The increase of firearm mortality and its relationship with the stagnation of life expectancy in Mexico

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Abstract *This study analyzes firearms mortality (FA) and their impact on life expectancy in Mexico –compared to other causes of deaths- during the three-year periods 2000-2002 and 2010-2012 and the weight of the different age groups in years of life expectancy lost (YLEL) due to this cause. Based on official death and population data, abridged life tables in Mexico were constructed for the three-year periods studied. Temporary life expectancy and YLEL for aged 15 to 75 by selected causes and age groups were calculated in each three-year period. Among men, FA mortality went from being the cause less YLEL caused in 2000-2002 to be the main cause of YLEL between 15 and 75 years in 2010-2012. Among women, YLEL for FA mortality had a higher relative growth. In both sexes, the greatest increase in YLEL by FA mortality was between 20 and 34 years. Findings indicate that the increase in FA mortality, especially among young people, has substantially contributed to the stagnation of life expectancy in recent years, and even his decline in the case of men. This reflects that violence linked to the FA is not only a security problem but also a collective health problem that must be copied in an interdisciplinary and intersectoral form if it is to increase the life expectancy of the country.*

Key words *Firearms, Life expectancy, Mortality, Violence*

Introduction

In Mexico, violent deaths have increased substantially in the last 20 years, particularly homicide and suicide rates[1-3]. Similarly, the presence of organized crime has increased, and with it, the crime associated with drug trafficking and the smuggling of high-powered firearms (FA), which has led some authors to conceptualize the levels of violence reached as a criminal insurgency[4,5]. The possession and use of FA are some of the aspects considered to underlie the high levels of violence observed in many Latin American countries today, and the case of Mexico is no exception[6].

FA are more lethal than other weapons, such as bladed weapons or blunt objects, which historically have had a greater presence in society[7]. Although Mexican law is strict regarding the possession and carrying of FA, it allows the right to possession under certain restrictions (related to the type and caliber of the weapon and whether it is exclusively used by the army) and after being registered with the Ministry of National Defense[8]. However, the illegal influx of FA into the country through both borders, particularly from the US-Mexico border[9], has predominantly led to the widespread availability of FA on the streets, which is reflected by the increased likelihood of fatalities resulting from criminal acts whose purpose was not in principle to take a person's life, such as robberies and street fights[7].

At the international level, FA have been reported to account for many more fatal injuries than any other type of weapon and for the majority of youth homicides[10]. In the United States, residents in states with the highest number of FA were six times more likely to die in an accident caused by an FA than those in states with fewer weapons[11]; moreover, the proportion of FA suicides in the United States is much higher than in other industrialized countries with more restrictive laws for FA possession[12].

Although Latin American authors have analyzed the mortality from FA from an epidemiological perspective[6,13,14], these studies are practically nonexistent in Mexico because the assumption has been that FA mortality is a substantial public safety issue. However, given the importance and magnitude of violence in the country, it appears necessary to address this problem along with the possible impact of FA-related deaths on the relative stagnation of life expectancy in Mexico.

According to official figures, life expectancy at birth increased relatively little between 1995 and 2010 (from 73.2 to 74 years)[15], which shows a deceleration of the decreasing mortality rate observed in previous decades. Although population aging and the consequent increase in mortality from chronic degenerative diseases may explain this finding to some extent, the increase in violent deaths – particularly those caused by FA – might also contribute to the years of life expectancy lost in the population and should be an element that warrants inspection when investigating the reasons for the recent slow growth of Mexican life expectancy.

Generally, studies that analyze the impact of violent deaths on life expectancy are relatively scarce[16-18], and even rarer are those evaluating the impact on LE from FA-related deaths[19], although agreement supporting the importance of this type of cause in the years of life expectancy lost is widespread.

In this context, this study aimed to analyze the effect of FA-related deaths in Mexico in recent years, to determine their impact on the country's life expectancy compared with other causes of death between the 2000-2002 and 2010-2012 triennia and to identify the degree to which different age groups contributed to the loss of years of life expectancy.

