



ELSEVIER

Contents lists available at ScienceDirect

Injury

journal homepage: [www.elsevier.com/locate/injury](http://www.elsevier.com/locate/injury)

## Epidemiological pattern of pediatric trauma in COVID-19 outbreak: Data from a tertiary trauma center in Iran



Mohammad Hossein Nabian<sup>a</sup>, Fardis Vosoughi<sup>a</sup>, Farid Najafi<sup>b</sup>, Seyyed Saeed Khabiri<sup>c,\*</sup>, Maziar Nafisi<sup>d</sup>, Javad Veisi<sup>e</sup>, Vahid Rastgou<sup>e</sup>, Salam Ghamari<sup>e</sup>, Amir Aakhashi<sup>e</sup>, Nader Bahrami<sup>e</sup>, Mehdi Naderi<sup>f</sup>, Shokofeh Maleki<sup>f</sup>, Mir Saeed Yekaninejad<sup>g</sup>

<sup>a</sup> Department of Orthopaedic and trauma surgery, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran

<sup>b</sup> Research Center for Environmental Determinants of Health (RCEdH), Health Institute, School of Health, Kermanshah University of Medical Sciences, Kermanshah, Iran

<sup>c</sup> Department of Orthopedic surgery, Clinical Research Development Centre, Taleghani and Imam Ali Hospital, Kermanshah University of Medical Sciences, Kermanshah, Iran

<sup>d</sup> Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran

<sup>e</sup> Department of Orthopedic surgery, School of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran

<sup>f</sup> Clinical Research Development Centre, Taleghani and Imam Ali Hospital, Kermanshah University of Medical Sciences, Kermanshah, Iran

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

### ARTICLE INFO

#### Article history:

Accepted 15 September 2020

#### Keywords:

Covid-19  
Sars-cov-2  
Pandemic  
Lock-down  
Children  
Trauma  
Epidemiology  
Fracture

### ABSTRACT

**Introduction:** In Iran, like most other countries, COVID-19 has had a deep impact on children's lives. Our hypothesis was that, a significant change in the number of pediatric injuries has happened in trauma centers. In the current study, we intend to identify the possible epidemiological shift in pediatric fracture patterns, by comparing the data from 'COVID-19 era' and the mean data from the past 2 years. To the best of our knowledge there are only few reports on epidemiology of pediatric fractures during the COVID-19 outbreak.

**Methods:** Data are reported in two sections. In the descriptive section, epidemiological data regarding pediatric fractures referred to Taleghani tertiary trauma center, including demographics, distribution curves, etiologies and fracture types are presented during the 'COVID era', from 1 March 2020 to 15 April 2020. In the comparative section, the aforementioned data are compared with mean data from the past 2 years, the 'non-COVID era'.

**Results:** Altogether 117 of the 288 trauma children (40.62%) had a fractured bone (145 fractures). Patients were mostly boys, with a mean age of 9.87 years (SD=5.27). The three most common fracture types in children included distal radius, mid-forearm and humeral supracondylar fractures. Compared to non-COVID era, the number of pediatric trauma admissions dropped from 589 to 288. No significant change happened in the mean age, male/female ratio and percentage of motor vehicle accidents. Proportion of proximal humeral, proximal forearm, carpal, and hand fractures declined. The number of open fractures significantly dropped (from 12 to 2).

**Conclusions:** In Iran, overall trend of pediatric trauma has been decreasing during the outbreak; but the lack of reduction in proportion of accidents may pose an alarm that an effective lock-down has not been imposed. This study has implications as to preparing appropriate resources particular to common "COVID era fractures".

© 2020 Elsevier Ltd. All rights reserved.

\* Corresponding author.

