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Mortality of motorcyclists in traffic accidents in the Brazilian Federal District from 1996 to 2007

ABSTRACT

OBJECTIVE: To describe sociodemographic characteristics and analyze temporal trends in the mortality of motorcyclists injured in traffic accidents.

METHODS: This was a time-series study with data from 580 motorcyclist deaths in the Brazilian Federal District from 1996 to 2007. The data were obtained from the Mortality Information System. Mortality rates specific for age and sex, the standardized rates (direct method), and the ratio of deaths per fleet (motorcycles) were calculated. The centralized moving average of the standardized mortality rate for men was calculated for a three-year period, and a linear regression model was constructed to study the evolution of mortality. The joinpoint method (inflection point) was used to calculate the annual increase in the standardized mortality rate.

RESULTS: Most of the motorcyclists killed were male (94.3%), mixed skin color (71.0%), and between the ages of 20 and 39 years (73.8%). The standardized mortality rate for resident motorcyclists (men) was 1.9 to 7.2 deaths/100,000 men between 1996 and 2007. Between 1998 and 2007, the ratio of deaths per fleet increased from 2.0 deaths/10,000 motorcyclists to 10.0 deaths/10,000 motorcyclists among men. There was an estimated annual increase of 0.48 deaths/100,000 men (95%CI 0.31, 0.65; p <0.001). The percent increase of the annual standardized mortality rate for males was 36.2% in the period from 1998-2007 (95%CI 21.2%, 53.2%; p <0.05).

CONCLUSIONS: The mortality rate resulting from motorcycle road accidents has increased dramatically. This increase is partially explained by the increase of the fleet of motorcycles. Individual characteristics of drivers, as well as local traffic conditions, need to be investigated for the planning of preventive policies.

DESCRIPTORS: Motorcycles. Accidents, Traffic, trends. Mortality. Time Series Studies.

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INTRODUCTION

Road traffic accidents (RTAs) are a serious public health problem worldwide, as they are responsible for a large number of cases of mortality and temporary and permanent disabilities. The World Health Organization (WHO) estimates that 1.2 million deaths result from RTAs each year, and there are even higher numbers of nonfatal and disabled victims, especially in emerging countries.[a] The

[a] World Health Organization. World report on road traffic injury prevention, Geneva; 2004. The global impact. Chapter 2, p. 33-61. [cited 2009 Feb 19]. Available from: http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/index.html

WHO estimates a 40% increase in mortality worldwide for these groups by 2030 if no effective preventive measures are adopted.[b] Approximately 62% of deaths from RTAs occur in ten countries, and Brazil ranks fifth in terms of the number of deaths.[c]

According to data from the Death Information System (*Sistema de Informação sobre Mortalidade*, SIM) from the Brazilian Ministry of Health, RTAs caused the deaths of 37,407 people in Brazil in 2007 (3.6% of the total deaths). That same year, 8,078 motorcyclists injured in traffic accidents died (21.6% of the total deaths from RTAs), an average of 22 deaths per day. This exceeded the proportion of deaths of car occupants (21.3%).[d]

Several Brazilian studies indicate that mortality from RTAs is higher among men, particularly young men (over 50% of deaths occur between the ages of 15 and 44),[7,12,22] and the proportion of motorcyclists among these victims is significant, ranging from 30% to 50%.[4,5,14]

Among the major policies related to the prevention of RTAs, the Brazilian Traffic Code (*Código de Trânsito Brasileiro*, CTB) Law No. 9503 was passed in 1998. The CTB has promoted the decentralization of traffic enforcement and set strict rules regarding speed limits and the mandatory use of safety equipment such as seatbelts and helmets. It also raised the value of traffic fines; created a rigorous system of scoring for traffic infractions, which can lead to the loss of one's driver's license; and set higher requirements for licensing drivers and for licensing vehicles.[7]

Despite the reduction in overall mortality from RTAs (from 11.4 deaths/100,000 men aged 20 to 49 years old) in the post-implementation period of the CTB,[7] the number of accidents involving motorcyclists has increased between 1980 and 2003, especially since 1995.[22] Since 1998, the death rate of motorcyclists injured in traffic accidents has continued to increase in all regions of the country, especially in cities with smaller populations.[e]

