

Violence and mortal accidents: analysis of the mortality from external causes in Colombia and Mexico, 1998-2015

Violencia y accidentes mortales: análisis de la mortalidad por causas externas en Colombia y México, 1998-2015

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Abstract

The main objective was to analyze the level, trend and impact of mortality by external causes in Colombia and Mexico between 1998 and 2015. The years of life lost were calculated for people younger than 85 years of age and their trend was estimated using a joinpoint regression analysis. The decomposition of life expectancy by cause of death and age groups was also calculated. In Colombia a significant decrease was observed in all the analyzed external causes of death; in Mexico, the increase of mortality by homicides and the continued rise in suicides reversed their declining trend. Mexico presented a higher mortality due to external causes than Colombia, which clearly shows the divergent trends in both countries.

Key words: Colombia, Mexico, external causes, mortality, life expectancy.

Resumen

El objetivo fue analizar el nivel, tendencia e impacto de la mortalidad por causas externas en Colombia y México entre 1998-2015. Se calcularon los años de vida perdidos en menores de 85 años de edad y su tendencia se estimó por medio de un análisis de regresión de modelos segmentados. Se obtuvo la contribución de dichas causas de muerte y por grupos de edad al cambio en la esperanza de vida al nacimiento. En Colombia se observó un descenso significativo de la mortalidad en todas las causas externas analizadas; en México el incremento de la mortalidad por homicidios, y el continuo ascenso de los suicidios revirtieron su tendencia decreciente. México presentó una mayor mortalidad por estas causas que Colombia, lo que claramente ilustra las tendencias divergentes en ambos países.

Palabras clave: Colombia, México, causas externas, mortalidad, esperanza de vida.

INTRODUCTION

Death from external causes is one of the world's leading health problems (Cardona *et al.*, 2008). These deaths are an indicator of health disparities and inequities, and have enormous social and economic impacts (Yunes and Zubarew, 1999). External causes of mortality are generally classified as either intentional or violent (suicide or homicide), unintentional (traffic or other accidents), and of undetermined intent.

Each year, homicides and suicides end the lives of an estimated 1.6 million people (520,000 and 815,000 people respectively), about 2.5 per cent of the global death total (WHO, 2014; Burrone *et al.*, 2012). Traffic accidents are the eighth leading cause of death and claim the lives of 1.2 million annually, about 2.25 per cent of the global total (CONAPRA, 2013). Over 2.4 million are killed each year by other accidents, about 4.41 per cent of the total deaths around the world (WHO, 2017).

Deaths from external causes affect every age group. However, the highest incidence is found among those aged 15 to 49, and are the main causes of death for this group globally (Yunes and Zubarew, 1999; WHO, 2014). In addition to the five million people who die annually from external causes, it is important to mention the large group that suffers non-fatal injuries. Many such serious accidents will require medical and psychological care and rehabilitation (CONAPRA, 2013), leading to social and economic costs in the billions of dollars (Yunes and Zubarew, 1999; WHO, 2014).

In Latin America, external cause mortality is very high and has a major effect on general mortality rates (Yunes and Zubarew, 1999). In Mexico, deaths from external causes have a marked presence in the nation's epidemiological profile, primarily in the 15 to 49 age group (INEGI, 2017). In 2015, over 63,400 people died from this type of cause in Mexico. That year, homicides were the seventh leading cause of death nationally, other accidents the eighth, traffic accidents the tenth, and suicides the sixteenth (INEGI, 2017). After a period of decline, homicide rates have increased in recent years (Dávila-Cervantes and Pardo-Montaño, 2013; Aburto *et al.*, 2016; González-Pérez *et al.*, 2017). Each year on average, 16,500 Mexicans are killed in traffic accidents, although these deaths represent a small fraction of reported traffic accidents (CONAPRA, 2013). Suicide, despite being the most infrequent among these causes of death in Mexico, has seen an uninterrupted increase over the last four decades (Borges *et al.*, 2016).

While mortality rates from other accidents have decreased, these causes of death have a severe impact on Mexican public health (Dávila-Cervantes and Pardo-Montaño, 2016).

Colombia is still considered one of the most violent countries in Latin America. External causes, especially violent causes, have been the nation's main causes of death from the 1980s through the beginning of the last decade, primarily because of the high rates of homicides and suicides (Acosta and Romero, 2014). Mortality from homicides tripled during this period (Carmona-Fonseca, 2005), while suicide rates began to increase in 1997 after remaining relatively stable through the 1980s and the beginning of the 1990s (Cendales et al., 2007). Accidental deaths decreased during this period (Moreno, 2014), and traffic accidents have remained at a low, almost uniform level (Franco-Agudelo, 1997). Currently, external causes remain one of the leading groups of causes of death in Colombia, especially among young people.

Deaths from external causes are a fundamental public health problem both in Mexico and in Colombia, making plain the need for an examination of the recent impact of these causes of death on public health and life expectancy in these two countries. The main objective of this study is to analyze the levels, trends and impact of external cause mortality at a national level in Colombia and Mexico between 1998 and 2015, disaggregated by sex and age groups. The study used the years of life lost (YLL) due to deaths from external causes in those between 0 and 85 years old, and calculated the contributions of these causes of death to changes in life expectancy at birth.

