Rev Saúde Pública 2009;43(2)

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Land transport injuries among emergency department visits in the state of São Paulo, in 2005

ABSTRACT

OBJECTIVE: To analyze the characteristics of visits resulting from land transport injuries.

METHODS: A total of 5,934 visits in four hospital emergency departments (ED) were analyzed, in the state of São Paulo, in 2005. A questionnaire based on the following three models was used to collect data: World Health Organization (WHO), Center for Disease Control and Prevention (CDC), and Pan American Health Organization (PAHO). Variables analyzed were as follows: type of road user (vehicle occupant, pedestrian, motorcyclist, and cyclist), sex, age group, and type of injury suffered. Logistic regression analysis was employed to test associations between variables. Odds ratios with their respective 95% confidence intervals were calculated.

RESULTS: The majority of victims were males (74.2%) in the 20-to-29-year age group (35.0%). Vulnerable road users totaled 72.4% of all cases (29.8% were motorcyclists, 24.1% pedestrians, and 18.5% cyclists). Victims aged between zero and 14 years who had suffered injuries were mostly pedestrians and cyclists; motorcyclists predominated among those aged between 15 and 39 years; and pedestrians among those aged over 50 years. About half of the cases suffered minor injuries (strains, dislocations, contusions and cuts), while the other half was comprised by fractures, traumatic brain injuries and internal injuries. Extremities were the most affected body parts, particularly among motorcyclists. The majority of victims were discharged at triage (87.6%). Compared to women, men were 1.5 times more likely to be admitted or transferred, or to die. Pedestrians, vehicle occupants and motorcyclists were, respectively, 2.7, 2.4 and 1.9 times more likely to be admitted or transferred, or to die than cyclists.

CONCLUSIONS: Measures aimed to protect vulnerable road users should be among the priorities to reduce land transport-related injuries.

DESCRIPTORS: Traffic Accidents. Risk Factors. First Aid. Emergency Medical Care. External Causes.

INTRODUCTION

Land transport accidents refer to injuries associated with the flow of vehicles and people on public roads, according to the classification from the International Classification of Diseases, 10th Revision (ICD-10). Such accidents represent a very high cost to society. World Health Organization (WHO) estimates show that about 1.2 million people lose their lives worldwide annually due to these causes; there is an even greater number of hospitalizations, emergency department visits, and physical and psychological sequelae.[12] In 2004, the WHO

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Received: 10/11/2007
Revised: 7/8/2008
Approved: 8/7/2008

released a world report[12] with mortality rates from several countries, where Brazil came in fifth place in the world ranking. This report also pointed out this problem's iniquity of impact, once the majority of injuries and deaths occurred in developing countries, affecting pedestrians, cyclists, and public transport users particularly, many of whom lack the resources to acquire a motor vehicle. In addition, this report made public an important concept for prevention policies, that of vulnerable road users, including pedestrians, cyclists, and motorcyclists.

Currently, traffic protection policies are still geared toward motor vehicle users. However, only by guaranteeing equal protection to vulnerable road users can a reduction in land transport-related injuries be achieved. Estimates from developed countries suggest that 80% of the total costs associated with vehicle collisions can be attributed to non-fatal events.[1] Thus, this type of study is essential to establish evidence-based interventions.

In December of 2005, there were over 14 million registered motor vehicles in the state of São Paulo, including cars, trucks, buses and other types of vehicles, representing 37% of the total number of vehicles nationwide.[a] This means a proportion of about 2.8 inhabitants per vehicle in this state. In the city of São Paulo this proportion was almost two inhabitants per vehicle,[a] which led to the "urban mobility crisis",[15] one of the factors that contributed to the *motoboy* boom (professional motorcycle messengers). It is not difficult to imagine that this increase in motor-vehicle use can cause several problems for the population, including injuries.

