Epidemiologic Aspects of Spinal Cord Trauma Cases among Traffic Accident Victims

ORIGINAL

Tatiana Farias Teódulo Palitot¹,
Alessandro Leite Cavalcanti², Gláucia de Souza Abreu³,
Liege Helena Freitas Fernandes⁴,
Cibele da Cruz Prates⁵, Gabriela Pereira Batista⁶,
Priscilla Maria da Silva Nascimento⁷,
Elaine Cristina Batista Tavares⁸,
Maria Aparecida de Freitas Silveira⁹,
Marcia Maria Almeida da Silva¹⁰

Abstract

Objective: To describe and analyze characteristics of cases of spinal cord Trauma (SCT) among traffic accident victims admitted to a referral hospital.

Method: Descriptive, analytical, cross-sectional study with quantitative approach, developed in the city of Campina Grande, in the state of Paraíba, Brazil. The population consists of 1,884 medical records of patients admitted to hospital after damage caused by traffic accidents from January to December 2016. Data were analyzed using descriptive and inferential statistics, adopting a significance level of 5%.

Results: Among the victims of traffic accidents, there was a male predominance (85.4%). The most affected age group was 21 to 30 years (29%). Accidents involving motorcyclists were predominant (82.9%) and 43 victims (2.3%) suffered spinal injury. Among these ones, there was a prevalence of males (86%), in the age group between 21 and 30 years (35.7%). In 30 cases (69.8%), the victims had spinal injuries. The cervical level (55.8%) was dominant. In addition, 46.7% of the victims were classified as ASIA and there were 9 cases (30%) of paraplegia and 1 case (3.3%) of tetraplegia. A bivariate analysis revealed a significant association between the variable presence of SCT and type of accident ($p < 0.001$), use of cervical collar ($p < 0.005$), injuries in other anatomical regions ($p < 0.001$), surgical treatment ($p < 0.001$) and outcome of the patient's situation ($p < 0.005$).

- 1 Master's degree in Public Health at Paraíba State University (UEPB). Parnamirim, RN, Brazil.
- 2 Post-doctorate in Pediatric Dentistry at Minas Gerais Federal University (UFMG). Campina Grande, PB, Brazil.
- 3 Master's degree in Public Health at Paraíba State University (UEPB). Cajazeiras, PB, Brazil.
- 4 Doctoral student in Dentistry at Paraíba State University (UEPB). Campina Grande, PB, Brazil.
- 5 Student in Dentistry at Paraíba State University (UEPB). Campina Grande, PB, Brazil.
- 6 Graduate in Nursing at Faculdade Campina Grande/FAC-CG (UNESC), Campina Grande. PB, Brazil.
- 7 Graduate in Nursing at UNIFACISA, Centro Universitário. Campina Grande, PB, Brazil.
- 8 Postgraduate in Dermatological Nursing at Estácio de Sá University. São José de Piranhas, PB, Brazil.
- 9 Postgraduate in Obstetrics Nursing and Neonatology at Santa Maria University (FSM). São Miguel, RN, Brazil.
- 10 Postgraduate in ICU, Urgency and Emergency at Centro Integrado de Tecnologia e Pesquisa (CINTEP). Paulista, PB, Brazil.

Contact information:

Maria Aparecida de Freitas Silveira.

Address: Rua Joca Moreno, 687, Sabino Leite. Postal code: 59920-000 São Miguel/RN, Brazil.

✉ aparecidafreitas1984@hotmail.com

Conclusions: Among the victims of traffic accidents and SCT there was a predominance of males, young individuals and motorcyclists.

Keywords

Epidemiology; Traffic-Accidents; Public Health; Spinal Injuries; Spinal Cord Trauma.

Introduction

Spinal cord trauma (SCT) has increased its incidence rate [1, 2] and may trigger a situation that has a devastating influence on the individual's life [1, 23]. Spinal cord trauma is often responsible for the emergence of serious psychological problems, which may continue for up to 10 years after its occurrence, causing changes in family daily life and in the relations of the individual in society [4].

This health problem results in several other conditions capable of increasing its severity, such as pressure injuries, pulmonary infections, deep vein thrombosis and others [5, 6, 7]. According to Sabre et al. [8], infections, cardiovascular problems and suicide were the leading causes of death in patients with SCT, reducing the life expectancy of these individuals compared to others.

