



Unintentional Injuries of Children and Adolescents Treated in Emergency Medical Services: a Cross-Sectional Study

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Abstract

Background/Aim: Unintentional injuries among children and adolescents have become a common issue in public healthcare. The study objective was to analyse the characteristics and identify predictors associated with unintentional injuries in children and adolescents treated in emergency medical services (EMS) in the Republic of Srpska, Bosnia and Herzegovina.

Methods: A cross-section study with retrospective analysis of WebMedic e-database from 14 EMS, in the period between January 2018 and December 2020 was conducted. Research included patients with unintentional injuries, aged ≤ 19 years, of both sexes. For comparison between groups, Chi-squared and multivariate logistic regression were used in risk factor analysis.

Results: A total of 1,856 cases were identified, most injuries resulted from falls (46.7 %) and traffic injuries (26.9 %). Boys were significantly more affected by injuries than girls ($p < 0.001$). Falls were the major cause for reporting to EMS among age groups of children (0-9 years) and adolescents (10-14 years), whereas injuries in traffic were dominant in adolescents aged 15 to 19. The most common injuries were head injuries (35.7 %). Risk factors of unintentional injuries were age ($p < 0.001$), sex ($p = 0.046$), weekday ($p = 0.016$), winter ($p = 0.014$), body region (head, abdomen, lower and upper limbs ($p < 0.001$), thorax ($p = 0.009$)).

Conclusions: There were significant differences in characteristics of unintentional injuries according to age and sex. Chances for occurrence of unintentional injuries among children increased with their age, especially for boys. These differences might indicate areas where preventive measures should be undertaken.

Key words: Unintentional injury; Child; Adolescent; Emergency medical services.

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Introduction

Unintentional injuries have become a common worldwide issue in the field of public health due to a wide range of morbidity and mortality among children and adolescents. Leading causes were traffic injuries, falls, burns, poisonings and drowning.¹⁻⁴ Children and adolescents account for almost 30 % of the world population. They

are particularly vulnerable to injuries due to their active and discovery driven nature in early years and risk-taking behaviour in adolescent years. According to the Global Burden of Disease 2017 study, an estimated 1900 children and adolescents die every day as a result of an injury.⁵

World Health Organization (WHO) suggests that 92 % of all deaths caused by injuries in children aged 0 to 4 are a result of unintentional injuries, in children aged 5 to 14 this share is 84 % and 56 % in young people aged 15 to 29.⁶ For each child that dies from unintentional injuries, there are even more hospitalised and there is a higher number of them treated in emergency services.⁷ In the European Union, 1 in 10 children each year suffer injuries that require emergency medical services.⁸ Eurostat reports for the EU-27 in the period of 2009-2018 have confirmed a well-known fact that children and adolescents are exposed to the highest risk from injuries when compared to adult population.⁹

Despite enormous progress in other areas of medicine, it seems that prevention of injuries is poorly targeted, inadequately financed and rarely evaluated.¹⁰ More importantly, most of these unintentional injuries are preventable, whereas the costs of their treatment are high.⁸ During the last fifty years, children's health has significantly changed. Wide-spread immunisation programs have almost completely eliminated the threat from infectious diseases. Injuries are the ones that pose a threat to the health of all children.¹¹ The rapid wave of urbanisation, demographic and dietary transitions, economic growth and technological development brought to a change in the epidemiological profile of most countries.¹² Changes of lifestyle and psychological characteristics of children such as impulsivity, curiosity, lack of knowledge make them vulnerable to occurrence of various types of injuries.¹³

In the Republic of Srpska, Bosnia and Herzegovina, there are no registers of unintentional injuries and there are no available data on the characteristics of children and adolescents requiring treatment in the Emergency Medical Service of the Republic of Srpska (EMS RS). Since unintentional injuries are predictable, a comprehensive assessment of the causes and characteristics of unintentional injuries in children and adolescents is of crucial importance and represents the basis for understanding the magnitude of this problem in country, as well as creating effective preventive measures.

Therefore, the objective of this study was to analyse the characteristics and identify risk factors associated with unintentional injuries in children and adolescents who were treated in the EMS RS of Bosnia and Herzegovina.

