

## TREND IN MORTALITY OF ELDERLY BY LAND TRANSPORT ACCIDENTS IN BRAZIL

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**ABSTRACT:** The present study aimed to analyze the trend in mortality by land transport accidents among Brazilian elderly individuals, from 1996 to 2013. Ecological, time-series study with secondary data collected by the Mortality Information System in April, 2015 concerning deaths by transport accidents. There were 88,273 deaths of elderly individuals caused by land transport accidents in Brazil, in the study period. All Brazilian regions showed a rising trend in mortality by transport accidents, which were more significant in the Northeastern region, followed by the Southern, Northern, Southeastern and Central-Western regions. These findings reveal the importance of surveillance of transport accidents, to support the implementation of effective health promotion policies, prevention and reduction of these events.

**DESCRIPTORS:** Traffic accidents; Mortality; Elderly; Time-series studies; Geriatric Nursing.

### TENDÊNCIA DA MORTALIDADE POR ACIDENTES DE TRANSPORTE TERRESTRE EM IDOSOS NO BRASIL

**RESUMO:** O objetivo foi analisar a tendência da mortalidade por acidentes de transporte terrestre em idosos brasileiros no período de 1996 a 2013. Estudo ecológico, de séries temporais com dados secundários captados pelo Sistema de Informação sobre Mortalidade, em abril de 2015, referentes aos óbitos por acidentes de transporte. Houve 88.273 óbitos por acidentes de transporte terrestre no período estudado entre idosos brasileiros. Todas as regiões apresentaram crescente tendência de mortalidade por acidentes de transporte, tendo o Nordeste a maior tendência, seguida do Sul, Norte, Sudeste e Centro-Oeste. Os resultados apontam a importância da vigilância de acidentes de transporte no apoio à implementação de políticas efetivas na promoção da saúde, prevenção e redução destes eventos.

**DESCRIPTORIOS:** Acidentes de trânsito; Mortalidade; Idoso; Estudos de Séries Temporais; Enfermagem Geriátrica.

### TENDENCIA DE LA MORTALIDAD POR ACCIDENTES DE TRANSPORTE TERRESTRE DE ANCIANOS EN BRASIL

**RESUMEN:** El objetivo fue analizar la tendencia de la mortalidad por accidentes de transporte terrestre en ancianos brasileños en el período de 1996 a 2013. Estudio ecológico de series temporales, con datos secundarios obtenidos a través del Sistema de Información sobre Mortalidad, en abril de 2015, referentes a los decesos por accidentes de transporte. Hubo 88.273 decesos por accidentes de transporte en el período estudiado entre ancianos brasileños. Todas las regiones mostraron creciente tendencia de mortalidad por accidentes de transporte, resultando que el Noreste mostraba tendencia mayor, seguido del Sur, Norte, Sudeste y Centro Oeste. Los resultados expresan la importancia de la vigilancia de accidentes de transporte en el apoyo a la implementación de políticas efectivas de promoción de salud, prevención y reducción de estos eventos.

**DESCRIPTORIOS:** Accidentes de Tránsito; Mortalidad; Anciano; Estudios de Series Temporales; Enfermería Geriátrica.

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## ● INTRODUCTION

Population aging, a global phenomenon, is a result of improvement in health care, decreased fertility rates and increased life expectancy at birth, and the growth of the elderly population has become faster over the past decades<sup>(1-2)</sup>. By 2015, the population aged 60 or more in Brazil is expected to reach 32 million. These projections rank the country sixth in terms of elderly population, in the world<sup>(1)</sup>.

Health problems and deaths in the elderly are often related to chronic-degenerative diseases. However, disorders from external causes are worth mentioning due to the recent increase in traffic accidents, particularly transport accidents, which are frequent and have the highest rates<sup>(3)</sup>. Land Transport Accident (ATT) is defined as the unintentional and preventable episode, capable of generating physical and emotional damage that involve pedestrians, motorcycle riders and occupants of vehicles<sup>(4)</sup>.

