

Mortality of motorcyclists due to traffic injuries in Brazil: a population-based study in Brazilian capitals

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<http://dx.doi.org/10.1590/1806-9282.66.10.1355>

SUMMARY

OBJECTIVE: To analyze the mortality trend of young men who were victims of traffic injuries involving motorcycles in all Brazilian capitals from 2001 to 2015.

METHODS: A time-series study on all deaths of men aged 20-39 years old due to traffic injuries involving motorcycles in all 27 Brazilian capitals. We used the joinpoint regression model for temporal analysis and calculated the Annual Percent Change (APC) and Average Annual Percent Change (AAPC) to verify the mortality trends.

RESULTS: A total of 12,058 deaths of young men were recorded in the Brazilian capitals during the period studied. The highest mortality rates were observed in Boa Vista/Roraima (34.0/100,000 population) and Palmas/Tocantins (29.80/100,000). Twelve of the 27 capitals showed an increasing trend in mortality, with the highest percentage increase being observed in Salvador (APC: 29.0%) and São Paulo (APC: 13.1%). None of the capitals showed a decline in the trend of mortality.

CONCLUSIONS: Overall, the mortality of young men from traffic injuries involving motorcycles shows an increasing trend in 12 of the 27 capitals, which represents a public health problem that requires the implementation of more effective public policies.

KEYWORDS: Accidents, traffic. Mortality. Epidemiology. Public Health. Motorcycles.

DATE OF SUBMISSION: 26-Feb-2020

DATE OF ACCEPTANCE: 22-Mar-2020

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INTRODUCTION

Mortality due to traffic injuries has become a public health problem worldwide¹. In 2016, traffic caused about 1.35 million deaths, representing the eighth global cause of mortality^{1,2}. Of these deaths, 50% were of individuals considered more vulnerable (pedestrians, cyclists, and motorcyclists), and young men constituted the risk group^{1,2}.

In 2016, Brasil registered 37,345 deaths resulting in a mortality rate of 18.1/100,000 population³, and it was one of the five countries with the highest traffic-related mortality, alongside India, China, USA, and Russia¹. An estimated 4.6 billion dollars are spent annually on traffic-related deaths and injuries in Brasil⁴.

Because of the high number of deaths due to traffic injuries, the World Health Organization (WHO) attributed the period of 2011-2020 as the “Decade of Action for Road Safety” with the goal of halving mortality from traffic injuries in the world⁵. Brasil has implemented the National Injury Reduction Plan, which involves strategic actions to improve road safety and reduce the occurrence of traffic injuries and deaths⁶. Since Brasil is a country of continental dimensions with marked socioeconomic disparities, studies are needed to assess the behavior of the trend of mortality from traffic injuries, especially with population groups at increased risk of death. In addition, investigations into how mortality rates behave can support public strategies and policies aimed at road safety⁷.

This study investigated the mortality trend of young men who were victims of traffic injuries involving motorcycles in all Brazilian capitals from 2001 to 2015.

METHODS

This was a time-series study including all deaths of young men aged 20 to 39 years old due to traffic injuries involving motorcycles that occurred in the 27 state capitals of Brasil from 2001 to 2015.

Data on the population were obtained from the Brazilian Institute of Geography and Statistics (IBGE). Data on the deaths were obtained from the Mortality Information System (SIM, in Portuguese) (<http://www2.datasus.gov.br>). All deaths of young men with the International Classification of Diseases (ICD-10) codes V20–V29 were included. The mortality rate was calculated by dividing the number of deaths of men aged 20-39 years old by the population of men

aged 20-39 years old per 100,000 population. Data were obtained by year for each of the state capitals of the country.

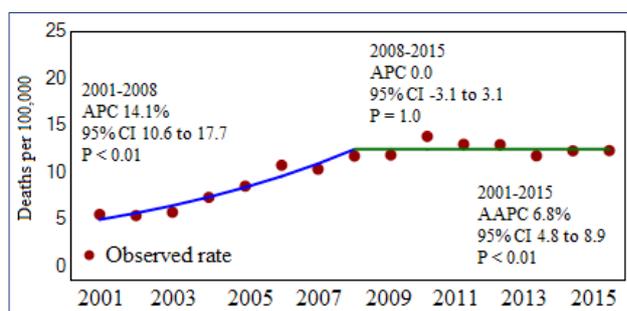
The temporal trend analysis was calculated using the joinpoint regression model (Joinpoint Regression Program 4.5.0.1, National Cancer Institute, USA) with Monte Carlo permutations and error autocorrelation based on date. This method allows identifying trends and change points and determining the Annual Percentage Changes (APC) and overall period (Average Annual Percent Change – AAPC). Trends were categorized as stable, increasing, or decreasing⁸. We considered a 95% confidence interval (95% CI) and 5% significance for all analyses.

