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ORIGINAL ARTICLE

Trends in mortality due to traffic accidents in Brazil during the period from 1997 to 2015 for the male population

Tendências da mortalidade em decorrência de traumas de trânsito no Brasil e nas unidades federativas entre os anos de 1997 e 2015 na população masculina

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Abstract

Background: Traffic accidents are one of the main causes of death in Brazil and the increase in the mortality rate is concerning. **Objective:** The study aims to perform a temporal analysis of mortality trends related to traffic accidents in Brazil and its states. **Method:** This is an ecological study of time series of mortality from traffic accidents in Brazil and its Federative Units. Data was obtained from the Information System for Mortality (SIM), processed by Datasus and classified under the headings V01 to V89 (CID-10). Specific mortality rates were calculated and adjusted by age. The temporal tendency analysis was run on the Joinpoint Regression Program. **Results:** The Brazilian male population showed no change in the average annual percentage for the mortality rate (-0.8%; CI 95% -1.7;0.1). Ten states showed increased mortality rates; nine presented a decline, and eight remained constant throughout the period. **Conclusion:** The male population showed no change in the rates, but the mortality rate for the general Brazilian population decreased by 1% per year from 1997 to 2015. Both general and male populations had a decrease of 4.6% and 4.9% per year during the last years, respectively (2012-2015).

Keywords: external causes; accidents; traffic accidents; mortality.

Resumo

Introdução: Acidentes de trânsito são uma das principais causas de morte no Brasil e no mundo. **Objetivo:** O estudo teve por objetivo realizar uma análise temporal da tendência de mortalidade por acidentes de transportes terrestres no Brasil. **Método:** Estudo ecológico de séries temporais da mortalidade por acidentes de transporte terrestre no Brasil no período de 1997 a 2015 para a população masculina. Os dados são provenientes do Sistema de Informação sobre Mortalidade (SIM), processados pelo Datasus e classificados nas rubricas V01 a V89 (CID-10). Foram calculadas as taxas específicas de mortalidade, ajustadas por idade, e realizada análise da tendência temporal através do software Joinpoint Regression Program. **Resultados:** A população brasileira masculina não apresentou mudanças na taxa de mortalidade ao longo dos anos (-0.8%; CI 95% - 1.7;0.1). Dez estados tiveram aumento nas taxas de mortalidade, nove reduziram e oito mantiveram as taxas. **Conclusão:** A população masculina não apresentou diferença nas taxas, entretanto, a população geral apresentou redução de 1% ao ano na taxa mortalidade. Além disso, ambas populações geral e masculina mostraram uma redução de 4,6% e 4,9% ao ano durante os últimos anos (2012- 2015).

Palavras-chave: causas externas; acidentes; acidentes de transporte; mortalidade.

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INTRODUCTION

Accidents from external causes are one of the main causes of death and injury worldwide and in Brazil, traffic accidents have a significant place amongst these[1]. The literature uses the term "traffic accidents" to describe accidents involving means of transport involved in a non-intentional, avoidable, event that leads to physical and/or emotional injuries[2]. Worldwide, more than 1.2 million people die annually, and more than 50 million have non-fatal injuries or sequelae due to ground transportation accidents[3]. In addition, low- and middle-income countries present higher mortality rates. In these countries, the most vulnerable population to suffer accidents are pedestrians, cyclists and motorcyclists, accounting for 49% of all deaths from traffic accidents[3].

The situation is no different in Brazil. In 2016, there was a fleet of more than 50 million automobiles and 20 million motorcycles. In the same year, 42.291 deaths were recorded due to traffic accidents. Furthermore, between 1998 and 2008, the mortality for motorcyclists and their passengers increased more than 700%[3-5]. The male population is the most affected by traffic accidents, being involved in 81.5% of all accidents. This is attributed mainly to greater risk exposure, as they tend to start driving at a younger age and use motorcycles[6,7]. Deaths in this population, at ages between 15- and 59-years old, lead to problems not only for the public health system but also for the economy, affecting the economically active population[8].

