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Aetiology, patterns and treatment modalities of paediatric fractures at Bugando Medical Centre, Mwanza, Tanzania

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Abstract

Background: Pediatric fractures are increasingly being recognized as a major public health problem worldwide. Little information is currently available on this type of injury in our local environment as there is a paucity of published data on this subject. This study aimed to determine the aetiological spectrum, patterns and treatment modalities of pediatric fractures at Bugando Medical Centre. The study provides baseline local data for the establishment of prevention strategies as well as treatment guidelines.

Methods: This was a cross-sectional study of pediatric patients presenting with long bone fractures at Bugando Medical Centre from January 2019 to July 2019. Ethical clearance was sought from the relevant authorities before the commencement of the study.

Results: A total of 111 pediatric trauma patients (M: F ratio = 1.2: 1) with fractures were studied. The age peak incidence at presentation was 5-10 years accounting for 48.6% of cases. The majorities of the fractures (46.8%) were due to falls and commonly occurred at home (48.6%). Upper limb fractures predominated (57.7%) with the majority involving the supracondylar of the humerus (50.5%). Open fractures were observed in 15 (13.5%) cases and all of them were Gustillo-type II. Only 7 (6.3%) patients received pre-hospital care. The majority of the patients, 74 (66.7%) were treated surgically mainly with open reduction and internal fixation accounting for 53.2% of cases.

Conclusion: This study demonstrated that the majority of pediatric fractures in our setting occur due to falls around the home environment and commonly affect children aged 5-10 years. The most common site of fracture was the humerus, most involving the supracondylar. Preventive strategies targeting reducing the occurrence of fall injuries in children are necessary to reduce the occurrence of pediatric fractures in this region.

Keywords: Pediatric fractures, aetiology, patterns, treatment modalities

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Background

Fractures are extremely common in pediatrics, representing a major public health problem worldwide (Court-Brown & Koval., 2006; Mäyränpää *et al*., 2010; Saw *et al*., 2011; Mansoor *et al*., 2015). It has been shown that pediatric fractures account for 10% to 25% of all pediatric injuries and that their effects are considerable with significant restriction of 42% to 64% in boys and 27% to 40% in girls, with remarkable variation in the estimates worldwide (Mansoor *et al*., 2015; Baig., 2017). While fractures more often occur in boys, girls usually sustain fractures at a younger age compared to boys (Khosla *et al*., 2003; Baig., 2017). Several genetic, endocrine, or systemic illnesses that affect bone metabolism may contribute to fractures, however, the majority of children who sustained fractures were otherwise healthy (Valerio *et al*., 2010).

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In many developed countries, fractures are a major cause of childhood morbidity and admission to hospitals (Cooper *et al*., 2004; Donaldson *et al*.,2008).In Tanzania, like other developing countries, fractures among the paediatric population constitute a major but neglected public health problem and yet have a significant effect on health services in terms of morbidity, mortality and long-term disability (Mfinanga *et al*., 2013; Simon et al., 2013). In these countries, paediatric fractures are increasingly being managed by non-orthopaedic surgeons, including traditional healers (Kihiko et al., 2010; Ndung'u et al., 2019). At Bugando Medical Centre, fractures in children are the single commonest cause of paediatric orthopaedic and trauma admissions comprising 17.3% of all paediatric injuries (Simon *et al*., 2013).

The causes and patterns of paediatric fractures have been reported to vary according to geographic area, socioeconomic status and environmental factors (Valerio et al., 2010; Baig., 2017). Studying the causes and patterns of paediatric fractures is essential in developing preventive strategies. The importance of analyzing the aetiology of fractures, and the circumstances and settings in which they occur in the various stages of development is to identify risky behaviors and specific environments which can be modified by specific preventive measures appropriate for specific age groups(Saw *et al*., 2011; Mansoor *et al*., 2015).

