ORIGINAL ARTICLE

Factors associated with incidence and mortality by road accidents involving motorcyclists and pedestrians: a rapid systematic review

Francisco Naildo Cardoso Leitão[a,b,c,d], Ítalla Maria Pinheiro Bezerra[e], Renata Martins Macedo Pimentel[b], Gabrielle do Amaral Virgínio Pereira[b], Adilson Monteiro[b,f], Alan Patricio da Silva[b], Beatriz Cecilio Bebiano[b], Andrés Ricardo Perez Riera[b]

[a]PhD candidate student in Health Sciences at Centro Universitário FMABC (FMABC) - Santo André, São Paulo, Brazil;

[b]Study Design and Scientific Writing Laboratory (LaDEEC/ FMABC) - Santo André, São Paulo, Brazil;

[c]Laboratório Multidisciplinar de Estudos e Escrita Científica em Ciência da Saúde (LaDEECCS/ UFAC) - Rio Branco, Acre, Brazil;

[d f]Universidade Federal do Acre (UFAC) - Rio Branco, Acre, Brazil.

[e]Escola Superior de Ciências da Santa Casa de Misericórdia de Vitória (EMESCAM) - Vitória, Espírito Santo, Brazil;

[f]Universidade Federal de Rondonópolis (UFR/MT) - Rondonópolis, Mato Grosso, Brazil

Corresponding author
nacal@outlook.com

Abstract

Introduction: traffic accidents are the third leading cause of death in the world. Vulnerable road users do not benefit from a high level of protection. As such, they face devastating consequences when involved in accidents.

Objective: to analyze the incidence and mortality, and associated factors in traffic accidents among motorcyclists and pedestrians.

Methods: rapid Systematic review of articles from the National Library of Medicine (PubMed), Virtual Health Library (VHL), and Web of Science databases using the descriptors Mortality, Accidents, traffic, Motorcyclists and Pedestrians. Inclusion criteria were: (1) studies involving pedestrians and motorcyclists; (2) the object of study is traffic accidents; (3) articles that studied mortality; and (4) articles published in the last ten years (2010-2019).

Results: of the 206 articles found, 19 met the inclusion criteria. Factors such as increased sales of motorcycles, darkness on the roads, older pedestrians, lack of safety equipment for motorcyclists, and drug and alcohol intake contribute to the increase of the mortality rate of these individuals.

Conclusion: mortality due to traffic accidents involving pedestrians and motorcyclists has increased during the analyzed period, especially among men.

Keywords: mortality, accidents, traffic, motorcycles, pedestrians.

Authors summary

Why was this study done?
This study was carried out to analyze the mortality, incidence, and associated factors in traffic accidents among motorcyclists and pedestrians. Thus, contributing to public health policies.

What did the researchers do and find?
The authors actively searched for studies published in the most robust scientific literature to analyze traffic accidents involving pedestrians and motorcyclists. The 19 articles filtered showed an increase in older pedestrians. Our findings revealed drugs and alcohol consumption, which contributes to the rise in the mortality rate of these individuals.

What do these findings mean?
It is one of the most problematic topics for public health in the world. It is essential to understand the behavior of people involved in traffic accidents related to pedestrians and motorcyclists, the most vulnerable population in traffic accidents in Brazil.

INTRODUCTION

Traffic accidents are a public health problem globally. Every day, hundreds of people lose their lives or suffer severe sequelae from traffic accidents.

The United Nations (UN) recognizes that these accidents are associated with behavioral factors, vehicle safety, and the precariousness of urban space due to the high rate of morbidity and mortality. This scenario is becoming worse due to the growing number of vehicles, lifestyle changes, and risk behaviors in the general population[1,2].

The World Health Organization (WHO) published the first global report on the prevention of road traffic injuries in 2004 and, for the first time, World Health Day focused on road safety. These causalities are the third leading cause of death in the world. Injuries mainly occur in people aged 15 to 20 years. About 90% of deaths and injuries occur in developing countries[3,4]. Moreover, the WHO estimates a 40% increase in worldwide mortality from this group of causes by 2030 if effective preventive measures are not adopted[5].

The advances of the automobile industries in Brazil generated multiplying effects of urban and social transformations[6]. The growth of the motorcycle fleet is expressive, with a 61% increase between 2002 and 2006. This growth was supported by federal policies that favored manufacturing, low cost, and financing facilitated by credit expansion, contributing to the increase of deaths from motorcycles in Brazil[7].

Modern cars have advanced safety features for protection in the event of a collision. The occupants have seat belts, airbags, and crumple zones. Pedestrians, cyclists, and motorcyclists face devastating consequences when involved in accidents; they are vulnerable road users and do not benefit from this level of protection[8].

Studies on traffic accidents in Brazil are scarce. Prevention and control actions are just beginning, and little is known about the behavior of motorcyclists and pedestrians, the safety conditions of roads and vehicles, traffic engineering, the human and environmental costs of the use of motor vehicles, and the traumatic consequences resulting from these accidents[9].

Therefore, this study aimed to identify the trend and incidence of mortality and associated factors in traffic accidents among motorcyclists and pedestrians.

METHODS

A rapid systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[10]. It was guided by the structured question: "What is the trend of mortality, incidence and associated factors in accidents involving motorcyclists and pedestrians?". The PICOS strategy was the base to build the research question (P) - motorcyclists and pedestrians; intervention (I) - traffic accidents; comparator (C) - not applicable; outcome (O) - death; and study (S): studies that follow the eligibility criteria. The findings and discussion of this study are presented with a descriptive and narrative approach.

In July 2020, it was registered in the PROSPERO Systematic Review Protocol Database to avoid unintentional duplication and reduce the risk of bias in selective reporting of the outcome. The registration identification is no. 199358, and, on August 16 of the same year, the definitive official registration code was no. CRD42020199358.

Research strategy

The search was focused on peer review articles published in the National Library of Medicine (Pubmed), Virtual Health Library (VHL), and Web of Science databases by keywords obtained by the VHL Descriptors in Health Sciences (DeCS).

