic, the MMR in both populations increased dramatically, primarily affecting the population with social security, to levels not seen in Mexico for three decades [12, 31]. This upward trend in MMR was modestly reversed in 2022.

During the analysis period, we observed persistent gaps in maternal deaths between populations with and without social security. As shown in Table 1. and Appendices 1.1 and 1.2, the profiles of maternal deaths in these two groups were consistently different. In the population without social security, we observed a higher frequency of maternal deaths among unmarried women, in the youngest age group (10-19y) and those with lower levels of education. Notably, between 2013 and 2018, the disparities in maternal death frequency among women with minimal or no formal education have increased significantly. These findings are consistent with previous studies that found that unmarried women might have less social support, fewer financial resources, and less consistent access to healthcare services, and education reduces the risk of maternal deaths, as it empowers women with essential knowledge about health practices, facilitates better access to healthcare services, and encourages the pursuit of prenatal care [32, 33]. Additionally, the frequency of maternal deaths in the population without social security was disproportionately higher in rural areas, which often have a larger Indigenous population and experience greater

Table 1 Ratio of proportions -No social security/social security- in sociodemographic characteristics of maternal deaths 2000-2022

	2000-2006	2007-2012	2013-2018	2019-2022	2000-2022
Panel A. Individuals					
Age (years)					
10-19	2.00	2.53	2.31	2.62	2.33
20-29	0.95	1.02	1.05	1.20	1.04
30-39	0.85	0.75	0.78	0.78	0.80
40-49	1.17	1.07	0.75	0.64	0.83
Schooling					
None	5.54	4.76	15.68	3.71	5.79
Primary	2.00	2.23	2.65	2.31	2.28
Secondary	0.69	0.96	1.24	1.39	0.99
High school or higher	0.26	0.36	0.43	0.51	0.37
Marital status					
Single	1.47	1.25	1.12	1.17	1.21
Married	0.94	0.96	0.98	0.98	0.97
Separated	1.20	1.16	0.76	0.64	0.85
Work	0.26	0.24	0.25	0.27	0.25
Received medical attention	0.87	0.93	0.94	0.94	0.91
Care service provider					
Public	0.78	0.86	0.92	0.88	0.85
Private	1.16	1.12	0.88	1.16	1.13
Other	2.64	2.21	1.42	1.52	1.87
Panel B. Place of residence					
Size of locality					
Rural	2.93	2.70	3.58	3.01	3.03
Semi-urban	1.68	1.60	1.27	1.55	1.53
Urban	0.80	0.87	0.89	0.94	0.86
Metropolitan	0.48	0.52	0.58	0.57	0.53
Indigenous population					
No indigenous presence*	-**	0.38	-**	-**	2.88
With dispersed indigenous population[a]	1.24	1.27	1.08	1.14	1.18
With presence of indigenous population[b]	0.65	0.68	0.73	0.70	0.69
Indigenous[c]	4.22	3.17	6.26	5.57	4.41
Degree of social marginalization					
Very low	0.51	0.55	0.58	0.58	0.54
Download	1.12	1.16	1.02	1.17	1.11
Media	2.52	2.18	2.17	2.01	2.27
High	3.44	3.21	4.18	4.47	3.69
Very high	5.79	4.66	24.24	8.53	7.01

Note: [a]Less than 40% indigenous population and less than 5,000 indigenous persons; [b]Less than 40% indigenous population and more than 5,000 indigenous persons, as well as municipalities with a significant presence of minority language speakers; [c]40% or more indigenous population. The ratio of proportions was calculated with the proportion of the attribute in deaths without social security as the numerator and the proportion of the same attribute in deaths with social security as the denominator. Values greater (less) than 1 in this ratio indicate over (under) representation of the population without social security, while values close to 1 would indicate similar proportions. *There were no maternal deaths with social security in places with no indigenous population. **No maternal deaths with social security were recorded these years

social marginalization. These findings emphasize the crucial role of sociodemographic factors and the need for targeted interventions to address these inequities.