Methods

This was an observational cross-sectional study based on secondary sources of information. The mortality data used were derived from the National Health Information System of the Ministry of Health[20]. Population data for the calculation of the national rates of FA-related deaths between 2000 and 2012 were obtained from population estimates and projections prepared by the National Population Council for Mexico between 1990 and 2030[21]. The rates were adjusted by the direct method, using the population of Mexico in 2010 as the standard population[21].

FA-related deaths were obtained by grouping all those codes that, in the 10th revision of the International Classification of Diseases (ICD)[22], refer to a death caused by an FA: accidents by FA (W32-W34), suicides by FA (X72-X74), homicides by FA (X93-X95) and events of undetermined intent by FA (Y22-Y24, Y35.0). Deaths were also analyzed for some of the recent leading causes of death in Mexico: ischemic heart disease (I20-I25), diabetes mellitus (E10-E14), malignant neoplasms (C00-C97) and motor vehicle traffic accidents (V02-V04 (.1, .9), V09.2-V09.3,

V09.9, V12-V14 (.3-.9), V19.4-V19.6, V20-V28 (.3-.9), V29-V79 (.4-.9), V80.3-V80.5, V81.1, V82.1, V83-V86 (.0-.3), V87.0-V87.8, V89.2, V89.9), the latter cause classified according to the criteria used in Mexico by the Ministry of Health[23].

According to the criteria of the Pan American Health Organization (PAHO), Mexico is among the continent's countries with high-quality mortality data (e.g., underreporting and ill-defined causes of death below 10%)[24]. The PAHO estimates for Mexico – underreporting of 0.8% and ill-defined causes of death of 2.1% in 2000-05[25] and 0.5% and 1.7%, respectively, circa 2012[24] – are quite similar in both periods and support the use of official mortality statistics in a study such as the present one of a national scope.

However, given the existence of deaths of unspecified age or sex (0.5% and 0.05% in 2000-02, 0.6% and 0.08% in 2010-12, respectively[20]), this situation was corrected by proportionally redistributing the deaths with age or sex disregarded – in general and for each cause examined – according to the relative weight of each age group and sex[26].

Based on the official information on deaths and population, abridged life tables were prepared, by sex, for the 2000-2002 and 2010-2012 triennia; for the construction of life tables, the EPIDAT version 3.1[27] program was used, which employs the model tables developed by Coale and Demeny[28] as references for the pattern of mortality, specifically for the West family of the model, which is recommended for countries with mortality levels similar to those of Mexico[29]. The triennial life tables were drafted to attenuate the effects of circumstantial changes in mortality, which might distort the overall trend.

Life tables were necessary to calculate -also through the EPIDAT[27] software-, the temporary life expectancy (TLE) between 15 and 75 years and the years of life expectancy lost (YLEL) between both ages. Generally, this was accomplished for mortality by FA and by the other causes studied, and by age groups in each triennium considered according to the Arriaga method[30,31], which was described in detail by himself and by Pollard[32] and employed by several authors[16,33] for the analysis of changes in mortality and its relation to life expectancy.

In practice, the YLEL calculation represents the difference between the maximum number of years that can be lived between two ages and the TLE, which is the average number of years lived by the population between those ages[30]. YLEL is calculated by multiplying the proportion of deceased persons between the ages x and $x + n$ in the stationary population from the life table by the difference between the average number of years they might have lived from x – provided mortality was eliminated – and the average number of years actually lived between x and $x + n$ by the population that died in that age group[31].

The method was applied under the assumption of a mortality of zero between both ages. This assumption, recommended by several authors[31,34], facilitates the interpretation of the indicator; thus, in the present study, the total YLEL between the ages "15" and "75" is equal to the difference between "75" and "15" (that is, the maximum number of years that might be lived between both ages if mortality were eliminated (in this case, 60 years) and the temporary life expectancy between "15" and "75", or the average number of years actually lived.

