Mexico's epidemic of violence and its public health significance on average length of life

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ABSTRACT

Objectives A disproportionate number of homicides have caused Mexican life expectancy to stagnate during the new millennium. No efforts currently exist to quantify the harm of violent acts on the lives of the general population. We quantified the impact of perceived vulnerability on life expectancy.

Methods Three Mexican national surveys on perceptions of public safety, life tables, and crime and vital statistics (2000–2014) were used. Prevalence rates of vulnerability/safety by age and sex were obtained from surveys at 2 different levels: federal state and home. The Sullivan method was used to estimate life expectancy lived with and without vulnerability for Mexican women and men.

Results Overall life expectancy at age 20 stagnated between 2005 and 2014 for females and males; yet, there was an increase of 40% and 70% in average number of years lived with vulnerability at the state and home levels, respectively. In 2014, female life expectancy at age 20 was 59.5 years (95% CI 59.0 to 60.1); 71% of these years (42.3 years, 41.6 to 43.0) were spent with perceived vulnerability of violence taking place in the state and 26% at the home (15.3 years, 15 to 15.8). For males, life expectancy at age 20 was 54.5 years (53.7 to 55.1); 64% of these years (34.6 years, 34.0 to 35.4) were lived with perceived vulnerability of violence at the state and 20% at the home (11.1 years, 10.8 to 11.5).

Conclusions The number of years lived with perceived vulnerability among Mexicans has increased by 30.5 million person-years over the last 10 years. If perceived vulnerability remains at its 2014 level, the average Mexican adults would be expected to live a large fraction of his/her life with perceived vulnerability of violence. Acts of violence continue to rise in the country and they should be addressed as a major public health issue before they become endemic.

INTRODUCTION

Intentional homicides exist in every country. Central America, including Mexico, has the highest homicide rates in the world.[1] The increase of homicide rates in Mexico during 2007–2014 has had a dramatic impact on the health status of the population,[2] for example, leading to a stagnation of the overall longevity.[3,4]

The homicide rate is a measure of the level of security and public exposure to violence.[1] Loss of human lives implies bereaved relatives and friends, but the effects of homicide are not limited to this.[5] Indirectly, the high levels of homicide rates have been related to worse cognitive performance of children exposed to this crime,[6] increased anxiety and depression levels,[7] and a decline in national economic growth rate.[8]

Inflicted mortality is only one expression of violence; the number of people affected by adverse health and socioeconomic consequences from any type of violence exceeds the number of victims of homicides alone.[9] Violence permeates in the population and creates numerous health problems: somatic, psychological and behavioural.[9,10] Invisible as some of these problems might be, the continuous exposure to violence affecting individuals and/or their surroundings takes a toll on people's psychological well-being. Thus, the fear and vulnerability prevalent in the population is traceable and as such, the health consequences of violence are measurable.

Efforts to quantify the impact of violence on health,[11] life spans[12] and the monetary costs related to actual and potential victims[13] have revealed the price tag of violence. Despite the rising violence that Central American populations are exposed to and its burden on society,[14] few efforts have attempted to unravel the implications for the health and well-being of populations. The aim of this study is to assess the impact of violence on well-being in the Mexican population by estimating the average number of years spent vulnerable of becoming victims of violence.

DATA

Ethics statement

This study involved secondary data analysis of public sources, which did not have any individual identifiers. As such, ethical approval for human subject research from the Institutional Review Board of the respective institutions was exempted.

Five data sources were used in the analysis: the 2005, 2010 and 2014 Mexican national surveys of perception of public safety 'Encuesta Nacional sobre Inseguridad' (ENSI-2005 and ENSI-2010),[15] and 'Encuesta Nacional de Victimización y Percepción sobre seguridad pública' (ENVIPE-2014),[16] life tables for the Mexican population for the same years,[17,18] national homicide counts[19] and official reported crime rates for kidnapping and extortion.[20] These surveys of the perception of public safety, ENSI and ENVIPE, are based on a probabilistic, multistage, stratified cluster sample design specifically created to assess characteristics of acts of violence, with a particular focus on the victim, victim's family and the context in which the event occurred.[15,16] The sample frame for ENSI-2005, ENSI-2010 and ENVIPE-2014 included 66 000, 73 370 and 95 517 households, respectively, with representation at the national, state and

metropolitan level. From each household, an individual aged 18 or older was randomly selected and interviewed to collect information on the household regarding sociodemographic factors, perception of public safety and the performance of the judicial system, as well as listing any violent act that a household member or respondent had been victims of. For example, the list of violent acts included in the ENVIPE-2014 survey was: theft, injuries, damage to property, threats, fraud, homicide, rape and other sexual offences, extortion and kidnapping. From these surveys, we selected people aged 20 or older representing over 93% of the survey respondents in ENSI-2005, ENSI-2010 and ENVIPE-2014.