In Brazil, until the 1980s, the motorcycle was used for leisure. In subsequent years, it gained acceptance as a fast, economical, low-cost vehicle.[f] The fleet of motorcycles increased 300% from 1998 to 2007.[g] Gradually, the motorcycle has become an important option for individual transport and a working tool for motorcycle-freighters and mototaxis, particularly in Asian countries including Laos, Indonesia, Cambodia, and Thailand, which account for more than 70% of the fleet of vehicles.[h]

With the increase of the fleet and the increasing use of motorcycles in the labor market, the occurrence likelihood of accidents involving motorcyclists is increased by other drivers' difficulty in visualizing the motorcycle, dangerous traffic behavior, and disregard for traffic laws. Article 56 of the CTB, which prohibited motorcycle traffic between lanes, was vetoed, despite the fact that moving between the rows of cars increases the risk of accidents involving motorcyclists.[23] In Brazil, few cities have exclusive lanes for motorcyclists.

The victims of traffic accidents are likely to suffer serious injuries in the head and extremities (upper and lower limbs), often have long periods of hospitalizations with serious sequelae, and sometimes the occurrence of fatal injuries.[1,3,16,17] The increased severity of accidents is related to the large body of exposure in motorcyclists and to the negligence of the use of safety equipment.[2,16] Studies of motorcyclists involved in traffic accidents show that higher proportions of fatalities occur among motorcycle drivers (45.2 to 83.6%) compared to passengers.[8,14,15,21]

The Brazilian Federal District (FD) has the highest proportion of cars per inhabitants in the country (one vehicle per 2.5 inhabitants), yet it is only smaller than the state of Santa Catarina, Southern Brazil (one vehicle per 2.3 inhabitants). The FD had 89,960 motorcycles in 2007, representing 9.2% of the total fleet, a ratio of 8.3 cars per motorcycle. In Brazil, in the same year, the proportion of motorcycles in relation to the total fleet was 22.5%. Although the FD displays one of the highest proportions of vehicles per inhabitants in the country, the ratio between motorcycles and inhabitants is 27 per 1,000 inhabitants. This is lower than that observed in the country overall, which is 43 motorcycles per 1,000

[b] Mathers CD, Loncar D. Updated projections of global mortality and burden of disease, 2002-2030: data sources, methods and results. Geneva: World Health Organization; 2005. [cited 2009 Feb 19]. Available from: https://www.who.int/healthinfo/statistics/bodprojectionspaper.pdf

[c] World Health Organization. Global status report on road safety: time for action. Geneva; 2009. The state of road safety around the world. Chapter 3, p.33-6. [cited 2010 Jan 10]. Available from: http://www.who.int/violence_injury_prevention/road_safety_status/2009/en/

[d] Sistema de Informações sobre Mortalidade. Informações de saúde. [cited 2009 Apr 20]. Available from: http://tabnet.datasus.gov.br/tabdata/sim/dados/cid10_indice.htm

[e] Ministério da Saúde Secretaria de Vigilância em Saúde. A violência no Brasil, abordando diferentes fontes. In: Saúde Brasil 2007: uma análise de situação de saúde. Brasília, DF; 2008. p.295-7.

[f] Matos RHF. Estudo exploratório das relações de trabalho como fator de influência do comportamento humano no trânsito: caso do motofrete [master's dissertation]. Brasília, DF: Faculdade de Tecnologia da Universidade de Brasília; 2007. [cited 2009 Feb 23]. Available from: http://bdtd.bce.unb.br/tedesimplificado/tde_busca/arquivo.php?codArquivo=4108

[g] Departamento Nacional de Trânsito. Frota de Veículos. [cited 2011 Mar 22]. Available from: http://www.denatran.gov.br/frota.htm

[h] Holz RF, Lindau LA. Panorama internacional do uso e operação de motocicletas [monografia]. Porto Alegre: Laboratório de Sistemas de Transporte da Universidade Federal do Rio Grande do Sul; 2009. [cited 2009 Aug 30]. Available from: http://www.cbtu.gov.br/monografia/2009/trabalhos/artigos/gestao/3_320_AC.pdf

inhabitants.[i] According to data from the Federal District Department of Transportation, 159,456 drivers were qualified to ride motorcycles in 2005, which corresponded to 14.9% of all drivers qualified in the FD.[j]

Despite the low motorization of motorcycles in the FD, motorcyclists are vulnerable and often compete with a significant number of vehicles. There has also been a general increase in fleets in recent years. Nonetheless, there has been a lack of studies about this region. Therefore, the purpose of this study was to characterize the motorcyclists killed in traffic accidents and analyze the temporal trends in mortality.