E-mail addresses: [dr.nabian@gmail.com](mailto:dr.nabian@gmail.com) (M.H. Nabian), [fardis.vosoughi@gmail.com](mailto:fardis.vosoughi@gmail.com) (F. Vosoughi), [fnajafi@kums.ac.ir](mailto:fnajafi@kums.ac.ir) (F. Najafi), [saeed.khabiri@gmail.com](mailto:saeed.khabiri@gmail.com) (S.S. Khabiri), [maziarnafisi@gmail.com](mailto:maziarnafisi@gmail.com) (M. Nafisi), [dr.javadveisi@gmail.com](mailto:dr.javadveisi@gmail.com) (J. Veisi), [vahid.rastgou68@gmail.com](mailto:vahid.rastgou68@gmail.com) (V. Rastgou),

[drsalamghamari@gmail.com](mailto:drsalamghamari@gmail.com) (S. Ghamari), [amir.akhashi@gmail.com](mailto:amir.akhashi@gmail.com) (A. Aakhashi), [naderbahrami87@gmail.com](mailto:naderbahrami87@gmail.com) (N. Bahrami), [m.naderi51@yahoo.com](mailto:m.naderi51@yahoo.com) (M. Naderi), [malekis99@yahoo.com](mailto:malekis99@yahoo.com) (S. Maleki), [yekaninejad@yahoo.com](mailto:yekaninejad@yahoo.com) (M.S. Yekaninejad).

## Introduction

Since the declaration of corona virus disease 2019 (COVID-19) pandemic in 12 March 2020 [1], and even earlier, people and health care workers all around the world have been gathered together in a common war against the severe acute respiratory syndrome caused by corona virus 2 (SARS-COV-2). Probably as Bill Gates wisely said, viral infections are the real threat to human lives in the 21st century [2]. Early reports of COVID-19 spread in China, focused on the adult population with no reports of COVID-19 in children [3], but as the infection became a pandemic and spread throughout the world, more and more reports of infected children were published [4,5]. Now we know that children are not completely safe. That being said, for unknown reasons children are less susceptible to this infection than the adult population [5]. There have been some studies focusing on trauma in COVID-19 era [6–27]. Nonetheless, data on possible changes in hospital admission and injury characteristics of traumatized children in lacking. These data could prove beneficial in preparing resources.

In Iran, COVID-19 has had a deep impact on children's lives [28]. COVID-19 in Iran, coincided with "Nowruz" which is the beginning of the Iranian new year. The significant rise in travels that happens every year on Nowruz, couldn't be effectively stopped and this helped faster spread of the outbreak in Iran [29]. On the other hand, every year, schools throughout the country are closed during the 2-week period of Nowruz holidays. This year, COVID-19 caused the Iranian schools to stay closed after Nowruz, for the first time in the 21st century. Due to social distancing and personal precautions mostly taken by people themselves, children mostly have had to stay at home and like in many other countries, keeping the kids entertained and mentally healthy, has become a real challenge for many families [30]. COVID-19 outbreak has caused a significant change in the number of injuries we encounter in trauma hospitals. In the current study, we intend to discuss this epidemiological shift in fracture patterns in children, by presenting the data from COVID-19 era and last year and compare them. To the best of our knowledge there are only few reports on epidemiology of pediatric fractures during the COVID-19 outbreak.

## Methods

This study has a descriptive and a comparative part. The descriptive part, is a retrospective analysis on patients referred to Taleghani Hospital, from March 1, 2020 (when social distancing precautions were imposed nationwide) until April 15 2020, the 'COVID era'.

The Committee on Ethics in Human Research at Kermanshah university has approved this study. Taleghani Hospital is a tertiary trauma center in western Iran, serving a minimum population of 2 million people in Kermanshah province plus neighboring provinces, and accepts a total 1500 to 3000 trauma patients per month (based on the data from Kermanshah local registry of fractures). Usually based on available records, 20–25% of patients admitted to the Orthopaedic emergency room are under 18 years old. Data regarding different fracture types in the referred trauma children, as well as mechanisms of injury, demographics, and distribution curves are presented.

In the second part of the study, the comparative part, mean data of 2018 and 2019 from the same center, and the same period of time are presented, which we will call it the 'non-COVID era'. This data will then be compared with the same data during the 'COVID era'.

Data are presented as means and standard deviations (SD) and percentages. Comparing data from each time period is conducted by using the Analysis of Variance (ANOVA) and Chi-squared tests.

