



# The Epidemiology of Limb Fractures in Children Admitted to an Emergency Department in Western Iran

Elham Shafiei<sup>1</sup>, Arash Nademi<sup>2</sup>, Ali Ashraf Mozafari<sup>1,3</sup>, Elham Bastani<sup>1</sup>, Taleb Kokhazadeh<sup>1</sup>, Kosar Yousefi<sup>1</sup> and Ali Sahebi<sup>1\*</sup>

<sup>1</sup>Clinical Research Development Unit, Shahid Mostafa Khomeini Hospital, Ilam University of Medical Sciences, Ilam, Iran

<sup>2</sup>Department of Statistics, Ilam Branch, Islamic Azad University, Ilam, Iran

<sup>3</sup>Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

\*Corresponding author: Clinical Research Development Unit, Shahid Mostafa Khomeini Hospital, Ilam University of Medical Sciences, Ilam, Iran. Email: ali.sahebi.phd@gmail.com

Received 2020 March 11; Revised 2020 June 07; Accepted 2020 June 14.

## Abstract

**Background:** The incidence of limb fractures in children depends on environmental factors and socioeconomic backgrounds.

**Objectives:** This study aimed to evaluate the epidemiology of limb fractures in 1 to 15-year-old children in Ilam City, Iran.

**Methods:** This retrospective study enrolled all children aged 15 and below admitted to the Emam Khomeini Hospital of the Ilam University of Medical Sciences between July 2012 and March 2018. Data including age, sex, injury mechanism, and injured organs were recorded in SPSS software and analyzed using a chi-square test.

**Results:** Out of 4877 children, 74.3% were boys, and 25.7% were girls, with the men to women ratio of 2.87 and the mean age of  $9.10 \pm 4.3$  years. Elbow and forearm with 39.35% and leg with 21.61% were the most common sites of fractures. Home, street, and sports fields were the commonplaces of injury with 50.7%, 28.3%, and 7.2%, respectively. The age range of 8-15 years, with 3693 cases (75.72%) was the most vulnerable age group. Fractures occurred mostly in spring and summer and less frequently in the other seasons.

**Conclusions:** Specific attention should be paid to the home environment and its safety for controlling injuries in preschool children. This includes increasing parents' knowledge of preventive measures. Moreover, improving the physical condition of pavements and crosswalks in the streets is necessary for the prevention of injuries.

**Keywords:** Fracture, Epidemiology, Pediatrics

## 1. Background

Limb fracture is a major cause of pediatric morbidity and admission to hospitals in children aged 1 to 15 years (1, 2). Children contribute to a high proportion of the population in each society (3). It is shown that fractures account for 10-25% of injuries in preschool children annually (4). The major place of pediatric fracture is the distal forearm, accounting for 25-30% of all fractures (5, 6). Public health authorities in all countries must have a good understanding of the magnitude and characteristics of fractures of the organs to understand and evaluate injury prevention strategies, resource allocation, and educational priorities.

Results of a study by Behdad et al. (3) showed that falling was the major cause of pediatric elbow fractures (86%). Another study showed that road crashes and falls were the two main causes of injuries, accounting for 57.3% and 37.1% of injuries, respectively. Another study showed that 60% of injuries in patients were falls (7).

Results of a study from Finland showed an increase in

forearm fractures in children aged 0 to 15 years in 2005 compared with data from 1983, despite an overall decrease in pediatric fractures (8). Reasons for changes in the incidence rate have not been elucidated, although several contributing factors have been suggested (9).

There are limited data on childhood fractures in Iran. According to a report, injuries are the category causing the highest disability-adjusted life year (DALY) rate (28% of the total) in Iran (10). Pediatric fractures, as many other types of injuries are commonly observed in Iran, and their incidence rate appears to be increasing. We conducted this study to evaluate the epidemiology of limb fractures in children.

## 2. Objectives

This study aimed to evaluate the epidemiology of limb fractures in children between 1 and 15 years of age in Ilam City, Iran.