Aging, as a natural process, leads to the decline of functional aspects, making individuals more vulnerable to accidents, especially transport accidents<sup>(2)</sup>. And since elderly are less able to recover from injury due to preexisting diseases, they are more likely to die from minor injuries and earlier than younger individuals. This statement is corroborated by the literature that shows that mortality rates from external causes among elderly are similar to those of adolescents and young adults<sup>(5-6)</sup>.

In 2013, there were 151,683 deaths from external causes among the general population in Brazil, and 27% of these deaths were caused by land transport accidents. This percentage is similar to the percentage of deaths of the elderly population in the same period, namely 26,933 deaths of elderly individuals by external causes, and 24% of them were related to land transport accidents<sup>(7)</sup>.

Despite the current public policies targeted to victims of land transport accidents, and those specifically targeted to the elderly population, the issue deserves greater consideration of the governmental authorities, who are expected to develop strategies to minimize the risk of accidents and improve the rehabilitation of this population<sup>(8)</sup> and reduce such accidents.

Given the complexity of the aging process associated to the serious risk posed by land transport accidents to the elderly population, we decided to investigate the occurrence of this event when associated to death, in order to contribute to public policies, and ensure that the elderly are safely transported. Therefore, the present study aimed to assess the trend in mortality by land transport accidents among Brazilian elderly individuals in the 1996-2013 period.

## ● METHOD

Ecological time-series study on mortality by transport accidents among Brazilian elderly, from 1996 to 2013.

Brazil has 5,570 cities and is divided into five regions: the Central-Western region, composed of four states; the Northeastern region, composed of nine states; the Northern region, with seven states. The Southeastern region, with four states and the Southern region, formed by three states, with a total estimated population of 20,590,599 people aged 60 years or more, that account for 10.7% of the general population. The elderly population living in each one of the regions in 2010 was as follows: 6% in the Central-Western; 26.4% in the Northeastern region; 5.2% in the Northern region; 46.2% in the Southeastern region (the largest population) and 16% in the Southern region<sup>(1)</sup>.

Data was collected in April 2015, at the Mortality Information System (SIM) of the website of the Information Technology Department of the Unified Health System (DATASUS), which provides information on deaths through the Tabnet program, when the variable "municipality of occurrence of death" is selected. The study population consisted of individuals aged 60 years or older, who died in land transport accidents in Brazil between 1996 and 2013.

The reason for selecting the abovementioned period for the analysis is that the SIM began to record death causes according to the rules of the International statistical classification of diseases and related health problems (ICD-10) – tenth revision in 1996, and the last year of the period was 2013, because SIM

information was available up to this year at the time of data collection.

Population data concern information obtained at the 2000 and 2010 censuses and other population estimates obtained from the website of the Ministry of Health <sup>(1)</sup>.

The causes of death are classified according to ICD-10 standards <sup>(9)</sup>. The analysis comprised deaths coded as: Pedestrian (V01 to V09), Pedal cyclist (V10 to V19), Motorcycle rider (V20 to V29), Occupant of three-wheeled motor vehicle (V30 to V39), Car occupant (V40 to V49), Occupant of pick-up truck or van (V50 to V59), Occupant of heavy transport vehicle (V60 to V69), Bus occupant (V70 to V79), Other land transport accidents (V80 to V89) <sup>(9)</sup>.

In order to assess the behavior and trend in mortality by land transport accidents linear regression with estimates of the parameters based on the method of least squares was used. The model used was:  $y_i = \beta_0 + \beta_1 X_i + \beta_2 X_i^2 + \dots + \beta_p X_i^p + e^i$ , where  $y_i$  is the number of deaths caused by land transport accidents;  $X_i$  is the year, which ranged from 1996 to 2013;  $i$  is the number of observations, that is,  $i = 1, \dots, 18$  and  $j$  determines the maximum degree in the polynomial, and  $e^i$  determines the amount of model parameters <sup>(10)</sup>.

The first model tested was simple linear regression ( $Y = \beta_0 + \beta_1 X$ ) and where appropriate second degree ( $Y = \beta_0 + \beta_1 X + \beta_2 X^2$ ) and third degree ( $Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 X^3$ ) polynomial equations were tested. The best regression model obtained used Akaike's information criteria <sup>(11)</sup>.