Traffic accidents are a major cause of SCT, which, according to Verma et al. [9], are responsible for the occurrence of 66.4% of trauma in general, being the main cause of spinal injury [1, 10, 11]. These types of accidents increase the severity because they trigger associated trauma, more serious injuries and higher mortality [12], besides causing psychological problems such as Posttraumatic Stress Disorder and depression [13, 14]. Thus they are a serious public health problem, being associated with economic consequences, disabilities, significant losses for the victim and all the family, influencing quality of life, and may lead to death [15].

Thus, observing the importance of traffic accidents as an etiological factor of spinal injury in the

Public Health context, the present study aimed to describe and analyze the characteristics of cases of SCT in traffic accident victims admitted to a referral hospital, in a medium-sized city in northeastern Brazil.

Method

The study was census based, descriptive, analytical and cross-sectional, developed in the city of Campina Grande, Brazil, whose estimated population was 410,332 inhabitants in 2017. The city has a total of 112 health facilities that serve the Brazilian Unified Health System (SUS, in Portuguese), 231 health facilities in general and 1,353 inpatient beds [16].

The study was conducted at Dom Luiz Gonzaga Fernandes Emergency and Trauma Hospital, which is part of the hospital network of the State of Paraíba, being a reference in trauma care for 203 cities of Paraíba and also for cities of other states, such as Rio Grande do Norte, Pernambuco and Ceará [17]. Data collection was performed at the Medical Archive and Statistical Service – SAME (Portuguese initials).

The population consisted of 1,884 medical records of victims of traffic accidents hospitalized from January to December 2016. These accidents involved pedestrians, motorcycles, bicycles and automobiles (including trucks and buses) [18].

The inclusion criterion was the minimum period of hospitalization of 24 hours. Were excluded the medical records of the victims who were hospitali-

zed at the time of collection, because they were not yet in the SAME and those who had a percentage of lack of information greater than 10% [19, 20].

The variables studied were gender, age, days of the week when the care took place, time of care, use of cervical collar at the time of care, type of accident, presence of SCT, skeletal level of the lesion, affected vertebrae, evaluation of the deficiency according to ASIA scale, paraplegia/quadriplegia diagnosis, trauma in other anatomical regions, craniofacial trauma, surgical treatment and outcome of the victim's situation.

The research instrument used was a form composed of objective questions, subdivided into dichotomous variables or multiple choice categories. Data were collected, from May to December 2017, by three researchers, with higher education in nursing and with experience in assisting patients with SCT, properly trained.

Data were entered by double typing into a database of SPSS (Statistical Package for The Social Sciences, IBM SPSS Armonk, New York, USA) version 20 and analyzed using descriptive statistics (absolute and percentage distributions, mean, median and standard deviation) and inferential statistics (Chi-squared test and Fisher's exact tests), adopting a significance level of 5%.

The Research Ethics Committee of Paraíba State University approved this research, under the Certificate of Presentation for Ethical Appreciation (CAAE – Portuguese initials) number 66123217.3.0000.5187.

Results

Among the victims of traffic accidents registered, it was found that males represented the most common victims (85.4%), being the ratio between males and females equivalent to 5.8:1. The most affected age group was between 21 and 30 years (29%), with a mean age of 33.18 years (Median = 30.0 years; SD = 15.9), with a minimum of less than 1 year and maximum 94 years old (**Table 1**).

Table 1. Absolute and percentile distribution of traffic accidents in relation to sociodemographic variables regarding the accident and presence of SCT.

Variables	Frequency	
	N	%
Sex [1,884]		
Male	1,609	85.4
Female	275	14.6
Age group [1,875]		
Less than 1 to 10 years old	56	3.0
11 to 20 years old	366	19.5
21 to 30 years old	544	29.0
31 to 40 years old	380	20.3
41 to 50 years old	247	13.2
51 to 60 years old	151	8.1
Over 60 years old	131	7.0
Part of the day [1,882]		
Morning	307	16.3
Afternoon	527	28.0
Night	752	40.0
Dawn	296	15.7
Weekend [1,884]		
Yes	855	45.4
No	1,029	54.6
Type of accident [1,884]		
Pedestrian	133	7.1
Cyclist	68	3.6
Car occupant	121	6.4
Motorcyclist	1,562	82.9
Presence of SCT [1,884]		
Yes	43	2.3
No	1,841	97.7
Outcome [1,779]		
Discharge from the hospital	1,527	85.8
Transfer	104	5.8
Death	148	8.3

Regarding the accident aspects, it was observed that the majority of the doctor's visits occurred at night (55.7%) and 45.4% were registered at the weekend. Regarding the type of accident, the most prevalent were those involving motorcyclists (82.9%), and the occurrence of SCT was 2.3%. In addition, it was found that 8.3% of the victims died (**Table 1**).

