

MOTORCYCLIST MORTALITY IN TRAFFIC ACCIDENTS: TEMPORAL TREND BETWEEN 1997 AND 2012

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ABSTRACT

The objective of this study was to describe the sociodemographic characteristics of motorcyclists killed in traffic accidents and analyze time trends in mortality from 1997 to 2012. It is an epidemiological study of the mortality of 320 motorcyclists living in Maringá, Paraná. Data were extracted from the Mortality Information System of the Department of Informatics of the Brazilian Health System (Datasus). Trend analysis was performed from the adjustment of a Poisson regression model for time series. The majority of victims (85.00%) were males, aged 20 and 39 years (62.19%), white (78.75%), with 8 to 11 years of schooling (38.75%) and single (62.82%). Deaths occurred more frequently in hospitals (53.13%) and only 16.87% of the individuals were working the time of the accident. There was a predominance of collisions with car/pickup truck (38.75%). There was a progressive increase in deaths of 8.2% per year (95% CI: 7% - 9%). From the estimated trend model, the average number of deaths increased from 8.42, in 1997, to 34.5, in 2012. These events represent a serious public health problem that has been increasing worldwide in significant proportions.

Keywords: Epidemiology. Time series studies. External causes. Traffic accidents. Mortality.

INTRODUCTION

Traffic accidents are responsible for large economic and social consequences, contributing significantly to extremely high mortality, and also generating temporary and permanent disabilities, affecting, without distinction, individuals around the world^(1,2).

In recent decades, there has been an increase in the number of victims involved in traffic accidents with motorcycles. Motorcyclists are extremely exposed and stand out in statistics with serious injuries and fatalities^(3,4).

The development of the motor vehicle industry has prioritized the safety of its occupants in addition to the comfort and power of the vehicles. However, while efforts have been made to provide safety to all road users, motorcyclists continue to be one of the most vulnerable groups^(4,5).

Knowledge of the reality of traffic accidents with motorcycle and consequent morbidity and mortality can contribute not only to the development of measures and programs to prevent injuries and deaths, but also to implement, establish and develop assistance programs.

In view of the above, and considering the

importance of traffic accidents involving motorcyclists due to their incidence as well as their severity and consequences, this study aimed to describe the sociodemographic characteristics of motorcyclists killed in traffic accidents and to analyze the temporal trend of mortality in the period from 1997 to 2012.

METHODOLOGY

This is an epidemiological, descriptive and retrospective study, with a longitudinal approach⁽⁶⁾, on traffic fatalities of motorcyclists in the municipality of Maringá, Paraná, from 1997 to 2012. During that period, there were 320 deaths of motorcyclists living in the city of Maringá. Data on these deaths were extracted from the Mortality Information System, available on the website of the Department of Informatics of the National Health System of the Ministry of Health (Datasus), which uses information on death certificates and demographic censuses of the Brazilian Institute of Geography and Statistics (IBGE). Traffic accidents involving motorcyclists were analyzed according to the codes of the 10th review of the International Statistical Classification of Diseases and Health-Related Problems⁽⁷⁾ and grouped from V20 to V29.

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Mortality data tabulations were performed on TabNet® and stored in an Excel® spreadsheet. For the analysis of this study, the following variables were used: age group (0 to 14, 15 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59 and individuals aged >60 years); sex (male and female); race/color (white, black/brown, yellow); schooling (none, 1-3, 4-7, 8-11 and 12 years and over); marital status (single, married and others); place of death (hospital, public highway and others); work accident (yes and no); type of accident (collision with pedestrian/animal, collision with pedal vehicle, collision with two or three-wheel motor vehicle, collision with car/truck, collision with heavy transport vehicle/bus, collision with non-motor vehicle, fixed and stopped object, accident without collision, other accidents and unspecified).

In order to model the annual death count, the Poisson distribution adapts to the main characteristic of the counting data, non-negative integer values. Thus, the annual trend analysis of motorcyclist mortality was performed by adjusting a Poisson regression model for time series⁽⁸⁾ of annual mortality $y_i \sim P(\mu_i)$ using the canonical linkage function, which, in the case of the Poisson distribution, is the logarithmic function. Therefore, this model can be written as $\eta_i = \beta_0 + \beta_1 t_i$, in which β_0 is the intercept, β_1 is the trend parameter to be estimated and the t_i is the i -th year of study. From the estimated trend coefficient and its respective standard error, it was possible to verify the existence of a statistically significant increasing or decreasing tendency. After adjusting the model, the residue independence assumption was verified from correlograms and by the Run's Test⁽⁸⁾. Normality and constant variance were also verified. The presence of trend could also be verified by the Cox-Stuart test⁽⁹⁾.