### 3. Methods

This retrospective study was carried out based on existing data from the data bank of the Emam Khomeini Hospital, affiliated to the Ilam University of Medical Sciences, between July 2012 and March 2018. The inclusion criteria were preschool (1 - 7 years) and school (8 - 15 years) age groups with limb fractures. Patients suffering from burns, hip and spine fractures, and poisoning were excluded. Data included the patients' demographics, a physiological state on admission, and definitive anatomic sites of injury. The injuries were grouped into standard anatomic categories based on the International Classification of Diseases and Related Health Problems (ICD-10).

Data were recorded in SPSS software (version 24.0 for windows) and analyzed using a chi-square test and Fisher's exact test. P-values less than 0.05 were considered statistically significant.

### 4. Results

The total number of injured children under the age of 1 to 15 years in Ilam City was 4877 between 2012 - 2018. There were 3614 (74.2%) boys and 1263 (25.8%) girls with the mean age of  $9.1 \pm 4.33$  years. Of the total number of children enrolled, 1834 (37.5%) were in the 1 - 7 year age group, and 3043 (62.5%) were in the 8 - 15 year age group. Out of 4877 fractures, 2471 cases occurred at home (50.6%), 165 (3.4%) in roads, and 349 (7.2%) in sports fields (Table 1). There was a statistical correlation between the place of accident and sex with age group ( $P < 0.001$ ).

Table 2 shows the frequency of injured subjects based on age group and sex. Elbow and forearm fractures were the most common types of fractures, representing 39.3% ( $n = 1919$ ) of all the cases, elbow and forearm fractures 39.3% ( $n = 1919$ ), and leg fracture (1054 cases, 21.6%) were the most common types of fractures, respectively. In the preschool (1 - 7 years) and school (8 - 15 years) age groups, the most common sites of fracture were also elbow and forearm with 33.5% and 41.2%, respectively. The sex ratio was 1161:673 (1.73%) in the 1 - 7 year age group and 2456:587 (4.18%) in the 8 - 15 year age group. The most common fractures ( $n = 3693$ , 75.72%) took place in the 8 - 15 year age group. According to the frequency of the injured subjects, subjects suffering from shoulder + arm (34.2%) and hand + wrist (49.2%) injuries mostly fell down the stairs. Moreover, subjects suffering from elbow + forearm (53.8%) and leg (57.0%) injuries mostly fell off to the ground. Furthermore, subjects suffering from pelvis + thigh (37.1%) injuries mostly fell from  $< 1$  m.

On the other hand, subjects suffering from foot (36.2%) injuries mostly fell from  $> 1$  m. The highest frequency of

injuries in subjects fall from  $< 1$  m, fell from  $> 1$  m, falling down the stairs, and falling off to the ground was related to hand + wrist (26.8%), elbow + forearm (40.0%), hand + wrist (28.2%), and elbow + forearm (56.6%) injuries, respectively.

The highest frequency of injured subjects based on place of accident was in avenues (elbow + forearm, 36.6%), roads (hand + wrist, 27.9%), freeways (hand + wrist, 28.3%), houses (elbow + forearm, 35.7%), workplaces (hand + wrist, 27.4%), sports fields (pelvis + thigh, 25.5%), villages (hand + wrist, 32.0%), and other places (elbow + forearm, 89.3%). There was a significant relationship between injury mechanism, place of accident, age group, and sex with body region damaged ( $P$  value  $< 0.001$ ).

Figure 1 shows the trend of the number of injured children from July 2012 to March 2018. The plot indicates an ascending trend with seasonal variations. Such that, the highest frequency of fractures occurred in spring and summer, while fractures had the minimum frequency in the other seasons. This issue can be observed in the trend of fractures based on monthly data, as indicated in Figure 2. The results in the figure based on injured subjects for the years 2012 to 2018 show that most fractures occurred during May, June, and July.