In terms of fatal injuries, analysis of data available in the *Sistema de Informações de Mortalidade* (*SIM* – Mortality Information System) of the Ministry of Health/ DATASUS (Unified Health System's Computer Department), for the state of São Paulo, in 2005, revealed that mortality rates from land transport-related injuries were 17.7 per 100,000 inhabitants, coming in second place among external causes. However, analysis on type of road user does not provide accurate information, once the majority of deaths were classified as "other land transport accidents" (45.8%). Previous studies showed that these problems are also important causes of hospitalizations in the *Sistema Único de Saúde* (*SUS* – Unified Health System).[7,10] These represent a substantial cost to the *SUS*, once hospitalizations resulting from land transport accident injuries are more expensive than those due to natural causes as a whole.[10] However, there are few studies showing morbidity in emergency departments.

Thus, seeking to fill the gap of knowledge about the more general characteristics of these problems, the present study aimed to analyze the characteristics of morbidity resulting from land transport-related injuries in hospital emergency department services, emphasizing the analysis of categories of road users.

METHODS

The data analyzed are part of a study entitled "Non-fatal violence victims", coordinated by the São Paulo State Department of Health. Data on visits made due to all external causes, in emergency departments selected in the state of São Paulo, were collected.[8]

This study has a cross-sectional design, and the target population is comprised by all the emergency department visits resulting from land transport-related injuries. Four emergency departments (ED) participated in the data collection, of which three (ED 1, ED 2, ED 3) are in the city of São Paulo and one in the countryside (city of Ribeirão Preto – ED 4). These hospitals were selected because they are large hospitals with 24-hour ED, whose service is highly regarded in their area.

The definition considered to categorize a case as land transport-related injury was that recommended by the WHO:[12] "collision involving at least one motor vehicle in motion, on a public or private road, resulting in at least one person with fatal or non-fatal injury". A road user was considered to be "an individual using any part of the road system as a motor vehicle occupant or otherwise".[12] Cases were classified into five categories of road users, according to the National Electronic Injury Surveillance System (NEISS) concepts,[18] used by the surveillance system at emergency departments in the United States:

- Motor vehicle occupant: Injury to a driver or passenger of a motor vehicle caused by a collision, rollover, crash, or other event involving another vehicle, an object, or a pedestrian and occurring on a public highway, street, or road (i.e., originating on, terminating on, or involving a vehicle partially on the highway). This category includes occupants of cars, pickup trucks, vans, heavy transport vehicles, buses, and sport utility vehicles (SUVs).

- Motorcyclist: Injury to a driver or passenger of a motorcycle resulting from a collision, loss of control, crash, or other event involving a vehicle, object, or pedestrian. This category includes drivers or passengers of motorcycles (i.e., classic style), sidecars, mopeds, motorized bicycles, and motor-powered scooters.

- Pedestrian (struck by/against a vehicle): Injury to a person involved in a collision, where the person was not at the time of the collision riding in or on

[a] Secretaria de Estado dos Transportes de São Paulo. Os transportes no Estado de São Paulo: balanço anual dos acidentes rodoviários, São Paulo 2005. [Report]

a motor vehicle, railway train, motorcycle, bicycle, airplane, streetcar, animal-drawn vehicle, or other vehicle. This category includes people struck by cars, pickup trucks, vans, heavy transport vehicles, buses, motorcycles, bicycles, and SUVs.

- Cyclist: Injury to a cyclist from a collision, loss of control, crash, or an event involving a moving vehicle or pedestrian. This category includes riders of bicycles, tricycles, and mountain bikes, but excludes injuries unrelated to transportation (i.e., moving) (e.g., repairing a bicycle).
- Other transport: Injury to a person boarding, alighting, or riding in or on all other transport vehicles involved in a collision or other event with another vehicle, pedestrian, or animal not described previously.

Data collection was carried out during the period of one year in ED 1 to 4 (December 2004 to November 2005) and six months in ED 2 (January to June 2005) and ED 3 (July to December 2005). Different periods of study were due to operational reasons. The instrument used to collect data was a questionnaire designed from models provided by the World Health Organization (WHO),[10] Centers for Disease Control and Prevention (CDC) and Pan American Health Organization (PAHO), which have been used for data collection in emergency departments, in some Latin American countries.

