

## ANALYSIS OF INJURIES CAUSED BY TRAFFIC TRAUMA IN THE POPULATION OF CHILDREN AND ADOLESCENTS TREATED IN EMERGENCY MEDICAL SERVICES

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**Abstract:** Road traffic injuries continue to represent a global epidemic and an urgent public health priority due to the international scope of morbidity and mortality. The main goal of this research was to analyze the way the injury occurred in relation to age and sex, and to identify the type of injury and the region of the body affected by the injury sustained in traffic in patients  $\leq 19$  years of age treated in the emergency medical services of the Republic of Srpska. Patients were divided into two age groups: children (0-9 years) and adolescents (10-19 years). A cross-sectional retrospective study was conducted, in which data from the national e-database WebMedic from 12 emergency medical services were analyzed in the period between January 2018 and December 2020. The search included patients, aged  $\leq 19$  years with a diagnosis of an unintentional injury that occurred as a result of the road traffic injuries. During the observed period, 499 cases were identified, of which 91.2% were referred to hospitalization. The average age was 13.9 years ( $SD=5.48$ ). Adolescents aged 10 to 19 (78.4%) were more often exposed to injuries ( $p<0.001$ ), with male predominance ( $p=0.006$ ). According to the nature of participants in traffic accidents, more than half of children and adolescents were passengers (51.9%), followed by pedestrians (13.8%) and motorcyclists (12.4%). According to the type of injury, superficial injuries (49.1%) and multiple injuries (18.4%) were most often identified. The most frequently affected region of the body where the injury occurred was the head (42.5%). Adolescents aged 10 to 19 and males were more often exposed to injuries caused by traffic accidents. These results could indicate the necessity of creating programs with targeted prevention in order to protect this high-risk group.

**Keywords:** children, adolescents, injuries, traffic accidents, emergency medical services.

### Introduction

Injuries sustained in traffic accidents continue to represent a global epidemic and an urgent public health priority due to the international scope of morbidity and mortality [1]. They are the ninth leading cause of death globally [2], and current trends indicate that traffic accidents will become the seventh leading cause of death by 2030 [2,3]. The total mortality from traffic accidents globally has increased by about 13%

since 2000 [4]. In response to this crisis, the Sustainable Development Goals of the United Nations (Goal 3.6) demanded that by the end of 2020, the number of deaths and injuries caused by traffic accidents should be reduced by 50% at the global level [5]. The World Health Organization (WHO) states that much of the morbidity and mortality among children and youth is preventable, and that low-cost measures that have been shown to have an impact, whether related to traffic accidents or poverty, could prevent as many as two-thirds of deaths. [6]. The Global Report on the State of Road Safety states that traffic injuries are currently the leading cause of death for children and young adults between the ages of 5 and 29, signaling the need for change in the current health agenda for children and adolescents, which largely neglected road safety until now [7]. According to data from the US National Center for Injury Control and Prevention, every hour, almost 150 children between the ages of 0 and 19 are treated in emergency rooms for injuries sustained in traffic. It is believed that more children between the ages of 5 and 19 die from injuries caused by traffic accidents than from any other type of injury [8]. Road traffic accidents are the leading cause of death for children in the USA [9]. Such trends are also maintained in the WHO European Region, where traffic injuries are the leading cause of death and disability among children and adolescents. Children represent a special group due to a number of risk factors because they can be injured as pedestrians on the way to school, as cyclists, as motorcyclists or as passengers in cars [10, 11]. Children are a special risk group in traffic injuries, and their risk factors for serious pediatric trauma on the road are multifactorial in nature [12]. Previous studies [3,13,14] have identified several factors that make children more vulnerable to traffic injuries, which include age, sex, propensity for risky behavior, and socioeconomic and other characteristics of parents/guardians and the use of safety protection when riding in motor vehicles or riding bicycles. A comprehensive assessment of the way the injury occurred, according to the nature of the participants in traffic accidents and the characteristics of injuries in children and adolescents, is of essential importance and represents the basis for assessing the magnitude of this problem in our country, as well as the creation of effective preventive measures. Considering all of the above mentioned, the main goal of this research was to analyze the way the injury occurred in relation to age and sex, and to identify the type of injury and the region of the body affected by the injury sustained in traffic in patients  $\leq 19$  years of age treated in emergency medical services of the Republic of Srpska.