Methods

Settings and participants

The study was approved by the Ethics Committee for Research on Humans and Biological Material, University of Banja Luka Faculty of Medicine (No 18/4.3/20) and Ministry of Health and Social Welfare of the Republic of Srpska (No 11/04-500-565/19). Retrospective analysis of the WebMedic e-database extracted data from 14 EMS RS for the period from 1 January 2018 to 31 December 2020 and included in total 17,029 children and adolescents aged ≤ 19 years, of both sexes, diagnosed with injuries. Patients who were diagnosed with at least one unintentional injury according to The International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) from Chapter XIX "Injury, poisoning and certain other consequences of external causes" (S00-T98), the cause of which was coded and categorised under Chapter XX "External causes of morbidity and mortality" (V01-Y98), were selected as the research subjects. Data on unintentional injuries were categorised according to age groups: children (< 1 , 1-4, 5-9 years), adolescents (10-14 and 15-19 years) as well as by the characteristics of unintentional injuries.

Data collection

The data of patients (age ≤ 19 years) who visited 14 EMS RS over the observation period of three years and were diagnosed with at least one diagnosis of unintentional injury upon admission were reviewed. Unintentional injuries were identified according to ICD-10, marked with codes S00-T98.¹⁴ For patients who had at least one diagnosis with an S-code different types of injuries related to single body regions or T-code to cover injuries to multiple or unspecified body regions as well as poisoning and certain other consequences of external causes, it was crucial to search for additional diagnoses that included external causes of unintentional injuries referred to in Chapter XX indicated by an external cause (V01-Y98), ICD-10. For the purposes of this research, the identification of codes of external causes, which by their mechanisms led to the occurrence of unintentional injuries, was carried out according to WHO recommendations and included: road traffic injuries (V01-V04, V06, V09-V80, V87, V89, V99), fire/burns (X00-X09, X10-X19), poisonings (X40-X49), falls (W00-W19) and drowning (W65-W74).³ All patients whose

injuries were verified as intentional (violence, suicide, self-harm) were excluded.

The demographic characteristics of the patients, which included: age, sex, local distribution of EMS according to regional centres of the Republic of Srpska Public Health Institute and time of reporting to the EMS were collected. The characteristics of unintentional injuries, which included five external causes of injury and the nature of the injury that occurred as a consequence of their action were monitored. External causes included traffic injuries, burns, poisoning, falls and drowning. The effects of external factors included an analysis of injuries according to the body region (head, neck, chest, abdomen/lumbar spine and pelvis, upper limbs, lower limbs, multiple injuries) for injuries caused by falls and road traffic injuries, whereas injuries caused by burns, poisoning and drowning were classified according to the nature of injuries (burns according to localisation, poisoning with medicinal or non-medicinal substances as well as other effects of external causes). The outcome variables referred to treatment status categorised as treated/discharged or referred to another centre for hospital treatment. Based on the obtained data, the characteristics of injuries regarding age and sex were described and risk factors associated with the occurrence of unintentional injuries were identified.

Data analysis

The statistical analysis included descriptive statistics (mean value, standard deviation, frequency, percentage), bivariate analysis using the Chi-square test for comparison between groups. The multivariate logistic regression analysis for assessment of risk factors was used. Incidence rates of children and adolescents with unintentional injuries were calculated based on national demographic data for the population aged ≤ 19 years obtained from the Republic of Srpska Institute for Statistics.¹⁵ Incidence rates of unintentional injuries were expressed as the number of cases per 100,000 persons per year for the age ≤ 19 years with a confidence interval of 95 %, for 2018, 2019 and 2020, respectively. The statistical analysis was performed by the software SPSS version 25.0. The level of statistical significance was set at $p < 0.05$.