An application to input data into the EpiInfo 2002 software program, version 3.3.2., was designed. Variables selected were the following: 1) demographics (sex, age, ethnicity, profession and level of education); 2) type of road user (motor vehicle occupant, motorcyclist, pedestrian, cyclist, or other); 3) injury characteristics (primary diagnosis and affected body part); 4) discharge status (treated and released, admitted/transferred or deceased). This information was analyzed as crude numbers and proportions.

A logistic regression model was used, aiming to assess variables associated with the discharge status. The dependent variable was discharge status, compiled into two categories (discharged and admitted, transferred or deceased). Independent variables were as follows: sex, compiled age group (<15 years, 15 to 29 years, 30 to 49 years and 50 years or older) and type of road user. Odds ratios (OR) were calculated, with their respective 95% confidence intervals (CI). Tests were conducted with a 5% significance level. Analyses were performed in the SPSS software program, version 13.0.

The research project was approved by the *Comitê de Ética em Pesquisa da Irmandade Santa Casa de Misericórdia de São Paulo* (City of São Paulo's Holy House of Mercy Brotherhood Research Ethics Committee).

RESULTS

There were 5,934 cases of injuries associated with land transport, corresponding to 11.6% of all visits resulting from external causes, in the period of study. The Tables and Figure only show the cases with information provided.

Table 1 show the distribution of visits, according to sex, age group and type of road user and/or public road. Men comprised 74.2% of all visits and women, 25.8%. Sex was not informed for 102 cases (1.7% of the total). The male/female ratio was 2.9, though it varied according to age group, being higher in the 20-to-29-year group and lower among infants aged less than five years and adults aged 60 years or older. This ratio also varied in terms of type of road user, reaching 7.0 among motorcyclists and 4.2 among cyclists.

Young adults, aged between 20 and 29 years, concentrated the highest proportion of cases, followed by the 30-to-39-year and 15-to-19-year age groups. However, the ratio of number of visits to age group revealed the importance of these injuries among the younger groups. The 20-to-29-year age group remained in the first place with 202.4 visits/year of age, followed by the 15-to-19-year age group with 161.4 visits/year of age, the 30-to-39-year age group with 91.5 visits/year of age, and the 5-to-9-year age group with 88.8 visits/year of age.

As regards the type of road user, the proportional importance of visits made by the most vulnerable groups, who accounted for 72.4% of all cases, was observed: motorcyclists were 29.8% of cases, pedestrians were 24.1% and cyclists were 18.5%. motor vehicle occupants accounted for 25.7% of all cases. The proportional distribution of these road users according to sex showed significant differences: women had higher proportions of injuries as pedestrians and motor vehicle occupants, whereas men were more frequently injured as motorcyclists and motor vehicle occupants.

The Figure shows the differences between road user categories, according to age group. Children and adolescents aged less than 15 years were injured mostly as cyclists and pedestrians, and only with a variation of each category's proportional importance. Among children aged less than five years old, for example, 40.4% of the cases were classified as cyclists and 37.6% as pedestrians, whereas in the 10-to-14-year age group, 62.5% of cases suffered injuries as cyclists and 16.7% as pedestrians. A change of pattern between 15 and 39 years of age is observed, where the motorcyclists' category becomes more frequent: 47.9% of cases in the 20-to-29-year age group were motorcyclists. From the age of 50 years on, pedestrians were responsible for the highest percentage of cases, especially in the age group of 60 years and older (61.6% of cases).

Table 1. Distribution of visits due to land transport-related injuries, according to age group and type of road user. State of São Paulo, Southeastern Brazil, 2005.

Variable	Male		Female		Total[a]		M:F ratio
	n	%	n	%	n	%	
Age group (years)							
0 to 4	125	2.9	80	5.3	205	3.5	1.6
5 to 9	285	6.7	159	10.6	444	7.7	1.8
10 to 14	309	7.2	127	8.5	436	7.5	2.4
15 to 19	577	13.5	230	15.4	807	14.0	2.5
20 to 29	1,646	38.4	378	25.2	2,024	35.0	4.4
30 to 39	696	16.2	219	14.6	915	15.8	3.2
40 to 49	343	8.0	129	8.6	472	8.2	2.7
50 to 59	158	3.7	83	5.5	241	4.2	1.9
≥60	146	3.4	94	6.3	240	4.1	1.6
Total[b]	4,285	100.0	1499	100.0	5,784	100.0	2.9
Type of road user							
Motor vehicle occupant	1,011	23.4	490	32.3	1,501	25.7	2.1
Motorcyclist	1,519	35.2	218	14.4	1,737	29.8	7.0
Pedestrian	866	20.1	538	35.5	1,404	24.1	1.6
Cyclist	870	20.1	209	13.8	1,079	18.5	4.2
Others	51	1.2	60	4.0	111	1.9	0.9
Total	4,317	100.0	1515	100.0	5,832	100.0	2.8

