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Motorcycle accidents in Belo Horizonte and its Metropolitan Region: linear mortality trend from 2000 to 2012

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ABSTRACT

Objective: To describe the profile and evolution of the mortality rate due to motorcycle accidents in Belo Horizonte and its Metropolitan Region, from 2000 to 2012. **Methods:** A time series study with data extracted from the Mortality Information System (*Sistema de Informações sobre Mortalidade*, SIM) and from the IBGE. A linear regression model was used, with a 5% significance level. **Results:** From 2000 to 2012 there was a 278% increase in the number of deaths. The population most affected was that of male individuals, aged 20 to 29 years old, of black/brown skin, without partners, and with 8 to 11 years of schooling. The mortality rate increased from 1.7 to 3.58 deaths/100,000 inhabitants, with an increasing trend ($\beta=0.25$ per year; $p<0.01$). **Discussion:** There was an increase in the mortality rate due to motorcycle accidents. The results of this study can contribute to the formulation of actions that prioritize the prevention of accidents in the public at greatest risk.

Keywords: Traffic accidents; Motorcycles; Mortality; Epidemiology.

INTRODUCTION

Land Transportation Accidents (LDAs) are defined by the International Classification of Diseases as injuries related to the traffic of vehicles and people on public roads[1]. In the last decades, LDAs have been gaining increasing importance in Brazil and worldwide, becoming an important public health problem, especially due to morbidity and mortality and to social and economic costs[2].

According to data from the World Health Organization (WHO), in 2018 LDAs were the eighth leading cause of mortality in the world and the first among children and young adults aged 5 to 29[3]. In Brazil, according to data from the Global Burden of Disease, in 1990 LDAs were the fifth leading cause of death, rising to the third place in 2016[4]. In addition, according to a Research Report published by the Institute for Applied Economic Research (*Instituto de Pesquisa Econômica Aplicada*, IPEA), in 2014 the spending on traffic accidents was approximately 10 billion reais[5].

In this scenario, motorcycles occupied the urban space as an alternative for fluidity in traffic, due to the increase in the car fleet, and the replacement of the inefficiency of public transportation, in addition to being a new possibility in the tele-delivery market. In addition, the ease of purchasing a motorcycle has contributed to the five-time growth of its fleet when compared to the car fleet. It should be noted, however, that this growth was not accompanied by an improvement in road infrastructure or by effective changes in the Brazilian legislation, leading to an increase in serious accidents and in deaths related to these vehicles[6].

According to a literature review, from 1996 to 2009 there was an exponential increase in the mortality rate due to motorcycle accidents in Brazil, varying from 0.5% to 4.5%, that is, an increase of 800% in the analyzed period, representing a mean increase of 19% per year, with young men being the main fatal victims[7].

In view of the relevance of this scenario, in 2009 the United Nations (UN) declared the Decade of Action for Road Safety in the period from 2011 to 2020, covering more than 110 countries, including Brazil. The goal is to reduce the current levels of mortality and injuries due to traffic accidents through actions based on strengthening management, improving road infrastructure, pre-hospital and hospital care for the injured, and vehicle and user safety[8]. In Brazil, a national action plan (the "Life in Traffic" Project) was created, implemented in 2010, and coordinated by the Ministry of Health with a view to this reduction. Belo Horizonte/Minas Gerais (MG) was one of the capitals chosen to develop the project, representing the Southeast region[9]. The state of MG has followed the Brazilian pattern of growth in the mortality rate due to motorcycle accidents and, from 2004 to 2013, the percentage variation of this rate was 114%[10]. One of the justifications for this variation can be explained by the National Traffic Department (*Departamento Nacional de Trânsito*, DENATRAN), where it was demonstrated that, between 2000 and 2012, there was a 333.48% increase in the fleet of motorcycles[11]. In view of this increase, the potential years of life lost, the high mortality from accidents related to these vehicles, in addition to their social and economic impact

on society, this study aims to describe the profile and evolution of the mortality rate due to motorcycle accidents between 2000 and 2012 in Belo Horizonte and its Metropolitan Region. According to our knowledge, the scarcity is highlighted of current published studies on this theme.