It is beyond the scope of this paper to identify the causal factors of this crossover of trends, but it is plausible that a combination of several factors may be at play. These factors include the deterioration of the supply of health services, in general, and maternal health services, in particular, in social security institutions during the second decade of the century, which needs to be documented, and an increase in the demand for services as a result of the rise in the number of people enrolled in

these institutions, which started in the second half of this same decade. The latter is supported by our estimates of health insurance coverage among women of reproductive age (10–54y), based on data from the National Household Income and Expenditure Survey (ENIGH in Spanish) for the period under study (see Appendix 2). This increasing enrollment possibly generated an increase in the demand and saturation of maternal health services in these institutions. To this we should add the concentration of resources on meeting the needs related to the Covid-19 pandemic in 2020 and 2021 [34–36]. This dire situation continued in 2022 after the pandemic ended, potentially reinforcing the importance of the first two factors mentioned above.

The evolution of MMR at the state level shows another aspect of the fragmentation of the health system beyond financing: the existence of a wide variety of national subsystems that do not have homogeneous patterns of prioritization and service delivery [37]. This may help explain the vast heterogeneity of the MMR among states and the different trends in the periods evaluated. For example, in Colima, the MMR was higher in the population with social security until 2019, but in the last period it was higher in the population without social security. In Mexico City, variations were observed throughout the analysis period, but the MMR was consistently higher in the population without social security. Hidalgo maintained an MMR of 31 in the population with social security for more than 15 years. Still, in the last period, it increased by 335% and was the state with the highest MMR in the population with social security (104). Generally, the pattern observed is a wide gap in the first period, then a contraction of the gap, and finally a transition to a higher MMR in the population with social security, but with significant intra- and interstate heterogeneity.

At the national level, the gap in MMR between the population with and without social security practically closed at the end of the period of analysis. Until 2010, the reduction resulted from a decreasing MMR in the population without social security. In 2018, the gap disappeared, but this is due to an increase in the MMR of the population with social security. Subsequently, a transition to a higher MMR was observed in the population with social security, which is at levels higher than those observed in 2000 among uninsured women. This could hardly be explained by a growth of affiliation to social security agencies of poorer and unhealthier women. Despite this, most maternal deaths occurred in the population without social security during the entire period of analysis. Causes such as fetal distress, postpartum haemorrhage, and prolonged pregnancy are more prevalent in the uninsured population than in the insured population (Appendices 3.1 and 3.2). This is possibly due to deficiencies in the availability of resources and quality of care in the institutions that serve the uninsured population, especially in prenatal care and delivery and puerperal care [38, 39]. These services also require adequate coordination, limited due to the enormous heterogeneity in performance and financing in providing services within these institutions [40, 41].

The Covid-19 pandemic likely played a central role in the increase in MMR from 2020 to 2022 [36]. First, the COVID-19 and pregnancy interaction made pregnancy a high-risk event [42–44]. This increase may also have been due to the fact that many pregnancy and postpartum complications or comorbidities were not adequately addressed due to the focus of public health care services on addressing pandemic-related needs [36]. This could explain the change in the proportion of indirect deaths from 12% in the 2013–2018 period to 19% in the 2020–2022 pandemic period (Appendix 4). This difference was mainly due to an increase in the proportion of deaths due to endocrine, nutritional, metabolic, infectious or parasitic, nervous system, and urinary system diseases, and suggests that maternal care did not adequately capture such complications. Some of these changes in indirect deaths were not similar between the population with and without social security. In the population with social security, there was a higher increase in deaths related to the digestive and respiratory systems. In contrast, in the population without social security, there was a greater increase in maternal deaths related to external causes (Appendices 3.1 and 3.2). Maternal deaths caused by Covid-19 accounted for 1.8% of total maternal deaths during 2020–2022. This same cause accounted for 2.3% and 1.3% of the insured and uninsured population, respectively. However, this figure is conservative since the data analyzed only allows us to explore the primary or root causes of death, not those related to Covid-19 complications.

