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Level of and change in road traffic mortality in Argentina, Chile, Colombia and Mexico, 2000-2011

Nivel y cambio de la mortalidad vial en Argentina, Chile, Colombia y México, 2000-2011

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ABSTRACT The aim of this study was to estimate the effect of run-over fatalities and traffic collisions in life expectancy in Argentina, Chile, Colombia and Mexico, between 2000 and 2011. Years of life expectancy lost (YLEL) were calculated for the periods 2000-2002 and 2009-2011. The results show that road traffic deaths made up between 1% and 4% of all deaths in each country. In the first period, the highest level of mortality occurred in Colombia (YLEL = 0.96) and the lowest in Argentina (YLEL = 0.59). In all the countries studied except Argentina, the impact of these deaths on life expectancy was reduced in the second period. The main change took place in Colombia, reaching 0.72 YLEL in the second period. It is concluded that traffic-related deaths have a negative impact on health systems, victims, the productive sector, and society in general. From this point of view, the issue of road transit must be considered a matter of public health, requiring multi-sector intervention in the design of national and regional policies.
KEY WORDS Accidents, Traffic; Years of Life Lost; Mortality.

RESUMEN El objetivo de este trabajo es estimar el efecto de las muertes por atropellos y colisiones de tránsito en la esperanza de vida en Argentina, Chile, Colombia y México, entre 2000 y 2011. Se calcularon los años de esperanza de vida perdidos (AEVP) para los trienios 2000-2002 y 2009-2011. Los resultados indican que los decesos ocurridos por el tránsito representaron entre el 1% y el 4% del total para cada país. En el primer trienio, el mayor nivel de mortalidad ocurrió en Colombia (AEVP = 0,96), mientras que el más bajo se registró en Argentina (AEVP = 0,59). A excepción de este último país, hacia el segundo trienio, se redujo el impacto de estos fallecimientos sobre la esperanza de vida. El principal cambio tuvo lugar en Colombia que pasó a 0,72 AEVP. Se concluye que las muertes asociadas con el tránsito impactan de manera negativa en los sistemas de salud, las víctimas, el sector productivo y la sociedad en general. Desde esta perspectiva, la situación vial representa un problema de salud pública que requiere la intervención multisectorial en el diseño de políticas de alcance nacional y regional.
PALABRAS CLAVES Accidentes de Tránsito; Años de Vida Perdidos; Mortalidad.

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INTRODUCTION

Traffic related injuries are a public health issue that still remains unresolved all over the world, and particularly in most of the countries of the Americas, resulting in a high number of people killed or disabled.[1]

At present, around 1.27 million people die annually in the world due to road related traumas, which represent the eighth cause of death with major impact in the reduction of the life expectancy rate. It is estimated that, if no measures with global reach are taken, then road related deaths may increase up to 2.4 million people by 2030, becoming the fifth ranked cause of death.[2]

In addition to the loss of human lives, traffic related traumas involve an important amount of non-lethal consequences, among which are temporary and permanent disabilities, sensorial and mental repercussions, as well as economic costs on an individual, family and community level.[1-3] Many statistics show that per every road related death, 35 individuals are injured,[1] and between 1 and 3 percent of the Gross Domestic Product of each country is destined to address these problems.[4]

Although everybody is exposed to potential injury while travelling on public roads, the chances to be involved in a run-over fatality or traffic collision vary between each person. In this sense, most part of road related casualties involve men (75 percent of all deaths) and individuals between 15 and 44 years old (59% of all deaths). In addition, it should be mentioned that people living in poorer conditions are prone to be affected by these type of accidents.[4]

The most frequent factors involved in run-over accidents and traffic collisions with motor vehicles are speeding, the disregard of traffic regulations (both by pedestrians and drivers), failure to comply with safety measures (such as seat belts, helmets, restraining car seats, among other items), the use of drugs and alcohol, before or during driving, the use of driving distractors (for example, cellphones).[1-3,5] Being aware of the existence of these factors while navigating public roads allows to consider the possibility of preventing injuries and casualties during transit. In this sense, prevention involves designing and implementing actions aimed at avoiding potentially traumatic situations (primary), ensuring safety of those involved in a traffic situation when it occurs (secondary) and speeding up the medical attention in the event of injury resulting from road accidents.[6,7] Nonetheless, it is known this issue is multidimensional and complex, which is why it requires implementing integrated measures that call for the involvement of sectors such as health, economics, transport and the civil society at large.