A first degree linear model was adjusted to verify the average behavior and possible trend. In a first degree polynomial model, parameter  $\beta_1$  is considered the angular coefficient of the model. 95% confidence intervals were constructed for parameter  $\beta_1$  to check whether the growth of all regions had the same angular coefficient <sup>(10)</sup>.

Since this study used secondary data from public databases, and due to the confidentiality of information related to human subjects, this study was exempt from approval by the Research Ethics Committee.

## ● RESULTS

In the 1996-2013 period there were 325,716 deaths of Brazilian elderly by external causes, and 27% ( $n = 88,273$ ) were coded as land transport accidents. Of these deaths by land transport accidents ( $n=88,273$ ), 5.5% occurred in the Northern region; 43.2% in the Southeastern region; 19.6% in the Southern region; 9.3% in the Central-Western region and 22.2% in the Northeastern region.

The rising trend in mortality by land transport accidents was more significant in the Northeastern region compared to the other Brazilian regions (Figure 1).

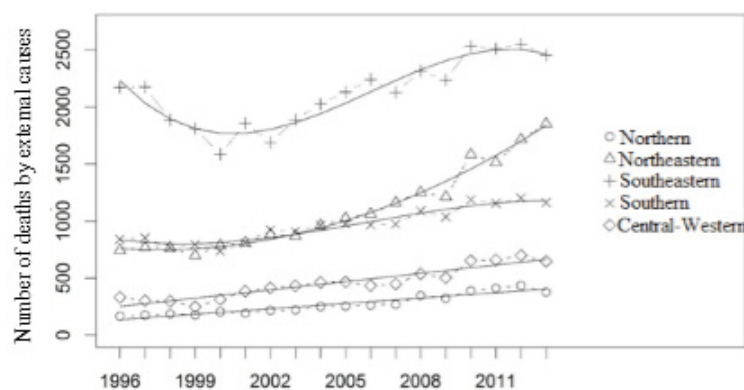


Figure 1 – Trend in mortality by land transport accidents among Brazilian elderly from 1996 to 2013. Maringá, PR, Brazil, 2015

Source: SIM / SUS, 2015

The results of analysis of trend in mortality, and the models adjusted for each region are shown in Table 1. All models showed residues that can be considered normal by Shapiro-Wilk test at 95% confidence.

Table 1 – Trend in mortality by land transport accidents among elderly in the 1996-2013 period, in the different Brazilian regions. Maringá, PR, Brazil, 2015

Region	Model	Trend	R <sup>2</sup> *	p-value**
Northern	$y = 15,74x + 120,91$	1996-2013: Increasing	0.90	0.15
Northeastern	$y = 4,52x^2 - 22,64x + 776,66$	1996-2013: Increasing	0.97	0.15
Southeastern	$y = -1,09x^3 + 36,12x^2 - 298,04x + 2492,59$	1996-2000: Decreasing 2000-2011: Increasing 2011-2013: Decreasing	0.89	0.35
Southern	$y = -0,23x^3 + 7,76x^2 - 45,77x + 874,74$	1996-1999: Decreasing 1999-2013: Increasing	0.92	0.76
Central-Western	$y = 24,18x + 227,66$	1996-2013: Increasing	0.88	0.47

\*Coefficient of determination; \*The residues can be considered normal by Shapiro-Wilk, test at 5% significance. Source: SIM/SUS, 2015.

The Southeastern region showed a decreasing trend in mortality from 1996 to 2000 and from 2011 to 2013, and in the Southern region such trend occurred from 1996 to 1999. In the other Brazilian regions and in all the other periods there was an increasing trend in deaths by land transport accidents among elderly in the 1996-2013 period (Table 1).

The Northeastern region showed a higher  $\beta_1$  value overlapping the Southeastern region. In a simple linear model, the  $\beta_1$  value can be considered a rate of growth. That is, when the intervals overlap, it cannot be affirmed that the regions are different. However, when the intervals do not overlap, one region differs from the other. Therefore, it can be affirmed that the Northeastern region showed the most significant increasing trend, which differed from all the other regions (Figure 2). In other words, there was overlap between the confidence intervals of the Northern, Southern, Southeastern and Central-Western regions, indicating that the Brazilian regions had equal rising trends in mortality by land transport accidents.