The age range of 15 to 75 years was chosen because it includes the stage of life with greatest economic activity; does not include mortality at the extremes of age, whose dynamics feature particular characteristics; and is a period of life when negative consequences of individuals' behaviors may manifest, as in the case of violent deaths[30].

Results

FA caused 138,564 deaths between 2000 and 2012, equivalent to 2.1% of all deaths in Mexico during that period. Annual figures ranged from 6,177 deaths in 2004 to 20,913 deaths in 2011[23].

After a sustained downward trend at the beginning of the 21st century, the adjusted FA mortality rate has increased since 2007, reaching its highest value in recent decades in 2011 – 17.98 per 100,000 population, specifically, 34.64 per 100,000 for men and 2.58 per 100,000 for women. These figures show that the male rate is more than 12-fold greater than the female rate (Figure 1). Although the adjusted rate in 2012 of 15.87 per 100,000 was slightly reduced than that of 2011, the former number is more than double the mortality rate from FA in 2000. Moreover, the greatest increase was seen between 2007 and 2011, when the rate increased by 187% (188% for men, 160% for women).

The distribution of deaths by FA according to intent (Table 1) varied over the last decade: although homicides have been responsible since 2000 for the great majority of these deaths, the relative proportion of FA-related deaths due to

homicide increased, accounting for nine out of ten such deaths over the 2010-2012 triennium. In contrast, the proportion of accidents and suicides by FA decreased significantly, notwithstanding similarities in the number of accidents in 2010-12 and that of the triennium 2000-02. Finally, an increase in the proportion of deaths due events of undetermined intent was observed; the absolute numbers increased, from 984 in 2000-02 to 3,806 in 2010-12, which places this category as the second-most important cause of FA death, behind only homicides.

The male TLE between 15 and 75 years decreased by nearly 1% between the two triennia studied, while the female TLE increased by 0.3% in that period (Table 2). Consistent with the aforementioned observations, male YLEL between 15 and 75 years increased by 7.7% between 2000-02 and 2010-12, while female YLEL decreased by 4%.

The analysis of YLEL by cause (Table 2) indicated that for men, FA-related deaths shifted from causing the least YLEL in the triennium 2000-02 to being the main cause of YLEL between 15 and 75 years in 2010-12. YLEL from this cause increased 164%, i.e., from 0.32 in 2000-02 to 0.85 in 2010-12. This increase was much higher than those observed for all other causes studied, which notably included decreased YLEL from ischemic heart disease.

Thus, FA-related deaths were responsible for nearly 12% of male YLEL in 2010-12, more than any of the other causes analyzed, followed in importance by diabetes mellitus and ischemic heart disease.

Regarding women, FA-related deaths caused the least YLEL in both triennia. Notably, however, YLEL due to FA increased by 134% between 2000-02 and 2010-12, a period in which YLEL from all other causes except for diabetes mellitus decreased.

Notwithstanding this increase, YLEL due to FA-related deaths scarcely represented 1.7% of the total female YLEL over the 2010-12 triennium.

The analysis of the pattern of YLEL from FA-related deaths according to age groups in each triennium (Figure 2) showed that first, in all age groups and for both sexes, the YLEL in 2010-12 were greater than those of the triennium 2000-02. However, for men, the increase in YLEL between the two periods was largely due to the observed increase in YLEL in the 15-44-year age group. The YLEL in the 2000-02 triennium over those ages were 0.26 and represented 80% of YLEL from FA; in 2010-2012, they totaled 0.74
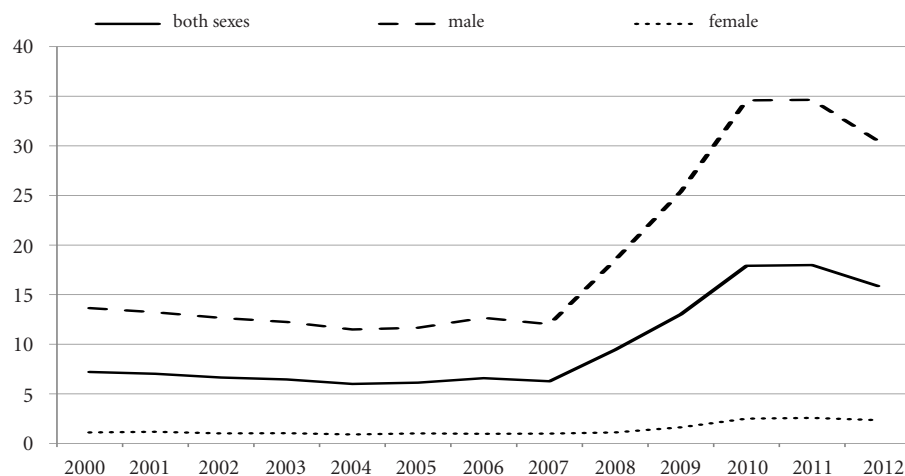
Figure 1. Age-adjusted firearm-related death rate (per 100.000 population) by sex. Mexico, 2000-2012.