METHOD

This is a study with an ecological design of time series, with data related to the mortality due to motorcycle accidents in LDAs from 2000 to 2012 in Belo Horizonte and in 33 municipalities that make up its Metropolitan Region.

The data used on the mortality rate due to motorcycle accidents were obtained from the SUS Informatics Department (DATASUS) managed by the Mortality Information System (SIM), which has Death Certificates (DCs) as source of data. Deaths were selected according to ICD-10, under codes V20 to V29, a category that includes accidents involving motorcyclists, considered by occurrence and stratified according to year (2000 to 2012), gender (male and female), age group(0 to 19 years old; 20 to 29 years old; 30 to 49 years old; 50 to 59 years old; 60 years old or more), race/skin color (white; black/brown; yellow/indigenous), marital status (with partner; without partner), and schooling (none; 1 to 3 years; 4 to 7 years; 8 to 11 years; 12 years or more).

The denominators used to calculate the general mortality rates, by age and gender, were obtained by the Brazilian Institute of Statistical Geography (*Instituto Brasileiro de Geografia Estatística*, IBGE), through censuses and inter-census projections, during the analyzed period. Data was extracted using the Tabnet (generic publicly available tabulator).

Initially, a descriptive analysis of the data was performed, based on the calculation of the frequencies and proportions. Subsequently, linear regression analyses were conducted to estimate the linear trend in mortality rates in the gender and age categories. Beta (β) coefficients and 95% confidence intervals were estimated, and levels of statistical significance of 5% ($p<0.05$) were considered. The results were presented by means of tables and figures.

Data was processed and analyzed in the Statistical Software for Professionals (Stata) software, version 14.0 (Stata Corp., Texas, USA).

RESULTS

From 2000 to 2012, there was a 278% increase in the number of deaths due to motorcycle accidents, with a predominance of male victims, ranging from 88.8% to 96.5% of the cases. The most affected age group was that from 20 to 29 years old in all the years studied, reaching the highest percentage of mortality in 2000 (57.45%), and the lowest in 2006 (34.33%). Regarding race/skin color, the most affected population was brown-skinned people, representing 66% of the deaths in 2000, and 54% in 2012. The majority of deaths occurred in individuals without partners, reaching approximately 82% in 2005 and 80% in 2012.

Regarding schooling, the number of deaths predominated in individuals with between 4 and 7 years and 8 to 11 years of study, varying over the analyzed period. In individuals

with 1 to 3 years of study, the variation was from 25.5% of the number of deaths in 2000 to 5.08% of the number of deaths in 2012 (Table 1).

The mortality rate of motorcyclists increased from 1.7 to 3.58 deaths/100,000 inhabitants in the analyzed period, that is, 110%, with an increasing trend (β=0.25 per year; p<0.01). In relation to males, the rate increased from 2.13 to 6.88 deaths/100,000 inhabitants (β=0.48 per year; p<0.01). For females, the variation was from 0.08 to 0.54 deaths/100,000 inhabitants(β=0.05 per year; p<0.01) (Figure 1).

The age groups up to 59 years old showed a statistically significant growth trend (p<0.01), with the greatest variation in the age group between 20 and 29 years old (β=0.60 per year; p=0.01), followed by the age groups of 30 to 49 years old (β=0.30 a year; p=0.01), 50 to 59 years old (β=0.20 a year; p=0.01), and 0 to 19 years old (β=0.09 per year; p=0.01). The age group of 60 years old or more had a small growth trend, but without statistical significance (β=0.04 per year; p=0.24) (Figure 2).

DISCUSSION

The results of the trend analysis of mortality in Belo Horizonte and its Metropolitan Region showed an increase of 110% in the mortality rate due to motorcycle accidents during the period from 2000 to 2012, with an increasing trend. In the years 2002, 2008 and 2011, there was a reduction in the mortality rate, and an increase was recorded in all the other years of the analyzed period.