Despite the wide range of economic, cultural and contextual situations among Latin American countries affecting, to a greater or lesser degree, the impact of traffic injuries,[8,9] the Pan American Health Organization (PAHO) has pointed out the imperative need to carry out a constant monitoring and evaluation of the traffic status, to estimate indicators for each country and to make comparisons between them.[1] In this regard, a report prepared by the World Health Organization (WHO) notes that in 2010 Colombia registered a traffic mortality rate of 15.6 deaths per day per every 100,000 inhabitants. In Mexico, this record was of 14.7, 12.3 in Argentina and 12.3 in Chile.[10] Although these data are useful to reflect the death risk, when comparing among different countries, it becomes more difficult to interpret. This is due to the variation in the structure of each society (sex and age), as they have different impact in mortality rates. Thus, this paper mainly seeks to estimate the effect of run-over and traffic collision deaths in life expectancy of Argentina, Chile, Colombia and Mexico between the years 2000-2011. To this end, the rate of Years of Life Expectancy Lost (YLEL) was used, as it can "determine the number of years individuals that die should have lived."[11] By using this indicator, it was possible to determine the impact run-overs and traffic collisions related deaths produced over the life expectancy rate. At the same time, the evaluation and comparison of traffic related mortality was made possible in the four selected countries.

Recent studies have evaluated the importance of road related mortality throughout the indicator of YLEL in many European countries.[12-14] In Latin America, many studies were published on a national level, although there is no comparative information along the countries of that region. In this sense, the YLEL indicators were used to calculate the mortality rate of Argentina between 1999-2002.

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If during that period, traffic related deaths could have been prevented, life expectancy of men and women would have increased 0.43 and 0.15, respectively. In addition, the report reveals that half of YLEL was due to deaths in individuals under the age of 35 years old.[15] Afterwards, a study was published in Brazil, in which the YLEL were calculated based on data provided by the Health and Transport Department of Brazil. The numbers were even more discouraging than in Argentina, as figures reveal a decrease of life expectancy of 0.8 and 0.2 in men and women, respectively, as a consequence of run-over and traffic collisions.[16]

MATERIALS AND METHODS

Study details

A descriptive, cross sectional study was performed, retrospective to the periods of 2000-2002 (in Argentina and Colombia), 1999-2001 (in Mexico), 2001-2003 (in Chile) and 2009-2011 (in all countries studied). Different initial periods were considered, as censuses in each country were carried out during half of the periods analyzed (except from Colombia, in which case the census was in 2005).

The selection of these four countries was based on the fact that all of them are facing an advanced demographic transition, in accordance with the classification of Demography Latin American and Caribbean Center (CELADE) [Centro Latinoamericano y Caribeño de Demografía].[17] This entity states that Chile and Mexico have the lowest levels of fertility and mortality rates, while Colombia and Argentina show medium levels in both indicators. Additionally, these four countries share a high percentage of death record coverage: Argentina has 99% (2008), Chile and Mexico have 95% (2009 and 2010) and Colombia has 94% (2009).[18]

In the four countries selected, the criteria used are based on the Classification International Disease and Related Health Problems, Tenth Revision (ICD-10).[19] Deaths from run-over and traffic collisions with land transport were identified by codes ranging between V01 and V89. In addition, deaths resulting from road events involving motor vehicles ranged in Y850 code were considered.

The comparison of the mortality rate between the selected countries does not require the application of correction factors regarding the time elapsed between the traffic accident and the death. Argentina, Colombia and Chile follow the recommendation of recording the casualties up to 30 days after the accident occurred. On the other hand, Mexico registers these type of deaths indefinitely.[4] When defining a traffic related death, the period of time used by the rest of the world ranges from the exclusive consideration of fatalities in the place of the accident, to including deaths that occurred after seven to thirty days and even considering any death produced as a consequence of a run-over accident or traffic collision, regardless of the time elapsed since the episode.