METHODS

We conducted an exploratory time-series study about mortality of motorcyclists injured in traffic accidents in the Distrito Federal from 1996 to 2007. Data were collected from theSIM. We selected the deaths of motorcyclists (drivers and/or passengers) who were victims of transport accidents (codesV20-V29 of the 10th revision of International Classification of Diseases - ICD-10).

In the descriptive analysis, the deaths in the FD were characterized by the date and place of occurrence, and victims were characterized by gender, age, marital status, schooling, skin color, condition at the time of the accident (driver or passenger), type of accident, and place of residence (resident or non-resident of the FD).

In the time-series analysis, only the deaths of residents of the FD were considered. Population data, estimated by the *Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute of Geography and Statistics, IBGE), were used to calculate the specific rates of annual mortality (stratified by gender and age) and the standardized mortality rates (by gender and age) by the direct method (standard population: Brazil, 2000). Given the small proportion of deaths in women, we chose to present only the death rates for males. Data on the entire fleet of motorcycles from the National Traffic Department (Denatran) were used to calculate the ratio of deaths per fleet (deaths per 10 thousand motorcycles) in Brazil and in FD for the years from 1998 to 2007. To explain the observed annual changes in mortality rates, we examined the Pearson correlation coefficient between the variables "year" and "fleet of motorcycles."

We calculated the centralized moving average of the three-year period standardized mortality rate in men. Then, a linear regression model was constructed with the moving average of the standardized mortality rate as the dependent variable and "year" as the independent variable. To avoid colinearity, the variable "year" was centered from 2001 (midpoint of the series).

To calculate the annual increase in the standardized mortality rate, we used the joinpoint method (inflection point). This allows the adjustment of a series of data from the fewest possible joinpoints (zero, i.e., a line without points of inflection), and it also tests whether the inclusion of more joinpoints is statistically significant.[10] The significance tests used are based on the permutation method of Monte Carlo and on calculation of the annual percentage change in the standardized mortality rate, which used the logarithm of the rate.

Statistical analysis was performed using Stata (version 9.0), SPSS (version 15.0) and the Joinpoint Regression Program (version 3.4.2). Statistical significance was set at $p < 0.05$.

The study was approved by the Ethics Committee of the School of Medical Sciences of Santa Casa de São Paulo (Report 067/09).

RESULTS

Between 1996 and 2007, there were 7,345 deaths of RTA victims in the FD, with 580 being motorcyclists (7.9%), 392 deaths from accidents without further specification, and 416 deaths from vehicle accidents of unspecified type. The number of deaths of motorcyclists increased from 25 in 1996 to 139 in 2007. The distribution of deaths over the year ranged from 5.5% in February to 11.2% in October. Sunday was the day of the week with the largest proportion of deaths (17.4%), followed by Tuesday (16.9%). In addition, 427 (73.6%) deaths occurred in hospitals (Table 1). The proportion of deaths on public roads increased from 14.7% in 2000-2003 to 29.8% during 2004-2007.

Most victims were male (94.3%), mixed skin color (71.0%), single (68.1%), aged between 20 and 39 years (73.8%), and schooling from 4 to 11 years (54.8%) (Table 2). A large number of deaths occurred in non-resident individuals (201 deaths, 34.7%). Schooling was ignored or unavailable for 17.1% of the victims, although an increase in the completion of formal education has occurred over the years. The skin color of victims in approximately 6% of deaths was not recorded. For the variable "occupation", the proportion of missing data reached 31%, which made this analysis impractical.

The most frequent type of RTA involving motorcyclists was collision with another vehicle (car, truck or van, 39.7%), followed by accidents without collision

[i] Ministério das Cidades. Departamento Nacional de Trânsito – Denatran. Frota de veículos, por tipo e com placa, segundo os Municípios da Federação. Brasília, DF; 2006. [cited 2008 Jul 4]. Available from: http://www.denatran.gov.br/frota_03.htm
[j] Departamento de Trânsito do Distrito Federal. Estatísticas de condutores por categoria. [cited 2010 Nov 10]. Available from: http://www.detran.df.gov.br

Table 1. Distribution of deaths of motorcyclists injured in traffic accidents according to characteristics of death. Brazilian Federal District, 1996-2007.