According to the Institute for Applied Economic Research (*Instituto de Pesquisas Econômicas Aplicadas – IPEA)*, the loss in production, as well as the hospital-medical care required, generates public expenditure estimated at US$ 12.6 billion per year[9]. To reduce the expenses related to traffic accidents, traffic accident prevention campaigns and laws have been implemented and should be regularly evaluated. Studies have shown that the implementation of laws such as the Brazilian Traffic Code (Law nº 9.503, September 23rd, 1997) and the zero-alcohol consumption law, popularly known as *Lei Seca* (Dry Law) (Law nº 11.705, June 19th, 2008), have generated a positive outcome with a reduction in the mortality rate. However, it tended to increase over the following years[4,6-8,10].

In 2010, The World Health Organization (WHO) established, and launched worldwide in 2011, the Decade of Action for Road Safety 2011-2020 to reduce deaths and injuries caused by traffic accidents by 50%[3,11]. These targets were also included in the Sustainable Development Goals[12]. To achieve the Decade of Action goals, the WHO[11] established five fundamental pillars: 1) road safety management; 2) safer roads and mobility; 3) safer vehicles; 4) safer road users; and 5) post-crash response. However, Davies and Roberts (2014), warn that both the United Nations Organization and the WHO should not allow industry interests to supersede public health concerns[13]. In Brazil, the main public awareness campaign for traffic accidents is *Maio Amarelo* (Yellow May), which has the aim "of drawing public attention to the high rates of mortality and injury caused by traffic accidents all around the world"[14].

In this context, the present study aims to perform a temporal analysis of mortality trends related to traffic accidents in Brazil and its states.

METHODS

The present study is an ecological time series of mortality due to traffic accidents in Brazil and its States during the period from 1996 to 2016. Data from the Brazilian Mortality Information System (SIM) processed by Datasus and classified according to the codes V01 to V89 of the 10th Edition of the International Statistical Classification of Diseases and Related Health Problems (ICD-10)[15]. Only the data from the male population was used given that it is the population most affected by traffic accident fatalities[8]. Data for means of transport used at time of death were collected from the SIM, from 1996 to 2016, for the general and male populations.

The data collected were the number of deaths from traffic accidents in Brazil and for each Brazilian State, as well as their respective estimated populations. Age-standardized mortality rate per 100,000 males was estimated according direct method in the Software Microsoft® Excel® 2016. The reference population was the standard global population[16]. The historical series were filtered using a moving average algorithm centered on three terms. Therefore, the final analysis period corresponded to the years from 1997 to 2015.

The software Joinpoint Regression Program, 4.4.0.0 Statistical Research and Application Branch, National Cancer Institute, USA, was used to analyze the temporal trend by using the Grid Search mode, with a maximum of three joinpoints, and to estimate the 95% confidence interval (95%CI). Mortality rates were considered stable when the average annual percentage change AAPC was not different from zero $p>0.05$; increasing when there was a positive variation with $p<0.05$, and decreasing when the variation was negative with $p<0.05$. The data were expressed as a percentage with CI95%[17].

According to the National Council of Health No 510/2016, there was no need for approval by the Ethics Committee in Research with Human Beings because it relied on aggregated information from databases.

RESULTS

During the period from 1996 to 2016, 563,270 men died due to traffic accidents on Brazilian roads, with 26.7% of these being 20 to 29-years old. The mortality rate due to traffic accidents in Brazil dropped from 34.56 per 100.000 inhabitants in 1997 to 29.45 deaths per 100.000 inhabitants in 2015. Figure 1 shows the temporal analysis with the annual percentage change of three joinpoints to Brazil during the period from 1997 to 2015. Although the mortality rate from traffic accidents for the general Brazilian population showed an average annual decrease of 1.0% (95%CI: -1.8; -0.1), there was no change in this rate for the male population -0.8% (95%CI: -1.7; 0.1; p = 0.1). Table 1 describes the information for the number of deaths throughout the period studied, divided by age group, for the male population, where the years were subgroups according to the joinpoints. At Figure 2 it is possible to identify the average annual change in the mortality trend in Brazil and its States.

