Original Article

POSI
IJPO

Patterns, Anatomical Distribution and Etiologies of Paediatric Fractures in a Tertiary Care Hospital in Sana'a City, Yemen: A Five-Year Retrospective Analysis

Ahmed S. Hudna MD[1], Mohammed M. Al-Zuhairi MBBS[2], Reham M. Mohammed MBBS[1], Yahya M. Farwan MBBS[3], Abdulrahman Y. Khamis MBBS[4], Kamal W. Yousef MBBS[4], Zinab A. Al-wardi MBBS[5]

Abstract

Background: Fractures in children are a major global health concern, contributing to morbidity, healthcare burden, and potential long-term disability. In Yemen, the epidemiology and management of paediatric fractures remain poorly documented. Therefore, this study aimed to investigate the patterns, anatomical distribution, etiologies and concomitant injuries associated with paediatric fractures over a five-year period from 2020 to 2024.

Methods: A retrospective cross-sectional study was conducted at the University of Science and Technology Hospital in Sana'a between January 2020 and December 2024 involving 466 medical records of children aged ≤18 years and with documented fractures. Data on demographics, fracture characteristics, etiology, and associated systemic injuries were extracted using a structured data collection sheet. Data were summarized using appropriate descriptive statistics.

Results: Among 466 children with fractures, the majority were boys (78.8%). The mean age was 11.0 ± 4.4 years, with 52.8% aged ≤11 years. Fractures were almost equally distributed between left and right sides (50.6% vs. 49.4%) and upper and lower limbs (46.6% vs. 45.3%), with pelvic fractures being rare (0.9%). Single fractures predominated (68%), while 32% involved multiple fractures; 7.3% had fractures at multiple anatomical sites. In the upper limbs, the radius (32.2%) and humerus (29.4%) were most frequently fractured. In the lower limbs, the femur (40.1%) and tibia (35.5%) fractures predominated. Multiple-site fractures most often involved phalanges of the hand with the tibia and fibula (26.5%). Quotidian injuries were the leading cause (72.1%), followed by road traffic accidents (21.5%). Concomitant injuries occurred in 4.5% of cases, primarily affecting the nervous system (76.2%).

Conclusions: Paediatric fractures in Sana'a predominantly affected boys and children aged ≤11 years, with an almost equal distribution between limbs and sides. The radius, humerus, femur, and tibia were most frequently affected. Injuries sustained during routine activities were the leading cause, followed by road traffic accidents. Concomitant injuries, mainly neurological were uncommon.

Keywords: Paediatric fractures, Daily-life injuries, Sport injuries, Yemen

Address of Correspondence
Dr. Ahmed Saleh Hudna,
Associate Professor of Paediatrics, Faculty of Medicine and Health Sciences, University of Science and Technology. Sana'a, Yemen.
E-mail: drahmedhudna@gmail.com

[1]Department of Paediatrics, Faculty of Medicine and Health Sciences, University of Science and Technology (USTY), Sana'a, Yemen.
[2]Department of Obstetrics, Al-Thawra Modern General Hospital, Sana'a, Yemen
[3]Department of Surgery, University of Science and Technology Hospital, Sana'a, Yemen
[4]Department of Medicine, University of Science and Technology Hospital, Sana'a, Yemen
[5]Al-Aliaa International Hospital, Sana'a, Yemen

DOI- https://doi.org/10.13107/ijpo.2025.v11.i03.242
www.ijpoonline.com
This is an Open Access journal, and articles are distributed under the terms of the Creative Commons Attribution Non-Commercial-Share Alike 4.0 License (http://creativecommons.org/licenses/by-nc-sa/4.0) which allows others to remix, tweak, and build upon the work non-commercially as long as appropriate credit is given and the new creation are licensed under the identical terms.

Introduction

Bone fractures significantly affect human health in terms of morbidity and mortality across all age groups. However, missed fractures frequently occur in paediatric trauma because of the unique anatomical and radiographic characteristics of developing bones, underscoring the need for heightened awareness of paediatric fracture patterns to ensure timely diagnosis and optimal clinical outcomes [1]. Males are

Submitted: 15/08/2025; Reviewed: 08/09/2025; Accepted: 09/11/2025; Published: 10/12/2025

more frequently affected across all age groups, with the peak incidence of fractures occurring at ages 11 to 12 in girls and 13 to 14 in boys [2-6]. The paediatric skeleton is distinct from the adult due to features such as growth plates, a thicker periosteum, and greater bone plasticity, leading to unique fracture patterns and influencing healing responses [7-9]. The thick, osteogenic periosteum in children promotes rapid healing and often permits non-surgical treatment [7-9]. Growth plates, critical for bone development, are prone to injury and require careful management to prevent long-term growth disturbances [9]. The pliability of paediatric bones contributes to their strong capacity for remodeling, particularly near active growth zones, often correcting alignment issues post-healing [7, 8].