Variable	1996 to 1999		2000 to 2003		2004 to 2007		Total	
	n	%	n	%	n	%	n	%
Year of death	71	12.2	143	24.7	366	63.1	580	100
Month that death occurred								
January	7	9.9	10	7.0	35	9.6	52	9.0
February	3	4.2	7	4.9	22	6.0	32	5.5
March	9	12.7	21	14.7	12	3.3	42	7.2
April	4	5.6	9	6.3	29	7.9	42	7.2
May	7	9.9	11	7.7	34	9.3	52	9.0
June	5	7.0	12	8.4	28	7.7	45	7.8
July	2	2.8	17	11.9	42	11.5	61	10.5
August	3	4.2	11	7.7	30	8.2	44	7.6
September	8	11.3	9	6.3	32	8.7	49	8.4
October	11	15.5	10	7.0	44	12.0	65	11.2
November	9	12.7	4	2.8	34	9.3	47	8.1
December	3	4.2	22	15.4	24	6.6	49	8.4
Day that death occurred								
Monday	9	12.7	21	14.7	55	15.0	85	14.7
Tuesday	15	21.1	22	15.4	61	16.7	98	16.9
Wednesday	9	12.7	14	9.8	52	14.2	75	12.9
Thursday	7	9.9	19	13.3	47	12.8	73	12.6
Friday	7	9.9	17	11.9	38	10.4	62	10.7
Saturday	9	12.7	25	17.5	52	14.2	86	14.8
Sunday	15	21.1	25	17.5	61	16.7	101	17.4
Place that death occurred								
Hospital	56	78.9	121	84.6	250	68.3	427	73.6
Public street	13	18.3	21	14.7	109	29.8	143	24.7
Home	0	0	0	0	2	0.5	2	0.3
Other	2	2.8	1	0.7	5	1.4	8	1.4

(35.7%). Drivers accounted for 67.8% of deaths, followed by 29.7% in the unidentified condition. There were 22 reported deaths in individuals under the age of 18, of which 14 (63.6%) were drivers (data not shown in Table).

In the majority of the years analyzed, higher specific mortality rates were observed in males in the group aged between 20 and 29 years (Figure 1). This age group also had the largest increase (184.9%) in mortality rate. In 2007, the risk of death from RTA in a male motorcyclist aged 20 to 29 was 15.2 times that of a 19-year-old man, 3.3 times greater than that of a man of 50 years or more, and 1.6 times greater than that of a man 30 to 49 years.

The standardized mortality rate for male motorcyclists injured in RTAs increased from 1.9 deaths per 100,000 men in 1996 to 7.2 deaths per 100,000 men in 2007. The ratio of male deaths per fleet of motorcycles increased from 2 per 10,000 (1998) to 10 per 10,000 (2007) (Figure 2).

From the linear regression model, there was an estimated annual increase of 0.48 deaths/100,000 men in the standardized mortality rate (CI 95% 0.31, 0.65; p <0.001). The coefficient of determination of the line obtained was high (R^2 adjusted = 0.83), suggesting that the variable "year" explains an important part of the observed variation in the standardized mortality rate. The variables "year" and "fleet of motorcycles" were strongly correlated (r = 0.99).

The percent increase in the standardized mortality rate for males was 36.2% in the period 1998-2007 (CI 95% 21.2%, 53.2%; p <0.05) (Figure 3).

DISCUSSION

Between 1996 and 2007, there were 7,345 deaths in RTA victims in the FD, of which 580 were motorcyclists (7.9%). In 2007, the deaths of motorcyclists accounted for 22.2% of deaths, and the death ratio

Table 2. Distribution of deaths of motorcyclists injured in traffic accidents according to personal characteristics. Brazilian Federal District, 1996-2007.