MATERIALS AND METHODS

This is an ecological, cross-sectional and comparative study, performed using information from vital statistics provided by the National Institute of Statistics and Geography (INEGI) in Mexico, and the National Administrative Department of Statistics (DANE) in Colombia. The data span the period from 1998 to 2015, cover a national level, and are disaggregated by sex and five-year age groups. For both countries, this data is considered to be of high quality (Mahapatra *et al.*, 2007). As in other research in this area, this study employed the International Classification of Diseases (ICD-10) to determine criteria for deaths from external causes, using the following codes: Transport (traffic) accidents (TA) (V00-V99); Other accidents (OA) (W00-X59); Homicides (X85-Y09, Y87.1); and Suicides (X60-X84, Y87.0) (Yunes and Zubarew, 1999; Burrone *et al.*, 2012; Roc-

kett *et al.*, 2012). OA includes falls, blows, and crushings; accidental drownings, accidents caused by forces of nature; animal attacks, and accidental poisonings (Moreno, 2014). This analysis does not take the category of Events of Undetermined Intent (Y10-Y34) into consideration; however, the study did analyze trends of these deaths just to avoid possible biases arising from underestimating external cause mortality.

YLL were calculated to estimate the average number of years of life that were lost between 1998 and 2015 as a result of deaths from external causes of those 0 to 85 years old. In other words, this research determined how many additional years people 85 and under who died of external causes would have likely lived. The study supposed a null mortality for the ages examined (0-85); by comparing the observed situation with a hypothetical zero mortality, the comparisons are standardized (Arriaga, 1996). This technique serves as a primary tool to measure changes in mortality rates and sheds light on mortality rates by cause (Arriaga, 1996), drawing out the effect that each cause has on population health. The YLL of those aged x to $x+n$, who died of cause of death j , is

$${}_{u,n}AP_{x,j} = {}_n d_{x,j} [(n - {}_n k_x) + (v - x - n)]$$

with the YLL average calculated as

$${}_{u,n}ap_{x,j} = \frac{[{}_n d_{x,j} (v - {}_n k_x - x)]}{l_a}$$

and with

$${}_n d_{x,j} = {}_n d_x \left(\frac{{}_n D_{x,j}}{{}_n D_x} \right)$$

assuming that deaths from cause of death j in the mortality table for each age group have the same distribution as the observed deaths; ${}_n k_x$ is the separation factor of the deaths; v is the highest age analyzed (85 in this study); and l_a is the number of living persons of the exact age a in the mortality table, or the lowest age analyzed (0 in this study). To calculate the average YLL from cause of death j , the YLL between the ages of a and v are added.

A joinpoint regression analysis based on a log-linear model, was used to estimate YLL trends for each cause of death (López-Campos, Ruiz-Ramos and Soriano, 2014). This method can identify significant changes in temporal trends. These regression analyses have the advantage of show-

ing changes in these trends, and providing an estimate of the increase (or decrease) in each interval using the annual percent change (APC) (López-Campos, Ruiz-Ramos and Soriano, 2014). The model begins with the minimum number of nodes or cutoff years (using a maximum of four) corresponding to a straight line. The model can verify whether the slope of the trend lines found in each segment are statistically different from that of any previous segments. These calculations were made using the open-source Surveillance, Epidemiology, and End Results (SEER) Software (Joinpoint Regression Program version 4.5.0.1). A 5 per cent level of statistical significance was chosen for the estimation of these models.

Standard demographic procedures were used to obtain life tables for the years 1998 and 2015 (Preston, Guillot and Heuveline, 2001). With these life tables we estimated the changes in life expectancy at birth (e_0) between those years. To calculate the contributions of different external causes of death by age group to these changes, we used an extension of Andreev's et al. decomposition model (2002), as performed by Gayet et al. (2014). This method consists in breaking down the differences between two e_0 into the contributions of each component part, be that age, cause of death or both together. In this way, the model calculates the amount that the mortality change contributes to or subtracts from the e_0 , for each external cause and/or age group. The change in life expectancy is calculated as

$$e_0^2 - e_0^1 = \sum_{x=0}^{\omega-n} \sum_{i=1}^k {}_n C_x^{(i)}$$

in which

$${}_n C_x^{(i)} = {}_n \delta_x \left[\frac{{}_n R_x^{(i,2)} \ln \{{}_n P_x^2\} - {}_n R_x^{(i,1)} \ln \{{}_n P_x^1\}}{\ln \{{}_n P_x^2\} - \ln \{{}_n P_x^1\}} \right]$$

With

$${}_n \delta_x = \frac{1}{2} \left\{ [e_x^2 - e_x^1] [{}_x p_0^1 + {}_x p_0^2] - [e_{x+n}^2 - e_{x+n}^1] [{}_{x+n} p_0^1 + {}_{x+n} p_0^2] \right\}$$

${}_n R_x^{(i,2)}$ being the proportion of the total of deaths attributed to a specific cause i , between the k causes of death considered in the analysis; ${}_n P_x$ is the probability that a person aged x years in the life table has of living n ad-

ditional years; e_0^1 and e_0^2 are the life expectancies for the years 1998 and 2015 respectively.

Deaths of unspecified ages were proportionally redistributed into the other age groups. Only deaths that occurred within the borders of each country were considered. Mortality registries that did not specify sex (1,849 cases) were excluded, as were the YLL from deaths of those 85 and older (41,027 total cases). These criteria excluded 2.64 per cent of the total amount of registered deaths used to calculate YLL.