In the analysis and interpretation of the results the statistical program "R 3.1.1"[®] was used, establishing the level of significance of 5%. The results were analyzed in simple and absolute frequencies and presented in the form of tables and figures.

Considering that this study used data from the public domain, available in the Datasus of the Ministry of Health, this research was exempted from the analysis of ethical submission by the Standing Committee on Ethics in Research Involving Human Beings of the State University of Maringá through Letter No. 05/2014.

RESULTS

Table 1 shows the prevalence of male mortality (85.00%). The highest proportion of males allowed establishing a male/female ratio of 5.6: 1.

Table 1. Distribution of deaths of motorcyclists involved in traffic accidents according to sociodemographic variables. Maringá, PR, 1997 to 2012.

Variable	Category	n	%
Sex	Male	272	85.00
	Female	48	15.00
Age group	0 – 14 years	3	0.93
	15 – 19 years	54	16.88
	20 – 29 years	136	42.50
	30 – 39 years	63	19.69
	40 – 49 years	41	12.82
	50 – 59 years	16	5.00
	> 60 years s	7	2.18
Color/Race	White	252	78.75
	Black/Brown	56	17.50
	Yellow	2	0.62
	Ignored	10	3.13
Schooling	None	2	0.62
	1 - 3 years	40	12.50
	4 - 7 years	89	27.81
	8 - 11 years	124	38.75
	>12 years	47	14.69
	Ignored	18	5.63
Marital status	Single	201	62.82
	Married	89	27.82
	Others	22	6.86
	Ignored	8	2.50

Source: Ministry of Health / Secretariat of Health Surveillance / General Coordination of Information and Epidemiological Analyses - Mortality Information System.

Regarding the age group, the majority (62.19%) were young adults, aged between 20 and 39 years and the age group of individuals aged 15 to 19 years was the second most present in the analyzed group (16.88%). The lowest frequencies were observed in the extreme age groups, up to 14 years and 60 years or more. The minimum age of the victims was one year and the maximum was 69 years (mean of 30 years, SD = 11.60, median of 25 years and mode of 21 years).

Regarding race/color, the frequency of deaths was higher in white individuals (78.75%), followed by individuals of the black/brown races (17.50%). The educational variable showed that the majority of the population had eight to 11 years of study (38.75%). Among the victims, 62.82% were single; and 27.82% married.

The analysis of the characteristics of the accidents (Table 2) revealed that the most frequent places of death were hospitals (53.13%) and the public highway (41.56%). With regard to information on work-related accidents, only 16.87% of the individuals who died developed work-related activities at the time of the accident.

Table 2. Distribution of deaths of motorcyclists involved in traffic accidents according to accident characteristics. Maringá, PR, 1997 to 2012.

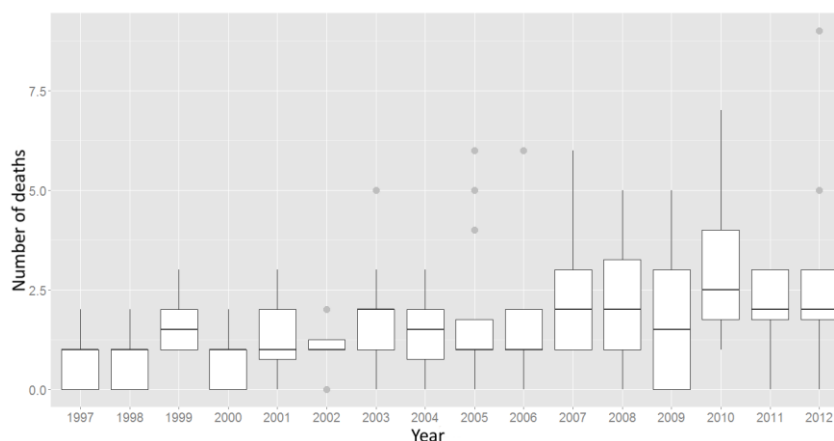
Variable	Category	n	%
Place of death	Hospital	170	53.13
	Public highway	133	41.56
	Others	4	1.25
	Ignored	13	4.06
Work accident	Yes	54	16.87
	No	203	63.44
	Ignored	63	19.69
ICD-10. V20 to V29 Motorcycle rider injured in a car accident - collisions	- With car/pickup truck	124	38.75
	- With fixed and stopped object	61	19.07
	- With heavy transport vehicle/bus	56	17.50
	- Accident without collision	39	12.18
	- With two or three-wheel motor vehicles	17	5.31
	- With pedestrian/animal	2	0.62
	- With pedal vehicle	1	0.32
	- With non-motorized vehicle	1	0.32
	Other and unspecified accidentes	19	5.93

Source: Ministry of Health / Secretariat of Health Surveillance / General Coordination of Information and Epidemiological Analyses - Mortality Information System.