The main message of this study is that MMR decreased during most of the first two decades of this century, and gaps between the population with social security and the uninsured population narrowed. The data suggest that access to social security had a positive effect on the evolution of this indicator. As of 2019, however, Mexico witnessed a transition in maternal mortality characterized by a significant increase in MMR, substantial intra- and interstate heterogeneities, and the disappearance of the protective influence of social security affiliation on maternal deaths.

Although we use the best available data sources, there are still problems of underreporting in Mexico for both live births and maternal deaths, which could alter the MMR estimate, especially in regions with a high degree of social

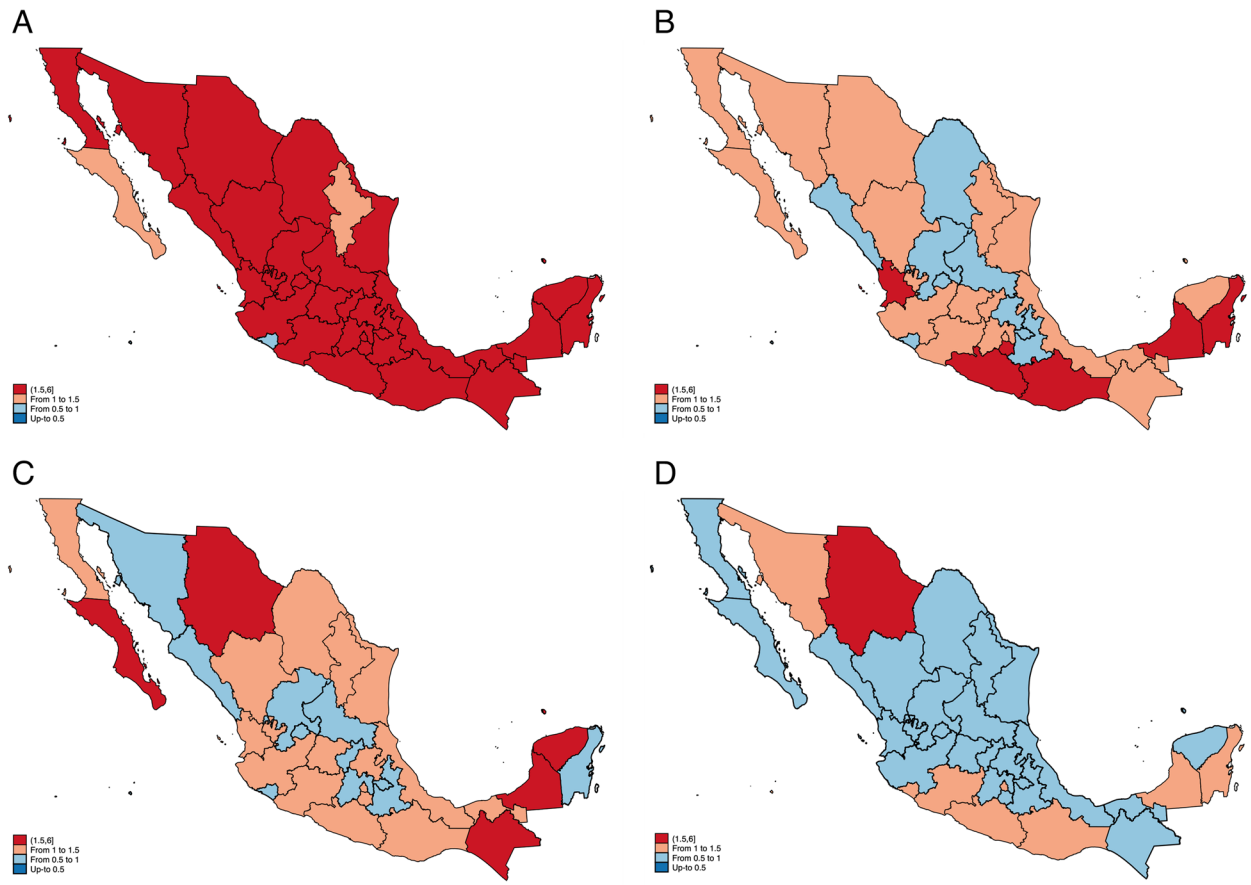

Fig. 3 Disparities -social security-no social security- in state mortality ratios. Mexico, 2000–2022. **A** 2000–2006. **B** 2007–2012. **C** 2013–2018. **D** 2019–2022. The ratio of MMRs was estimated with MMR without social security in the numerator and MMR with social security in the denominator. The ratio was placed in four categories: 0–0.5 (blue), > 0.5–1 (light blue), > 1–1.5 (light red) and > 1.5 (red). The four categories were defined according to the values observed in the baseline period (2000–2006)