**Table 1**

Statistics and Demographic data from the COVID and non-COVID era (NA: Not Applicable).

|                         | Non-COVID (%) | COVID (%)   | P-value |
|-------------------------|---------------|-------------|---------|
| Mean age                | 9.87 (5.33)   | 9.98 (5.50) | 0.119   |
| Male-Female ratio       | 2.39          | 2.64        | 0.273   |
| Trauma Admissions       | 589           | 288         | NA      |
| Patients with fractures | 247           | 117         | NA      |
| Total fractures         | 295           | 145         | NA      |

**Table 2**

Percentage of different mechanisms of injury in trauma patients during the non-COVID and COVID era.

| Mechanism of injury    | Non-COVID | COVID | P-value |
|------------------------|-----------|-------|---------|
| Falling                | 58.9      | 49.3  | 0.008   |
| Motor Vehicle Accident | 9.6       | 8.3   | 0.51    |
| Direct blow            | 13.5      | 14.9  | 0.55    |
| Penetrating injury     | 16.1      | 25.7  | <0.001  |
| Other                  | 1.9       | 1.7   | 0.88    |

Calculating P-values for compared percentages was performed with OpenEpi software [31]. All analyses are conducted using SPSS software version 25.0 (IBM corporation). P value < 0.05 is considered significant.

## Results

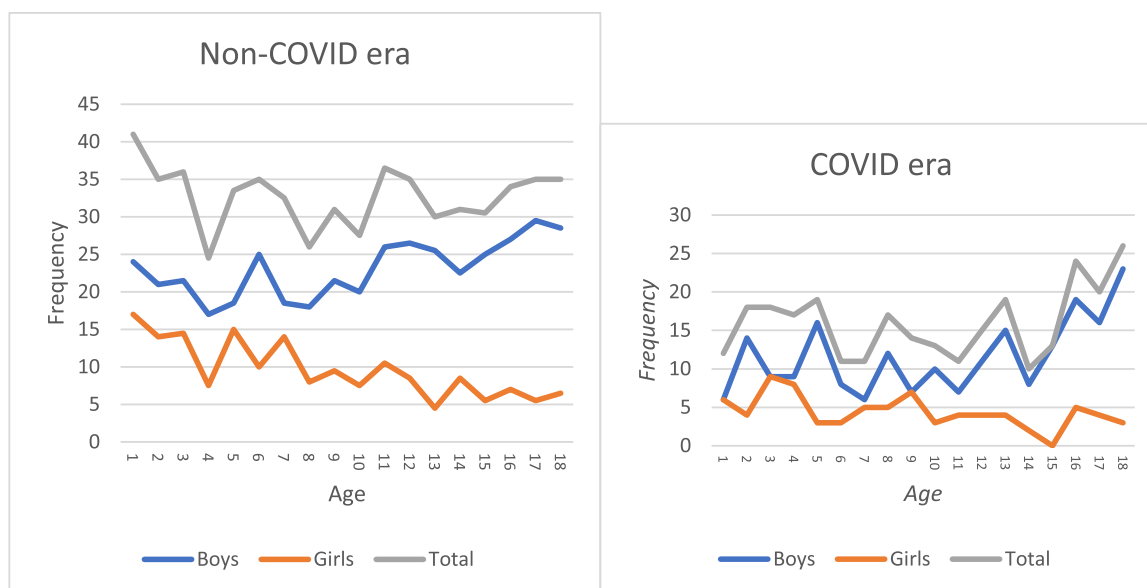
### Descriptive section

Altogether 288 trauma patients under 18 years old referred to our center during the study time frame, of whom 117 patients (40.62%) had a fractured bone with total of 145 fractures. Demographic characteristics are depicted in Table 1. Patients were mostly boys (M/F ratio: 2.64), with a mean age of 9.87 years (SD=5.27). The three most common fracture types in children included distal radius, mid-forearm and distal humeral supracondylar fractures in order of prevalence. During COVID-19 outbreak, 2 open fractures and 7 dislocations (3 in the lower limb and 4 in the upper limb) were encountered, in our emergency rooms. Frequency diagrams were used to demonstrate age-wise distribution of cases among boys and girls (Fig. 1).

### Comparative section

Compared to the similar 45-day time period in the non-COVID era, the number of trauma patients has declined from 589 to 288. A similar 52% decline was seen in the number of pediatric fractures. A decrease in the mean age of children with fracture was seen, although it was not statistically significant (from 9.87 to 9.98). Male to female showed a non-significant increase from 2.39 to 2.64 ( $P = 0.273$ ). The total number of fractures in boys and girls have decreased alike. Despite the general decline in the number of children referring with a fracture, relative percentages of different mechanisms of injury show no significant changes ( $P = 0.116$ ) (Table 2).