Information on homicide counts (ICD-10 code: X85-Y09) was available by sex and single years of age for each year from 2000 to 2014.[19] Reported numbers were age-standardised using the age-specific population counts for Mexico in 2014. Rates of kidnapping (the act of abducting someone and holding them captive) and extortion (obtaining something, especially money, through force or threats) were available on an annual basis without disaggregation by age or sex.[20] Period life tables, elaborated by the Mexican Demographic Society (SOMEDE) for the Mexican population for 2005 and 2010, were used[17] together with life tables forecasted for 2014 and 2020.[18] The median projection of the latter life tables is comparable with official projected life tables with the advantage that they are stochastic, which means that they take into account the uncertainty that surrounds mortality. Such uncertainty was used here for calculating the corresponding CIs. These mortality data are available by sex and single-age, with an open age-group 107 and older.

Measures

Vulnerability was measured by respondents' perception of crime in 2005, 2010 and 2014 at two levels (federal state, hereafter referred to as state, and at home) based on answers to the question 'In terms of crime, how do you consider living in your [state/home] is?' with two response options: 'vulnerable' and 'safe'. The prevalence of vulnerability was estimated at every age for the two levels: state, π_x(state) and home, π_x(home); where π_x denotes the prevalence of vulnerability in the population at age x. Local polynomial regressions were applied to the prevalence rates to smooth out the data and avoid fluctuations from age to age, while maintaining only minor deviations from the raw data (see online supplementary appendix). This process also allowed us to carry out sensitivity analysis to confirm the robustness of our results (see online supplementary appendix).

METHODS

The Sullivan method was used to calculate the person-years and the remaining years of life spent with and without vulnerability at different ages.[21] Let the number of years lived by the population at age x be represented by the life table measure of person-years (L_x). The product of the person-years and the prevalence rate of vulnerability allow separating L_x into person-years lived with and without vulnerability, as $L_x \times \pi_x$ and $L_x \times (1 - \pi_x)$, respectively. From these two sets of person-years, standard life table calculations are performed to obtain life expectancies lived with and without vulnerability.[22] Thus, the average number of years lived at age x, e_x, is decomposed as the number of years lived with vulnerability and years without vulnerability: $e_x = e_x(\text{vulnerability}) + e_x(\text{without vulnerability})$. More details on the Sullivan method are available elsewhere.[21] Life expectancies with and without vulnerability were calculated for locations: state and home.

The 95% CIs of life expectancies with vulnerability were derived from the 95% CI from the life tables and the SEs from the prevalence of vulnerability.[18 21] Calculations were done by single years from ages 20 to 95, with an open age-group 96 and older, and separately by sex. We used a normal z-test for the statistical significance of differences between the prevalence of vulnerability by age for males and females. Finally, we used prevalence rates in 2005–2014 to project the prevalence for year 2020 using three approaches: constant, linear and quadratic. All the analyses were carried out using the R software (http://www.r-project.org/).

Limitations

Limitations of our study should be mentioned. First, our initial goal was to measure the number of years that the Mexican population spends in fear of acts of violence. However, the survey used did not explicitly ask for the level of fear that people were in. Instead, we used the question on vulnerability/safety as a proxy to the former concept. Second, our results include only violent acts directly having an impact on individuals as assessed by the ENSI and ENVIPE surveys.[15 16] Although our selected surveys only include certain types of crimes, our results represent the perception of vulnerability and security reflecting the overall experience of the respondent. Third, the Sullivan method assumes that the same mortality pattern follows irrespective of the living status (ie, with and without vulnerability).[21] Although stress caused by violent acts might raise the risk of death of those feeling vulnerable,[23] we have no follow-up longitudinal studies to disentangle differential mortality related to vulnerability in the Mexican population. This illustrates the urgent need to collect longitudinal data that inform more precisely on the impact of the violence that the Mexican population has been exposed to in the first years of the 21st century.[2–4]