Paediatric fractures most frequently occur in the upper limbs, particularly in the distal humerus, distal ulna, distal radius, hand, fingers, and clavicle [3-6, 10, 11]. Several clinical factors have been linked to an increased fracture risk in children, including obesity, low bone mineral density, and poor calcium and vitamin D consumption [12-14]. Environmental factors also play a role, with most injuries occurring at home, followed by playgrounds and sports facilities [15-17]. These fractures may result from accidental trauma, non-accidental trauma (e.g., child abuse), and pathologic conditions (e.g., bone disease) [18, 19], with accidental trauma being the most common cause and often associated with sporting activities, recreation, playground equipment, bicycles, skateboards, trampolines, motor vehicle collisions, and even gunshots [2-6, 20, 21]. Distinguishing between accidental and non-accidental injuries remains challenging for clinicians, with significant consequences for misdiagnosis in either direction [22].

Effective management of paediatric fractures requires comprehensive clinical evaluation, encompassing detailed history-taking, thorough physical examination, and appropriate imaging [23, 24]. Such management aims to achieve and maintain anatomic alignment, facilitate functional recovery, and preserve growth potential [25]. Paediatric fractures are often managed non-surgically due to high healing potential, though surgery is necessary for complex cases such as open, pathologic, or unstable fractures, and when conservative treatment fails [26]. The management of paediatric fractures depends on the child's age, fracture site, severity, and displacement and includes both non-operative and operative approaches [27, 28]. Younger children with stable and non-displaced fractures are usually treated non-surgically, while older children or those with displaced or unstable fractures often require surgical intervention [27].

Paediatric fractures can lead to a number of early and late complications that significantly impact recovery and long-term outcomes. The nature and severity of these complications often depend on the type of fracture and the treatment approach. These complications include growth disturbances, malunion or nonunion, compartment syndrome and neurovascular injuries [15, 29-32]. In Yemen, there is a lack of studies about paediatric fractures. Therefore, this study aimed to investigate the patterns, anatomical distribution, etiologies and concomitant injuries associated with paediatric fractures.

Methods

Study design and setting

A retrospective cross-sectional study was conducted at the University of Science and Technology Hospital (USTH), a tertiary healthcare facility based in Sana'a city, from January 2020 to December 2024. Medical records of paediatric patients aged 18 years or younger diagnosed with fracture were included in the study. Records with incomplete data were excluded.

Data extraction

A structured data sheet was used to extract data on the age and gender of children, fracture site (skull, clavicle, upper limb, lower limb, pelvis, spine, and extremities), fracture etiology (daily-life injuries, sports injuries, road traffic injuries, abuse, birth-related, or iatrogenic causes), and associated systemic traumas (nervous, endocrine, circulatory, respiratory, digestive, urinary, or reproductive).

Data analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp., Armonk, NY, USA). Continuous variables were described using the mean and standard deviation (SD) for normally distributed data, while categorical variables were presented as frequencies and percentages.

Ethical considerations

This study was approved by the Research Ethics Committee of the Faculty of Medicine and Health Sciences at the University of Science and Technology in Sana'a, Yemen. Administrative permission was also obtained from the USTH. Patient information was handled confidentially and securely.

Results

Characteristics of children with fractures

Table 1 shows that among 466 children with documented fractures, the majority were males (78.8%). The mean age of children was 11.0±4.4, with over one half being aged ≤11 years.

Characteristics of fractures

Table 2 shows that fractures occurred almost equally on the left and right sides of the body (50.6% vs. 49.4%, respectively). The anatomical distribution was also comparable between the upper and lower limbs (46.6% vs. 45.3%, respectively), while pelvic fractures accounted for only 0.9% of the cases, and

Table 1. Characteristics of paediatric patients with fractures admitted to the USTH in Sana'a City (2020–2024)*

Characteristics	*n*	(%)
Age (years)		
Mean ±SD: 11.0±4.4 (range: 1-18)		
≤11	246	-52.8
>11	220	-47.2
Gender		
Male	367	-78.8
Female	99	-21.2

Table 2. Characteristics of fractures among paediatric patients admitted to the USTH in Sana'a City (2020–2024)*

Fracture characteristics	*n*	(%)
Fracture laterality		
Right-sided	230	-49.4
Left-sided	236	-50.6
Fracture site		
Upper limb	211	-45.3
Lower limb	217	-46.6
Pelvis	4	-0.9
Multiple sites	34	-7.3
Fracture count		
Single	318	-68
Multiple	148	-32

*** The total number of children was 466. USTH, University of Science and Technology.**

multiple-site fractures were observed in 7.3% of children. Regarding fracture counts, the majority of children had single fractures (68%), while 32% had more than one fracture.