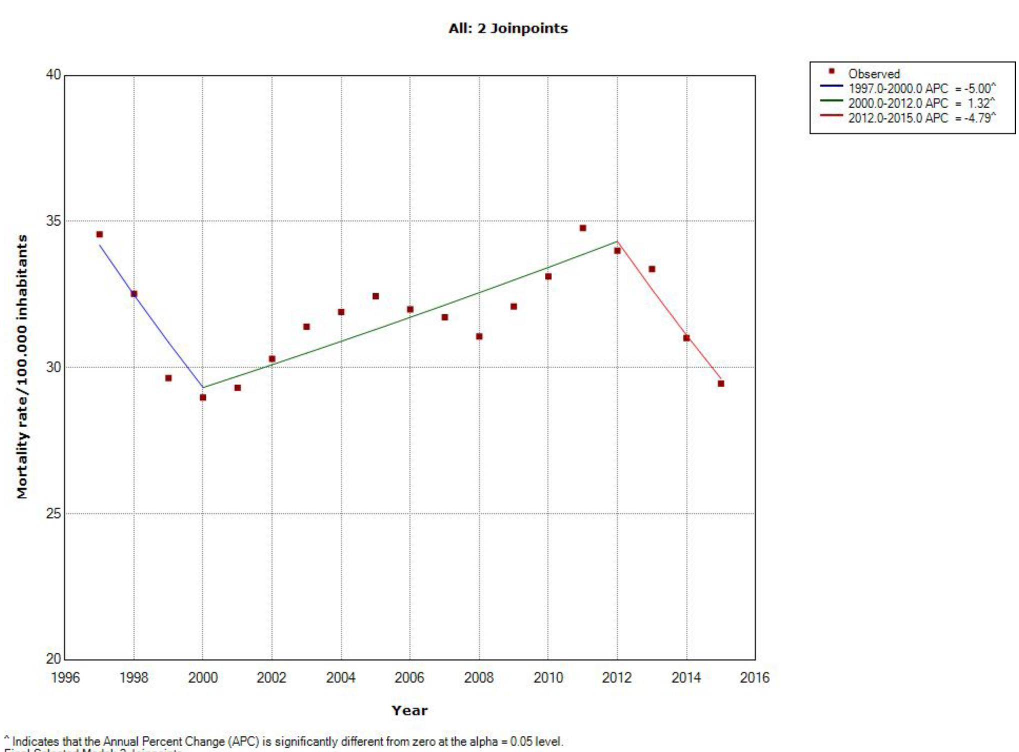

Figure 1. Temporal analysis with the annual percentage change of three join points to Brazil during the period from 1997 to 2015

Table 1. Deaths during the years from 1997 to 2015, by age group, for the Brazilian male population

Group Age	Year of death			Total	%
	1997-2000	2001-2012	2013-2015		
0-9	4187	9393	1591	15171	2,7
10-19	11626	36661	9617	57904	10,3
20-29	25688	99188	25784	150660	26,7*
30-39	21399	73621	21318	116338	20,7*
40-49	15246	58832	16471	90549	16,1*
50-59	9618	40016	12650	62284	11,1
60-69	6035	24261	7855	38151	6,8
70-79	3438	14515	4343	22296	4,0
>80	1460	6407	2050	9917	1,8
Total	176467	178800	208003	563270	100