In Pubmed, the identification of potential articles was performed through the descriptors: Mortality AND Accidents, Traffic AND Motorcycles AND Pedestrians in "All fields." In the Web of Science platform, "Topic" and document types (article) used the same descriptors. In the VHL, the search was by title, abstract, and subject, all with the same descriptors.

Selection strategy

The selection was made as follows: (I) search for articles in the databases; (II) reading of titles and abstracts, with analysis according to the eligibility criteria and; (III) full-text analysis of the works, being included in the systematic review only those that met all the inclusion criteria[11,12].

Inclusion criteria

Published studies were eligible when meeting the following criteria: (1) studies envolving pedestrians and motorcyclists; (2) the study object is a traffic accident;

(3) focused on mortality; and (4) articles published in the last ten years (2009-2019). There were no restrictions on sample size and foreign language.

Exclusion criteria

Articles were excluded if: (1) they used secondary databases (for example, books, theoretical works, or literature reviews); (2) studied samples that do not include motorcyclists and pedestrians; (3) duplicates; (4) studied a specific age (only elderly, children or adults); (5) had no direct relationship with traffic accidents; (6) do not differentiate the vehicles involved in traffic accidents and; (7) focuses on different subjects such as injury patterns, medical screenings, autopsies, mass transport.

Data extraction and study quality

The data retrieved were compiled in Microsoft Excel 2019. The form consisted of fields filled in by a reviewer in the following order: (1) identification of the study (name of the first author, year, and country); (2)

Methods; (3) aspects of the target population (age and sex); (4) aspects of the intervention performed (sample size, presence of supervision, frequency, session duration, and follow-up); (5) presence and (6) loss of follow-up; and (7) results studied.

To increase confidence in selecting articles, all search and selection steps were independently reviewed by two researchers who, after reading all the papers, agreed to establish which ones met the inclusion criteria.

■ RESULTS

Searches were performed in Pubmed, Virtual Health Library (VHL), and Web of Science databases, resulting in 206 articles; 81 articles were excluded due to duplicity. The main reason for exclusion in filtering by title was the focus on other subjects (clinical diagnosis, autopsies, medical screenings, types of injuries, head trauma, educational inequality, neurological trauma, among others). The flowchart below shows each step of the selection strategy (figure 1).
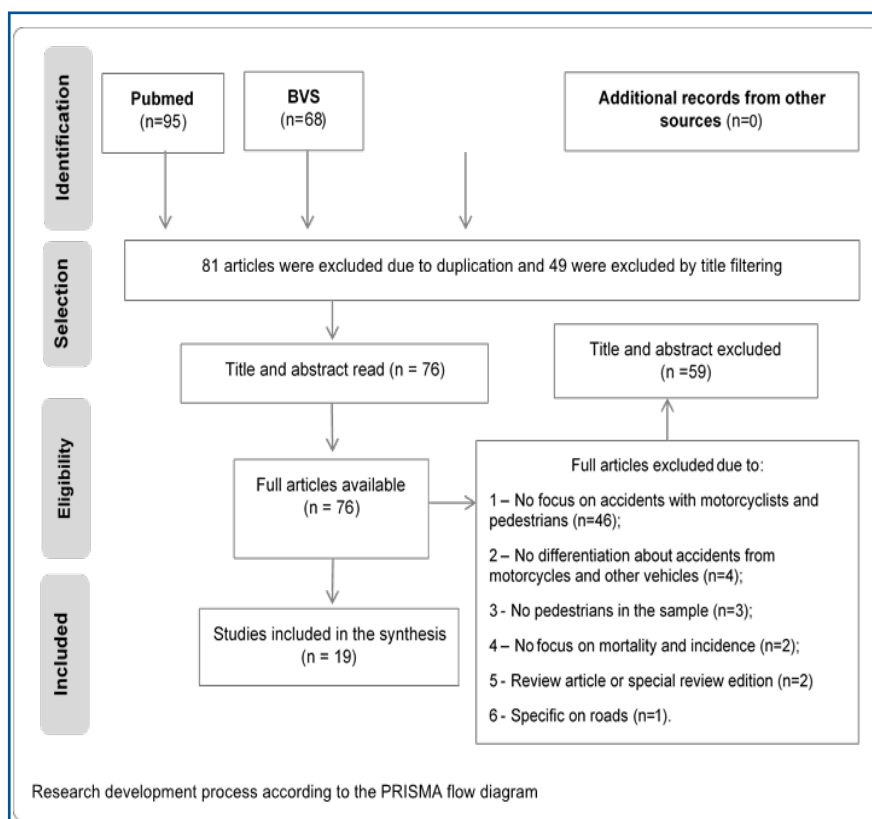
Figure 1: Flowchart of the article search and selection strategy according to the PRISMA recommendation
Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

After filtering by reading the titles, the next step was to read the abstract of 76 articles. At this stage, articles were excluded mainly because they did not focus on accidents involving motorcycles and pedestrians (n=46), did not differentiate the vehicles involved in the accident (n=4), there were no pedestrians in the sample (n=3), did not have a focus on mortality and incidence of these accidents (n=2), review articles or special review edition (n=2), and specific studies on roads (n=1). Finally, 19 articles were thoroughly read.

Study characteristics

Table 1 summarizes the 19 studies included for the synthesis: eight were descriptive[7,8,13-17], two longitudinal[18,19], two retrospective analyzes[20,21], three cross-sectional[22-24], two prospective[25,26], one quantitative[27] and one retrospective descriptive study[28].

Although systematic reviews of randomized clinical trials are frequent, there is evidence of a growing number of literature assessments based on observational research, such as cohort, case-control, cross-sectional, series, and case reports[29]. For these reasons, there was no restriction by the type of study.

All the studies had, as a sample, accidents involving pedestrians and motorcyclists. Four of them[8,11,16,28] specifically address pedestrians, motorcyclists, and cyclists.

In 15 of them, the mortality was higher among men, whether pedestrians or drivers, and in only one, the difference between the sexes was not significant. Some studies did not present values by sex[12,15,17].