The study did not require approval from an ethics committee as the databases are in the public domain without individual identifiers.

RESULTS

A total of 12,058 deaths of men aged 20 to 39 years old due to traffic injuries involving motorcycles were recorded in the Brazilian capitals from 2001 to 2015. This corresponds to 17% (12,058/71,090) of deaths across the country in the period. The mortality rate in the capitals went from 5.52/100,000 (n=394 deaths) in 2001 to 12.32/100,000 in 2015 (n=107 deaths) (AAPC 6.8%; 95% CI 4.8 to 8.9; $P < 0.01$) (Figure 1). In 2001, 12 capitals had mortality rates higher than the national (6.84/100,000). In 2015, eight capitals had a higher mortality rate than the national rate (18.33/100,000). When considering the entire period (2001-2015), eight capitals stood out with rates higher than the national rate (14.80/100.00), two from the Northern region (Boa Vista/Roraima and Palmas/Tocantins), two from the

FIGURE 1. TIME TREND OF THE MORTALITY RATE OF MEN 20-39 YEARS OLD DUE TO TRAFFIC INJURIES INVOLVING MOTORCYCLES, PER BRAZILIAN CAPITALS FROM 2001-2015.

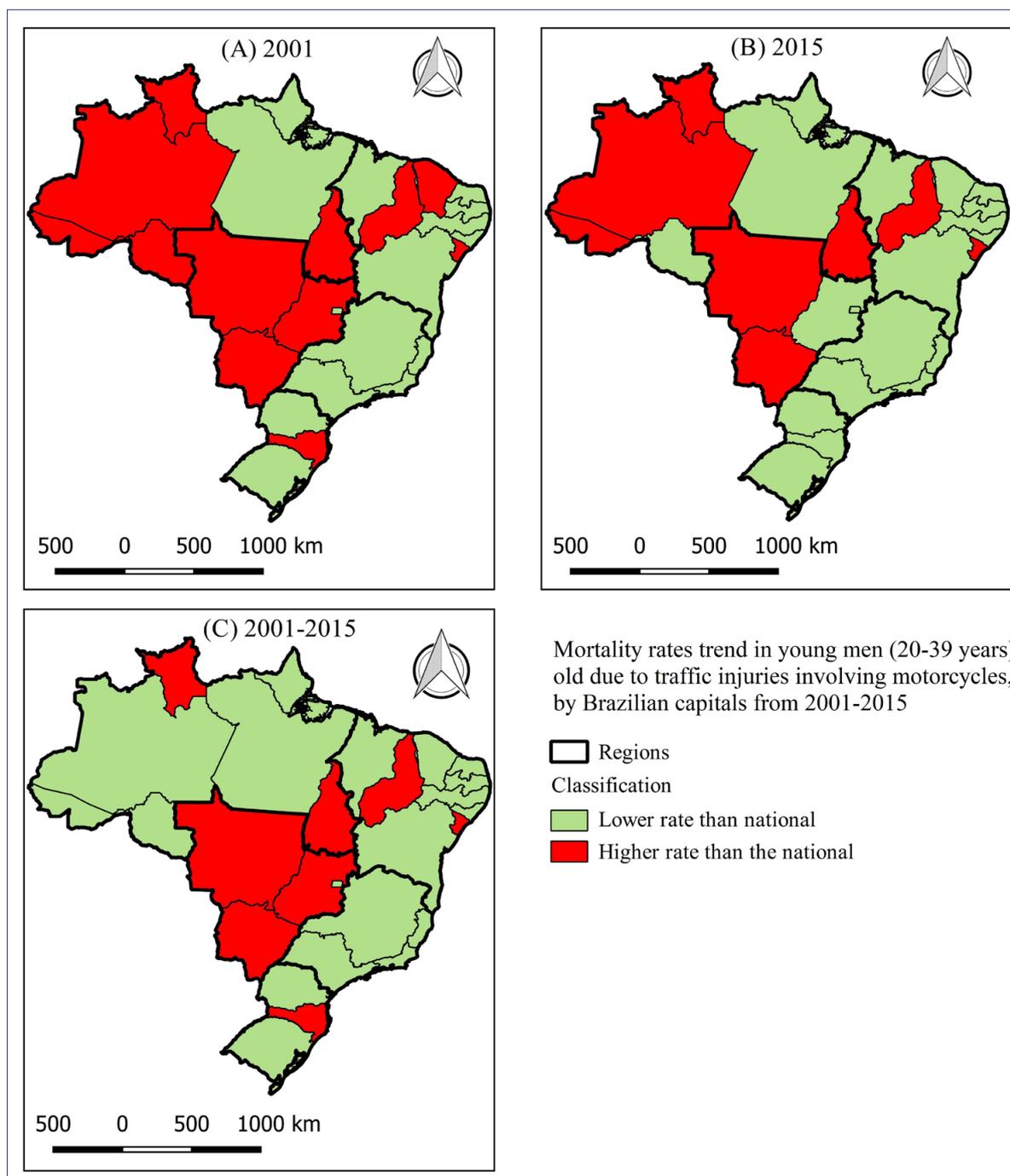


Northeast (Teresina/Piauí and Aracaju/Sergipe), three in the Central-West (Goiânia/Goiás, Cuiabá/Mato Grosso and Campo Grande/Mato Grosso do Sul), and one in the South (Florianópolis/Santa Catarina). The highest mortality rates were observed in Boa Vista/Roraima (34.00/100,000 population) and Palmas/Tocantins (29.80/100,000) (Figure 2).

Twelve of the 27 Brazilian capitals showed an increasing trend, three in the North, five in the

Northeast, two in the Southeast and two in the Central West. The largest increase in mortality rate was detected in Salvador/Bahia (AAPC: 29.0%; $p < 0.001$), with a mortality rate varying from 0.4/100,000 in 2001 to 9.4/100,000 in 2015, followed by São Paulo/São Paulo (AAPC: 13.1%; $p < 0.001$), with a rate going from 4.4 to 11.1/100,000 from 2001 to 2015. None of the capitals had a decreasing trend (Table 1). The absence of death records in different years of the time series