## **Materials and methods**

A cross-sectional, retrospective study was conducted, whereby data from 12 emergency medical services of the Republic of Srpska (EMS RS) for the period from January 1<sup>st</sup>, 2018, to December 31<sup>st</sup>, 2020, were extracted from the national e-base WebMedic. Data on injuries were obtained from medical records through computer-generated codes from the International Statistical Classification of Diseases, 10th revision (ICD-10). The search included patients aged  $\leq 19$  years, of both sexes, with a diagnosis of an injury whose mechanism of occurrence was caused by a traffic accident. Injuries were identified according to ICD-10, marked with codes from group XIX (S00-T98). Injuries that occurred in traffic were classified according to the

anatomical location of the part of the body where they occurred. The analysis included codes that included different types of injuries divided by body regions into: head (S00-S09), neck (S10-S19), chest (S20-S29), abdomen and small pelvis (S30-S39), upper extremities (S40-S69), lower extremities (S70-S99) and injuries involving multiple body parts (multiple injuries T00-T07). For patients who had at least one diagnosis with an S or T code, there was a significant search according to the main and/or additional diagnoses, whereby the search included codes from group XX, ICD-10 and which were related to traffic accidents in in which the injured are classified according to the nature of the participants into: pedestrians (V01-V09), cyclists (V10-V19), motorcyclists (V20-29), passengers (V40-V79), car drivers (40.0, 40.5, 49.0, 49.4) and those who were not marked (V99). All patients whose injuries were verified as: injuries sustained during vehicle repair or closing car doors (W00-W59), intentional assault by motor vehicle (Y03), intentional self-harm (X81-X83) were excluded. Data on injuries caused by traffic accidents is categorized according to: age groups of children (0-9 years) and adolescents (10-19 years), characteristics of participants in traffic accidents, characteristics of injuries (type of injury and anatomical region of the body) and outcome variables during treatment in EMS. Demographic characteristics of patients were collected, which included: age, sex, local distribution of SHMP according to regional centers of the Institute of Public Health of the Republic of Srpska (PHI RS) and time of reporting to EMS. In the mentioned period, 1,856 children and adolescents with a diagnosis of unintentional injury were identified, and 499 patients with injuries caused by traffic trauma were included in the final analysis.

The conducted research was approved by the Ministry of Health and Social Welfare of the Republic of Srpska (number: 11/04-500-565/19 dated 25 September 2019) and the Ethics Committee for Research on Humans and Biological Material of the Faculty of Medicine of the University of Banja Luka (number: 18/4.3/20 from 07.02.2020).

Statistical analysis of the data included descriptive statistics, bivariate analysis with the use of the Chi-square test for comparison between groups, with correction according to Yates if necessary. Data processing was performed using the SPSS version 25 software package. The level of statistical significance was  $p < 0.05$ .

## Results

In the three-year period from January 1<sup>st</sup>, 2018, until December 31<sup>st</sup>, 2020, in 12 EMS RS, injuries caused by traffic accidents were identified in 499 patients. The average age was 13.9 years, with boys being affected 1.1 times more often than girls. During the observation period, 91.2% of cases were referred to hospitalization, and the average time of reporting to EMS due to injuries sustained in traffic accidents was 14h and 58min. An overview of the basic characteristics of patients treated in EMS for traffic injuries is presented in Table 1.

Table 1. The basic characteristics of patients treated in emergency medical services for road traffic injury

Variables	n	%
<b>Age in years (n=499; M=13,9 SD=5,48)</b>		
Children (0-9 year)	108	21,6
Adolescents (10-19 year)	391	78,4
<b>Sex</b>		
Male	283	56,7
Female	261	43,3
<b>Region EMS* PHI*</b>		
Banja Luka region (n=8 EMS)	395	79,2
Bijeljina region (n=2 EMS)	92	18,4
Doboj region (n=1 EMS)	6	1,2
Istočno-Sarajevo region (n=1 EMS)	6	1,2
<b>Outcomes in EMS and hours (M=14:58. SD=6:33)</b>		
Outpatient treatment/discharged	44	8,8
Hospital treatment	455	91,2

n – number; M – mean value; SD – standard deviation; EMS – emergency medical service; PHI – Institute of Public Health

