



Helmet use and injury severity among crashed motorcyclists in Brazilian state capitals: an analysis of the violence and accidents survey 2017

Uso de capacete e gravidade de lesões em motociclistas vítimas de acidentes de trânsito nas capitais brasileiras: uma análise do Viva Inquérito 2017

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ABSTRACT: *Objective:* To analyze the effect of helmet use on injury severity among motorcyclists and passengers involved in traffic accidents. *Methods:* Cross-sectional study of traffic accidents involving motorcyclists attended at the emergency healthcare units participating in the Violence and Accidents Survey Conducted in Sentinel Emergency Departments (Viva Survey) 2017. *Results:* There was a predominance of individuals aged 18 to 29 years old (46.6%), black (75.2%), with high school education (50.6%). Alcohol use was observed in 14.1% of cases. Helmet use was associated with a 76% reduction in the occurrence of head trauma and a 28% reduction in the referral, hospitalization or death. *Conclusion:* Young, male, black individuals and those with low education were the most frequent victims of accidents. Helmet use was protective for severe injuries. *Keywords:* External causes. Traffic accidents. Health surveys. Ambulatory care. Patient acuity. Motorcycles.

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RESUMO: *Objetivo:* Analisar o efeito do uso de capacete na gravidade de lesões em condutores e passageiros de motocicletas envolvidos em acidentes de trânsito. *Métodos:* Estudo de corte seccional sobre vítimas de acidentes de transporte terrestre envolvendo motociclistas, atendidos nos serviços de urgência e emergência e participantes do Inquérito de Vigilância de Violências e Acidentes (Viva Inquérito) 2017. *Resultados:* Verificou-se predomínio de indivíduos na faixa de 18 a 29 anos (46,6%), negros (75,2%) e com ensino médio (50,6%). Em 14,1% dos acidentes houve relato de uso de álcool. O uso do capacete reduziu em 76% a ocorrência de trauma crânioencefálico e em 28% a ocorrência de encaminhamento para outro hospital, internação ou óbito. *Conclusão:* Motociclistas jovens, negros, de baixa escolaridade e do sexo masculino apresentaram-se mais vulneráveis aos acidentes. O uso do capacete mostrou-se protetor para lesões graves.

Palavras-chave: Causas externas. Acidentes de trânsito. Inquéritos epidemiológicos. Assistência ambulatorial. Gravidade do paciente. Motocicletas.

INTRODUCTION

Trauma caused by traffic accidents result in important social, economic, environmental and health impacts, in addition to overloading health services¹. In 2013, deaths and injuries from this cause were responsible for an overall cost of 3% of the global gross domestic product (GDP), and in low- and middle-income countries, this cost reached 5% of the GDP².

In Brazil, traffic accidents are the second leading cause of death among all external causes of mortality, with a higher occurrence in the population aged 15 to 39 years old. The main fatal victims are motorcyclists, who represent about one third of deaths from traffic accidents¹. From 2004 to 2013, there was an increasing trend in mortality in this group, with an increment in the average annual rate of 7.98% (95%CI 5.71 – 10.29)³. Between 2010 and 2017, there was a reduction in the number of deaths in all groups of victims of traffic accidents, with the exception of motorcyclists, mainly in the North and Northeast regions⁴.

The causality of accidents among motorcyclists involves multiple factors, such as vulnerability due to the type of vehicle, vertiginous increase in the fleet, lack of road and vehicle safety, risky behaviors^{2,5}, in addition to the increasing use of this vehicle as a work tool, without proper approaches to ensure work safety⁶. One of the preventable factors that contribute to the increase in the severity of injuries in motorcyclists refers to the lack of use of protective equipment. Cranioencephalic injuries, for example, are directly related to not wearing a helmet¹.

Knowing the factors that influence the use of protective equipment as well as the effectiveness of these devices for preventing serious injuries and deaths is fundamental to plan and improve public policies and guide law enforcement actions and educational campaigns. Thus, this study aims to describe the characteristics of traffic accidents among motorcyclists and to analyze the factors associated with helmet use, as well as the effect of this use on injury severity.

