Violence and fatal accidents: Analysis of mortality from external causes in Colombia and Mexico, 1998-2015

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Abstract: The purpose is to analyze the level, trend and impact of external mortality in Colombia and Mexico from 1998 to 2015. The years of life loss of children under the age of 85 were calculated, and the trend was estimated by model regression analysis. These causes of death and age groups contribute to changes in life expectancy at birth. In Colombia, mortality from all analyzed external causes decreased significantly; in Mexico, the rising murder death rate and the rising suicide rate have reversed their downward trend. The mortality rate in Mexico is higher than that in Colombia, which clearly shows the different trends in the two countries.

Keywords: Colombia; Mexico; External causes; Mortality; Life expectancy

1. Introduction

Mortality from external causes is currently one of the major global public health problems (Cardona, Pelaez, Aidar, et al., 2008). It is an indicator of health inequality and has a significant social and economic impact on the population (Yunes and Zubarew, 1999). The external causes of death are usually divided into intentional or violent ones (suicide and murder) and unintentional ones (traffic accident or other accidents).

It is estimated that 1.6 million people die each year from murder and suicide (520,000 and 815,000 respectively), accounting for more than 2.5% of the total global deaths (WHO, 2014; Burrone, Bella, Acosta, et al., 2012). Road traffic accidents caused 1.2 million deaths. It’s the eighth leading cause of death, accounting for 2.25% of the total number of deaths (National Accident Prevention Commission, 2013); other accidents cause more than 2.4 million deaths each year, accounting for 4.41% of the total deaths (WHO, 2017).

External deaths affect the population of all ages. However, the highest incidence is in the 15-49 age group, which is the leading cause of death worldwide (Yunes and Zubarew, 1999; WHO, 2014). An important feature is that, in addition to 5 million deaths each year, a large number of people suffer from non-fatal injuries, many of whom are seriously injured due to the need for medical, psychological or rehabilitation care (National Accident Prevention Commission, 2013), resulting in billions of dollars in social and economic costs (Yunes and Zubarew, 1999; WHO, 2014).

In Latin America, mortality from these causes is very high and has a significant impact on overall mortality (Yunes and Zubarew, 1999). In Mexico, external deaths account for a high proportion of epidemiological investigations in the country, mainly between the ages of 15 and 49 (INEGI, 2017). In 2015, only 63,400 people died from such diseases. In the same year, murder was the seventh leading cause of
death in the country; there are 8 other accidents; traffic accidents were listed as the 10th leading cause of death and suicide ranked 16th (INEGI, 2017). In recent years, murders have increased after a period of decline (Davila-Cervantes and Pardo-Montanio, 2013; Aburto, Beltran-Sanchez, Garcia-Guerrero, et al., 2016; Gonzalez-Perez, Vega-Lopez, Souza, et al., 2017). On average, 16,500 Mexicans die in traffic accidents every year, but the death toll accounts for only a small proportion of reported traffic accidents (National Accident Prevention Commission, 2013). With regard to suicide, although their participation in this cause of death group was the lowest in the country, the suicide rate had increased steadily over the past 40 years (Borges, Benjet, Orozco, et al., 2016). Although mortality from other accidents has decreased, these accidents have the greatest impact on the health of the Mexican population (Davila-Cervantes and Pardo-Montanio, 2016).

For its part, Colombia remains considered one of the most violent countries in Latin America. In general, external causes, especially violence, were the main causes of death from the 1980s to the early 1990s, mainly due to the high incidence of murder and suicide (Acosta and Romero, 2014). During this period, the murder mortality rate tripled (Carmona-Fonseca, 2005); suicide rates have increased since 1997 after relatively stable periods in the 1980s and the early 1990s (Cendales, Vanegas, Fierro, et al., 2007). However, accidental deaths showed a downward trend (Moreno, 2014), during which road traffic accidents remained at an almost consistent low level (Franco-Agudelo, 1997). At present, external causes are one of the main causes of death in Colombia, especially adolescents and youth.

Therefore, in Mexico and Colombia, external mortality is a major public health problem. In this context, the question arises about the recent impact of such causes of death on the health and life expectancy of the people of both countries. In view of this, the main purpose of this study is to analyze the level, trend and impact of external mortality in Colombia and Mexico by sex and age group from 1998 to 2015. The average life expectancy (AVP) between 0-85 years and the contribution of these causes of death to changes in life expectancy at birth were used.