FIGURE 2. MORTALITY RATES IN YOUNG MEN 20-39 YEARS OLD DUE TO TRAFFIC INJURIES INVOLVING MOTORCYCLES, PER BRAZILIAN CAPITALS FROM 2001-2015.



in Rio Branco/Acre (2003, 2006, and 2008–2011) and Macapá/Amapá (2011) made the application of segmented regression unfeasible. Rio Branco/Acre and Macapá/Amapá registered 74 and 68 deaths in the period, respectively (Table 1).

DISCUSSION

Brasil has experienced a change in its morbidity and mortality profile in recent decades, with a considerable increase in deaths from chronic diseases and external causes (interpersonal violence and traffic injuries)^{9–11}. In this study, we investigated the deaths of a population group at a higher risk of death (young

men aged 20–39 years) due to traffic injuries involving motorcycles to identify the behavior in a 15-year time series in Brazilian capitals. Our findings call attention to the increasing trend in mortality, even in the period after the introduction of an emergency plan to reduce traffic-related deaths.

In view of this finding, some explanations are offered. Factors such as tax incentives for the installation of industrial motorcycle manufacturing centers, combined with the increased purchasing power of the Brazilian population and easier access to credit, resulted in an expansion in the number of motorcycles, not only in absolute numbers, but also in comparison with other vehicles^{9,12}. In 1990, for example, the

TABLE 1. TREND OF MORTALITY RATES IN YOUNG MEN AGED 20–39 YEARS OLD DUE TO TRAFFIC INJURIES INVOLVING MOTORCYCLES, PER BRAZILIAN CAPITALS FROM 2001 TO 2015.

