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MORTALITY IN TRAFFIC ACCIDENTS: TEMPORARY TREND BETWEEN 1996 AND 2012

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ABSTRACT
The objective of the present study was to analyze the temporal trend of mortality in traffic accidents between 1996 and 2012. It is an epidemiological study of the mortality of 368 victims living in Maringá, Paraná. Data were extracted from the Mortality Information System of the Department of Informatics of the National Health System. The analysis of temporal trend of mortality was performed from the adjustment of a Poisson regression model to time series. The majority of the victims (76.35%) were male, aged 20 and 39 years (48.36%), had white color/race (81.52%), with between 8 and 11 years of study (28.54%) and single (44.30%). Deaths occurred more frequently on public roads (62.77%) and, at the time of the accident, 8.96% of the individuals were working. There was a predominance of collisions between cars, pick-up trucks and trucks (27.17%). Annually, there was a 5.2% increase in the number of deaths. It is concluded that, among the components of external causes, traffic accidents are responsible for a large number of deaths.

Keywords: Epidemiology. Time series studies. External causes. Trafficaccidents. Mortality.

INTRODUCTION

Traffic accidents stand out as an important public health problem on a global, national and regional scale and are responsible for a large number of deaths[1]. They cause approximately 1.3 million deaths annually, 90% of them in low- and medium-incomecountries. In 2013, low- and middle-income countries had the highest mortality rates due to traffic accident traffic per 100,000 inhabitants (24.1 and 18.4, respectively) compared to high-income countries(9.2)[2]. In Brazil, mortality due to traffic accidents in 2013 was estimated at 23.4 per 100,000 inhabitants[2].

These occurrences are due to the association of several factors related to the precarious infrastructure of roads and highways, increase of the circulating fleet, deficient road system, vehicle conditions, traffic disorganization, general deficiency of surveillance, users' risk behaviors, migration of the rural population to urban areas and the lack of investment in traffic safety and engineering[3]. For victims, the consequences of these occurrences are trauma, sequelae, need for specialized pre-hospital and in-hospital care, potential years of life lost and deaths[1].

Thus, traffic accident statistics show lack of safety and investments in this area, and the impacts of these events are observed in negative indicators, as they entail high costs for victims, families, society and the health system[1,4]. The prevention and reduction of deaths due to traffic occurrences are associated with the commitment of the public authorities to the adequate planning and directing of human and financial resources, and related to public policies implemented in a coordinated way among all segments of society[5].

The elaboration of this study is justified by the fact that knowledge of the reality of traffic accidents and consequent mortality can contribute not only to the development of measures and programs to prevent injuries and deaths but also to implement, inform and develop programs of assistance to individuals involved in these occurrences.It can also provide a real diagnosis of the situation to carry out other studies that serve as a reference to the multidisciplinary team and to establish behaviors that aim to reduce this event in the population.

Considering this perspective and considering the importance of traffic accidents for the occurrence of deaths, the objective of this study was to analyze the temporal trend of mortality between 1996 and 2012.

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METHODOLOGY

This is an epidemiological, descriptive and retrospective study with a longitudinal approach[6] on mortality from motor vehicle accidents in the city of Maringá, PR, from 1996 to 2012. The data collection was performed in 2014, the year in which information was available for the study period. All data on the mortality of the 368 victims were extracted from the Mortality Information System available on the Department of Informatics of the National Health System of the Ministry of Health (Datasus), which uses information from death certificates and from demographic censuses performed by the Brazilian Institute of Geography and Statistics (IBGE). Accidents were analyzed according to codes from the 10th revision of the International Statistical Classification of Diseases and Health-Related Problems[7] and grouped from V40 to V49 (car occupant injured in transport accident).

The following variables were used for the analysis of this study: age range (0 to 14, 15 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59 and individuals aged> 60 years old), sex (male and female); race/color (white, black/brown, yellow); schooling (none, 1-3, 4-7, 8-11 and 12 years and more); marital status (single, married and others); place of occurrence (hospital, public highway and others); work accident (yes and no) and type of accident (collision withpedestrian or animal, collision with pedal cycle, collision with two- or three-wheeled motor vehicle, collision with car or pick-up truck, collision with heavy transport vehicle or bus, collision with nonmotor vehicle, collision with fixed or stationaryobject, noncollision transport accident, other and unspecifiedaccidents).

