Frequency of Paediatric Orthopaedic Injuries and Related Factors in One Year
A Hospital in Northern Iran

Abstract
Background & Aim: Orthopedic trauma is a common injury in children and may cause deep and permanent psychological and physical damages for the patients and their families. Recognition of the incidence rate of these injuries can help design effective treatment plans. This study aimed to identify various dimensions of orthopedic trauma in children in Abu Ali Sina Hospital of Sari, Northern Iran.

Materials and Methods: In this prospective descriptive study, patients under the age of 16 years with orthopedic injuries, hospitalized in Bu Ali Sina Hospital during 2015-2016 were entered into the research. Information related to the age, gender, and mechanism trauma was collected. Data analysis was performed in SPSS using Chi-square, as well as paired and one-sample t-tests.

Results: In total, 525 patients below the age of 16 years were assessed, (65.3%) with a mean age of 9.7±4.4 were male years and the rest were female (34.7%) with the mean age of 7.7±6.4 years. While most injuries in male subjects were within the age range of 14-16 years, for female participants two peaks in the age ranges of 2-4 and 14-16 years was seen. Moreover, 81.7% of the fractures were related to the upper limbs while 18.3% of the traumas were observed in the lower limbs. Furthermore, the most common location of incidents was home, and most frequent mechanism in both genders was falling (42.3%). In addition, the most common time of injuries was the fall season (44.6%). According to the results, most orthopedic trauma (56.7%) were observed in children and adolescents with normal body mass indexes, and only 8.29% of fracture cases were related to obese or overweight patients aged 2-16 years.

Conclusion: Children are at risk of severe orthopedic trauma, which is due to lack of information, awareness, and education. Examining the safety of children and keeping them away from such injuries is essential and must be studied in other large cities in other the developing countries.

Keywords: Orthopedics, Fractures, Bone, Child

Received: 9 months before printing; Accepted: 1 month before printing

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Introduction
One of the most common injuries in children is orthopaedic trauma, which causes many physical problems, economic losses and long-term physical disabilities1-3. Every year, one out of four American children suffer from injuries and require medical care3-6. Some of the most common orthopaedic traumas reported in various studies include fracture, dislocation, and damage to the soft tissue, among which fracture is recognized as the most important orthopaedic damage in children3,7-9.

The risk of fractures throughout life is 42-64% in male children and 27-40% in female children8,10. In general, fractures are normally observed in female individuals at lower ages, compared to male children9,11-13. In all studies, there is a higher incidence rate of fractures in males, cause of which is unknown and might be due to biological and social factors and more physical activities or higher vulnerability of this gender3,8,9. In addition, most studies have reported the most common fracture site to be the forearm bones or distal radius8,9.
The possibility of fracture in children can be determined in various environments depending on the type of damage, and the necessary recommendations could be made to parents in order to prevent trauma in children. While various mechanisms (e.g., falling, crashes, exercise, cycling) cause orthopaedic injuries in children, falling is the most common cause of injury reported in most studies. Falling from the stairs is a major contributor to the trauma of children, especially under the age of five. However, the trauma mechanisms in smaller children are still not clear. Moreover, the trauma mechanism gradually changes based on children’s age, in a way that increased age and activities of children are associated with a higher risk of damage in these individuals.

Not only paediatric orthopaedic injuries cause psychological, social and economic problems for patients and families, but also they can lead to long-term physical impairments. Therefore, addressing the epidemiology of diseases is extremely important to prevent the occurrence of damaging incidents. It is notable that the prevalence and epidemiology of orthopaedic traumas might be completely different in various countries or even in different regions of a country. With this background in mind, this research aimed to evaluate the frequency of orthopaedic injuries and related factors in children referred to the emergency department of Abu Ali Sina Hospital during 2015-2016.