The majority of paediatric fractures are preventable, and a clear understanding of the causes, injury patterns and treatment modalities of these injuries is essential for the establishment of prevention strategies as well as treatment protocols (Valerio et al., 2010; Baig., 2017). The data on the causes, patterns and treatment modalities of paediatric fractures is also essential in developing fracture prevention and intervention guidelines. The data currently available is mainly obtained from the western and developed populations. This data is not necessarily applicable in our region and cannot thereby be reliably used in guiding preventive or interventional guidelines in our setting. This study was therefore aimed to determine the aetiology, patterns and treatment modalities of paediatric fractures seen in a tertiary care hospital.

Methods and Patients

Study design and setting

This was a descriptive cross-sectional hospital-based study of paediatric patients presenting with fractures at Bugando Medical Centre over a period of seven months from January 2019 to July 2019. The study was conducted in the emergency department, the neonatal ward and the paediatric orthopaedic & trauma wards of Bugando Medical Centre. The hospital is located in Mwanza City on the southern border of Lake Victoria in the northwestern part of Tanzania. It is a consultant, specialized and tertiary health institution serving the whole of the north-western part of Tanzania, serving a population of about 18 million people from Mwanza, Geita, Kagera, Mara, Shinyanga, Simiyu, Tabora, Kigoma and Katavi. It is also a teaching hospital for the Catholic University of Health and Allied Sciences.

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The hospital has a total bed capacity of about 960 and attends around 293,283 patients per year, including paediatric patients being about 1,853. The hospital has a specialized orthopaedic and trauma department which serves most of the trauma patients around this area, both self-referral and referrals from other hospitals. It has ten functioning theatres for elective patients, whereby two of which are dedicated to orthopaedic surgeries only. In addition, one functional operating room is available for emergency surgeries in the emergency department. The orthopaedic and trauma department has two wards for male and female patients with a total capacity of seventy beds. The department has nine surgeons who perform general and specialized orthopaedic surgeries, two registrars, nurses and attendants staff The average number of patients admitted and attended as out-patients are 45 and 109 respectively in a month. Out of these admitted patients about three are treated non-operatively and 42 undergo operative treatment. All this information was taken from BMC medical records.

Study population

The study included all paediatric patients aged below 18 years presenting to the emergency department and paediatric orthopaedic and trauma ward of BMC with radiologically confirmed traumatic long bone fractures and who consented/assented to the study. Patients with spine fractures were excluded from the study as these are managed by neurosurgeons. Patients with pathological fractures were also excluded from the study. Sample size estimation of the participants was calculated using Yamane – Taro (1967). Convenience sampling of patients who met the inclusion criteria was performed until the sample size was reached.

Data collection procedure

Data were collected using a pre-tested questionnaire. The questionnaire was pre-tested to check the clarity and consistency of questions and required details. The research assistant, who was a registrar working in the orthopaedic and trauma department was trained on the use of the data collection tool before the commencement of the data collection procedure. Participants who were treated as outpatients were observed at the emergency department and the orthopaedics outpatient clinics. Parents or caretakers together with children who could understand the study details have explained the purpose of the study and their role. Consent was obtained from the parents or caretakers and assent was obtained from the children.

All subjects that agreed to participate in the study were interviewed by the principal investigator or research assistant to get socio-demographic information, mechanism of injury, time of injury and place of injury. The site of injury and type of fracture patterns were described by the attending surgeon, principal investigator and/or research assistant following clinical evaluation and radiographic investigations. The modality of treatment and fracture fixation methods were dictated by the attending surgeon. All the information was recorded in a data collection form comprising social-demographic characteristics, mechanism of injury, time of injury, place of injury and treatment modalities.

Statistical data analysis

Data were entered using epi-Data version 3.1 (Atlanta, US) and analyzed using STATA version 13 (Collage Station, Texas, US). The median (+IQR) and ranges were calculated for continuous variables, whereas proportions and frequency were used for categorical variables. Chi-square ($\chi 2$) and Fisher's exact tests (depending on the size of the data set) were used to test for the significance of the association between the different independent variables. A *p*-value of < 0.05 was considered to constitute a statistically significant difference. Data were presented in form of tables, bars and pie charts.