RESULTS

Colombia

In 1998, male deaths from external causes represented 33.3 per cent of the total number of deaths registered in Colombia. These deaths reached a maximum of 34.7 per cent in 2002, and decreased to 18.3 per cent in 2015. Among women, this figure reached a maximum of 7.4 per cent in 1998, and dropped to 3.8 per cent in 2015. Homicides were the most frequent external cause of death, both for men (approximately 63 per cent) and for women (36 per cent). Suicides were the least common external cause of death, at 6.1 per cent for men and 10.5 per cent for women. The male to female external cause mortality ratio oscillated between 6.0 and 7.3 male deaths for each female death. For homicides, the male to female ratio was above 10.2 throughout the period studied, while this ratio for the remaining causes was less than 4.75.

Between 1998 and 2002, the YLL due to deaths from external causes among Colombian men was 8.1; approximately what the life expectancy would be expected to increase by, if deaths by these causes were eliminated (Table 1). During this period, mortality from external causes decreased significantly (Table 2), and in 2015 lowered to 3 YLL (Figure 1). A similar behavior was observed among women, with 0.9 YLL between 1998 and 2002, later lowering to 0.47 YLL in 2015. While this is a significant decrease, it was lower in terms of APC than the decrease among males (Table 2).

In terms of change due to each external cause of death, YLL due to homicides decreased greatly, from a maximum of 5.9 YLL in 2001 to 2.1 in 2015 for men. Homicide YLL for women saw a maximum of 0.53 in 2002, and decreased to 0.19 in 2015 (Figure 1).

Table 1: Average years of life lost by external cause of death and by sex, Colombia and Mexico, 1998-2015

<i>Causes of death</i>		1998	1999	2000	2001	2002	2003	2004	2005	2006
Males Colombia	Total External Causes	8.0136	8.1067	8.2894	8.3738	8.2453	7.3686	6.5519	5.9085	5.6239
	Homicides	5.1638	5.3773	5.7701	5.9051	5.8876	5.0232	4.2483	3.6701	3.3781
	Suicides	0.3802	0.3910	0.4102	0.4152	0.3795	0.3778	0.3801	0.3608	0.3623
	Traffic accidents	1.6167	1.4232	1.3420	1.2816	1.2040	1.1800	1.1224	1.0802	1.0887
	Other accidents	0.8530	0.9152	0.7671	0.7719	0.7742	0.7876	0.8012	0.7973	0.7948
Females Colombia	Total External Causes	1.2529	1.3173	1.2140	1.2818	1.2532	1.1691	1.0562	0.9887	0.9677
	Homicides	0.4207	0.4391	0.4649	0.5212	0.5294	0.4648	0.3921	0.3397	0.2935
	Suicides	0.1126	0.1109	0.1182	0.1193	0.1163	0.1217	0.1060	0.0963	0.0945
	Traffic accidents	0.4436	0.4089	0.3669	0.3596	0.3388	0.3338	0.3178	0.2940	0.2953
	Other accidents	0.2760	0.3584	0.2640	0.2817	0.2687	0.2490	0.2402	0.2586	0.2844
Males México	Total External Causes	4.7336	4.6653	4.5590	4.4624	4.3150	4.2153	4.1068	4.0701	4.1166
	Homicides	1.3091	1.1955	1.0538	0.9987	0.9510	0.9269	0.8615	0.8788	0.9168
	Suicides	0.3056	0.3114	0.3274	0.3493	0.3470	0.3618	0.3676	0.3655	0.3599
	Traffic accidents	1.3206	1.3340	1.3454	1.3086	1.3212	1.3178	1.3449	1.3681	1.4131
	Other accidents	1.7983	1.8244	1.8325	1.8058	1.6957	1.6087	1.5328	1.4576	1.4267
Females México	Total External Causes	1.1590	1.1863	1.1638	1.2085	1.1743	1.1431	1.1153	1.1125	1.1277
	Homicides	0.1715	0.1584	0.1474	0.1437	0.1394	0.1405	0.1285	0.1341	0.1349
	Suicides	0.0518	0.0534	0.0572	0.0714	0.0679	0.0711	0.0698	0.0726	0.0702
	Traffic accidents	0.3630	0.3640	0.3694	0.3801	0.3874	0.3831	0.3814	0.3838	0.4055
	Other accidents	0.5727	0.6105	0.5898	0.6133	0.5796	0.5484	0.5355	0.5219	0.5172
<i>Causes of death</i>		2007	2008	2009	2010	2011	2012	2013	2014	2015
Males Colombia	Total External Causes	5.5480	5.4692	5.5392	5.2408	4.9313	4.7067	4.4829	4.0361	4.1141
	Homicides	3.2577	3.1975	3.4239	3.2296	2.9522	2.7181	2.5093	2.0905	2.0506
	Suicides	0.3623	0.3749	0.3564	0.3372	0.3306	0.3366	0.3182	0.3241	0.3453
	Traffic accidents	1.1440	1.1246	1.0745	0.9847	0.9709	1.0221	1.0423	1.0289	1.1236
	Other accidents	0.7840	0.7722	0.6844	0.6893	0.6776	0.6299	0.6130	0.5926	0.5946
Females Colombia	Total External Causes	0.9339	0.9126	0.9087	0.8460	0.8089	0.7583	0.7406	0.7203	0.7154
	Homicides	0.2929	0.2880	0.3209	0.3024	0.2777	0.2518	0.2322	0.2134	0.1938
	Suicides	0.0918	0.0909	0.0874	0.0768	0.0750	0.0743	0.0766	0.0690	0.0904
	Traffic accidents	0.2873	0.2774	0.2740	0.2472	0.2343	0.2367	0.2476	0.2527	0.2558
	Other accidents	0.2619	0.2563	0.2265	0.2196	0.2218	0.1955	0.1843	0.1853	0.1753
Males Mexico	Total External Causes	4.0671	4.4505	4.7836	4.9530	5.0229	4.9475	4.5129	4.1361	4.0344
	Homicides	0.7415	1.1771	1.5905	2.0018	2.1031	2.0070	1.7213	1.4448	1.4090
	Suicides	0.3479	0.3658	0.3845	0.3625	0.4135	0.3983	0.4177	0.4284	0.4062
	Traffic accidents	1.2228	1.3550	1.3522	1.2046	1.2313	1.2479	1.1500	1.1165	1.0488
	Other accidents	1.7550	1.5526	1.4565	1.3840	1.2750	1.2944	1.2239	1.1464	1.1704
Females Mexico	Total External Causes	1.0919	1.1009	1.1083	1.1144	1.1097	1.1271	1.0444	1.0067	0.9960
	Homicides	0.1072	0.1401	0.1736	0.2214	0.2431	0.2445	0.2291	0.1989	0.1903
	Suicides	0.0743	0.0831	0.0880	0.0853	0.1016	0.0968	0.0961	0.1057	0.1047
	Traffic accidents	0.3555	0.3744	0.3724	0.3513	0.3328	0.3461	0.2955	0.2850	0.2867
	Other accidents	0.5550	0.5032	0.4743	0.4564	0.4323	0.4396	0.4237	0.4171	0.4143