In accordance with the data gathered by the WHO, out of the 178 countries surveyed in 2009, 45% consider using the thirty-day period to define a traffic related death for the recording of casualties.[2] The election of the thirty-day period is based on a study published by the Transport Research Laboratory that proved that most individuals who die as a consequence of a run-over fatality or traffic collision were consumed by their injuries in a time lapse of thirty days. Although the extension of such period would imply a marginal increase of numbers, it is also true that it would demand a disproportionally large increase of surveillance efforts on the part of the appropriate authorities and entities in each country.[20]

Sources of information

The information about population and deaths occurred during the period of 1999-2011 derives from the following official sources of each country:

- Argentina: Secretary of Health Statistics and Information (DEIS) [Dirección de Estadística e Información de Salud] within the Ministry of Health of Argentina.
- Chile: Secretary of Health Statistics and Information (DEIS) [Dirección de Estadística e Información de Salud] within the Ministry of Health of Chile.

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- Colombia: National Statistics Department (DANE) [Departamento Administrativo Nacional de Estadísticas].
- Mexico: National Institute of Statistics and Geography (INEGI) [Instituto Nacional de Estadística y Geografía] and Secretary of Health (SS) [Secretaría de Salud].

Method

The measures used to study the rates and changes of mortality were calculated based on two types of basic information: a) the absolute number of deaths during a period of time, and b) the size of the population related to these events.[21] This information helped calculate the rate of years of life expectancy lost (YLEL) that helps to determine the additional amount of years that those who die should have lived at a certain age.[11] The next formula was used:

$$ {}_nAEVP_x\,(z) = {}_np_x\,(z)\,[\,(n + A_{x+n}) - {}_nk_x\,] $$

Where:

${}_np_x\,(z)$ is the percentage of deaths ranged between the ages x and x+n times the cause of death z in the population of the life table.
A_{x+n} is the average number of years between x and x+n that the deceased person could have lived if the fatality had not occurred.
${}_nk_x$ is the average of years lived between x and x+n times by the population that die in that age range.

To calculate the YLEL, temporary life expectancies were included, which measure the average of years that the population of each country ranges between two ages if the fatality due to a certain cause had not occurred.[11] In this paper, the interval of both ages is between birth and seventy-nine years of age. Deceased of eighty years old or older were excluded as they belong to an open age range in the construction of the life table for each period. The temporary life expectancy cannot be calculated for an open group of people of advanced ages, given that the years that someone could live and not die would be infinite. This limitation presented by the YLELs have a minor consequence over the impact of life expectancy, as the amount of people over eighty years old or more represent at least 2.5% of the population of each country during the periods analyzed.

In addition, the speed or rate of change of mortality due to traffic injuries was analyzed, that is to say, the average annual percentage change of the YLEL between both periods for the four countries. In this sense, it was analyzed in which age groups, men and women, a faster decrease or increase of the mortality was produced, and its consequent impact in the life expectancy. The annual percentage change is the annual percentage to which the gross rate of mortality has been changing during the period analyzed,[22] which is calculated as follows:

$$ CPA_{t,t+i} = 100\,.\,\{1 - [1 - (d_t - d_{t+i}) / d_t\,]^{1/i}\,\} $$

Where:

$CPA_{t,t+i}$ is the annual perceptual change between the years t and t+i.
d_t is the amount of years of life expectancy lost in the year t.
d_{t+i} is the amount of years of life expectancy lost in the year t+i.

Initially, the data was processed for the calculation of life expectancy at birth, by the Population Analysis System (PAS),[23] and, following, the YLEL were calculated for all the causes of death and specifically for road run-over and traffic collision fatalities, per country, sex and age grouped in five categories: from 0-14, 15-29, 30-44, 45-49, and 60 years of age or more.

FINDINGS

General mortality rates and years of life expectancy lost

During the first triennium, Argentina showed the highest mortality rate in men among the countries selected, followed by Colombia, Mexico and finally, Chile. During the second triennium, a decrease of the total mortality rate was evidenced, impacting on the differential increase of life expectancy at birth in each country. The most notorious change was in Colombia, where life expectancy in men increased almost four years. Regarding

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mortality in women, during the first triennium, Mexico registered the highest rate of general mortality, followed by Argentina, Colombia and Chile, respectively. Between both periods, it was shown that in the four countries selected the mortality rate decreased, making a positive impact on the average of years in women. Table 1 shows that the main decrease of deaths was in Colombia, which produced an increase in life expectancy for approximately two years.