Methods

This research was conducted on patients aged below 16 years, hospitalized in the emergency department of Abu Ali Sina Hospital due to orthopaedic traumas. Inclusion criteria were different types of orthopaedic traumas caused by traffic accidents and other types of injuries in children. After enrolling the patients into the research, information such as age, gender, height, weight, trauma mechanism, type of trauma, injury site, the referral season and place of incident were recorded for each patient. The data obtained was completed based on clinical examination, radiological assessments, and intraoperative findings. Trauma mechanism included falling, fall from a height, exercising, traffic accidents, and cycling. Furthermore, the type of trauma was fracture, dislocation, fracture dislocation, contusion, and tear. In general, the injury site was divided into three upper extremities, lower extremity, and pelvis. The incident location included home, school, park, gym, and street. Data analysis was performed in SPSS using Chi-square, one sample t-test (to evaluate normal quantitative variables and compare the mean with a criterion number, paired t-test (for comparison of mean in two dependent states (paired)), independent t-test (to compare the mean between two independent groups), as well as analysis of variance and post hoc tests (for comparison of means in more than two independent groups).

Results

During January 2015-2016, a total of 525 patients aged below 16 years referred to the emergency department of Abu Ali Sina Hospital due to various orthopaedic traumas. All of these individuals met the inclusion criteria of the current research. Incidence Rate of Orthopaedic Trauma in Patients Aged below 16 Years Based on Age

Results related to the evaluation of the distribution frequency of the patients based on age (Diagram 1) demonstrated a higher rate of trauma in adolescents aged 14-16 years (22.9%), compared to others. On the other hand, infants aged below two years (6.4%) had a lower rate of orthopaedic traumas, compared to the other patients. In this regard, a significant difference was observed between the subjects within the mentioned age ranges in terms of orthopaedic trauma (P=0.001).

Diagram 1. Distribution Frequency of Patients Based on Age
In this study, the mean age of the male and female subjects was reported to be 9.7±4.4 and 7.7±6.4 years, respectively, demonstrating a significant difference in this regard (P<0.001).

Moreover, evaluation of the distribution frequency of trauma in patients at various ages separated by the mechanism of orthopaedic trauma (Diagram 2) indicated that the provenance of orthopaedic traumas was higher in four-year-old female children, compared to male subjects. However, the rate of orthopaedic traumas was higher in male patients aged above four years (maximum: 16 years), compared to female participants. The peak of this difference is between the ages of 14 and 16 years since 42.2% of this age group consists of male subjects. According to the results of Pearson's chi-squared test, there was a significant relationship between the age and gender of the subjects (P<0.001).

**Incidence Rate of Orthopaedic Trauma in Patients below the Age of 16 Years According to Gender**

The frequency distribution of the patients studied based on gender indicated that male subjects were more exposed to orthopaedic traumas, compared to female participants (65.3% vs. 34.7%). In this regard, there was a significant difference between male and female children in terms of the prevalence rate of orthopaedic traumas (P<0.001).

**Incidence Rate of Orthopaedic Trauma in Patients Aged below 16 years According to Trauma Mechanism**

Evaluation of the mechanism of orthopaedic traumas in patients showed that the majority of patients (34.2%) aged below 16 years experienced trauma caused by falling, and only 2.1% of the participants were referred to the hospital with orthopaedic traumas caused by cycling (Diagram 2). According to the results, there was a significant difference in the prevalence rate of orthopaedic traumas in terms of trauma mechanism (P<0.001).

**Incidence Rate of Orthopaedic Injuries in Patients below 16 Years Based on the Damaged Area**

Evaluation of the limbs injured in patients indicated that none of the patients had pelvic fractures, and all orthopaedic traumas were observed in the upper or lower limbs of patients. Nonetheless, the incidence rate of orthopaedic traumas in the upper limbs of patients was more than twice the incidence rate in the lower limbs. It seems that this difference in the incidence rate of orthopaedic traumas in the upper and lower extremities was statistically significant (P<0.001).
Incidence Rate of Orthopaedic Traumas in Patients below 16 Years Based on the Referral Season
Evaluation of the referral season of patients to Abu Ali Sina Hospital revealed that most (44.6%) and least (8.4%) cases with orthopaedic injuries referred to this healthcare center in fall and winter, respectively. According to Diagram 4, there was a statistically significant difference in the incidence rate of orthopaedic traumas of 16-year-old adolescents in four seasons of the year (P<0.001) (Diagram 4).

