Original Article

Traffic accident and homicide mortality in Curitiba, Paraná, Brazil, 1996-2011

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Abstract

Objective: to describe trends in mortality due to homicides and traffic accidents among people living in Curitiba, Parana, Brazil, from 1996 to 2011. **Methods**: this is an ecological time-series study using National Mortality Information System data; trend analysis was performed by polynomial regression models according to sex. **Results**: the mortality coefficient due to traffic accidents among males declined from 61.7 in 1996 to 28.4 in 2011 (-46%), whilst among females it decreased from 16.5 to 7.3 deaths per 100,000 inhabitants (-44.2%); in turn, the mortality coefficient for homicides among males rose from 32.5 to 69.3 (+113.2%), whilst among females it rose from 4.4 to 5.3 deaths per 100,000 inhabitants (+20.4%). **Conclusion**: mortality due to homicides increased; prevention strategies to tackle violence should be aimed at the specificities of external causes and greater male exposure to these injuries.

Key words: External Causes; Violence; Accidents, Traffic; Homicide; Time Series Studies.

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Introduction

External causes are composed of different diseases and conditions, mainly by traffic accidents and homicides. They are an important Public Health issue due to their magnitude in hospitalizations and mortality rates, possible reason for early pensions and retirements, besides their negative impact in the life quality of those affected.[1]

In this context, quality information related to deaths from homicides and traffic accidents is not considered just a technical matter. It is an important tool for proper decision-making regarding intervention strategies.[1] A detailed analysis of mortality due to these causes may assist in the improvement of public health policies.[2]

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Studies regarding deaths from external causes in general are limited to the male population.[2] It is important to expand the knowledge of policy makers and health professionals about the mortality trends for homicides and traffic accidents in both sexes, as one of the elements used to understand the impact's magnitude of some public policies interventions adopted to reduce the occurrence of violence – for example, the "Dry Law"[3] and the Maria da Penha Law.[4]

Apart from all the geopolitical, economic, social and educational differences, it became clear in the first decade of the 2000s, an increase in mortality trends for homicides and traffic accidents in different parts of the world: from Kenya,[5] Venezuela, Panama, El Salvador and Puerto Rico[6] to the United States of America.[7] In Brazil, the scenario has not been different and mortality rates due to these causes increased greatly over the same period, mainly in the country's Northeast region.[8]

Regarding homicide, this study aimed to describe the magnitude and timing trend of this event in the period 2001-2010, considering its male victims aged between 10-24 years old, according to municipalities in the states of Paraná and Santa Catarina. Homicides were found to have greater magnitude in Paraná's municipalities.[2] On the other hand, a study conducted in five Brazilian capital cities, including Curitiba (Paraná state capital), presented the *Life in Traffic Project* as a strategy of intersetorial articulations able to reduce traffic fatalities.[9] In addition to being the capital city of the state, Curitiba, as the most populous city of Paraná, stands out for the importance and need to describe deaths trend from external causes in the population.

Are important studies on mortality from homicides and traffic accidents, accounted for the largest proportion of deaths due to external causes in the country.[1] Further studies and discussions in the Public Health context about the visibility of homicides and accidents showed by morbidity and mortality indicators are necessary.[10] Knowing the magnitude of these events is a condition for the development of programs related to health promotion and injury prevention from accidents and violence.[3]

The objective of this study was to describe trends in mortality due to homicides and traffic accidents among people living in Curitiba, Paraná, Brazil, from 1996 to 2011.

Methods

This is an ecological time-series study which described homicide mortality and traffic accidents of residents in Curitiba from 1996 to 2011. In 2010, Curitiba, Paraná's capital, had a population of over 1,800,000 inhabitants and its index human development (HDI) was 0.823, the highest value for the state and the tenth of the country.[11]

External causes are classified in Chapter XX of the 10th Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10): Traffic accidents (V01-V99) and assaults (X85-Y09). Mortality rates were calculated through the ratio between the number of deaths from certain causes (traffic accidents or homicides) and the population of each year of the series, multiplied by 100,000. For this, information on the death certificate (*DO*) were used on the data collection form from the Mortality Information System (*SIM*) and information regarding the resident population estimated by the Brazilian Institute of Geography and Statistics (*IBGE*), available at the IT Department of the National Health System (*DATASUS*) Brazilian/Ministry of Health.

