JHGD
Journal of Human Growth and Development

www. jhgd.com.br

ORIGINAL ARTICLE

Temporal evolution of traffic accident mortality rates in the State of São Paulo, Brazil, in the period 2009-2019

Beatriz Cecilio Bebiano[a,b], Luiz Carlos de Abreu[a-e], Rafael Carboni de Souza[a,b] , Cleber Furlan[f], José Luiz Figueiredo[f], Woska Pires da Costa[g], Francisco Naildo Cardoso Leitão[a-c], Luciano Miller Reis Rodrigues[a,b]

Open acess

[a]Laboratório de Delineamento de Estudos e Escrita Científica, Centro Universitário FMABC – Santo André, São Paulo, Brasil;

[b]Programa de Pós-Graduação em Ciências da Saúde, Centro Universitário FMABC – Santo André, SP, Brasil;

[c]Laboratório Multidisciplinar de Estudos e Redação Científica em Ciências da Saúde, Centro de Ciências da Saúde e Esportes, Universidade Federal do Acre - Rio Branco, Acre, Brasil;

[d]Centro de Ciências da Saúde, Universidade Federal do Espírito Santo – Vitória, Espírito Santo, Brasil;

[e]University of Limerick School of Medicine – Limerick, Ireland.

[f]Programa de Pós-graduação em Cirurgia. Universidade Federal de Pernambuco, Recife, Brasil

[g]Instituto Federal Goiano - Campus Morrinhos, Morrinhos, Goiás, Brasil;

Corresponding author
luizcarlos.deabreu@ul.ie

Manuscript received: may 2023
Manuscript accepted: december 20213
Version of record online: april 2024

ORCID Authors

Beatriz Cecilio Bebiano – https://orcid.org/0000-0002-4192-4416
Rafael Carboni de Souza – https://orcid.org/0000-0001-5694-8202
Francisco Naildo Cardoso Leitão – https://orcid.org/0000-0001-7743-2512
Luiz Carlos de Abreu - https://orcid.org/0000-0002-8465-6327
Luciano Miller Reis Rodrigues – https://orcid.org/0000-0001-6891-5395
Woska Pires da Costa
https://orcid.org/0000-0002-8841-2039;
Cleber Furlan
https://orcid.org/0009-0002-4554-9673
José Luiz Figueiredo
https://orcid.org/0000-0003-0915-7947

Abstract

Introduction: external causes are considered a public health problem in the world, associated with socioeconomic, political, and cultural diversities. Among them, traffic accidents stand out.

Objective: to assess the trend in traffic accident mortality for each sex in the state of São Paulo, Brazil.

Methods: ecological study of time series analyses. Secondary data referring to deaths from traffic accidents by place of residence in the state of São Paulo, Brazil, in the period 2009 - 2019 were used.

Results: the total mortality rate in 2019 for females is 39.80 and for males, 185.85, with a reduction of 4.96% per year for both sexes. The trends in mortality from traffic accidents for females proved to be stationary for motorcyclists, motorized tricycle, pickup truck, heavy transport vehicle, and bus occupants at the end of the study period. For males, the same pattern was observed, but only for truck, heavy transport vehicle, and bus occupants. In the rest of the vehicles, the mortality rate showed decreasing trends.

Conclusion: the highest number of deaths occurred among males (81.38%), aged between 20 and 49 years (58.70%), single (49.12%), on public roads (46.73%) and hospitals (45.64%). Females have more stationary trends than males.

Keywords: traffic, accidents, mortality, motor vehicles.

Suggested citation: Bebiano BC, Abreu LC, Souza RC, Costa WP, Leitão FNC, Furlan C, Figueiredo JL, Rodrigues LMR. Temporal evolution of mortality rates due to traffic accidents in the state of São Paulo, Brazil, in the period 2009-2019. *J Hum Growth Dev. 2024; 34(1):31-42.* DOI: http://doi.org/10.36311/jhgd.v34.15048

Authors summary

Why was this study done?
This is a very relevant issue for global public health. Traffic accidents still have high mortality rates, mainly in developing countries.

What did the researchers do and find?
The researchers of this study used secondary data, publicly available and without personal information of the victims, to calculate the death rate from traffic accidents and its trends. Although the rates in question have decreased and their trends are mostly stationary, it is important to pay attention to other vulnerable populations, such as women and children from 0 to 9 years of age.

What do these findings mean?
The study shows that public policies mitigate the problem and that they should be created with more magnitude.

Highlights
The female population has more stationary trends for mortality rates due to traffic accidents than males.
Mortality rates from traffic accidents for the male population is almost five times higher than for the female population.

INTRODUCTION

External causes are considered a public health problem in the world, associated with socioeconomic, political, and cultural diversities. Among them, traffic accidents stand out.

Every day, hundreds of people lose their lives or suffer serious sequelae in traffic accidents. Traffic accidents are a public health problem worldwide[1]. In 2021, the World Health Organization (WHO) initiated, in Geneva, the Decade of Action for Road Safety (2021-2030), with the goal of preventing at least 50% of deaths and injuries in traffic until the last year of the project1 Currently, 3.5 million people die every day on the roads. Predictions are that traffic accidents will cause more than 13 million deaths. Regarding age group, it is already established that traffic accidents are the main cause of death of children and young people worldwide.

According to the World Health Organization (WHO) Global Status Report on Road Safety 2018, 1.35 million people died from road accidents worldwide. Even with advances in areas such as legislation, vehicle safety and post-accident care, the numbers do not decrease[2] This number is probably high due to the advance of the automobile industry, which means that more and more people have access to vehicles such as cars and motorcycles.

A total of 90% of traffic accidents happen in underdeveloped countries, even though they have half the number of vehicles sold worldwide3. In deaths from traffic accidents, Iran is 5th in the world and 1st in the Western Mediterranean region. Among high-income countries, the United States had the highest numbers in 2013[4].

According to the WHO, in 2013, half of the deaths from traffic accidents occurred among pedestrians and cyclists. Only 79 countries have policies to protect these people. In the same year, only 68 countries had public policies to promote the use of bicycles and walking, taking care of the environment[5].