Table 2 presents the results of the type of injury according to the nature of the participant in traffic accidents in relation to the age of the subjects. Of the total number of injured, more than half of children and adolescents were passengers (51.9%), followed by pedestrians (13.8%) and motorcyclists (12.4%). The results of the Chi-square test showed that there was a statistically significant difference between the ways the injury was sustained according to the characteristics of the participants in traffic accidents in relation to age ( $p < 0.001$ ), whereby the group of adolescents was more often injured in traffic accidents (78.4%) in comparison to children.

Table 2. The way injuries occurred according by participation in traffic accidents in relation to the age

Injured in Road traffic	Children (0-9 year)	Adolescents (10-19 year)	Total	$\chi^2$ p-value
Pedestrians	14 (13.0%)	55 (14.1%)	69 (13.8%)	34.28 $p < 0.001$
Cyclists	10 (9.3%)	30 (7.7%)	40 (8.0%)	
Motorcyclists	1 (0.9%)	61 (15.6%)	62 (12.4%)	
Passengers	76 (70.4%)	183 (46.8%)	259 (51.9%)	
Car drivers	0 (0.0%)	37 (9.5%)	37 (7.4%)	
Unmarked	7 (6.5%)	25 (6.4%)	32 (6.4%)	
<b>Total</b>	108 (21.6%)	391 (78.4%)	499 (100%)	

$\chi^2$  - Chi-square test; p – value statistically significant ( $p < 0.05$ );

The distribution of injuries caused by traffic accidents in relation to sex showed that boys were injured more often as passengers, motorcyclists and cyclists, with a statistically significant difference between male and female sex ( $\chi^2=16.21$ ,  $p=0.006<0.05$ ) (Picture 1).

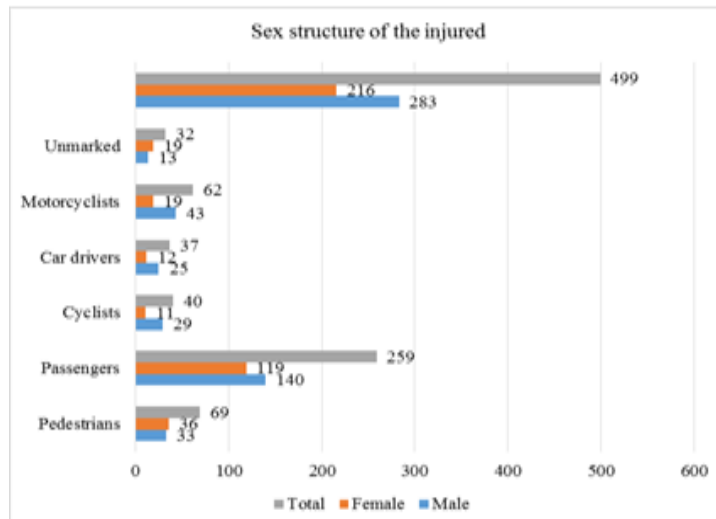


Figure 1. Distribution the way of injuries occurred according to by participation in traffic accidents in relation to the sex

By analyzing the types of injuries, superficial injuries ( $n=245$ ; 49.1%), multiple injuries ( $n=92$ ; 18.4%) and dislocations, sprains and strains ( $n=56$ ; 11.2%) were most often identified, whereby adolescents were statistically significantly more susceptible to the mentioned types of injuries compared to children ( $\chi^2=23.13$ ,  $p=0.002<0.05$ ). Table 3 presents the results of injuries classified according to the anatomical region of the body in relation to the age groups of children and adolescents. Head injuries were the most common in all age groups with 42.5%, and the most vulnerable were adolescents (30.3%), where there was a statistically significant difference in the affected body region in relation to age groups ( $p<0.05$ ).