In order to model the annual death count, the Poisson distribution adapts to the main characteristic of the counting data, non-negative integer values. The mortality trend analysis performed from the adjustment of a Poisson regression model to time series $y_i \sim P(\mu_i)$ with log[f0](μ_i)= β_0+β_1 t_(i,) i=1,…17, in which is the intercept, β_1 is the coefficient accompanying the independent variable year and t_i is the i-th year of study. The function of canonical connection was used, which, in the case of the Poisson distribution, is the logarithmic function. From the estimated trend coefficient and its respective standard error, it was possible to verify the existence of a statistically significant increasing or decreasing trend. After adjusting the model, the residue independence assumption was verified from correlograms and from 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, we used the statistical program "R 3.1.1"®, 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 a database of DATASUS of the Ministry of Health, the 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 the Ordinance no. 03/2015 - COPEP.

RESULTS

Table 1 shows the prevalence of male mortality (76.35%). The highest proportion of males allowed a male/female ratio of 3.2: 1.

Regarding the age group, we observed that the majority (48.36%) were young adults, aged between 20 and 39 years. Next, the age group of individuals aged 40 to 49 years was the most present in the analyzed group (14.95%) and the lowest frequencies were observed in the extreme age groups, up to 14 years and 60 years or more. The minimum age found was one year and the maximum was 81 years (mean of 30 years, SD = 11.60, median of 25 years and mode of 21 years).

Regarding race/color, it is observed that the frequency of deaths was higher among white individuals (81.52%), followed by black/brown individuals (6.53%). The schooling variable showed that the majority of the victims had eight to 11 years of study (28.54%). Among the victims, 44.30% were single and 40.21% married.

The analysis of the characteristics of the accidents (Table 2) showed that the most frequent place of deaths was the public highway (62.77%), followed by hospitals (30.98%). With regard to information on work-related accidents, 8.96% of the individuals who died were developing work-

related activities.

Table 1. Distribution of deaths due to traffic accidents according to sociodemographic variables. Maringá, PR, Brazil, 1996 to 2012.

Variable	Category	n	%
Sex	Male	281	76.35
	Female	87	23.65
Age range	0 – 14 years old	25	6.79
	15 – 19 years old	38	10.32
	20 – 29 years old	93	25.27
	30 - 39 years old	85	23.09
	40 - 49 years old	55	14.95
	50 – 59 years old	36	9.79
	≥ 60 years old	36	9.79
Color/Race	White	300	81.52
	Black/Brown	24	6.53
	Yellow	10	2.71
	Ignored	34	9.24
Schooling	None	6	1.64
	1 - 3 years	38	10.32
	4 - 7 years	71	19.29
	8 - 11 years	105	28.54
	≥12 years	69	18.75
	Ignored	79	21.46
Marital status	Single	163	44.30
	Married	148	40.21
	Others	39	10.60
	Ignored	18	4.89

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

Table 2. Distribution of deaths due to car accidents according to accident characteristics. Maringá, PR, Brazil, 1996 to 2012.

Variable	Category	n	%
Place of death	Hospital	114	30.98
	Public highway	231	62.77
	Home	2	0.55
	Others	11	2.99
	Ignored	10	2.71
Work accident	Yes	33	8.96
	No	226	61.42
	Ignored	109	29.62
CID – 10. V40 to V49 Car occupant injured in transport accident –collisions	- With car or pick-up truck	100	27.17
	- Noncollision transport accident	67	18.21
	- With heavy transport vehicle or bus	57	15.49
	-With fixed or stationary object	47	12.77
	- With nonmotor vehicle	1	0.27
	- Other and unspecifiedaccidents	96	26.09

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

Regarding the types of accidents, the most frequent were the collisions with car/pick-up truck/truck (27.17%), as well as other and unspecified accidents, which include occupants of railway trains ans railway vehicles, special transport vehicles, vehicles used in industrial and agricultural áreas, etc. (26.09%) and accidents without collision (18.21%). Also worthy of mention are the collisions with heavy

transport vehicles or buses (15.49%) and collisions with fixed and stationary objects (12.77%).