2. Materials and Methods

An ecological, cross cutting and comparative study was conducted based on the statistical data of dynamic mortality by sex and five-year age group from the National Institute of statistics and geography of Mexico (INEGI) and the National Bureau of statistics of Colombia (DANE) for the period 1998-2015; the data for these two countries are considered to be of high quality (Mahapatra, Shibuya, Lopez, et al., 2007). According to the criteria of the international classification of diseases (ICD-10), death from external causes is considered as: Traffic accidents (AT) (V00-V99); other accidents (OA) (W00-X59); homicide (X85-Y09, Y87.1); suicide (X60-X84, Y87.0), and other related studies (Yunes and Zubarew, 1999; Burrone, Bella, Acosta, et al., 2012; Rockett, Regier, Kapusta, et al., 2012). OA includes falls, beatings, crushing and traumatic contact; accidental drowning; accidents caused by natural and environmental factors; animal attacks; accidental poisoning (Moreno, 2014). It should be noted that other non-claim events of ICD-10 (Y10-Y34) were not considered in the analysis. However, in order to exclude possible bias due to underestimation of the cause of death considered, death trends classified as intentional injury were also analyzed.

The purpose of calculating the average life year is to estimate the average life expectancy of deaths from external causes between the ages of 0 and 85 from 1998 to 2015, i.e. to determine how many more years people who died from these causes before the age of 85 should have lived. The zero mortality hypothesis between two selected age groups was used, which had the advantage that the comparison is standardized when the observed mortality was compared with the assumed zero mortality (Arriaga, 1996). This technique is one of the main tools for measuring changes in mortality levels and helps to explain and understand studies on cause mortality (Arriaga, 1996), taking into account these changes and their impact on population health. The mean arterial pressure of people who died of cause of death \(j\) between the ages of \(x\) and \(x + n\) is:

\[
\bar{d}_{x+n} = \frac{n \cdot d_{x+n} \cdot \left( \left( n - nK_x \right) + (v - x - n) \right)}{l_a}
\]

The average AVP is calculated as follows:

\[
\bar{A} = \frac{\frac{1}{l_a} \cdot d_{x+n} \cdot \left( v - nK_x - x \right)}{l_a}
\]

(2)

Use

\[
\bar{d}_{x+n}
\]

(3)

It is assumed that the cause of death in mortality table \(j\) in each age group is the same as the observed death distribution;
\( k_x \) is the separation factor of death; \( v \) is the highest age in the analysis (85 years in this case) and \( l_a \) is the number of living people at the exact age \( a \) in the mortality table (the initial age in the analysis or 0 year in the study). In order to calculate the average AVP of cause of death \( j \), the AVP between \( a \) and \( v \) ages must be added.

AVP trends for each cause of death were estimated by a piecewise model regression analysis based on log linear models (Lopez-Campos, Ruiz-Ramos, and Soriano, 2014). This method is used to identify significant changes in time trends. The advantage of these regressions is that they show changes in trends and estimate the degree of growth (or decrease) in each interval by annual percentage change (APC) (Lopez-Campos, Ruiz-Ramos, and Soriano, 2014). The model starts from the minimum number of nodes or the number of years of cutting (corresponding to the straight line) for up to four years, and tests whether the trend slope of each segment is statistically different from that of the previous segment. These calculations were performed using the surveillance, epidemiology and final results program of free software (SEER; Joinpoint Regression Program, version 4.5.0.1). The estimates of these models chose a statistical significance level of 5%.

Life tables for 1998 and 2015 were obtained using standard demographic procedures (Preston, Guillot and Heuveline, 2001) to estimate changes in life expectancy at birth \( e_0 \). The extended model developed by Andrevv et al. (2002) and Gayet et al. (2014) was used to calculate the contribution of the cause of death by age group to this change. This method decomposes the difference between two and zero into the contribution of each component, whether by age, cause of death or both, that is, calculate the \( e_0 \) value of each external cause and/or age group that causes or subtracts the change in mortality. The change in life expectancy is calculated as follows:

\[
e_0^2 - e_0^1 = \sum_{x=0}^{\omega-n} \sum_{i=1}^{k} nC_x^{(i)}
\]