METHODS

Cross-sectional study on motorcyclists victims of traffic accidents admitted to emergency departments that participated in the Violence and Accident Survey (*Inquérito de Vigilância de Violências e Acidentes – Viva Survey*) 2017. Data were collected during 30 consecutive days, between September and December 2017, in services enabled for emergency care within the scope of the Unified Health System (*Sistema Único de Saúde – SUS*) of 23 Brazilian state capitals and the Federal District.

The sample calculation considered the number of admissions by external causes in each emergency unit in September 2016. A minimum sample of two thousand visits was calculated, considering a variation coefficient $< 30.0\%$, standard error < 3 and design effect ($deff$) = 2. A probabilistic one-stage clustered sampling approach was used to select 12-hour day and night shifts stratified by the type of healthcare unit (emergency care unit, hospital, and specialized health service). The number of shifts in each service was calculated by dividing the minimum sample size by the average number of admissions by external causes in the same unit in previous editions of Viva Survey.

Data were collected using a standardized form applied by trained interviewers. All admissions from external causes in the selected shifts were deemed eligible, except for individuals who sought care for the same occurrence more than once, such as situations of medical returns and/or complications of assistance.

Motorcyclists were defined as anyone who travels by motorcycle or in a sidecar or trailer attached to this type of vehicle, including drivers and passengers. The analysis was restricted to motorcyclists admitted to public emergency care services due to traffic accidents. The variables analyzed were gender (male; female), age group (0 to 9; 10 to 17; 18 to 29; 30 years old or older), self-declared race/color (white; black [black and brown]; yellow/indigenous), education (up to elementary school; high school; higher education), type of victim (driver; passenger), nature of the injury (without physical injury; contusion, sprain/dislocation; cut/laceration; traumatic brain injury (TBI); others), affected body part (head/neck/spine; trunk/upper limbs; lower limbs; multiple organs), helmet use (yes; no), alcohol consumption (yes; no), work-related event (yes; no), and evolution (discharge/evasion; referral/hospitalization/death).

Descriptive analyses of the sample characteristics regarding traffic accidents involving motorcyclists were carried out according to sociodemographic characteristics by driver and non-driver. The frequencies of helmet use were described and the associations between helmet use and the severity of injuries among motorcyclists were analyzed. The occurrence of TBI and case progression to referral to another hospital, hospitalization or death were considered proxies for injury severity. All analyses were stratified according to the type of victim (drivers and passengers), after which an aggregated analysis of drivers and passengers was carried out.

Bivariate associations were analyzed using the χ^2 test, with second-order Rao-Scott correction for complex samples. Prevalence ratios and their confidence intervals were calculated

using Poisson regression with robust variance. Multivariate analyses of the associations between the use of helmets and the occurrence of TBI and the case progression were also carried out in order to obtain the prevalence ratios adjusted for other variables that could contribute to the severity of the injury. The selection of adjustment variables was performed with the aid of a directed acyclic diagram (DAG). Age of the victim and use of alcohol by the driver were retained as adjustment variables in the model. Since only the use of alcohol by the driver was relevant for adjustment, and considering that there is no information about the driver whenever the admitted person was a passenger, this variable was included only in the analysis of injured drivers.

The analyses were performed using the survey module of Stata, version 14, considering the complex sampling strategy. All analyses were performed considering a significance level of 5%.

The Viva Survey Project was approved by the National Commission for Ethics in Research (Conep) of the Ministry of Health, under Opinion No. 2.234.509, 8/23/2017 — Certificate of Presentation for Ethical Appreciation (CAAE): 67709417.0.0000.0008. Data collection was carried out after the verbal agreement of the victims, or their guardians or caregivers when they were under 18 or unconscious.

RESULTS

Traffic accidents accounted for 11,802 emergency admissions, of which 7,813 (62.6%) were accidents involving motorcyclists. Ten cases were excluded from the analysis because the victims were not classified as drivers or passengers of the vehicle.