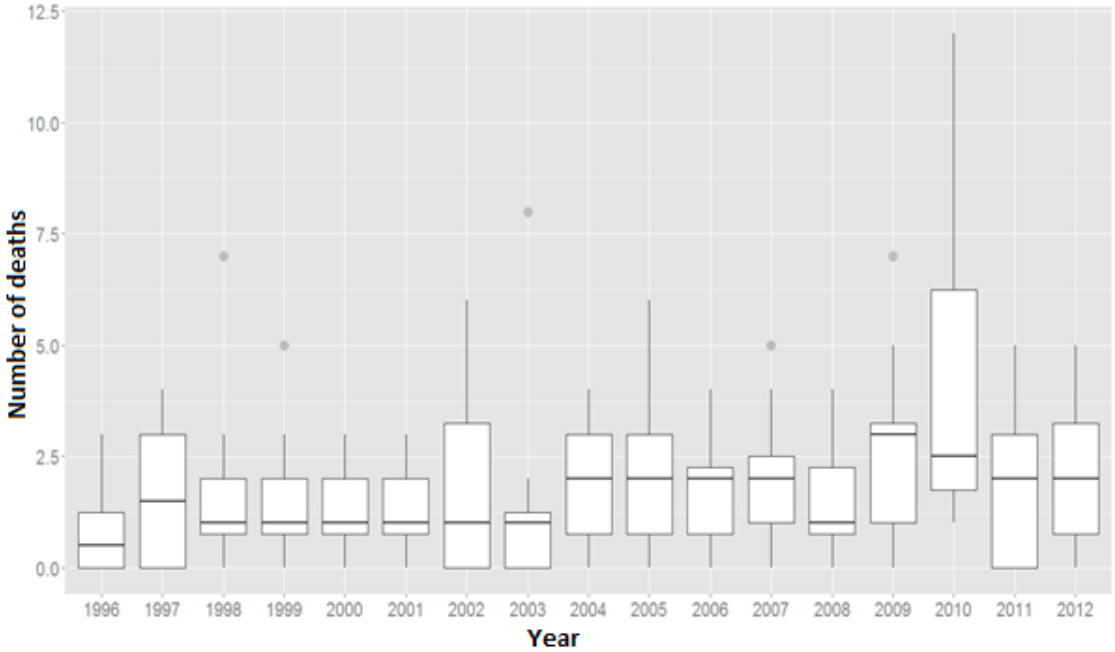

Figure 1. Box-Plot of the monthly number of fatal cases according to the year of occurrence. Maringá, PR, Brazil, 1996 to 2012.

Figure 1 shows the Box-Plot of the monthly number of fatal cases. There is the presence of outliers, that is, months in which the number of cases was much higher. In May 2010 there was the highest number of deaths, 12 deaths, which is observed by the upper limit of the box-plot for the year. The mean monthly death rate was 1.8 cases.

Figure 2 shows the Poisson model for the annual series of fatal cases. We observe in gray the confidence interval for the estimated trend and the black central line represents the Poisson model adjusting the trend. Since the coefficient of the variable year is positive, there is a positive trend. In some years, there were significant changes above the expected, with death peaks in 2007 (26 - 7.06%), 2009 (33 - 8.96%) and 2010 (50 - 13.58%).