Table 2 shows that among the victims with SCT, there was a predominance of cases related to the cervical region (55.8%), with a predominance of vertebrae C6 and C2, with a percentage of 31.4% and 22.9%, respectively. Among the thoracic vertebrae, Th7 and Th8 represented 19.2% of the cases and, in the lumbar region, the L1, L2, L4 and L5 vertebrae were equally affected (22.2%). Among the 43 victims with SCT, 18 (41.9%) had multiple vertebrae affected.

Table 2 also shows that 69.8% of the victims had spinal injury, with an incidence of 77.9 per 1,000,000 inhabitants. When classifying them according to the ASIA scale criteria, 46.7% were considered as ASIA E, followed by ASIA A (36.7%). In addition, 81.8% of patients in cases classified as ASIA A were diagnosed with paraplegia.

SCT cases were more prevalent among males (86%) (male to female ratio was 6:1), aged 21 to 30 years (35.7%). The average age was 37.0 years (Median = 33.0; SD = 15.3), with a minimum age of 16 and a maximum of 74 years. In 53.5% of cases, the medical care occurred at night, 60.5% during the week and 67.4% involved motorcycle

Table 2. Distribution of SCT cases in relation to its clinical features.

Variables	Frequency	
	N	%
Skeletal level [43]		
Cervical	24	55.8
Thoracic	12	27.9
Lumbar	6	14
Uninformed	1	2.3

Variables		Frequency	
		N	%
Affected vertebrae			
Cervical [35] ^a	C1	1	2.8
	C2	8	22.9
	C3	3	8.6
	C4	2	5.7
	C5	7	20
	C6	11	31.4
	C7	3	8.6
Thoracic [28] ^a	Th3	2	7.1
	Th4	2	7.1
	Th5	1	3.6
	Th6	2	7.1
	Th7	5	17.9
	Th8	5	17.9
	Th9	4	14.3
	Th10	2	7.1
	Th11	2	7.1
	Th12	2	7.1
	No answer	1	3.6
Lumbar [9] ^a	L1	2	22.2
	L2	2	22.2
	L3	1	11.1
	L4	2	22.2
	L5	2	22.2
Spinal injury [43]	Yes	30	69.8
	No	8	18.6
	No answer	5	11.6
Classification according to ASIA scale [30]	A	11	36.7
	B	1	3.3
	C	1	3.3
	D	2	6.7
	E	14	46.7
	No answer	1	3.3
Paraplegia and Tetraplegia Diagnosis [11]			
Paraplegia diagnosed ^b		9	81.8
Tetraplegia diagnosed ^c		1	9.1
No answer		1	9.1
a: More than one vertebra was affected in some cases; b: 30% of all victims with spinal injury; c: 3.3% of all victims with spinal injury.			

accidents (**Table 3**). The use of cervical collar was verified in 96.7% of the victims and 48.8% had associated trauma. Craniofacial trauma affected 32.6% of the victims, while death occurred in 17.1% of the cases. Among the 14 victims who underwent surgical treatment, 8 underwent spinal surgery (**Table 3**).

Bivariate analysis revealed a significant association between the presence of SCT and the type of accident ($p < 0.001$), use of cervical collar ($p < 0.05$), occurrence of trauma in other body regions ($p < 0.001$), surgical treatment ($p < 0.001$) and outcome of the victim's situation ($p < 0.05$) (**Table 3**).

Discussion

This study aimed to analyze the occurrence of SCT among traffic accident victims hospitalized at a referral hospital of a city in the Northeast of Brazil. It was observed that this type of injury was a serious public health problem, causing disabilities and dependence of individuals [21].

The use of alcohol is one of the main causes of these traffic accidents, because it increases the disrespect of the laws [22], causes changes in the driving ability of drivers [22, 23] and, consequently, makes individuals more exposed to fatal accidents. Accidents reported were more prevalent among males during the third decade of life (**Table 1**), showing that men are more likely to drive less cautiously [1, 24], since they consume more alcohol and other drugs compared to women.