exclusion [8]. In addition, the under-registration of births may have increased during the pandemic due to the closure of civil registries and the overload of work once they were opened. Therefore, the 2021 and 2022 MMR estimates may be reduced as birth registration adjusts upward [45]. This does not imply that there has been no increase in MMR compared to previous years, given the rise in maternal deaths during these years and the assumption of a birth rate similar to that of previous years. On the other hand, the available data did not allow us to ascertain whether the deceased women received prenatal, delivery, and postpartum care in a social security facility, in the private sector, or services aimed at the population without social security. While this may overestimate the mortality attributable to social security, it also highlights the barriers created by fragmentation between and within health subsystems, including for establishing a high quality health information system [40]. Future analyses could seek to estimate the risk of maternal deaths associated with insurance status, controlling for individual sociodemographic characteristics and place of residence. In addition, more detailed analyses are needed to establish causality and the degree of influence of health system financing on maternal deaths, as well as the factors that accentuate the gaps between the population with and without social security, including those outside the health system.

One of the main objectives of UHC is to improve the population's health by reducing barriers that hinder access to basic services, such as maternal health services [12]. The findings of this study indicate that Mexico, like many LMICs, must strengthen maternal care. This process should include:

i) the documentation of the evolution and current situation of maternal health, including maternal mortality;
ii) the identification of barriers to timely access to prenatal and delivery care services;
iii) the identification of the intersectoral actions needed to empower women, especially those who are part of vulnerable populations, and
iv) the use of this information to strengthen maternal health services.