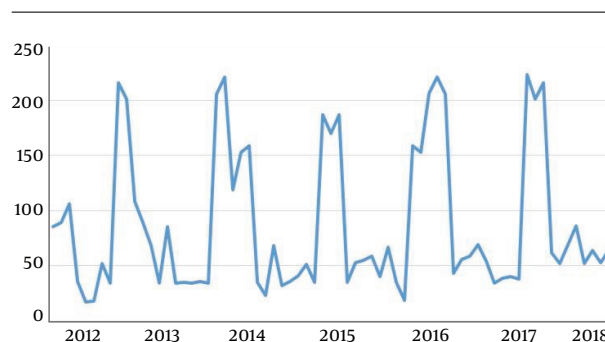


Figure 1. The trend of change during the six-year study. The results of the trend of change during our six-year study were seasonal.

### 5. Discussion

The findings of this study showed a clear male gender preponderance in limb fractures with a boy to girl ratio of 2.8 to 1. Fractures were shown to be more common in boys in the childhood period in other studies in Iran (11-16); however, this difference was not significant in some other studies (17). This can be attributed to risk-taking behaviors among boys (beginning after infancy and extending to elderhood) that expose them to more prevalent and severe injuries, or to cultural and traditional training disciplines which have more restricted and controlled supervision on

**Table 1.** The Frequency of Injured Subjects Based on Place of Accident and Sex (P Value = 0.000)<sup>a</sup>

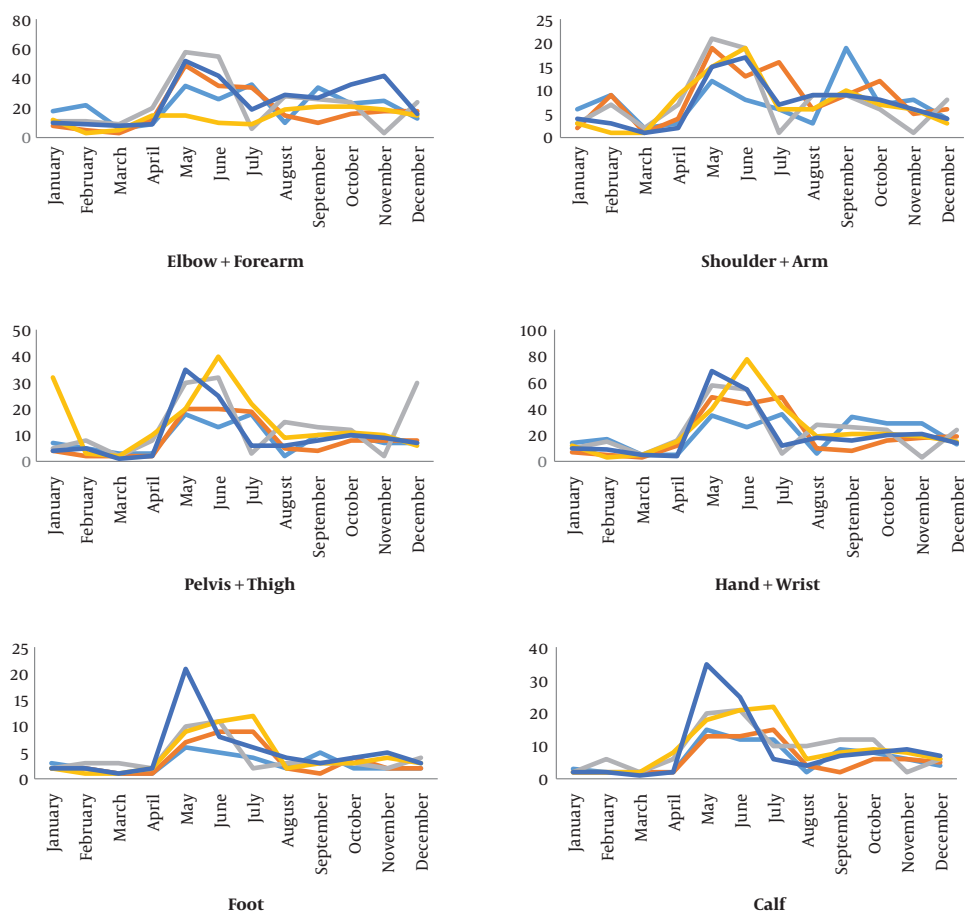
Place of Accident, Sex	Age Group		Total	Prevalence, %
	1-7	8-15		
Avenue	412 (22.5)	967 (31.8)	1379 (28.3)	28.27
Road	43 (2.3)	122 (4.0)	165 (3.4)	3.3
Freeway	30 (1.6)	30 (1.0)	60 (1.2)	1.2
House	1204 (65.7)	1267 (41.6)	2471 (50.7)	50.6
Workplace sports field	28 (1.5)	147 (4.8)	175 (3.6)	3.5
Village	38 (2.1)	311 (10.2)	349 (7.2)	7.1
Other	49 (2.7)	98 (3.2)	147 (3.0)	3.0
Total	28 (1.5)	103 (3.4)	131 (2.7)	2.6
Boy	1832 (100)	3045 (100)	4877 (100)	
Girl	1158 (63.2)	2456 (80.7)	3614 (74.2)	74.10
Girl	676 (36.8)	587 (19.3)	1263 (25.8)	25.89