According to a survey by the Ministry of Health on the panorama of morbidity and mortality due to accidents involving motorcyclists in Brazil, the motorization rate went from 3.9 motorcycles per 100 inhabitants in 2004 to 10.7 motorcycles per 100 inhabitants in 2013, that is, a growth of 176%[10]. Such an increase in the fleet can be explained by the possibility of insertion in the labor market, the inefficiency of the public transportation system, time optimization, and the easy financing for purchasing a motorcycle[6,7,12].

It is believed that the reductions in the mortality rates in the aforementioned years are related to Resolution No. 136, of April 2nd, 2002[13], which increases the values of traffic fines, and to Law No.11,705, of June 19th, 2008[14], which provides for the "Prohibition Law", with the purpose of establishing zero blood alcohol levels (with a tolerance up to 0.2 g/L) in vehicle drivers, and for the application of penalties in case it is not complied with. Data published in a time series study with mortality data due to LDAs between 1980 and 2014 demonstrate that the mortality rate decreased after the implementation in the Prohibition Law[15]. However, in the results of this study, it is possible to perceive an increase in the mortality rate in the following year, 2009, demonstrating that the Law was effective, but during a certain period, as indicated in other studies[15].

In 2011, the reduction in the mortality rate can be explained by the implementation of the "Life in Traffic" Program in Belo Horizonte, developed by the Brazilian government as a strategy for the National Health Plan of the Decade of Traffic Safety Actions. According to Moraes in a survey to assess the "Life in Traffic" Project from 2010 to 2011, there was a 16.8% reduction in the mortality rate

Table 1. Number (n) and Proportion (%) of motorcycle accidents, according to gender, age group, race/skin color, schooling and marital status – Belo Horizonte and its Metropolitan Region, 2000-2012.