As regards the YLEL, in the first triennium, Colombia registered the highest decrease of this indicator, in relation with the rest of the countries. The annual average of total deaths represented that most Colombian population between birth and eighty years old, lived 19.8 years less. During the same period, the population of Argentina and Mexico lost 18.9 and 18.5 of years of life expectancy. On the other hand, Chile was the country with less decrease, evidencing just 14.6 of YLEL.

Although in the four countries selected, a decrease of mortality between both periods was registered, such decrease did not happen at the same speed. The Colombian population reduced its general mortality rate at a speed of 3% annually. This produced the most notorious change in the general mortality rate. Chile and Argentina reached an annual decrease of 1.8% and 1.3%, respectively, while Mexico had the slowest percentage change of the gross mortality rate, with an annual decrease of 0.5%. Table 2 shows the YLEL in men and women during both periods analyzed in the four countries selected.

Traffic related years of Life expectancy lost

If run-over fatalities and traffic collisions are included, then it is possible to mention that, during the periods analyzed, the proportion of traffic related deaths ranged between 1% and 4% of the total of diseases in each country. Except for Argentina, a reduction in the participation of these type of deaths was observed between the periods analyzed.

In relation with the YLEL related to road-users, Colombia showed the highest mortality level during the first triennium (Figure 1). The Colombian population, between birth and eighty years old, lived one year less due to traffic related deaths. Mexicans lost more than 0.86 years of life expectancy, while Chile and Argentina lost 0.72 and 0.59 years of life expectancy, respectively, due to the same cause.

For the second period analyzed, the level of road mortality in Mexico was relatively stable. In Colombia and Chile, several improvements were achieved, which helped reduce the YLEL to 0.72 and 0.62 years respectively. On contrast, as can be seen in Figure 1, the situation worsened for the Argentinian population, which lost 0.66 years (one additional month from in relation to the

Table 1. Life expectancy at birth in Argentina, Chile, Colombia and Mexico, periods 2000-2002 and 2009-2011.

Country	Men			Women		
	Initial triennium 2000-2002	Final triennium 2009-2011	Difference	Initial triennium 2000-2002	Final triennium 2009-2011	Difference
Argentina	70.27	72.16	1.88	78.16	78.94	0.79
Chile	74.45	75.93	1.48	80.90	81.73	0.84
Colombia	71.72	75.49	3.78	80.12	81.94	1.82
Mexico	72.81	73.03	0.22	77.88	78.82	0.94

Source: Own elaboration based on data from the Secretary of Health Statistics and Information, National Ministry of Health (Argentina); from the Department of Statistics and Health Information, Ministry of Health (Chile); from the National Administrative Department of Statistics (Colombia); and from the National Statistics and Geography Institute and the Secretary of Health (Mexico).

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Table 2. Years of life expectancy lost due to general mortality in Argentina, Chile, Colombia and Mexico, periods 2000-2002 and 2009-2011.

Country	Men		Woman		Both sexes	
	Initial triennium 2000-2002	Final triennium 2009-2011	Initial triennium 2000-2002	Final triennium 2009-2011	Initial triennium 2000-2002	Final triennium 2009-2011
Argentina	11.93	10.45	6.94	6.31	18.88	16.76
Chile	9.19	7.88	5.36	4.67	14.56	12.55
Colombia	12.74	9.50	7.02	5.48	19.76	14.98
Mexico	11.14	10.92	7.40	6.79	18.54	17.71

Source: Own elaboration based on data from the Secretary of Health Statistics and Information, National Ministry of Health (Argentina); from the Department of Statistics and Health Information, Ministry of Health (Chile); from the National Administrative Department of Statistics (Colombia); and from the National Statistics and Geography Institute and the Secretary of Health (Mexico).

first period) of life expectancy between birth and eighty years old.