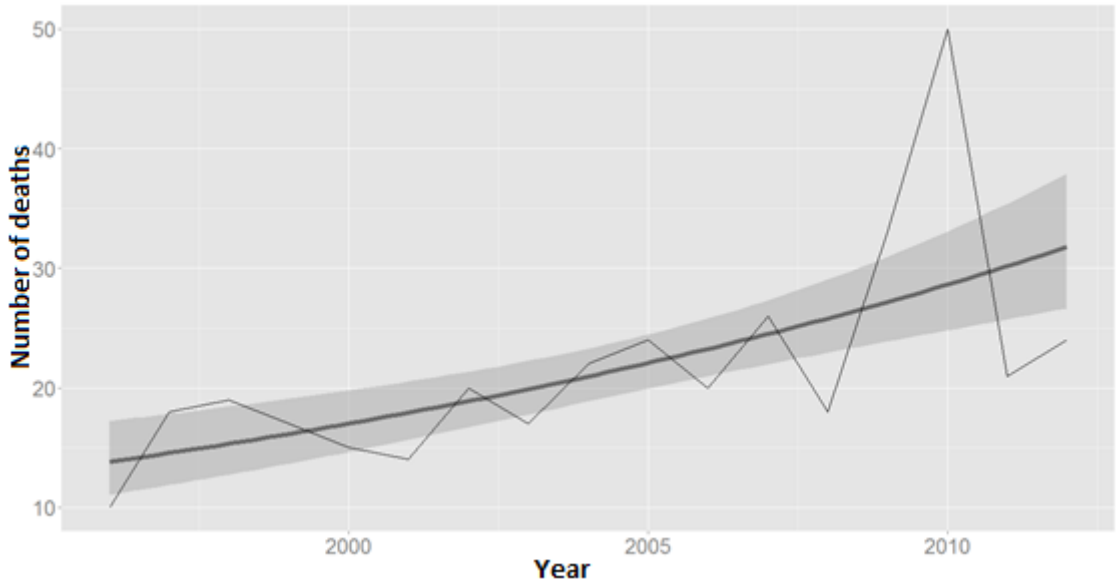

Figure 2. Model for the counting series of the Poisson series of the annual number of fatal cases due to traffic accidents according to the year of occurrence. Maringá, PR, Brazil, 1996 to 2012.

If we increase a unit of time, the relative variation in the expected value is given by $\frac{\hat{\mu}(x+1)}{\hat{\mu}(x)} = \exp(0.0502) = 1.0502$, that is, the expected number of deaths increases by approximately 5.2% per year.

It is also observed, from the estimated model, that if one considers the initial moment of the analysis, the parameter β_0 = 2.62, that is, the intercept of the model in the y-axis, we would have an estimate of exp (2.62) = 13.73 deaths/year. In contrast, at the end of the analyzed period, the estimate for 2012, the 17th year, is given by exp (2.62 + 0.052 x 17) = 33.2 deaths/year. If the behavior of the time series remained the same for four years, the adjusted model would indicate that in 21 years the number of deaths due to traffic accidents would be tripled.

The normal confidence interval was built on the scale of the (logarithmic) binding function, then transformed to the scale of the variable number of deaths. The presence of the trend was also confirmed by the Cox-Stuart test(9) (p-value< 0.0001).

The estimates of the parameters of the Poisson regression model showed the following measures: for the intercept (β_0), the estimate was 2.620, standard error of 0.11 and p-value <0.001. For the variable year(β_1), the estimate was 0.052, standard error of 0.01 and p-value <0.001. Thus, the adjusted model was given by: $\hat{\mu}(x) = \exp(2.62 + 0.05207 x_i)$. The assumptions of normality and independence of residues were also analyzed. By the Shapiro-Wilk test(10) (p-value = 0.067), it was not rejected the hypothesis that the residuals follow normal distribution and in order to verify the absence of autocorrelation the Durbin-Watson test[11] (p-value= 0.450) was used,which did not reject the hypothesis of null autocorrelation.

DISCUSSION

Among the components of external causes, traffic accidents contribute significantly to extremely high mortality in all societies, affecting all individuals without distinction. These events constitute a great magnitude phenomenon and involve a complex dynamics between host (man), agent (vehicle) and the environment (highway)(1,5), thus creating a worrying and critical point in world mortality statistics.

The data from this study confirmed once again the absolute prevalence of deaths among males, similar to other studies in which the predominance of the mortality of men in traffic accidents exceeded 70.0%(1,12). Risk behaviors such as alcohol and drug use, excessive speed and the non-use of personal protective equipment may justify the greater involvement of males in severe traffic accidents.

In the present study, approximately half of the victims (48.36%) were young individuals, aged between 20 and 39 years. The lowest percentage of deaths were observed in the extreme age groups between 0 and 14 years old (6.79%) and individuals aged ≥60 years (9.79%). In Spain, data from a study revealed that of the total number of men killed in traffic accidents, 2.4% were aged between 0 and 14 years, 47.1% between 15 and 34 years and 32.7% between 35 and 64 years. In the group of individuals aged ≥ 65 years, they were 17.8%. Among women, 37.4% were aged between 15 and 34 years, 26.1% between 35 and 64 years and 31.0% were 65 years or more[1].

Results of a study[12] conducted in Maringá revealed that mortality was concentrated between the ages of 20 and 39 years, followed by the age group from 40 to 59 years. Men presented a 4.2 times greater chance of death due to traffic accidents when compared to women.

The greater mortality of young individuals due to traffic accidents can be a result of several factors: lower adherence of this group to prevention and safety measures, search for excitement at excessive speeds, impulsivity, alcohol and drug use, inexperience, adoption of behavior risk, disobedience to traffic laws, lack of ability to perceive danger and solve problems, overconfidence and the false impression that the motor vehicle is synonymous with freedom, adventure and challenges[13].