RESULTS

Time-trends of kidnapping, extortion and homicides between 2000 and 2014 in Mexico are shown in figure 1. The kidnapping rate more than doubled over the period, from 0.6 (95% CI 0.54 to 0.64) to a peak of 1.4 (1.36 to 1.50) per 100 000, and extortions had a sixfold increase from 1.2 (1.09 to 1.23) to 6.9
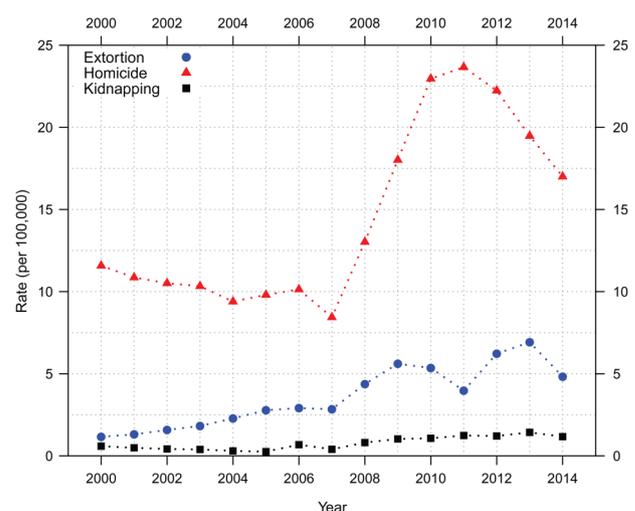

Figure 1 Rates of extortion, homicide and kidnapping for the Mexican population from 2000 to 2014. Source: data from INEGI[19] and SEGOB.[20]

(6.77 to 7.07) per 100 000. Homicide rates declined from 2000 to 2007, from 11.6 (11.37 to 11.79) to 8.4 (8.26 to 8.61) per 100 000, had a sharp increase between 2007 and 2011 with a peak of 23.7 (23.38 to 23.94) deaths per 100 000 in 2011 (a total of 27 213 deaths) and declined thereafter. Still, homicide rates in 2014 remained at more than double the level of 2007. These high homicide rates, along with the high rates in other types of violence, have had a toll on the population's well-being as seen in the prevalence of vulnerability.

Table 1 includes the prevalence of self-reported vulnerability for 2005, 2010 and 2014 for Mexican females and males at the state and home levels. Importantly, 2005 shows the prevalence for the time before the increase in violence, particularly homicide, whereas the other years capture the period of increase in violence (see figure 1). Vulnerability at the state level is higher than at home, at every time, age and for both sexes. Age patterns of the prevalence of vulnerability show a decline with age for 2005, whereas 2010 and 2014 are characterised by beginning with a slight increase and then a decline with age. In 2005, the prevalence peaks at ages 20–49, whereas in 2010 and 2014 it has shifted to older ages 40–59. In 2005, 2010 and 2014, females' highest concentration of vulnerability at the state level increases from 56% to 72% and goes further up to 74%, and vulnerability at the home level begins at 17%, rising to 23% and 30%, for those same years. Males reported significantly less vulnerability compared to females at ages 20–69 at the state and home levels.

Life table survival functions for Mexican females at ages 20 and older in 2005 and 2014 are practically identical, reflecting stagnation in overall survival in the decade (figure 2). At each age, the number of person-years is separated into those lived with and without vulnerability with a further disaggregation of vulnerability at the state (figure 2, top row) and home (bottom row) levels. The average number of person-years with

vulnerability at the state level is more than three times higher than those at home, but the upturn in vulnerability between 2005 and 2014 is greater at home, and the gap between vulnerability at the state and home levels falls. Males show similar results although with fewer person-years with vulnerability (see online supplementary appendix).