Regarding the types of accidents involving motorcyclists, collisions with car/pickup truck (38.75%) and collision with fixed object (19.07%) were the most frequent. Collisions with heavy transport vehicles/buses (17.50%) also stood out. Accidents without collision accounted for 12.18% of cases.

In order to assess the distribution of the monthly

occurrence of motorcycle fatalities over the years, Figure 1 presents the Box-Plot of this variable, in which a progressive increase is observed each year. There is the presence of outliers, that is, months in which the number of cases was much higher. The highest number of deaths was recorded in December 2012⁽⁹⁾. The mean monthly death rate was 2.06, SD = 1.39.

**Figure 1.** Distribution of the monthly occurrence of deaths of motorcyclists involved in traffic accidents according to year of occurrence. Maringá, PR, 1997 to 2012.

A model was set to estimate the trend for the data on the number of motorcyclists killed per year, as shown in Figure 2. In gray, the confidence interval for the estimated trend is presented, and the central line in black shows the Poisson model adjusting to the trend. The average number of deaths, which was 8.42 in 1997, increased to 34.5

in 2012, that is, increased four-fold in 16 years. If the growth pace continues the same in 21 years, the mortality of motorcyclists will be six times higher. It is worth noting that, in some years, significant and above expectations changes have been observed, with peak deaths in 2007 (8.75%), 2008 (8.44%), 2010 (11.25%) and 2012 (10, 32%).

The Shapiro-Wilk test (10) (p-value= 0.71) did not rejected the hypothesis that the residues follow normal distribution and the Durbin-Watson test⁽¹¹⁾ (p-value= 0.99) verified the absence of autocorrelation in the residues.

Thus, in addition to the adjusted model, the statistically significant positive trend was also confirmed by the Cox-Stuart test⁽⁹⁾ (p-value <0.0001).

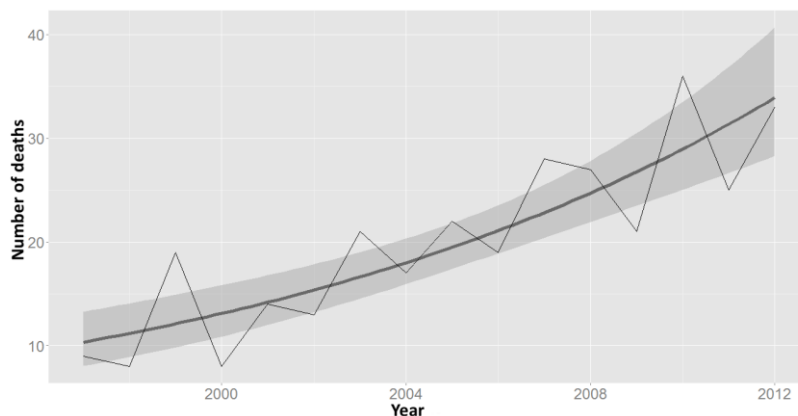


Figure 2. Observed time series of the annual number of dead motorcyclists and Poisson model adjusting the trend. Maringá, PR, 1997 to 2012.

DISCUSSION

Economic difficulties and high unemployment rates observed in our country have boosted the acquisition of motorcycles for the development of formal and informal work activities. In addition, the loss of workers' purchasing power also drove the acquisition of this type of lower-cost vehicle. And because of its agility, reduced maintenance cost and transiting and parking facilities in slow traffic, it has become a working tool⁽¹²⁾.

Motorcyclist mortality is an important public health problem, not only in terms of form and breadth, but also because of the vulnerability of its occupants^(4,5). It should be understood as the expression of the social value of death, because when it occurs, it does not only affect the individual, the family and the group in which one lives, but it also affects society as a whole, which is deprived of one's economic, social and intellectual potential⁽¹⁾.