Standard population: population of Mexico in 2010, estimated by Consejo Nacional de Población (CONAPO, its acronyim in Spanish).
Source: Prepared by the authors based on data from the National Health Information System of the Ministry of Health, Mexico.

and accounted for 87% of total YLEL from FA between 15 and 75 years. In particular, YLEL between the ages of 20 and 34 in 2010-12 were approximately triple those of the triennium 2000-2002.

Regarding women, the highest increase in YLEL was also observed in the 20-34-year age group, although the rates were lower than those of men. For both sexes, the age group with the highest number of YLEL is 25 to 29 years.

Table 3 compares mortality by FA, diabetes mellitus, motor vehicle traffic accidents, malignant neoplasms and ischemic heart disease in terms of YLEL according to age and sex in the triennium 2010-2012.

As observed in this context, among men, FA are responsible for more YLEL between the ages of 15 and 44 than any of the other causes analyzed, whereas diabetes has a greater impact beyond the age of 45 years. In particular, FA-related deaths cause more YLEL between the ages of 20 and 34 than all other causes of death studied combined. Notably, in the 15-19-year age group, FA-related deaths cause a greater number of YLEL than motor vehicle traffic accidents.

Among women, YLEL from FA-related deaths between the ages of 15 and 29 years are less than YLEL due to malignant tumors and motor vehicle traffic accidents. Beyond the age of 30 years, the relative weight of FA-related deaths decreases

Table 1. Firearm-related deaths according to intent: Mexico, 2000-2002 and 2010-2012.
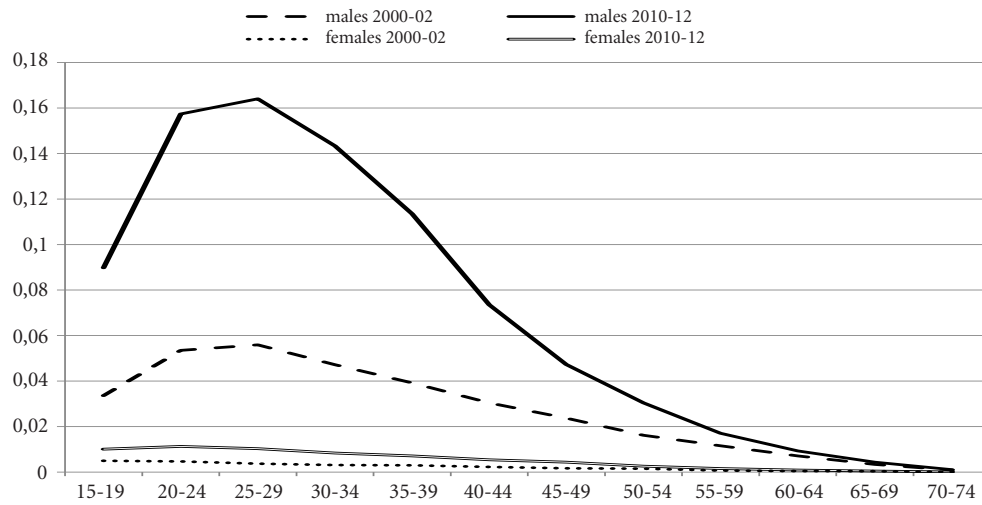
	2000-2002		2010-2012	
	Absolute numbers	%	Absolute numbers	%
Homicides	16034	78.4	53253	88.6
Events of undetermined intent	984	4.8	3806	6.3
Suicides	2096	10.2	1666	2.8
Accidents	1349	6.6	1386	2.3
Totals	20463	100.0	60111	100.0