Only three[8,13,27] of the 19 studies included were carried out in developed countries.

Table 1: Literature records found in databases on mortality from traffic accidents.

AUTHOR/YEAR	MAIN FINDINGS
Cabarkapa M., 2018[12]	The consequences for vulnerable road users are more significant than for other participants. Pedestrian mortality rates are higher in Montenegro than in the EU, followed by motorcyclists and cyclists; changes in the pedestrian fatality ratio showed a downward trend, particularly after implementing campaigns to improve pedestrian safety in 2014. Despite improved protection for vulnerable road users, it is less successful than for people in vehicles. The distribution of fatalities among cyclists, motorcyclists, pedestrians, and car occupants has a clear correlation.
Rodrigues, *et al.*, 2018[18]	There were 48,879 hospital admissions for pedestrians in the city of São Paulo. Pedestrian collisions occurred mainly by automobiles (21.0%), motorcycles (10.1%), buses (4.0%), and bicycles (1.5%), with an increase in those caused by motorcycles, cars, and buses and decrease in being run over by bikes. Regarding gender, they occur mainly in males (70.1%), 61.5% of cases, between the age groups of 20 to 59 years. Injuries to the lower limbs are the most frequent, as in a traffic accident, they have initial contact against the vehicle.
Parreira *et al.*, 2012[20]	Three thousand seven hundred eighty-three blunt trauma victims were included, aged between 14 and 99, (76.0% males). The most frequent trauma mechanisms were accidents involving motorcyclists in 924 cases (24.4%), being run over in 855 (22.6%). Motorcyclists had a lower mean age, lower mean systolic blood pressure at admission, and lower mean Abbreviated Scale of Injuries in the head segment, with the majority, were male.
Hasani *et al.*, 2019[22]	Of a total of 10,742 pedestrians, 63.3% are men, 10,059 were injured, including 3,771 women (37.5%) and 6,288 men (62.5%), 469 were killed, including 105 women (22.4%) and 364 men (77.6%), the result of 214 people was unknown. Some risk factors for increasing pedestrian fatality in urban traffic accidents are not considered risk factors in suburban accidents, such as age, gender, lighting condition, day of the week in terms of holidays, vehicle type, and pedestrian position. Furthermore, the only common risk factor in urban and suburban accidents is the type of road. The risk of pedestrian deaths in urban accidents was higher on two undivided lanes than on one-way streets, while in suburban accidents, the risk of fatality was lower on two- lane roads than on one-way roads.
Vanlaar *et al.*, 2016[8]	Although the number of fatalities and the rate among vulnerable road users may be decreasing, no trend is apparent when analyzing the proportions of these fatalities among motor vehicle users. The trend of motorcycle deaths is increasing. Mortality rates for elderly pedestrians with serious injuries are high. The rate of people aged 15 and under are higher in cyclists and between 16-25 years in motorcyclists. Among fatally injured pedestrians tested for alcohol and drugs, 39.7% and 43.4% were positive, respectively. Head injuries were more prevalent among the severely injured and cyclists. Men are over-represented in terms of alcohol consumption; in terms of positive drug tests, gender differences were not significant.
Bouaoun *et al.*, 2015[13]	The average annual number of fatal accidents recorded by the police in metropolitan France was 3634. The majority were men (76.0%), being 3.4 times higher than women, almost a quarter of all fatalities in 21 to 29 years old. Car occupants were responsible for 56.3% of deaths, motorcycle users for 27.0%, pedestrians for 13.1%, cyclists for 3.4% and public transport users for 0.3%. Annual fatality rates were 6.3 per 100 million trips, 5.8 per billion kilometers traveled and 0.20 per million hours spent traveling. The risk of death is 20 to 32 times greater for motorized two-wheel users than for car occupants. The risk for pedestrians compared to car occupants was similar according to the time spent on the trip, lower according to the number of trips, and higher according to the distance covered. People aged 17-20 and 21-29 years of age and 70 and over had the highest rates.

Continuation - Table 1: Literature file found on mortality from traffic accidents.