Where

\[
nC_x^{(i)} = n\delta_x \left[ \frac{nR_x^{(2)}\ln\{nP_x^2\} - nR_x^{(1)}\ln\{nP_x^1\}}{\ln\{nP_x^2\} - \ln\{nP_x^1\}} \right]
\]

Use

\[
n\delta_x = \frac{1}{2} \left[ (e_x^2 - e_x^1) \left[ xP_0^1 + xP_0^2 \right] - (e_{x+n}^1 - e_{x+n}^1) \left[ x+nP_0^1 + x+nP_0^2 \right] \right]
\]

\( nR_x^{(2)} \) is the proportion of the total number of deaths attributed to specific causes of \( i \) among the \( k \) causes of death considered in the analysis; \( nP_x \) refers to the probability that a \( x \)-year-old survivor has more than \( n \) years of death in the life circle; \( e_0^1 \) and \( e_0^2 \) are life expectancy in 1998 and 2015 respectively.

The number of deaths in non-specific age groups is allocated proportionally to other age groups. Only domestic deaths were considered, excluding: (I) unspecified records by sex (1,849 cases); (II) for AVP, the number of deaths over the age of 85 (41,027 cases in total) is not considered. On this basis, 2.64% of the records were discarded for AVP calculation.

3. Result

3.1 Colombia

In 1998, male deaths from external causes accounted for 33.3% of the total recorded in Colombia (the highest in 2002 was 34.7%), which fell to 18.3% in 2015; women peaked at 7.4% in 1998 and fell to 3.8% in 2015. Prominent was the murder cases in which men (about 63%) and women (36%) had the highest participation rate in the external cause group. Among these causes, the suicide rate was the lowest (6.1% for men and 10.5% for women). The male/female ratio of external deaths was 6 to 7.3 males per female; throughout the period, the rate of homicides exceeded 10.2, while the rate of other cases was less than 4.75.

Between 1998 and 2002, the average life expectancy of Colombian men suffered from external causes was about 6.1 years, indicating that if these causes of death were eliminated, life expectancy of people aging from 0 to 85 years would increase by 6.1 years (Tables 1a and 1b). During the reporting period, external mortality decreased significantly (Table 2), reaching three average levels in 2015 (Figure 1). From 1998 to 2002, women also had similar behavior, and the average arterial pressure was 0.920, which decreased to 0.47 in 2015; the decrease in AVP was significant, although it was lower
than that in men in APC (Table 2).

<table>
<thead>
<tr>
<th>Reason</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total external cases</td>
<td>1.3550</td>
<td>1.0089</td>
<td>0.8074</td>
<td>0.6098</td>
<td>0.6880</td>
<td>0.7671</td>
</tr>
<tr>
<td>Murder cases</td>
<td>0.0968</td>
<td>0.1091</td>
<td>0.1237</td>
<td>0.1383</td>
<td>0.1539</td>
<td>0.1695</td>
</tr>
<tr>
<td>Suicide cases</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
</tr>
<tr>
<td>Traffic accidents</td>
<td>0.1843</td>
<td>0.2476</td>
<td>0.0766</td>
<td>0.3182</td>
<td>0.0968</td>
<td>0.0534</td>
</tr>
<tr>
<td>Other accidents</td>
<td>0.2953</td>
<td>0.2953</td>
<td>0.2953</td>
<td>0.2953</td>
<td>0.2953</td>
<td>0.2953</td>
</tr>
</tbody>
</table>

Source: Self-compiled based on data from DANE (Colombia) and INEGI (Mexico) from 1998 to 2015.

Table 2b. Average life years lost due to external death and gender in Colombia and Mexico, 2007-2015

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Total external causes</td>
<td>0.4284</td>
<td>0.4361</td>
<td>0.4438</td>
<td>0.4515</td>
<td>0.4592</td>
<td>0.4669</td>
<td>0.4746</td>
<td>0.4823</td>
<td>0.4900</td>
</tr>
<tr>
<td>Murder cases</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
</tr>
<tr>
<td>Suicide cases</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
</tr>
<tr>
<td>Other accidents</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
</tr>
</tbody>
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Source: Self-compiled based on data from DANE (Colombia) and INEGI (Mexico) from 1998 to 2015.