Motorcycle use as a means of transport has increased rapidly in recent years, in the same way as motorcycle accidents, making it an important cause of physical disability and death, especially among young males⁽¹²⁾.

The data from this study confirmed, once again, the absolute prevalence of male deaths in motorcycle accidents. These results are similar to those of a study carried out in the city of Maringá, with motorcyclists, which identified that 89.65% of the fatal victims were male, in a ratio of 4.2 men for

each woman⁽¹²⁾.

In the present study, more than half of the motorcyclists (62.19%) were young individuals, aged between 20 and 39 years. The mean age was approximately 28 years. These results confirm the relationship between young individuals and the serious consequences of traffic events⁽⁵⁾.

Researchers point out the use of alcohol and drugs, excessive speed, risk behaviors, disobedience to traffic laws, lack of ability and capacity to perceive danger and solve problems, overconfidence and the false impression that motorcycle is synonymous with freedom, excitement, adventure and challenges as features inherent in young motorcyclists^(5,13).

In motorcycle accidents, the triad must be interrelated: host (man), agent (vehicle) and environment (way). Thus, other factors that contribute to the increase of accidents and traffic mortality statistics are the increase of the circulating fleet caused by economic development; poor road system; traffic disorganization; general deficiency of supervision; vehicle conditions; precarious conditions of roads and highways; migration of the rural population to urban areas; lack of investments in traffic safety and engineering⁽¹⁴⁾.

The present study revealed that the highest proportion of individuals who died were white (78.75%), with schooling between eight and 11 years (38.75%) and single (62.82%). The variable race/color is directly related to the characteristics of the population, differing between the different

regions of the country. In the state of Paraná, according to the demographic census of the year 2010, white individuals represented 70.05% of the population⁽¹⁵⁾; in the city of Maringá, 64.19%⁽¹⁵⁾.

As for marital status, single individuals are presumed to be more likely to suffer serious or fatal accidents, probably by adopting higher-risk behaviors, including the use of alcoholic beverages and drugs and the non-use of safety equipment⁽¹⁶⁾.

Among the 320 motorcyclists who died as a result of traffic accidents, more than half of them died at the hospital and 41.56% on public roads. A survey conducted in the city of Maringá showed that the majority of motorcyclists (68.96%) died in the first 24 hours after the occurrence⁽¹²⁾.

On the work accident information, the records indicated that 63.44% of the motorcyclists were not developing work activities at the time of the occurrence. However, in general, many motorcyclists work in informality, transporting goods, products and passengers. Workers without a formal employment relationship are subject to long hours, negative effects on the labor process, damage to physical and emotional health, conflicting situations between work and personal life and high risk of fatal accidents⁽¹⁷⁾. On the other hand, another study showed that the market for fast deliveries, passenger transport, the possibility for young people to obtain income without qualification, pressure for occasional services, high demand of tasks and precarious working relationships contribute to the involvement of workers without employment relationship in traffic accidents⁽³⁾.

In the present study, the results showed a higher proportion of victims in collisions with cars/pickup trucks, with heavy transport vehicles/buses and with fixed and stopped objects. Regarding the type of accident, data from a study⁽¹⁸⁾ conducted in the city of Maringá showed that motorcycle collision with a car/pickup truck was also the most frequent (55.45%), followed by falls (17.99%). In this same study, the type of accident was associated with the mortality of motorcyclists⁽¹⁸⁾.

Through the distribution of the monthly number of deaths, this study identified a progressive increase in deaths each year. Traffic incidents involving motorcyclists increased proportionately as the fleet of these vehicles increased. This increase in the fleet and the increase in the indexes of these occurrences can be attributed to its increasingly frequent use in formal and informal economic market, to the long

hours of work of its users, which can lead to periods of fatigue, tiredness, reduction of reflexes and ability to concentrate, and to encouragement to high productivity of motorcyclists⁽¹⁸⁾.

Mortality, as a consequence of motorcycle traffic accidents, has increased worldwide, especially in low- and middle-income countries, in significant proportions, evidencing the serious public health problem and the increase in mortality due to these occurrences⁽¹⁹⁾.

Data from a descriptive study of time series on motorcyclist mortality rates carried out in Brazil between 1996 and 2009 showed an increase in deaths of 800%⁽²⁰⁾. Mortality rates due to traffic accidents also showed a pattern of evolution between 1987 and 2011 in Spain, similar to that of other countries, including Finland, France, Australia, Greece and Portugal⁽¹⁾.