Regarding different fracture types (Fig. 2), fractures of humeral supracondylar region, radioulnar shaft, distal forearm and proximal tibia showed a significant increase. On the other hand, proportion of proximal humeral, proximal forearm, carpal, and hand fractures declined. However, the three most common fracture types in children remained the same: Distal radius, mid-forearm and distal humeral fractures in order of prevalence. The number of open fractures significantly dropped from 12 open fractures in 2019 to 2 open fractures during the pandemic. In the non-COVID era, 3



**Fig. 1.** Distribution curves in the non-COVID (left) and COVID (right) era. In each diagram, the horizontal axis shows patients' age, while the vertical axis shows frequency in boys (blue curve) and girls (orange curve) and in total (Grey curve).

dislocations (2 elbow and 1 finger dislocations) referred to our center which in turn increased during quarantine to 7 dislocations (3 in the lower limb and 4 in the upper limb).

## Discussion

The current study shows a reduction in the number of injured children referred to orthopedic emergency during COVID-19 outbreak. This was expected, owing to social distancing and home quarantine, which has caused a change in people's behavior and lifestyles. Schools, kindergartens and sports activities were closed in Iran since March 1, 2020 and we witnessed a significant reduction in city traffics. These factors, along with the parents' fear of infecting their children by going to hospitals [32], have caused about 50 percent reduction in fracture patients referring to our emergency rooms. Similar even more significant trend has been recorded in other countries (50–70%) [33,34].

The proportion of trauma patients who were found to have a fractured bone didn't change during the outbreak. The overall number of trauma patients has decreased, but in contrast to similar studies on adults [33], in our study we saw no significant change in the fracture demographics. This could be due to the fact that previously children were not majorly affected by non-lock down activities. The mean age and male to female ratio have remained unchanged.

Comparing the distribution curves of the 'COVID era' with the past two years (Fig. 1), the general pattern is similar, but the difference between number of fractures in boys and girls has declined dramatically in the 'COVID era'. This might be in part due to the floor effect: The overall number of cases in both sexes has dropped, but frequency in girls in some age groups is so low that can't decline further as much as the boys. Moreover, compared with girls, boys were probably more involved with lock-down activities in the 'non-COVID era' [22,35], thus the impact of lock-down was more significant in boys.

Regarding mechanism of injury, Iran is one of the countries with a high rate of trauma due to motor vehicle accidents [36]. Surprisingly, no statistically significant change happened in the percentage of motor vehicle accidents during COVID-19 outbreak (P-value = 0.51). However, we expected to see lower traffic injuries during lock down. This could pose an alarm, that most probably lock-down measures were not effective enough. On the other hand, percentage of simple falls decreased significantly concurrent to a rise in penetrating injuries. In fact, it has been our common experience that fractures due to simple falls (mostly distal radius and mid-forearm fractures) in children usually rise in school season. It seems that closing of schools as well as stopping sports activities during the 'COVID era' has caused fewer simple falls to happen. Furthermore, more penetrating injuries were witnessed as a result of children playing with sharp objects at home. This shows the need for educating parents and paying more attention to children's safety at home. A report from the UK stated that despite the declining risks outside the house, because of possible problems inside the houses, the collisions of people at home caused injury. [34]. Christey et al. also reported increased trauma at home and farm and less accidents along with general decline in trauma patients [33].

In the case of fracture locations, distal radial, mid-forearm and supracondylar humerus fractures were the most common, both before and during the COVID-19 pandemic. In the case of supracondylar humerus fractures, a significant rise in percentage is seen, which can be due to the fact that it mostly occurs in the setting of low energy falls [22].

In this study, changes in the age and sex distribution of various types of fractures couldn't be presented due to the small number of cases. Multi-center studies could shed more light on the prevalence of fractures and different fracture patterns in children throughout COVID-19 pandemic according to age and sex, which are crucial information, helpful in preparing adequate resources for this susceptible population.

