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Years of Potential Life lost Due to Motorcycle Accidents

ORIGINAL

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Abstract

Introduction: Traffic accidents represent a serious public health problem, because they kill approximately 1.24 million persons annually, and leave another 20 to 50 million with non-fatal lesions and traumatisms worldwide. In Brazil, in the year 2011, motorcyclists alone were responsible for one third of these deaths. Therefore, the aim of this study was to estimate the years of potential life lost due to motorcycle accidents, according to sex and age group, and analyze the trend of the indicator for the state of Pernambuco in the period from 2005 to 2014.

Methods and Results: An ecological study based on data from the System of Information about Mortality was used. The indicator and rate were calculated by using the age limit of 70 years. The linear regression model and Kruskal-Wallis and Mann-Whitney tests were used, at the level of significance of 5% and confidence of 95%. The most affected sex and age-range were men between 20-29 years of age. The rates followed a trend of growth in both sexes, in the young population with the exception of those from 10 to 19 years of age.

Conclusions: This context points out the magnitude and precociousness of motorcycle accidents in both sexes and the young population.

Keywords
Motorcycles; Traffic Accidents; Years of Potential Life Lost.

Introduction

Traffic accidents, one of the components of the group of external causes [1], represent a serious public health problem, because every year, they kill approximately 1.24 million persons and leave another 20 to 50 million with non-fatal lesions and traumatisms worldwide. This scenario has significant impact on individuals, communities and national economies, and higher growth rates of these numbers have been observed in countries with low and medium income [2, 3].

Accidents are normally understood as being fortuitous, unintentional events that produce damage and/or injury. When they cause severe damage or even death, they are converted into fatalities. However, there are some factors that increase the probability of occurrence of these events; such as areas with deficient signaling, problems with maintenance of vehicles or roadways, the population's traffic safety education, police traffic control and enforcement, among others, that would lead to these accidents being more predictable and avoidable. [3] Therefore, the accident must be understood as "an unintentional and avoidable event, causing physical lesions and or emotional lesions in the domestic sphere, or in other social environments, such as work, traffic, school, sports and leisure". [4]

In view of this, the National Traffic Council (CONTRAN) has affirmed that a large portion of the traffic accidents are predictable, and therefore, avoidable; they are included in the list of avoidable causes of death by interventions of the Brazilian national health system (SUS). [5, 6] In Brazil, the avoidable deaths are considered those that may be completely or partially reduced by adequate health promotion actions, linked to adequate health care and sectoral actions, and are dependent on the technology available and accessible to the greater portion of the Brazilian population, or the technology offered by SUS. [6, 3]

Approximately half the traffic deaths occur among motorcyclists, pedestrians and cyclists worldwide, and these are considered vulnerable users. [2] Furthermore, young adults, the majority of them men, are the main victims of these accidents, representing important socioeconomic impact. In addition to men, studies have also pointed out the significant increase in these rates in the female population. [7-9]

A study conducted in the period from 1980 to 2011 showed not only the growth in mortality, but the change in the structure and composition of these accidents in Brazil. [3] After 1996, it pointed out the drastic increase of 932.1% in the deaths among motorcyclists, with this increase being more significant after 2008 when it presented a mean annual growth of 15%. In Brazil, in the year 2011, motorcyclists alone were responsible for one third of these deaths. Thus motorcyclists became the focus and explanatory cause of the growth in road traffic deaths.

Among the regions of the country, the Northeastern region presented the states with the highest proportions of accidents involving motorcyclists among the traffic accidents in 2011. In Pernambuco the death of motorcyclists accounted for 48.6% of the total number of deaths in traffic accidents. [3]

The rapid increase in the number of motorized two-wheeled vehicles has been accompanied by the increase in lesions and deaths among their users. [2] The growing fleet of motorcycles, scooters and mopeds, encouraged mainly by their ease of acquisition and mobility, have elevated the their number in the fleet circulating in the country. This condition may increase the probability of these accidents occurring, generating a socioeconomic impact on society.

The prematurity with which these deaths occur and their more frequent incidence in young adults have a significant effect on the loss of years of potential life in the population affected. This impact may be analyzed by means of the indicator relative to Years of Potential Life Lost (YPLL). [4] The concept of years of potential life lost was proposed with the

main purpose of comparing the importance relative to the different causes of death in a certain population. [10]

In this context, the aim of this study was to estimate the years of potential life lost due to motorcycle accidents, according to sex and age group, and analyze the trend of the indicator for the state of Pernambuco in the period from 2005 to 2014.