It was also observed in this study that the highest proportion of deaths were among white individuals (81.52%), with schooling between 8 and 11 years (28.54%) and singles (44.30%). Regarding race/color, it is important to mention that this variable is directly related to the characteristics of the population, differing between the various regions of the country. In the state of Paraná, according to the demographic census of 2010, white individuals accounted for 70.05% of the population[14]. In the municipality of Maringá, these were 64.19%[14].

The greater involvement of white individuals in traffic events was also evidenced in other studies[12,15]. Among brown and black individuals, deaths totaled 38.0% and among indigenous and yellow people, 0.5%, following the race/color distribution pattern of

the population[12]. This same research[12] identified that of the individuals with information about schooling (58.0%), 35.0% had up to four years of study. The percentage of deaths of individuals with more than four years of study was higher among whites and yellows (40.0% and 47.0%, respectively).

As for single individuals, it is assumed that they are more likely to suffer serious or fatal accidents, probably because of the increased adoption of risk behaviors, use of alcoholic beverages and drugs and the non-use of safety equipment[13]. Other authors[16] still consider the fact that single people generally do not have established families and established life plans, thus being more likely to be involved in risk situations, in addition to the social values and beliefs of male invulnerability.

Among the 368 victims who had died, more than half (62.77%) had died on the public highway and 30.98% in the hospital. Other authors[15] also identified in a study carried out in Maringá that 41.56% of deaths due to traffic accidents had occurred at the scene of the accidentand 53.13% during hospitalization.

Considering that in this study the highest occurrence of deaths took place on the public highway, there is the need of investments and improvements in infrastructure, signage, lighting and adequate supervision, as well as strategies to promote safe traffic, prevention through educational actions and intersectoral actions of all levels of government[5]. The social losses of high mortality in traffic accidents are related to the potential years of life lost and high costs to the health systems, family and society[1].

In the present study, there was no relation of victims with work activities. However, it should be noted that, in general, many individuals work informally, transporting goods, products and passengers. Workers without a formal employment relationship are subject to long working hours, without rest periods, low pay, excessive workload, physical and emotional health impairment, and limitation and worsening of quality of life, as well as conflicting relationships between work and personal life, resulting in involvement in fatal accidents[17].

Regarding the type of accident, the largest number of victims was observed in collisions with cars, pick-up trucks or truck. Subsequently, other and unspecified accidents were the most frequent. Collisions with heavy vehicles, often considered the most severe, were responsible for 15.49% of the victims. Collisions between moving vehicles are responsible for a high percentage of fatalities and serious injuries. Authors identified in a study[16] conducted in Maringá that 38.75% of the accidents were collision with cars, pick-up trucks or trucks. In another study[5], authors identified that approximately 43.7% of accidents occurred between these types of vehicles.

A survey conducted in the state of Paraná showed the high number of accidents involving cars. The occurrences with participation of this type of vehicle were responsible for about 63.0% of the collisions, being the most severethose among cars and trucks[18].

In the analysis of the monthly series of mortality, it was observed in this study that the mean number of deaths was 1.8 cases per month. In May 2010, there were the highest number of deaths, 12 deaths. In the analysis of the annual series of fatal cases, there was a 5.3% increase in the number of deaths over the years.

The mortality from traffic accidents has shown a model of evolution. In Brazil, between 2000 and 2010, the mortality rate due to traffic accidents ranged from 18 to 22.5 deaths per 100,000 inhabitants, leading to a reduction in the risk of death for pedestrians and an increase for drivers of vehicles and motorcyclists[19]. In 2013, there were approximately 29.0% deaths from traffic accidents, equivalent to more than 43 thousand deaths or about 120 thousand deaths per day[2]. Between 1990 and 2015, the mortality of pedestrians and occupants of motor vehicles was higher than motorcyclists and pedal cyclists. The risk of death was 3.4 times higher among occupants of motor vehicles[20].

Death rates from traffic accidents have shown an increase in the last 25 years in Spain, similar to those in other countries such as Finland, France, Australia, Greece and Portugal[1]. Across the world, more than 1.2 million people die as a result of traffic accidents. In 2010, these events represented the eighth leading cause of death. It is estimated that in 2030 it will be the fifth[2].