Ethical considerations

Approval and ethical clearance to conduct the studies were sought from the Joint CUHAS/BMC Research, Ethics and Review

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Committee with ethical clearance number CREC/375/2019. BMC administration also provided permission to collect data from the patients in all involved areas.
Written informed consent/assent was requested from parents/guardians/caretakers of the children after being satisfied with the information explained to them by the principal investigator or research assistant about the study, their role and risks. Willingness to participate in the study was respected and participants were free to decline the study even after being enrolled without compromising their ongoing management. Patients' confidentiality was highly maintained using codes and no individual identity was disclosed in data analysis or dissemination of results. The data collection tools and other participants' information were secured by the principal investigator. Management of all the children included in the study was left to the attending surgeon, and the researcher did not influence their management or outcome in any way.

Results

Patients' and socio-demographic characteristics

During the study period, a total of 111 (97.4%) met the inclusion criteria and therefore were enrolled on the study. Among the 111 participants enrolled in the study, their ages at diagnosis ranged from 4 – 16 years with a median age of 7 [IQR 5 – 12] years. Their age incidence was 5-10 years accounting for 48.6% of cases (Figure 1). Sixty (54.0%) were males and 51 (46.0%) were females with a male-to-female ratio of 1.2:1.

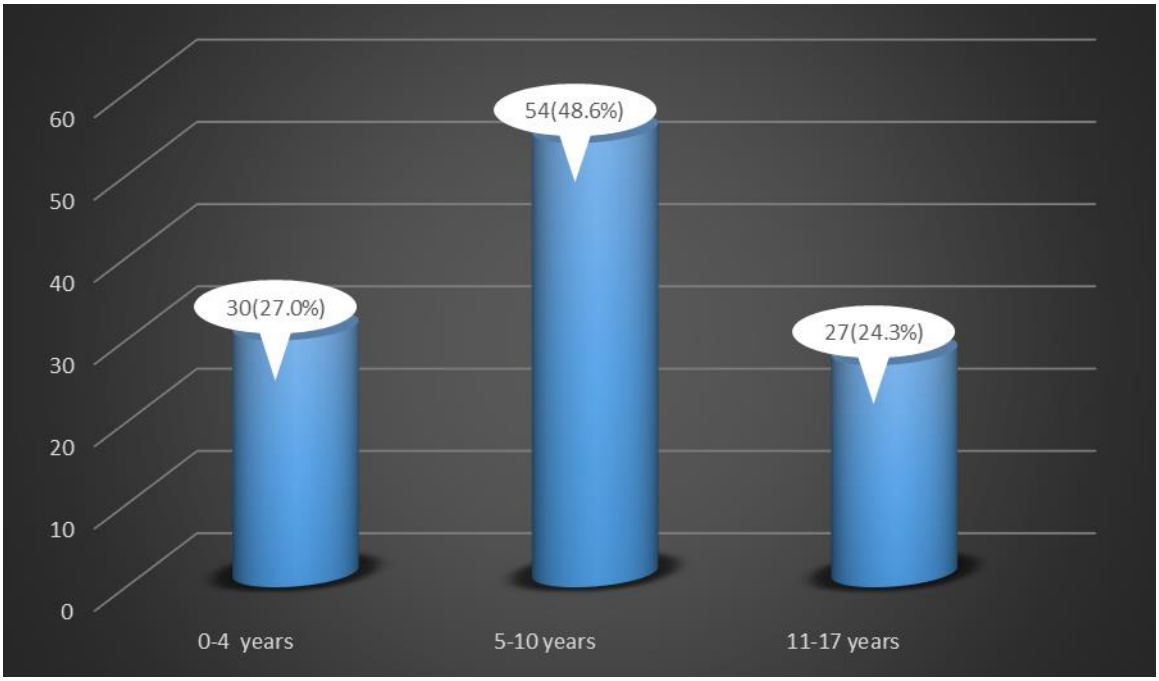

Figure 1: Age group distribution

Aetiological spectrum and occurrence of paediatric fractures

Fall from a height was the most common cause of fractures accounting for 46.8% of cases. Boys had significantly more fractures that resulted from falls than girls(*p*-value = 0.032). For the rest of the causes of injury, no statistically significant difference was noted between boys and girls, as shown in Table 1. Regarding the time of injury, the majority of the patients, 108 (97.3%) sustained fractures during the daytime. Of most of the fractures, 54(48.6%) occurred at home. Boys were statistically more likely to sustain a fracture at home than girls (*p*-value = 0.002) (Table 1).