Source: Prepared by the authors based on data from the National Health Information System of the Ministry of Health, Mexico.

Table 2. Years of life expectancy lost (YLEL) due to selected causes of death in persons aged between 15 and 75 years, by sex: Mexico, 2000-2002 and 2010-2012.

	2000-2002	2010-2012	Cambio relativo (%) 2000-02/ 2010-12	AEVP (%) por causa, 2000-2002	AEVP (%) por causa, 2010-2012
Males					
Firearms	0.3227	0.8512	163.77	4.89	11.99
Diabetes mellitus	0.6593	0.8075	22.48	9.99	11.37
Motor vehicle traffic accidents	0.4677	0.4878	4.30	7.09	6.87
Malignant neoplasms	0.5523	0.6056	9.65	8.37	8.53
Ischemic heart disease	0.7224	0.6989	-3.25	10.95	9.84
Total YLEL	6.5967	7.1018	7.66		
Temporary life expectancy	53.4	52.9	-0.94		
Females					
Firearms	0.0267	0.0626	134.46	0.68	1.65
Diabetes mellitus	0.7043	0.7292	3.54	17.83	19.27
Motor vehicle traffic accidents	0.1080	0.1063	-1.57	2.73	2.81
Malignant neoplasms	0.2862	0.2692	-5.94	7.25	7.11
Ischemic heart disease	0.9373	0.8561	-8.66	23.73	22.63
Total YLEL	3.9492	3.7838	-4.19		
Temporary life expectancy	56.05	56.21	0.29		

Source: Prepared by the authors based on data from the National Health Information System of the Ministry of Health, Mexico.

Figure 2. Years of life expectancy lost (YLEL) due to firearms-related deaths by age groups and sex. Mexico , 2000-2002 and 2010-2012.

Source: Prepared by the authors based on data from the National Health Information System of the Ministry of Health, Mexico.

Table 3. Years of life expectancy lost (YLEL) due to selected causes of death in persons aged between 15 and 75 years, by age group and sex: Mexico, 2010-2012 .

	Firearms	Diabetes Mellitus	Motor Vehicles Traffic Accidents	Ischaemic Heart Diseases	Malignant Neoplasms
Males					
15-19	0,0898	0,0014	0,0634	0,0037	0,0266
20-24	0,1574	0,0040	0,0888	0,0085	0,0274
25-29	0,1640	0,0071	0,0756	0,0140	0,0267
30-34	0,1433	0,0148	0,0613	0,0202	0,0281
35-39	0,1135	0,0258	0,0523	0,0300	0,0353
40-44	0,0735	0,0469	0,0399	0,0408	0,0452
45-49	0,0473	0,0852	0,0324	0,0604	0,0610
50-54	0,0304	0,1255	0,0275	0,0845	0,0844
55-59	0,0171	0,1593	0,0209	0,1013	0,1044
60-64	0,0093	0,1645	0,0145	0,1076	0,1153
65-69	0,0044	0,1244	0,0084	0,0925	0,0997
70-74	0,0011	0,0487	0,0027	0,0420	0,0449
Females					
15-19	0,0101	0,0021	0,0167	0,0017	0,0173
20-24	0,0113	0,0041	0,0173	0,0025	0,0163
25-29	0,0103	0,0065	0,0139	0,0038	0,0224
30-34	0,0084	0,0087	0,0104	0,0048	0,0346
35-39	0,0071	0,0163	0,0099	0,0086	0,0549
40-44	0,0054	0,0305	0,0082	0,0124	0,0747
45-49	0,0044	0,0596	0,0076	0,0209	0,1067
50-54	0,0026	0,1011	0,0069	0,0325	0,1293
55-59	0,0016	0,1427	0,0056	0,0422	0,1356
60-64	0,0009	0,1649	0,0051	0,0552	0,1275
65-69	0,0005	0,1362	0,0034	0,0550	0,0968
70-74	0,0001	0,0565	0,0012	0,0296	0,0402