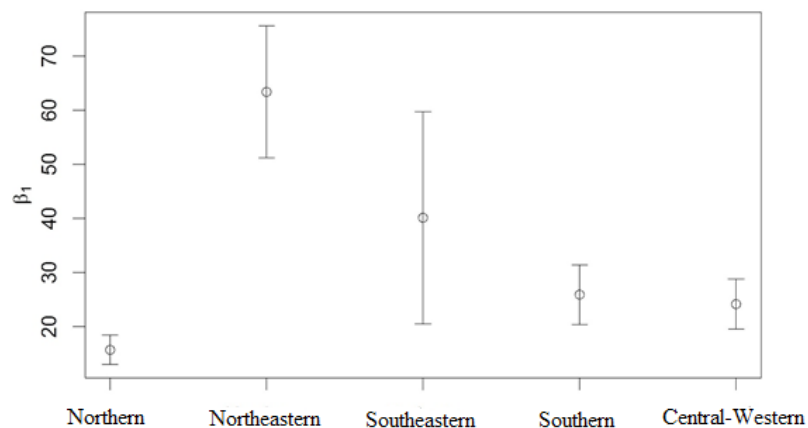


Figure 2 – Confidence intervals for model  $\beta_1$ , according to the Brazilian regions, 1996 to 2013. Maringá, PR, Brazil, 2015

Source: SIM/SUS, 2015.

A polynomial model was adjusted for each region and respective types of accidents. Figure 3 summarizes these results.

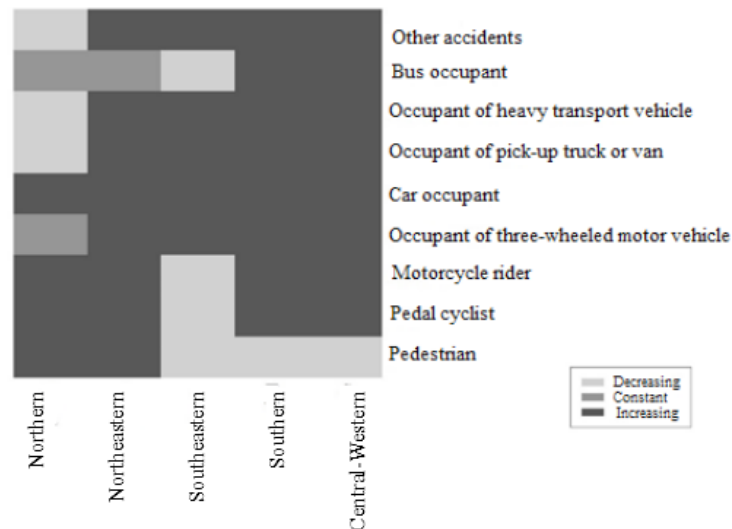


Figure 3 - mortality trends by types of road accidents among Brazilian elderly in the 1996-2013 period. Maringa, PR, Brazil, 2015

Source: SIM / SUS, 2015.

The trend analysis of the Northern region shows that accidents involving elderly pedestrians, pedal cyclists, motorcycle riders and motor vehicle occupants have tended to increase. On the other hand, occupants of pick-up trucks or vans and heavy transport vehicles and other transportation accidents showed a decreasing trend, whereas occupants of three-wheeled motor vehicles showed a constant trend in mortality in the 1996-2013 period.

In the Northeastern region, there was an increasing trend for all types of accidents involving elderly, except for the bus occupant subtype, which showed a constant trend.

Analysis of the Southeastern region showed an increasing trend for occupants of three-wheeled motor vehicles, cars, pick-up trucks or vans and heavy transport vehicles. For other types of transport accidents, the remaining types of accidents declined among the elderly. It can be observed that the South and Central-Western regions showed increasing mortality trends for all categories included in ICD-10 during the study period, except for the pedestrian subtype, which showed decline.

## ● DISCUSSION

In the 18-year study period, despite the oscillation in trends in certain periods, there is an increasing trend for the number of deaths in elderly associated to land transport accidents. Several factors must be considered in the analysis of trend variations, with emphasis to increase in the elderly population in the country, improvement of economic conditions as well as of the quality of information recorded in the Death Certificate (DO).