Variable	1996 to 1999		2000 to 2003		2004 to 2007		Total	
	n	%	n	%	n	%	n	%
Gender								
Male	65	91.5	135	94.4	347	94.8	547	93.3
Female	6	8.5	8	5.6	19	5.2	33	5.7
Age (years)								
Under 19	9	12.7	15	10.5	29	7.9	53	9.1
20 to 29	39	54.9	75	52.4	173	47.3	287	49.5
30 to 39	16	22.5	34	23.8	91.0	24.9	141	24.3
40 to 49	2	2.8	14	9.8	52.0	14.2	68	11.7
50 or more	5	7.0	5	3.5	20.0	5.5	30	5.2
No information	0	0.0	0	0.0	1	0.3	1	0.2
Skincolor								
White	11	23.9	30	21.0	76	20.8	117	20.2
Black	1	2.2	2	1.4	12	3.3	15	2.6
Yellow	0	0.0	0	0.0	1	0.3	1	0.2
Mixed	25	54.3	111	77.6	276	75.4	412	71.0
No information	9	19.6	0	0.0	1	0.3	35	6.0
Marital status								
Single	44	62.0	97	67.8	254	69.4	395	68.1
Married/consensual union	20	28.2	39	27.3	96	26.2	155	26.7
Separated/widowed	6	8.5	5	3.5	14	3.8	25	4.3
Ignored/no information	1	1.4	2	1.4	2	0.5	5	0.9
Schooling (years)								
None	4	5.6	6	4.2	13	3.6	23	4.0
1 to 3	0	0.0	15	10.5	57	15.6	72	12.4
4 to 7	0	0.0	44	30.8	96	26.2	140	24.1
8 to 11	0	0.0	55	38.5	123	33.6	178	30.7
12 or more	2	2.8	10	7.0	56	15.3	68	11.7
Ignored/no information	65	91.5	13	9.1	21	5.7	99	17.1
Place of residence								
Federal District	47	66.2	84	58.7	248	67.8	379	65.3
Outside of Federal District	24	33.8	59	41.3	118	32.2	201	34.7

(males) per fleet was 10.0 deaths per 10,000 motorcycles, almost five times the number of fatal crashes involving cars (2.2 deaths for every 10,000 cars). About 95% of motorcyclists who died as a result of RTAs were male, similarly to results in other national studies, in which the proportion of men was higher than 80%.[1,5,18] The largest proportion of deaths among men aged 20 to 29 years is consistent with other studies on mortality by RTAs using secondary data[22] and studies conducted in emergency services.[4,6,14,15]

Over 65% of motorcyclists who died as a result of RTAs were single, as noted by other authors.[17,25] Veronese et al[25] raised the hypothesis that, in some cases, the prevalence of mortality among singles is due to a lack of commitment to a family, which would make

motorcyclists take greater risks in traffic, by causing or suffering accidents.

Nearly half of motorcyclists injured between 2004 and 2007 had eight or more years of schooling, following the pattern of two studies conducted in São Paulo, Southeastern Brazil, where 35.0[4] and 53.9%[9] of motorcyclists treated in the emergency services had completed high school.[4,9] Similarly to other national and international studies, motorcyclists had a higher death rate than passengers.[1,8,14,21]