Table 3. Region of the body affected by the injury sustained in traffic

Injury area body	Children (0-9 year)	Adolescents (10-19 year)	Total	$\chi^2$ p-value
Head	61 (12.2%)	151 (30.3%)	212 (42.5%)	15.88 p=0.01
Neck	12 (2.4%)	48 (9.6%)	60 (12.0%)	
Thorax	1 (0.2%)	20 (4.0%)	21 (4.2%)	
Abdomen and small pelvis	3 (0.6%)	11 (2.2%)	14 (2.8%)	
Upper limbs	5 (1.0%)	44 (8.8%)	49 (9.8%)	
Lower limbs	8 (1.6%)	50 (10.0%)	58 (11.6%)	
Multiple body regions	18 (3.6%)	67 (13.4%)	85 (17.0%)	

$\chi^2$  - Chi-square test; p – value statistically significant ( $p<0.05$ )

## Discussion

The conducted research showed that injuries caused by traffic accidents in male adolescents aged 10 to 19 years occurred significantly more compared to the group of children, which could indicate that this age group represents an extremely high-risk factor for the occurrence of injuries in traffic. This distribution of data was confirmed by the authors who, in their research on unintentional injuries, showed that among boys aged 15 to 19, injuries caused by traffic accidents were the most common reason for visits to emergency medical services in the Republic of Srpska [15]. The reason adolescents are more injured in traffic compared to children could be explained by the fact that they are more often alone in traffic, which actually makes them more vulnerable to injuries. Similar results were presented in a study conducted in Sweden, where the greatest absolute differences in the risk of traffic injuries were found among male adolescents aged 15 to 19 [16]. We also find these statements in the WHO report "Ten strategies for keeping children safe on the road", which indicates that the age group of 15 to 17 years is the most vulnerable to traffic accidents [17]. Our study also shows the existence of sex differences in the total sample of injuries caused by traffic accidents where males were more often represented (56.7%) compared to females. This distribution of data is suggested by research conducted in Denmark, where it was shown that boys were at a higher risk of traffic injuries [18]. Despite these risks, much can be done to prevent traffic injuries. The WHO Global Report [7] described that road safety depends on several factors: political support, financing and effective policy; safe roads; safe vehicles; safe participants in traffic; and timely and efficient care after an accident. Stewart et al. [19] indicated that the use of safety belts and child safety seats reduces the severity of injuries during accidents by as much as 40 to 70%. According to the nature of traffic participants, our research showed that more than half of children and adolescents were injured as passengers in motor vehicles (51.9%), while adolescents were most often injured as pedestrians, motorcyclists, cyclists and car drivers. A previously conducted study showed that passengers in motor vehicles (60.1%) in all age groups of children and all types of road users were the most affected [1]. Similar characteristics in relation to the participation of children aged 0 to 16 years in traffic accidents were also shown by the study by Lee et al. where of all the victims in traffic accidents, passengers were the most represented with 60.4% [20]. With new scientific research and the development of new technologies, ideas about how to best protect child travelers continue to develop. Driving with a passenger in the back seat is safer than driving in the front seat, especially when the vehicle does not have airbags. Safety seats for children and booster seats are rarely available in countries with low national income, and it is recommended that those traveling with children should use the equipment provided for this [19]. However, it is important to always follow current guidelines for the safety of child passengers. Analyzing the types of injuries and the affected region of the body, this research showed that superficial injuries and head injuries were the most common in both the group of children and the group of adolescents. This is also indicated by a retrospective study on unintentional injuries, conducted in the emergency medical services of the Republic of Srpska, which analyzed 17,029 children over a period of 3 years and showed that the majority of children and adolescents suffered head injuries that were