Life expectancies with and without vulnerability are summarised in table 2. Between 2005 and 2014, life expectancy at age 20 increased by a third of a year for females (2005: 59.2 years, 95% CI 59.2 to 59.3; 2014: 59.5 years, 59.0 to 60.1) and stagnated for males (2005 and 2014 at 54.4 years, 53.7 to 55.1). On the contrary, life expectancy with vulnerability increased its share over time.

While females have greater life expectancy than males at every age, they spend most of the extra years with perceived vulnerability. Importantly, the percentage difference in years spent with vulnerability between the sexes is highest at younger adult ages. In 2005, for example, females aged 20 spent about 51% of their remaining life with vulnerability at the state level (30.1 years, 95% CI 29.7 to 30.5), while the corresponding value for males is about 46% (24.9 years, 24.5 to 25.4). By 2014, vulnerability has reached alarming levels: females aged 20 spent about 71% of their remaining life with vulnerability at the state level (42.3 years, 41.6 to 43.0), whereas the corresponding value for males is about 64% (34.6 years, 34.0 to 35.4).

A large increase of life span spent in years of vulnerability between 2005 and 2014 is seen at state and home levels. For example, at age 20, female life expectancy with vulnerability at the home level increases linearly from 14% in 2005, to 20% in 2010 and 26% in 2014 (2005: 8.4 years, 95% CI 8.2 to 8.7; 2010: 11.7 years, 11.5 to 12.1; 2014: 15.3 years, 15.0 to 15.8). The corresponding proportions for males are 12%, 16% and 20%, for 2005, 2010 and 2014, respectively (2005: 6.5 years, 95% CI 6.3 to 6.9; 2010: 8.6 years, 8.4 to 8.9; 2014:
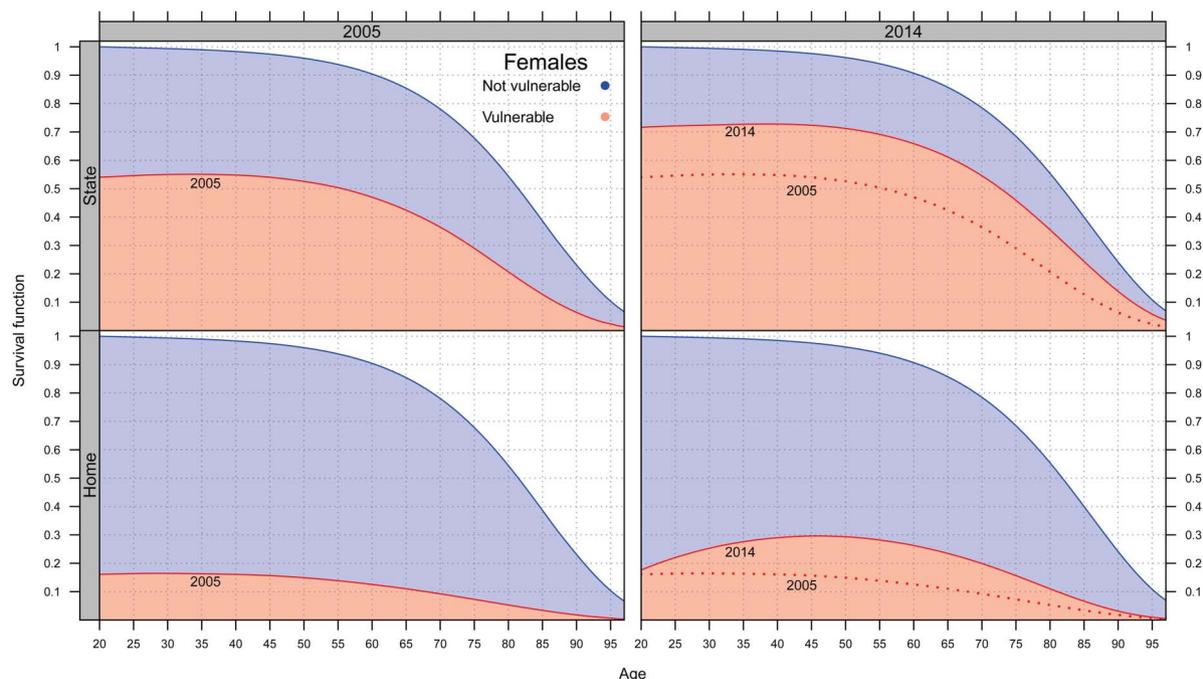

Figure 2 Person-years lived with and without vulnerability at the state (top row) and home (bottom row) levels for Mexican females aged 20 and older in 2005 and 2014. Source: Authors' calculations, data from the ENSI-2005, ENSI-2010[15] and ENVIPE-2014[16] surveys, and period life tables.[17 18]

11.1 years, 10.8 to 11.5). Life expectancies with vulnerability at other ages also show similar expanding share in Mexican lives over the 2005–2014 decade.