[a] Total does not include 102 cases for which there was no information about sex.

[b] Total does not include 150 cases for which there was no information about sex and age.

Table 2 shows road user categories according to the age group, level of education, primary diagnosis, affected body part and discharge status. In terms of level of education, the majority of individuals aged over 18 years reported having completed elementary school, even though the proportion of cases varied according to the road user category. Among motorcyclists, the majority reported having completed high school. Body extremities were the most affected body parts in all road user categories, but particularly among motorcyclists. About half of the cases showed injuries that could be classified as less severe (strains, dislocations, contusions, and cuts), whereas the other half was comprised by more severe injuries, such as fractures, traumatic brain injuries and internal injuries.

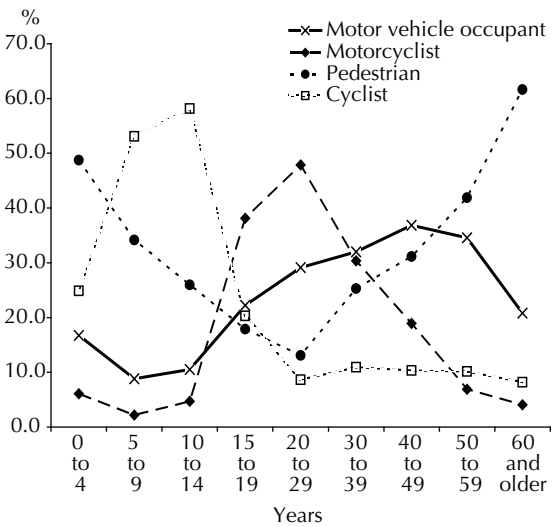

Figure. Proportional distribution of emergency departments visits due to land transport-related injuries, according to age group and type of road user. State of São Paulo, Southeastern Brazil, 2005.

The majority of cases were treated and released (87.6%), while 11.0% were either admitted or transferred and 1.4% deceased. The percentages of admittance and deaths were higher among pedestrians. Table 3 shows logistic regression results; men were 1.5 times more likely to be admitted or transferred or to die than women. Compared to the youngest age group (zero to 14 years), individuals aged 50 years or older were 1.54 times more likely to be admitted or transferred or to die, whereas this chance was 64% lower in the 15-to-29-year age group. Compared to cyclists, pedestrians were 2.73 times more likely to be admitted or transferred or to die; motor vehicle occupants, 2.36 times; and motorcyclists, 1.93 times.

Table 2. Distribution of frequencies of types of road users, according to level of education, primary diagnosis, affected body part and discharge status. State of São Paulo, Southeastern Brazil, 2005.