Results

Characteristics of the sample

In the period from 1 January 2018 to 31 December 2020, a total of 17,029 children and adolescents diagnosed with injuries coded S00-T98 were examined in 14 EMS in the Republic of Srpska and unintentional injuries were identified in 1,856 cases (664/699/493/for each observed year, respectively). Unintentional injuries accounted for 10.9 % of all examinations for the age ≤ 19 years. The incidence of unintentional injuries among children and adolescents aged 0 to 19 years was 313/100,000 (95 % CI = 289-337) for 2018, 333/100,000 (95 % CI = 309-358) for 2019 and 226/100,000 (95 % CI = 206-246) for 2020. The average age of the patients was 10.36 years (SD = 6.30), with boys vs girls ratio of 2.54. Adolescents aged 15 to 19 (36.2 %) were the most exposed to unintentional injuries. The primary characteristics of patients treated in EMS for unintentional injuries are presented in Table 1.

Table 1: The primary characteristics of patients treated in emergency medical services (EMS) for unintentional injuries

Variables	n	%	
Age in years (n = 1,856; M = 10.36. SD = 6.30)			
	< 1 year	11	0.6
Children (n = 839; 45.2 %)	1-4 years	483	26.0
	5-9 years	345	18.6
	10-14 years	346	18.6
Adolescents (n = 1017; 54.8 %)	15-19 years	671	36.2
	Sex		
	Male	1332	71.8
	Female	524	28.2
Region EMS* RS and injury hours (M = 16.02; SD = 6.34)			
	Banja Luka region (n = 9 EMS)	1593	85.8
	Bijeljina region (n = 2 EMS)	211	11.4
	Doboj region (n = 2 EMS)	21	1.1
	East Sarajevo region (n = 1 EMS)	31	1.7
Outcome in EMS			
	Outpatient treatment/discharged	449	24.2
	Referred to another centre for hospital treatment	1407	75.8

n = number; M = mean value; SD = standard deviation; RS = the Republic of Srpska; EMS = Emergency medical service.

Causes and characteristics of unintentional injuries in children and adolescents in relation to the age and sex

Out of all five causes that led to unintentional injuries, the most common ones were injuries



caused by falls (46.7 %) and road traffic injuries (26.9 %). Observing at the age groups, falls were the leading cause of unintentional injuries among the group of children from 0 to 9 years (< 1 year (63.6 %), from 1 to 4 years (49.1 %), from 5 to 9 years (69.3 %)) and among adolescents aged 10 to 14 (59.5 %). Among adolescents aged 15 to 19, the leading causes were injuries in traffic (45.6 %). There was a statistically significant difference ($p < 0.001$) between the external causes that, by their mechanisms, led to unintentional injuries in relation to the age of children and adolescents ($p < 0.001$) (Table 2).

After examining the relationship between the causes that led to the occurrence of unintentional injuries in relation to sex, a statistically significant difference was noted, with boys being more affected by those injuries ($p < 0.001$). Unintentional injuries caused by falls were the most common reason for visits to EMS, accounting for a total of 46.7 % of all cases, 56.7 % of them were boys and 21.4 % were girls. After falls, injuries in traffic were identified as the second most common cause of injuries between the sexes, accounting for 26.9 % of all cases of unintentional injuries, 21.9 % of them were boys and 41.2 % were girls. Causes of unintentional injuries in relation to sex are presented in Table 3.

Table 2: The causes of unintentional injuries among children and adolescents in relation to the age

Variables		Age (in years)					Total	X ² -test p-value
Causes of UI	ICD-10 code	Children < 1	1-4	5-9	Adolescent 10-14	15-19		
Road traffic injuries	V01-V04, V06, V09-V80, V87, V89, V99	n	2	51	55	85	306	499
		%	18.2	10.6	15.9	24.6	45.6	
Fire/Burns	X00-X09, X10-X19	n	1	172	42	43	56	314
		%	9.1	35.6	12.2	12.4	8.3	
Poisoning	X40-X49	n	1	23	7	12	131	174
		%	9.1	4.8	2.0	3.5	19.5	
Falls	W00-W19	n	7	237	239	206	178	867
		%	63.6	49.1	69.3	59.5	26.5	
Drowning	W65-W74	n	0	0	2	0	0	2
		%	0.0	0.0	0.6	0.0	0.0	
Total		n	11	483	345	346	671	1856
		%	0.6	26.0	18.6	18.6	36.2	

n = number; UI = unintentional injury; ICD-10 = International Classification of Diseases Tenth Revision; X² - Chi-square test; *p* - value statistically significant ($p < 0.05$)