Regarding the death certificates, it is known that the deaths due to basic causes recorded in "other external causes" or "accidents of unspecified nature", or even "other transport accidents" are now more accurately recorded, which facilitates the completion of certificates, though further improvements are still needed,

Mortality trend analysis allows assessing, in addition to the behavior of land transport accidents in a given population, preventive actions, such as the improvement of surveillance of land transport accidents, and the implementation of relevant public policies. It is also necessary to assess whether

there is an adequate coordination between prehospital care and prompt and efficient response of the hospital emergency care service and whether the control actions, both in primary and secondary levels, contribute to reduce these accidents.

Analysis of a simple linear model showed that the Northeastern regions had the most significant increasing trend in mortality by land transport accidents among elderly, while the other regions had similar trends. This corroborates the literature that reported trend changes in this region due to the increase in the number of urban centers and hence increase in mortality rates<sup>(12)</sup>.

Besides these factors, in the Northeastern region people do not make satisfactory use of safety devices, particularly seat belts in the front and rear seats of the cars. It is known that the use of this device is an effective measure to reduce serious injuries in land transport accidents. Therefore, educational strategies should be implemented to encourage the use of seat belts by car occupants<sup>(12)</sup>.

The Southeastern region showed the highest rates of transport accidents, which is similar to another study that reported a decreasing trend in mortality rates by transport accidents in the 1996-2000 and 2011-2013 periods, which might have been influenced by the fact that death certificate forms did not specify this type of accident, as mentioned above, and after 2008, due to the establishment of the so-called "Dry law"<sup>(13)</sup>.

The enactment of Law 11,705/2008, known as "Dry Law", was a governmental initiative aimed to reduce land transport accidents. The Law led to changes in the attitudes of the population regarding the consumption of alcoholic beverages and the driving of motor vehicles. The Ministry of Health reported a reduction in the number of people who had road accidents in highways throughout the country, generating savings of 50 million reais in the first month after the promulgation of the referred law<sup>(14)</sup>.

Although the rising trend in mortality rates due to land transport accidents in the Northern region was less significant than that of the other Brazilian regions, according to a study, the subjects involved in land transport accidents in this region have shown the lowest rate of compliance with traffic safety regulations compared to people involved in land transport accidents in the other regions of the country<sup>(12)</sup>.

These regional differences have already been observed after the implementation of the National Traffic Code in 1998, with a considerable decrease in mortality rates by road traffic accidents in Brazil, in the Southern and Southeastern regions, which was not observed in the Northeastern, Northern and Central-Western regions<sup>(13)</sup>.

In African, Asian and Latin American countries, most victims of traffic accidents are pedestrians and pedal cyclists. Most of them are low-income individuals<sup>(12)</sup>. In the present study, in the Northern and Northeastern regions there was a rising trend in the mortality of pedestrians, whereas for the subtype pedal cyclists, there was increase in the number of deaths in these two regions, as well as in the Southern region.

Elderly are more susceptible to be run over by vehicles on the road because of their reduced mobility and inaccurate perception of their capabilities<sup>(12,15)</sup>. A Brazilian study found higher rates of older elderly being hit and killed in land transport accidents<sup>(16)</sup>, corroborating a study conducted in the United States, according to which individuals aged 80 and over accounted for 39% of the elderly hit by cars on the roads<sup>(5)</sup>.

Worldwide, an estimated 1.2 million people are killed each year in land transport crashes and as many as 50 million are injured as a result of land transport accidents, most of them on the road network: pedestrians, pedal cyclists and motorcycle riders<sup>(3)</sup>. In the present study, only the Southeastern region showed a decreasing trend in mortality by motorcycle accident, while the opposite occurred in the other regions in the study period.

The number of fatal motorcycle accidents has been truly alarming. Between 1996 and 2007 the number of accidents increased by 820%, and one factor that may have contributed to these rates is the expansion in the motorcycle fleet in the country and the speed and low cost of this transport mode<sup>(17)</sup>. Motorcycle accidents have a high potential for death to the riders<sup>(18)</sup>.