Injured motorcycle occupants were mainly aged 18 to 29 years old (46.6%), black (75.2%), and with high school education (50.9%). Alcohol use in the six hours prior to the occurrence was reported by 14.1% of injured motorcyclists and approximately one-third of the accidents were related to work. Comparing injured passengers and drivers, there was a predominance of men among drivers (86.6%) and women among passengers (64.5%) (Table 1).

The most frequent injuries were bruises, sprains/dislocations (33.4%), and cuts/lacerations (29.2%). TBI was observed in 2.9% of the sample. The lower limbs were the most affected parts of the body (42.2%), followed by upper limbs/trunk (29.9%) and multiple organs (16.0%). Head/neck/spine injuries were affected in 12.0% of cases (Table 2).

The mean prevalence of helmet use among admitted injured motorcycle occupants was 81.8% (95%CI 79.8 – 83.6), ranging from 97.6% (95%CI 95.8 – 98.6) in Cuiabá (MS) to 53.8% (95%CI 45.4 – 62.0) in Belém (PA) (Figure 1).

There were lower proportions of helmet use among young people, under 18 years of age, blacks (PR = 0.93; 95%CI 0.90 – 0.96) and who used alcohol (PR = 0.74; 95%CI 0.70 – 0.79), and higher proportions of equipment use among individuals with higher education,

involved in work-related accidents (PR = 1.20; 95%CI 1.15 – 1.25) and among drivers (PR = 1.11; 95%CI 1.07 – 1.15) compared to passengers (Table 3).

Helmet use was associated with a 76% reduction (PR = 0.24; 95%CI 0.18 – 0.32) in the occurrence of traumatic brain injury and a 28% reduction (PR = 0.72; 95%CI 0.62 – 0.83) in referrals to other services, hospitalizations or deaths, compared to discharge/eviction (Table 4).

DISCUSSION

The results of this study pointed out the vulnerability of motorcyclists to accidents and the importance of wearing a helmet in reducing the severity of injuries. Despite the

Table 1. Emergency care for accidents involving motorcyclists, according to the victim's characteristics, alcohol use and relationship with work, by type of victim. Selected services in 23 capitals* and the Federal District in 2017.

Characteristics		Passenger (n = 1,380)		Driver (n = 6,423)		Passenger and Driver (n = 7,803)	
		n	%**	n	%**	n	%**
Gender***	Female	905	64.5	1,011	13.4	1,916	22,8
	Male	475	35.5	5,412	86.6	5,887	77,2
Age range***	0 to 9 years	78	4.4	11	0.1	89	0.9
	10 to 17 years	219	15.3	256	4.2	475	6.2
	18 to 29 years	565	42.5	3,070	47.5	3,635	46.6
	30 years+	517	37.9	3,080	48.3	3,597	46.3
Race/Color	White/Caucasian	275	22.3	1,318	22.5	1,593	22.5
	Black	1,033	74.8	4,798	75.3	5,831	75.2
	Yellow/Indigenous	36	2.8	153	2.3	189	2.4
Education***	Up to elementar school	571	43.1	2,268	36.6	2,839	37.9
	High school	586	46.8	3,158	51.8	3,744	50.9
	Higher education	133	10.2	708	11.5	841	11.3
Work-related event ***		265	22.0	2,109	37.7	2,374	34.8
Suspected use of alcohol		159	13.3	898	14.2	1,057	14.1

*Macapá, Florianópolis and Porto Alegre were not included in the research; **weighted percentage; ***p < 0.05.

relevance of these findings, it is important to note that this study used data on care provided only by intentionally selected public emergency care services that were considered to be local references for treatment of external causes, which limits the possibility of generalization results.