Regarding the age group, individuals from 21 to 30 years old were predominant, confirming previous studies [25]. This is a worrying fact, since this population group has active participation in labor activities. The accidents, therefore, negatively influence the economy of the country, due to the emergence of incapacities for work and consequent dependence on the public system for survival. This endorses the United Nations stating that the econo-

Table 3. Distribution of SCT cases in relation to sex, age group, part of the day when the medical care occurred, weekend, type of accident, use of cervical collar, trauma in other anatomical regions, craniofacial trauma, surgical treatment and outcome of the victim's situation.

Variables	SCT				%
	Yes		No		
	N	%	N	%	
Sex					
Male	37	86.0	1,572	85.4	0.904
Female	6	14.0	269	14.6	
Age group (years old)					
Less than 1 to 10	0	0.0	56	3.0	0.419
11 to 20	4	9.5	362	19.7	
21 to 30	15	35.7	529	28.9	
31 to 40	10	23.8	370	20.2	
41 to 50	4	9.5	243	13.3	
51 to 60	5	11.9	146	8	
Over 60	4	9.5	127	6.9	
Part of the day					
Day	20	46.5	814	44.3	0.769
Night	23	53.5	1,025	55.7	
Weekend					
Yes	17	39.5	838	45.5	0.436
No	26	60.5	1,003	54.5	
Type of accident					
Car occupant	14	32.6	107	6.5	0.001
Motorcyclist	29	67.4	1,533	93.5	
Cervical Collar					
Yes	29	96.7	509	74.5	0.004
No	1	3.3	174	25.5	
Trauma in other anatomical regions					
Yes	21	48.8	1,841	100.0	0.001
No	22	51.2	0	0.0	
Craniofacial Trauma					
Yes	14	32.6	770	41.8	0.223
No	29	67.4	1,071	58.2	
Surgical treatment					
Yes	14	32.6	1,224	66.5	0.001
No	29	67.4	617	33.5	
Outcome					
Discharge/Transfer	34	82.9	1,597	91.9	0.038
Death	7	17.1	141	8.1	

mic losses resulting from these accidents and their consequences may diminish the benefits of economic growth in developing countries [26].

Most accidents happened at night, mainly on weekends. This fact can also be explained by the use of alcohol and other drugs, which is more frequent at night and on weekends [27, 28], as well as more abusive and dangerous attitudes performed by drivers while driving vehicles [28]. In the present study, concerning the time, we had as limitation the fact that the time found in the medical records refers to the service and not to the occurrence of the accident.

Regarding the type of accident, there was a predominance of occurrences involving motorcyclists, corroborating previous studies [29, 30]. This situation can be explained by inappropriate behavior of motorcyclists, disrespect for traffic laws, lack of exclusive lanes for motorcyclists and the very structure of the motorcycle that makes it difficult for other drivers to see it [28]. It is noteworthy that there is an stimulus to manufacture, buy and use motorcycles in Brazil, providing an increase in the number of accidents involving this type of vehicle, as well as compensation for death or disability. Motorcycles have become a widely used means of transportation, mainly due to their versatility and low cost when compared to cars [31]. In Brazilian North and Northeast regions, the number of motorcycles exceeds or is similar to the number of cars [32], making individuals in these regions even more susceptible, since the most used types of vehicles and the safety measures adopted in traffic influence the number of victims involved in these accidents [33].

Among the population of this study, 8.3% of traffic accident victims died. Other studies have shown lower hospital mortality rates, ranging from 1.0 in various types of trauma [34] to 3.9% only among victims of traffic accidents [35]. The death rates resulting from traffic accidents decreased in some countries [36, 37], including Brazil [38], however,

among victims of external causes, traffic accidents were responsible for the majority of deaths [25, 39]. Mortality in high-degree accidents may result from the absence of compliance with safety rules and the lack of use of protective equipment [40].

Comparing several countries in relation to the mortality rate, it can be seen that some laws in force in developed countries, aimed at reducing traffic accidents, also helped in developing countries [37]. The educational method directed to changes in the behavior of adolescents, regarding the use of protective equipment and non-ingestion of alcoholic beverages while driving, was efficient [41]. Other contributing factors such as weather circumstances, the technical condition of the vehicle and the driver should also be assessed, as the driver is responsible for a large proportion of accident cases [42].