The condition of public roads is also a relevant factor. In Guadalajara, a city in the state of Jalisco, Mexico, factors related to pedestrian mortality are bus stops at intersections and characteristics of the road system, such as the presence of traffic islands, vehicle flow and pedestrian flow[6].

In Brazil, since the creation of the Brazilian Traffic Code (CTB - Law 9,503 of 1997) until 2008[6], traffic accidents increased by 121%7. However, between 1996-2015, there was a 63.2% decrease in pedestrian deaths, a variation of the standardized coefficient from 8.9 to 3.3 per 100,000 inhabitants. Run overs are higher among men and the elderly[8].

Even so, between 1998 and 2014, the CTB provided savings of R$71 billion (Brazilian currency) related to lost production, health care and patient removal and transfer[9].

In 2012, the law that prohibits the use of alcohol in traffic (Law 11,503, of 2008), called Lei Seca, underwent an intense reformulation, reducing the rate of alcohol when taking the breathalyzer test and increasing rigor in the application of penalties[10]. Between 2007 and 2013, there was a process of greater application, especially during holidays and weekends, which may explain the reduction in the rates[11]. A study proves that between June 2014 and December 2015 a third of fatal traffic accidents in São Paulo are related to alcohol use[12].

São Paulo is the richest and most populous state in Brazil. However, there are still gaps in the scientific literature on mortality rates and factors associated with traffic accidents among road users in this state of the Federation. Therefore, the objective of this study is to evaluate the trend of mortality due to traffic accidents in the state of São Paulo.

METHODS

This is an ecological study of time series analyses. Secondary data referring to deaths from traffic accidents by place of residence in the state of São Paulo, Brazil, in the period 2009 - 2019 were used.

Data collection took place through data available at the Department of Informatics of the SUS ("Informações de Saúde – DATASUS")[13]. The information comes from cities in the state of São Paulo, which has an area of 248,219.63 km^2 (Fundação SEADE, 2019). The state's Gross Domestic Product (GDP) is R$2,222,466 (Brazilian currency) and the Human Development Index (HDI) is 0.783 (IBGE). In Brazil, it is the state that has the most vehicles - a total of 29,057,749 (IBGE). The state has 646 municipalities and 46 million inhabitants, of which 3.23 million are aged ≥70 years (Fundação SEADE). The analyzed data correspond to the period between January 1, 2009, and December 31, 2019.

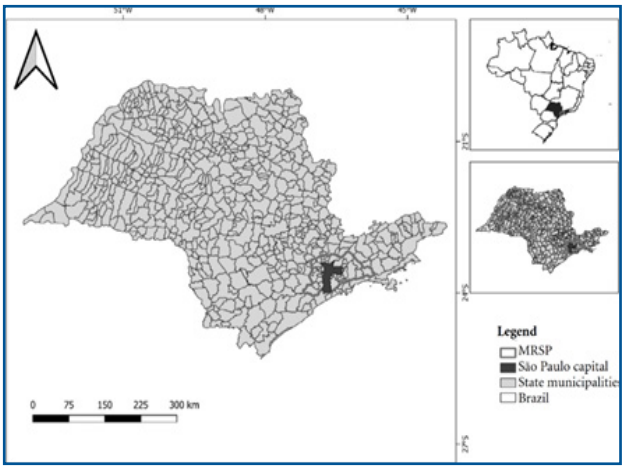

Figure 1: Location of the State of São Paulo and the Metropolitan Region of São Paulo (RMSP) in Brazil
Source: https://doi.org/10.1590/1413-81232020259.17082020.

Deceases were counted from deaths from external causes - traffic accidents reported in the Mortality Information System (SIM), from DATASUS, considering the place of residence.

To construct the mortality rates, data were collected from the projection of the population of the state by sex and simple age: 2000-2060, according to information provided by DATASUS (board 1).

Board 1: Projection of the population residing in the State of São Paulo distributed by year, considering the period from 2009 to 2019

Year	Inhabitants
2009	42,075,716
2010	42,486,692
2011	42,888,198
2012	43,281,358
2013	43,663,669
2014	44,035,304
2015	44,396,484
2016	44,749,699
2017	45,094,866
2018	45,429,330
2019	45,752,757

Source: IBGE/Diretoria de Pesquisas. Coordenação de População e Indicadores Sociais. Gerência de Estudos e Análises da Dinâmica Demográfica. Projeção da população do Brasil e Unidades da Federação por sexo e idade para o período 2000-2030.

All deaths from external causes of morbidity and mortality (Chapter XX), according to the 10th Revision of the International Classification of Diseases (ICD-10) that occurred in the period between 2009 and 2019, were included. The categories of traffic accidents, according to the ICD-10, are:

V01 – V09: Pedestrian injured in transport accident.

V10 – V19: Pedal cyclist injured in transport accident.

V20 – V29: Motorcycle rider injured in transport accident.

V30 – V39: Occupant of three-wheeled motor vehicle injured in transport accident.

V40 – V49: Car occupant injured in transport accident.

V50 – V59: Occupant of a pick-up truck or van injured in transport accident.

V60 – V69: Occupant of a heavy transport vehicle injured in transport accident.

V70 – V79: Bus occupant injured in transport accident.

V80 – V89: Other land transport accidents.

It should be noted that the category of other land transport accidents (V80 – V89) included all accidents involving animal-drawn vehicles, trains or railway vehicles, trams, special motor transport used in industrial, agricultural or construction areas, vehicles designed for use not on public roads and non-motorized vehicles.

Water, air and space transport accidents and unspecified accidents were excluded.

Data were extracted from the file transfer service provided by the Department of Informatics of the Unified Health System (DATASUS) ("Informações de Saúde – DATASUS"), which began with the systematic recording of mortality data (Vital Statistics - Mortality and Live Births).

To access data, the programs TABNET and TABWIN were used, developed to perform quick tabulations. Data were collected by two different researchers and reviewed by a third investigator to avoid collection bias and ensure the quality of the analyzed data.