Note that *, the three highest percentages
Fonte: DataSus.gov.br

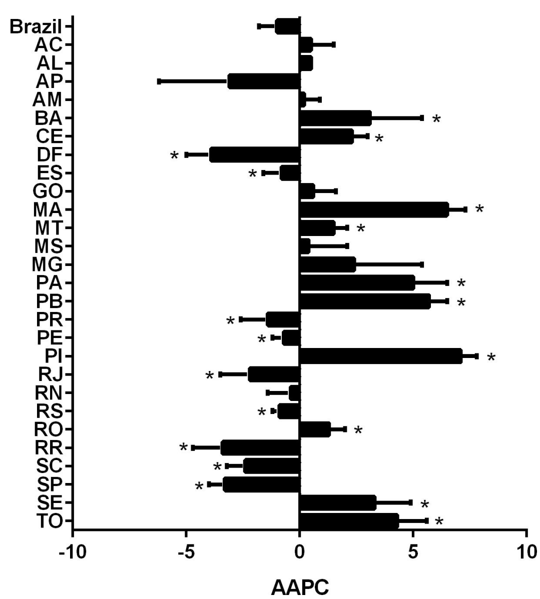

Figure 2. Average annual change in the mortality trend in Brazil and its States

Ten Brazilian States showed increased mortality rates due to traffic accidents, nine States showed a decrease in the rates, and eight remained stable. Table 2 demonstrates the evolution for age-adjusted rates throughout the period from 1997 to 2015, as well as the average annual percentage change during the period. Piauí was the Brazilian State with the greatest increase in the mortality rate during the period, 7.1% (95%CI: 6.4; 7.8) per year, while Distrito Federal showed the greatest reduction, 3.9% (95%CI: -5.0; -2.8) per year.

Figure 3 shows the mortality rate behavior, adjusted throughout the period for the States of the South, Southeast, Mid-West, North and Northeast regions. It shows that, while the South and Southeast regions presented a declining mortality rate, the North and Northeast regions showed an opposite tendency.

Table 2. Mortality rate from traffic accidents during the years from 1997 to 2015, for the male population, adjusted by age, for the Brazilian states

UF	Year of death																			AAPC
	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	
										NORTH										
AC	25.9	26.6	26.4	28.7	31.6	32.2	28.6	27.1	24.0	25.0	25.2	28.3	30.3	32.5	33.9	32.1	30.7	28.0	28.0	0.5
AM	22.3	21.6	20.5	19.4	18.7	18.2	19.6	21.0	22.8	21.2	20.3	18.0	19.9	21.8	23.6	23.1	21.4	20.4	19.12	0.2
AP	39.6	37.6	38.9	41.2	45.8	44.7	43.6	41.3	40.5	36.1	31.1	30.0	30.3	34.6	33.3	32.5	28.3	28.0	18.58	-3.1
PA	22.2	21.2	20.0	18.8	20.5	21.9	23.1	24.2	24.9	25.3	25.7	24.8	26.2	27.0	29.9	36.5	42.3	47.7	42.93	5.0*
RO	38.5	38.2	39.5	37.7	37.2	38.9	40.0	39.7	40.7	40.3	45.2	48.0	54.9	57.5	61.1	61.2	56.8	51.5	45.50	1.3*
RR	86.8	92.1	83.1	75.9	70.3	62.7	51.1	42.6	47.3	55.7	55.0	52.3	49.5	50.0	53.6	55.7	54.5	51.4	43.59	-3.4*
TO	26.6	33.9	39.1	42.3	46.6	48.3	54.3	53.3	52.5	49.0	51.6	54.4	57.8	59.2	60.8	59.2	56.7	56.4	57.71	4.3*
										NORTHEAST										
AL	43.7	44.3	40.4	37.2	36.5	35.8	36.1	35.6	37.1	37.4	36.0	36.6	38.7	43.3	45.9	45.1	44.3	42.0	41.31	0.5
BA	15.9	15.3	14.6	15.1	16.0	16.4	16.8	18.6	20.4	22.2	21.2	20.6	23.0	26.6	30.4	30.5	29.8	28.5	26.88	3.1*
CE	29.8	29.8	28.8	30.4	32.8	35.1	37.5	38.5	38.8	37.2	35.5	33.0	34.5	36.8	42.4	44.4	45.4	45.5	42.27	2.3*
MA	14.1	13.5	13.2	14.0	16.6	18.6	21.0	23.3	25.0	26.4	28.4	30.3	31.9	33.9	37.6	40.9	41.5	42.3	41.77	6.5*
PB	14.6	19.1	20.5	20.7	23.8	25.8	29.6	30.4	32.6	32.3	33.9	34.1	35.6	34.8	37.7	39.7	42.4	41.9	41.79	5.7*
PE	36.7	35.5	33.6	31.8	31.8	31.2	31.2	29.9	30.0	29.5	29.1	29.5	32.0	34.8	36.6	36.6	35.1	33.5	32.75	-0.7*
PI	19.3	20.0	23.3	25.2	28.7	30.7	33.8	36.7	41.4	43.8	46.3	46.9	50.5	54.1	58.6	61.5	63.6	65.3	64.32	7.1*