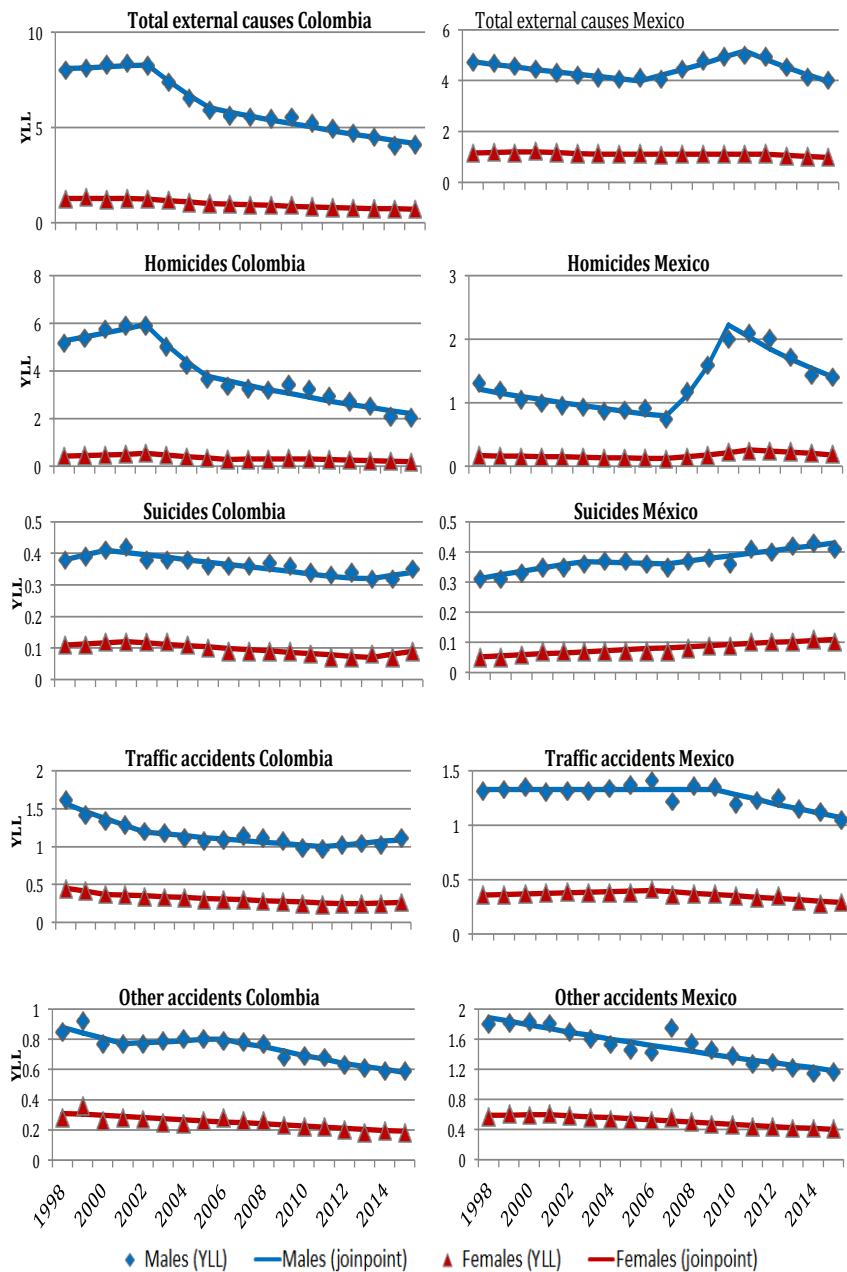
Source: Prepared by the authors using data supplied by DANE (Colombia) and INEGI (Mexico), 1998-2015.