The trend analysis was performed by polynomial regression model in which the mortality rate as primary cause of death and sex was considered the dependent variable (y) and the years of the selected period, the

independent variable (x). The variable 'time' centralized was used, i.e.: instead of working with X, we used the term X-2003, where 2003 is the midpoint of the historical series. Scatter plots of the mortality rates and years of the study were built to identify the function to express the relationship between them and thus choose the polynomial order for the analysis, estimating from this functional relationship the polynomial regression model. As a model of precision measurement, we adopted the coefficient of determination (r^2). Note that the data were normally distributed, verified by the Kolmogorov-Smirnov test, and the description of analyses confirmed the assumption model's homoscedasticity.[12] Initially, we tested the simple linear regression model ($Y = \beta_0 + \beta_1 X$); and later models of higher order, the second ($Y = \beta_0 + \beta_1 X + \beta_2 X^2$) or third degree ($Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 X^3$). The best model was considered to be the one with the highest statistical significance (smallest p-value) and residuals with no bias. When two models proved to be similar from a statistical point of view, for the same variable, we chose the simplest model, taking into account the principle of parsimony. It was considered significant trend the one in which the estimated model obtained $p < 0.05$. The grouping of data was performed with Microsoft Excel 2010 software, and treatment and analysis performed with the Statistical Package for Social Sciences (SPSS) software version 20.0.

The project was approved by the Standing Committee on Ethics in Human Research of the State University of Maringá (*COPEP/UEM*): Presentation Certificate to Ethics Assessment (*CAAE*) No. 33177414.0.0000.0104.

Results

In the period 1996-2011, there were 15,024 deaths of residents in Curitiba from homicides and traffic accidents; 85.7% of them among men. The mortality rate from traffic accidents in males, 61.7 in 1996, decreased to 28.4 deaths per 100,000 inhabitants in 2011, representing a reduction of 46%. For women, the coefficient declined from 16.6 in 1996 to 7.4 in 2011, down 44.2%. Despite the reduction in the mortality rate from traffic accidents in both sexes in the period, it was observed that for every female death, there were, on average, 3.9 male deaths (Table 1).

The decrease in mortality from traffic accidents can be seen in Figures 1A and 1B. The average mortality rate from traffic accidents among women was 10.3 deaths per 100 thousand inhabitants, with a decline of 0.43 per year (Table 2). The polynomial regression of third degree showed that, for males, the decline has slowed since 2000, with further acceleration from 2008 on (Figure 1B). Among men, the average mortality rate was 38.4 with a decrease of 0.05 per year. The decline in mortality from traffic accidents, although faster for women, was significant for both sexes: in males, $p < 0.001$ and $r^2 = 0.98$; and in females, $p < 0.001$ and $r^2 = 0.77$ (Table 2).

Unlike traffic accidents, homicide mortality rates have increased in the period: among men, it rose from 32.6 to 69.3 deaths per 100 thousand inhabitants, a relative increase of 113.2%; for women, the coefficient rose from 4.4 to 5.3, an increase in the risk of death by homicide of 20.4%. It is noteworthy that the high male mortality observed during each year of the series, was always above 7, reaching 17.7 male deaths for each female death in 2006 (Table 1). The elevation in coefficients' pattern of homicide mortality for both sexes can be seen in Figures 2A and 2B. Trend analysis showed that the homicide mortality increased significantly for men ($p < 0.001$; $r^2 = 0.95$) and women ($p < 0.001$; $r^2 = 0.76$). In men, the average mortality rate in the period was 56.8 with an increase trend of 3.8 deaths per 100,000 inhabitants each year. In women, the average mortality rate was 4.8 with upward trend of 0.29 each year (Table 2).