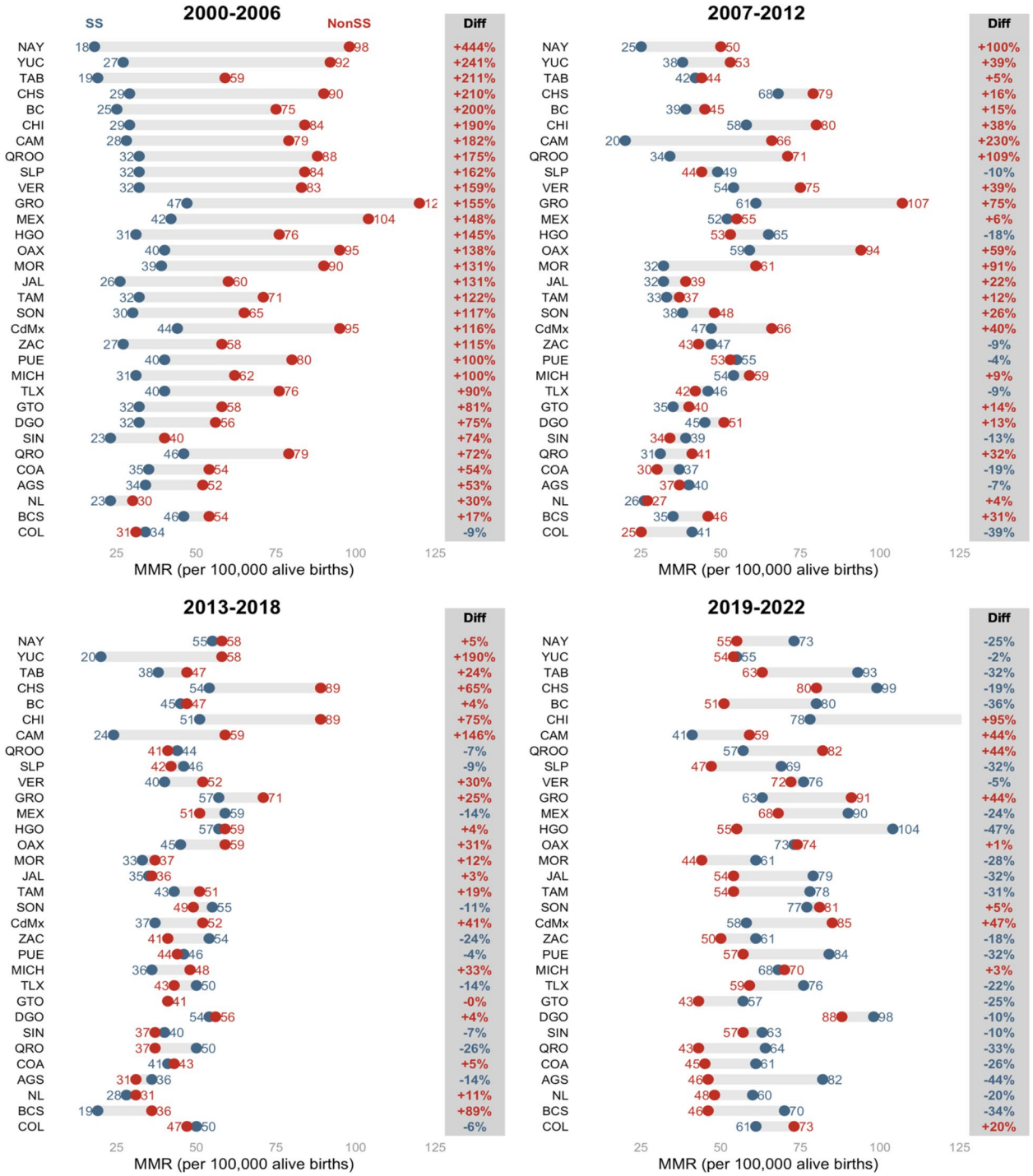

Fig. 4 Disparities -social security-no social security- in the state maternal mortality ratio. Mexico, 2000-2022. The dots represent the state MMR in the corresponding period for the population without social security in red and the population with social security in blue. The percentage values shown to the right of each panel are the percentage differences relative to the population with social security. The percentages above and below the MMR for social security are shown in red and blue, respectively

This study contributes mainly to the implementation of the first two measures. Knowing the evolution of maternal mortality between the population with and without social security makes it possible to quantify maternal deaths and inequalities in access to maternal health services. This will eventually help prevent such deaths and control this unacceptable public health problem, by informing the design and implementation of effective policies.

Abbreviations

MMR	Maternal Mortality Rate
LMICs	Low and middle-income countries
UHC	Universal Health Coverage
MDGs	Millennium Development Goals
LAC	Latin America and the Caribbean
IMSS	Mexican Social Security Institute
ISSSTE	The Institute of Security and Social Services for State Workers
SEDENA	The Health Services of the Defense
MARINA	The Health Services of the Navy
PEMEX	Petroleos Mexicanos
INSABI	Instituto de Salud para el Bienestar
ICD	International Classification of Diseases
INEGI	National Institute of Statistics and Geography

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12939-024-02357-3.

Supplementary Material 1. Appendix 1.1. Proportions of maternal deaths without social security by sociodemographic characteristics, 2000-2022.[a]Less than 40% Indigenous population and less than 5,000 Indigenous persons; [b]Less than 40% Indigenous population and more than 5,000 Indigenous persons, as well as municipalities with a significant presence of minority language speakers; [c]40% or more Indigenous population.

Supplementary Material 2. Appendix 1.2. Proportions of maternal deaths with social security by sociodemographic characteristics, 2000-2022.[a] Less than 40% Indigenous population and less than 5,000 Indigenous persons;[b] Less than 40% Indigenous population and more than 5,000 Indigenous persons, as well as municipalities with a significant presence of minority language speakers;[c] 40% or more Indigenous population. ncr: non cases recorded.

Supplementary Material 3. Appendix 2. Distribution of Mexican women aged 10–54 by health insurance, 2000–2022. Estimates based on data from the National Survey of Household Income and Expenditures (ENIGH, in Spanish) 2012–2022. *This programme was terminated by the current government in 2019 and replaced with the Institute of Health for Wellbeing (INSABI).