Table 2: Joinpoint analysis used to identify changes in trends between 1998 and 2015

	Cause of death	Period of study		Period 1		Period 2		Period 3		Period 4	
		Years	PCA	Years	PCA	Years	PCA	Years	PCA	Years	PCA
Males Colombia	Total External Causes	1998-2015	-4.5*	1998-2002	0.6	2002-2005	-10.0	2005-2015	-3.7*	--	--
	Homicides	1998-2015	-6.0*	1998-2002	3.1	2002-2005	-13.9	2005-2015	-5.3*	--	--
	Suicides	1998-2015	-1.3*	1998-2000	3.6	2000-2013	-1.7*	2013-2015	2.6	--	--
	Traffic accidents	1998-2015	-2.1*	1998-2002	-6.6*	2002-2011	-1.9*	2011-2015	2.2	--	--
	Other accidents	1998-2015	-2.1*	1998-2001	-4.5	2001-2006	0.8	2006-2015	-3.6*	--	--
Females Colombia	Total External Causes	1998-2015	-3.8*	1998-2002	-0.4	2002-2005	-7.2	2005-2015	-3.5*	--	--
	Homicides	1998-2015	-5.2*	1998-2002	6.6*	2002-2006	-14.2*	2006-2010	1.3	2010-2015	-8.8*
	Suicides	1998-2015	-3.1*	1998-2001	3.3	2001-2013	-4.5*	2013-2015	10.2	--	--
	Traffic accidents	1998-2015	-3.3*	1998-2000	-9.0*	2000-2012	-3.7*	2012-2015	3.3	--	--
	Other accidents	1998-2015	-3.0*	--	--	--	--	--	--	--	--
Males Mexico	Total External Causes	1998-2015	0.0	1998-2006	-2.1*	2006-2011	5.3*	2011-2015	-6.3*	--	--
	Homicides	1998-2015	3.6*	1998-2007	-4.7*	2007-2010	41.4*	2010-2015	-8.7*	--	--
	Suicides	1998-2015	1.7*	1998-2003	3.8*	2003-2007	-0.6	2007-2015	2.2*	--	--
	Traffic accidents	1998-2015	-1.1*	1998-2009	0.0	2009-2015	-3.6*	--	--	--	--
	Other accidents	1998-2015	-2.7*	--	--	--	--	--	--	--	--
Females Mexico	Total External Causes	1998-2015	-0.8*	1998-2001	1.1	2001-2004	-2.5	2004-2012	-0.1	2012-2015	-3.9*
	Homicides	1998-2015	2.8*	1998-2007	-3.7*	2007-2011	21.6*	2011-2015	-7.2*	--	--
	Suicides	1998-2015	4.1*	--	--	--	--	--	--	--	--
	Traffic accidents	1998-2015	-1.4*	1998-2006	1.1	2006-2015	-3.5*	--	--	--	--
	Other accidents	1998-2015	-2.4*	1998-2001	0.7	2001-2015	-2.8*	--	--	--	--

Source: Prepared by the authors using data supplied by DANE (Colombia) and INEGI (Mexico), 1998-2015.

Figure 1: Years of life lost due to external causes, Colombia and Mexico, 1998-2015



Source: Prepared by the authors using data from DANE (Colombia) and INEGI (Mexico), 1998-2015

The reduction in the homicide mortality rate for both sexes was statistically significant throughout the period of the study (Table 2). A decrease in suicides also contributed to a reduction in the mortality rate for both sexes, although the APC was higher among women. Traffic accidents also decreased for both sexes until 2011, but after that the mortality rate from this cause rose. The OA gradually decreased in both sexes (Figure 1; Table 2). In terms of change by age group, YLL from external causes among men was concentrated in young people and adults, with over 80 per cent of the total deaths occurring in those between 15 and 49. Among Colombian women, deaths were concentrated in the 15 to 64 age group, although over 30 per cent of deaths from OA occurred in those under 5. YLL from injuries of undetermined intent decreased for both sexes across the period studied, with slight increases in 2008 and in 2011.

In Colombia, between 1998 and 2015, life expectancy at birth increased by 4.2 years for men and 2.9 years for women (Table 3). Among men, 60 per cent of this increase resulted from the decrease in mortality from external causes, which was centered mainly among those 15 to 29 and 30 to 49 years old. For women, while the external cause mortality rate also decreased, the change was less than that seen in men, and it was concentrated in those younger than 5 and between 15 and 49 (Table 3). Homicides were the external cause of death with the greatest effect on the e_0 increase for men, principally for the group between 15 and 49. The other three external causes also contributed positively to e_0 change in men, although in lesser amounts and in other age groups: the effect from suicides centered among those 15 to 29 years old; TA mainly among those 15 to 49, and the decrease in mortality due to OA was concentrated in those younger than 5 and between 15 and 49. For women, TA was the external cause of death that most contributed to the change in life expectancy, centered in those younger than 5; the second-highest contributing cause was homicides, particularly among those from 15 to 49. The positive contribution of the decrease of OA stands out, primarily in those under 5; while suicides contributed little to the change, and were centered in the 15 to 29 age group.