Variable	Vehicle occupant		Motorcyclist		Pedestrian		Cyclist		Others		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Level of education[a]												
Illiterate	11	1.5	5	0.5	31	5.1	7	2.8	2	3.4	56	2.1
Elementary school	327	46.3	401	41.5	347	57.3	157	62.8	33	55.9	1,265	48.9
High-school	302	42.7	521	53.9	215	35.5	80	32.0	21	35.6	1,139	44.0
University	67	9.5	40	4.1	13	2.1	6	2.4	3	5.1	129	5.0
Total	707	100.0	967	100.0	606	100.0	250	100.0	59	100.0	2,589	100.0
Primary diagnosis												
Fracture	149	10.0	292	17.0	196	13.9	166	15.2	14	12.4	817	14.1
Strain/dislocation/ contusion	395	26.6	622	36.3	374	26.6	339	31.1	54	47.8	1,784	30.7
Cut	249	16.7	338	19.7	212	15.1	298	27.4	12	10.6	1,109	19.1
TBI	242	16.3	155	9.0	213	15.1	181	16.6	19	16.8	810	13.9
Internal injury	19	1.3	10	0.6	13	0.9	6	0.6	-	-	48	0.8
Others	432	29.1	299	17.4	400	28.4	99	9.1	14	12.4	1,244	21.4
Total[b]	1,486	100.0	1,716	100.0	1,408	100.0	1,089	100.0	113	100.0	5,812	100.0
Affected body part												
Head/face	476	41.0	240	17.2	346	32.3	361	37.5	28	28.9	1451	30.9
Thorax/abdomen/ pelvis	147	12.7	77	5.5	91	8.5	66	6.8	15	15.4	396	8.5
Extremities	537	46.3	1,081	77.3	634	59.2	537	55.7	54	55.7	2,843	60.6
Total[b]	1,160	100.0	1,398	100.0	1,071	100.0	964	100.0	97	100.0	4,690	100.0
Discharge status												
Treated and released	1,280	86.2	1,519	89.1	1,154	82.7	995	92.9	102	94.4	5,050	87.6
Admitted/transferred	178	12.0	168	9.9	209	15.0	72	6.7	6	5.6	633	11.0
Deceased	27	1.8	17	1.0	33	2.3	4	0.4	-	-	81	1.4
Total[b]	1,485	100.0	1,704	100.0	1,396	100.0	1,071	100.0	108	100.0	5,764	100.0

[a] Includes the population aged 18 years or older exclusively.

[b] Totals do not include cases with unknown information on variable under study (122 cases without information on primary diagnosis; 1,244 cases without information on affected body part; and 170 cases without information on discharge status)
TBI: traumatic brain injury

DISCUSSION

In the findings of this study, the group of motorcyclists was responsible for the majority of ED visits. Most of them are young workers, with low professional qualification, whose services have become often required in urban areas of the state. There is an inherent risk in this type of work, as it is currently performed, which lies in the demand for fast deliveries. Urgency is "as important in the work of a *motoboy* as to guarantee their job".[17] A qualitative study in the city of Campinas, in the state of São Paulo, while discussing the relationship between motorcyclists and traffic violations, pointed out that the motorcycle was viewed by them as a symbol of adventure and challenge.[5] Among several intervention strategies to reduce these injuries are: the creation of motorcycle-only lanes on high-risk roads; qualification courses for *motoboys*, given by more experienced motorcyclists;[13] use of bright-colored clothing and accessories; promotion of traffic rules of sociability;[13] and the involvement of employers and service clients with safety issues. The lowest percentage of head/face injuries among motorcyclists, compared to other road users, found in this study, for example, may have resulted from the fact that helmet use is mandatory in Brazil. The United Kingdom reached a 25% reduction in injuries among young motorcyclists by restricting access to more powerful motorcycles.[1]

In major urban areas, pedestrians usually represent a considerable proportion of those injured in traffic.[14] In New York city, between 1998 and 2002, pedestrians

Table 3. Odds ratio (OR) comparing cases that were treated and released and cases that were admitted, transferred, or deceased. State of São Paulo, Southeastern Brazil, 2005.

Variable	Adjusted OR (95% CI)	p
Sex		
Male	1.51 (1.24;1.84)	<0.01
Female	1.00	
Age group (years)		
0 to 14	1.00	
15 to 29	0.64 (0.50;0.83)	<0.05
30 to 49	1.05 (0.81;1.35)	NS
≥50	1.54 (1.14;2.10)	<0.05
Type of road user		
Motor vehicle occupant	2.36 (1.75;3.18)	<0.01
Motorcyclist	1.93 (1.42;2.62)	<0.01
Pedestrian	2.73 (2.05;3.63)	<0.01
Cyclist	1.00	<0.01