When disaggregating the data about sex, many differences could be appreciated in all of the countries. In line with global mortality patterns, deaths occurring as a consequence of traffic related injuries were characterized by sustained excess of male mortality. During the first triennium analyzed, Chilean men suffered a year of life loss four times higher than women. A similar situation was observed in Mexico and Colombia, where rates registered were closer to the excess male mortality of Chile. On the other hand, Argentinian men lost life expectancy over three times more than women. During the period 2009-2011, the difference in the mortality between both sexes strengthened in Colombia and Argentina, as opposed to Chile, where the excess male mortality decreased as a consequence of the

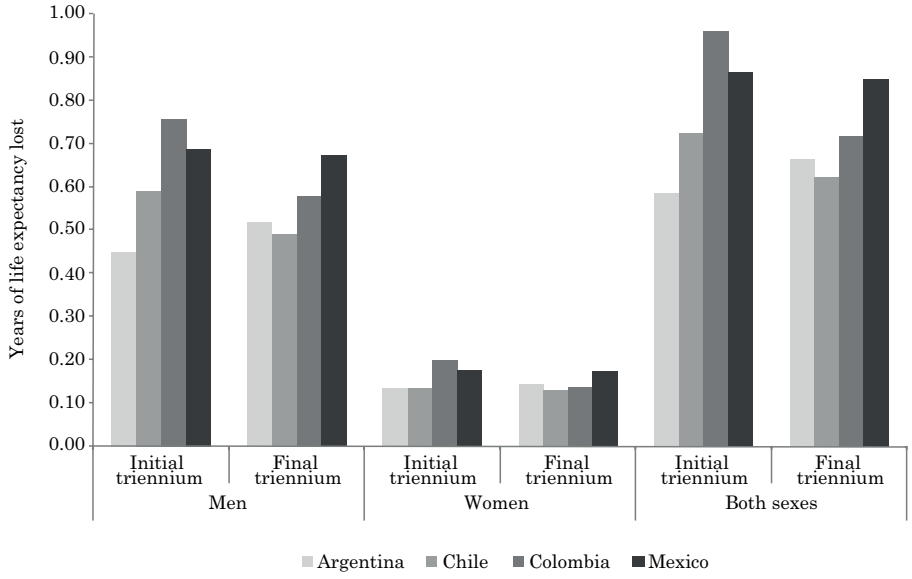

Figure 1. Years of life expectancy lost due to run-over and traffic collisions. Argentina, Chile, Colombia and Mexico, periods 2000-2002 and 2009-2011.

Source: Own elaboration based on data from the Secretary of Health Statistics and Information, National Ministry of Health (Argentina); from the Department of Statistics and Health Information, Ministry of Health (Chile); from the National Administrative Department of Statistics (Colombia); and from the National Statistics and Geography Institute and the Secretary of Health (Mexico).

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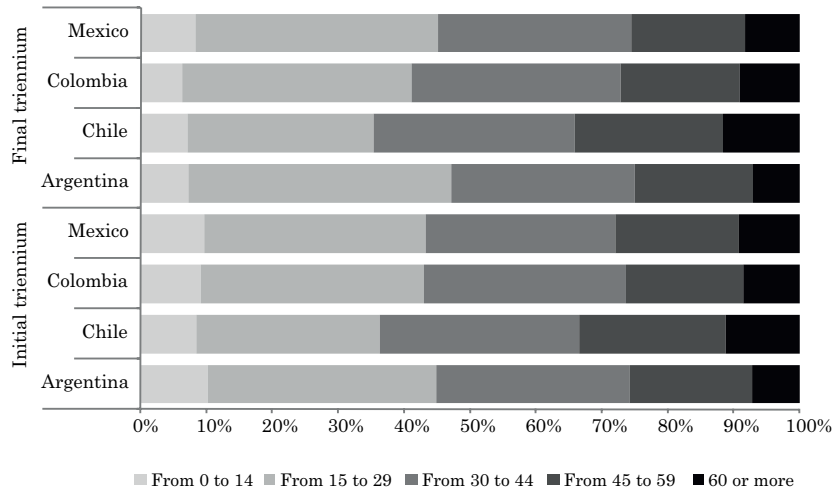

Figure 2. Proportion of years of life expectancy lost due to run-over and traffic collisions by age for men. Argentina, Chile, Colombia and Mexico, periods 2000-2002 and 2009-2011.