Method

This was an ecological study, with the unit of analysis being the state of Pernambuco. [11] The years of potential life lost (YPLL), caused by mortality due to motorcycle accident in Pernambuco were estimated according to sex and age-range, using the database of the System of Information about Mortality (SIM) (for mortality), and the Brazilian Institute of Geography and Statistics ("Instituto Brasileiro de Geografia e Estatística - IBGE"), for population data, both made available in the electronic site of the Department of Informatics of SUS (DATASUS).

The period of study was between 2005 and 2014. However, to construct the rate, the last year of analysis was 2012, because this was the last year for demographic data by IBGE, available for tabulation. Data collection occurred in the month of July 2016.

The mortality data made available by SIM did not differentiate the characteristics established by DENATRAN/CONTRAN between two-wheeled vehicles. Therefore, the following four categories were considered motorcycles: motorcycles, motor scooters, mopeds due to their characteristic of vulnerability. Relative to definitions, motorcycles are considered two-wheeled self-propelled vehicles, with or without sidecar, driven by driver in the mounted position. Motor scooter: two-wheeled self-propelled vehicles, driven by a driver in a seated position. Moped: two- or three-wheeled vehicles, provided with an internal combustion engine, with a cylinder capacity not exceeding fifty cubic centimeters (3.05 cubic inches), and maximum design speed not exceeding 50 kilometers per hour.

In view of the foregoing, for the purposes of this study, all the deaths with codes from V20 to V29 motorcycles were grouped, according to the mortality coding established for International Classification of Disease 10th Revision (ICI-10)

The age-ranges were grouped into periods of every ten years, according to the following age categories: 10 to 19; 20 to 29; 30 to 39; 40 to 49. [13] Analysis by sex was divided into male and female, using the same age-ranges. The data ignored were not computed.

The YPLL expressed the effect of the deaths that occurred prematurely in relation to the duration of life expectancy for a certain population. [14] This indicator fits in well into the category of Social Indicators and may help manager to define priorities for the prevention of premature deaths. The simplicity of calculation and ease of understanding made it easy to use them. [10]

The bases and the method of calculation were those proposed by Romeder and McWhinnie[10]. However, for the purposes of presenting the formula, the proposition of Kerr-Pontes and Rouquayrol (2003) was used. [14] Considering the life expectancy at birth of 73.9 and 71.1 presented for Brazil and Pernambuco, respectively, in 2010 [15], the YPLL were calculated using the age limit of 70 years, by means of the following formula:

YPLL due to motorcycle accidents = $\sum$ ai di,

Where:

i = 1

ai = difference between the mean of the age limit and the midpoint of each age-range, by using the age limit of 70 years.

di = number of deaths that occurred due to motorcycle accident in each age-range.

Bearing in mind the life expectancy at birth having exceeded 70 years in Brazil and in Pernambuco, the number of deaths that occurred at each midpoint of the age-ranges established was mul-

tiplied by the number of years lacking to achieve that age limit. Thus, it was possible to identify the age-ranges in which the prematurity of deaths was outstanding among motorcycle accidents, presenting a higher quantitative YPLL in comparison with the other age-ranges. The same process was performed for the male and female sexes in the same age-ranges.

For the purpose of allowing a comparison between different sizes of population and population pyramids, the rates of YPLL (RYPLL) were calculated, adapted from the method of Romeder and McWhinnie [10] corroborated by Reichenheim and Werneck [16] for the entire period, sex and age-range, following the formula below:

RYPLL due to motorcycle accidents = $\sum$ ai di x 100.000/N

Where:

i = 1

ai = difference between the mean of the age limit and the midpoint of each age-range. By using the age limit of 70 years.

di = number of deaths that occurred due to motorcycle accident in each age-range.

N = number of persons between the ages of 1 and 70 years in the reference population.

The mean YPLL per death was calculated as the result of dividing the total YPLL by the number of deaths considered for each year of the study. This procedure allowed the mean age at which the deaths occurred to be known. [17]

The mortality rate per motorcycle accident was also calculated by means of the formula: Number of deaths divided by the population exposed to risk in the same period, multiplied by 100.000. This was also analyzed according sex and age-range.

The quantitative variables were presented by means of the measure of central tendency (mean). As a way of comparing the means of the indicators with the victim's sex, the Mann-Whitney test was used, considering the indicators did not present normal distribution by the Shapiro-Wilk test ($p < 0.000$). Comparison between the age-ranges was tested by means of the Kruskal-Wallis test. The level of statistical significance of 5% and interval of confidence of 95% were adopted for all the tests applied. The interval of confidence for the rate was calculated assuming the Poisson distribution.