Diagram 4. Frequency Distribution of Patients Based on the Referral Season

The Incidence Rate of Orthopaedic Trauma in Patients below 16 Years Based on BMI
The mean BMI of children and adolescents assessed in the study was estimated at 18.7±4.3 kg/m², in a way that the lowest and highest BMI rates were reported to be 9.2 and 44.4 kg/m², respectively. In addition, the statistical comparison of male and female subjects regarding BMI rate showed a significant difference in this regard. In order to evaluate the incidence rate of orthopaedic traumas in children and adolescents aged below 16 years based on BMI, we must first determine the physical size of patients. To this end, we applied the BMI-for-age percentile chart, which is a tool for monitoring the growth rate of male and female individuals aged 2-20 years. According to this diagram, subjects had one of the following BMI rates:

After excluding 24 children aged below two years (4.6%) from 525 children and adolescents (without undermining the purpose of the project) and estimating the BMI of 501 patients (4.95%) aged 2-16 years, it was determined that the highest incidence rate of orthopaedic traumas (56.7%) was observed in children and adolescents with normal BMI rates, and overweight children constituted 29.8% subjects with orthopaedic injuries. These results demonstrated that being obese or overweight could not be the independent cause of orthopaedic traumas. According to Diagram 6, there was an apparent difference between the incidence rate of orthopaedic traumas in patients with normal BMIs and other patients, which was statistically significant (P<0.001) (Diagram 6).

Diagram 6. Distribution Frequency of Patients Aged 2-16 Years Based BMI

Discussion
According to the results of the current research, regardless of the size and height and weight, the different orthopaedic injuries inflicted on children
can be very dangerous\textsuperscript{(16)} despite the fact that orthopaedic injuries are common in paediatric patients, and according to some reports, about 25% of children are exposed to injury every year. There are limited epidemiological studies in this field. Most studies conducted on the risk of fracture are from Scandinavia country, according to which the risk of fracture from birth to age 16 years was 42% for males and 27% for females\textsuperscript{(13)} In a study by Aghakhani et al. performed to evaluate the epidemiology of orthopaedic trauma in children and adolescents in Tehran, 1081 patients below the age of 19 years were hospitalized with orthopaedic injuries, the majority of whom were male (76.8%). The mean age of female and male subjects was 8.67±4.63 and 11.04±5.06 years, respectively, demonstrating a significant difference in this regard (P<0.001), which is in line with our findings\textsuperscript{(7)}. In the majority of studies, the higher incidence rate of fractures was related to male subjects\textsuperscript{(9,16)}. However, the reason for this higher rate is not clear and might be related to biological and social factors and more physical activities or higher vulnerability of this group of people\textsuperscript{(15)}. Evaluation of these factors and determining high-risk children in both genders can contribute to the prevention of trauma in these individuals.

In the present study, the mean age of the male and female subjects was reported to be 9.7±4.4 and 7.7±6.4 years, respectively, demonstrating a significant difference in this regard (P<0.001) (patients evaluated with a mean age of 9.0±4.6 years within the age range of 3 months to 16 years). According to the results, the most common seasons of referral due to orthopaedic trauma were fall (44.6%) and spring (34.1%), respectively. In a research by Landin, the risk of fractures increased in both genders up to the age of 11-12 years. However, while this rate reduced in female participants after the mentioned age, it continued to increase in male subjects, which is inconsistent with our findings\textsuperscript{(10)}. In another study by Cooper et al., fracture gradually increased and reached its maximum rate in 11-year-old and 12-year-old female and male subjects, respectively, and decreased after that. Similar results were reported by Schalmon et al.\textsuperscript{(8,9)}, and Rennie et al. marked that the maximum incidence rate of orthopaedic injuries was observed in female and male participants aged 12 and 13 years, respectively\textsuperscript{(13)}. Nonetheless, the trauma mechanism in children is not always recognized accurately. Sometimes in very small patients who were damaged when they were alone, the trauma mechanism was recorded as a possibility. Therefore, the trauma mechanism was not reported in all cases of this study. In the current research, falling was the most common cause of injury (42.3%). Similarly, Rennie\textsuperscript{(13)} reported that falling was the most common cause of trauma (56%). Trauma mechanism gradually changes based on the age of children. In this study, falling was the most common cause of trauma in both groups, followed by sport-related incidents. Meanwhile, cycling had the least contribution to traumas.