Source: Prepared by the authors based on data from the National Health Information System of the Ministry of Health, Mexico.

substantially, with malignant neoplasms and diabetes mellitus causing the most YLEL.

Discussion

Although the mortality rate due to FA in Mexico in 2000 might not have been considered low (6.9 per 100,000), it was nevertheless not among the highest in the world[35]. However, since the decline in that rate between 2000 and 2007, the risk to the Mexican population of death by FA has sharply increased recently. According to international statistics, Mexico in 2012 was among the countries with the highest mortality rates by FA worldwide, surpassed only by Latin American countries such as Honduras, El Salvador, Guatemala, Venezuela, Colombia and Brazil[36,37], and with a rate higher than that of the United States, the industrialized country with the highest mortality rate due to FA[38].

A comparison between the rates in Mexico and the United States better illustrates the changes that have occurred in recent years: whereas in 2000, the mortality rate from FA in Mexico was only two-thirds that of the United States (6.9 per 100,000 vs. 10.2 per 100,000)[35], in 2012, it was 50% higher than the US rate (15.9 per 100,000 vs. 10.5 per 100,000)[38].

Although an increase in FA-related deaths was observed for both sexes, it was more pronounced among men than women; thus, although the male excess mortality due to FA over the entire period studied is evident, it has been amplified since 2008. Indeed, the male rate has been at least 12-fold higher than the female rate since that time, including in 2008, when the male rate (18.5 per 100,000): female rate (1.11 per 100,000) ratio was 16.6: 1. These figures surpass those observed in Argentina (10.6: 1)[15] and the United States (6.2: 1)[38] in 2012.

In this context, it is worth emphasizing that if FA were considered a cause of death in 2012, it would rank as the sixth leading cause of death in Mexico due to the number of FA-related deaths in both sexes (18,707 in that year), causing more deaths than motor vehicle traffic accidents or chronic obstructive pulmonary diseases – to mention only a few of the causes that have traditionally caused many deaths in the country – or any independently analyzed type of malignant neoplasm (trachea, bronchi and lung, breast, cervix or prostate) or other more lifestyle-related causes, such as alcoholic liver diseases or HIV/AIDS[20].

Because the vast majority of FA-related deaths over the last decade in Mexico were homicides, some arguments proposed in previous studies[1,2,18] to explain the evolution of the homicide rate in Mexico, with a pattern similar to the rate of FA-related deaths in recent years, may be valid to understand the reduction in the mortality rate from FA between 2000 and 2007 and its remarkable rise thereafter.

Thereby, although the decline appears related to certain structural improvements, such as the increase in gross domestic product per capita, a slight decrease in poverty levels and relatively low levels of unemployment, among others, the increase in FA-related deaths observed after 2007 would not only respond to the worsening of these conditions – which undoubtedly has occurred, as is the case of the increase in the percentage of people in poverty since 2008[39] – but also to the effect of conjunctural factors. Such factors include the intensification of the fight against drug-trafficking cartels for the control of territories, which implies the use of even more powerful firearms (cartels have gone from the use of 38-mm revolvers to the use of assault rifles such as the AK-47)[40], the war against organized crime undertaken by the Mexican government since 2007 (with the deployment of the army in much of the country), high levels of impunity and corruption in the country's security and justice systems[41,42] and the increasing number of firearms in the hands of civilians, which mostly enter illegally along the border with the United States[1,35].