Motorcyclists are constantly prone and subject to injuries that can lead to death or even temporarily or permanently limiting the development of their daily activities. For this group, despite all the advances obtained through modern vehicle designs and safety equipment, the inequality in the protection conditions, or their greater exposure on the highways in relation to the users of other vehicles, is a determining factor for their greater morbidity and mortality^(3,4).

CONCLUSION

In general, the results showed the predominance of mortality among male, young adults, white and single motorcyclists. More than half of the victims died in hospitals and the most frequent type of accident was a car/pickup truck collision. There was a progressive increase in deaths each year, and the mean number of deaths increased significantly during the analyzed period. In some years, important variations were observed, with peaks of deaths higher than predicted.

Some limitations of this study are the source of information used, which does not include variables important for determining mortality, such as alcohol and drug use, the nature of the injury, the time and day of the occurrence, the use of the helmet and other safety equipment, the condition and the length of time the victim has their license, meteorological conditions, as well as severity indicators, such as the Glasgow Coma Scale and Revised Trauma Score during pre- and in-hospital care.

Therefore, the results found do not exhaust the numerous possibilities of analysis of the problem in other sources of information. The mortality of motorcyclists in traffic shows in several aspects the multiple dimensions that involve this event and

reinforce the urgency of articulated actions between government and all segments of society, essential for the planning of interventions in individual and collective health.

MORTALIDADE DE MOTOCICLISTAS EM ACIDENTES DE TRÂNSITO: TENDÊNCIA TEMPORAL ENTRE 1997 E 2012

RESUMO

O objetivo deste estudo foi o de descrever as características sociodemográficas dos motociclistas mortos em acidentes de trânsito e analisar a tendência temporal da mortalidade no período de 1997 a 2012. Estudo epidemiológico da mortalidade de 320 motociclistas, residentes em Maringá, Paraná. Os dados foram extraídos do Sistema de Informação sobre Mortalidade do Departamento de Informática do Sistema Único de Saúde (Datasus). A análise de tendência foi realizada a partir do ajuste de um modelo de regressão de Poisson para séries temporais. A maioria das vítimas (85,00%) era do sexo masculino, na faixa etária entre 20 e 39 anos (62,19%), branca (78,75%), com escolaridade entre oito e 11 anos de estudo (38,75%) e solteira (62,82%). Os óbitos ocorreram com maior frequência nos hospitais (53,13%) e no momento do acidente, e apenas 16,87% dos indivíduos estavam trabalhando. Houve predomínio das colisões com automóvel/caminhonete (38,75%). Observou-se aumento progressivo de mortes de 8,2% ao ano (IC 95%: 7% - 9%). A partir do modelo estimado de tendência, a média de óbitos aumentou de 8,42, em 1997, para 34,5, em 2012. Conclui-se que esses eventos representam um grave problema de saúde pública, aumentando em todo o mundo, em proporções significativas.

Palavras-chave: Epidemiologia. Estudos de séries temporais. Causas externas. Acidentes de trânsito. Mortalidade.

MORTALIDAD DE MOTOCICLISTAS EN ACCIDENTES DE TRÁNSITO: TENDENCIA TEMPORAL ENTRE 1997 E 2012

RESUMEN

El objetivo de este estudio fue describir las características sociodemográficas de los motociclistas muertos en accidentes de tráfico y analizar la tendencia temporal de la mortalidad en el período de 1997 a 2012. Estudio epidemiológico de la mortalidad de 320 motociclistas, residentes en Maringá, Paraná, Brasil. Los datos fueron extraídos del Sistema de Información sobre Mortalidad del Departamento de Informática del Sistema Único de Salud (Datasus). El análisis de tendencia fue realizado a partir del ajuste de un modelo de regresión de Poisson para series temporales. La mayoría de las víctimas (85,00%) era del sexo masculino, en la franja etaria entre 20 y 39 años (62,19%), blanca (78,75%), con escolaridad entre ocho y 11 años de estudio (38,75%) y soltera (62,82%). Los óbitos ocurrieron con mayor frecuencia en los hospitales (53,13%) y en el momento del accidente, y solo 16,87% de los individuos estaban trabajando. Hubo predominio de las choques con automóvil/camioneta (38,75%). Se observó aumento progresivo de muertes de 8,2% al año (IC 95%: 7% - 9%). A partir del modelo estimado de tendencia, el promedio de óbitos aumentó de 8,42, en 1997, para 34,5 en 2012. Se concluye que estos eventos representan un grave problema de salud pública, aumentando en todo el mundo, en proporciones significativas.