Table 3: The causes of unintentional injuries among children and adolescents in relation to the sex

Variables		Sex		Total	X ² -test p-value
Causes of UI	ICD-10 code	Male	Female		
Road traffic injuries	V01-V04, V06, V09-V80, V87, V89, V99	n	283	216	499
		%	21.2	41.2	26.9
Fire/Burns	X00-X09, X10-X19	n	191	123	314
		%	14.3	23.5	16.9
Poisoning	X40-X49	n	102	72	174
		%	7.7	13.7	9.4
Falls	W00-W19	n	755	112	867
		%	56.7	21.4	46.7
Drowning	W65-W74	n	1	1	2
		%	0.1	0.2	0.1
Total		n	1332	524	1856
		%	71.8	28.2	100

n = number; UI = unintentional injury; ICD-10 = International Classification of Diseases Tenth Revision; X² - Chi-square test; *p* - value statistically significant ($p < 0.05$)

Consequences of external causes

The characteristics of the nature of the injury that occurred was analysed due to the cause related to age of children and adolescents. In injuries caused by falls and road traffic injuries, three most common positions in relation to the body region were identified. Head injuries were the most common in all age groups with 35.7 % and the most vulnerable group were children under the age of 1 (63.6 %). In addition to head injuries, upper limbs injuries were the most common ones with a total share of 15.5 %, most of them in the group of adolescents aged 10 to 14 (24.6 %). Similar situation was identified in injuries of the lower limbs and their total share was 10.2 % in

the same age group (16.8 %). Compared to other age groups, children aged 1 to 4 were most exposed to burns (33.7 %), whereas poisoning by substances of non-medical origin was most often identified in adolescents aged 15 to 19 (18.9 %). The age of children and adolescents was identified as a statistically significant predictor for the occurrence of unintentional injuries caused by external factors ($p < 0.001$) (Table 4).

Risk factors connected with unintentional injuries in children and adolescents

The multivariate logistic regression to analyse the risk factors among injured children and adolescents treated for unintentional injury in the

Table 4: Consequences of external causes of unintentional injuries among children and adolescents in relation to age

Consequences of external causes (S00-T98)		Age (in years)					Total	X ² -test p-value	
		Children < 1	1-4	5-9	Adolescent 10-14	15-19			
Injury area body (Falls, Road traffic injuries)									
Head (S00-S09)	n	7	213	160	104	179	663	489.52 < 0.001	
	%	63.6	44.1	46.4	30.1	26.7	35.7		
Neck (S10-S19)	n	0	7	8	10	38	63		
	%	0.0	1.4	2.3	2.9	5.7	3.4		
Thorax (S20-S29)	n	0	3	1	12	16	32		
	%	0.0	0.6	0.3	3.5	2.4	1.7		
Abdomen, lower back, lumbar spine, pelvis and external genitals (S30-S39)	n	0	5	9	9	12	35		
	%	0.0	1.0	2.6	2.6	1.8	1.9		
Upper limbs (S40-S69)	n	2	35	65	85	100	287		
	%	18.2	7.2	18.8	24.6	14.9	15.5		
Lower limbs (S70-S99)	n	0	15	41	58	76	190		
	%	0.0	3.1	11.9	16.8	11.3	10.2		
Multiple body regions (T00-T07)	n	0	10	10	13	63	96		
	%	0.0	2.1	2.9	3.8	9.4	5.2		
Nature of injury (Burns, Poisoning, Drowning)									
Burns specified by site (T20-T28)	n	1	163	39	41	52	296		489.52 < 0.001
	%	9.1	33.7	11.3	11.8	7.7	15.9		
Burns multiple unspecified body regions (T29-T32)	n	0	9	3	2	4	18		
	%	0.0	1.9	0.9	0.6	0.6	1.0		
Poisoning by drugs, medicaments and biological substances (T36-T50)	n	1	6	1	1	4	13		
	%	9.1	1.2	0.3	0.3	0.6	0.7		
Toxic effects of substances chiefly nonmedicinal as to source (T51-T65)	n	0	17	6	11	127	161		
	%	0.0	3.5	1.7	3.2	18.9	8.7		
Sequelae of injuries (T90-T98)	n	0	0	2	0	0	2		
	%	0.0	0.0	0.6	0.0	0.0	0.1		
Total	n	11	483	345	346	671	1856		
	%	100.0	100.0	100.0	100.0	100.0	100.0		