Anatomical distribution of fractures

Table 3 shows that the most frequent fractures in the upper limbs were of the radius (32.2%) and humerus (29.4%), followed by combined ulna and radius fractures (18%). The least common upper limb fractures ranged from 0.5% for the clavicle and complex fractures involving the ulna, radius, metacarpal bones, and phalanges of the finger to 7.6% for isolated ulna fractures. For lower limbs, the most frequent fractures involved the femur (40.1%) and the tibia (35.5%), followed by combined tibia and fibula fractures (8.8%) and fractures to metatarsal bones (7.4%). The least common lower limb fractures ranged from 0.9% for combined fractures of the tibia and tarsal bones to 1.8% for those involving phalanges of the toes.

Regarding fractures affecting multiple sites, the most frequent combination involved the phalanges of the fingers, tibia, and fibula (26.5%), followed by fractures of the radius and femur, ulna and tibia, and radius and tibia, each accounting for 5.9% of cases. In contrast, all other patterns were observed in only one patient each (2.9%) (Table 3).

Table 4. Etiology of fractures among paediatric patients admitted to the USTH in Sana'a City (2020–2024)*

Fracture etiology	*n*	(%)
Daily-life injuries (falls, cuts, twists, furniture-related, crush injuries, or bites)	336	-72.1
Road traffic injuries (car accident, bicycle accident, etc.)	100	-21.5
Unknown causes of fracture	18	-3.9
Gunshots or explosions	7	-1.5
Sports injuries (playground, soccer, swimming-related, etc.)	2	-0.4
Abuse injuries	2	-0.4
Birth-related injuries	1	-0.2

*** The total number of children was 466. USTH, University of Science and Technology.**

Table 5. Concomitant injuries with fractures among paediatric patients admitted to the USTH in Sana'a City (2020–2024)*

Type of concomitant injury	*n*	(%)
Nervous system injury	16	-76.2
Digestive system injury	2	-9.5
Circulatory system injury	1	-4.8
Respiratory and digestive system injuries	1	-4.8
Digestive and urinary system injuries	1	-4.8

*** The total number of children with concomitant injuries was 21. USTH, University of Science and Technology.**

Fracture etiology

Table 4 shows that the most frequent cause of paediatric fractures was daily-life injuries (72.1%), followed by road traffic injuries (21.5%). In contrast, 1.5% of fractures were caused by gunshots or explosions (1.5%), while sports, abuse, and birth-related injuries each accounted for less than 1% of all fractures. The etiology for 3.9% of fractures was unknown.

Concomitant injuries

Of 466 children with fractures, 21 (4.5%) had concomitant injuries. Among these, nervous system injuries were the most common, occurring in 16 patients (76.2%), followed by digestive system injuries in 2 patients (9.5%). Circulatory system injury, combined respiratory and digestive system injuries, and combined digestive and urinary system injuries were each documented in one patient (4.8%) (Table 5).

Discussion

To our knowledge, this is the first study in Yemen to comprehensively describe the demographic characteristics, anatomical distribution, and etiologies of paediatric fractures

Table 3. Anatomical distribution of fractures among paediatric patients admitted to the USTH in Sana'a City (2020–2024)

Site of fracture	*n*	(%)
Upper limb(*N* = 211)		
Clavicle	1	-0.5
Scapula	3	-1.4
Humerus	62	-29.4
Ulna	16	-7.6
Radius	68	-32.2
Carpal, metacarpal, and phalanges of finger	9	-4.3
Metacarpal bones	8	-3.8
Ulna, radius, metacarpal bones, and phalanges of finger	1	-0.5
Ulna and radius	38	-18
Humerus, ulna, and radius	3	-1.4
Humerus and ulna	2	-0.9
Lower limb(*N* = 217)		
Femur	87	-40.1
Tibia	77	-35.5
Tarsal bones	9	-4.1
Metatarsal bones	16	-7.4
Phalanges of toes	4	-1.8
Tibia and fibula	19	-8.8
Femur and tibia	3	-1.4
Tibia and tarsal bones	2	-0.9
Multiple sites (*N* = 34)		
Pelvis and femur	1	-2.9
Skull and humerus	1	-2.9
Phalanges of finger, tibia, and fibula	9	-26.5
Vertebrae, femur, and tibia	1	-2.9
Radius and femur	2	-5.9
Rib and humerus	1	-2.9
Ulna and tibia	2	-5.9
Humerus and tarsal bones	1	-2.9
Skull, clavicle, ulna, and radius	1	-2.9
Ulna, radius, and femur	1	-2.9
Phalanges of finger and tibia	1	-2.9
Radius and tibia	2	-5.9
Skull and tibia	2	-5.9
Ulna, radius, and tarsal bones	1	-2.9
Carbal bone and phalanges of toes	1	-2.9
Humerus, femur, and metatarsal bones	1	-2.9
Phalanges of finger and tarsal bones	1	-2.9
Skull and radius	1	-2.9
Humerus and femur	1	-2.9
Pelvis, ulna, and radius	1	-2.9
Pelvis and humerus	1	-2.9
Rib, pelvis, and femur	1	-2.9