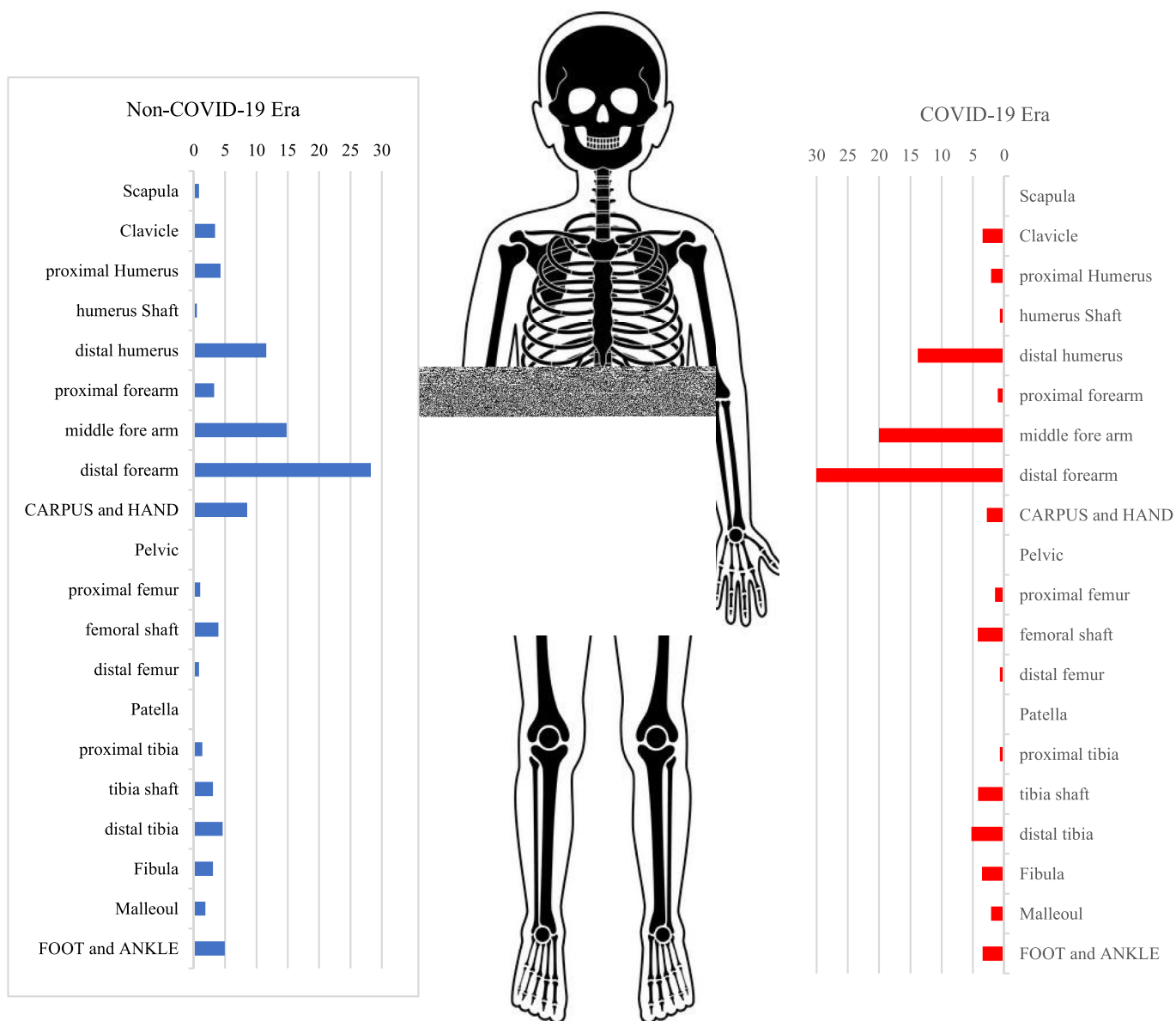


Fig. 2. Frequency charts for different fracture types during the non-COVID (left) and COVID (right) era.

**Conclusions**

Overall trend of pediatric trauma has been decreasing during the outbreak; but the lack of reduction in proportion of accidents may pose an alarm that an effective lock-down has not been imposed. This study has implications as to taking appropriate measures and preparing resources particular to common “COVID era traumatology”. Moreover, this study shows the need for attention to children safety and taking precautions at homes and playgrounds to prevent them from being injured.

**Funding**

Authors did not receive funding from any agencies in the public, commercial, or not-for-profit sectors.

**Declaration of Competing Interest**

None.