Among the 580 deaths, 22 (3.8%) were individuals under 18 years of age. Of those under age 18, 63.6% were drivers, although they had no driver's license. Studies suggest that the proportion of motorcycle riders under the age of 18 years may be greater than
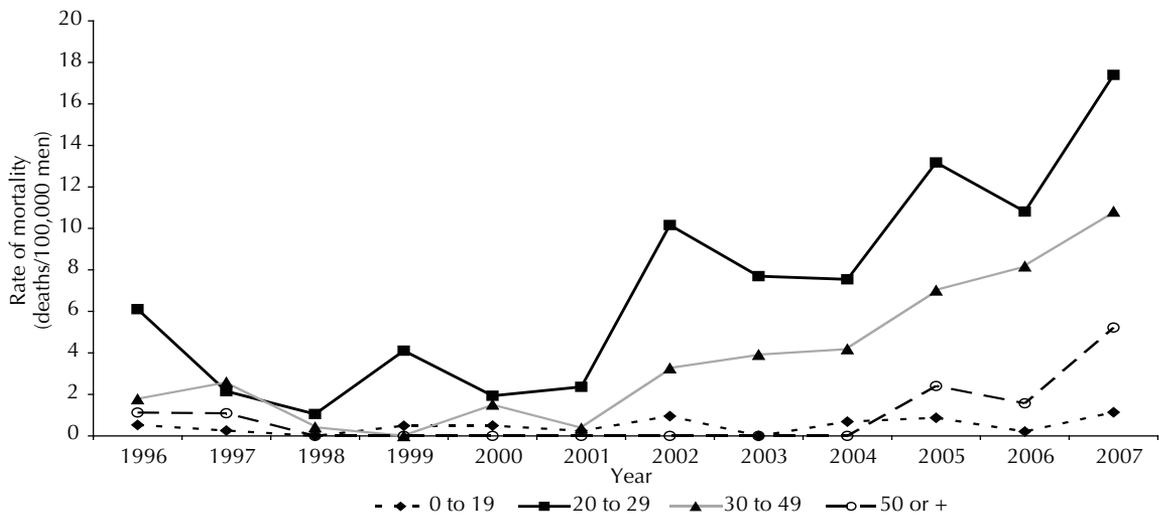
Figure 1. Specific rate of mortality of male motorcyclists from the Federal District injured in transport accidents by age group from 1996 to 2007.
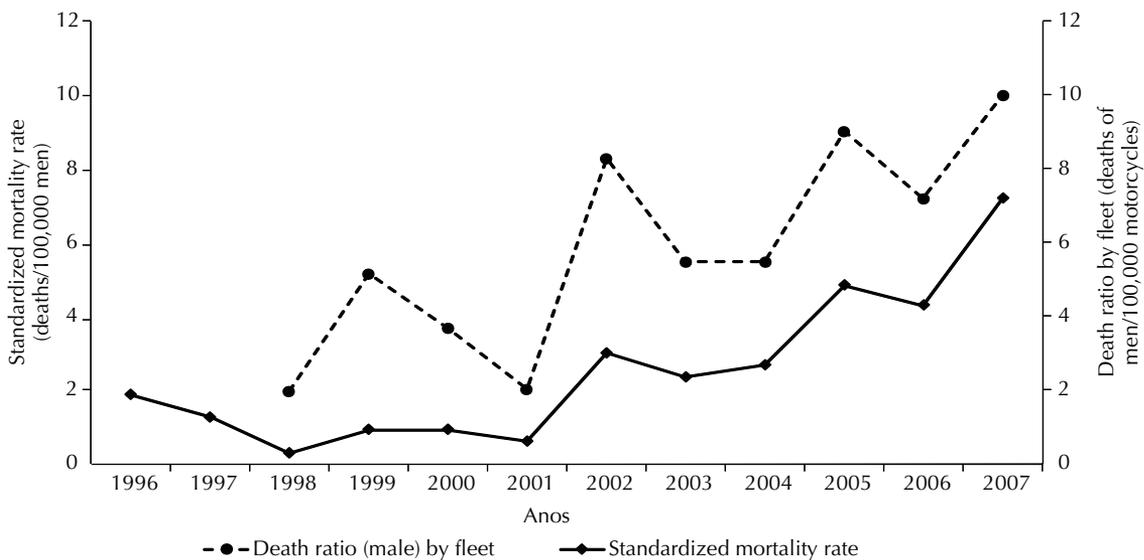

Figure 2. Standardized mortality rate of male rider residents of the Federal District traumatized in motor vehicle accidents and death ratios due to motorcycle fleets from 1996 to 2007.

30%,[1] and some authors associate driving such vehicles before the allowed age with the issue of transgression during adolescence.[16] The mortality of a teen driver is a complex phenomenon, which could partially be explained by the inherent characteristics of this group, such as immaturity, feelings of omnipotence, a tendency to overestimate their skills, little experience, limited ability to drive, and risky behaviors.[13]

The predominant deaths of motorcyclists of mixed skin color (75.6%) contrasts with the distribution of the local population by skin color. According to the 2000 Census, only 44.8% of men reported to be mixed.[k] In Brazil, the mortality rates of white and brown male motorcyclists were, respectively, 4.3 and 4.0 deaths/100,000 inhabitants in 2003. The comparison of mortality rates of white and brown males based on schooling showed highest risk of death for motorcyclists with four or more years of schooling for both categories of skin color.[1]