<sup>a</sup>Values are expressed as No. (%).**Table 2.** The Frequency of Injured Subjects Based on Age Group and Sex (P Value = 0.000)

	Shoulder + Arm (%) (R)(%) (C)	Elbow + Forearm (%) (R)(%) (C)	Hand + Wrist (%) (R)(%) (C)	Pelvis + Thigh (%) (R)(%) (C)	Leg (%) (R)(%) (C)	Foot (%) (R)(%) (C)
<b>Sex</b>						
Boy	344 (9.5) (70.8)	1398 (38.7) (72.9)	654 (18.1) (81.8)	220 (6.1) (60.9)	857 (23.7) (81.3)	141 (3.9) (54.9)
Girl	142 (11.2) (29.2)	521 (41.3) (27.1)	146 (11.6) (18.2)	141 (11.2) (39.1)	197 (15.6) (18.7)	116 (9.2) (45.1)
<b>Age group</b>						
1-7	184 (15.5) (37.9)	397 (33.5) (20.7)	249 (21.0) (31.1)	137 (11.6) (38.0)	122 (10.3) (11.6)	95 (8.0) (37.0)
8-15	302 (8.2) (62.1)	1522 (41.2) (79.3)	551 (14.9) (68.9)	224 (6.1) (62.0)	932 (25.2) (88.4)	162 (4.4) (63.0)
<b>Falls</b>						
Fall from ≥ 1 m	112 (14.0) (23.0)	156 (19.5) (8.1)	214 (26.8) (26.8)	121 (15.2) (33.5)	102 (12.8) (9.7)	93 (11.7) (36.2)
Fall from < 1 m	94 (11.0) (19.3)	342 (40.0) (17.8)	163 (19.0) (20.4)	134 (15.7) (37.1)	67 (7.8) (6.4)	56 (6.5) (21.8)
Fall from stairs	166 (11.9) (34.2)	388 (27.7) (20.2)	394 (28.2) (49.2)	78 (5.6) (21.6)	284 (20.3) (26.9)	89 (6.4) (34.6)
Fall to ground	114 (6.2) (23.5)	1033 (56.6) (53.8)	29 (1.6) (3.6)	28 (1.5) (7.8)	601 (32.9) (57.0)	19 (1.0) (7.4)
<b>Place of accident</b>						
Avenue	83 (5.9) (17.1)	717 (36.6) (37.4)	101 (26.0) (12.6)	125 (12.1) (34.6)	289 (15.4) (27.4)	64 (4.0) (24.9)
Road	17 (10.3) (3.5)	43 (26.1) (2.2)	46 (27.9) (5.8)	32 (19.4) (8.9)	15 (9.1) (1.4)	12 (7.3) (4.7)
Freeway	5 (8.3) (1.0)	16 (26.7) (0.8)	17 (28.3) (2.1)	10 (16.7) (2.8)	7 (11.7) (0.7)	5 (8.3) (1.9)
House	269 (10.9) (55.3)	881 (35.7) (45.9)	452 (18.3) (56.5)	51 (2.1) (14.1)	683 (27.6) (64.8)	135 (5.5) (52.5)
Workplace	31 (17.7) (6.4)	46 (26.3) (2.4)	48 (27.4) (6.0)	25 (14.3) (6.9)	12 (6.9) (1.1)	13 (7.4) (5.1)
Sports field	61 (17.5) (12.6)	75 (21.5) (3.9)	87 (24.9) (10.9)	89 (25.5) (24.7)	26 (7.4) (2.5)	11 (3.2) (4.3)
Village	15 (10.2) (3.1)	24 (16.3) (1.3)	47 (32.0) (5.9)	26 (17.7) (7.2)	19 (12.9) (1.8)	16 (10.9) (6.2)
Other	5 (3.8) (1.0)	117 (89.3) (6.1)	2 (1.5) (0.2)	3 (2.3) (0.8)	3 (2.3) (0.3)	1 (0.8) (0.4)
Total	486 (10.0)	1919 (39.3)	800 (16.4)	361 (7.4)	1054 (21.6)	257 (5.3)