**Acknowledgement**

The authors would like to thank the Omid Sohrabi, Bahareh Safari, and Clinical Research Development Center, Taleghani and Imam Ali Hospitals, Kermanshah University of Medical Sciences, Kermanshah, Iran, for support, data gathering, cooperation, and assistance throughout the period study and manuscript preparation. We wish to acknowledge the valuable comments for the reviewers who add valuable insight to papers despite their busy schedules. We wish to acknowledge the valuable comments of the reviewers who add valuable insight to papers despite their busy schedules.

**References**

- [1] Velavan TP, Meyer CG. The COVID-19 epidemic. *Trop Med Int Health* 2020;25:278–80.
- [2] Gates B. Responding to Covid-19—A once-in-a-century pandemic? *New England Journal of Medicine* 2020;382:1677–9.
- [3] [The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China]. *Zhonghua Liu Xing Bing Xue Za Zhi* 2020;41:145–51.

- [4] Dong Y, Mo X, Hu Y, Qi X, Jiang F, Jiang Z, et al. Epidemiology of COVID-19 Among Children in China. *Pediatrics* 2020.
- [5] Coronavirus Disease 2019 in Children - United States, February 12–April 2, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:422–6.
- [6] Bram JT, Johnson MA, Magee LC, Mehta NN, Fazal FZ, Baldwin KD, et al. Where Have All the Fractures Gone? The Epidemiology of Pediatric Fractures During the COVID-19 Pandemic. *J Pediatr Orthop* 2020.
- [7] Giorgi PD, Schirò GR, Capitani D, D'Aliberti G, Gallazzi E. Vertebral compression fractures in multiple myeloma: redefining the priorities during the COVID-19 pandemic. *Aging Clin Exp Res* 2020:1–4.
- [8] Catellani F, Coscione A, D'Ambrosi R, Usai L, Roscitano C, Fiorentino G. Treatment of Proximal Femoral Fragility Fractures in Patients with COVID-19 During the SARS-CoV-2 Outbreak in Northern Italy. *J Bone Joint Surg Am* 2020.
- [9] Pieracci FM, Shiroff A. Surgical Stabilization of Rib Fractures during the COVID-19 Pandemic. *J Trauma Acute Care Surg* 2020.
- [10] Iyengar K, Vaish A, Vaishya R. Revisiting conservative orthopaedic management of fractures during COVID-19 pandemic. *J Clin Orthop Trauma* 2020.
- [11] Tognù A, Barbara E, Pacini I, Bosco M. Proximal humeral fracture surgery in the COVID-19 pandemic: advocacy for regional anesthesia. *Reg Anesth Pain Med* 2020.
- [12] Maniscalco P, Poggiali E, Quattrini F, Ciatti C, Magnacavallo A, Vercelli A, et al. Proximal femur fractures in COVID-19 emergency: the experience of two Orthopedics and Traumatology Departments in the first eight weeks of the Italian epidemic. *Acta Biomed* 2020;91:89–96.
- [13] Liu J, Mi B, Hu L, Xiong Y, Xue H, Zhou W, et al. Preventive strategy for the clinical treatment of hip fractures in the elderly during the COVID-19 outbreak: wuhan's experience. *Aging (Albany NY)* 2020;12:7619–25.
- [14] Lal H, Sharma DK, Patralekh MK, Jain VK, Maini L. Out Patient Department practices in orthopaedics amidst COVID-19: the evolving model. *J Clin Orthop Trauma* 2020.
- [15] Yu EW, Tsourdi E, Clarke BL, Bauer DC, Drake MT. Osteoporosis Management in the Era of COVID-19. *J Bone Miner Res* 2020.
- [16] Girgis CM, Clifton-Bligh RJ. Osteoporosis in the age of COVID-19. *Osteoporos Int* 2020:1–3.
- [17] Muñoz Vives JM, Jornet-Gibert M, Cámara-Cabrera J, Esteban PL, Brunet L, Delgado-Flores L, et al. Mortality Rates of Patients with Proximal Femoral Fracture in a Worldwide Pandemic: preliminary Results of the Spanish HIP-COVID Observational Study. *J Bone Joint Surg Am* 2020.