Thus, to reduce the mortality resulting from these accidents, there is a need for laws aimed at the prevention of traffic accidents, as well as more effective enforcement by the public authorities and educational activities focused on the safe performance of vehicle drivers and the use of protective equipment.

Regarding the SCT, the cervical region has also been described in other studies [7, 9, 11, 43] as the most damaged skeletal level, including after motorcycle accidents [44]. Concerning accidents involving automobiles, injury in the lumbar region was predominant [12]. The thoracic region is the most affected when related to road accidents in general [45]. Traumatic spinal cord injury occurs mainly due to situations of hyperflexion, hyperextension, vertical compression, excessive rotation, excessive lateral tilt and sudden excessive traction of the spine [46, 47]. In order to reduce such movements, the National Traffic Council has made it compulsory for vehicles to wear a three-point seat belt and head restraint in all seat positions. Head restraint is directly related to cervical movement [48]. The fact that motorcycles are the most involved vehicles in accidents and do not have mandatory mechanisms

to prevent these injuries seems to explain why the cervical level was the most affected in this study.

Regarding the predominance of the most affected vertebra, other studies show different results, being L1 the more frequent [6, 44] and most lesions were between Th1 and S5 [49], which shows the importance of knowledge about these characteristics in a given population, generating subsidies for decision-making regarding specific prevention actions, such as the use of cervical collars in initial care by health professionals, and guidance on the importance of the use of head restraints and seat belts in automobiles. These actions may decrease the risk of a cervical injury.

More than two thirds of the victims in the population of this study had spinal injury, a result similar to that described in Cambodia [44] and higher than reported in China [6] and Iran [12]. The incidence of this injury, as found in this study, can be considered high when compared to others [2, 11, 49], which makes this situation even more worrying in this locality.

As traumatic spinal injury may be due to several mechanisms [46, 47], a more detailed study on the mechanism involved in the accident is necessary to make possible comparisons, which was not possible in this study due to the lack of information in the medical records.

Regarding the classification according to the ASIA Scale, our study differs from others ones who also made this assessment, which verified the predominance of ASIA A [10, 44, 45] and ASIA D [49]. Paraplegia was predominant over quadriplegia, and such conditions were only evident in victims who were classified as ASIA A. Other studies classified cases as complete and/or incomplete paraplegia and/or paraplegia [1, 49] and paraplegia/paraparesis or quadriplegia/quadruparesis [10] in all cases. As a result of a complete spinal cord injury, depending on the level of the injury, paraplegia and quadriplegia may occur [50]. DeVivo et al. [51] provide an alternative diagnosis of classifications, subdividing them into 4

groups: (1) C1-C8 ASIA A (complete quadriplegia); (2) C1-C8 ASIA B, C or D (incomplete quadriplegia); (3) Th1-S5 ASIA A (complete paraplegia); and (4) Th1-S5 ASIA B, C or D (incomplete paraplegia). The fact that different forms of diagnosis were used regarding paraplegia/quadruplegia in this study and in the others mentioned, makes it difficult to make further comparison.

However, it is important to highlight the occurrence of paraplegia and quadriplegia in this population, affecting 33.3% of all cases of this injury, as such situations generally incur disabling conditions which can trigger physical, psychological and economic problems for the victim and his family [3, 4].

Men were the predominant victims of SCT, corroborating several studies [6, 7, 11, 43, 45]. The average age in this study is in agreement with other ones previously performed [7, 10, 12, 44, 45]. Being male, young, using alcohol and illicit drugs are the main risk factors associated with this type of injury [50].

Cases of SCT resulting from accidents involving motorcycles were more frequent, corroborating previous findings [19, 52]. Accidents involving motorcycles cause a larger number of injuries and more serious ones, which are more frequent in the head, chest, abdomen and extremities, when compared to car accidents [52, 53].

Motorcyclists generally expose themselves to injuries to a greater extent due to misuse or reduced use of protective equipment [22, 54]. Comparing victims of motorcycle accidents who wore a helmet or not, for example, there were more serious injuries to the head / neck, face, chest and extremities and the occurrence of deaths was significantly higher among motorcycle riders who did not wear a helmet. Regarding the cases of cervical vertebra fractures, this number was also significantly higher concerning those who did not wear a helmet [55].