Data on deaths from Traffic Accidents were collected using the ICD-10 (V01-V89) and stratified according to sex, age groups (from 0 to 09 years old, 10-19 years old, 20-49 years old, 50 years old and over), education, marital status, place of occurrence and calendar years (2009 - 2019).

The gross mortality rate was calculated according to ICD-10 category (V01-V89), broken down by sex (female or male) and year (2009 - 2019), expressed per one million inhabitants, according to the equation:

$$\text{Mortality} = \frac{\text{Number of deaths in the period}}{\text{Resident population in the middle of the period}} \times 1{,}000{,}000{,}000 \quad (1)$$

The time series of population mortality rates were constructed using the Prais-Winsten linear regression test, as proposed by Antunes and Cardoso (2015)[14]. Thus, the angular coefficient (β) and the respective probability (p) were estimated, considering a significance level of 95%. The Annual Percent Change (APC) was also calculated, a percentage that establishes the annual change of a certain rate, considering a significance level of 95%, according to the following equations.

$$APC = (10^{\beta} - 1) \times 100\% \quad (2)$$

$$(95\%CI)_{ul} = (10^{\beta_{max}} - 1) \times 100\% \quad (3)$$

$$(95\%CI)_{ll} = (10^{\beta_{min}} - 1) \times 100\% \quad (4)$$

Legend: β - angular coefficient of the linear regression; ul - upper limit; ll - lower limit of the confidence interval.

To carry out the analysis, the variable Y - dependent - was considered as the mortality rate and the variable X - independent - as the measure of time (in years) and sex. The APC was classified as increasing, decreasing or stationary trends. Trends were classified as stationary when the p-value was not significant, that is, p>0.05.

Statistical analyzes were performed with the software STATA 14.0 (College Station, TX, U.S. 2013).

The present study complied with all the ethical criteria required by Brazilian legislation. It was carried out through a secondary database, without patient identification, using information such as: population data, obtained from the general population census; and deaths, collected from the Mortality Information System. All these sources of information are in the public domain and freely accessible.

According to Resolution No. 510/2016, of April 7, 2016, of the National Health Council, it is not necessary to carry out the registration and evaluation in Research Ethics Committees/National Research Ethics Committee (CEP/CONEP) of research that use information publicly accessible, pursuant to Law Nº. 12,527, of November 18, 2011.

RESULTS

The characterization of deaths from traffic accidents recorded by place of residence in the state of São Paulo, Brazil, during the study period, is illustrated in table 1.

Table 1: Characterization of deaths from traffic accidents recorded by place of residence in the state of São Paulo, Brazil (2009-2019)

Variables	Absolute Frequency (n)	Relative Frequency (%)
Sex		
Female	13,058	18.55
Male	57,279	81.38
Ignored	45	0.06
Age group		
From 0 to 9 years	1,331	1.89
From 10 to 19	6,348	9.02
From 20 to 49	41,315	58.7
50 years or older	20,433	29.03
Ignored	955	1.36
Place of occurrence		
Residence	482	0.68
Public highway	32,896	46.74
Hospital	32,123	45.64
Other health facility	1,904	2.71
Others	2,708	3.85
Ignored	269	0.38
Marital status		
Single	34,576	49.13
Married	19,132	27.18
Widow/widower	2,799	3.98
Judicially separated	4,616	6.56
Other	1,784	2.53
Ignored	7,475	10.62
Education		
Non	1,373	1.95
1 to 3 years	6,292	8.94
4 to 7 years	16,654	23.66
8 to 11 years	18,735	26.62
12 years or more	4,981	7.08
Ignored	22,347	31.75

Source: Mortality Information System (SIM). Department of Informatics of the Unified Health System (DATASUS). *Projection of the population of Brazil and Federation Units by sex and age for the period 2000-2030.

From 2009 to 2019, 70,382 (100%) deaths from traffic accidents were reported in the State of São Paulo, Brazil. The highest number of deaths occurred among males (81.38%), aged between 20 and 49 years (58.70%), single (49.12%), on public roads (46.73%) and hospitals (45.64%). Regarding education, information was ignored in most cases (31.75%), followed by deaths in people with 8 to 11 years of study (26.61%).

Through figure 2, it is possible to observe that the highest number of deaths occurred in 2012. There was a significant decline in fatalities from 2015 onwards, with the lowest number in 2018.

Regarding the categories of the International Code of Diseases - 10th Edition (ICD-10), pedestrians (26.11%), motorcyclists (24.33%), people involved in other types of traffic accidents (21.22%) and car occupants (20.92%) died more (table 2).

Mortality rates (table 3) and estimated trends from Prais-Wisten regression with respective trends in traffic accident mortality (table 4) are described below.

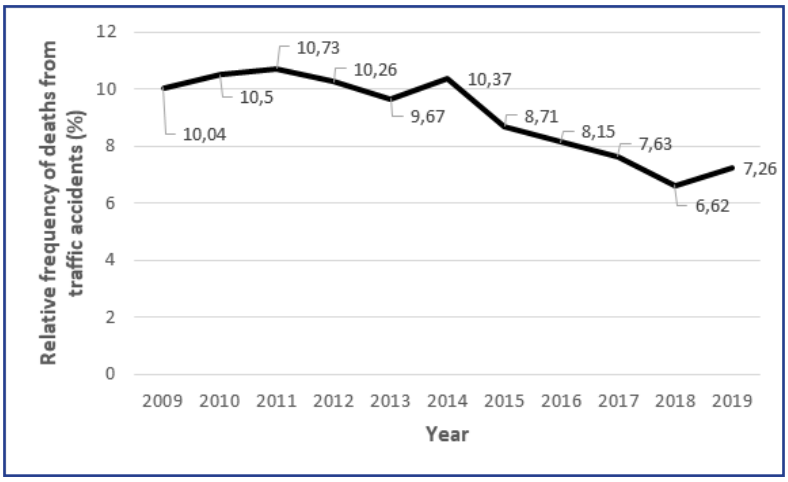

Figure 2: Temporal distribution of deaths from traffic accidents in the state of São Paulo, from 2009 to 2019