- [18] Sornsa-Ard T, Niramitsantiphong A, Liawrungrueang W. Management of Traumatic Spinal Fracture in the Coronavirus Disease 2019 Situation. *Asian Spine J* 2020.
- [19] Giorgi PD, Villa F, Gallazzi E, Debernardi A, Schirò GR, Crisà FM, et al. The management of emergency spinal surgery during the COVID-19 pandemic in Italy. *Bone Joint J* 2020 xxx.
- [20] Nuñez JH, Sallent A, Lakhani K, Guerra-Farfan E, Vidal N, Ekhtiari S, et al. Impact of the COVID-19 Pandemic on an Emergency Traumatology Service: experience at a Tertiary Trauma Centre in Spain. *Injury* 2020.
- [21] Hsieh TY, Dedhia RD, Chiao W, Dresner H, Barta RJ, Lyford-Pike S, et al. A Guide to Facial Trauma Triage and Precautions in the COVID-19 Pandemic. *Facial Plast Surg Aesthet Med* 2020;22:164–9.
- [22] Rennie L, Court-Brown CM, Mok JY, Beattie TF. The epidemiology of fractures in children. *Injury* 2007;38:913–22.
- [23] Zhu Y, Chen W, Xin X, Yin Y, Hu J, Lv H, et al. Epidemiologic characteristics of traumatic fractures in elderly patients during the outbreak of coronavirus disease 2019 in China. *Int Orthop* 2020:1–6.
- [24] Wilson JM, Schwartz AM, Farley KX, Devito DP, Fletcher ND. Doing Our Part to Conserve Resources: determining Whether All Personal Protective Equipment Is Mandatory for Closed Reduction and Percutaneous Pinning of Supracondylar Humeral Fractures. *J Bone Joint Surg Am* 2020.
- [25] Mi B, Chen L, Xiong Y, Xue H, Zhou W, Liu G. Characteristics and Early Prognosis of COVID-19 Infection in Fracture Patients. *J Bone Joint Surg Am* 2020;102:750–8.
- [26] Mi B, Chen L, Xiong Y, Xue H, Zhou W, Liu G. Characteristics and Early Prognosis of COVID-19 Infection in Fracture Patients. *J Bone Joint Surg Am* 2020.
- [27] Joob B, Wiwanitkit V. Carpal Fracture and COVID-19 Infection: observation from Thailand. *Indian J Orthop* 2020;54:393.
- [28] Naseri A, Hosseini MS. Do Not Neglect the Children: considerations for COVID-19 Pandemic. *Indian Pediatr* 2020.
- [29] Kaffashi A, Jahani F. Nowruz travelers and the COVID-19 pandemic in Iran. *Infect Control Hosp Epidemiol* 2020;1.
- [30] Fegert JM, Vitiello B, Plener PL, Clemens V. Challenges and burden of the Coronavirus 2019 (COVID-19) pandemic for child and adolescent mental health: a narrative review to highlight clinical and research needs in the acute phase and the long return to normality. *Child Adolesc Psychiatry Ment Health* 2020;14:20.
- [31] Dean AG S.K., Soe M.M. *OpenEpi: open Source Epidemiologic Statistics for Public Health*, Version 3.01. [www.OpenEpi.com](http://www.OpenEpi.com), updated 2013/04/06, accessed 2020/05/28.
- [32] Lazzarini M, Barbi E, Apicella A, Marchetti F, Cardinale F, Trobia G. Delayed access or provision of care in Italy resulting from fear of COVID-19. *Lancet Child Adolesc Health* 2020;4:e10–ee1.
- [33] Christey G, Amey J, Campbell A, Smith A. Variation in volumes and characteristics of trauma patients admitted to a level one trauma centre during national level 4 lockdown for COVID-19 in New Zealand. *N Z Med J* 2020;133:81–8.
- [34] Thornton J. Covid-19: A&E visits in England fall by 25% in week after lockdown. *Bmj* 2020;369:m1401.
- [35] Tandon T, Shaik M, Modi N. Paediatric trauma epidemiology in an urban scenario in India. *J Orthop Surg (Hong Kong)* 2007;15:41–5.
- [36] Derakhshanrad N, Yekaninejad MS, Vosoughi F, Sadeghi Fazel F, Saberi H. Epidemiological study of traumatic spinal cord injuries: experience from a specialized spine center in Iran. *Spinal Cord* 2016;54:901–7.