activities, and even games, related to girls. All of our cases were under the age of 15 years, and household events were the most common cause of injury (50.7%) among them. This is within the ranges reported from India, i.e., 47% to 60.8% (17), but extremely different from those reported by

Pandya, with 2.9% of upper and 5.0% lower extremity fractures at home (18). This high rate of injury at home in Ilam City may be due to poor safety measures considered in the construction of buildings, and also, since a majority of children spend their free time at home due to inadequate or



**Figure 2.** The monthly trend of variations based on injured subjects for the years 2012 to 2018

even absence of public places for doing sports and other recreational activities. Another cause of the above finding may be the inadequate attention of parents to their children for either their involvement in outdoor economic activities to support the family, which is an increasing event in the developing countries, or their trust on grandparents, or even elder siblings, for the care of youngsters, who may need support themselves in their daily activities. In other words, this may show a change in lifestyle in the Iranian community, as new houses are within multi-level buildings with limited space for children to safely doing required daily and recreational activities. This may be observed in other parts of the country with similar percentages, and thus, needs further nation-wide studies.

The most common sites of fracture were forearm, elbow, and wrist, which is similar to other studies (19, 20). However, the results of Asadi et al. (14) showed that head and neck (71.2%) and extremity (15.5%) injuries had the highest frequency.

Moreover, the current study showed that most injuries occurred during May, June, and July. The reason is just that the closure schools and the free time of the children close during these months, and it is similar studies in other countries and Iran (14, 15). Equipping playgrounds with safety equipment and improving safety in streets, parks, and sports fields can be helpful in preventing child injuries. Moreover, the adoption of safety rules in these places are effective.

Results from studies by Rijal and Dhakal (21) and Khodayari Zarnaq (22) showed fall as the common mechanism of fractures. It was 36.2% of the causes of fracture in our study and is more common in younger children between 8 - 15 years. The discrepancy in the frequency of different events in the mentioned studies can be due to variation in the average age of the studied populations. Moreover, the field of study can affect the results. Attracting the attention of those involved in these events, including urban and civil development experts may result in preventive mea-

tures and rules, which may eventually lead to a safe society.

### 5.1. Limitations

ICD codes for hip and thigh fractures do not cover hip fractures, and thus, we used limb fractures.

### 5.2. Conclusions

Childhood fracture in urban regions of developing countries may result in a heavy burden on society and health resources due to lifelong morbidity. Concerning household events as the main source of injuries, preventive measures should be initiated from home and extended to public places by providing an appropriate education for parents, planning and implementing facilities and rules in the building of houses, sports fields, and streets, and producing equipment to provide specific needs of this age group and guarantee a healthy population for the future.

### Footnotes

**Authors' Contribution:** Study design: ES and EB. Data collection: TK and KY. Data analysis: AN and AAM. Writing the manuscript: AS and ES.