AUTHOR/YEAR	MAIN FINDINGS
Zangooei. *et al*., 2013[14]	Pedestrians have the highest average age, and motorcyclists have the lowest. The average age of male occupants of pedestrians and motor vehicles is higher than that of women in these categories. In contrast, for motorcyclists, the average age of men is lower than that of women. The youngest dead are male motorcyclists (average age 28). In all groups, men have more fatalities than women. The category of pedestrians has the highest number of deaths (919), and the group of motor vehicle occupants has the lowest (707). Deaths decreased during 2006-2007 and increased after the hospital stay. Among all road users, the riskiest group is the male motorcyclist. The head is the most affected part in fatal road accidents, as 64% in motor vehicle occupants, 73% of pedestrians, and 76% of motorcyclists die from head injuries.
Edirisinghe *et al*., 2014[28]	Of the 328 fatality cases included, 48% (157) were pedestrians, 45% (147) were two-wheel motorcyclists, and 5% (16) three-wheeled drivers/occupants. The majority (87%) were male, and 43% of pedestrians were elderly. Head injuries are statistically significant in the pedestrian group compared to other vulnerable road users.
Chalya *et al.*, 2010[23]	384 patients with motorcycle injuries, representing 37.2% of all road traffic accidents in Tanzania. More than two-thirds (69.5%) were male, and the average age was 25.7 years. Motorcyclists accounted for most victims with motorcycle injuries (212, 55.2%), followed by passengers (130, 33.9%) and pedestrians (42, 10.9%). Helmet use was recorded in 87 patients (22.7%). The mortality rate was 16.7% (64 deaths), 284 (73.9%) accidents occurred during the day, and 92 (23.9%) at night. In 8 (2.2%), the time was not specified or missing.
Ogunlusi *et al.*, 2011[25]	The total number of patients studied was 136 in 115 accidents; 127 were men, 105 were pilots, 21 passengers, 3 pedestrians and 7 additional passengers. The age group was from 15 to 72 years old, with an average of 27.93. Most of them did not wear a helmet. About 45% had consumed alcohol/marijuana. Only 4 patients died. A considerable proportion of accidents are collisions between motorcycles and other vehicles. 53% of accidents occurred over the weekend.
Aduayi *et al.*, 2016[24]	150 motorcyclists were victims. The male to female ratio was 4:1. Only 4 (2.7%) wore a helmet at the time of the injury. About a third of patients (39.3%) arrived at the hospital within 16 hours of the injury. The mortality rate was 10.7%. The mean age was 41 in10 years. Based on the patient's position concerning the motorcycle at the time of injury, there were three categories of victims comprising 49.3% motorcyclists, 36.7% passengers, and 14% pedestrians. The most significant number of deaths was among motorcyclists.
Solagberu et al., 2014[26]	A total of 702 pedestrians were included, 70% men, with a female ratio of 2.4, representing 1.76% of accidents occurred on highways, 22% on city center roads, and 2% elsewhere. Among vehicles, 33% were motorcycles, 27% cars, 22% buses, 6% trucks, 2.4% tricycles, and 9% others. The overall fatality was 10%. Crossing roads represented almost two-thirds of collisions (63.5%) while walking on the pavement (17.1%), standing at a bus stop (12.0%), or in front of a store/house (4.8%). Road collisions involved 534 pedestrians (76.1%), mainly motorcycles (25.9%), cars (19.2%) and buses (17.2%).
Damsere *et al*, 2010[21].	There were 812 pedestrian victims, 33% fatal, 45% serious injuries requiring hospitalization, and 22% not hospitalized. Crossing the highway was responsible for more than 70% of deaths. There were significantly fewer deaths in 2005 and 2006. According to the police, traffic accidents decreased considerably from 37% in 1997-1998 to 27% in 2003-2004. The probability of a pedestrian fatality in Ghana due to speeding is 65%. Compared to buses, pedestrians were less likely to die when hit by private cars (52%), pickup trucks (57%), and motorcycles (86%). Deaths at night were more frequent, and pedestrian deaths were significantly higher on the road sections without traffic signals than those with them.

Continuation - Table 1: Literature file found on mortality from traffic accidents.

AUTHOR/YEAR	MAIN FINDINGS
Sadeghi *et al,* 2016[19].	This study analyzed 15,331 injuries in 21 hospitals in the capital of Iran. The total number of deaths from road traffic injuries was 266; 77% were outpatients, 22.1% were hospitalized, 26% were pedestrians, 32% were motorcyclists, 4.6% were cyclists, and 37.1% were not motorcyclists. The average age of all victims was 32.8 years. The majority, 251 deaths, occurred in public university hospitals. These were distributed as 32 (80%) deaths in public teaching hospitals, seven (17.5%) deaths in other public hospitals, and one (2.5%) death in private hospitals. Among the twelve hospitals, six were public teaching hospitals, two were public hospitals, and four were private hospitals. The risk of mortality for men was more significant than for women.
McAndrews *et al.*, 2013[27]	The number of motorcycle trips in 2009 was 118% higher than in 2001. The total number of hospital fatalities and injuries was 6,667 and 32,335, respectively. The total number of injuries was 162,598. Motor vehicle occupants are responsible for 79% of deaths, 74% of hospital injuries, and 90% of emergency injuries. Motorcyclists accounted for the second-largest share of deaths (13%), hospital injuries (16%), and emergency department injuries (5%). Men accounted for 68% of fatal accidents and 61% of hospital injuries. Women suffered the most injuries in the emergency department (53%). Black people had the second-highest rate of hospital injuries, and Asians had the lowest mortality rates. Black people travel longer for time and distance, with 78% motor vehicle, 17% walking, 4% transit and <1% bicycle, and white people were 90% motor vehicle, 6% walking, 2 % of traffic and 1% bicycle. Motorcyclists are at the most significant risk, and death rates for cyclists and pedestrians are higher than for motor vehicle occupants. Pedestrians and cyclists have higher mortality rates than motor vehicle occupants. For American Indians, the proportion is lower for hospital injuries and deaths.
Chandran et al., 2012[15]	Road traffic death rates have increased since 2000. 39,211 deaths were recorded, resulting in a crude death rate of 20.7 per 100,000 population. Pedestrian mortality averaged 5.46/100,000 inhabitants. The mortality of elderly pedestrians (<80 years old) is 20.1/100,000 inhabitants, 10 times higher than that of 0-9 years old. The 20 to 29 age group is most affected by motorcycles deaths, with a maximum mortality rate of 10.76/100,000 inhabitants. Men have a higher rate in all age groups, even higher in those on motorcycles. Mortality of vulnerable road users accounts for more than half (51%) of all road traffic deaths, and most deaths are evenly distributed among pedestrian and motorcyclist deaths.
Leveau CM. 2013[16]	Two space-time clusters with high mortality risk in motorcycle users were reported in north-central Argentina and the province of La Pampa, southwest of the province of Buenos Aires. Higher mortality rates are recorded in more densely populated departments. Motorcyclist mortality showed a significant increase during the second half of the 2001-2010 period in the central and north-central regions of the country. As of 2004, there was a constant increase in sales of these vehicles, favored by the affordable prices of low-displacement motorcycles. Deaths of motorcycle users have been associated to the increment sales of these vehicles.
Marín-León et al., 2012[7]	Between 1995 and 2008, the motorization rate in Campinas, Brazil, went from 39 to 61 cars per 100 inhabitants. The increase in the motorcycle fleet was expressive, going from 3 to 9 motorcycles per 100 inhabitants. The percentage of accidents involving victims was 19.3% in 1995, increasing to 24.8% in 2008. The proportion of pedestrians being run over, which was 5.6% in 1995, decreased to 4.3% in 2008. Pedestrian deaths fell from 55.3% to 29.7%, and those of motorcycle occupants increased. The risk of men dying from traffic accidents was always more significant than that of women. In 2008, 8.2 and 3.6 men died for every woman among vehicle occupants and pedestrians, respectively. Out of every thousand accidents involving motorcycles, 4 caused the death of pedestrians, with 6.7 deaths of pedestrians being run over by motorcyclists for every fatal accident by a car. Vehicle occupant mortality was higher among young people aged 15 to 29 years.