USTH, University of Science and Technology.

in a major tertiary care hospital. Accordingly, its findings provide a valuable foundation for understanding fracture patterns in the paediatric population of the country and for guiding targeted prevention and management strategies. The present study revealed a marked predominance of fractures among boys, with nearly four out of five fractures occurring in boys. This is consistent with previous studies elsewhere [4, 33-38]. For instance, in a retrospective analysis of 3,350 children with 3,413 limb fractures in Hong Kong, boys outnumbered girls by a ratio of 2.7:1 overall, increasing to 5.5:1 in adolescents [33]. Similarly, a 10-year hospital-based study in a single center in Hong Kong involving 6,493 fractures among children revealed that the boy-to-girl ratio rose from 1.4:1 in infancy to 4.9:1 in adolescence [35]. In a population-based study from Olmsted County, Minnesota (1979–1988), 850 children sustained 951 physeal fractures, with boys accounting for 66% and girls 34%, yielding a male-to-female ratio of 2:1 [34]. The higher incidence of fractures in boys is likely due to their increased engagement in physically demanding activities and sports, along with a greater tendency for risk-taking behaviors, which predispose them to traumatic injuries [39-41].

In this study, the mean age of children with fractures was 11 years, with a slightly higher proportion of fractures occurring in those aged 11 years or younger, indicating the vulnerability of children to fractures at both preadolescence and early adolescence. This could be attributed to several factors, including their greater engagement in physically demanding activities. Additionally, the rapid growth phase during preadolescence and early adolescence can temporarily weaken bone strength, making fractures more likely [42, 43]. This finding is consistent with findings reported elsewhere [33, 39, 43]. However, slight differences could be observed across studies depending on the age group included in each study.

The present study revealed a near-equal distribution of fractures between the left and right sides of children, suggesting the lack of inherent biological or environmental bias toward either side of the body. This finding is consistent with the similar bilateral fracture rates among Chinese children in Guangdong [4]. However, this finding contrasts with other studies that have reported a dominance of fractures on one side. For example, left-sided dominance of upper limb fractures has been noted in Swedish children [44], while left-sided diaphyseal fractures were found to be more common among Indian children [45]. A study on rib fractures in abused children in the United States also found a significant left-side predominance, with 67% of rib fractures occurring on the left side [46]. These discrepancies in laterality across different populations underscore that the distribution of fractures in children can vary significantly based on a number of factors, including the specific age group, mechanism of injury, and geographic location.

The study's finding of a near-equal distribution between upper

(46.6%) and lower limb fractures (45.3%) is noteworthy, as it contrasts with many studies that report a clear predominance of upper limb fractures in paediatric populations. For instance, in a large regional trauma center study in the United Kingdom, upper limb fractures were more common than lower limb fractures among children, accounting for 51% and 21% of emergency admissions, respectively [47]. Likewise, studies in China and Switzerland found that upper limb fractures comprised approximately 80% of all childhood fractures [4, 48]. This divergence of our finding from this global trend may be attributed to local variations in children's activity profiles, socioeconomic conditions, and the predominant injury mechanisms in our setting.

The predominance of single fractures (68%) over multiple fractures (32%) in the present study concurs with epidemiological data from other settings. For instance, Qiu et al. [4] reported that single fractures substantially outnumber multiple fractures in paediatric populations in China, indicating that low-to-moderate impact injuries remain the most common mechanism of trauma. Single fractures, while more common, often present less complexity than multiple fractures, which are associated with higher energy trauma and increased risk of complications [49]. The complexity and potential severity of multiple fractures underscore the importance of thorough evaluation and appropriate management in paediatric trauma cases.

In this study, fractures of the radius (32.2%) and humerus (29.4%) emerged as the most common upper limb injuries among children, followed by combined ulna and radius fractures (18%). This finding is consistent with that reported in other studies, where the radius and humerus have been the most frequently fractured upper limbs [4, 50, 51]. While clavicle fractures are often reported as common in neonates and young children [52], their low frequency in our study may reflect the predominance of older children in our sample or underrepresentation of birth-related injuries.