Table 2: Death by traffic accident according to the International Code of Diseases 10th Edition (ICD-10) category by place of residence in the state of São Paulo, Brazil (2009-2019)

ICD-10 Categories	Absolute frequency (n)	Relative frequency (%)
V01-V09 – Pedestrian injured in transport accident	18,377	26.11
V10-V19 – Pedal cyclist injured in traffic accident	2,847	4.05
V20-V29 – Motorcycle rider injured in transport accident	17,124	24.33
V30-V39 – Occupant of three-wheeled motor vehicle injured in transport accident	93	0.13
V40-V49 – Car occupant injured in transport accident	14,726	20.92
V50-V59 – Occupant of a pick-up truck or van injured in a transport accident	441	0.63
V60-V69 – Occupant of a heavy transport vehicle injured in transport accident	1,454	2.07
V70-V79 – Bus occupant injured in transport accident	378	0.54
V80-V89 – Other land transport accidents	14,942	21.23
Total	70,382	100.00%

Source: Sistema de Informações sobre Mortalidade (SIM). Departamento de Informática do Sistema Único de Saúde (DATASUS).

The total mortality rate in 2019 for females is 39.80 deaths per 1 million inhabitants and 185.85 for males, with a reduction of 4.96 per year for both sexes (APC = -4, 96).

It was observed that female mortality rates for the year 2019 showed higher rates for traffic accidents involving pedestrians (13.05 deaths per 1 million inhabitants) and cars (11.37 deaths per 1 million inhabitants), despite the reduction in the values of these scores observed over the period studied.

In 2019, males had a mortality rate for pedestrians of 44.51 deaths per 1 million inhabitants, and motorcyclists of 59.69 deaths per 1 million inhabitants. The rate for car occupants is 36.57 and for other land transport accidents 27.69 deaths per 1 million inhabitants), with a slight decrease.

Table 3: Mortality rate (x1,000,000) due to traffic accident by sex of residents in the state of São Paulo, Brazil (2009-2019)

ICD-10 Category	Mortality rate (per 1,000,000 inhabitants)											
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Sex
V01-V09	22.38	22.81	22.09	22.67	18.95	20.18	18.28	16.25	15.03	11.80	13.05	Female
V10-V19	1.26	1.25	1.24	1.05	0.99	0.89	1.24	0.62	0.48	1.05	0.78	
V20-V29	6.13	7.09	8.27	8.47	6.77	7.74	6.21	6.52	7.08	6.25	7.84	
V30-V39	0.05	0.05	0.14	0.09	0.18	0.04	0.04	0.00	0.04	0.09	0.00	
V40-V49	15.13	15.40	16.21	15.98	16.56	19.42	12.78	13.34	12.58	10.31	11.37	
V50-V59	0.37	0.14	1.15	0.32	0.23	0.18	0.09	0.22	0.09	0.35	0.13	
V60-V69	0.23	0.28	0.05	0.46	0.36	0.36	0.31	0.09	0.57	0.26	0.34	
V70-V79	0.56	0.65	0.69	0.55	0.36	1.70	0.53	0.48	0.57	0.39	0.69	
V80-V89	14.61	13.77	14.38	13.47	12.95	11.59	10.43	10.35	7.69	6.55	5.60	
Total	60.74	61.44	64.22	63.04	57.34	62.10	49.92	47.86	44.13	37.05	39.80	
V01-V09	73.50	71.36	71.41	65.83	62.14	67.15	53.75	46.56	47.10	38.57	44.51	Male
V10-V19	14.57	12.71	12.60	10.46	10.60	11.99	9.74	9.35	9.91	8.89	9.90	
V20-V29	66.02	72.99	75.48	71.42	67.77	70.84	61.20	61.22	57.01	47.96	59.69	
V30-V39	0.43	0.43	0.43	0.33	0.37	0.37	0.27	0.23	0.18	0.45	0.09	
V40-V49	53.23	58.07	55.21	52.04	51.30	55.44	46.89	41.70	35.48	32.67	36.57	
V50-V59	1.16	1.67	2.51	2.53	1.72	1.52	1.24	1.13	1.08	1.21	1.33	
V60-V69	5.02	6.79	7.24	6.19	6.05	6.69	6.04	5.31	5.00	4.29	5.19	
V70-V79	1.11	0.86	1.09	1.03	0.98	1.75	0.69	0.73	0.54	0.45	0.89	
V80-V89	63.08	65.20	65.39	63.86	56.51	56.73	49.17	44.75	40.03	36.03	27.69	
Total	278.13	290.09	291.36	273.71	257.45	272.48	228.99	210.97	196.33	170.52	185.85	

Legend: V01-V09 – Pedestrian injured in transport accident; V10-V19 – Pedal cyclist injured in transport accident; V20-V29 – Motorcycle rider injured in transport accident; V30-V39 – Occupant of a three-wheeled motor vehicle injured in transport accident; V40-V49 – Car occupant injured in transport accident; V50-V59 – Occupant of a pick-up truck or van injured in transport accident; V60-V69 – Occupant of a heavy transport vehicle injured in transport accident; V70-V79 – Bus occupant injured in transport accident; V80-V89 – Other land transport accident.
Source: Sistema de Informações sobre Mortalidade (SIM). Departamento de Informática do Sistema Único de Saúde (DATASUS).