In a study by Fridman et al. on 56691 children with injuries, soccer playing was introduced as the main cause of trauma, specifically in children aged 14-16 years\textsuperscript{(15)}. In other reports, soccer and basketball were introduced as sports with the highest rate of injury\textsuperscript{(17)} Among sport equipment, skates and scooters were reported to be the major contributor to children’s trauma\textsuperscript{(18)}. In addition, seasonal differences have been observed in the emergence of fractures\textsuperscript{(15)}.

In a research by Park et al., the highest incidence rate of lower limb fractures was reported in the summer season, followed by fall, spring, and winter. Meanwhile, most lower limb fractures were observed in winter\textsuperscript{(18)}. In the present study, the highest incidence rate of fractures was in the seasons of fall and spring, which might be due to the high rainfall in autumn in the northern part of the country and possibility of children slipping due to the slippery condition of the ground. In the research by Park et al., the location of fractures was 2.5 times higher in winter, compared to spring, which could be related to the cold weather and more presence of children in homes and performing more in-home exercises\textsuperscript{(18)}.

In terms of the location of the injury, the highest incidence rate of fractures was related to home in the current research, which is in line with the results obtained in other studies. This result might be due to the cold weather of this region of Iran and more staying of children in their homes. On the other hand, the school was recognized as the second location (26.1%) with most incidence rate of fractures, which might be due to the opening of schools in the fall and more spending time in the school environment and higher level of sports activities by children. In all studies, there was a higher level of reports on upper limb fractures, compared to the fractures of the lower extremities, which is consistent with our findings since our results were indicative of 69.1% upper limb injuries and 30.9% upper limb fractures. From 525 children and adolescents assessed, 56.7% of orthopaedic traumas were observed in subjects with normal BMIs, and only 29.8% of the injuries were related to obese or overweight children and adolescents aged 2-16 years.
One of the major drawbacks of the present study was lack of access to all information of patients with orthopaedic injuries. Another limitation was lack of cooperation of some of the patients. Therefore, a written informed consent was obtained from all subjects prior to the research, and the necessary licenses were attained from the university.

Conclusion

According to the results of the present study, the most orthopaedic injuries were related to the adolescents within the age range of 14-16 years. In addition, the highest incidence rate of orthopaedic traumas (7.56%) was observed in children and adolescents with normal BMIs. In terms of location, home and school were the most common places of incidents, respectively. Moreover, the highest and lowest incidence rates of orthopaedic traumas in patients below the age of 16 were reported in the seasons of fall and winter, respectively. In addition, the results demonstrated that the incidence rate of orthopaedic traumas in the upper limbs of patients was twice the rate of injuries in the lower extremities. Regarding the mechanism of orthopaedic traumas, falling was the most common cause of injury in patients. It is recommended that more extensive studies be performed in other cities in order to obtain more realistic and accurate information about this field. By doing so, the data collected from cities of Iran could be used to reduce this type of injuries in individuals at all age ranges, especially children and elders, who are the most vulnerable members of the society.

Research limitation: lack of sufficient information obtained from adjacent cities and provinces and lack of adequate data on fracture site in each body limb in terms of the damaged bones.

In the end, it is suggested that further studies be conducted in other cities to determine the fracture site in each limb in terms of injured bones and the mechanism most responsible for the type of fracture. In addition, it is recommended that the cause of the incidents and trauma that could not be determined in the present research be evaluated in future studies.

We failed to separate contusions from fractures, and there is no explanation on lack of pelvic fractures in the studied group, which might be due to the type of referrals of patients. It is notable that the authors declare that there is no conflict of interest regarding the publication of this article.

References