The study showed that young people, aged 18 to 29 years old, black, and male were the main victims of traffic accidents involving motorcycles admitted to the selected emergency care units. More than a third of the events were work-related, and 15% of the injured persons were under the influence of alcohol. The lower limbs were the most frequently affected parts of the body, and TBI was observed in 2.9% of the sample. More educated individuals and motorcyclists who used the vehicle for work reasons were more likely to be wearing a helmet. Individuals who wore the helmet at the time of the accident had a 76% reduction in the occurrence of traumatic brain injury and about 30% reduction in referrals to other services, hospitalizations or deaths.

Table 2. Emergency care for accidents involving motorcyclists, according to the characteristics of the injury and care, by type of victim. Selected services in 23 capitals* and the Federal District in 2017.

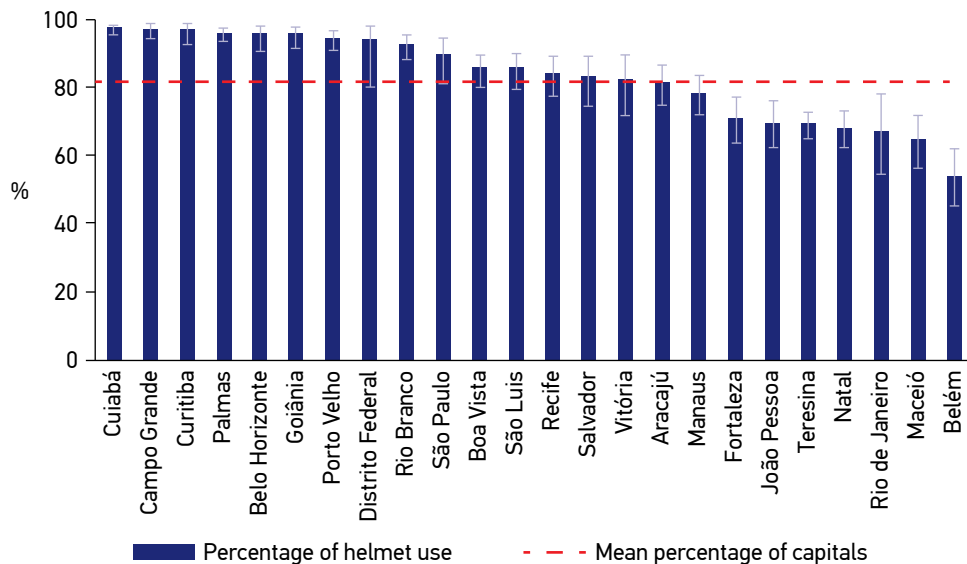
Characteristics	Passenger (n = 1,380)		Driver (n = 6,423)		Passenger and Driver (n = 7,803)	
	n	%**	n	%**	n	%**
Nature of the injury****						
No physical injury	55	3.2	138	2.1	193	2.3
Contusion, sprain/dislocation	719	36.0	1,700	32.8	2,419	33.4
Cut/laceration	560	29.7	1,825	29.1	2,385	29.2
Head trauma	27	2.5	164	3.0	191	2.9
Others***	535	28.5	2,002	33	2,537	32.1
Affected part of the body****						
Head/Neck/Spine	206	11.9	673	12.0	879	12.0
Trunk/Upper limbs	487	24.2	1,804	31.1	2,291	29.9
Lower limbs	852	46.2	2,273	41.3	3,125	42.2
Multiple organs	291	17.6	945	15.7	1,236	16.0
Evolution						
Discharge/Evasion	1,381	76.0	4,027	72.6	5,408	73.2
Referral/Hospitalization/Death	456	24.0	1,636	27.4	2,092	26.8

*Macapá, Florianópolis and Porto Alegre were not included in the research; **weighted percentage; ***includes fractures, amputations, dental trauma, polytrauma and other types of injury; ****p < 0.05.