Table 4: Prais-Winsten regression estimates on traffic accident mortality by sex of residents in the state of São Paulo, Brazil (2009-2019)

ICD-10 Category	Beta	95% CI Beta		p	APC	95% CI APC		Trend	Sex
V01-V09	-0,0277176	-0,0373909	-0,0180443	<0.001	-6,18	-8,25	-4,07	Decreasing	Female
V10-V19	-0,0274442	-0,0486149	-0,0062735	0,017	-6,12	-10,59	-1,43	Decreasing	
V20-V29	-0,0005429	-0,0132484	0,0121627	0,925	-0,12	-3,00	2,84	Stationary	
V30-V39	-0,0038374	-0,0790969	0,0714221	0,907	-0,88	-16,65	17,88	Stationary	
V40-V49	-0,0165951	-0,0319339	-0,0012563	0,037	-3,75	-7,09	-0,29	Decreasing	
V50-V59	-0,0431443	-0,0915883	0,0052997	0,075	-9,46	-19,01	1,23	Stationary	
V60-V69	0,0239782	-0,0259743	0,0739308	0,306	5,68	-5,81	18,56	Stationary	
V70-V79	-0,008017	-0,0363839	0,0203499	0,539	-1,83	-8,04	4,80	Stationary	
V80-V89	-0,0414721	-0,0598924	-0,0230519	0,001	-9,11	-12,88	-5,17	Decreasing	
Total	-0,0220901	-0,0332497	-0,0109305	0,002	-4,96	-7,37	-2,49	Decreasing	
V01-V09	-0,0278113	-0,0357246	-0,019898	<0.001	-6,20	-7,90	-4,48	Decreasing	Male
V10-V19	-0,0173615	-0,0248705	-0,0098524	0,001	-3,92	-5,57	-2,24	Decreasing	
V20-V29	-0,0130947	-0,0219509	-0,0042384	0,009	-2,97	-4,93	-0,97	Decreasing	
V30-V39	-0,0414242	-0,0650472	-0,0178012	0,003	-9,10	-13,91	-4,02	Decreasing	
V40-V49	-0,0210441	-0,0339258	-0,0081625	0,005	-4,73	-7,51	-1,86	Decreasing	
V50-V59	-0,003812	-0,0460403	0,0384164	0,843	-0,87	-10,06	9,25	Stationary	
V60-V69	-0,0087986	-0,0258964	0,0082991	0,274	-2,01	-5,79	1,93	Stationary	
V70-V79	-0,0273136	-0,0578487	0,0032215	0,074	-6,10	-12,47	0,74	Stationary	
V80-V89	-0,0354841	-0,0530876	-0,0178807	0,001	-7,85	-11,51	-4,03	Decreasing	
Total	-0,0220471	-0,0311982	-0,012896	<0.001	-4,95	-6,93	-2,93	Decreasing	

Legend: V01-V09 – Pedestrian injured in transport accident; V10-V19 – Pedal cyclist injured in transport accident; V20-V29 – Motorcycle rider injured in transport accident; V30-V39 – Occupant of a three-wheeled motor vehicle injured in transport accident; V40-V49 – Car occupant injured in transport accident; V50-V59 – Occupant of a pick-up truck or van injured in transport accident; V60-V69 – Occupant of a heavy transport vehicle injured in transport accident; V70-V79 – Bus occupant injured in transport accident; V80-V89 – Other land transport accident.
Source: Sistema de Informações sobre Mortalidade (SIM). Departamento de Informática do Sistema Único de Saúde (DATASUS).

DISCUSSION

In the state of São Paulo, during 2009 to 2019, a total of 70,382 individuals were fatal victims of traffic accidents. Despite advances observed in the temporal evolution of mortality rates, it was observed that in females there is still a predominance of mortality rates with stationary trends. In males, mortality is mostly observed with decreasing trends. However, mortality rates from traffic accidents for males are almost five times higher than for females.

These facts illustrate the need to strengthen intervention strategies and changes in public policies, in order to achieve a reduction in mortality for all categories, reaching users of all types of vehicles and all sexes.

In the Eastern Mediterranean Region, east coast of the Mediterranean Sea, Sengoelge *et al.*[15], when analyzing data on traffic accidents in the years 1995, 2005 and 2015, found that the mortality rates for the entire region were higher than the global average for the three reference years and for the three income levels studied, except in 1995. Low-income countries in the region had mortality rates twice as high as the global average, even with a decreasing trend.

In developed countries, such as the United States of America (USA), Sauber et al. identified that the country could make strides to reach lower mortality rates, like other high-income countries. From 2000 to 2013, mortality from traffic accidents went from 14.9 to 10.3 per 100,000 inhabitants. For other countries, such as Belgium and New Zealand, the decrease was from 10.0 to 4.4 per 100,000 inhabitants. The rate of fatalities from motor vehicle accidents in the United States during 2013 (10.3 per 100,000 - 32,894 deaths) was approximately double the average rate of the comparison countries[4].

Sex and mortality from road traffic accidents

In this study, it was observed that men had high mortality rates from traffic accidents compared to women. In 2019, despite having lower mortality rate scores (185.85 deaths per 1 million inhabitants) for males compared to the values presented in 2009 (278.13 deaths per 1 million inhabitants), these rates were still much higher than those presented by females at the end of the study period (39.80 deaths per 1 million inhabitants). That is, the mortality rate of males is almost five times higher than that of women, considering the year 2019.

Higher numbers for males were also observed in Malawi, a Southeast African country, from 2008 to 2012. In the 11,467 accidents that occurred, there were 4,518 fatalities, of which 3,696 were male[16]. In Marília, São Paulo, Brazil, in 2012, the same pattern was observed. After a descriptive analysis of police reports and death certificates, 78 fatal victims were found, 17 women and 61 men[17]. In Kermanshah province, western Iran, from 2004 to 2013, 4,870 people died from traffic accidents. Of these, 3,807 were men and 1,063 were women[18].

This difference is probably due to cultural differences between men and women in some countries and because men are more often at risk, thanks to the use of alcohol and drugs, high speed and the lack of protective devices, such as helmets and seat belts[19].

Although women had lower mortality rates compared to men, it was highlighted that in most of the analyzed categories, women showed stationary trends in mortality from land traffic accidents; while men, mostly, had a predominance of decreasing trends.

Females showed stationary trends for accidents involving motorcycles, three wheeled vehicles, pick-up trucks and vans, heavy transport vehicles and buses; for men, the same pattern is observed only for the last three vehicles mentioned.