Table 3. Average life years lost due to external death and gender in Colombia and Mexico, 2007-2015

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<tr>
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<tbody>
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<td>0.4361</td>
<td>0.4438</td>
<td>0.4515</td>
<td>0.4592</td>
<td>0.4669</td>
<td>0.4746</td>
<td>0.4823</td>
<td>0.4900</td>
</tr>
<tr>
<td>Murder cases</td>
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<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
<td>0.0322</td>
</tr>
<tr>
<td>Suicide cases</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
</tr>
<tr>
<td>Traffic accidents</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
<td>0.0361</td>
</tr>
<tr>
<td>Other accidents</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
<td>0.0534</td>
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<td>0.0534</td>
<td>0.0534</td>
</tr>
</tbody>
</table>

Source: Self-compiled based on data from DANE (Colombia) and INEGI (Mexico) from 1998 to 2015.

Due to the cause of death, the average number of deaths in homicides decreased significantly, from a maximum of 5.9 in 2001 to 2.1 in 2015. The mean arterial pressure in women decreased from 0.53 in 2002 to 0.19 (Figure 1). The decline in homicide mortality was statistically significant for both men and women throughout the study period (Table 2). Moreover, suicide led to lower mortality rates for men and women, although women had a higher APC. Similarly, as of 2011, male and female mortality rates had decreased, but since 2011, male and female mortality rates have increased. Overall, OA in both sexes showed a downward trend (Figure 1 and Table 2). According to the age group, the male exogenous AVP was mainly concentrated in the young and adult age groups, of which more than 80% occurred between the ages of 15-49. Colombian women were mainly between the ages of 15-64, but it is worth noting that more than 30% of OA occurs between the ages of 0-4. During this period, the average value of accidental injuries for both men and women showed a downward trend, with a slight increase in 2008 and 2011.
Table 2. Joinpoint analysis identifies changes in trends from 1998 to 2015

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Total study time</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Issue 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year</td>
<td>PCA</td>
<td>Year</td>
<td>PCA</td>
<td>Year</td>
</tr>
<tr>
<td>Suicide cases</td>
<td>1998-2015</td>
<td>-13*</td>
<td>1998-2000</td>
<td>3.6</td>
<td>2000-2013</td>
</tr>
<tr>
<td>Other accidents</td>
<td>1998-2015</td>
<td>-2.1*</td>
<td>1998-2001</td>
<td>-4.5</td>
<td>2001-2006</td>
</tr>
<tr>
<td>Other accidents</td>
<td>1998-2015</td>
<td>-3.0*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Murder cases</td>
<td>1998-2015</td>
<td>3.6*</td>
<td>1998-2007</td>
<td>-4.7*</td>
<td>2007-2010</td>
</tr>
<tr>
<td>Suicide cases</td>
<td>1998-2015</td>
<td>1.7*</td>
<td>1998-2003</td>
<td>3.8*</td>
<td>2003-2007</td>
</tr>
<tr>
<td>Traffic accidents</td>
<td>1998-2015</td>
<td>-1.1*</td>
<td>1998-2009</td>
<td>0.0</td>
<td>2009-2015</td>
</tr>
<tr>
<td>Other accidents</td>
<td>1998-2015</td>
<td>-2.7*</td>
<td>-</td>
<td>-</td>
<td>--</td>
</tr>
<tr>
<td>Suicide cases</td>
<td>1998-2015</td>
<td>4.1*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Traffic accidents</td>
<td>1998-2015</td>
<td>-1.4*</td>
<td>1998-2006</td>
<td>1.1</td>
<td>2006-2015</td>
</tr>
<tr>
<td>Other accidents</td>
<td>1998-2015</td>
<td>-2.4*</td>
<td>1998-2001</td>
<td>0.7</td>
<td>2001-2015</td>
</tr>
</tbody>
</table>

Source: Self-compiled based on data from DANE (Colombia) and INEGI (Mexico) from 1998 to 2015.

Between 1998 and 2015, life expectancy at birth in Colombia increased by 4.2 years for men and 2.9 years for women (Tables 3a and 3b). The main reason for the increase in men was the decline in mortality from external causes (accounting for 60% of the total increase), which was mainly concentrated between the ages of 15-29 and 30-49; in contrast, mortality from external causes decreased in women, but the change was smaller than that in men, mainly under the age of 5 and between the ages of 15-49 (Tables 3a and 3b).