caused by falls and traffic accidents [15]. Similar to our results, it was also confirmed by a previously conducted study which showed that in 48.5% of children and adolescents, the most frequently affected injury in relation to the region of the body was the head [21]. Variations of injuries according to age groups depend on the activity and behavior pattern related to a certain age of children and adolescents [22,23]. Our research showed that during the observation period, a large number of patients were referred for hospitalization (91.2%), while fatal outcomes were not registered in EMS RS. In the National retrospective study, that examined the characteristics of unintentional injuries among hospitalized children in the Republic of Srpska, the authors state the existence of variations between the causes of hospitalization within the group of adolescents and indicate that, among adolescents aged 15 to 19 years, the leading cause of hospitalization was precisely injuries caused in traffic accidents, which accounted for as much as 62.6% of cases in total hospital treatment [24]. Eurostat reports that in the European Union (EU) member countries, and according to the data of the Injury Database EU for the period from 2009 to 2018, 12.7% of cases require hospitalization, and 87.3% are treated on an outpatient basis, emphasizing that children, adolescents and young adults are at the highest risk of injury [25]. This is the first study in our region that examined the characteristics of injuries caused by traffic accidents in children and adolescents treated in the EMS RS. The results provide data on the ways in which injuries occurred according to the nature of participation in the traffic, the age and sex of the children, and the characteristics of the injuries. However, there are several limitations. First, we analyzed data from 12 EMS RS, of which 8 EMS belong to the Banja Luka region, and the involvement of other regions of the RS was absent, therefore, one should consider this when generalizing the results. Second, no information was included about the study population that was treated in the family medicine team for traffic injuries, which should be considered in the future. Third, there was no information available in the e-database about factors from the social environment of children and adolescents, as well as information about family characteristics, without which risk factors cannot be assessed. Therefore, future research should be focused precisely on the mentioned factors related to the occurrence of injuries caused by traffic trauma among this population.

## **Conclusion**

This study showed that, among patients who were treated in emergency medical services of the Republic of Srpska for injuries caused by traffic accidents, there were significant differences according to age groups and sex. It was shown that male adolescents aged 10 to 19 years were significantly more affected by injuries considering all characteristics of road users. According to the type of injury, superficial injuries were most often identified, and head injuries were the most dominant in all age groups. The data obtained in this way, which showed the existence of differences between age groups, sex, and characteristics of injuries, can direct policy makers and experts in the field of public health to the necessity of creating programs with targeted prevention in order to protect this high-risk group.

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## ANALIZA POVREDA UZROKOVANIH SAOBRAĆAJNIM TRAUMATIZMOM U POPULACIJI DJECE I ADOLESCENATA LIJEČENIH U SLUŽBAMA HITNE MEDICINSKE POMOĆI

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**Sažetak:** Povrede nastale u saobraćaju i dalje predstavljaju globalnu epidemiju i hitan javni zdravstveni prioritet zbog međunarodnog obima morbiditeta i mortaliteta. Osnovni cilj ovog istraživanja bio je analizirati način nastanka povrede u odnosu na dob i pol, te identifikovati tip povrede i regiju tijela zahvaćenu povredom zadobijenom u saobraćaju kod pacijenata  $\leq 19$  godina liječenih u službama hitne medicinske pomoći Republike Srpske. Pacijenti su podijeljeni u dvije starosne grupe na djecu (0-9 godina) i adolescente (10-19 godina). Sprovedena je retrospektivna studija presjeka pri čemu su analizirani podaci iz nacionalne e-baze WebMedic iz 12 Službi hitne medicinske pomoći u periodu između januara 2018. i decembra 2020. godine. U pretragu su uključeni pacijenti, dobi  $\leq 19$  godina sa postavljenom dijagnozom nenamjerne povrede koja je nastala kao posljedica saobraćajne nezgode. Tokom posmatranog perioda identifikovano je 499 slučajeva, pri čemu je 91,2% upućeno na hospitalizaciju. Prosječna starosna dob bila je 13,9 godina ( $SD=5,48$ ). Adolescenti dobi od 10 do 19 godina (78,4%) češće su bili izloženi povredama ( $p<0,001$ ), sa predominacijom muškog pola ( $p=0.006$ ). Prema svojstvu učesnika u saobraćajnim nezgodama više od polovine djece i adolescenti bili su putnici (51,9%), zatim pješaci (13,8%) i motociklisti (12,4%). Prema tipu povrede najčešće su identifikovane površinske povrede (49,1%) i višestruke povrede (18,4%). Najčešće zahvaćena regija tijela na kojoj je povreda nastala bila je glava (42,5%). Adolescenti dobi od 10 do 19 godine i muški pol češće su bili izloženi povredama uzrokovanim saobraćajnim nezgodama. Ovi rezultati bi mogli ukazati na neophodnost kreiranja programa sa ciljanom prevencijom kako bi se zaštitila ova visokorizična grupa.

**Ključne riječi:** djeca, adolescenti, povrede, saobraćajne nezgode, hitna medicinska pomoć.