The trend of evolution of the indicators was tested by linear regression considering the trend of positive growth of the coefficient and assuming the value of $p < 0.05$. The evolution of general PYLL was presented by means of the lowess curve, as a way of presenting the evolution in the period of time studied.

The mean YPLL per motorcycle was calculated as the result of dividing the total YPLL by the number of deaths considered for each year of the study and according to sex.

The variables measured were presented by means of tables and graphs For tabulation, treatment and presentation of data and calculation of indicators, the resources of the statistical program Stata 12.0 and Microsoft Excel 2013 were used.

Considering the availability of data in the electronic sites of DATASUS, and that these data are aggregated and in the public domain, it was not necessary to submit the study to the Research Ethics Committee.

Results

The traffic accidents caused by motorcycles in Pernambuco in the period 2005-2014 resulted in the death of 5591 persons, of whom 90.3% were men. With the analysis of risk expressed by the mortality rate, men were also shown to be the largest number of victims. Youngsters were most affected, especially in the age-range between 20 and 29 years, both victims in general and when evaluated by sex. The age-range between 10 and 19 showed no trend towards growth. However, the other age-ranges in both men and women presented growth between the years 2005 and 2012 **(Table 1)**.

Table 1. Distribution of the mortality rate due to motorcycle accidents according to sex, age-range and trend. Pernambuco, Brazil. 2005 to 2012.

Mortality rate due to motorcycles	Mean Rate*	IC95%**		p-value for trend[a]
General	7.8	7.2	8.5	0,040
Male	137.6	133.9	141.3	0.008
Female	15.5	14.3	16.9	<0.001
General per age-range				
11 to 19	4.1	3.4	4.9	0.379
20 to 29	13.6	11.9	15.6	0.211
30 to 39	9.7	8.2	11.3	0.240
40 to 49	6.7	5.5	8.1	0.209
Male per age-range				
11 to 19	62.5	58.6	66.7	0.341
20 to 29	249.6	238.8	260.8	<0.001
30 to 39	181.3	172.0	190.8	0,001
40 to 49	122.5	114.9	130.4	0.008
Female per age-range				
11 to 19	16.3	14.2	18.7	0.278
20 to 29	22.3	19.1	25.8	<0.001
30 to 39	11.9	9.6	14.5	0.010
40 to 49	11.1	8.9	13.7	0.040

*: Rate per 100.000 inhabitants. **: Assuming Poisson Distribution aAll the indicators presented: [a]: positive coefficient for the trend analysis performed by means of linear regression.

The magnitude of the motorcycle accident in the period between 2005 and 2014 was measured by the years of potential life lost (YPLL) considering the age limit of 70 years. This indicated that on an average 2136.8 years were lost. However, when the men and women were verified separately, the men represented higher losses than the women, with a trend towards growth in the period in question.

When analyzing the age-ranges, persons between the ages of 20 and 29 years represented a higher mean value of years lost both in general and when men and women were analyzed separately. This growing trend remained during the ten-year period. Of the age-ranges studied in general, only persons between 40 and 49 years of aged presented statistical significance for the trend. However, when separated by sex, no growth could be affirmed only for the younger persons, between 10 and 19 years. The significant growth in YPLL was pointed out after the year 2008, when the years lost went from a mean of 1401.1 before, to 2578.2 as from 2009 (p = 0.0388). Mann-Whitney Test **(Table 2)**.

Table 2. Distribution of the years of potential life lost due to motorcycle accidents for 70 years, according to sex, age-range and trend. Pernambuco. Brazil. 2005-2014.

YPLL 70 years	Mean	IC 95%		p-value	p-value for trend[a]
General	2136.8	1515.8	2757.9		0.042
Male	3771.2	2738.5	4804.0	<0.0001*	0,019
Female	432.9	339.6	526.1		0.001
General					
10 to 19	974.7	583.2	1366.2		0.368
20 to 29	5100.6	2804.7	7396.4	0.0003**	0,192
30 to 39	2426.4	1267.7	3585.1		0.100
40 to 49	975.4	506.5	1444.3		0.046
Male					
10 to 19	1509.3	842.9	2175.7		0.290
20 to 29	9373.0	7095.5	11650.5	0.0001**	0.002
30 to 39	4494.3	3176.8	5811.8		0.000
40 to 49	1744.2	1110.2	2378.2		0.000
Female					
10 to 19	377.2	251.7	502.7		0.445
20 to 29	828.1	600.6	1055.6	0.0004**	0.053
30 to 39	358.6	206.0	511.1		0,000
40 to 49	206.6	104.6	308.5		0.000