Continuation - Table 1: Literature file found on mortality from traffic accidents.

AUTHOR/YEAR	MAIN FINDINGS
Besharati *et al.*, 2018[17]	34,178 accidents involving pedestrians were identified. 87.3% occurred on urban roads and 12.7% in rural segments. All accidents involving pedestrians over the age of 60 ocurred in dark zones and were fatal. If the pedestrian is less than six years old and the lighting is dim, the fault maybe 3.6 times more likely to be fatal. The risk of pedestrian fatality would increase 3.5 times for an urban road. In the case of darkness, the accident is 3.2 times more likely to be fatal. The driver was found "not guilty" by 9.4%. The probability of the driver not being at fault would be 3.1 times greater in fatal accidents where the driver and pedestrian are female and there is no traffic. It is 4.2 times greater in deadly accidents where street lighting, pedestrians' dark clothing color, and the accident occurred near a vacant lot. The probability of the driver not being at fault is four times greater in fatal accidents where the pedestrian is waiting on the side of the road. The likelihood of the rider failing can be 2.4 times greater if the rider is over 60 years old. If the motorcyclist and pedestrians belong to children under 19 and over 60 years of age, the accident could be 5.3 times more likely to be fatal.

Countries where the studies were performed

Four from Brazil[7,17,18,20]; four from Iran[14,17,19,22]; two in Nigeria[19,26]; one in Montenegro[12]; one in Canada[8]; one in France[13]; one in Sri Lanka[9]; one in Tanzania[23]; one in Saint Lucia[25]; one in Ghana[21]; one in the United States[27]; and one in Argentina[16].

■ DISCUSSION

Some studies showed geographic restriction when analyzing data from only one city or state, making generalization impossible.

Four articles were produced in Iran. Iranian women are free to drive; however, married women must have their husbands' permission[29]. It can be interpreted as a kind of prejudice in the country.

The safety for pedestrians and motorcyclists is lower compared with the drivers of other types of vehicles[12]. The evicence of this review shows that the highest mortality occurs among men. In addition, most of the studies included were carried out in underdeveloped or developing countries.

Data on the safety of vulnerable road users, who are not protected in traffic accidents, such as pedestrians, cyclists, motorcyclists, and mopeds, were analyzed in Montenegro and the European Union. The exposure of this group is higher in low and middle territrories[12].

For groups of vulnerable road users in Montenegro and the European Union, between 2000 and 2016, pedestrian mortality rates were the highest, followed by motorcyclists and cyclists. The risk of pedestrian mortality in road traffic is significantly higher in Montenegro than in the European Union[12].

In a fourteen-year time series in Brazil, there were 48,879 admissions for being run over pedestrians in São Paulo city. Pedestrian collisions occurred mainly by automobiles (21.0%), motorcycles (10.1%), buses (4.0%) and bicycles (1.5%). During the years analyzed, there was an increase in pedestrians being run over, 70.1% in males. Lower limb injuries are the most frequent, as they have initial contact with the vehicle. The prevention of traffic accidents is essential because of the morbidity and mortality and the costs they represent. It is necessary to discuss the problem involving the public authorities, transit organs, communities, drivers, and pedestrians[18].

An analysis of the protocols of blunt trauma victims was performed. Motorcyclists were the victims most frequently attended to in the emergency, surpassing in absolute numbers the victims of being run over, falls, car accidents, and physical aggression. Motorcyclists had lower frequency and severity of head injuries and higher frequency and severity of limb injuries. In Brazil, accidents involving motorcyclists are frequent and severe; they need to be targeted by specific actions related to prevention and improvement of care[20].

In Iran, the fatality rate from pedestrian traffic accidents is very high. That's why their safety is one of the most crucial problems in the healthcare system. Data on all pedestrian-related traffic accidents were investigated from two databases. Some risk factors that increase pedestrian fatality in urban traffic accidents are not considered risk factors in suburban accidents, such as age, gender, lighting condition, day of the week, holidays, vehicle type, and pedestrian position. The only common factor is the type of road[22].

The number of deaths at night was higher, probably due to lack of street lighting, lack of lights in vehicles, fatigue, and drivers' drowsiness. The increase in pedestrian movement and the frequency of road accidents involving a pedestrian are significantly increased[22].

Motorbikes are low-cost means of transport, seen as a good option at a time of economic crisis, in addition to allowing their users to avoid traffic jumps, as observed in France. A study with secondary data shows that the risks for motorized two-wheel users are incredibly high compared to other types of road users, mainly due to the combination of speed and lack of protection (except for helmets). Regardless of the exposure unit considered, these users have much higher fatality rates than other types of road users, having 20 to 32 times the chance of death[13].

A study of fatal road accidents was carried out in a province in Iran. The male/female ratio is 3.41, even higher among motorcyclists. The ratio between injuries to the head and other body parts (trunk and lower body) was 2.51; pedestrians had the highest head injuries (38.2%). Women are more vulnerable at the scene of the accident, according to the study. Pedestrians aged 21-30 years, motorcyclists aged 41-50 years, and motor vehicle occupants aged 31-40 years have the highest mortality rate[14].

The study also states that developing nations have insufficient financial resources for road safety, focusing on riskier groups. Adequate facilities for elderly pedestrians, training courses before obtaining a motorcyclist's license, information on the risk of death for road users, and improved management of patients with head injuries may be good options[14].

In Sri Lanka, pedestrian deaths were around 33%, and drivers and cyclists accounted for 44%. Analysis of different pedestrian variables for other types of vulnerable road users shows that older men, road crossing, head injuries, brain injuries, multiple and head injuries were significantly higher in the pedestrian group. There was a difference in the cause of death: head and numerous injuries were statistically significant among pedestrians, compared to other users, which can be explained by the absence of protective equipment such as helmets[9].