n = number; X² - Chi-square test; p - value statistically significant ($p < 0.05$)

Table 5: Risk factors among injured children and adolescents treated for unintentional injuries in the Republic of Srpska emergency medical services (EMS)

Factors	OR	95 % CI (lower-upper bound)	p-value
Age (years)			
> 1	0.864	0.529-1.411	0.559
1-4	0.568	0.517-0.624	< 0.001
5-9	0.833	0.746-0.930	0.001
10-14	0.876	0.782-0.980	0.021
15-19		Reference	
Age group			
Children (0-9 years)	0.531	0.471-0.597	< 0.001
Adolescent (10-19 years)		Reference	
Sex			
Male	1.147	1.003-1.313	0.046
Female		Reference	
Days of the week			
Working days	1.165	1.029-1.318	0.016
Weekend		Reference	
Season			
Spring	0.945	0.794-1.125	0.527
Summer	1.032	0.879-1.212	0.698
Autumn		Reference	
Winter	0.790	0.655-0.952	0.014
Body part injured			
Head	0.568	0.518-0.623	< 0.001
Neck	1.069	0.932-1.227	0.339
Thorax	0.795	0.669-0.945	0.009
Abdomen	0.615	0.521-0.727	< 0.001
Upper limbs	0.489	0.443-0.541	< 0.001
Lower limbs	0.560	0.503-0.622	< 0.001
Multiple body regions		Reference	

OR – Odds ratios; CI – Confidence interval; Reference – reference category; EMS = Emergency medical service; p - values were calculated by logistic regression analysis.

EMS RS (Table 5) was used. After observing age as a risk factor, children aged 1 to 4 years ($p < 0.001$), 5 to 9 years ($p = 0.001$) and 10 to 14 years ($p = 0.021$) had a significantly lower chance of unintentional injury compared to adolescents aged 15 to 19. It was determined that boys had a significantly higher risk compared to girls ($p = 0.047$). Unintentional injuries occurred more often during working days ($p = 0.016$). For different body injuries where the injury occurred, head ($p < 0.001$), thorax ($p = 0.009$), abdomen ($p < 0.001$), upper and lower limbs ($p < 0.001$), had a lower risk of injury compared to multiple body regions.

Discussion

This study showed that the total share of unintentional injuries in the Republic of Srpska EMS was

10.9 % and that there were differences that varied according to the causes depending on the age and sex of children and adolescents. The results of the Spanish National Study from 2017 showed that EMS visits due to unintentional injuries have increased and that they cause significant morbidity.⁸ The share of unintentional injuries in EMS was 20 %, whereas international research shows a slightly higher percentage (30.0 %) of injured children and adolescents in EMS due to unintentional injuries.^{8, 16} The detailed data on unintentional injuries in the RS EMS are not regularly collected. From a multidisciplinary point of view, there is a need for better recording of the external causes that lead to injuries and the circumstances under which they occur and the introduction of a registry that would document unintentional injuries in the RS EMS with the aim of reviewing this issue and establishing more effective prevention measures.