NS: statistically not significant

accounted for almost half of the deaths.[14] In the present study, they represented a significant number of ED visits in all age groups. In addition, logistic regression showed that, compared to cyclists, pedestrians were the road users with highest probability of injuries resulting in admittance or death. Such fact is expected, given the fragility of the human body in a collision with a vehicle. The risk of a pedestrian dying as a result of a run-over is approximately 80% if the vehicle is moving at 50 kilometers an hour (km/h), and 10% if the vehicle is at 30km/h.[12] In this way, traffic jams, common in large cities of the state of São Paulo, can contribute to protect motor vehicle occupants, by preventing vehicles from moving at high speeds, but not pedestrians. Educational campaigns have been suggested as a key component to prevent pedestrian injuries, especially among children and the elderly.[12] In Brazil, differently from several developed countries, it is still necessary to promote respect for basic traffic rules among all road users, such as respect for pedestrian crosswalks and traffic signs. Some measures have proved to be effective, such as speed reduction in high-risk locations, residential areas and around schools.[1] A study aimed at measuring the impact before and after the introduction of speed bumps in Ghana showed a reduction of 51% in annual pedestrian deaths in this country.[1] The introduction of speed cameras in locations at high risk of collision led to a reduction of 56% in fatal and non-fatal injuries among pedestrians in the United Kingdom and 28% in South Korea.[1]

High proportions of injuries among motorcyclists and pedestrians are expected. However, there was a substantial percentage of cyclists attended, even though these road users are not usually in Brazilian studies on this issue. In the present study, these events were more important among children aged between five and 14 years, and it was not possible to determine how much of these injuries occurred during leisure activities. Bicycles do not usually move at high speeds, compared to motorcycles. Thus, some of these cases probably do not result from collisions, but rather from a loss of control of the bicycle, among other possibilities. This would explain the higher proportion of discharges in this group, compared to other road users. In addition, US emergency departments' 2004 data on injuries among cyclists showed that the age group between ten and 14 years was at higher risk for such injuries.[9] It also showed that the body extremities and, subsequently, the head/face were the most affected body parts.[9] The use of helmets among cyclists is low worldwide, despite the evidence that its use can reduce the risk of traumatic brain injury in this group to between 63% and 88%.[12] Bicycle lanes are also a measure with proven effectiveness.[12]

By interpreting the results from this study, some limitations stand out. One of them was the impossibility to use a more accurate severity measure, such as the Glasgow Coma Scale or another equivalent scale, as this would imply the use of a more complex questionnaire and training courses for doctors, which could compromise data collection viability. Another limitation of the study concerns data generalization, which is compromised because the hospitals selected are not a representative sample of the state of São Paulo, thus not enabling rate calculation. On the other hand, several findings of the present study are consistent with scientific literature data and can be generalized. The predominance of land transport-related injuries among males and young people is a common finding in Brazil[7] and abroad.[12,18] Data from the cities of Catanduva[3] and Londrina,[2] Southeast and Southern Brazil, respectively, also showed that motorcyclists accounted for the highest proportions of land transport-related, non-fatal ED visits. The importance of pedestrians in the public system's mortality and hospitalizations was also indicated by other studies.[7,16] The predominance of cyclists, aged 19 years or younger, among non-fatal victims of land transport-related injuries was also observed in a hospital of the state of Minas Gerais.[6]

Finally, it is necessary to point out that the repercussions of traffic on human health go beyond injuries. One intervention named "traffic calming", more commonly adopted by European countries, have proved to be promising to reduce fatal and non-fatal injuries.[4] This concept concerns a set of strategies used by urban traffic engineers and planners that aim to slow down or reduce traffic. This improves pedestrians and cyclists' safety, and the environment for residents, and it also contributes to the reduction of noise and air pollution. In addition, better enforcement of current laws is an important factor to be considered. It is estimated that,

if all traffic safety laws in the European Union were effectively enforced, related deaths and injuries would be reduced by 50%.[1]

Findings from the present study were consistent with WHO evidence that vulnerable road users represent the majority of traffic-injured victims,[11] especially in low- and average-income countries.[1] In the state of São Paulo, in particular, due to the large number of motor vehicles and inhabitants, to share the road system in a safe way is one of the greatest challenges for society and governmental authorities.

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Research funded by the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq – National Council for Scientific and Technological Development – Process n° 505446/2004-9).