Note that *, $p<0.05$
Fonte: DataSus.gov.br

Table 2. Continued...

UF	Year of death																			AAPC
	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	
RN	28.4	28.0	28.6	26.4	26.8	25.1	25.5	25.6	27.6	27.2	26.7	26.1	28.9	30.5	31.7	30.0	29.3	28.0	26.69	-0.4
SE	25.0	25.2	28.7	34.8	37.5	38.2	40.1	38.6	37.9	36.7	38.5	41.5	46.1	47.9	50.5	50.1	50.8	46.4	41.60	3.3*
MID-WEST																				
DF	58.7	52.0	49.5	48.3	47.5	48.8	49.0	49.0	46.1	43.8	41.4	39.4	38.4	38.6	36.5	33.5	29.8	28.6	26.8	-3.9*
GO	41.0	40.8	39.9	41.8	44.3	44.5	46.3	45.5	44.1	41.1	40.3	41.3	44.4	45.3	47.2	46.5	46.3	45.7	43.3	0.6
MT	43.3	41.8	43.9	46.0	50.5	50.5	54.1	52.3	52.9	49.8	50.9	53.3	55.4	55.1	54.4	54.0	54.9	54.1	51.5	1.5*
MS	45.2	40.2	35.3	36.2	39.4	43.9	48.4	50.7	51.5	49.1	47.2	46.3	47.2	49.1	51.1	51.2	48.8	47.7	42.9	0.4
SOUTHEAST																				
ES	45.6	44.3	43.2	43.2	45.1	45.3	45.0	42.9	43.7	44.8	47.0	45.9	46.5	46.8	49.4	48.5	46.6	42.6	37.7	-0.8*
MG	31.5	27.7	23.6	21.8	22.3	24.5	26.4	28.0	29.4	29.8	30.1	29.6	30.5	32.1	33.5	39.0	42.9	47.7	42.9	2.4
RJ	38.1	33.5	29.3	28.1	29.1	29.5	30.0	29.9	30.6	29.1	27.3	24.1	24.4	24.6	26.7	26.9	26.3	25.5	22.9	-2.2*
SP	38.8	36.3	30.6	29.0	26.7	27.9	27.6	28.1	27.7	27.5	27.5	26.8	26.3	25.8	25.5	24.6	23.2	22.7	20.8	-3.3*
SOUTH																				
PR	52.0	48.8	44.9	43.2	42.6	43.9	46.9	48.1	48.5	47.2	46.7	45.6	46.3	46.8	49.3	49.2	47.2	43.5	39.1	-1.4*
RS	32.2	30.3	28.4	28.0	29.0	29.1	30.4	29.8	29.5	27.8	27.1	26.7	28.2	28.5	28.8	27.4	26.6	25.8	24.5	-0.9*
SC	55.2	50.4	44.8	45.2	45.3	47.0	49.1	50.0	51.9	50.7	48.9	46.3	44.8	45.2	44.3	43.4	39.7	37.9	34.4	-2.4*