Traffic accidents involving motorcycles result in high mortality rates in Brazil, as pointed out by several studies⁷⁻¹¹, with an increasing trend from 2000 to 2015⁷. This epidemic of deaths results from multiple factors, such as the rapid growth of the motorcycle fleet in the country, the precarious road infrastructure, the sharing of roads, in addition to behavioral issues such as excessive speed, alcohol use and not wearing a helmet¹⁶⁻¹⁸. It is noteworthy that the growth of the motorcycle fleet, in the last decades, concentrated mainly in the North, Northeast and Midwest regions and in small municipalities. This was due to the replacement of non-motorized means of transportation, such as bicycles and animals, by motorcycles^{2,7}, due to its low maintenance costs¹², improved traffic fluidity, lack of quality in public transports^{13,14} and tax incentives for buying this type of vehicle^{7,15}.

The high number of work-related motorcycle accidents requires further studies on work relationships and strategies related to work safety¹. Contributing factors to these accidents are the demands and pressure from employers and customers for fast services, excessive working hours, precarious working relationships, in addition to inadequate road infrastructure^{6,17-20}. Data from the National Health Survey (*Pesquisa Nacional de Saúde – PNS*), a survey of national representativeness of the domiciled population, carried out in 2013, showed that 30% of work accidents, about 1.9 million accidents, occurred while commuting to the work place²¹.

The association of alcohol use and driving was observed in about 15% of the events. Driving under the influence of alcohol has been considered one of the main risk factors for the occurrence of traffic accidents as it affects the driver's reflexes and increases risky choices,



*Macapá, Florianópolis, and Porto Alegre were not included in the research.

Figure 1. Frequency of helmet use in the total of drivers and passengers attended by motorcycle accidents in selected services in 23 capitals* and the Federal District in 2017.

such as transgression of traffic legislation^{21,22}. According to results of the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico – Vigitel*), a telephone survey representative of the population with landline telephony in Brazilian capitals, conducted in 2018, the frequency of adults who reported driving motor vehicles after drinking alcoholic beverages was 11.4% for the group of Brazilian capitals, varying from 5.7% in Recife to 24.1% in Teresina²³. In 2013, data from the PNS 2013 also showed that between 30 and 39% of people over 18 years of age who drink and drive cars or motorcycles drove under the effect of alcohol²⁴, with a two-times-greater chance of a traffic accident among those who drive after drinking alcohol²⁵. In addition, drivers who suffered an accident after using alcohol were mostly young men²⁵.

The characteristics of the injuries, with a high number of cuts, lacerations and TBI associated with the high percentage of hospitalization, referral to another hospital and death,

Table 3. Emergency care for accidents involving motorcyclists, according to sociodemographic characteristics of drivers, wearing a helmet. Selected services in 23 capitals* and the Federal District in 2017.

Characteristics		%**	p	PR	95%CI
Gender	Female	78.9	0.162		
	Male	80.8			
Age range	0 to 9 years	51.5	< 0.001	0.63	0.50 – 0.79
	10 to 17 years	57.4		0.70	0.63 – 0.78
	18 to 29 years	81.7		Ref.	
	30 years+	82.6		1.01	0.98 – 1.04
Race/Color	White/Caucasian	84.9	< 0.001	Ref.	
	Black	78.8		0.93	0.90 – 0.96
	Yellow/Indigenous	86.0		1.01	0.95 – 1.08
Education	Up to elementar school	73.3	< 0.001	Ref.	
	High school	83.6		1.14	1.10 – 1.18
	Higher education	91.4		1.25	1.19 – 1.30
Occupant	Passenger	73.8	< 0.001	Ref.	
	Driver	81.8		1.11	1.07 – 1.15
Work-related event		9.4	< 0.001	1.20	1.15 – 1.25
Suspected use of alcohol		62.6	< 0.001	0.74	0.70 – 0.79

*Except Macapá, Florianópolis, and Porto Alegre; **weighted percentage; PR: prevalence ratio; 95%CI: 95% confidence interval; Ref.: reference.

reveal the magnitude and severity of injuries in motorcyclists. In addition, it is emphasized that TBI is directly related to not wearing a helmet¹.