The external cause of death that contributed most to the decline in male e0 murdered is mainly between the ages of 15 and 49. Three other external causes also have a positive impact on male e0, although the number is small, and three other external causes also have a positive impact in other age groups: the positive impact of suicide was concentrated between the ages of 15 and 29; the positive contribution of AT was mainly between 15-49 years old; the decline of OA mortality was mainly concentrated under the age of 5 and between the ages of 15-49. For women, OA was the external cause of death...
that contributed the most to life expectancy, with a focus on people under the age of 5; the second largest case was murder, especially between the ages of 15 and 49. It is necessary to emphasize the positive contribution of OA, especially among children under the age of 5; the contribution of suicide was very small, mainly concentrated in the age group of 15-29.

**Figure 1.** Years of life lost due to external causes in Colombia and Mexico, 1998-2015.
Source: Self-compiled based on data from DANE (Colombia) and INEGI (Mexico) from 1998 to 2015.
3.2 Mexico

In 1998, external causes accounted for 16.9% of the total number of male deaths in Mexico, and this figure increased to 17.1% in 2011 and decreased to 14.1% in 2015. In 1998, women accounted for 5%, which fell to 4.1% in 2015. Unlike Colombia, the main external causes of death in Mexico in 1998 were OA—the male (37%) and the female (48%). After 2009, homicides became the main cause of male external death (up from 43% in 2011); the main cause for female external death was still OA (41.3%). Among the external causes, suicide accounts for the lowest proportion. Violence and fatal accidents: death analysis... in both sexes (less than 11%), but showing an upward trend. Between 1998 and 2015, the
male/female ratio was 3.8 to 4.8 male deaths per female; this rate peaked at 9.6 in 2010, and the male murder rate per woman was higher than 6.7 in all study years; the suicide rate showed a downward trend throughout the period.

In 1998, due to external reasons, the average life expectancy of men lost 4.7 years and showed a downward trend in 2006 (Figure 1). Since that year, this figure had risen to five peaks in 2011, which meant that the mortality rate from all external causes in that year and before 2014 was higher than that in Colombia. Subsequently, AVP decreased to 2007 levels (Figure 1). This means that these reasons have not changed over this period of time (Table 2). During the study period, the trend of mean arterial pressure in women was stable and decreased slightly.

Between 2007 and 2011, the average crime rate of male and female murders increased (Tables 1a and 1b, Figure 1). There was a significant increase in male suicide mortality; for women, for this reason, the mean arterial pressure doubled without any breakpoints in its growth trend (Table 2). Compared with TA, TA of both sexes decreased slightly but statistically significantly during the study period (Tables 1a and 1b). For OA, mortality decreased throughout the period; among men, there was no turning point in this trend. Unlike Colombia, Mexico's AVP was concentrated in men aged 15-64 (80% of the total male AVP were caused by external reasons) and women aged 15-84 (more than 66%), with a high proportion under the age of five. In Mexico, the average arterial pressure of unexplained intentional injury decreased in both men and women until 2008, but there was a significant and unusual increase in 2011 and another decrease in 2015.

Between 1998 and 2015, \( e_0 \) in Mexico increased by 2.3 years for men and 1.8 years for women (Tables 3a and 3b). In general, external factors contributed less to the change of \( e_0 \), especially for men under the age of 5 and 50-64 in Colombia; although the contribution of external factors to female \( e_0 \) was mainly the decline of mortality for children under 5, a large part of these changes were offset by the increase in female mortality between the ages of 15 and 29. The causes of death for reducing male \( e_0 \) were murder and suicide, mainly between the ages of 15 and 49. The mortality of AT and OA in men decreased, mainly under the age of 5 and between the ages of 15-64. Moreover, murder and suicide also reduced two causes of death for women aged 15 to 49. It highlighted the positive contribution of TA to \( e_0 \) and OA in all age groups before the age of 65.

4. Discussion

The external cause of death is one of the major public health problems in Latin America. These are seen as indicators of lack of access and quality of care and are mechanisms for controlling and preventing the risk of exposure accidents and attacks (Gomez, 2008). These causes cause tragic personal losses (Aburto, Beltran-Sanchez, Garcia-Guerrero, et al., 2016) and high economic and social costs (Yunes and Zubarew, 1999), and may cause physical injury, disability and/or psychological consequences to victims, resulting in a large number of AVP and a decline in life expectancy, which is a manifestation of the decline in people's life quality.