*: Mann- Whitney. **: Kruskal-Wallis. [a]: All the indicators presented a positive coefficient for the trend analysis performed by means of linear regression

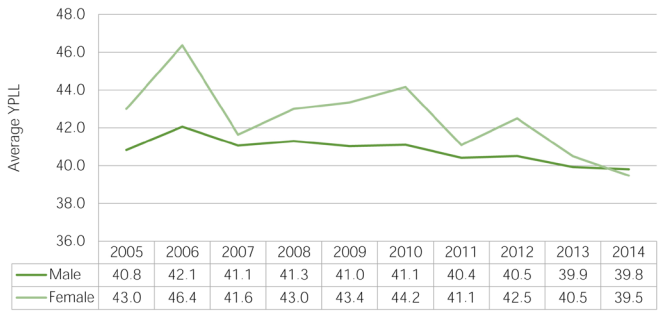
In relation to rates of years of potential life lost (RYPLL) per 100 thousand inhabitants presented in **Table 3**, an increase was observed in both the female and male sex throughout the period studied. In relation to the age-ranges, no significant growth was shown for victims between 10 and 19 years of age only, in spite of the positivity of the coefficient in the regression analysis. In the same way as for

Table 3. Distribution of the rate of years of potential life lost due to motorcycle accidents according to sex, age-range and trend. Pernambuco. Brazil. 2005-2012.

YPLL 70 years	Mean	IC 95%		p-value	p-value for trend[a]
General	319.2	315.2	323.2	<0.0001*	0.049
Male	557.4	550.0	564.9		0.015
Female	68.1	65.4	70.8		0.003
General					
10 to 19	219.5	214.1	225.1	0.0295**	0.366
20 to 29	618.8	606.6	631.1		0.211
30 to 39	342.9	333.9	352.1		0.240
40 to 49	170.3	164.0	176.8		0.209
Age Group (years)					
10 to 19	333.7	324.5	343.0	0.0002**	0.330
20 to 29	1136.1	1112.9	1159.7		0.000
30 to 39	643.4	625.9	661.2		0.001
40 to 49	312.4	300.2	324.9		0.008
Age Group (years)					
10 to 19	87.8	82.8	93.1	0.001**	0.234
20 to 29	101.4	94.5	108.6		0.000
30 to 39	42.4	38.0	47.1		0.010
40 to 49	28.3	24.7	32.2		0.040

*: Interval of confidence assuming the Poisson distribution.
[a]: All the indicators presented a positive coefficient for the trend analysis performed by means of linear regression.
Source: The authors' own compilation from SIM and IBGE data made available by DATASUS, tabulated by means of Tabnet in April, 2014.

Figure 1: Evolution of mean YPLL per annum according to sex. Pernambuco. Brazil. 2005-2014.



YPLL, the predominant age-range was that of 20 to 29 year in the general analysis and in both sexes.

When analyzing the evolution of the RYPLL, the authors observed discrete oscillations up to the year 2008, the point when the rate started to show a considerable increase until the end of the period studied. Analysis of the rates established by using the age limit of 70 years, showed they followed the same trend throughout the years, with the increase in the life expectancy increasing the number of years of potential life lost.

When the means YPLL per individual for a life expectancy of 70 years at birth were analyzed according to year and sex, the authors observed that women lost life earlier than men did in the majority of years, except for the year 2014, in which the mean YPLL for men were higher than they were for women. In the years in which women's value exceeded those of men's, in the period, these values oscillated from a maximum that occurred in 2006, and a minimum that occurred in 2014 **(Figure 1)**.

Discussion

The mortality rate due to motorcycle accidents represented important impact on the deaths occurring in traffic accidents in Pernambuco. In the present study, the finding that caused concern was the trend toward significant growth in numbers that took place as from 2008. In Brazil, the year 2008 was marked by fiscal measures as a way of regulating the economy affected by the world economic crisis. In this period, one of the sectors most affected was the automotive industry. [18,19] The tax reductions may have contributed to the increase in the fleet of vehicles, contributing to a significant increase in these deaths.

Association between the fleet and the mortality rate has been presented by the World Health Organization [2, 3], when it analyzed the traffic accidents in Brazil in its edition of the Map of Violence. It also showed the participation of motorcycles in the

fleet of vehicles in the country, and its projection of growth with a period of growth similar to that of the behavior shown by the mortality rate. This fact ratified the public health problem caused by the motorcycle.