In a study in Tanzania, 37.2% of traffic accidents involve motorcycle users. The average age was 25.7 years. Injuries are among the leading causes of disability and death, and the primary victims are motorcyclists, passengers, and pedestrians in their productive age group. Contrary to the result of another study[22], 73.9% of accidents occurred during the day, 23.9% at night, and 2.2%, it was not specified. Young adult men in their reproductive and productive age group are commonly affected[23].

In St. Lucia, a study was carried out in the hospital emergency room with 115 patients who had injuries from motorcycles accidents. Most were weekend accidents, and 52.9% of patients were not wearing a helmet. The main reasons were collision between motorcycles (n=50), with other vehicles (n = 20) and motorcycle crash (n = 21). Alcohol has been identified as a major contributor to the fatal crash[25].

The study revealed that men were injured more than women, suggesting that men are more vulnerable to trauma. This proportion can be explained by the fact that the motorcycle is not used for commercial transport. Driving this vehicle is considered a male activity in St. Lucia. The age of patients ranged from 15 to 72 years. An education program on the high risks associated with helmetless motorcycling is recommended, including laws limiting alcohol concentration in the blood[25].

Research in an emergency unit from Nigeria of 150 individuals analyzed motorcycle-related injuries' associated factors and outcomes. The male-to-female ratio was 4:1 in patients aged 20 to 29 years. Only 2.7% of patients wore a helmet at the time of the accident, 39.3% of patients arrived at the hospital within 16 hours of the injury, and the mortality rate was 10.7%. The motorcycle collision caused the most significant number of deaths. Therefore, the authors emphasize the need for preventive measures, law enforcement, and behavioral changes among motorcycle users[24].

Accidents of pedestrians seeking care at the busiest emergency room in Lagos, Nigeria, were analyzed. The article reported that the highest incidence of pedestrian accidents was due to motorcycles. There is a need to strengthen the health system, especially regarding emergencies, and improve hospitals' capacity to deal with these events[26].

Car use is low in Ghana, and public transport is non-existent or associated with unfair fares forcing people to make most of their travel on foot. For this reason, pedestrian injury patterns were examined from a database[21].

There has been a considerable reduction in pedestrian mortality rates since 2004, corresponding to an increase in traffic calm and a focus on pedestrian safety. Mortality rates during the night were notably higher[22]. According to the study, steps that can decrease deaths include reducing vehicles' speed in settlements, providing traffic measures, and better lighting[21]. It suggests that the increase in preventive devices has improved pedestrian safety.

A longitudinal study in Iran investigated accidents in two-wheeled vehicles and pedestrians. The majority, 77%, were outpatients, and 22.1% were hospitalized. Of the victims, 26% were pedestrians, 32% were motorcyclists, 4.6% were cyclists, and 37.1% were not motorcyclists. The mortality risk for men was higher. The results emphasize the need for outpatient care in hospitals. Being a vulnerable road user increases the risk of death compared to other types of traffic victims. The risk rate for mortality of victims referred to public teaching hospitals is 5.8 times higher than in other hospitals[19].

A study on the risk of transport injuries in Wisconsin, USA, uses two sources of information on fatal and non-fatal injuries. When traffic-related injuries are represented, the problem mainly affects adults, white drivers, and men. It is essential to differentiate the risk of transport accidents in different modes of travel, transport policies and programs, and public health. The pattern is that the road transport system is not equally safe for everyone. The concerted effort to protect children has been successful, but teens, older drivers, American Indians, and black people are increasing risks[27].

One approach to reducing these disparities would be to focus analysis and prevention on the travel patterns, behaviors, and environments of specific demographic groups, rather than the population, and implement measures to reduce the risk of traveling, especially for those with a relatively greater chance, like motorcyclists, teenagers and cyclists[27].

Data on Brazilian traffic fatalities were extracted from a database of deaths of vulnerable road users, such as pedestrians and motorcyclists. Elderly pedestrians are at exceptionally high risk, and motorcycle deaths are increasing rapidly, coinciding with the motorcycle fleet increase. Death rates among bicycle users are the lowest. Road safety interventions should target vulnerable road users[15].

Using three different sources of data, a study conducted in Argentina analyzed the variations in the mortality of motorcycle users. Motorcyclist mortality increased in the second half of the period studied in the central and central-north regions of the country. It was found that higher mortality rates are generally recorded in areas with greater population density. Brazil also showed an increase in motorcycle mortality, which coincides with the rise in the number of motorcycles in circulation[16].

In Campinas, Brazil, a study of secondary data on traffic accidents registered an increase in the means of

transport, with the motorization rate going from 39 to 61 vehicles per 100 inhabitants. The increase in the motorcycle fleet was even more expressive, going from three to nine motorcycles per 100 inhabitants in the same period. The percentage of accidents with victims from 19.3% increased to 24.8%. The percentage of pedestrians who were run over, which was 5.6%, decreased to 4.3%. There was a change in the type of fatality: pedestrian deaths decreased and motorcycle deaths increased[7].

The risk of men dying from traffic accidents in all periods analyzed and the mortality of vehicle occupants was higher among young people aged 15 to 29 years. For every thousand motorcycle accidents, four caused the death of pedestrians, with 6.7 deaths of pedestrians being run over by a motorcycle for each fatal accident by a car. Thus, the research indicates that the groups at most significant risk for traffic accidents are motorcyclists, the male population in general, and, above all, young people[7].

Accident data in Iran were used in a descriptive analysis of pedestrian incidents. The simultaneous existence of pedestrians over 60 years old and darkness in an accident increases the risk by 2.5. Thus, the study claims that the interaction of lighting and the dark color of pedestrian clothing can increase the risk of death. This problem can be solved by creating electroluminescent or retro-reflective materials attached to clothing, as well as persuading pedestrians to wear colorful clothing to increase their visibility[17].

In Brazil, the mortality of vulnerable road users represents more than half (51%) of all traffic deaths[15]. Motorcyclists are generally more vulnerable as most of them may be driving drunk and exceeding the speed limit. Alcohol consumption causes carelessness and loss of concentration and speeding and neglecting the use of safety equipment such as a helmet[20].