These results confirmed the great impact of external mortality on the life expectancy of the two populations, and also explained their different behaviors in terms of the cause of death, age and gender. In Colombia, mortality from all external causes has decreased significantly, especially that from murders since 2002 (Sanchez, Diaz, Pelaez, et al., 2012; Davila-Cervantes and Pardo-Montanio, 2015; Salazar, Buitrago, Molina, et al., 2015). The mortality from all external causes of both men and women have declined. This meant that external causes of death are no longer the main cause of death in Colombia (Acosta and Romero, 2014); this happened in the 1990s, and Colombia had the highest mortality rate from these causes in the world (Briceno-Leon, Villavez, and Concha-Eastman, 2008). However, the situation in Mexico was different. Although mortality from external causes did not increase during the reporting period, the increase in homicide mortality (Aburto, Beltran-Sanchez, Garcia-Guerrero, et al., 2016; Davila-Cervantes and Pardo-Montanio, 2015) and the continued rise in suicide rates (Borges, Orosco, Medina-Mora, et al., 2016) since 2008 had reversed the downward trend of these causes in the decade before this date. It stressed that from 2011, the mortality rate of men and women in 2004 was higher than that of Colombia, which clearly showed the different trends between the two countries.

It must be emphasized that the trend of unproven intentional injuries in Colombia is the same as that of all the external causes analyzed, which seems to indicate that there is no deviation in the estimates. In Mexico, by contrast, although the behavior of these causes is similar to that of external causes, there was an abnormal increase in 2011, the year with the highest murder mortality rate in the country's recent history. This result may indicate a serious underestimation of the impact of external mortality (especially murder cases) described in the present report on the country's life expectancy in that year; it is suggested that the situation on this subject be further addressed in future studies.

There is evidence that men lose four times as much life as women due to external causes, mainly adolescents and young people (Burrone, Bella, Acosta, et al., 2012). The dynamics of this difference in morbidity and mortality between men and women caused by external causes were related to different social learning behaviors in the process of establishing gender identity (Figueroa, 2015; Burin and Meler, 2000). This male identity model includes expected behaviors (such as ability, risk and control) to cope with the different situations they face every day. From childhood, men have learned to take risks and internalized these behaviors (Figueroa, 2007). This stage reaches its peak in adolescence and adulthood. The age at
which deliberately expose themselves to hazardous situations becomes the expected social condition for men (Figueroa, 2015). Although in the process, they expose their health and well-being, which, most of the time, lead to their own death (Trevino-Siller, Villanueva-Borbolla, Marcelino-Sandoval, et al., 2014; Mansfield, Addis and Mahalik, 2003). Therefore, it can be said that the main factors related to external mortality are gender and age (Figueroa, 2007; Trevino-Siller, Villanueva-Borbolla, Marcelino-Sandoval, et al., 2014).

In both countries, the external cause was mainly male murder, mainly between the ages of 15 and 49, although the trend was opposite: the murder mortality rate in Colombia has decreased significantly since 2002; in Mexico, however, the opposite is true, with a significant increase between 2008 and 2012, consistent with other studies (Gonzalez-Perez, Vega-Lopez, Souza, et al., 2017). The decrease in murders in Colombia was due to the increased mobility and effectiveness of the armed forces (Moreno and Cendales, 2011) of the Colombian plan implemented in 1999 (Palacios and Serrano, 2010), which led to the gradual disintegration of drug trafficking organizations, which in turn led to the reorganization of production chains, the distribution and sale of narcotic drugs and the decline in cocaine crops (Baron, 2009; Garcia, Giraldo, Lopez, et al., 2012). In contrast, the rise in murder violence in Mexico was due to military intervention as part of the federal government’s anti-drug campaign in 2007 (Lee and Bruckner, 2017). As the army entered the drug trafficking corridor, conflicts with cartels led to an increase in murders. In turn, the strategic dismissal of cartel leaders undermined their internal relations, which led to division and thus triggered an internal succession war, and led to the escalation of murders mainly among young people (Molzahn, Rodriguez-Ferreira and Shirk, 2013).