[k] DATASUS. Informações de Saúde: População residente – Distrito Federal. [cited 2010 Feb 21]. Available from:
http://tabnet.datasus.gov.br/cgi/deftohtm.exe?ibge/cnv/popdf.def
[1] Ministério da Saúde. Secretaria de Vigilância em Saúde. Mortalidade por acidentes de transporte terrestre. In: Saúde Brasil 2005: uma análise de situação de saúde no Brasil. Brasília, DF; 2005. p. 451-534. (Série C. Projetos, Programas e Relatórios).
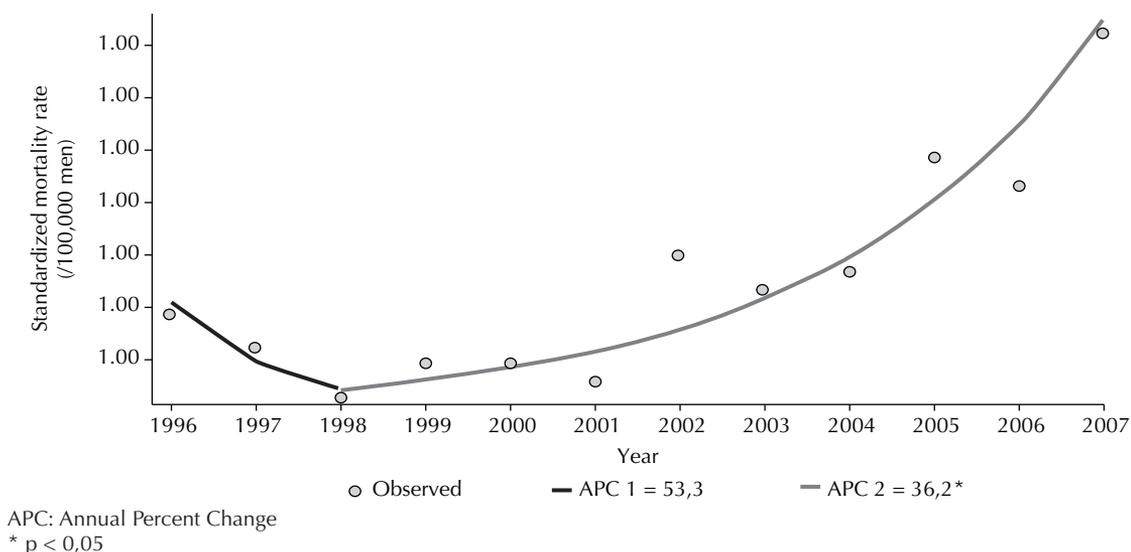
APC: Annual Percent Change
* p < 0,05

Figure 3. Annual percentage increase of the standardized mortality rate for male motorcyclists injured in transportation accidents. Brazilian Federal District, 1996-2007.

Over 70% of deaths in motorcyclists in the FD occurred in hospitals. In contrast to this finding, a study conducted in India showed that 42.8% of the deaths occurred before the victim arrived at the hospital.[8] Despite the severity of the injuries generally suffered by motorcyclists,[11] it is possible that the availability of emergency and pre-hospital services in the FD explains the lower proportion of deaths on public roads. DATASUS data indicate that the average duration of hospitalization of motorcyclist RTA victims was 10.7 days between 1998 and 2007, and 24.1% of the hospitalized victims died before completing 12 hours of hospitalization.

The finding of a higher proportion of deaths on Sundays is difficult to explain because the majority of motorcyclists died in hospitals. It is impossible to determine whether this finding reflects the higher concentration of accidents that day or if accidents that occurred on other days of the week caused the hospitalization of the victims who later died. Studies analyzing RTA victims treated at emergency services in Teresina (PI, Northern Brazil) and Maringá (PR, Southern) in 2006 and 1999, respectively, showed that the highest number of RTAs involving motorcycles occurred on Fridays and Saturdays.[8,14] Other studies in Maringá (PR)[m] and Londrina (PR, Southern Brazil) in 2004 and 2005, , showed Sunday as the day of the week with the highest number of RTAs involving motorcyclists.[19,20] The lowest proportion of deaths was observed in February (5.5%). An association between the number of deaths of motorcyclists and times of the year has not been observed in the literature.

Because the data described in this study refer to the date and place of death (and not the accident), it was impossible to explore the distribution of accidents over the periods of the day. Liberatti et al[13] found a higher concentration (39.6%) of fatal crashes at night (6:00 to 11:59 pm). It is possible that the higher incidence of fatal accidents at night is a consequence of reduced visibility, fatigue at the end of the day, and higher consumption of alcoholic beverages. Some authors suggest that among professional drivers, the excessively long workday – up to 15 hours without interruption – may be one of the factors associated with the higher incidence of accidents in the night period.[19]

Collisions of motorcycles with cars or trucks were responsible for a significant proportion of deaths (35.9%) in this study. This type of accident can be a consequence of the difficulty of other drivers in seeing the approaching motorcycle and avoiding the collision and the unpredictable movement of motorcyclists between the rows of cars in motion,[1,3,23,24] among other factors.