CONCLUSION

Traffic accidents are responsible for major economic and social consequences, and high cost to the health system and constitute a major threat to all users of public roads. These events are one of the main causes of death due to trauma, especially among the young and productive age population. It is important to consider that developed countries face the issues related to these events, proposing and implementing prevention and control measures. On the other hand, in

developing countries, there are worse socioeconomic conditions that, consequently, make it difficult to implement preventive and harm reduction measures.

The identification of factors contributing to these occurrences and the epidemiological profile of the victims provide key indicators and information to the official bodies and to all segments of society, aiming at the constant improvement of safety measures in traffic. In this sense, it is important to develop and continue studies that may contribute to a better knowledge of the problem, in view of the increase in mortality due to traffic accidents around the world.

In general, the results found showed the predominance of mortality in males, young adults, whites and singles. More than half of the victims died on the public highway and the most frequent type of accident was the collision with a car, pick-up truck or truck. There has been a progressive increase in deaths each year. In some years, important variations were observed, with peaks of deaths higher than predicted.

Some limitations of this study may be pointed out, namely 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 helmets and other safety equipment, condition and time of license of the victim, meteorological conditions, as well as severity indicators, such as the Glasgow Coma Scale and Revised Trauma Score in pre- and in-hospital care.

Despite the limitations found, the sources of data collection provide important contributions to determine the profile of morbidity and mortality due to traffic accidents, which are crucial for the formulation of public policies of prevention and health care, since the data set represent a fundamental tool of epidemiological information.

Therefore, the results do not exhaust the numerous possibilities of analysis of the problem in other sources of information. Knowledge of the reality of traffic incidents and consequent mortality can contribute not only to the development of measures and programs to prevent injuries and deaths but also to implement, inform and develop prevention and care programs.

MORTALIDADE EM ACIDENTES AUTOMOBILÍSTICOS: TENDÊNCIA TEMPORAL ENTRE 1996 E 2012

RESUMOI

O objetivo do estudo foi analisar a tendência temporal da mortalidade em acidentes automobilísticos entre 1996 e 2012. Estudo epidemiológico da mortalidade de 368 vítimas, residentes em Maringá, Paraná. Os dados foram extraídos do Sistema de Informação sobre Mortalidade do Departamento de Informática do Sistema Único de Saúde. A análise de tendência temporal da mortalidade foi realizada a partir do ajuste de um modelo de regressão de Poisson para séries temporais. A maioria das vítimas (76,35%) era do sexo masculino, na faixa etária de 20 e 39 anos (48,36%), da cor/raça branca (81,52%), com escolaridade entre oito e 11 anos de estudo (28,54%) e solteiros (44,30%). Os óbitos ocorreram com maior frequência na via pública (62,77%) e, no momento do acidente, 8,96% dos indivíduos, estavam trabalhando. Houve predomínio das colisões com automóvel/picape/caminhonete (27,17%). Anualmente, verificou-se um aumento de5,2% no número de óbitos.Conclui-se que, entre os componentes das causas externas, os acidentes de trânsito são responsáveis por um grande número de mortes.

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

MORTALIDAD EN ACCIDENTES AUTOMOVILÍSTICOS: SERIE TEMPORAL ENTRE 1996 Y 2012

RESUMEN

El objetivo del estudio fue analizar la serie temporal de la mortalidad en accidentes automovilísticos entre 1996 y 2012. Estudio epidemiológico de la mortalidad de 368 víctimas, residentes enMaringá, Paraná, Brasil. Los datos fueron extraídos del Sistema de Información sobre Mortalidad del Departamento de Informática del Sistema Único de Salud. El análisis de serie temporal de la mortalidad fue realizado a partir del ajuste de un modelo de regresión de Poisson para series temporales. La mayoría de las víctimas (76,35%) era del sexo masculino, en la franja de edad de 20 y 39 años (48,36%), color/raza blanco(a) (81,52%), con escolaridad entre ochoy 11 años de estudio (28,54%) y soltero (44,30%). Los óbitos ocurrieron con mayor frecuencia en la vía pública (62,77%) y, en el momento del accidente, el 8,96% de los individuos estaba trabajando. Hubo predominio de las colisiones con automóvil/picape/camioneta (27,17%). Anualmente, se ha observado un aumento de 5,2% en el número de óbitos. Se concluye que, entre los componentes de las causas externas, los accidentes de tránsito son los responsables por un gran número de muertes.

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

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