Note that *, $p<0.05$
Fonte: DataSus.gov.br

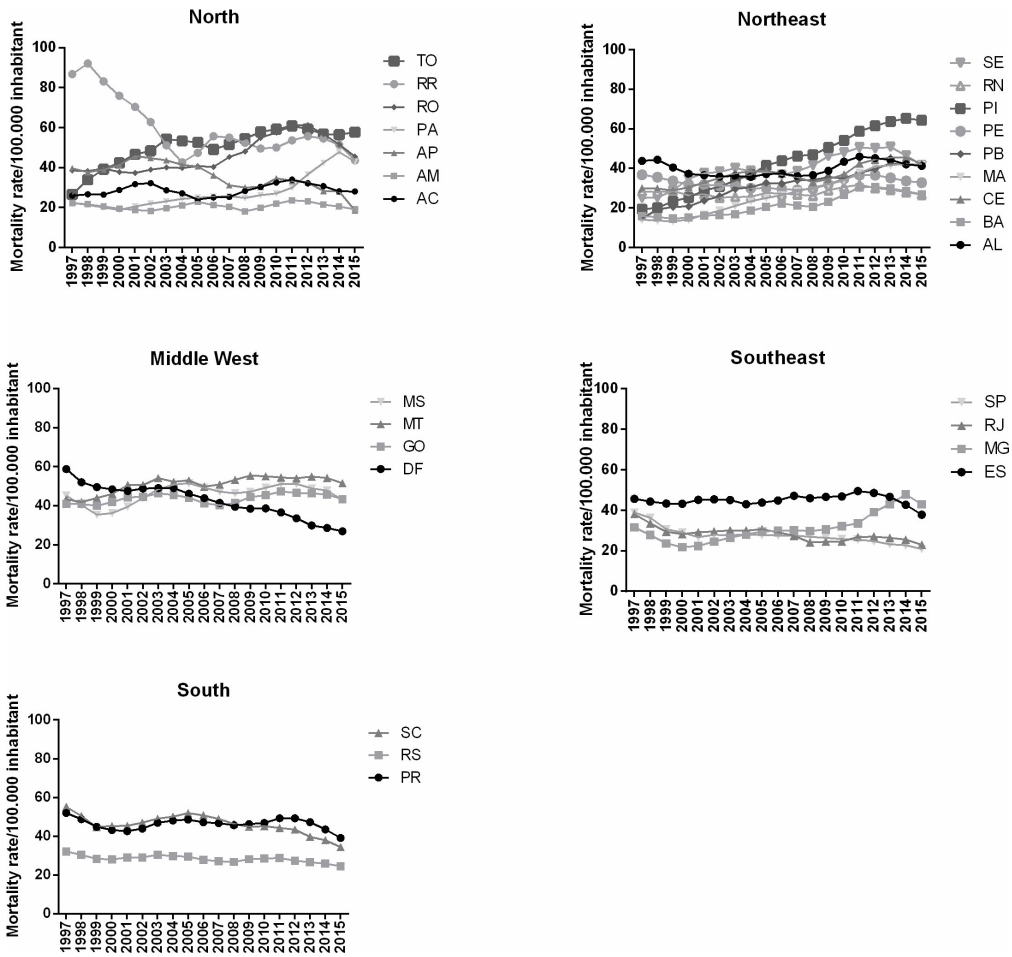

Figure 3. The mortality rate behavior, adjusted throughout the period for the States of the South, Southeast, Mid-West, North and Northeast regions

Data about the means of transport for the general population show that pedestrian injuries were the main cause of death at 26.1%, followed by car (19.7%) and motorcycle (18.9%) accidents. However, for the male population, pedestrian injuries represent 19.9% of deaths, followed by motorcycle injuries (17.0%) and car accidents (15.3%).

DISCUSSION

Despite the improvement in the records of the Brazilian Mortality Information System over the years, the quality of the data may be corrupted due to underreporting of information about cause of death, leading to an underestimated mortality rate. It is possible to investigate the circumstances surrounding the death and to modify the cause of death in the information system. However, there is no way to guarantee that necessary modifications have been carried out. Barreto et al.[18] and Barros et al.[19] argued that underreporting of accidents, mainly for pedestrians, is an important factor that can cause changes in mortality rates. They claim that it also happens in other places in Brazil and around the world. Given this, the data source may be a potential study limitation.