Year	n (%)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Gender														
Male	n (%)	45 (95.74)	54 (93.1)	83 (96.51)	64 (91.43)	97 (94.17)	100 (92.59)	119 (88.81)	137 (89.54)	194 (93.72)	135 (92.47)	178 (95.19)	186 (88.57)	164 (92.13)
Female	n (%)	2 (4.26)	4 (6.9)	3 (3.49)	6 (8.57)	6 (5.83)	8 (7.41)	15 (11.19)	16 (10.46)	13 (6.28)	11 (7.53)	9 (4.81)	24 (11.43)	14 (7.87)
Age (years old)														
0-19	n (%)	5 (10.64)	13 (22.41)	15 (17.44)	14 (20.00)	14 (13.59)	15 (13.89)	29 (21.64)	19 (12.42)	35 (16.91)	14 (9.59)	18 (9.63)	22 (10.48)	24 (13.48)
20-29	n (%)	27 (57.45)	29 (50.00)	34 (39.53)	34 (48.57)	54 (52.43)	49 (45.37)	46 (34.33)	80 (52.29)	106 (51.21)	71 (48.63)	93 (49.73)	91 (43.33)	74 (41.57)
30-49	n (%)	13 (27.66)	14 (24.14)	33 (38.37)	16 (22.86)	30 (29.13)	39 (36.11)	49 (36.57)	46 (30.07)	55 (26.57)	50 (34.25)	61 (32.62)	81 (38.57)	60 (33.71)
50-59	n (%)	2 (4.26)	1 (1.72)	3 (3.49)	1 (1.43)	4 (3.88)	2 (1.85)	5 (3.73)	7 (4.58)	8 (3.86)	9 (6.16)	11 (5.88)	12 (5.71)	15 (8.43)
60 or more	n (%)	0 (0.00)	1 (1.72)	1 (1.16)	5 (7.14)	1 (0.97)	3 (2.78)	5 (3.73)	1 (0.65)	3 (1.45)	2 (1.37)	4 (2.14)	4 (1.90)	5 (2.81)
Race/Skin color														
White	n (%)	13 (27.66)	27 (46.55)	48 (55.82)	26 (37.14)	40 (38.83)	42 (38.89)	47 (35.07)	55 (36.18)	72 (34.78)	53 (36.30)	77 (41.18)	71 (33.81)	60 (33.71)
Black	n (%)	3 (6.38)	5 (8.62)	4 (4.65)	4 (5.71)	10 (9.71)	8 (7.41)	14 (10.45)	15 (9.87)	22 (10.63)	10 (6.85)	21 (11.23)	23 (10.95)	22 (12.36)
Brown	n (%)	31 (65.96)	26 (44.83)	34 (39.53)	40 (57.15)	53 (51.46)	58 (53.70)	73 (54.48)	81 (53.29)	113 (54.59)	83 (56.85)	89 (47.59)	115 (54.76)	96 (53.93)
Indigenous	n (%)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.66)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Asian	n (%)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.48)	0 (0.00)
Schooling (years)														
None	n (%)	0 (0.00)	1 (1.72)	2 (2.38)	1 (1.45)	1 (0.98)	1 (0.95)	0 (0.00)	1 (0.68)	1 (0.49)	1 (0.70)	2 (1.08)	1 (0.48)	1 (0.56)
1-3	n (%)	12 (25.53)	4 (6.90)	3 (3.57)	2 (2.90)	4 (3.92)	12 (11.43)	13 (9.92)	13 (8.90)	14 (6.86)	7 (4.90)	5 (2.69)	13 (6.25)	9 (5.08)
4-7	n (%)	23 (48.94)	24 (41.38)	29 (34.52)	33 (47.83)	33 (32.35)	36 (34.29)	61 (46.56)	53 (36.30)	72 (35.29)	47 (32.87)	59 (31.72)	76 (36.54)	54 (30.51)
8-11	n (%)	9 (19.15)	28 (48.28)	35 (41.67)	29 (42.03)	56 (54.90)	50 (47.62)	47 (35.88)	73 (50.00)	95 (46.57)	74 (51.75)	106 (56.99)	98 (47.12)	95 (53.67)
12 or more	n (%)	3 (6.38)	1 (1.72)	15 (17.86)	4 (5.80)	8 (7.84)	6 (5.71)	10 (7.63)	6 (4.11)	22 (10.78)	14 (9.79)	14 (7.53)	20 (9.62)	18 (10.17)
Marital status														
Has a partner	n (%)	15 (31.91)	16 (28.07)	16 (19.05)	14 (20.29)	29 (28.43)	18 (17.31)	33 (25.00)	32 (21.19)	33 (15.94)	30 (20.69)	39 (20.86)	44 (20.95)	34 (19.10)
No partner	n (%)	32 (68.09)	41 (71.93)	68 (80.95)	55 (79.71)	73 (71.57)	86 (82.69)	99 (75.00)	119 (78.81)	174 (84.06)	115 (79.31)	148 (79.14)	166 (79.05)	144 (80.90)
Total		47	58	86	70	103	108	134	153	207	146	187	210	178