Lower limb fractures in the present study were dominated by femoral (40.1%) and tibial (35.5%) fractures, which is in line with literature showing these anatomical locations as frequent targets of high-energy trauma, including road traffic accidents, falls from heights, and severe sports injuries [53, 54]. These injury patterns underline the importance of preventive strategies targeting high-energy trauma mechanisms, especially in environments where road safety measures, gaming infrastructure, and sports safety protocols may be limited.

While multiple-site fractures were relatively uncommon in the present study, their presence and distribution provide important insights into injury patterns. The most frequent combination involved the phalanges of the fingers, tibia, and fibula (26.5%), suggesting a mechanism of injury that affects both the upper and lower limbs simultaneously, such as falls from a height or crush injuries. However, the complexity and rarity of multiple-site fractures highlight the need for a multidisciplinary approach to optimize patient outcomes [55].

Daily-life injuries, including falls, crush injuries, and furniture-related accidents, were the leading cause of about two-thirds of fractures among children in the present study, followed by road traffic accidents in about one-fifth of cases. This finding is consistent with that reported among Indian children attending a major hospital in Delhi, where daily-life injuries, including falls, were the leading cause of about two-thirds of fractures among children, followed by road traffic accidents [16]. In contrast, a retrospective cohort study in Switzerland reported that ankle fractures in children and teenagers were mainly caused by sports activities (49.4%), followed by falls (20.4%) and road traffic accidents (11.3%) [56]. In a nationwide analysis from the Swedish Fracture Register, falls accounted for the majority of femur fractures in younger children, whereas traffic-related accidents were the leading cause among adolescents, together comprising the predominant etiologies across age groups [57]. In Austria, paediatric hand fractures were mainly caused by entrapment injuries in younger children and ball sport–related trauma in older children [21]. These variations highlight the complex interplay between age, activity type, and environmental factors in shaping the epidemiology of paediatric fractures, emphasizing the need for targeted prevention strategies tailored to specific populations and injury mechanisms.

The occurrence of concomitant injuries in 4.5% of cases, which predominantly involved the nervous system, underscores the importance of thorough trauma assessment in paediatric patients presenting with fractures. In this study, neurological involvement occurred in over three-quarters of cases with concomitant injuries. This finding suggests that mechanisms such as falls from a significant height and road-traffic accidents may result in multi-system trauma [58], highlighting the need for multidisciplinary management in severe paediatric trauma cases. A retrospective analysis of 10,486 paediatric fractures admitted to an orthopaedic department in Guangdong, China found that concomitant nerve damage was found to occur in 3.1% of cases [4]. Targeted preventive strategies addressing high-risk mechanisms, such as fall prevention and improved road safety measures, could reduce the burden of fracture-related neurological injuries in paediatric populations.

This study provides insights into the pattern of paediatric fractures in a tertiary care hospital in Yemen and serves as a baseline for future research and injury prevention initiatives. However, it has a number of limitations inherent to its retrospective design. First, there could be potential underreporting or misclassification of fracture etiology and incomplete documentation of associated injuries. Prospective studies are therefore needed to reduce missing data and

potential bias. Second, as the study was conducted in a single tertiary care hospital, the findings may not fully represent fracture patterns in other settings of the country, particularly in rural areas. Accordingly, multi-center studies are recommended to include both urban and rural areas to enhance the representativeness of fracture patterns and account for geographic variability in injury mechanisms.

Conclusion

This retrospective analysis reveals several key patterns of paediatric fractures at a tertiary care hospital in Sana'a. The data show that fractures occurred more frequently in boys, with a slight predominance among children aged 11 years or younger. Fracture distribution is almost equal between the upper and lower limbs and exhibited no significant laterality between the right and left sides. Single fractures predominated, with the radius and humerus being the most frequently affected upper limb bones, while the femur and tibia were the most frequently affected in the lower limbs. Multiple-site fractures were relatively uncommon. The leading cause of these paediatric fractures was daily-life injuries, followed by road traffic accidents. Concomitant injuries, primarily neurological, were present in a minority of cases, which highlights the need for comprehensive trauma assessment upon admission. These findings provide a benchmark for local paediatric trauma patterns and inform targeted prevention strategies, clinical management, and resource allocation in similar low-resource and conflict-affected contexts.

References

1. George MP, Bixby S. Frequently missed fractures in paediatric trauma: a pictorial review of plain film radiography. Radiol Clin North Am. 2019;57(4):843-55. doi: 10.1016/j.rcl.2019.02.009.

2. Rennie L, Court-Brown CM, Mok JY, Beattie TF. The epidemiology of fractures in children. Injury. 2007;38(8):913-22. doi: 10.1016/j.injury.2007.01.036.