Results from this study showed that falls were the leading cause of injuries among children aged 0 to 9 and adolescents aged 10 to 14, whereas road traffic injuries were the most common reason for visiting the RS EMS in the group of adolescents aged 15 to 19 years. Similar results were presented in the review paper by Dellinger and Gilchrist,¹⁷ where falls were the leading cause of non-fatal injuries in younger children, whereas injuries caused by traffic accidents were the leading cause of injuries in adolescents aged 17 to 18. Several studies have confirmed that unintentional falls were the leading cause of non-fatal injuries in ER visits in children under 14 years of age.^{18, 19} In countries with low net national product, 40 % of all falls occur exactly among children and adolescents under 15 years of age.¹²

This research also showed the existence of sex differences where boys were significantly more represented in RS EMS. The predominance of the male gender according to the causes of unintentional injuries is also suggested in other studies and WHO reports.^{1, 3, 10} The reason boys are more prone to injury is explained by previously conducted research that indicates that sex differences might be the result of biological factors,²¹ a more dynamic lifestyle, less controlled behaviour¹⁰ and a higher level of physical activity and different patterns of behaviour compared to girls.²² Boys are more at risk of unintentional injuries irrespective of the injury mechanism.²³

The results obtained after analysing injuries according to body regions showed that head injuries were the most dominant ones in all age groups, with children younger than 1 year affected the most, which is in accordance with previous studies.^{1, 24} Young children are more likely to suffer head injuries than older children and one of the reasons is the size of the child's head, the soft and elastic bones of the skull and the weaker supporting structures of the neck, that all contribute to head impact, which is different from that of an adult.¹⁰ Head injuries are common, with specific characteristics among certain groups, requiring not only individual emergency medical care but prevention strategies on the population level.²⁴

This research showed that during the three-year period, there were no fatal outcomes registered in the RS EMS. A large percentage of patients were referred to another centre for hospital treatment, which is worrying information and may point to severity of the injuries. On the other

hand, Eurostat reports that in EU member states and according to data from the EU Injury Database for the period from 2009 to 2018, 12.72 % of cases required hospital treatment and 87.28 % were treated in outpatient clinics, emphasising that children, adolescents and young adults are at the highest risk of injury.⁹ Analysing the risk factors, our research showed that boys were at a higher risk of unintentional injuries compared to girls, which is in line with the previous findings.^{4, 25} The reason for this could be the fact that boys are more physically active than girls and show more interest in competitive and physical activities and games.²⁵ The risks of unintentional injuries are multifactorial in nature. They are mainly defined by children's individual factors such as age, sex, psychological factors and behavioural factors, then by social and financial factors of the family, but also by other factors in the child's social environment.²⁶ Evaluating the risk factors, a significant correlation between age and unintentional injuries was found and the occurrence of unintentional injuries increased with the children's age, which is in accordance with previous studies.^{25, 26}

Strengths and limitations

First, according to authors' knowledge this is the first study in the Republic of Srpska, Bosnia and Herzegovina that examined the characteristics of unintentional injuries in children and adolescents treated in EMS. Second, the major strengths were the robust sample size. The results provide data on the causes that led to unintentional injuries according to the age and sex of the children, the characteristics of the injuries and certain risk factors related to them. However, there are also several limitations. First, even though data from 14 EMS RS was analysed, 9 of these were in Banja Luka region, therefore other regions in the Republic of Srpska were under-represented, so it is necessary to avoid generalisation of the results. Secondly, the e-database did not contain information on factors from the social environment of children and adolescents and information on family characteristics (level of parents' education, material status, etc) and the risk factors cannot be adequately assessed without this information. Therefore, future research should be focused directly on the mentioned factors related to the occurrence of unintentional injuries among this population.

Conclusion

This study has shown that there were significant differences in causes and characteristics of injuries according to age groups and sex among patients treated in the RS EMS for unintentional injuries. Falls were the major cause for reporting to EMS among children aged 0 to 9 and adolescents aged 10 to 14, whereas traffic accidents were the leading cause for reporting to the RS EMS in adolescents aged 15 to 19. Boys were significantly more affected by unintentional injuries. Head injuries were the most dominant ones in all age groups when caused by falls and traffic accidents. Moreover, differences in injuries among age groups, sex and causes of unintentional injuries indicate where preventive measures should be undertaken. In order to prevent unintentional injuries, the development of programs in the community should be implemented, which should focus on the factors that influence the occurrence of injuries caused by falls and road traffic injuries. Programs should be holistically oriented and aimed at educating children and parents in order to change behaviour in the home environment, but also in the community.

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Conflict of interest

None.

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