Regarding the use of cervical collar in the group of victims of SCT, despite the high lack of information in medical records, it was high, showing that health professionals who provide immediate care

at the scene of accidents adopt the use of collar as a norm, in accordance with the PHTLS (Prehospital Trauma Life Support), which considers its priority use in prehospital trauma care [47].

The occurrence of trauma associated with SCT was also verified in other studied populations [6, 12, 43, 44]. The most commonly affected regions are the thoracic one and the head [6, 43]. In this research, craniofacial trauma affected one third of the victims of SCT. In the United Kingdom, it was found that the occurrence of spinal injury was significant among victims of maxillofacial trauma [56]. In addition, with regard to the etiology of the injury, the occurrence of spinal injuries in victims of oral and maxillofacial trauma resulting from traffic accidents was four times higher. This fact can be explained by the force that is transmitted from the skull and facial skeleton to the cervical spine during the accident, which highlights the need for immobilization and imaging of the cervical spine in all victims of oral and maxillofacial trauma, always considering them as potential victims of spinal injury [56].

An important fact is that, although certain vertebrae were more affected, almost half of the victims of SCT had more than one affected vertebra, a fact evidenced in other studies [6, 12, 44]. In addition, more than half of the victims of SCT who underwent surgical procedures went through spinal surgery, similar to those previously described [44, 57]. In a study conducted in Spain, the reduction in the number of surgical procedures was directly proportional to the number of affected vertebrae [57].

Thus, the fact that this study found a high number of victims with more than one affected vertebra may explain the high rate of surgical procedures performed and, consequently, associated hospital expenses. In addition, in other study [58], despite the completion of surgeries, most patients continued to have clinical symptoms, being unable to return to work, requiring postoperative consultation and health care, indicating the need for direct and indirect costs.

Regarding traffic accidents in general, a study shows that the average stay during hospitalization was almost one week, leading to significant expenses among these victims [52]. In this context, we highlight the importance of this injury resulting from traffic accidents, especially involving motorcycles, as a public health problem, economically affecting the situation of the public health system.

The mortality rate of victims of SCT was lower than that found in Tanzania [7] and higher than that found in Spain [57]. The safety measures adopted in the countries may explain differences in the incidence of SCT, as well as in the occurrence of deaths resulting from them. In Spain, for example, the reduction in the mortality rate from these injuries was mainly due to efficient traffic education campaigns, associated with improvements in road conditions and safety equipment, including seat belts that were included in the rear seats of cars, for example [57].

Comparing deaths in the groups with and without SCT, there was a higher percentage of deaths among victims of SCT. According to some studies, among the victims of traffic accidents, the majority died due to chest injuries [59] and brain trauma, followed by multiple trauma [60].

In a previous study [43], it was found that among victims of traumatic spinal injuries, the main causes of death were secondary complications to injury in the group of patients who were hospitalized for more than one week, and those who died within the first 24 hours presented associated injuries more often than those who survived the first 24 hours. In addition, another study showed that most deaths among these victims had cervical spine injury between C4 and C5 [57].

Spinal injury has many complications, such as pressure ulcers, postural hypotension, autonomic dysreflexia, deep vein thrombosis, urinary tract infections, neurogenic bowel, and others [61]. Thus, the most frequent deaths among the victims of SCT in the population of this study may be related to the

higher number of injuries to the cervical spine, the presence of associated injuries and possible complications, but a study correlating such factors would be necessary for further evaluation.

In general, traffic accidents and their consequences can cause economic problems for victims, families and the country, either due to the costs of diagnostic methods, treatments and compensation, or the reduction or loss of productivity of disabling situations that may result from these accidents [62], such as spinal injuries.

For professionals, especially those who participate in the initial care of the victim and those who work in referral hospitals for trauma, this study aimed to provide support on the importance of rigorous assessment of these victims, preventive measures for these injuries and an improvement in patient care, in order to use strategies to resolve possible physical and psychological problems resulting from these injuries, even during initial care and hospitalization.

Conclusion

Among the victims of traffic accidents with SCT, there was a predominance of male, young individuals and accidents involving motorcyclists, with abuse of alcohol and other drugs.

Given this scenario, it is evident that the findings described in this study can serve as a basis for municipal and state governments to promote educational activities emphasizing the correct use of protective equipment, in an attempt to reduce dangerous attitudes while driving vehicles, as well as to encourage compliance with traffic laws, intensify the correct enforcement of the law and to apply the appropriate penalties to violators, thus reducing the amount of traffic accidents and their consequences.

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