3. Markiewitz ND, Garcia-Munoz J, Lilley BM, Oduwole S, Shah AS, Williams BA. Epidemiologic changes in paediatric fractures presenting to emergency departments during the COVID-19 pandemic. J Pediatr Orthop. 2022;42(8):e815-e20. doi: 10.1097/bpo.0000000000002194.

4. Qiu X, Deng H, Su Q, Zeng S, Han S, Li S, et al. Epidemiology and management of 10,486 paediatric fractures in Shenzhen: experience and lessons to be learnt. BMC Pediatr. 2022;22(1):161. doi: 10.1186/s12887-022-03199-0.

5. Cintean R, Eickhoff A, Zieger J, Gebhard F, Schütze K. Epidemiology, patterns, and mechanisms of paediatric trauma: a review of 12,508 patients. Eur J Trauma Emerg Surg. 2023;49(1):451-9. doi: 10.1007/s00068-022-02088-6.

6. Rosendahl K, de Horatio LT, Habre C, Shelmerdine SC, Patsch J, Kvist O, et al. The incidence of fractures in children under two years of age: a systematic review. BMC Musculoskelet Disord. 2024;25(1):528. doi: 10.1186/s12891-024-07633-5.

7. Lindaman LM. Bone healing in children. Clin Podiatr Med Surg. 2001;18(1):97-108.

8. Rodríguez-Merchán EC. Paediatric skeletal trauma: a review and historical perspective. Clin Orthop Relat Res. 2005;(432):8-13.

9. Thornton MD, Della-Giustina K, Aronson PL. Emergency department evaluation and treatment of paediatric orthopaedic injuries. Emerg Med Clin North Am. 2015;33(2):423-49. doi: 10.1016/j.emc.2014.12.012.

10. Kalenderer O, Gürcü T, Reisoğlu A, Ağuş H. [The frequency and distribution of fractures in children presenting to the emergency service]. Acta Orthop Traumatol Turc. 2006;40(5):384-7.

11. Arora R, Fichadia U, Hartwig E, Kannikeswaran N. Paediatric upper-extremity fractures. Pediatr Ann. 2014;43(5):196-204. doi: 10.3928/00904481-20140417-12.

12. Goulding A. Risk factors for fractures in normally active children and adolescents. Med Sport Sci. 2007;51:102-20. doi: 10.1159/000103007.

13. Ryan LM. Forearm fractures in children and bone health. Curr Opin Endocrinol Diabetes Obes. 2010;17(6):530-4. doi: 10.1097/MED.0b013e32833e9c8b.

14. Varkal MA, Gulenc B, Yildiz I, Kandemir I, Bilgili F, Toprak S, et al. Vitamin D level, body mass index and fracture risk in children: vitamin D deficiency and fracture risk. J Pediatr Orthop B. 2022;31(2):e264-e70. doi: 10.1097/bpb.0000000000000867.

15. Joeris A, Lutz N, Wicki B, Slongo T, Audigé L. An epidemiological evaluation of paediatric long bone fractures - a retrospective cohort study of 2716 patients from two Swiss tertiary paediatric hospitals. BMC Pediatr. 2014;14:314. doi: 10.1186/s12887-014-0314-3.

16. Sural S, Verma A. The clinical profile of musculoskeletal injuries in children attending a major hospital in Delhi, India. J Clin Orthop Trauma. 2015;6(1):12-8. doi: 10.1016/j.jcot.2014.12.007.

17. Xiao X, Ding Y, Zheng Y, Gao Y, Li H, Liu R, et al. Epidemiological investigation of paediatric fractures-A retrospective cohort study of 1129 patients. Medicina (Kaunas). 2023;59(4). doi: 10.3390/medicina59040788.

18. Manan MR, Rahman S, Komer L, Manan H, Iftikhar S. A Multispecialty approach to the identification and diagnosis of nonaccidental trauma in children. Cureus. 2022;14(7):e27276. doi: 10.7759/cureus.27276.

19. Haney S, Scherl S, DiMeglio L, Perez-Rossello J, Servaes S, Merchant N. Evaluating young children with fractures for child abuse: clinical report. Paediatrics. 2025;155(2). doi: 10.1542/peds.2024-070074.

20. Baldwin K, Pandya NK, Wolfgruber H, Drummond DS, Hosalkar HS. Femur fractures in the paediatric population: abuse or accidental trauma? Clin Orthop Relat Res. 2011;469(3):798-804. doi: 10.1007/s11999-010-1339-z.

21. Arneitz C, Bartik C, Weitzer CU, Schmidt B, Gasparella P, Tschauner S, et al. Distribution and pattern of hand fractures in children and adolescents. Eur J Pediatr. 2023;182(6):2785-92. doi: 10.1007/s00431-023-04915-3.