The actual number of people aged 20 and above feeling vulnerable to violence can be calculated as the product of the estimated years spent with vulnerability and the population size at this age. For 2005, 2010 and 2014, the number of Mexican person-years lived with vulnerability is 53.1, 77.3 and 83.6 million, respectively. This is equivalent to an increase in the number of years with vulnerability of 30.5 million, resulting from the increase in violence in the country between 2005 and 2014.

If the increasing tendency in the perception of vulnerability continues to 2020, female life expectancy at age 20 is estimated to be 60.11 years (CI 61.11 to 59.11), of which 71% (62% to 87%) could be spent with vulnerability at the state and 33% (26% to 37%) at the home level. For males, the corresponding life expectancy is estimated to be 54.96 years (55.96 to 53.96), with 64% (43% to 79%) with vulnerability at the state and 26% (21% to 30%) at the home level. Thus, for females and males, while vulnerability at the state level could stay in the same range, safety perception at home might experience a substantial increase compared with values for 2014.

DISCUSSION

This is the first study to unravel implications of violence, other than homicides, on average length of life in the Mexican population. We dissect average years of life into years living with and without vulnerability. Based on the perception of vulnerability in 2005, 2010 and 2014, Mexicans' feelings of safety have reached remarkable low levels and rather than improving they are worsening. While in 2005 Mexican adults spent less than half of their life spans with perceived vulnerability of violence, they now spend two-thirds of their life spans with vulnerability. Home is defined as the less vulnerable shelter, although the shadow of vulnerability is also evident there. Mexican females enjoy greater life expectancies than males, but much of that extra life span is marred by the perception of vulnerability.

Our results show that the proportion of people living with vulnerability increases in relation to the distance from their home. It can be speculated that this incremental perceived vulnerability corresponds to people's interpretation of the mass media description of distant events at the state and national level (eg, http://www.economist.com/blogs/graphicdetail/2012/11/mexican-drug-war), their visual inspection of their surroundings including the perception of corruption and impunity of public institutions,[24] and their own experience (home). This concentric identification of individuals and the negative effect of violence in the media is known as the 'third-person effect' favouring the in-group.[25] However, 7% of the Mexicans interviewed in 2014 responded in a reverse manner perceiving higher security outside their home.[16] This might be related to family or partner violence[9 26] not fully explored in the survey.

Some evidence indicates that Mexicans have learned to cope with violent shocks.[27] However, our results indicate that violence has left an imprint on people's perceptions of their surroundings. Among those interviewed in the ENVIPE-2014 survey,[16] a third (33%) reported the experience of a violent event in years previous to 2013 as opposed to 14% in 2013. Nonetheless, victims of previous years reported the same levels of vulnerability as victims in 2013. The sequels of violent events can last for a long time and their impact can be seen in somatic and mental health.[9 10]

The perception of vulnerability of the Mexican population has increased in parallel with the greater number of homicides in the country. The lowest number of homicides in the decade was reported in 2007 (see figure 1), and surveys on security indicated that 29% of the population reported living with vulnerability the previous year.[28] By 2011, however, the number of homicides had increased by threefold, whereas 71% of respondents reported living with vulnerability.[15] These high levels of homicides[19] and perceived vulnerability have remained high until the present (see table 1). Furthermore, other types of violence, as kidnapping and extortion reported in figure 1, obtained from official crime reports by victims[20] also indicate an important toll of violence on the Mexican population. Although these numbers show a dismaying picture, they only represent an underestimate of the actual violence that the Mexican population is exposed to.[29]