Supplementary Material 4. Appendix 3.1 Total (percentage) direct and indirect maternal deaths by cause of death categories for the periods 2000-2006, 2007-2012, 2013-2018, 2019, and 2020-2022 in the population without social security in Mexico. *External causes are classified under codes V01-Y98, which correspond to transport accidents (V01 - V99), other external causes of accidental injury (W00 - X59), intentional self-harm (X60 - X84), assault (X85 - Y09), event of undetermined intent (Y10 - Y34), legal intervention and operations of war (Y35 - Y36), complications of medical and surgical care (Y40 - Y84), sequelae of external causes of morbidity and mortality (Y85 - Y89), supplementary factors related to causes of morbidity and mortality classified elsewhere (Y90 - Y98).

Supplementary Material 5. Appendix 3.2 Total (percentage) direct and indirect maternal deaths by cause of death categories for the periods 2000-2006, 2007-2012, 2013-2018, 2019, and 2020-2022 in the population with social security in Mexico. *External causes are classified under codes V01-Y98, which correspond to transport accidents (V01 - V99), other external causes of accidental injury (W00 - X59), intentional self-harm (X60 - X84), assault (X85- Y09), event of undetermined intent (Y10 - Y34), legal intervention and operations of war (Y35 - Y36), complications of medical and surgical care (Y40- Y84), sequelae of external causes of morbidity and mortality (Y85 - Y89), supplementary factors related to causes of morbidity and mortality classified elsewhere (Y90 - Y98).

Supplementary Material 6. Appendix 4. Total (percentage) direct and indirect maternal deaths by cause of death categories for the periods 2000-2006, 2007-2012, 2013-2018, 2019, and 2020-2022 in Mexico.*External causes are classified under codes V01-Y98, which correspond to transport accidents (V01 - V99), other external causes of accidental injury (W00 - X59), intentional self-harm (X60 - X84), assault (X85 - Y09), event of undetermined intent (Y10 - Y34), legal intervention and operations of war (Y35 - Y36), complications of medical and surgical care (Y40 - Y84), sequelae of external causes of morbidity and mortality (Y85 - Y89), supplementary factors related to causes of morbidity and mortality classified elsewhere (Y90 - Y98).

Acknowledgements
We would like to express our special thanks to Blanca Laura Ortega Román and Liliana Ordáz Salazar for their role as general coordinator and research assistant of the project.

Memorial quote
We dedicate this manuscript to our colleague and friend Sandra G. Sosa-Rubí, PhD, who inspired us to analyse equity during her fruitful lifetime and passed away in March 2021.

Authors' contributions
ESM and CPA conceived the idea for this study, contributed equally to work and accordingly shared first authorship. ESM designed the study, while CPA led the formal analysis and performed the data curation. ESM, CPA and OGD wrote the first draft of the manuscript. OGD provided critical inputs on multiple iterations. DCG, LF, AMB, CM, TH, and RMS provided critical input on multiple drafts. All authors were involved in the review of the paper and approved the final version. ESM is the guarantor of the work; as such, he had full access to all the data in the study and accepts responsibility for the integrity of the data and the accuracy of the data analysis. The final version of the manuscript was revised and approved by all authors.

Funding
This study was funded by the NIHR GHPSR researcher-led grant NIHR150067 using UK aid from the UK Government to support global health research. The views expressed in this publication are those of the author(s) and not necessarily those of the NIHR or the UK government.

Data availability
Data analyzed were obtained from the public repository of the annual mortality microdata produced by the National Institute of Statistics and Geography of Mexico (INEGI for its acronym in Spanish) (available at https://www.inegi.org.mx/programas/mortalidad/?ps=Microdatos).

Declarations

Ethics approval and consent to participate
Not applicable. This study involved no human participants and was approved by the Research, Ethics, and Biosecurity Committees of the National Institute of Public Health of Mexico (ID:2358/1826/S21-2022).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 21 October 2024 Accepted: 5 December 2024
Published online: 30 January 2025

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