Discussion

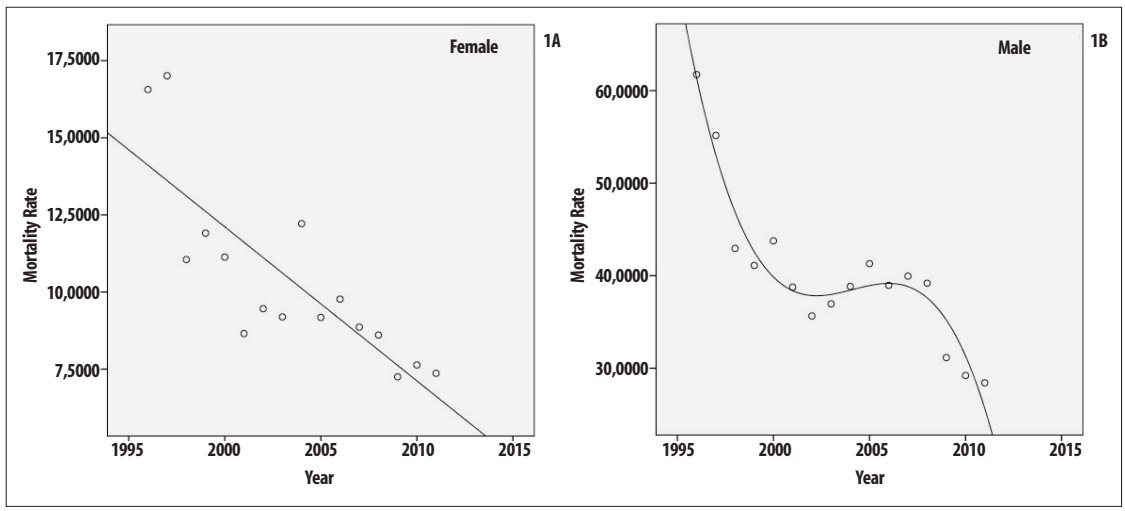
Among the main findings of this research, mortality rates decrease from traffic accidents for men and women are to be highlighted. On the other hand, the mortality rates for homicides increased for both sexes. It is also important to note that, for the two causes of deaths analyzed, men always have mortality rates higher than women, in all the years investigated.

This study has some limitations. One of them stems from the quality of the data from the Mortality Information System (*SIM*). Despite the improvement of the records in this system, verified over the years,[13] underreporting of information about the cause of death or a high percentage of deaths classified as 'death by undetermined intent' can still be common, leading to underestimation of mortality rates due to external causes. In cases of death due to these causes, sometimes only the nature of the injury is recorded and there is no indication if it was by accident, homicide or suicide, impairing a

Table 1 – Mortality rates from traffic accidents and homicides (per 100,000 inhabitants), according to sex in Curitiba, Paraná, 1996-2011

Year	Accidents		Coefficient ratio M/F[a]	Homicides		Coefficient ratio M/F[a]
	Male	Female		Male	Female	
1996	61.73	16.56	3.7	32.56	4.43	7.3
1997	55.16	17.01	3.2	41.98	3.68	11.4
1998	42.95	11.05	3.8	35.30	3.48	10.1
1999	41.11	11.91	3.4	41.77	4.50	9.2
2000	43.77	11.13	3.9	41.27	2.54	16.2
2001	38.76	8.65	4.4	43.78	5.22	8.3
2002	35.65	9.46	3.7	50.61	3.74	13.5
2003	36.95	9.19	4.0	54.80	4.37	12.5
2004	38.83	12.22	3.2	67.22	4.53	14.8
2005	41.30	9.18	4.5	60.76	4.70	12.9
2006	38.96	9.77	3.9	77.92	4.40	17.7
2007	39.95	8.86	4.5	73.35	5.06	14.5
2008	39.19	8.61	4.5	80.66	6.61	12.2
2009	31.15	7.25	4.3	79.11	7.77	10.2
2010	29.22	7.64	3.8	81.19	9.16	8.8
2011	28.41	7.36	3.8	69.31	5.31	13.0