Among the ENVIPE-2014 interviewees, crimes in 2013 and those years preceding 2013 were evenly distributed between female and male victims at 13% and 15%, and 32% and 35%, respectively.[16] Nevertheless, our results show that the share of people living with vulnerability is greater for women than for men, particularly for younger adults. Furthermore, there is a larger sex disparity at the state than at the home level. This difference in perception might be related to differential processing of information regarding perceived threats between men and women. Evidence from clinical psychology indicates that

Table 1 Prevalence of self-reported vulnerability among Mexicans (%), 2005, 2010 and 2014

Age-group	State			Home		
	Female	Male	p Value*	Female	Male	p Value*
2005						
20–29	54	49	0.000	16	13	0.000
30–39	56	51	0.000	17	13	0.000
40–49	56	49	0.000	16	13	0.000
50–59	54	46	0.000	15	12	0.000
60–69	51	43	0.000	14	9	0.000
70–79	44	41	0.125	10	10	0.723
80–89	37	35	0.478	9	7	0.387
90+	27	40	0.160	11	12	0.876
2010						
20–29	67	63	0.000	17	13	0.000
30–39	71	65	0.000	21	17	0.000
40–49	72	67	0.000	23	18	0.000
50–59	71	67	0.000	23	19	0.000
60–69	67	65	0.085	21	19	0.025
70–79	63	59	0.016	17	15	0.115
80–89	58	54	0.200	14	10	0.036
90+	54	47	0.357	19	15	0.495
2014						
20–29	72	63	0.000	22	16	0.000
30–39	74	63	0.000	28	21	0.000
40–49	74	65	0.000	30	24	0.000
50–59	74	67	0.000	30	25	0.000
60–69	72	66	0.000	27	24	0.007
70–79	68	63	0.001	23	18	0.000
80–89	62	59	0.166	17	17	0.871
90+	63	55	0.250	13	14	0.715

Data from the ENSI-2005, ENSI-2010[15] and ENVIPE-2014[16] surveys.
*p Values of differences in the prevalence of vulnerability between females and males were estimated with a normal z-test.

Table 2 Mexican life expectancy with and without vulnerability at selected ages, 2005, 2010 and 2014

	Age	Life expectancy (95% CI)	Vulnerable expectancy (95% CI)		Vulnerable expectancy (% of total)	
			State	Home	State	Home
2005						
Females	20	59.2 (59.2 to 59.3)	30.1 (29.7 to 30.5)	8.4 (8.2 to 8.7)	51	14
	40	40.0 (40.0 to 40.1)	19.4 (19.1 to 19.9)	5.2 (5.1 to 5.6)	49	13
	60	22.4 (22.4 to 22.5)	9.6 (9.3 to 10.0)	2.4 (2.3 to 2.7)	43	11
	80	9.2 (9.2 to 9.3)	2.9 (2.5 to 3.4)	0.7 (0.5 to 1.0)	31	8
Males	20	54.4 (54.4 to 54.5)	24.9 (24.5 to 25.4)	6.5 (6.3 to 6.9)	46	12
	40	36.5 (36.5 to 36.6)	15.9 (15.6 to 16.4)	4.1 (3.9 to 4.4)	44	11
	60	20.2 (20.2 to 20.3)	8.0 (7.7 to 8.4)	2.1 (1.9 to 2.4)	40	11
	80	8.6 (8.6 to 8.7)	2.6 (2.2 to 3.0)	1.0 (0.7 to 1.4)	30	12
2010						
Females	20	59.3 (59.3 to 59.4)	39.8 (39.4 to 40.2)	11.7 (11.5 to 12.1)	67	20
	40	40.1 (40.1 to 40.2)	26.6 (26.3 to 27.0)	8.1 (7.9 to 8.4)	66	20
	60	22.5 (22.5 to 22.5)	14.0 (13.7 to 14.4)	4.1 (3.9 to 4.4)	62	18
	80	9.3 (9.3 to 9.4)	5.1 (4.8 to 5.5)	1.4 (1.2 to 1.7)	55	16
Males	20	53.8 (53.8 to 53.9)	34.0 (33.6 to 34.4)	8.6 (8.4 to 8.9)	63	16
	40	36.4 (36.4 to 36.5)	22.8 (22.5 to 23.3)	6.1 (5.9 to 6.4)	63	17
	60	20.2 (20.2 to 20.3)	12.0 (11.7 to 12.4)	3.1 (2.9 to 3.3)	59	15
	80	8.5 (8.5 to 8.6)	4.4 (4.1 to 4.8)	1.0 (0.8 to 1.3)	52	12
2014						
Females	20	59.5 (59.0 to 60.1)	42.3 (41.6 to 43.0)	15.3 (15.0 to 15.8)	71	26
	40	40.3 (39.8 to 40.8)	28.2 (27.7 to 28.9)	10.6 (10.3 to 11.0)	70	26
	60	22.6 (22.3 to 23.0)	15.1 (14.7 to 15.6)	5.2 (4.9 to 5.5)	67	23
	80	9.4 (9.3 to 9.6)	5.5 (5.2 to 5.9)	1.4 (1.2 to 1.7)	59	15
Males	20	54.4 (53.7 to 55.1)	34.6 (34.0 to 35.4)	11.1 (10.8 to 11.5)	64	20
	40	36.6 (36.1 to 37.1)	23.4 (22.9 to 24.1)	8.0 (7.7 to 8.4)	64	22
	60	20.4 (20.1 to 20.7)	12.7 (12.3 to 13.2)	4.1 (3.8 to 4.4)	63	20
	80	8.7 (8.6 to 8.9)	5.0 (4.6 to 5.4)	1.4 (1.2 to 1.7)	57	16