Mexico

In Mexico in 1998, deaths from external causes accounted for 16.9 per cent of the total registered male deaths. This figure rose to 17.1 per cent in 2011 and decreased to 14.1 per cent in 2015. Among Mexican women in 1998, external causes were responsible for 5 per cent of total deaths; this figure was reduced to 4.1 per cent by 2015.

Table 3: Contributions to change in life expectancy by external cause of death, age and sex, Colombia and Mexico, 1998-2015

Colombia								
Sex	Age-groups	Homicides	Suicides	Traffic accidents	Other Accidents	Total external causes	Other causes	Total
Males	0 a 4	0.0047	0.0000	0.0160	0.0449	0.0655	0.7035	0.7691
	5 a 14	0.0164	-0.0001	0.0302	0.0179	0.0645	0.0250	0.0894
	15 a 29	1.0700	0.0310	0.1087	0.0659	1.2756	0.1479	1.4235
	30 a 49	0.7247	0.0020	0.1129	0.0534	0.8931	0.2723	1.1654
	50 a 64	0.1660	0.0029	0.0392	0.0122	0.2203	0.4334	0.6536
	65 a 84	0.0311	-0.0011	0.0196	-0.0011	0.0485	0.0975	0.1460
	85 +	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0018	-0.0017
	Total	2.0129	0.0347	0.3267	0.1931	2.5674	1.6778	4.2452
Females	0 a 4	0.0177	-0.0009	0.0711	0.0965	0.1844	1.1817	1.3661
	5 a 14	0.0075	0.0005	0.0180	0.0083	0.0343	0.0258	0.0602
	15 a 29	0.0622	0.0164	0.0253	0.0118	0.1157	0.0878	0.2035
	30 a 49	0.0440	0.0013	0.0236	0.0070	0.0759	0.1731	0.2490
	50 a 64	0.0161	-0.0010	0.0175	0.0062	0.0387	0.5255	0.5642
	65 a 84	0.0047	-0.0001	0.0142	0.0054	0.0242	0.4314	0.4556
	85 +	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0020	-0.0020
	Total	0.1522	0.0160	0.1697	0.1353	0.4732	2.4234	2.8966
Mexico								
Sex	Age-groups	Homicides	Suicides	Traffic accidents	Other Accidents	Total external causes	Other causes	Total
Males	0 a 4	0.0111	0.0000	0.0408	0.1424	0.1943	1.3515	1.5458
	5 a 14	0.0031	-0.0024	0.0105	0.0174	0.0286	0.0096	0.0382
	15 a 29	-0.0111	-0.0094	0.0121	0.0593	0.0508	0.0424	0.0932
	30 a 49	-0.0412	-0.0179	0.0354	0.0583	0.0346	0.2107	0.2453
	50 a 64	0.0105	-0.0039	0.0253	0.0423	0.0742	0.2016	0.2758
	65 a 84	0.0053	-0.0002	0.0109	0.0179	0.0339	0.0849	0.1188
	85 +	-0.0002	0.0000	-0.0003	-0.0004	-0.0009	-0.0032	-0.0041
	Total	-0.0226	-0.0339	0.1346	0.3372	0.4153	1.8976	2.3129
Females	0 a 4	0.0043	0.0000	0.0098	0.0568	0.0709	0.8665	0.9374
	5 a 14	0.0025	-0.0052	0.0094	0.0167	0.0234	0.0266	0.0500
	15 a 29	-0.0188	-0.0184	-0.0024	0.0118	-0.0279	0.0748	0.0470
	30 a 49	-0.0092	-0.0108	0.0117	0.0172	0.0089	0.2589	0.2678
	50 a 64	0.0036	-0.0018	0.0097	0.0109	0.0225	0.2860	0.3085
	65 a 84	0.0028	-0.0001	0.0082	0.0077	0.0185	0.1822	0.2008
	85 +	0.0002	0.0000	0.0003	0.0000	0.0005	0.0070	0.0076
	Total	-0.0148	-0.0362	0.0468	0.1211	0.1169	1.7021	1.8190

Source: Prepared by the authors using data supplied by DANE (Colombia) and INEGI (Mexico), 1998-2015.

Unlike in Colombia, in Mexico OA were the principal external causes of death in 1998, both for men (37 per cent) and women (48 per cent). After 2009, homicides became the leading external cause of death among men (reaching 43 per cent in 2011), while OA continued as the main cause among women (41.3 per cent). For both sexes, suicide was the least common external cause of death (less than 11 per cent), but they continued to increase. Between 1998 and 2015, the male to female death ratio varied between 3.8 and 4.8 male deaths for each female death. For homicides, this ratio reached a peak of 9.6 in 2010, and for every year in the study, the ratio was over 6.7 male homicides for each female homicide. The male to female ratio for suicides decreased throughout the period studied.

On average, Mexican men in 1998 lost 4.7 years due to deaths from external causes. This figure decreased until 2006 (Figure 1) when it began to increase, reaching a maximum of 5 YLL in 2011. That was a higher figure than in Colombia, and remained thus through 2014 (table 1). YLL in Mexican men then dropped back to the level observed in 2007 (Figure 1); showing no net change during this period (table 2). Women had a stable YLL level, with a slight decrease during the period studied.