Source: Own elaboration based on data from the Secretary of Health Statistics and Information, National Ministry of Health (Argentina); from the Department of Statistics and Health Information, Ministry of Health (Chile); from the National Administrative Department of Statistics (Colombia); and from the National Statistics and Geography Institute and the Secretary of Health (Mexico).

lower impact of men fatalities. These changes in mortality between both periods were mainly related to the differences between male mortality in each country. Specifically, Colombia registered a sharp decline, contrary to Argentina where an increase was registered.

Regarding age groups with bigger losses in terms of years of life expectancy, the most affected

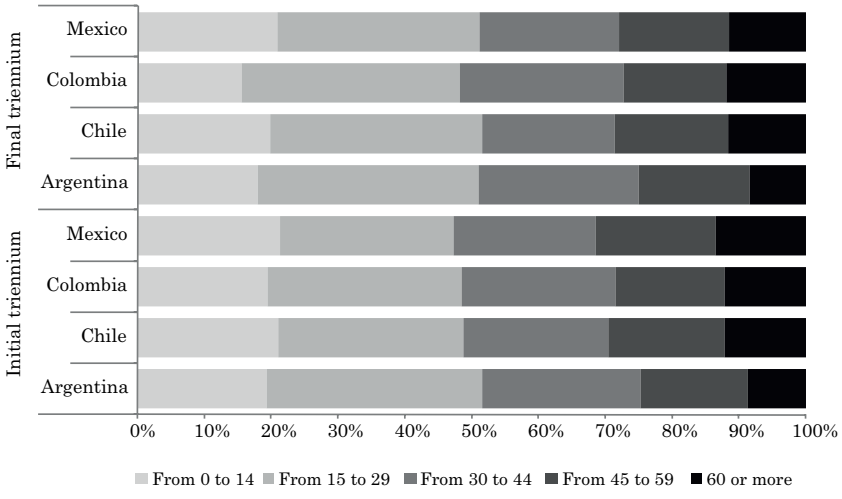

Figure 3. Proportion of years of life expectancy lost due to run-over and traffic collisions by age for women. Argentina, Chile, Colombia and Mexico, periods 2000-2002 and 2009-2011.

Source: Own elaboration based on data from the Secretary of Health Statistics and Information, National Ministry of Health (Argentina); from the Department of Statistics and Health Information, Ministry of Health (Chile); from the National Administrative Department of Statistics (Colombia); and from the National Statistics and Geography Institute and the Secretary of Health (Mexico).

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by road mortality were people whose ages ranged between 15-44 years old. In each country, men in this age group lost around 60% of YLEL due to run-over fatalities and traffic collisions during the first triennium. The evolution of male road mortality between those ages showed the increase of the importance or relative importance in these four countries by the second triennium under analysis. Particularly, the most relevant increases were registered in the age group of 15-29 years old in Argentina (34.7% against 39.9%) and Mexico (33.6% against 36.8%). In contrast, it should be noted that the main reductions occurred in the age group of 0-14 years old in Argentina (10.2% against 7.2%) and Colombia (9.1% against 6.3%) (Figure 2). In the period 2009-2011, excluding Chile, in the analyzed countries there was more than 66% of the YLEL among teenagers and adults of 15-44 years old. Figure 2 shows the development of the proportions of the YLEL in both periods.

On the other hand, during the first triennium, deaths of female teenagers and adults between 15-44 years old accounted for 56% of the YLEL in Argentina. In Colombia, this proportion reached 52%, in Chile 49%, and in Mexico 47%. In the second triennium analyzed, Chile and Mexico had the main changes in the proportion of the YLEL, countries where there was an increase by four percentage points in the participation of the age group of 15-29 years old, as it can be seen in Figure 3.