a) M/F: male/female



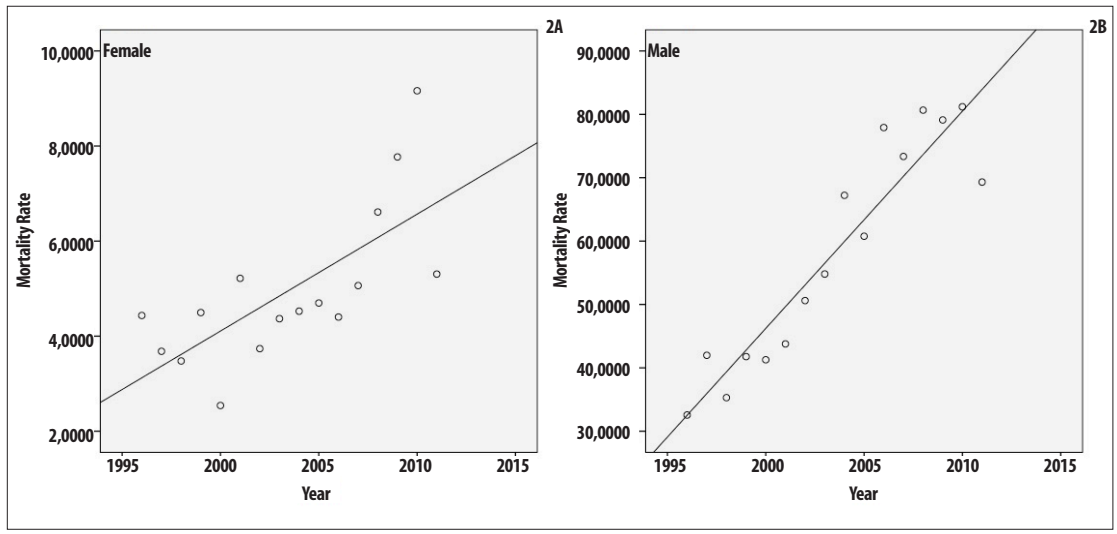
Figures 1A and 1B – Scatter plots of traffic accident mortality rates (per 100,000 inhabitants) by sex in Curitiba, Paraná. Brazil, 1996-2011

Table 2 - Linear trend equation for mortality rates due to homicides and traffic accidents,[a] by sex, in Curitiba, Paraná, 1996-2011

Mortality Rate	Model				r^2	p [b]	Trend
	β_0	β_1	β_2	β_3			
Male-Accidents	38.42	0.40	0.14	-0.05	0.98	<0.001	Decreasing
Female-Accidents	10.33	-0.43	–	–	0.77	<0.001	Decreasing
Male-Homicides	56.84	3.83	–	–	0.95	<0.001	Increasing
Female-Homicides	4.76	0.29	–	–	0.76	<0.001	Increasing

a) Total deaths from homicides = 8,458; total deaths from traffic accidents = 6,566

b) p value from the polynomial regression model



Figures 2A and 2B – Scatter plots of homicide mortality rates (per 100,000 inhabitants) by sex in Curitiba, Paraná, 1996-2011

reliable analysis of mortality and, consequently, of the basis statistical data set used for planning prevention strategies.[14] However, in this study, the number of records of 'death from undetermined intent' was small (11) and their exclusion probably did not influence the analysis and interpretation of findings.

On the record of death at *SIM*, it is important to highlight the possibility of changing the *causa mortis* or the addition of conditions that have influenced it, obtained after investigation. However, there is no way to monitor and ensure that all the necessary changes – after this investigation – will take effect.