According to international sources, individuals in Mexico circa 2007 had more than 15.5 million FA[43], of which only 2.8 million were registered[44]. Most observers agree that the availability of firearms increases the lethality of violence and moves in tandem with the increase in firearm homicides[35].

It is against this violent environment that the impact of firearms on the health of the Mexican population and particularly on the behavior of life expectancy in the country must be analyzed. Concurrent with the increase in FA-related deaths, in the period considered in this study, the male temporary life expectancy between 15 and 75 years was reduced by 1%, while the female temporary life expectancy increased by only 0.29%. These results are consistent with the slowdown observed in the increase in life expectancy at birth in Mexico[15].

The findings of this study show that life expectancy between 15 and 75 years might have

grown more in the decade analyzed, or at least would not have regressed as occurred among men, had the FA mortality rate not increased drastically in recent years and thus the number of YLEL from this cause. In particular, during the triennium 2010-12, the negative impact of FA-related deaths on male life expectancy between the ages of 15 and 75 years was greater than that of the main causes of death in the country, with the greatest impact on younger ages evident in both sexes.

Unfortunately, almost no studies at the international level exist to compare the impact of firearms on life expectancy. One exception is the study by Lemaire[19], who estimated, using a methodology different from the one employed in this study, the YLEL (from age 0) by FA for the United States in the year 2000 at 0.46 for men and 0.08 for women; both rates are above the YLEL found in this study for Mexico in the triennium 2000-2002 (although for the temporary life expectancy between 15 and 75 years).

The greater impact of FA-related deaths on male life expectancy must be understood from a gender perspective. While violence is not an exclusive practice of men, it is culturally related to male identity. Social norms not only assign males the role of protector and defender but also accept his role in yielding to violent, risky and extreme behaviors; thus, contextually, the possession of an FA is a symbol of male power and status[35]. Whereas men predominantly participate in activities of organized crime, particularly those of drug cartels that have great power derived from the possession and use of high caliber FA, alternatively, in an environment where violence has been normalized, indeed glorified, in which insecurity predominates and FA are easily accessible, conflict resolutions between men commonly unfold violently using FA[18].

Together with these factors, conditions exist that favor the increase in violence among the youth population: social inequality, the lack of jobs (or the precarization of labor), the academic impoverishment in secondary education that lowers the possibility of achieving appropriate scores for university admission and the lack of sufficient openings for study at public universities, coupled with the fact that the largest number of adolescents and young people in the history of the country now exists, which generates a high number of young people between 15 and 29 years old who are not employed or enrolled in education or training (almost seven million according to the Organization for Economic Co-operation

and Development, OECD[45]). This constellation of factors favors an increased likelihood that young people will be exposed to criminal acts or be involved in committing crimes, belong to a gang or be recruited by organized crime, which increases the access of young people to FA[46,47].

Concurrently, among many young people, the idea that having an FA in the home as necessary to defend oneself against crime is widespread given the lack of trust in the authorities[48]. The presence of a high number of FA on the black market and the ease of obtaining them, factors that young people themselves recognize[48], leads to accidents, suicides with this type of weapon and many criminal acts involving FA, causing more FA-related deaths.

Many of the deaths caused by FA are considered preventable, making this pandemic a problem to be addressed by public health professionals[35]. However, analyzing the impact of deaths caused by FA from an epidemiological approach does not imply that this issue is viewed from a medical perspective. What warrants recognition is that this problem is not only one of lacking security but also a complex public health challenge and that moreover, any solution must involve the participation of different sectors and the discussion of knowledge from different disciplines to prevent deaths from this cause to the greatest extent possible[13].

Clearly, FA are not essential to perpetrating violent acts. However, their importance resides in the fact that FA increase the reach and lethality of violence; therefore, disassociating them from violent conflicts must become an objective in itself in the context of public policies aimed at reducing violence. When this goal is successfully fulfilled, lives will be saved even if the rates of aggression and robbery remain high[35].