In this study, all Brazilian regions showed an increasing trend in mortality in accidents involving some subtypes of occupants of vehicles, either occupants of three-wheeled motor vehicles, cars, pickup trucks or vans, heavy transport vehicle or bus. A study that used time-trend analysis of mortality by land transport accidents between 2000 to 2010 reported increased deaths of occupants of these vehicles in states of the Southeastern, Southern, Northeastern and Central-Western regions<sup>(13)</sup>.

Another study conducted in the Northeastern region found a high percentage of deaths of car occupants, which is the transport mode with most fatalities. This fact can be explained by lack of awareness of the importance of wearing safety equipment such as seat belts, "airbags", seat belts for children and motorcycle helmets<sup>(17)</sup>.

It should be noted that the economic development may have contributed to the increase in the number of deaths by land transport accidents, due to the large circulation of motor vehicles without regulations and standards on the establishment of mechanisms of adaptation to this expansion. Also, scarce surveillance, ineffective public transport and inappropriate infrastructure are also factors that contribute to urban violence<sup>(19)</sup>.

Land transport accidents are, for the most part, predictable and preventable. Therefore, this problem can be approached by rational analysis and interventions. It is known that prevention of accidents is a public health issue, especially among the elderly population, with its peculiarities, which require joint actions by several sectors.

Brazilian initiatives to address high mortality rates in traffic have been implemented more decisively since 1998 with the introduction of the National Traffic Code, which, in its first year reduced by 7.4% mortality rates by traffic accidents<sup>(14)</sup>.

Moreover, the Ministry of Health has led actions of surveillance and prevention of injuries and deaths caused by transport, as well as health promotion actions, such as the National Policy for the Reduction of Morbidity and Mortality from Violence and Accidents (PNRMAV), sanctioned by ordinance GM/MS n° 737, of 05/16/2001. However, so far there no assessments have been made on the efficiency of this legislation, based on the reduction of mortality and morbidity rates by land transport accidents. The results of this study corroborate the literature, regarding the little impact of the introduction of these laws on road traffic accidents, i.e., there has been some decrease, though not significant, in road traffic fatalities<sup>(15)</sup>.

Aging-related interventions should aim to ensure that functional, physical and mental capabilities are maintained with good quality of life. It is imperative that in addition to accessibility to services, there is flexibility to identify situations that are constantly changing, in an attempt to provide comprehensive care for the elderly, with the delivery of social services, appropriate working conditions, housing, safety, food, transport and recreation.

A urban area more suitable to the peculiarities of elderly people is needed, and is also necessary to invest in the culture of solidarity, targeting a community that embraces all its members. Safe mobility is an essential right, and some measures need to be discussed, e.g. appropriate traffic lights, especially in the busiest routes, accessibility and safety to users of bus stops, readability of information, taking into account the visual limitations caused by aging<sup>(20)</sup>. Moreover, stricter supervision of traffic is necessary, with the adoption of educational and punitive measures to those who cause traffic accidents and protection of vulnerable users of public roads<sup>(17)</sup>.

The limitations of the present study are related to the statistical method adopted, such as problems with the polynomial regression model, which does not control serial correlation, as well as obstacles to the use of secondary data on the quality of information regarding deaths, which may differ according to the organization of the services in each state/region. However, such limitations do not invalidate the effort taken in data analyzes and the contribution of this study to the clarification of the health status of the elderly population and to the collection of more accurate data on basic causes of death.

## ● CONCLUSION

The results of this study provided reflections on the mortality profile in transport accidents among Brazilian elderly, from 1996 to 2013. They show a significant increasing trend in all regions, with emphasis on the Northeastern region, and regarding the types of accidents, there was an increasing trend for car occupants, in all regions, during the study period.

The elaboration of consistent road safety strategies supported by national policies, plans and programs that establish specific interventions, such as the improvement of road infrastructure and adaptation and/or improvement of the conditions of health institutions to ensure they provide adequate care to victims of trauma is suggested. Moreover, the encouragement of educational practices that address the risks of land transport accidents to the general population and to the elderly. Finally, further studies are needed, especially of assessment of and support to policies, plans and programs aimed to reduce morbimortality by land transport accidents and that contemplate future policies on the issue.

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