Capital	Period	APC (95% CI)	AAPC (95% CI)	Trend
Porto Velho/Rondônia	2001–2015	10.5 ^a (5.2; 16.0)	10.5 ^a (5.2; 16.0)	Increasing
Rio Branco/Acre	– ^b	– ^b	– ^b	– ^b
Manaus/Amazonas	2001–2015	6.0 ^a (2.7; 9.5)	6.0 ^a (2.7; 9.5)	Increasing
Boa Vista/Roraima	2001–2003 2003–2007 2007–2015	–65.9 (–89.3; 8.9) 47.0 (–17.7; 162.5) –0.9 (–12.7; 12.5)	–4.8 (–22.3; 16.7)	Stable
Belém/Pará	2001–2015	11.2 ^a (5.3; 17.6)	11.2 ^a (5.3; 17.6)	Increasing
Macapá/Amapá	– ^b	– ^b	– ^b	– ^b
Palmas/Tocantins	2001–2015	–2.0 (–4.5; 0.7)	–2.0 (–4.5; 0.7)	Stable
São Luís/Maranhão	2001–2015	6.2 ^a (3.0; 9.6)	6.2 ^a (3.0; 9.6)	Increasing
Teresina/Piauí	2001–2015	11.5 ^a (8.5; 14.6)	11.5 ^a (8.5; 14.6)	Increasing
Fortaleza/Ceará	2001–2015	–0.3 (–3.4; 2.9)	–0.3 (–3.4; 2.9)	Stable
Natal/Rio Grande do Norte	2001–2015	4.1 (–1.8; 10.4)	4.1 (–1.8; 10.4)	Stable
João Pessoa/Paraíba	2001–2015	10.0 ^a (4.1; 16.2)	10.0 ^a (4.1; 16.2)	Increasing
Recife/Pernambuco	2001–2015	9.3 ^a (4.9; 13.9)	9.3 ^a (4.9; 13.9)	Increasing
Maceió/Alagoas	2001–2015	0.7 (–4.6; 6.4)	0.7 (–4.6; 6.4)	Stable
Aracaju/Sergipe	2001–2015	6.9 ^a (3.8; 10.1)	6.9 ^a (3.8; 10.1)	Stable
Salvador/Bahia	2001–2015	29.0 ^a (16.2; 43.2)	29.0 ^a (16.2; 43.2)	Increasing
Belo Horizonte/Minas Gerais	2001–2015	6.9 ^a (2.3; 11.7)	6.9 ^a (2.3; 11.7)	Increasing
Vitória/Espírito Santos	2001–2015	0.3 (–6.2; 7.4)	0.3 (–6.2; 7.4)	Stable
Rio de Janeiro/Rio de Janeiro	2001–2009 2009–2012 2012–2015	16.3 ^a (8.9; 24.1) –33.0 (–63.2; 21.9) 29.8 (–3.8; 75.2)	5.8 (–6.5; 19.6)	Stable
São Paulo/São Paulo	2001–2015	13.1 ^a (5.7; 21.0)	13.1 ^a (5.7; 21.0)	Increasing
Curitiba/Paraná	2001–2006 2006–2015	39.0 ^a (6.4; 81.7) –5.1 (–14.9; 5.9)	8.8 (–2.0; 20.7)	Stable
Florianópolis/Santa Catarina	2001–2015	1.6 (–3.2; 6.5)	1.6 (–3.2; 6.5)	Stable
Porto Alegre/Rio Grande do Sul	2001–2015	2.9 (–0.3; 6.2)	2.9 (–0.3; 6.2)	Stable
Campo Grande/Mato Grosso do Sul	2001–2008 2008–2015	28.4 ^a (14.6; 43.8) –4.6 (–14.8; 6.8)	10.7 ^a (3.1; 18.7)	Increasing
Cuiabá/Mato Grosso	2001–2015	4.5 (–0.4; 9.6)	4.5 (–0.4; 9.6)	Stable
Goiânia/Goiás	2001–2004 2004–2015	20.4 (–2.7; 49.0) –1.7 (–4.5; 1.2)	2.7 (–1.8; 7.4)	Stable
Brasília/Distrito Federal	2001–2007 2017–2015	30.8 ^a (12.3; 52.2) –4.3 (–13.2; 5.6)	9.4 ^a (1.5; 18.0)	Increasing

Legend: ^a Statistical significance (P <0.05); ^b Inconsistent data made the temporal analysis unfeasible; APC: Annual Percent Change; AAPC: Average Annual Percent Change.

Brazilian fleet of motorcycles was 1.5 million and in 2014 this number reached 22 million units circulating in the country¹³. Also, the main consumers of these vehicles are young men, with lower purchasing power and low educational level^{14,15}.

In the North and Northeast regions, the expansion in the number of motorcycles was even more intense. In the North region, the motorcycle fleet increased from 224,150 in 2001 to 1,757,003 in 2015, accounting for an increase of around 684%¹⁶. In the Northeast region, the motorcycle fleet varied from 766,886 in 2001 to 5,825,032 in 2015, which represents an increase of nearly 660%¹⁶. In this study, the three capitals with the highest rates were observed in the North (Boa Vista/Roraima and Palmas/Tocantins) and Northeast (Teresina/Piauí) areas. In Teresina/Piauí, 84% of victims of traffic injuries assisted by the Emergency Ambulance Service in 2009 were involved in motorcycle injuries and 76% of these individuals were men¹⁷.