Source: Created for the purposes of this study.
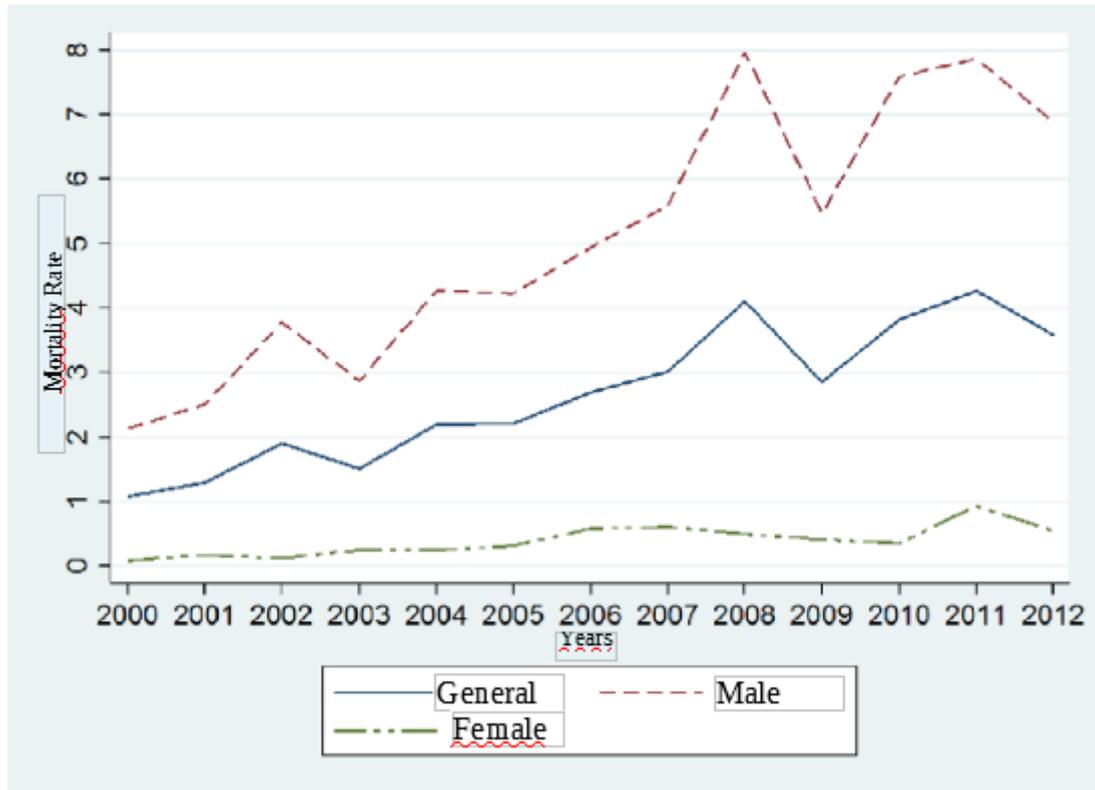
Figure 1. Mortality rate due to motorcycle accidents, according to the victim's gender – Belo Horizonte and its Metropolitan Region, 2000-2012
Source: Created for the purposes of this study.
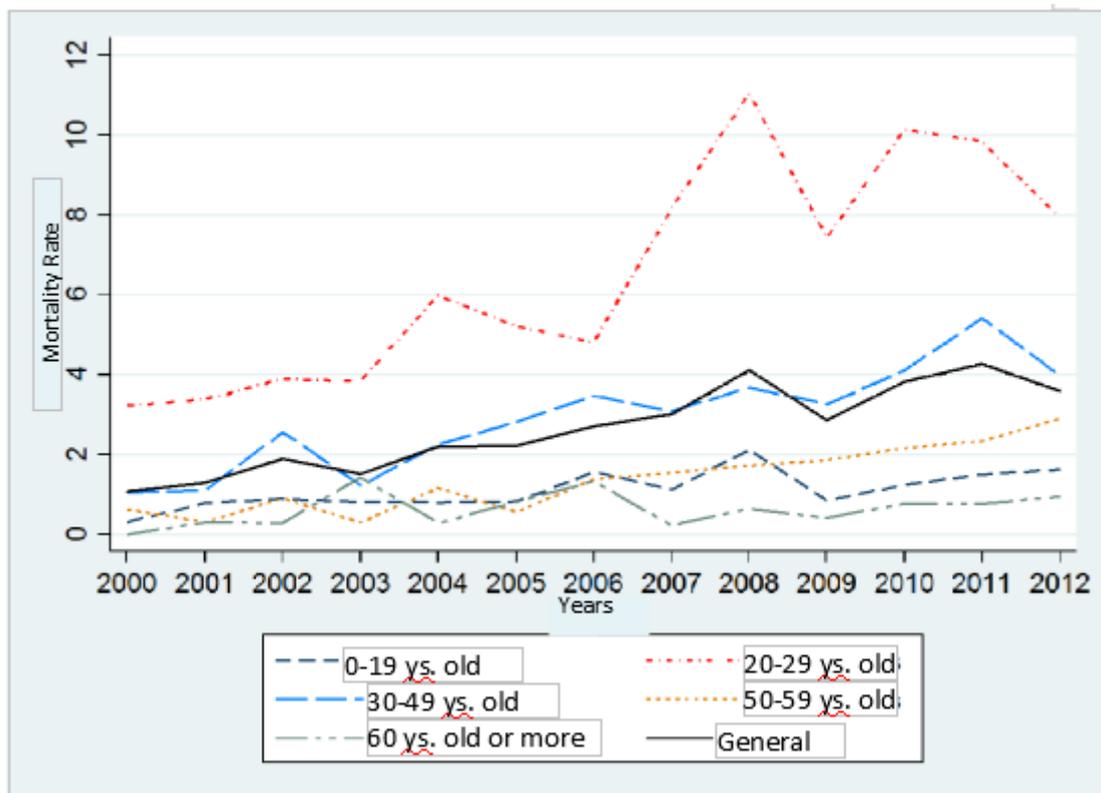
Figure 2. Mortality rate due to motorcycle accidents, according to the victim's age group – Belo Horizonte and its Metropolitan Region, 2000-2012
Source: Created for the purposes of this study.