In addition to the elevated mortality rates found in the present study, it showed the early age at which death due to traffic accidents caused by motorcycles occurred. The magnitude of this was expressed by the indicator of the years of potential life lost by the victims, and the behavior of this throughout the years between 2005 and 2014. The rate showed a trend towards growth in the general and in the analyses for the male and female sexes.

Some authors [20] identified a discrete reduction in the total number of YPLL when they compared the 3-year periods, due to the increase in the mean age of occurrence of these deaths in Minas Gerais. However, due to the number of fatal traffic accident victims, they observed an increase in the indicator YPLL/100.000 inhabitants.

The male sex presented a higher quantity of years of potential life lost than the female sex. However, in these deaths, women were shown to be younger. The greater participation of men in the quantity of years of potential life lost may be related to the higher absolute number of these events among the male sex. Whereas, women were victims at an earlier age than men. Nevertheless, a reduction was observed over the course of the years.

In Minas Gerais the impact of traffic accident deaths was demonstrated by the total loss of 8,894.46 years of life /100,000 inhabitants identified through the calculation of the YPLL between 1996 and 2007. Each fatal victim due to this cause of death suffered a loss of 43.24 years of life, in which 95% of these victims were between 36.17 and 37.29 years of age. [20]

Similar evidence was presented in another study in Pernambuco in the year 2007. The authors the mean YPLL of 35.10 years due to land transport accidents, of which the majority were motorcyclists (27.49%) with a mean YPLL of 39.34. That is, slightly lower than the value found in this study. Men were the victims who lost the most years of potential life. For all types of victims analyzed by the authors, such as pedestrians, motorcyclists and automobile occupants, the age-range from 20 to 39 years concentrated a large portion of the YPLL. [21]

A study conducted in Colombia in 2010 showed the years of potential life lost in traffic accidents pointing out a total of 192,975.5 years of which 81.4% of these years were attributed to men and 18.6% to women. A larger proportion is attributed to men resulting from their greater exposure to driving the vehicles. The most affected age-range was between 15 and 29 years. [22]

The participation of persons of an economically active age among those of between 20 and 29 years old was significant, and so was the increase in their participation in the period analyzed; The World Health Organization (*WHO)* (2010) [23] has affirmed that traffic accidents were the main cause of death of persons between the ages of 15 and 29 years. The participation of men and youngsters in the accidents had a social impact and an impact on national economies.

At world level, the WHO affirmed that approximately half of all the traffic deaths occurred among pedestrians, cyclists and motorcyclists, and these were considered vulnerable users. The large majority of these deaths involved persons under the age of 50 years; and over 20 to30 million persons suffered lesions requiring hospitalization or specialized medical treatment. Trends suggest that traffic accidents will be ranked the 5th highest cause of death in 2030. [2]

In this context, motorcycles constitute a driving factor of traffic violence at present, with a trend towards growth, and must therefore be faced with measures and strategies suited to the magnitude of the problem.

Conclusion

This study pointed out the magnitude of traffic accidents caused by motorcycles, by means of the indicator of years of potential life lost and its respective rate. These data express the early age at which these lives were ended. An increase in this indicator was found in a general context for the state of Pernambuco, when all the years were analyzed. The young population and the male sex were the most affected in terms of the highest number of years lost. However, women were victims at an earlier age in the majority of the years studied.

The magnitude of the problem caused by motorcycles refers to a critical situation, bearing in mind the prematurity with which these accident occur; and the characteristics of avoidability of these causes, by means of preventive measures and intersectoral actions with the purpose of minimizing the fatal damage.

Considering the use of secondary data sources that depend on the registration instruments, which feed the Information System, being correctly filled out, this study may present limitations. These may be related to filling out and correct information about the basic cause of death. Further studies are necessary for in-depth study of the topic and survey of new point of discussion concerning accidental deaths.

Collaborators

Author, Flávia Emília Cavalcante Valença Fernandesa, made a substantial contribution to the conception, planning, analysis, data interpretation and writing of the article. Authors: Rosana Alves de Melo, Roseane da Silva Lemos, Saulo Bezerra Xavier, Joebson Maurilio Alves dos Santos, Rodrigo Gomes de Arruda, Arnaldo de França Caldas Júnior and Tatiane Almeida de Menezes contributed by providing guidance and critical review of the content, and approval of the final version of the manuscript.

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