YLL due to homicides increased for both sexes (table 1) in Mexico, primarily between 2007 and 2011 (figure 1). Male mortality from suicide showed a statistically significant increase; while YLL for women for suicides doubled, and the upward trend showed no joinpoints (Table 2). For both sexes, TA showed a light, statistically significant decrease during the years examined (Table 1). The mortality rate from OA decreased across the period, without joinpoints. In contrast to Colombia, YLL in Mexico among men were concentrated among those 15 to 64 —this age group had 80 per cent of the total of male YLL due to deaths from external causes. Among women, most YLL were concentrated in the 15 to 84 age group, with over 66 per cent of the total, as well as a high percentage in children under 5. YLL in Mexico due to injuries of undetermined intent decreased for both sexes until 2008, but in 2011 showed an unusual and substantial increase, before beginning to subside again in 2015.

Between 1998 and 2015, e_0 in Mexico increased by 2.3 years for men and 1.8 for women (Table 3). External causes as a whole added less to the change in e_0 in Mexico than they did in Colombia, especially for males under 5 and those from 50 to 64. The primary element of the effect of external cause deaths on the change in female e_0 was the decrease in female mortality under 5 years old; however, much of that decrease was cancelled out by the increase in mortality of those between 15 and 29. Homicides and

suicides were the causes of death that reduced e_0 in men, primarily those between 15 and 49. Male mortality rates due to TA and OA dropped, the effect being centered in those under 5 and between 15 and 64. Both homicides and suicides reduced female e_0 in those aged 15 to 49. Both TA and OA had a notable, positive effect on e_0 , occurring in all age groups under 65.

DISCUSSION

External causes of death are a primary public health problem in Latin America. These causes are considered to be indicators of lack of access to quality medical care; which helps reduce and prevent the risk of accidents and violence (Gómez, 2008). These causes of death bring tragic human consequences (Aburto *et al.*, 2016) and enormous economic and social costs (Yunes and Zubarew, 1999). They can also result in physical harm, disability and/or psychological sequelae in victims, high levels of YLL, and lowered life expectancy. Accidents and violence represent a deterioration of quality of life.

The results presented here corroborate the high impact of external cause mortality on life expectancy in both countries. They also highlight the varying behaviors among causes of death, age groups and sex. In Colombia, all of the external causes analyzed showed a significant decrease in mortality, especially in homicides beginning in 2002 (Sánchez *et al.*, 2012; Dávila-Cervantes and Pardo-Montaño, 2015; Salazar *et al.*, 2015); the decrease is seen in both men and women. This confirms that external causes are no longer the principal group of causes of death in Colombia (Acosta and Romero, 2014); in the 1990s, Colombia had the highest external cause mortality levels in the world (Briceño-León, Villaveces and Concha-Eastman, 2008). Mexico reveals a different panorama. Although external cause mortality did not increase in the period studied, the increase in homicide mortality since 2008 (Aburto *et al.*, 2016; Dávila-Cervantes and Pardo-Montaño, 2015) and the continued rise of suicides (Borges *et al.*, 2016) reversed the decreasing trend of these causes seen in the previous decade. Since 2011 for men and 2004 for women, Mexico has had higher mortality rates from these causes than Colombia, demonstrating the divergent trends in these two countries.

Injuries of undetermined intent in Colombia decreased alongside all external causes analyzed, suggesting an absence of bias in the calculations performed. In Mexico, on the other hand, injuries of undetermined intent generally behaved similarly to other external causes, but displayed an un-

usual increase in 2011—the year with the highest homicide rate in the nation’s recent history. This may point towards a significant underestimation of the impact of the external causes considered here on Mexico’s 2011 life expectancy, especially from homicides; further research should be performed in this area.

This study confirms that male YLL due to deaths from external causes is as much as four times higher than that of women, primarily among youth and young adults (Burrone *et al.*, 2012). The dynamic of this external cause morbimortality differential between men and women has been associated with behavior stemming from differentiated socialization processes during gender identity construction (Figueroa, 2015; Burin and Meler, 2000). The masculine identity model encompasses expected behavior such as competition, risk and control, to be used in the varied situations faced each day. Males learn to take risks beginning in childhood, and they internalize these behaviors (Figueroa, 2007). This situation reaches its maximum expression during adolescence and young adulthood; ages at which the intentional exposure to risk becomes an expected social setting that legitimates them as men (Figueroa, 2015). However, they also risk their health and wellbeing during this process, and may lose their very lives (Treviño-Siller, 2014; Mansfield, Addis, and Mahalik, 2003). In this context, gender and age are arguably the principal factors associated with external cause mortality (Figueroa, 2007; Treviño-Siller, 2014).

In both countries, external cause mortality was dominated by male homicides, primarily among the 15 to 49 age group. However, this study documented two contrasting tendencies: in Colombia, the homicide mortality rate decreased significantly beginning in 2002; but in Mexico, this rate increased sharply between 2008 and 2012. These findings are consistent with other research (González-Pérez *et al.*, 2017). The decrease in homicides in Colombia is attributed to the 1999 implementation of Plan Colombia (Palacios and Serrano, 2010). The Plan enabled increased armed forces mobility and efficiency (Moreno and Cendales, 2011), and made possible the gradual dismantling of drug trafficking organizations. This in turn led to a reconfiguration in the chains of command related to the production, distribution and sale of narcotics, as well as a decrease in coca cultivation (Baron, 2009; García *et al.*, 2012). In contrast, the rise in homicide violence in Mexico is attributed to military operations conducted in 2007 as part of the federal government’s anti-drug campaign (Lee and Bruckner, 2017). While troops made headway into drug trafficking routes, clashes with cartels caused an increase in homicides. At the same time, the strate-

gic targeting of cartel leaders destabilized their internal workings. Cartels divided and waged internal wars of succession, further escalating the homicide rate, principally among young adults (Molzahn, Rodríguez-Ferreira and Shirk, 2013).