The highest mortality rate in this study was registered for men aged 20 to 29 years (17.4 deaths/100,000 in 2007). Andrade & Mello-Jorge,[1] in a study conducted in Londrina in 1996, found specific mortality rates for young riders higher than those observed in the DF (37.0 deaths per 100,000 inhabitants).

The risk of death of motorcyclists injured in RTAs greatly increased in the FD (36.2% per year), which may be linked to several factors. The increased number of motorcycles, and therefore, motorcyclists, result in a higher number of individuals susceptible to accidents and the increase in the absolute number of deaths from this cause.

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[m] Oliveira NLB. Fatores associados ao risco de lesões e óbito de motociclistas envolvidos em ocorrências de trânsito [tese de doutorado]. São Paulo: Escola de Enfermagem da Universidade de São Paulo; 2008.

Regarding public policies on transportation, the federal government granted tax concessions and other benefits for the purchase of motorcycles in the 1990s. This was done under the guise of the creation of jobs and allowing low-income youth to have access to a means of motorized transport, thereby raising the number of motorcycles in circulation in the country. However, the structure of the traffic routes was not adequately prepared, and there were no effective inspection actions.[23] The poor conditions of roads, signaling, average velocity of flow, drainage, and lighting also increase the risk of accidents involving motorcyclists.

The precarious work conditions for professional motorcyclists are another determinant for the increased risk of accidents. In general, these motorcyclists perform services for which they are paid according to their productivity, which would exacerbate the quest for speed at the expense of respect for traffic laws and the practice of defensive driving.[1,3,19,23,24] Interestingly, the same society that uses (and appreciates) the services of professional motorcyclists, requiring them to be as quick as possible, consider them to be dangerous individuals in traffic.

Studies that correlate death certificates with police reports would allow a better understanding of traffic accidents involving motorcyclists and the conditions that lead to these deaths. Thus, it would be possible to establish the relevance of factors such as maintenance of motorcycles, use of helmets and other safety equipment, the behavior of motorcyclists in traffic, and the severity of injuries experienced by motorcyclists in accidents.

The interpretation of results must include consideration of limiting factors related to the quality of data on mortality, especially concerning flaws in the completeness and validity of the records. For example, in 2007, among the 626 deaths due to accidents in the FD, 3.5% were caused by RTAs without specification of the vehicle or victim. Additionally, no information was available regarding the condition of the driver or passenger at the time of the accident in 29.7% of motorcyclists killed in RTAs. Moreover, in the period from 1996 to 2007 in the FD, there were 416 deaths classified as being caused by accidents "with a motor or non-motorized vehicle, type of vehicle unspecified" (V89) and 392 as a result of "accident without any specification" (X59). While the number of deaths coded as "unspecified vehicle accident" was reduced from 231 in the years from 1996 to 1999 to 50 between 2004 and 2007 and the number of deaths by "accident not otherwise specified" was reduced from 178 to 105, the deaths of injured motorcyclists increased from 71 to 366. Thus, it is possible that a proportion of deaths of motorcyclists injured in accidents has not been accounted for, especially at the expense of errors in classifying the type of accident, as is described in the literature.[2] Improving the quality of information on the cause of death is one possible explanation for the small number of deaths of motorcyclists in the early years of the series and for its great growth in subsequent years. Moreover, in general, the DIS in the FD has been enhanced significantly and has high coverage rates (90%) and low proportions of ill-defined deaths. The proportion of ill-defined deaths (Chapter XVIII of CID 10), which already had low values in 2000 (4.7%), declined even more, reaching 2.4% of total deaths in 2007. Another limitation of this study was the impossibility of knowing whether the victim was or was not working when the accident occurred, which does not allow more detailed investigations of the deaths of professional motorcyclists.

In conclusion, this study highlights the increased mortality of motorcyclists by RTAs in the DF, especially among young men. However, the deaths represent only a small portion of the total number of motorcyclist victims of RTAs. Thus, further studies are needed to provide more detailed evidence about the risk of accidents and deaths in motorcyclists. These are issues of great relevance to public health.

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