The estimates for mortality, years of life lost (YLL) and disability-adjusted life years (DALY), from Global Burden of Diseases Study, in the period from 1990 to 2015, show that traffic accidents are the second highest cause of death by external causes, second only to homicides. Pedestrian road injuries and road injuries involving motorcycles remained in second and third positions, respectively, for the DALYs[20].

The present study sought to calculate a time trend mortality rate for traffic accidents for the male population in Brazil and its states during the period from 1997 to 2015. The study identified that the mortality rate remained stable. Of the deaths, it is important to highlight that men aged between 20 and 29 years old are the group most involved in traffic accidents resulting in death. This result corroborates with other studies, which show that this age group is the most affected by traffic accidents[7,21-23]. These studies also report that it happens both for a specific sex or both sexes, and they relate the increase in mortality to several factors such as alcohol consumption prior to driving, smartphone use while driving, increase in vehicle fleet, speeding, misuse or non-use of helmet, fatigue, and other[7,21-23].

In this study, Piauí was the state with the largest increase in mortality due to traffic accidents. According to Santos et al.[1], this state showed an increase of 381.2% in motorcyclist deaths during the years from 1998 to 2004, which corroborates with our findings. Studies also demonstrate that the male population, aged between 15 and 34 years old, is the most affected, reporting that alcohol consumption, weekends, and not using a helmet were the main causes of accidents and deaths in this state[1,7]. Additionally, the male population, in general, presents riskier social behavior with greater exposure to injury and death due to driving at higher speed, greater alcohol consumption, being more aggressive, and a tendency to perform risky maneuvers while driving[18,24,25].

Andrade and Mello-Jorge[21] describe in their study that, besides the brute rates being higher in the Southern region, the adjusted rates have shown a higher number of deaths per 100,000 inhabitants in Northeast and Middle-West regions. In addition, the Southeast has lower rates, both for brute and adjusted rates. These findings may be related to lower education levels in Northeastern States in comparison with the South and Southeast, an association between higher alcohol consumption and lower education level[26,27], an increase in vehicle fleet[5], and fewer legal controls in these regions[2,27]. In the present study, it is possible to notice a trend of maintenance and decline of the mortality rates in South and Southeastern states, while the North and Northeastern states showed increased rates, which corroborates with previous studies.

This study also identified a decline in mortality right after the implementation of the Brazilian Traffic Code, in 1998. However, this annual decline continued only until the year 2000, when rates started increasing again[21]. This finding is related to other national studies that demonstrate a decline in mortality after the implementation of the Brazilian Traffic Code. They affirm that the implementation of public policy such as the National Policy for Decreasing Mortality from Accidents and Violence, in 2001, the implementation and investments in the Emergency Mobile Care Service (SAMU), the introduction of Brazil's Dry Law, and public awareness campaigns, such as Yellow May, are essential for the effectiveness of the response for victims and a consequent reduction in mortality rates[2,19,27].

Nevertheless, this reduction is temporary. Ineffective enforcement of traffic safety regulations, aggressiveness while driving, inadequate public health infrastructure and shortfalls in access to health services may contribute to the increasing mortality rate from traffic accidents[28]. Therefore, it is necessary to identify what has been done to reduce the risk of death due to traffic accidents, and what changes could be undertaken to resolve foreseeable problems. One interesting measure would be the creation of an exclusive motorcycle lane, separating motorcyclists from general traffic and reducing potential impacts between motorcycles and other vehicles, which has proven effective in countries that have already implemented it[29,30].

As a future proposal, in addition to investigating the behavior of the mortality rate, a survey of accident circumstances could be carried out. Thus, more information would be available to find ways to reduce accidents. Further, investigating accident related expenses, as well as for hospitalization and rehabilitation of injuries due to accidents is essential for public health planning.

CONCLUSION

It was possible to observe that the mortality rate from traffic accidents in the general population decreased 1.0% per year. The annual average percentage for the male population, however, remained stable. In addition, when considering the period from 2012 to 2015, both general and male population mortality rates demonstrate a decrease of 4.6% and 4.9% per year, respectively.

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