22. Malik S, Malik S, Theobald P, Jones M. Distinguishing fractures from accidental and non-accidental injury in children. J Trauma Treat.

2012;1:e102.

23. England SP, Sundberg S. Management of common paediatric fractures. Pediatr Clin North Am. 1996;43(5):991-1012. doi: 10.1016/s0031-3955(05)70447-8.

24. Boutis K. The emergency evaluation and management of paediatric extremity fractures. Emerg Med Clin North Am. 2020;38(1):31-59. doi: 10.1016/j.emc.2019.09.003.

25. Musgrave DS, Mendelson SA. Paediatric orthopaedic trauma: principles in management. Crit Care Med. 2002;30(11 Suppl):S431-43. doi: 10.1097/00003246-200211001-00008.

26. Ömeroğlu H. Basic principles of fracture treatment in children. Eklem Hastalik Cerrahisi. 2018;29(1):52-7. doi: 10.5606/ehc.2018.58165.

27. Schalamon J, Petnehazy T. The management of traumatic fractures in children. Minerva Pediatr. 2009;61(2):185-92.

28. Murphy D, Raza M, Monsell F, Gelfer Y. Modern management of paediatric tibial shaft fractures: an evidence-based update. Eur J Orthop Surg Traumatol. 2021;31(5):901-9. doi: 10.1007/s00590-021-02988-0.

29. Leiblein M, Lustenberger T, Schulz AK, Schmitz-Rixen T, Marzi I. Neurovascular complications after supracondylar humerus fractures in children. Trauma Case Rep. 2017;8:16-9. doi: 10.1016/j.tcr.2017.01.013.

30. Mills LA, Simpson AH. The risk of non-union per fracture in children. J Child Orthop. 2013;7(4):317-22. doi: 10.1007/s11832-013-0521-8.

31. Ahmed N, Kuo YH. Factors associated with compartment syndrome after a tibial fracture in children. Trauma Surg Acute Care Open. 2023;8(1):e001158. doi: 10.1136/tsaco-2023-001158.

32. Le B, Mudiganty S, Skalak T. Physeal growth arrest in distal radius fracture: a case report. J Orthop Case Rep. 2024;14(7):83-7. doi: 10.13107/jocr.2024.v14.i07.4584.

33. Cheng JC, Shen WY. Limb fracture pattern in different paediatric age groups: a study of 3,350 children. J Orthop Trauma. 1993;7(1):15-22. doi: 10.1097/00005131-199302000-00004.

34. Peterson HA, Madhok R, Benson JT, Ilstrup DM, Melton LJ, 3rd. Physeal fractures: Part 1. Epidemiology in Olmsted County, Minnesota, 1979-1988. J Pediatr Orthop. 1994;14(4):423-30. doi: 10.1097/01241398-199407000-00002.

35. Cheng JC, Ng BK, Ying SY, Lam PK. A 10-year study of the changes in the pattern and treatment of 6,493 fractures. J Pediatr Orthop. 1999;19(3):344-50.

36. Mahabir RC, Kazemi AR, Cannon WG, Courtemanche DJ. Paediatric hand fractures: a review. Pediatr Emerg Care. 2001;17(3):153-6. doi: 10.1097/00006565-200106000-00001.

37. Korup LR, Larsen P, Nanthan KR, Arildsen M, Warming N, Sørensen S, et al. Children's distal forearm fractures: a population-based epidemiology study of 4,316 fractures. Bone Jt Open. 2022;3(6):448-54. doi: 10.1302/2633-1462.36.bjo-2022-0040.r1.

38. Nwadinigwe CU, Ihezie CO, Iyidiobi EC. Fractures in children. Niger J Med. 2006;15(1):81-4. doi: 10.4314/njm.v15i1.37124.

39. Landin LA. Epidemiology of children's fractures. J Pediatr Orthop B. 1997;6(2):79-83. doi: 10.1097/01202412-199704000-00002.

40. Valerio G, Gallè F, Mancusi C, Di Onofrio V, Colapietro M, Guida P, et al. Pattern of fractures across paediatric age groups: analysis of individual and lifestyle factors. BMC Public Health. 2010;10:656. doi: 10.1186/1471-2458-10-656.

41. Koga H, Omori G, Koga Y, Tanifuji O, Mochizuki T, Endo N. Increasing incidence of fracture and its sex difference in school children: 20 year longitudinal study based on school health statistic in Japan. J Orthop Sci. 2018;23(1):151-5. doi: 10.1016/j.jos.2017.09.005.