Another limitation of this study is the exclusion of the basic cause of death in cases of 'legal interventions' (Y35), which are often classified as death for homicide. Furthermore, it is worth mentioning that, in order to enable a comparison of the results with information from other Brazilian cities and even other countries, it is necessary to standardize the coefficients. And, finally, there is the use of polynomial regression as one more limitation, since it is not possible to control the serial autocorrelation. In the case of this study, a correlation between members of a series of observations ordered in time may have occurred.

The reduction in mortality rates from traffic accidents for both sexes over the period under study may be a reflect of the different media educational campaigns carried out by the sectors of health, economy and social security, as well as the enactment of Law No. 11,705, dated June 19, 2008, called "Dry Law", which prohibits the consumption of alcohol by drivers in an amount greater than 0.1 mg of alcohol per liter of air expelled in the breathalyzer (or 2dg of alcohol per liter of blood).[5]

In the same scenario, also capable of influencing the decline in mortality from traffic accidents, the *Life in Traffic Project* stands out. This is an international initiative implemented in 2010 in five Brazilian municipalities – among them, Curitiba – focusing mainly on the implementation of inter-sectorial interventions, hinged together, in order to reduce traffic deaths.[9]

Although the traffic accident mortality rate has presented a downward trend, the world gross data for the year 2010 are alarming concerning the number of deaths: more than 1.2 million.[15] Corroborating the results of this study, a literature review study[16] pointed out that, in Brazil, in 1998, 30,890 people died in traffic accidents. In 2008, this number raised 19% (36,666 deaths) compared to 1998, while the Brazilian population have grown 17% in the course of those years. However, if the period from 1998 to 2000 showed a decrease in the number of casualties (28,995 deaths), once again a steady rise was observed in the following years, reaching 37,407 deaths in 2007.

According to a study conducted in the municipality of Rio de Janeiro, the decrease of fatal crashes between July 2007 (before the "Dry Law") and July 2008 (after the "Dry Law") was nearly 13%.[17] These data are in line with those presented by the Brazilian Association of Traffic Medicine,[18] reporting 24% reduction in calls to traffic accidents conducted by the Emergency Medical Service (*SAMU*) in São Paulo since the enactment of the "Dry Law". In this study, a great decrease of deaths from traffic accidents from 2008 on was also observed for men.

However, the same could not be observed in motorcycle accidents, specifically. Motorcycles are part of the urban landscape and are efficient transport tools, especially in large cities. However, the driving form and the driver and passenger's vulnerability have contributed to the increase in traffic accidents and mortality, especially in males. A study conducted in Campinas, São Paulo state, for example, pointed out that, although there has been a reduction in the lethality of motorcycle accidents between 2000 and 2008, this category represented 49.3% of all fatal accidents in the period. The motorcycles have been identified as being responsible for most of pedestrian crashes (66.7%) and fatal pedestrian crashes (4 deaths/1,000 accidents).[19] The social and cultural behavior of male population is characterized by greater exposure to risk injuries and deaths: high speed driving, higher alcohol consumption, higher aggressiveness in traffic, tendencies to perform risky maneuvers, among other habits that predispose them to accidents.[17,19] In addition to the driver's sex, a study conducted with 750 motorcycle riders in two municipalities of Paraná state – Londrina and Maringá – pointed to the association of major accidents with features such as younger age (18-24 years old), cell phone use while driving, speeding and more than one work shift.[20]

The present study and the literature suggest that intervention strategies as the Dry Law may impact on reducing mortality rates from traffic accidents, in both men and women. Nevertheless, the male sex is still a major perpetrator of cases led to death, imposing the current challenge of public management in the areas of Health and Safety: planning and implementing strategies and policies that aim to achieve other risk behaviors, especially those committed by men, much beyond the use of alcohol by drivers of vehicles.

On the other hand, the homicide mortality rates showed significant increase for both sexes. Unlike these results, a study conducted in the municipality of São Paulo showed a decrease of 74% in homicide mortality from 1996 to 2008, a trend not observed for other external causes, such as traffic accidents, suicides and armed robbery. According to the authors of the aforementioned study, its findings stem from the fact that the reduction in mortality from external causes result from processes that influence, in different ways, interpersonal lethal violence;[3] which explains, in part, the fact that the capital of Paraná in the period assessed by this study also have presented a decrease in traffic accidents mortality rates and increased mortality rates due to homicides.