**Conflict of Interests:** None to declare.

**Ethical Approval:** This paper is a part of a research project approved by the Medical University of Ilam (No. 967008/82), Iran.

**Funding/Support:** None declared by author.

### References

- Sharma PN, Bang RL, Al-Fadhli AN, Sharma P, Bang S, Ghoneim IE. Paediatric burns in Kuwait: incidence, causes and mortality. *Burns*. 2006;**32**(1):104-11.
- Dlj M, Jm N, Jm G, Cg M. Concurrent upper limb and hip fracture in the elderly. *Injury*. 2020. doi: [10.1016/j.injury.2020.02.073](https://doi.org/10.1016/j.injury.2020.02.073). [PubMed: [32089282](https://pubmed.ncbi.nlm.nih.gov/32089282/)].
- Behdad A, Behdad S, Hosseinpour M. Pediatric elbow fractures in a major trauma center in Iran. *Archives of trauma research*. 2013;**1**(4):172-5. doi: [10.5812/atr.8098](https://doi.org/10.5812/atr.8098). [PubMed: [24396773](https://pubmed.ncbi.nlm.nih.gov/24396773/)].
- Nomura O, Ota N, Inoue N, Shimomura S. The pucker sign in children with an upper limb fracture: A case-series. *Am J Emerg Med*. 2018;**36**(4):724-6. doi: [10.1016/j.ajem.2017.08.036](https://doi.org/10.1016/j.ajem.2017.08.036). [PubMed: [28826638](https://pubmed.ncbi.nlm.nih.gov/28826638/)].
- Kanda T, Endo N, Kondo N. Low Bone Mineral Density of the Forearm and Femur among Postmenopausal Women with Metaphyseal Comminuted Fracture of the Distal Radius. *Tohoku J Exp Med*. 2019;**249**(3):147-54. doi: [10.1620/tjem.249.147](https://doi.org/10.1620/tjem.249.147). [PubMed: [31708524](https://pubmed.ncbi.nlm.nih.gov/31708524/)].
- Ploegmakers JJW, Groen W, Haverlag R, Bulstra SK. Predictors for losing reduction after reposition in conservatively treated both-bone forearm fractures in 38 children. *J Clin Orthop Trauma*. 2020;**11**(2):269-74. doi: [10.1016/j.jcot.2019.04.022](https://doi.org/10.1016/j.jcot.2019.04.022). [PubMed: [32099292](https://pubmed.ncbi.nlm.nih.gov/32099292/)]. [PubMed Central: [PMC7026527](https://pubmed.ncbi.nlm.nih.gov/PMC7026527/)].
- Khaji A, Zargar M, Karbakhsh M. Extremity fractures in children: a hospital based study in Tehran. *Chin J Traumatol*. 2010;**13**(4):217-21. [PubMed: [20670578](https://pubmed.ncbi.nlm.nih.gov/20670578/)].
- Mäyränpää MK, Mäkitie O, Kallio PE. Decreasing incidence and changing pattern of childhood fractures: A population-based study. *Journal of Bone Mineral Research*. 2010;**25**(12):2752-9. doi: [10.1002/jbmr.155](https://doi.org/10.1002/jbmr.155).
- Schmikli SL, Backx FJ, Kemler HJ, van Mechelen W. National survey on sports injuries in the Netherlands: target populations for sports injury prevention programs. *Clin J Sport Med*. 2009;**19**(2):101-6. doi: [10.1097/JSM.0b013e31819b9ca3](https://doi.org/10.1097/JSM.0b013e31819b9ca3). [PubMed: [19451763](https://pubmed.ncbi.nlm.nih.gov/19451763/)].
- Afkhami AA. Medicine and Public Health in Modern Iran: Historical and Sociological Perspectives. *Iranian Studies*. 2020;**53**(1-2):3-7. doi: [10.1080/00210862.2019.1706426](https://doi.org/10.1080/00210862.2019.1706426).