Motorcycles are considered to be one of the most dangerous forms of motorized transport due to the small size of the vehicle and the absence of the structure and protective devices that are present in cars, resulting in greater exposure of the occupants to the impact and greater vulnerability to multiple and more severe trauma^{26,27}. This vulnerability is even greater when there is a division of road space with larger vehicles¹⁶, resulting in a 30 times greater risk of death, when compared to the risk that occupants of other types of motorized vehicles are exposed^{28,29}. Thus, motorcyclists suffer disproportionately higher risks and more severe injuries from traffic accidents.

The current study showed that an important proportion of the victims did not wear a helmet, despite their mandatory status in the country³⁰⁻³². Enacting and enforcing laws to address risk factors is an effective measure to reduce deaths and injuries from traffic accidents³³, with a major impact on the severity of these accidents³⁴. This study reinforces the importance of the helmet as a safety device to prevent serious injuries. These findings are in accordance with evidence from the World Health Organization, which points to the

Table 4. Emergency care for accidents involving motorcyclists, according to type of injury, evolution, and type of victim. Selected services in 23 capitals* and the Federal District in 2017.

		Gross PR	95%CI	Adjusted PR	95%CI
Head trauma					
Driver and Passenger**	Without helmet	8.13	Ref.		Ref.
	With helmet	1.82	0.24	0.18 – 0.32	0.24
Driver***	Without helmet	8.13	Ref.		Ref.
	With helmet	1.82	0.22	0.16 – 0.31	0.25
Passenger**	Without helmet	5.4	Ref.		Ref.
	With helmet	1.7	0.31	0.17 – 0.58	0.33
Referral to other hospitals/Hospitalization/Death					
Driver and Passenger**	Without helmet	22.69	Ref.		Ref.
	With helmet	16.37	0.72	0.62 – 0.84	0.72
Driver***	Without helmet	23.83	Ref.		Ref.
	With helmet	16.97	0.71	0.61 – 0.84	0.80
Passenger**	Without helmet	19.19	Ref.		Ref.
	With helmet	13.36	0.7	0.5 – 0.97	0.71

*Except Macapá, Florianópolis, and Porto Alegre; **weighted percentage; ***analyses adjusted by age and driver alcohol use; PR: prevalence ration; 95%CI: 95% confidence interval; Ref.: reference.

protective effect of helmet use, with a 70% reduction in the chances of TBI and up to a 40% reduction in the chances of death¹⁷.

The study also revealed that young, black, low-educated, and male motorcyclists are more vulnerable to motorcycle accidents. The use of the helmet is shown to be protective against serious injuries, showing the importance of intensifying educational and law-enforcement measures¹ focused on motorcyclists and aiming the use of the helmet, considering its effectiveness in preventing severe injuries.

In Brazil, among the strategies to face the problem, the Life in Traffic Program (*Programa Vida no Trânsito – PVT*) stands out as the main national response to the challenges of the United Nations' global target for road safety and the Sustainable Development Goals (SDG). The PVT is a management and governance strategy focused on integrated actions, guided by local evidence and integrated data analysis, carried out through intersectoral plans, aiming to reduce morbidity and mortality from traffic injuries³⁵. In addition, the program seeks to promote safe and sustainable mobility in public spaces for the circulation of people. The program's priorities are the qualification of information to guide actions; the implementation of intersectoral and integrated actions on traffic law enforcement, education, infrastructure, health care and health promotion; interventions aimed at increasing the use of protective equipment, reducing speed, improving legislation and increasing enforcement actions focused on drink-drive behaviors and use of protective equipment; the improvement of sustainable urban transport and road infrastructure; prioritizing vulnerable groups of victims (motorcyclists, pedestrians, cyclists, and others identified locally); and strengthening intersectorality in the three management spheres³⁶.

It is noteworthy that, although Brazil achieved a reduction in deaths from traffic accidents between 2010 and 2017, the mortality rates of motorcyclists continue to rise, constituting a permanent challenge to tackle traffic deaths and injuries in the country. Thus, it is recommended to strengthen and expand intervention programs that emphasize intersectorality, the use of qualified information and the planning and execution of actions based on local evidence, such as the PVT.

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