Other factors can play an important role when associated with the significant increase in motorcycles, such as: precarious conditions of roads and highways, deficiencies in traffic inspection, and lack of structural adaptations on highways and cities^{11,15}.

In large cities or metropolises, the increase of the motorcycle fleet occurs both from the low cost of acquiring and maintaining the vehicle and from the speed of travel that the motorcycle promotes when compared to other vehicles, especially in the face of tumultuous traffic in these cities^{17,18}. On the other hand, the increase in flow at peak times associated with structural deficiencies in the roads, deficits in the inspection mechanisms, and tiredness/fatigue of drivers create a scenario determinant to the occurrence of injuries involving motorcyclists¹⁸.

Motorcycles have taken on a new role in Brazilian society and in many other low- and middle-income countries. The motorcycle went from a leisure vehicle used on weekends to a working instrument for thousands of individuals¹¹. The professions of *motorcycle courier* and *motorcycle taxi* and, more recently the delivery of parcels by apps, can have substantial impacts on the occurrence of injuries involving motorcyclists^{9,11,19}. Studies on the working conditions of *motorcycle couriers* have shown that the indiscriminate demand for services causes them to institute an exacerbated work rhythm that leads them to violate traffic laws in order to be able to fulfill deliveries in a timely manner²⁰. In addition, these professionals largely neglect the use of personal protective equipment¹⁹.

This process is potentially influenced by the working relationship to which these professionals are exposed¹⁹. As both *motorcycle taxis* and *motorcycle couriers* are self-managed, they have no formal employment relationship and their financial gain is dependent only on their work capacity, which results in an intensification of the workday in the search for compensation for the low added value of each task completed^{19,20}.

Even with methodological care, this study has the following limitations: i) use of secondary data whose quality can be questioned; ii) the inadequate filling out of the death certificate (DO) with the presence of the garbage code, and cases that occurred in hospitals whose underlying cause was not registered as a motorcycle injury; and iv) the underreporting of deaths.

CONCLUSION

The context shown in this study is worrying. Twelve of the 27 capitals showed an increasing trend in mortality. We advocate that broad public policies that include multisectoral actions, strengthening and guaranteeing the application of traffic legislation, structural improvements in the Brazilian road network, and consistent educational actions can contribute to the reduction of the problem in Brasil.

Financial Support

This study did not receive any financial support.

Conflict of interest

The authors have no conflict of interest to declare.

Author's Contribution

Carlos Dornels Freire de Souza, Leonardo Feitosa da Silva, Thiago Cavalcanti Leal, João Paulo Silva de Paiva, Gibson Barros de Almeida Santana: Participated in the development of the concept, planning of the study, data collection and analysis, discussion of the results, scientific writing, as well as in the review and approval of the final version of the work.

Michael Ferreira Machado, Maria Deysiane Porto de Araújo, Divanise Suruagy Correia, Roberto Andrade Medronho, Victor Santana Santos, Mônica de Avelar Figueiredo Mafra Magalhães: Participated in the writing of the results, discussion, scientific writing, as well as in the review and approval of the final version of the work.

RESUMO

OBJETIVO: Analisar a tendência temporal da mortalidade de homens jovens vítimas de acidente de trânsito envolvendo motocicletas em todas as capitais brasileiras de 2001 a 2015.

MÉTODOS: Estudo de séries temporais incluindo as mortes de homens de 20 a 39 anos por lesões no trânsito envolvendo motocicletas nas 27 capitais brasileiras. Para a análise, foi utilizado o modelo de regressão do ponto de inflexão e calculada a Variação Percentual Anual (APC) e a Variação Percentual Anual Média (AAPC).

RESULTADOS: Foram registradas 12.058 mortes de homens jovens nas capitais brasileiras durante o período estudado. As maiores taxas de mortalidade foram observadas em Boa Vista/Roraima (34,0/100.000 habitantes) e Palmas/Tocantins (29,80/100.000). Doze capitais apresentaram tendência crescente de mortalidade, sendo o maior aumento percentual em Salvador (APC: 29,0%) e São Paulo (APC: 13,1%). Nenhuma das capitais mostrou declínio nas taxas.

CONCLUSÕES: A mortalidade de jovens por lesões no trânsito envolvendo motocicletas tem mostrado uma tendência crescente em 12 capitais, o que representa um problema de saúde pública que requer a implementação de políticas públicas mais eficazes.

PALAVRAS-CHAVES: Acidentes de trânsito. Mortalidade. Epidemiologia. Saúde pública. Motocicletas.

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