In a study conducted in the state of Alagoas, in northeastern Brazil, it was found that before the implementation of Lei Seca (2001-2007), the growth in general mortality from traffic accidents and for men showed a statistically significant increase. After the law (2008-2015), the opposite occurred, with a decline for both groups. For women, the behavior was the same in both periods, which also demonstrates that more public policies are needed to reduce traffic accidents for this population[20].

In the USA, in a study that examined the characteristics and risks of fatal traffic accidents of drivers who had children as passengers, it was identified that female drivers were involved in twice as many fatal accidents (10,861 accidents) alone with child passengers (from 0 to 9 years old) compared to male drivers (4,445 accidents). In contrast, fewer women with passengers 16 years of age and older (5,672 women) were involved in fatal accidents than men (8,680 men). Drivers (especially women) with child passengers are more likely to be distracted, even with extra care regarding risky behavior[21].

However, Roehler and collaborators identified that, in traffic accidents, an unprotected driver, such as wearing a seat belt, is a strong indicator that the child passenger will also be unprotected[22].

In a study developed in Korea, the authors highlighted that the use of this item has preventive effects in cases of fatal traffic accidents. Seat belt use was significant for both drivers and passengers. Of the 297 deaths, 239 victims were not wearing a seat belt[23].

For work-related traffic accidents in Spain, López and colleagues concluded that the results show a different pattern for men and women from 2010 to 2013. The total number of cases included in the study was 847, of which 748 (88.3%) were men and 99 (11.7%) were women. Most accidents (428) for men occurred during the working day and, for women (77), on the way to the workplace[24].

Considering public policies, in the city of São Paulo, São Paulo, Brazil, in the period from 2010 to 2016, it was found that, after the reduction of maximum speed on public roads, the decline in mortality from traffic accidents was accentuated. For men, the mortality rate was from 18.46 to 10.99 per 100,000 inhabitants and, for women, from 3.66 to 2.80 per 100,000 inhabitants, differences that are significantly relevant[25,26].

It is observed that, for males, intense and well-structured public policies are necessary to reduce the number of deaths. Men are still the biggest fatalities, even though they show decreasing trends for most accident categories, according to the ICD-10, as demonstrated in this study.

Also, despite the fact that there are lower rates for the female population, the progress aimed at reducing mortality is stationary for accidents involving motorcycles, three wheeled motor vehicles, pickup trucks and vans, heavy transport vehicles and buses. It is possible that public policies aimed at reducing traffic accidents are not reaching this population. More investigations are necessary to understand the risk factors associated with land transport accidents and women so that strategic plans can be improved.

Mortality from road traffic accidents by vehicle

In this study, the difference between the total mortality rates between both sexes is striking. Men still die more in traffic than women, mainly from accidents involving pick-up trucks and vans, heavy transport vehicles and buses.

In a study carried out with Brazilian secondary data on age, education, and race/skin color, in 2011, 2012 and 2013, the authors found that the region with the most deaths was the Southeast, followed by the Northeast. The South, Midwest and North regions have the fewest deaths. The biggest victims are motorcycle riders, car occupants, other transport vehicles and pedestrians in the same period[27].

In a study carried out in Goiânia, capital of Goiás, Brazil, the Southwest, North, Northwest, and East health districts showed stationary trends for all vehicles involved. There is a increasing trend for accidents involving cars in the Goiânia and Sul districts and a decreasing trend for those involving pedestrians, motorcycle riders and three wheeled motor vehicles in the same regions[19].

Still in Goiânia[28], by establishing a linkage between the Mortality Information System (SIM), Hospital Information System of the Unified Health System (SIH/SUS) databases and a single list of victims consolidated by the Traffic Department (Detran) and by the Serviço de Atendimento Móvel de Urgência (Emergency Care Service - SAMU), found that the proportion between men and women was similar. Most victims were motorcycle riders, car occupants and pedestrians.

In a study carried out in Iran and its neighboring countries[3], it was found that, although there is a decline in traffic accidents in all countries, except Pakistan, these are still a serious public health problem. Most victims are motorcycle riders, car occupants and pedestrians and there is no relationship between the sociodemographic profile and deaths from traffic accidents in these countries.

Even with this reduction, the study found that the mortality rate involving other means of transport reduced more for men, compared to women. This fact corroborates this study, which found more stationary than decreasing trends for females.

According to Abegaz and colleagues, traffic accidents are the second most common cause of external accidents in Ethiopia. In the region, almost half of the accidents happen between motorcycle riders, pedestrians, and pedal cyclists and 2/3 of the victims are male. The mortality rate was 37/100,000 inhabitants in 2016[29].

This study has limitations. Considering the data collection, through the Department of Informatics of the Unified Health System (DATASUS) ("Informações de Saúde – DATASUS"), it is not possible to access information such as day of the week of the accident, month, period of day or type and jurisdiction of the road or lane. In addition, much of the information is ignored when filling in documents, such as the victim's education or marital status.

In addition, all this ignored or inaccessible information is also important for public managers. With them, public policies and actions that prioritize the reduction of traffic accidents could be more exact, for each group of the entire population of the State of São Paulo.

CONCLUSION

The highest number of deaths occurred among males (81.38%), aged between 20 and 49 years (58.70%), single (49.12%), on public highways (46.73%) and hospitals (45.64%).

Females have more stationary trends for traffic accidents involving land transport vehicles than males. Men have nearly five times higher mortality rates than women.

Public policies in relation to the reduction of traffic accidents have shown positive results, especially for the male population. However, more attention is needed for the female population.

Author contributions

All authors contributed to the manuscript. 1 - Beatriz Cecilio Bebiano: Participated in data collection, data analysis, statistical analysis and writing of the text; 2 - Luiz Carlos de Abreu: Participated in the study design, statistical analysis, discussion of results, final version of the text, general orientation of the research, and definition of the study design; 3 - Rafael Carboni de Souza: Participated in data collection, data analysis, statistical analysis and writing of the text; 4 - Francisco Naildo Cardoso Leitão: Participated in data collection, data analysis, statistical analysis and writing of the text; 5 - Luciano Miller Reis Rodrigues: Participated in the study design, statistical analysis, discussion of results, final version of the text, general orientation of the research, and definition of the study design.