Study limitations

All studies included in the synthesis of this review were performed with information taken from a database or medical protocols provided by hospitals. These analyses can generate restrictions due to the lack of harmonization among the databases concerning accidents, underreporting, inability to access specific factors, and lack of detailed information on the severity of injuries.

In the specific case of hospital protocols, amnesia of patients, victim family or health professionals who do not have complete facts about the incidents is also a limitation.

Contributions to public health

Mortality, both in pedestrians and motorcyclists, is higher in males. Factors such as increased sales of motorcycles, older pedestrians, lack of safety equipment for motorcyclists, and drug or alcohol intake increase the rate and incidence of death.

Inadequate lighting is also an important environmental factor, which contributes to increasing the risk of this fatality. In addition, most accidents are consequences of human failures and problems on public roads, considering the lack of traffic education on the part of the population.

This systematic review is extremely important for public policy recommendations to managers aiming to reduce fatalities from traffic accidents, especially among motorcyclists and pedestrians. There is a need to strengthen the health system, especially about emergencies, through research audits and injury control, improve the capacity of hospitals, intensify actions to improve crosswalks and handrails along walkways, and build more walkways and, above all, to carry out effective urban planning.

The application of safety measures, as recommended in legislation and health education, and the use of all possible advertising, including pamphlets and posters, are essential. Only in this way will it be possible to reduce these individuals' number of accidents and deaths.

CONCLUSION

Mortality due to traffic accidents with pedestrians and motorcyclists has increased in recent years, especially among men.

Acknowledgments

REFERENCES

1. Mendonça MFS de, Silva AP de SC, Castro CCL de. Análise espacial dos acidentes de trânsito urbano atendidos pelo Serviço de Atendimento Móvel de Urgência: um recorte no espaço e no tempo. Rev bras epidemiol. dezembro de 2017; 20(4): 727–41. DOI: 10.1590/1980-5497201700040014

2. Reichenheim ME, Souza ER de, Moraes CL, Jorge MHP de M, Silva CMFP da, Minayo MC de S. Saúde no Brasil 5: Violência e lesões no Brasil: efeitos, avanços alcançados e desafios futuros. Lancet. 2015; 75–89. DOI: 10.1016/S0140- 6736(11)60053-6

3. Gómez MS. [Road traffic injuries: an example of public health]. Gac Sanit. setembro de 2015;29 Suppl 1:1. DOI: 10.1016/j.gaceta.2015.09.003

4. Cubí-Mollá P, Peña-Longobardo LM, Casal B, Rivera B, Oliva-Moreno J. Pérdidas laborales atribuibles a la mortalidad prematura por lesiones de tránsito entre 2002 y 2012. Gac Sanit. 1o de setembro de 2015; 29: 79–84. DOI: 10.1016/j.gaceta.2015.03.004

5. WORLD HEALTH ORGANIZATION (WHO) et al. Promovendo a defesa da segurança viária e das vítimas de lesões causadas pelo trânsito: um guia para organizações não governamentais. Geneva: WHO, 2013.

6. Leitão PA, Bezerra IMP, Santos EFS, Ribeiro SL, Takasu JM, Carlesso JL, Campos MF, Abreu LC. Mortality due to traffic accidents, before and after the reduction of the average speed of motor vehicles in the city of São Paulo, Brazil, from 2010 to 2016. Journal of Human Growth and Development 2019 29(1): 83- 92. DOI: https://doi.org/10.7322/jhgd.157755

7. Marín-León L, Belon AP, Barros MB, Almeida SD, Restitutti MC. Tendência dos acidentes de trânsito em Campinas, São Paulo, Brasil: importância crescente dos motociclistas [Trends in traffic accidents in Campinas, São Paulo State, Brazil: the increasing involvement of motorcyclists]. Cad Saude Publica. 2012;28(1):39- 51. DOI:10.1590/s0102-311x2012000100005

8. Vanlaar W, Mainegra Hing M, Brown S, McAteer H, Crain J, McFaull S. Fatal and serious injuries related to vulnerable road users in Canada. J Safety Res. 2016; 58: 67-77. DOI: 10.1016/j.jsr.2016.07.001

9. Edirisinghe PA, Kitulwatte ID, Senarathne UD. Injuries in the vulnerable road user fatalities; a study from Sri Lanka. J Forensic Leg Med. 2014; 27: 9-12. DOI: 10.1016/j.jflm.2014.07.002

10. Hutton B, Salanti G, Caldwell DM, Chaimani A, Schmid CH, Cameron C, et al. The PRISMA Extension Statement for Reporting of Systematic Reviews Incorporating Network Meta-analyses of Health Care Interventions: Checklist and Explanations. Ann Intern Med. 2015; 162(11): 777-84. DOI: 10.7326/M14-2385

11. Montenegro MMS, Duarte EC, Prado RR, Nascimento AF. Mortalidade de motociclistas em acidentes de transporte no Distrito Federal, 1996 a 2007. Rev Saude Publica. 2011; 45(3): 529-38. DOI: https://doi.org/10.1590/S0034-89102011000300011

12. Čabarkapa M. A problem of the safety of vulnerable road users in Montenegro. Int J Inj Contr Saf Promot. 2018; 25(4): 352-364. DOI: 10.1080/17457300.2018.1431936

13. Bouaoun L, Haddak MM, Amoros E. Road crash fatality rates in France: a comparison of road user types, taking account of travel practices. Accid Anal Prev. 2015; 75: 217-225. DOI: 10.1016/j.aap.2014.10.025

14. Zangooei Dovom H, Shafahi Y, Zangooei Dovom M. Fatal accident distribution by age, gender and head injury, and death probability at accident scene in Mashhad, Iran, 2006-2009. Int J Inj Contr Saf Promot. 2013; 20(2): 121- 133. DOI: 10.1080/17457300.2012.692694