42. Blimkie CJ, Lefevre J, Beunen GP, Renson R, Dequeker J, Van Damme P. Fractures, physical activity, and growth velocity in adolescent Belgian boys. Med Sci Sports Exerc. 1993;25(7):801-8. doi: 10.1249/00005768-199307000-00008.

43. Schalamon J, Dampf S, Singer G, Ainoedhofer H, Petnehazy T, Hoellwarth ME, et al. Evaluation of fractures in children and adolescents in a Level I Trauma Center in Austria. J Trauma. 2011;71(2):E19-25. doi: 10.1097/TA.0b013e3181f8a903.

44. Mortensson W, Thönell S. Left-side dominance of upper extremity fracture in children. Acta Orthop Scand. 1991;62(2):154-5. doi: 10.3109/17453679108999245.

45. Reddy S, Dhaniwala N. Diaphyseal fractures in paediatric age group in rural area: a demographic study. J Datta Meghe Inst Med Sci Univ. 2019;14(3):189-91.

46. Kriss S, Thompson A, Bertocci G, Currie M, Martich V. Characteristics of rib fractures in young abused children. Pediatr Radiol. 2020;50(5):726-33. doi: 10.1007/s00247-019-04599-8.

47. Deakin DE, Crosby JM, Moran CG, Chell J. Childhood fractures requiring inpatient management. Injury. 2007;38(11):1241-6. doi: 10.1016/j.injury.2007.05.023.

48. Merckaert S, Chaibi E, Meriem S, Kwiatkowski B, Divjak N, Zambelli PY. Epidemiology of paediatric upper extremity fractures in a tertiary care center in Switzerland. Pediatr Emerg Care. 2021;37(12):e825-e35. doi: 10.1097/pec.0000000000002047.

49. Harrington J, Sochett E. The child with multiple fractures, what next? Pediatr Clin North Am. 2015;62(4):841-55. doi: 10.1016/j.pcl.2015.04.006.

50. Lee S-H, Jeong W-K, Kim H-w, Song K-S, Shin H-D, Shim J-S, et al. Upper extremity fractures in children-prospective epidemiological study of tertiary medical institutes. J Korean Orthop Assoc. 2007;42(2):270-5.

51. Rossi L, Panuccio E, Leigheb M. Current concepts on paediatric clavicle, humerus, radius and ulna fractures. Chirurgia. 2023;36(5):273-80.

52. Mumtaz Hashmi H, Shamim N, Kumar V, Anjum N, Ahmad K. Clavicular fractures in newborns: what happens to one of the commonly injured bones at birth? Cureus. 2021;13(9):e18372. doi: 10.7759/cureus.18372.

53. Liu H, Wang H, Shao B, Lu H, Zhang S, Ou L, et al. Epidemiological evaluation of traumatic lower limb fractures in children: Variation with age, gender, time, and etiology. Medicine (Baltimore). 2019;98(38):e17123. doi: 10.1097/md.0000000000017123.

54. Phala MP, Rachuene PA, Socutshana B, Bila KS. Access gate-related lower limb fractures in children and adolescents: a review of injury patterns and evaluation of associated injuries. SA Orthop J. 2022;21(4):198-201.

55. Lamb LC, Montgomery SC, Wong Won B, Harder S, Meter J, Feeney JM. A multidisciplinary approach to improve the quality of care for patients with fragility fractures. J Orthop. 2017;14(2):247-51. doi: 10.1016/j.jor.2017.03.004.

56. Steiger C, De Marco G, Cuérel C, Tabard-Fougère A, Chargui M, Dayer R, et al. A retrospective epidemiological cohort study of ankle fractures in children and teenagers. J Child Orthop. 2023;17(4):348-53. doi: 10.1177/18632521231182424.

57. Engström Z, Wolf O, Hailer YD. Epidemiology of paediatric femur fractures in children: the Swedish Fracture Register. BMC Musculoskelet Disord. 2020;21(1):796. doi: 10.1186/s12891-020-03796-z.

58. Oleck NC, Dobitsch AA, Liu FC, Halsey JN, Le TT, Hoppe IC, et al. Traumatic falls in the paediatric population: facial fracture patterns observed in a leading cause of childhood injury. Ann Plast Surg. 2019;82(4S Suppl 3):S195-s8. doi: 10.1097/sap.0000000000001861.

Declaration of patient consent : The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

How to Cite this Article

Hudna AS, Al-Zuhairi MM, Mohammed RM, Farwan YM, Khamis AY, Yousef KW, Al-wardi ZA. Patterns, Anatomical Distribution and Etiologies of Paediatric Fractures in a Tertiary Care Hospital in Sana'a City, Yemen: A Five-Year Retrospective Analysis. International Journal of Paediatric Orthopaedics. September-December 2025; 11(3): 02-09.