While reducing FA-related deaths is required to achieve an increase in life expectancy in Mexico, particularly that of men, it would be timely and necessary, not only for the country's public health but also for national security, to design and standardize national and local preventive policies along with the generation of debate to analyze legislation on the possession, carrying and use of FA and the implementation of actions to control the illegal entry of firearms into the country[13,49]. Among other things, these objectives involve designing or strengthening programs that promote peaceful coexistence in families and schools and that prohibit the entry of arms into the latter. Additional measures include conducting campaigns to raise awareness among the population that

keeps FA in their homes regarding FA storage, corresponding safety measures and responsible FA use, as well as to stimulate amnesty policies for the owners of illegal FA through the implementation of plans to repurchase or exchange FA for toys[49-51].

Evidently, policies concerning the control of FA must be viewed in the context of a comprehensive policy that addresses the various dimensions of violence[14] because without an adequate strategy to attack basic social problems, such as poverty, social inequality, unemployment and hence the lack of opportunities for a decent life, coupled with the need to reduce existing levels of impunity in the country and to re-evaluate existing policies to reduce illegal drug trafficking and limit their consumption, the demand for FA and the number of deaths caused by them will scarcely be reduced.

Additionally, strategies devised to change the social and cultural norms that perpetuate violence are necessary, particularly regarding the acceptance of FAs as conflict-resolution instruments[51], which is certainly not an easy task. This undertaking implies the need to work with communities to ensure that people believe that they can successfully resolve conflicts peacefully and that violence is not necessary, nor FA, to resolve disagreements[52]. In this context, the modification of social norms should effectively contribute to reversing values that traditionally are associated with the hegemonic concept of masculinity and that imply the exercise of violence [18]. However, for these strategies to be successful, drastic reductions in the levels of impunity and corruption that permeate the country's judicial system are necessary.

This study presents some limitations. First, although the coverage and quality of mortality records in Mexico is generally satisfactory and has improved markedly with respect to the final decades of the previous century[53], challenges remain. These include the underreporting of child deaths and maternal mortality rates in the states with the greatest social marginalization[54] that might lead to an underestimation of mortality

rates and therefore an overestimation of life expectancy. These factors warrant caution regarding the interpretation of any results extracted from the life tables, such as TLE or YLEL. However, the fact that the differences were relatively small, i.e., less than 1%, between the official life expectancies and those calculated in the study (for example, official male life expectancy at birth in 2012 was 71.4[15] and was estimated at 71.8 in this study for the triennium 2010-12) allows us to assume that no overestimation occurred that was so marked as to substantially affect the interpretation of the results presented here.

Similarly, the lack of complete records concerning FA-related deaths or deficiencies in the information quality may be suspected, particularly because the vast majority of FA-related deaths were due to homicide, which might have led to an underestimation of mortality by FA and YLEL from this cause. However, no evidence exists that these problems occur in any particular triennium or that they are so prominent as to have a significant impact on the comparisons and analyses performed.

Finally, should other assumptions have warranted consideration for the calculation of YLEL[34], assuming any of them indeed were, the results would not have altered the meaning of the findings based on the zero-mortality assumption. For example, had the real mortality assumption between 15 and 75 years been employed, although YLEL would have decreased for all causes compared to those calculated in this study, FA mortality would have remained as the main cause of YLEL for men in the triennium 2010-12.

Despite the aforementioned limitations, the results found allow a reasonable and novel approach to the recent patterns of FA-related deaths in Mexico and their negative impact on the country's life expectancy. The use of an indicator such as YLEL adds strategic value to the analysis of changes in FA-related deaths in recent years; moreover, it offers decision makers concrete evidence of the impact of FA on the health of the Mexican population and their role in life expectancy stagnation in the country, particularly for men.

Collaborations

GJ González-Pérez and MG Vega-López participated in the design of the study, data analysis and interpretation, initial conception and writing of the article, critical review of the importance of the intellectual content of the article and the editing and approval of its final version. ME Flores-Villavicencio participated in the design of the study, review of the article and approval of the final version.

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