Another important factor to be considered is the improvement in the quality of records and coverage of information systems, as shown in a study conducted in the state of Pernambuco.[21] These two aspects contribute

greatly to identify the profile of the events in specific locations, allowing even the comparison between different regions, as well as support the discussion and implementation of specific interventions for each context.

The findings of this study corroborate with a study [22] conducted in Brazil, which showed an 8% increase in homicide mortality rate solely from 2000 to 2003, being higher in men, just as was identified in a research that analyzed the homicide mortality in Paraná, from 1970 to 2005.[23] Another study, of trend analysis on data from 121,297 homicides occurred in the Americas between 1999 and 2009, showed that 89% of the deaths occurred to men.[6] Similarly, a study conducted in the municipality of Maceió, Alagoas, showed that this capital, registered 5,735 homicides between 2007-2012, of which 94.8% of the victims were male.[24]

The association between masculinity and violence, observed in society, has been discussed in scientific and academic circles.[25] Research has found that men, since their teens, take a more reckless attitude toward life, and are more exposed and vulnerable to being victims of violent events. In such circumstances, they experience, on the one hand, tensions and anxieties generated by a constantly threatened identity and challenged to assert by manly, authoritarian and aggressive behavior, turning them into agents of violence; on the other hand, exposure to aggression and other forms of violence that these behaviors provide, turns them into targets of violence. This youth behavior, most often, extends into adulthood, perpetuating the same risks of generating and suffering violence.[25]

In the case of violence against women, when it does not culminate in death, there is a negative impact on economic, social and reproductive aspects of life, including on children.[26] In Brazil, on August 7, 2006, Law No. 11,340, better known as Maria da Penha Law was enacted. This Law is responsible for creating mechanisms to restrain domestic and family violence against women.[4] However, national studies[25,26] have shown that the implementation of this Law has not impacted significantly on the reduction in mortality due to homicide among women, and the rates have continued to rise, as evidenced in that study.

Women homicides represent about 10% of total mortality due to aggression. Despite having lower ratios of deaths from assaults, the murders of women are a social problem without comparison in the male population, since the majority of female homicides are related to gender condition.[27] The reality of these homicides deserve special attention of public managers so that the law might be indeed fulfilled and thus the frequency of aggression and death among women victimized by violence will be reduced, especially domestic violence.

Clearly on the data collected and literature searched, combat strategies and prevention of mortality from traffic accidents and homicides must be guided by the characteristics of each place and the various determinants of these occurrences and should not be addressed by a single strategy intervention. The external causes have assumed increasing importance in the overall structure of causes of death, affecting more developed south-central areas of the country, according to the records of the Ministry of Health.[28]

Finally, it highlights the diverging trend between these two mortality due to external causes described in the study – a reduction in the mortality rate from traffic accidents and an increase in mortality rate from homicides – reinforcing the importance of conducting less aggregated trend studies according to groups of causes, in order to enable a more complete understanding of these phenomena and thus support the implementation of specific strategies addressing these issues. On the results presented, it is clear that the confrontation of both traffic accidents and homicides is multidetermined and should involve policies and intersetorial actions, which may transform for the better the general living conditions of the population.

Authors' contributions

Barreto MS contributed to the drafting of the manuscript, data analysis and interpretation and literature review.

Teston EF contributed to the data analysis, literature review and manuscript drafting.

Latorre MRDO contributed to the study design, statistical analysis, results interpretation and manuscript drafting.

Mathias TAF contributed to the data analysis and interpretation, literature review and manuscript drafting.

Marcon SS contributed to the study design, data analysis and interpretation, literature review and manuscript drafting.

All authors approved the manuscript's final version and declared to be responsible for all aspects of the work, ensuring its accuracy and integrity.

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