Conflicts of Interest

The authors report no conflict of interest.

Data availability statement

All data used in this paper is available at the Department of Informatics of the SUS ("Informações de Saúde – DATASUS").

Funding

The authors would like to thank the the Instituto Federal Goiano for their support and the conditions necessary for the successful completion of this study.

REFERENCES

1. Naildo Cardoso Leitão F, Maria Pinheiro Bezerra Í, Martins Macedo Pimentel R, Do Amaral Virgínio Pereira G, Monteiro A, Patricio da Silva A, et al. Factors associated with incidence and mortality by road accidents involving motorcyclists and pedestrians: a rapid systematic review. J Hum Growth Dev [Internet]. 2022 Jan 31;32(1):72–82. Available from: http://pepsic.bvsalud.org/scielo.php?pid=S0104-12822022000100008&script=sci_abstract&tlng=en
2. World Health Organization. Global status report on road safety 2018 [Internet]. Genève, Switzerland: World Health Organization; 2019 [cited 2024 Mar 5]. 420 p. Available from: https://www.who.int/publications/i/item/9789241565684
3. Sadeghi-Bazargani H, Samadirad B, Moslemi F. A decade of road traffic fatalities among the elderly in north-West Iran. BMC Public Health [Internet]. 2018 Jan 8;18(1):111. Available from: http://dx.doi.org/10.1186/s12889-017-4976-2
4. Sauber-Schatz EK, Ederer DJ, Dellinger AM, Baldwin GT. Vital Signs: Motor Vehicle Injury Prevention - United States and 19 Comparison Countries. MMWR Morb Mortal Wkly Rep [Internet]. 2016 Jul 6;65(26):672–7. Available from: http://dx.doi.org/10.15585/mmwr.mm6526e1
5. WHO global status report on road safety 2013: supporting a decade of action [Internet]. World Health Organization; 2013 [cited 2024 Mar 5]. Available from: https://www.who.int/publications/i/item/9789241564564
6. BRASIL. Lei nº 9.478, de agosto de 1997, art. 1: inciso VIII [Available from: http://www.planalto.gov.br/ccivil_03/leis/l9478.htm.
7. Bacchieri G, Barros AJD. Acidentes de trânsito no Brasil de 1998 a 2010: muitas mudanças e poucos resultados. Rev Saúde Pública [Internet]. 2011 Oct [cited 2024 Mar 5];45(5):949–63. Available from: https://www.scielo.br/j/rsp/a/nfK6jyHn9GrG8G7Cdsm9fhn/abstract/?lang=pt
8. Fernandes CM, Boing AC. Mortalidade de pedestres em acidentes de trânsito no Brasil: análise de tendência temporal, 1996-2015. Epidemiol Serv Saude [Internet]. 2019 Apr 8;28(1):e2018079. Available from: http://scielo.iec.gov.br/scielo.php?script=sci_abstract&pid=S1679-49742019000100024&lng=pt&nrm=iso
9. Kume L. É possível reduzir as mortes no trânsito? O efeito do novo código brasiliero de trânsito. 2007 Jan 10 [cited 2024 Mar 5]; Available from: https://repositorio.fgv.br/items/05fddcb3-f1d4-4d0d-b5cc-75e0b9f0776a/full
10. de Oliveira NLB, de Sousa RMC. Traffic accidents with motorcycles and their relationship to mortality. Rev Lat Am Enfermagem [Internet]. 2011 Mar-Apr;19(2):403–10. Available from: http://dx.doi.org/10.1590/s0104-11692011000200024
11. Malta DC, Silva MMA da, Albuquerque GM, Lima CM de, Cavalcante T, Jaime PC, et al. A implementação das prioridades da Política Nacional de Promoção da Saúde, um balanço, 2006 a 2014. Ciênc saúde coletiva [Internet]. 2014 Nov [cited 2024 Mar 5];19(11):4301–12. Available from: https://www.scielo.br/j/csc/a/6CwVSjyyxwQhj8SMvYNrs9h/abstract/?lang=pt
12. Andreuccetti G, Leyton V, Lemos NP, Miziara ID, Ye Y, Takitane J, et al. Alcohol use among fatally injured victims in São Paulo, Brazil: bridging the gap between research and health services in developing countries. Addiction [Internet]. 2017 Apr;112(4):596–603. Available from: http://dx.doi.org/10.1111/add.13688
13. Brasil, Ministério da Saúde. Banco de dados do Sistema Único de Saúde - DATASUS . Informações de Saúde – DATASUS. Available from: https://datasus.saude.gov.br/informacoes-de-saude-tabnet/
14. Antunes JLF, Cardoso MRA. Uso da análise de séries temporais em estudos epidemiológicos. Epidemiol Serv Saúde [Internet]. 2015 [cited 2024 Mar 5];24(3):565–76. Available from: https://www.scielo.br/j/ress/a/zzG7bfRbP7xSmqgWX7FfGZL/abstract/?lang=pt
15. Sengoelge M, Laflamme L, El-Khatib Z. Ecological study of road traffic injuries in the eastern Mediterranean region: country economic level, road user category and gender perspectives. BMC Public Health [Internet]. 2018 Feb 13;18(1):236. Available from: http://dx.doi.org/10.1186/s12889-018-5150-1
16. Manyozo S, Moodie R. Road traffic collisions in Malawi: Trends and patterns of mortality on scene. Malawi Med J [Internet]. 2018 Jun;30(2):132–3. Available from: http://dx.doi.org/10.4314/mmj.v30i2.14
17. Biffe CRF, Harada A, Bacco AB, Coelho CS, Baccarelli JLF, Silva KL, et al. [Epidemiological profile of traffic accidents in Marília, São Paulo State, Brazil, 2012]. Epidemiol Serv Saude [Internet]. 2017 Apr-Jun;26(2):389–98. Available from: http://dx.doi.org/10.5123/S1679-49742017000200016