Palabras clave: Epidemiología. Estudios de series temporales. Causas externas. Accidentes de tránsito. Mortalidad.

REFERENCES

1. Melchor I, Nolasco A, Moncho J, Quesada JA, Pereyra-Zamora P, García-Senchermés C, et al. Trends in mortality due to motor vehicle traffic accident injuries between 1987 and 2011 in a Spanish region (Comunitat Valenciana). *Accid Anal Prev*. 2015 Apr; 77: 21-8.
2. Moreno NT da S, Dalmas JC, Martins EAP. Run over: epidemiological analysis of the last four years. *Cienc Cuid Saúde*. 2016 out/dez; 15(4):693-700.
3. Rocha G da S, Schor N. Motorcycle accidents in the municipality of Rio Branco in the State of Acre: characterization and trends. *Cienc Saúde Coletiva*. 2013 jan/mar; 18(3):721-31.
4. Erhardt T, Ricea T, Troszaka L, Zhub M. Motorcycle helmet type and the risk of head injury and neck injury during motorcycle collisions in California. *Accid Anal Prev*. 2016 jan; 86: 23-8.
5. Sant'Anna FL, Andrade SM de, Sant'Anna FHM, Liberatti CLB. Motorcycle accidents: comparison between the years 1998 and 2010 in Londrina, Southern Brazil. *Rev Saúde Pública*. 2013 jun; 47(3): 607-15.
6. Rouquayrol MZ, Gurgel M. *Epidemiologia & Saúde*. 7ª ed. São Paulo: Medbook; 2013.
7. Organização Mundial da Saúde, Organização Panamericana da Saúde. *Classificação estatística internacional de doenças e problemas relacionados à saúde*. 8ª ed. São Paulo: Edusp; 2000.
8. Kadem B, Fokianos K. *Regression Models for Time Series Analysis*. New York: Wiley; 2002.
9. Conover WJ. *Practical nonparametric statistics*. 3rd ed. New York: Wiley; 1999.
10. Shapiro SS, Wilk MB. An analysis of variance test for normality (complete samples). *Biometrika*. 1965 Dec; 52(3-4): 591-611.
11. Durbin J, Watson GS. Testing for serial correlation in least squares regression III. *Biometrika*. 1971 Apr; 58(1):1-19.

12. Oliveira NLB de, Sousa RMC de. Factors associated with the death of motorcyclists in traffic accidents. *Rev Esc Enferm USP*. 2012 Dec; 46(6):1379-86.
13. Moller M, Haustein S. Factors contributing to young moped rider accidents in Denmark. *Accid Anal Prev*. 2016 Feb; 87:1-7.
14. Almeida RLF de, Bezerra Filho JG, Braga JU, Magalhães FB, Macedo MCM, Silva KA. Man, road and vehicle: risk factors associated with the severity of traffic accidents. *Rev Saúde Pública*. 2013 Aug; 47(4):718-31.
15. Instituto Paranaense de Desenvolvimento Econômico e Social. *Caderno Estatístico do Estado do Paraná*. Curitiba: Iparde; 2017.
16. Gómez-Restrepo C, Gómez-García MJ, Naranjo S, Rondón MA, Acosta-Hernández AL. Alcohol consumption as an incremental factor in health care costs for traffic accident victims: evidence in a medium sized Colombian city. *Accid Anal Prev*. 2014 Dec; 73: 269-73.
17. Bohle P, Quinlan M, Kennedy D, Williamson A. Working hours, work-life conflict and health in precarious and "permanent" employment. *Rev Saúde Pública*. 2004 dez; 38(supl): 19-25.
18. Oliveira NLB de, Sousa RMC de. Risk for injuries among motorcyclists involved in traffic incidents. *Rev Esc Enferm USP*. 2012 out; 46(5):1133-40.
19. Cavalcanti AL, Lucena BM, Rodrigues IS, Silva AL, Lima TT, Xavier AF. Motorcycle accidents: morbidity and associated factors in a city of northeast of Brazil. *Tanzan. J Health Res*. 2013 oct; 15(4):209-15.
20. Martins ET, Boing AF, Peres MA. Motorcycle accident mortality time trends in Brazil, 1996-2009. *Rev Saúde Pública*. 2013 out; 47(5):931-41.

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