15. Aruna Chandran , Tanara Rosângela Vieira Sousa , Yayi Guo , David Bishai , Flavio Pechansky & The Vida No Transito Evaluation Team (2012) Road Traffic Deaths in Brazil: Rising Trends in Pedestrian and Motorcycle Occupant Deaths,Traffic Injury Prevention, 13: sup1, 11-16, DOI: 10.1080/15389588.2011.633289

16. Leveau CM. Variaciones espaciales en el patentamiento y la mortalidad de usuarios de motocicletas por lesiones de tránsito en Argentina [Spatial variations in motorcycle registrations and the mortality of motorcycle users due to traffic injuries in Argentina]. Salud Colect. 2013; 9(3): 353-362. DOI:10.1590/S1851- 82652013000300006

17. Besharati MM, Tavakoli Kashani A. Which set of factors contribute to increase the likelihood of pedestrian fatality in road crashes? Int J Inj Contr Saf Promot. 2018; 25(3): 247-256. DOI:10.1080/17457300.2017.1363781

18. Rodrigues CL, Armond J de E, Górios C, Pereira RGV. Acidentes de trânsito por atropelamentos na cidade de São Paulo: Série histórica. Arquivos Catarinenses de Medicina. 1o de junho de 2018;47(2):147–55.

19. Sadeghi-Bazargani, Homayoun & Vahidi, Reza & Abhari, Ali. (2016). Predictors of Survival Rates of Motor Vehicle Accidents Among Motorcyclists, Bicyclists and Pedestrians in Tabriz, Iran. Trauma Monthly. 21.   DOI: 10.5812/traumamon.26019

20. Parreira JG, Gregorut F, Perlingeiro JA, Solda SC, Assef JC. Análise comparativa entre as lesões encontradas em motociclistas envolvidos em acidentes de trânsito e vítimas de outros mecanismos de trauma fechado [Comparative analysis of injuries observed in motorcycle riders involved in traffic accidents and victims of other blunt trauma mechanisms]. Rev Assoc Med Bras (1992). 2012; 58(1): 76-81. DOI: https://doi.org/10.1590/S0104-42302012000100018

21. Damsere-Derry J, Ebel BE, Mock CN, Afukaar F, Donkor P. Pedestrians' injury patterns in Ghana. Accid Anal Prev. 2010; 42(4): 1080-1088. DOI: 10.1016/j.aap.2009.12.016

22. Hasani, J., Khorshidi, A., Erfanpoor, S., Nazparvar, B., Hashemi Nazari S. Comparison of Risk Factors for Pedestrian Fatality in Urban and Suburban Traffic Accidents. Archives of Trauma Research, 2018; 7(2): 39-44. DOI: 10.4103/atr.atr_7_18

23. Chalya PL, Mabula JB, Ngayomela IH, et al. Motorcycle injuries as an emerging public health problem in Mwanza City, north-western Tanzania. Tanzan J Health Res. 2010; 12(4): 214-221.

24. Aduayi OS, Aduayi VA, Komolafe EO. Patterns of pre-hospital events and management of motorcycle-related injuries in a tropical setting. International Journal of Injury Control and Safety Promotion. 3 de julho de 2017; 24(3): 382–7. DOI: 10.1080/17457300.2016.1213300;

25. Ogunlusi JD, Nathaniel C. Motorcycle trauma in a St Lucian hospital. West Indian Med J. 2011; 60(5): 557-561.

26. Solagberu BA, Balogun RA, Mustafa IA, et al. Pedestrian injuries in the most densely populated city in Nigeria-an epidemic calling for control. Traffic Inj Prev. 2015; 16(2): 184-189. DOI: 10.1080/15389588.2014.921817

27. McAndrews C, Beyer K, Guse CE, Layde P. Revisiting exposure: fatal and non-fatal traffic injury risk across different populations of travelers in Wisconsin, 2001-2009. Accid Anal Prev. 2013; 60: 103-112. DOI: 10.1016/j.aap.2013.08.005

28. Galvão TF, Pereira MG. Revisões sistemáticas da literatura: passos para sua elaboração. Epidemiol Serv Saúde. março de 2014; 23(1): 183–4. DOI: https://doi.org/10.5123/S1679-49742014000100018

29. Santos R. Por Detrás do Véu da Mulher Iraniana. Revista Brasileira de Direito Internacional — RBDI, 2007. 6(6). DOI: http://dx.doi.org/10.5380/rbdi.v6i6.9777

Resumo

Introdução: os acidentes de trânsito são a terceira causa de morte no mundo. Os usuários vulneráveis da estrada não têm um alto nível de proteção como outros tipos de vítimas. Portanto, esses indivíduos enfrentam consequências devastadoras quando envolvidos em acidentes.

Objetivo: identificar a tendência da mortalidade, incidência e fatores associados aos acidentes de trânsito entre motociclistas e pedestres por meio de revisão sistemática da literatura.

Método: trata-se de uma revisão sistemática das bases de indexação da National Library of Medicine (PubMed), Virtual Health Library (VHL) e Web of Science utilizando os descritores Mortality AND Accidents, Traffic AND Motorcycles AND Pedestrians. Para a seleção dos artigos, foram incluídos aqueles que obedeciam aos seguintes critérios: população que (1) inclui motociclistas e pedestres e (2) se envolveu em acidentes de trânsito; e artigos que (3) estudaram mortalidade, incidência e / ou fatores associados a acidentes de trânsito e (4) foram publicados nos últimos 10 anos.

Resultados: dos 206 artigos encontrados, 19 preencheram os critérios de inclusão. Fatores como aumento da venda de motocicletas, escuridão das vias, pedestres mais velhos, falta de equipamentos de segurança para os motociclistas e ingestão de drogas e / ou álcool contribuem para o aumento da taxa de mortalidade e incidência desses indivíduos.

Conclusão: a mortalidade por acidentes de trânsito com pedestres e motociclistas tem aumentado nos últimos anos, com alta prevalência de mortalidade entre os homens. A maioria dos acidentes foi devido a falhas humanas e / ou deficiências nas vias públicas.

Palavras-chave: mortalidade, acidentes de trânsito, motocicletas, pedestres.