- Jalili Y, Yassaghi A, Khatib MM, Gholzadeh A. Effect of transverse faults on fracture characteristics and borehole instability in the Asmari reservoir of Zagros folded belt zone, Iran. *Journal of Petroleum Science Engineering*. 2020;**188**:106820. doi: [10.1016/j.petrol.2019.106820](https://doi.org/10.1016/j.petrol.2019.106820).
- Parsa A, Esmaili B, Hallaj Moghadam M, Omidi Kashani F, Dadgar-moghaddam M, Rezaeian A. Comparison of closed with open reduction in supracondylar humerus fracture. *International Journal of Pediatrics*. 2020.
- Kelishadi R, Qorbani M, Motlagh ME, Ardalan G, Moafi M, Mahmood-Arabi M, et al. Frequency, Causes, and Places of Unintentional Injuries in a Nationally Representative Sample of Iranian Children and Adolescents: The CASPIAN-IV Study. *International journal of preventive medicine*. 2014;**5**(10):1224-30. [PubMed: [25400879](https://pubmed.ncbi.nlm.nih.gov/25400879/)].
- Asadi P, Asadi K, Rimaz S, Monsef-Kasmaie V, Zohrevandi B, Mohtasham-Amiri Z. Epidemiology of trauma in children admitted to Poursina teaching hospital. *Journal of Guilan University of Medical Sciences*. 2015;**23**(92):9-15.
- Dolatbadi AA, Mohseninia N, Amiri M, Motamed H, Asl AH. Pediatric trauma patients in Imam Hossein emergency department; an epidemiologic study. *Iranian journal of emergency medicine*. 2016;**3**(1):4-8.
- Mobasheri F, Azizi H, Rastbaf F. The epidemiological pattern of injuries among children under 15 years of age in Fasa in 2013. *Journal of Fasa University of Medical Sciences*. 2016;**6**(1):69-78.
- Tandon T, Shaik M, Modi N. Paediatric trauma epidemiology in an urban scenario in India. *Journal of Orthopaedic Surgery*. 2007;**15**(1):41-5. doi: [10.1177/230949900701500110](https://doi.org/10.1177/230949900701500110). [PubMed: [17429116](https://pubmed.ncbi.nlm.nih.gov/17429116/)].
- Pandya NK, Baldwin K, Wolfgruber H, Christian CW, Drummond DS, Hosalkar HS. Child abuse and orthopaedic injury patterns: analysis at a level I pediatric trauma center. *Journal of Pediatric Orthopaedics*. 2009;**29**(6):618-25. doi: [10.1097/BPO.0b013e3181b2b3ee](https://doi.org/10.1097/BPO.0b013e3181b2b3ee). [PubMed: [19700994](https://pubmed.ncbi.nlm.nih.gov/19700994/)].
- Mozafari J, Motamed H, Hanafi MG, Fatehifar B. The diagnostic value of neuron-specific enolase in children with mild blunt trauma requiring cranial CT scan. *Open Access Emergency Medicine: OAEM*. 2020;**12**:1. doi: [10.17795/soj-6773](https://doi.org/10.17795/soj-6773). [PubMed: [32021497](https://pubmed.ncbi.nlm.nih.gov/32021497/)].
- Jafari D, Joudi S, Panahy PHS. Clinical and Radiographic Evaluation of the Operative Treatment of Lateral Humeral Condylar Fracture in Children at Shafa Hospital, Tehran, Iran. *Shafa Orthopedic Journal*. 2017;**4**(1).
- Rijal A, Dhakal N. Trend of Orthopedic Trauma Patients and Seasonal Variation. *Galore International Journal of Health Sciences Research*. 2020;**5**(1):13-6.
- Khodayari Zarnaq R, Saadati M, Rezapour R, Baghaie H. Epidemiology of Injuries in Children Younger Than Five Years Old - Tabriz. *J Comper Oediatr*. 2018;**9**(4). e62092. doi: [10.5812/compreped.62092](https://doi.org/10.5812/compreped.62092).