On the other hand, the suicide rate of the two countries shows the opposite trend and obvious age and gender differences. In Colombia, this proportion has decreased significantly mainly between the ages of 15 and 29, which is a positive contribution to \( e_0 \). In Mexico, the growth trend reported since the 1970s continued (Borges, Orozco, Medina-Mora, et al., 2016; Borges, Orozco, Benjet, et al., 2010), which reduced \( e_0 \) concentrated between the ages of 15 and 49. The main factors associated with this cause of death are previous suicide attempts (Borges, Orozco, Benjet, et al., 2010), men, mental disorders (mainly depression), drug and alcohol abuse (Sheehan, Rogers, Williams, et al., 2013), and the increase of chronic degenerative diseases, which may cause great pain to patients (Rojas-Cabrera, 2015). Economic losses, economic instability, underemployment and poverty increase anxiety and can lead to suicide (Borges, Orozco and Medina-Mora, 2012; Xavier, Gomes, Nazareth, et al., 2006).

After analyzing the impact of AT on the number of \( e_0 \) and AVP, PTA mortality decreased in both countries, although Colombia has rebounded slightly since 2012. As in other cases, mortality in these two countries is mainly concentrated in young people (Chandran, Kahn, Sousa, et al., 2013). In addition to Mexican women, the mortality rate of women under the age of 5 was also high; these causes of death usually have the greatest impact on pedestrians, followed by motorcyclists and cyclists, i.e. vulnerable users. The main risk factors associated with AT are the increase in the number of vehicles in motion and the so-called dangerous behaviors, such as speeding, drug abuse (alcohol or drugs), not using seat belts, non-compliance with traffic signs and the use of distractors (such as mobile phones) while driving (Trevino-Siller, 2014).

The OA mortality decreased in both countries. Its incidence depends on the stage of people’s life. For example, children are at increased risk of ingesting foreign bodies, resulting in airway obstruction; and people during adolescence and youth engage in dangerous activities; the elder are more likely to fall (Paulsen-Sandi and Mejia-Salas, 2005; Dorta-Figueroedo, Godo-Gonzalez, Castellon-Gonzalez, et al., 2013).

According to the above results and considering the importance of death from external causes in the epidemiological research of the two countries, there must be accurate information to monitor its incidence, and conduct multidisciplinary research to focus on the dynamics of multiple factors related to deaths from these causes. Young people are the main victims of external death; about three-quarters of the total loss of life caused by these causes of death occurred in adults and young people. Therefore, for actions to prevent these diseases, it is necessary to take into account the age groups most affected and the gender factor (Figueroa, 2007; Trevino-Siller, 2014), including the participation of all sectors of society, and must also take into account the specificity of each cause of death.

These actions should aim to continue to reduce mortality from external causes in Colombia and reverse the current trend of murder and suicide in Mexico, which would offset the benefits of the decline in at and OA mortality. Traffic accidents can be prevented by restricting the use of alcoholic beverages, reducing speed limits, strengthening the use of safety facilities, improving infrastructure and signs on public roads and promoting compliance with road rules; suicide through early detection and timely treatment of its risk factors; killing through violence prevention programs and stricter restrictions on access to firearms. Given the various factors associated with accidents, joint preventive measures should be promoted, including information campaigns, as well as the development and implementation of standards (Lund and AARø, 2004).

4.1 Limitations

The results presented should be interpreted in the light of certain important limitations. First, the focus of this study is death. It does not take into account that many non-fatal events will occur in every external cause death, so the impact of external
causes on population health may be underestimated. That is, in this study, it is impossible to determine the health damage caused by traffic injury, attempted suicides or various accidents, which will not lead to death and may lead to huge social and economic costs, such as permanent disability, incapacity to work, the need for special care, psychotherapy and the use of rehabilitation services. Second, because the information used is horizontal, it is impossible to analyze the possible causes of the different causes of death analyzed. Third, estimates of murder and suicide mortality may be underestimated due to the nature of the phenomena studied. In the case of murder, deaths caused in armed conflicts or killed by illegal groups are not recorded and covered by the National Death Register (Moreno and Cendales, 2011); with regard to suicide, there is a tendency to hide suicide due to cultural or religious reasons and registration procedures (Rodriguez, 2006; Madge and Harvey, 1999).

Nevertheless, mortality data in the region, especially in Mexico and Colombia, have gradually improved (Mahapatra, Shibuya, Lopez, et al., 2007). Despite the limitations of this study, the results obtained are related to explaining the changes in external mortality in Colombia and Mexico, the impact on population life expectancy and the different trends in the two countries.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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References


Carmona-Fonseca J. (2005). Cambios demográficos y epidemiológicos en Colombia durante el siglo XX [Demographic and


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