Suicide also showed opposite tendencies in Mexico and Colombia, revealing important differences in its behavior by age and sex. In Colombia, suicide decreased significantly, principally among those 15 to 29, which was reflected in a positive contribution to e_{θ} . In Mexico, suicides continued to increase as they have since the 1970s (Borges *et al.*, 2016; Borges *et al.*, 2010), reducing the e_{θ} ; that change centered in those aged 15 to 49. The main factors associated with suicide are being male, having attempted suicide previously (Borges *et al.*, 2010), mental illness (primarily depression), drug and alcohol consumption (Sheehan *et al.*, 2013), and an increase in chronic degenerative diseases, which can cause severe pain in those who suffer from them (Rojas-Cabrera, 2015). Economic losses and instability, underemployment and poverty also increase anxiety, and can be potential detonators for suicide (Borges, Orozco and Medina-Mora, 2012; Xavier *et al.*, 2006).

Looking at the impact of TA on e_{θ} and YLL, there has been a clear decrease in TA mortality in both countries (Escanés, Agudelo-Botero and Cardona, 2015), although in Colombia this rate saw a slight upturn as of 2012. TA mortality was concentrated in young people in both countries, and as in other contexts, mainly in men (Escanés, Agudelo-Botero and Cardona, 2015; Chandran *et al.*, 2013). Mexican females were the exception, among whom the TA mortality rate for those under 5 is also high. This cause of death generally affects vulnerable actors: first pedestrians, followed by motorcyclists and bicyclists. The main risk factors associated with TA are the increase in the number of vehicles in circulation; and risky behavior such as speeding, drug and alcohol use, not wearing a seatbelt or obeying traffic laws, and the use of distractions (like cellphones) while driving, among other factors (Treviño-Siller, 2014).

Mortality rates due to OA dropped in both countries, especially among young people. OA incidence depends on the age group; for example, small children are at higher risk of swallowing objects that obstruct their breathing, adolescents are more likely to engage in risky behavior, and older people are more likely to have consequential falls (Paulsen-Sandi and Mejía-Salas, 2005; Dorta-Figueroa *et al.*, 2013).

Given these results, and the importance of external cause mortality in the epidemiological profile of both countries, having accurate data that

allows observers to keep track of external cause incidence is critical. At the same time, new multidisciplinary studies should focus on analyzing the dynamics of the multiple factors associated with external cause mortality. Young adults are the primary victims of external cause mortality; almost three-quarters of the total years of life lost from these causes of death come from adolescents and young adults. Actions aimed at preventing these deaths should have in mind the age groups most impacted by them, and incorporate a gender perspective (Figueroa, 2007; Treviño-Siller, 2014). They should seek the participation of all sectors of society, and recognize the distinct particularities of each cause of death. Actions like these should aim to continue reducing external cause mortality in Colombia, and to reverse the current rising trends in homicides and suicides in Mexico, which wipe out the gains obtained from mortality reductions in TA and OA. TA can be further prevented by restricting alcohol use, lowering speed limits, reinforcing the use of safety features, improving infrastructure and roadway signage, and promoting traffic safety. Suicides can be prevented via early detection and timely treatment of risk factors; and homicides, with violence prevention plans and tougher restrictions on access to firearms. Given the broad range of factors associated with accidents, groups of preventative measures can be promoted together, such as information campaigns, and establishing and enforcing compliance with safety norms and standards (Lund and Aarø, 2004).

Limitations

To interpret these results, certain important limitations should be acknowledged. First, this study is focused on fatalities, without taking into account the enormous number of non-lethal external cause incidents that occur for each death. Because of this, the full impact of external causes on public health may be underestimated. In this study, it was not possible to examine public health impacts from traffic injuries, suicide attempts or the vast group of accidents that do not end in death. These accidents can entail grievous social and economic harms such as permanent disabilities, loss of working capability, and the need for special care, psychological therapies and rehabilitation services (Escanés, Agudelo-Botero and Cardona, 2015). Second, the cross-sectional nature of the information used in this study obstructs an analysis of the possible causal factors of the different causes of death analyzed. Third, owing to the nature of this phenomenon, it is probable that the estimations of homicide and suicide mortality are low. Homicides are underreported for deaths that occur during armed conflicts

or at the hands of illegal groups. These deaths are not counted, and stay out of the national mortality registries (Moreno and Cendales, 2011). Suicides are also often underreported or concealed for cultural or religious reasons, as well as for complications encountered in registry procedures (Rodríguez, 2006; Madge and Harvey, 1999).

In spite of this, mortality data has progressively improved in the region, especially in Mexico and Colombia (Mahapatra *et al.*, 2007). Although this study has these limitations, the results obtained illuminate the variations produced in mortality rates from external causes in Colombia and Mexico, show their impact on life expectancy, and the different trends in each country.

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