due to LDAs in Belo Horizonte, showing the importance of the Program.[16]

In relation to the increase in the mortality rates in the period analyzed in this study, aspects such as the risk behavior of motorcyclists and the trauma mechanism of accidents stand out. Among the risk behaviors related to the increase in the mortality due to motorcycle accidents, the consumption of alcoholic beverages, driving in the traffic lane corridors, and speeding can be mentioned. Alcohol consumption associated with driving is recognized as a real aggravating factor in traffic accidents[6,7]. Due to their effects on the nervous system, alcoholic beverages offer a feeling of confidence to the drivers, and produce alterations in the attention capacity, in coordination, and in reaction time[7].

Driving in the traffic lane corridors is a risk factor due to the difficulty for the drivers of other vehicles (mainly of larger vehicles like buses) to see the motorcycles. Climatic conditions and the structural condition of the roads can also increase motorcycle instability, increasing the number of accidents[17].

In addition to these factors, speeding, which is closely related to non-compliance with traffic laws, directly interferes with the trauma mechanism of motorcycle accidents, since speed is an important factor responsible for the production of kinetic energy. In the case of motorcycles, there is great vulnerability of the motorcyclist and the passenger since their bodies are exposed during the accident, except for the head that is protected by the helmet, aggravating the trauma, as all the kinetic energy produced is transferred to the victim[15].

Regarding the profile of fatal victims due to motorcycle accidents, the characteristics found in the present study corroborate those observed in the literature[2, 7, 10, 15, 18]. Young, single, male victims with low socioeconomic status are more frequently involved in the accidents, which can be explained by their greater exposure to traffic and risky behaviors related to driving and alcohol use[7, 10, 15]. Some characteristics, such as inexperience, pleasure in experiencing sensations of risk, and impulsiveness are behaviors found in this group and, often, the effect of socio-cultural patterns[17]. In the results presented in the Violence and Accident Surveillance System, in 2014, of the total number of calls for traffic accidents in the 24 capitals and in the Federal District, the most affected population were brown-skinned individuals with 9 to 11 years of study, similarly to what was found in that paper[18].

Finally, it is emphasized that, among one of the limitations of this study is the fact that it refers to the use of mortality data by the SIM. This system has been configured as an important data source tool in epidemiological studies. However, problems like absence of data are still common[12].

In addition, to our knowledge, there is shortage of time series studies focused on the theme, with data on motorcyclist mortality in LDAs in Belo Horizonte and in municipalities of its Metropolitan Region, in the periods included in this research.

CONCLUSION

The results of this study demonstrate that the trend of mortality due to motorcycle accidents in Belo Horizonte and its Metropolitan Region

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had an increasing trend, despite attempts to reduce it. We believe in the importance of actions that cover not only punitive laws, but multi-sectoral actions related to education in traffic and that prioritize the prevention of this type of accidents, especially in men and in the age groups at greater risk.

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