DISCUSSION

Although mortality rates inform a preliminary idea about the traffic situation of each country, these rates are limited in two aspects: a) they do not reflect the impact they produce in the changes of the average life rates or the population and b) it is difficult to compare one community in two different periods of time because, if the rates represent higher or lower levels in mixed ages during the comparison of two periods, it becomes very difficult to determine which was the period with greater general mortality.[11]

For such reasons, measuring the level and change of traffic mortality throughout the YLEL was appropriate to reach the target proposed in this work. From that perspective, Argentina was the only country (among the other countries analyzed) that had an upward trend in the impact of road deaths over life expectancy between the periods analyzed while the rest of the countries showed decreases of different magnitude. What happened in Argentina could be connected to the increased volume of motor vehicles purchase by citizens, a fact that was, in turn, the result of a higher purchasing power reflected by the increase in GDP per capita, from $7,701.4 dollars in 2000 to $13,693.7 in 2011.[24] In this sense, the increase of the vehicle fleet of Argentina resulted in an increase of traffic flow in its roads and, by extension, greater exposure to the death risk in run-over fatalities or traffic collisions. In contrast, Colombia showed the most marked reduction of the YLEL registering a 25% decrease in this indicator. In this country, the GDP per capita increased in the period studied (it increased from $2,503.5 to $7,124.5) which was accompanied by the implementation of traffic prevention measures. In this regard, comprehensive road safety plans with clear targets and financial support were implemented, while progress was made in improving the road traffic on legal framework.[25] Although to a lesser extent, Chile also decreased the YLEL close to 14%, which could be linked to improvements in education and road training, changes in the current legislation and implementation of comprehensive plans[25] were recorded. Finally, although road deaths evolved into a minor impact on life expectancy in Mexico, the reduction has less magnitude among the selected countries (about 2%).

The results indicate the urgent need Argentina faces to reverse the trend in the evolution of the level of road mortality and the rest of the countries to consolidate the decline showed here. It is therefore essential to design and implement targeted strategies to different users of public roads, including drivers, pedestrians, motorcyclists and cyclists,[26-29] to promote preventive behaviors. Such interventions should also be raised from multiple sectors of society[30, 31] to promote synergy of education, health, public safety, government, community organizations and the general population. One aspect that is crucial to this issue is strengthening the use of security elements as well as providing more and better signs on public roads and infrastructure fitted to the needs of site-specific

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mobility. Similarly, it is essential to promote the compliance with traffic regulations and encourage permanent information campaigns throughout society,[27,32] particularly related to control and decrease consumption of alcohol, psychoactive and use of electronic devices.

Most of the deaths in road traffic are concentrated mainly in male teenagers and adult men, which is consistent with the results of other publications.[16,30,32,33] As pointed out by several studies,[30,34,35] these groups tend to assume greater risk than the rest of the population, resulting in increased exposure to risk, based on differential levels of risk perception and aggressive circulation. In this sense, it is advisable to direct public policy differentials to men and women as well as to specific age groups. Regarding this last aspect, run-over and traffic crashes are linked to premature deaths of road-users. At the same time, they represent a high burden in the years of healthy life lost and years free of disability,[32, 36, 37] causing many people to have to spend long periods of time with physical or mental limitations or, in some cases who have to live with support and permanent instruments (such as canes or wheelchairs) to improve mobility.

For future research, it is suggested that the analysis of the YLEL by traffic deaths be extended to more disaggregated geographical scales such as regions, provinces or municipalities, in order to generate more accurate evidence so as to design and implement public policies that adapt to the characteristics of each context.

While this work was aimed to study the cases of the people deceased, the findings obtained do not provide a way of identifying health damage arising from road traffic injuries and do not end up with the death of the victims. Consequently, it is not possible to estimate the costs associated with disability, job loss, special care and psychological implications, among others. In this regard, it is recommended to incorporate comparative analyses that consider these aspects for future studies. In this way, public policies could be designed to achieve greater effectiveness when reducing the impact of deaths from traffic run-over fatalities and traffic collisions.

CONCLUSION

In summary, road safety is one of the priorities in the agenda in Latin America. While interventions should focus mainly on the most vulnerable groups, such as those identified in this work, it is essential to permanently update and revise national laws and regulations on the matter to evaluate more deeply the impact of programs and their level of compliance. This will help to take rapid and effective corrective actions on this growing concern for road safety. Since injuries due to run-over and traffic collisions are a current phenomenon, to a greater or lesser extent, in all of the countries in the region, it is recommended to create opportunities for the exchange of the best prevention practices so that they can be adapted to the particular needs of each context, a strategy that has proved to be successful and cost-effective in other countries.

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