Authors' calculations, data from the ENSI-2005, ENSI-2010[15] and ENVIPE-2014[16] surveys, and period life tables.[17 18]

women are more likely than men to report higher levels of anxiety.[30] Though, greater vulnerability of crime among women does not necessarily translate into a higher risk of being victimised.[31]

In other countries in Central America, for example, Honduras, Belize, El Salvador and Guatemala, as well as in South America, for example, Venezuela, Brazil and Colombia, similar high levels of homicides are reported. In many cases, homicide rates are actually higher than in Mexico.[1] Furthermore, in the Americas, homicides are frequently linked to other criminal activities, particularly those related to drug cartels and gangs,[32] and thus other violent acts are also high. The high proportion of years lived with vulnerability presented here for the Mexican population could be expected to be present in these countries too. More research is needed to quantify and understand the toll that violence is having on the well-being of the residents of Central and South America. The strong migration flows back and forth from Central to North America,[33] and their tight links to violent events,[34] related to gangs[32] and drug cartels,[35] make the increasing violence problem in the south a cross-regional concern and therefore a top priority for public health research.

Our results clearly indicate major implications of the upsurge of violence and homicides in Mexico in the past decade with a remarkable impact on the well-being of the Mexican population. Between 2000 and 2014, rates of kidnapping, extortion and homicide increased by twofold, threefold and twofold, respectively, whereas the proportion of people living with vulnerability skyrocketed. There is an urgent need to see this problem as a major public health issue and to address it accordingly.[2] There should be prevention strategies at the state and home levels as

What is already known on this subject

Numerous studies have documented an increase in drug-related violence in Mexico after 2007.[27 32] Research on its causes and consequences point towards drug-related crime.[1 9] This is particularly notable in Mexico, which had one of the lowest homicide rates of the Latin American region a decade earlier.[2–4] Few studies have used the perception of vulnerability to assess the impact of violence on the quality of life for the general population;[7 28] furthermore, no article has attempted to calculate the number of years that Mexicans would spend living with vulnerability.

What this study adds

The alarming proportion of Mexicans' lives spent with perceived vulnerability of violence at the state and at home illustrates the burden violence poses on the psychosocial well-being of the population. The high level of violence in other Latin American countries[1] leads to assumptions that vulnerability plays a similar role in these countries. Ideally, policymakers should use preventive strategies to address the burden of violence felt in families and on a social level. However, neutralising violence using state force has been shown to be counterproductive in the Mexican context.[4]

well as for the entire nation.[9] Efforts should be implemented as part of the educational and social policies and programmes, and particular efforts should be made to help victims of violence.[10] Equity in access to health, education, work and economic opportunity as well as interventions to reduce childhood exposure to violence and its devastating consequences, which carry over into later life, are essential to avoid major effects in subsequent generations.[9] Yet, the Mexican government has been unable so far to guarantee the safety of its population and no major efforts have been made to address the structural roots of the problem.

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