18. Hamzeh B, Najafi F, Karamimatin B, Ahmadijouybari T, Salari A, Moradinazar M. Epidemiology of traffic crash mortality in west of Iran in a 9 year period. Chin J Traumatol [Internet]. 2016 Apr 1;19(2):70–4. Available from: http://dx.doi.org/10.1016/j.cjtee.2015.12.007
19. Aquino ÉC de, Neves CM, Morais Neto OL. Tendências da mortalidade por acidentes de transporte terrestre no município de Goiânia, Brasil, 2006-2014. Epidemiol Serv Saúde [Internet]. 2018 Dec 13 [cited 2024 Mar 5];27(4):e2017268. Available from: https://www.scielo.br/j/ress/a/hXSWSpt38zm5ztd7NkTDVjC/abstract/?lang=pt
20. Souza CDF de, Paiva JPS de, Leal TC, Silva LF da, Machado MF, Araújo MDP de. Mortality in motorcycle accidents in Alagoas (2001-2015): temporal and spatial modeling before and after the "lei seca." Rev Assoc Med Bras [Internet]. 2020 Jan 24 [cited 2024 Mar 5];65(12):1482–8. Available from: https://www.scielo.br/j/ramb/a/GnHhDZsJfkFQxsqsC3JvJcL/?lang=en
21. Maasalo I, Lehtonen E, Summala H. Drivers with child passengers: distracted but cautious? Accid Anal Prev [Internet]. 2019 Oct;131:25–32. Available from: http://dx.doi.org/10.1016/j.aap.2019.06.004
22. Roehler DR, Elliott MR, Quinlan KP, Zonfrillo MR. Factors Associated With Unrestrained Young Passengers in Motor Vehicle Crashes. Pediatrics [Internet]. 2019 Mar;143(3). Available from: http://dx.doi.org/10.1542/peds.2018-2507
23. Kwak BH, Ro YS, Shin SD, Song KJ, Kim YJ, Jang DB. Preventive Effects of Seat Belt on Clinical Outcomes for Road Traffic Injuries. J Korean Med Sci [Internet]. 2015 Dec;30(12):1881–8. Available from: http://dx.doi.org/10.3346/jkms.2015.30.12.1881
24. López-Ruiz M, Mancebo Fernández N, Pérez K, Serra Saurina L, Benavides FG. Lesiones mortales de tráfico en España relacionadas con el trabajo según el motivo del desplazamiento y según sexo (2010-2013). Rev Esp Salud Publica [Internet]. 2017 [cited 2024 Mar 5];0–0. Available from: https://pesquisa.bvsalud.org/portal/resource/pt/ibc-159577
25. Leitão PDA, Bezerra IMP, Santos EFDS, Ribeiro SDL, Takasu JM, Carlesso JS, et al. Mortalidade por acidentes de trânsito, antes e após redução da velocidade média de veículos automotores na cidade de SãoPaulo, Brasil, no período de 2010 a 2016. J Hum Growth Dev [Internet]. 2019 May 6;29(1):83–92. Available from: http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S0104-12822019000100011&lng=pt&nrm=iso&tlng=pt
26. Souza RC de, Abreu LC de, Bebiano BC, Leitão FNC, Rodrigues LMR. Trend of traffic accident mortality rate among motorcyclists in the state of São Paulo, Brazil, from 2015 to 2020. Rev Bras Epidemiol [Internet]. 2022 Dec 5;25:e220037. Available from: http://dx.doi.org/10.1590/1980-549720220037
27. Andrade SSC de A, Mello-Jorge MHP de. Mortality and potential years of life lost by road traffic injuries in Brazil, 2013. Rev Saude Publica [Internet]. 2016 Oct 3;50(0):59. Available from: http://dx.doi.org/10.1590/S1518-8787.2016050006465
28. Mandacarú PMP, Rabelo IVM, Silva MAA da, Tobias GC, Morais Neto OL de. Óbitos e feridos graves por acidentes de trânsito em Goiânia, Brasil - 2013: magnitude e fatores associados. Epidemiol Serv Saúde [Internet]. 2018 May 7 [cited 2024 Mar 5];27(2):e2017295. Available from: https://www.scielo.br/j/ress/a/YrCkdQ4zqQDvpDzxhBsQhCf/abstract/?lang=pt
29. Abegaz T, Gebremedhin S. Magnitude of road traffic accident related injuries and fatalities in Ethiopia. PLoS One [Internet]. 2019 Jan 29;14(1):e0202240. Available from: http://dx.doi.org/10.1371/journal.pone.0202240oS one. 2019;14(1):e0202240.

Resumo

Introdução: causas externas são consideradas um problema de saúde pública no mundo, associadas às diversidades socioeconômicas, políticas e culturais. Dentre elas, destacam-se os acidentes de trânsito.

Objetivo: avaliar a tendência da mortalidade por acidentes de trânsito para cada sexo no estado de São Paulo, Brasil.

Método: estudo ecológico de análise de séries temporais. Foram utilizados dados secundários referentes a óbitos por acidentes de trânsito por local de residência no estado de São Paulo, Brasil, no período de 2009 a 2019.

Resultados: a taxa de mortalidade total em 2019 para o sexo feminino é de 39,80 e para o masculino, de 185,85, com redução de 4,96% ao ano para ambos os sexos. As tendências de mortalidade por acidentes de trânsito para o sexo feminino mostraram-se estacionárias para motociclistas, triciclo motorizado, caminhonete, veículo de transporte pesado e ocupantes de ônibus ao final do período de estudo. Para o sexo masculino, o mesmo padrão foi observado, mas apenas para os ocupantes de caminhão, veículo de transporte pesado e ônibus. No restante dos veículos, a taxa de mortalidade apresentou tendências decrescentes.

Conclusão: o maior número de óbitos ocorreu no sexo masculino (81,38%), com idade entre 20 e 49 anos (58,70%), solteiros (49,12%), em vias públicas (46,73%) e hospitais (45,64%). Mulheres têm mais tendências estacionárias do que homens.

Palavras-chave: acidente de trânsito, mortalidade, veículos automotores.