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Table 1: Timing, aetiology and place of injury of paediatric fractures.

Description	Sex		p-value
	Boys N (%)	Girls N (%)	
Timing of injury			
Day	58 (53.7)	50 (46.3)	0.754
Night	2 (66.7)	1 (33.3)	0.819
Fracture aetiology			
Road traffic accident	12 (30.8)	27 (69.2)	0.780
Hit by a heavy object	5 (71.4)	2 (28.6)	0.319
Fall from the height	33 (63.5)	19 (36.5)	0.032
Child abuse	0 (0.0)	0 (0.0)	-
Sports and games	10 (76.9)	3 (23.1)	0.251
Place of injury			
Home	34 (62.9)	20 (37)	0.002
Sideway/along the road	12 (30.8)	27 (69.2)	0.229
Recreation	2 (50.0)	2 (50)	0.789
School	14 (100.0)	0 (0.0)	ᵞ 0.091

ᵞ ***p*-value obtained by 1-sided Fischer's exact test**

Patterns of paediatric fractures

The majority of the fractures, 64 (57.7%) were in the upper extremities, of which the humerus was the most common fractured bone among all accounting for 56 (50.5%) cases. The majority of the humeral fractures involved the distal metaphysis region (87.5%), and this was statistically significant (*p*-value = 0.013) as shown in table 3 below. Open fractures were observed in 15 (13.5%) cases and all of them were Gustillo-type II. Majority of the patients with open fractures [12 (80.0%)] presented to the EMD six hours after the injury. There was no statistically significant difference between arrival time and gender as shown in Table 2.

Table 2: Patterns of paediatric fractures.

Patterns of fractures	Sex		p-value
	Boys N (%)	Girls N (%)	
Anatomical location of the fracture			
Humerus	42 (75)	14 (25)	0.099
Radius and ulna	7 (87.5)	1 (12.5)	0.779
Femur	23 (74.2)	8 (25.8)	0.059
Tibia and fibula	8 (80)	2(20)	0.719
Others	4 (66.7)	2(33.3)	0. 309
Type of fracture			
Closed Fracture	56 (58.3)	40 (41.7)	0.586

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Open Fracture	4 (26.7)	11 (73.3)	0.115
Gustillo& Anderson's classification of open fractures			
Type I	0	0	0
Type II	11(73.3)	4(26.7)	0.069
Type IIIA	0	0	
Arrival time (for open fracture)			
< 6 hours after injury	0	3 (100.0)	[Y]0.328
> 6 hours after injury	4 (33.3)	8 (66.7)	0.734

Others: include, clavicle, metacarpals, phalanges, tarsal and metatarsal
[Y] p-value obtained by 1-sided Fischer's exact test

Table 3: The level of fracture in long bones.

Fractured Bone	Level of fracture (%)			p-value
	Proximal	Middle	Distal	
Humerus	4(7.1)	3(5.4)	49(87.5)	0.013
Radius and ulna	0(0.0)	3(37.5)	5(62.5)	0.094
Femur	4(17.4)	15(65.2)	4(17.4)	0.553
Tibia and fibula	1(10.0)	6(60.0)	3(30.0)	0.078

Treatment modalities of paediatric fractures
Only 7 (6.3%) patients received pre-hospital care in this study. The majority of the patients, 74 (66.7%) were treated surgically whereby open reduction and internal fixation was the most common operative procedure performed accounting for 59 (53.2%) of the cases as shown in Figure 2.

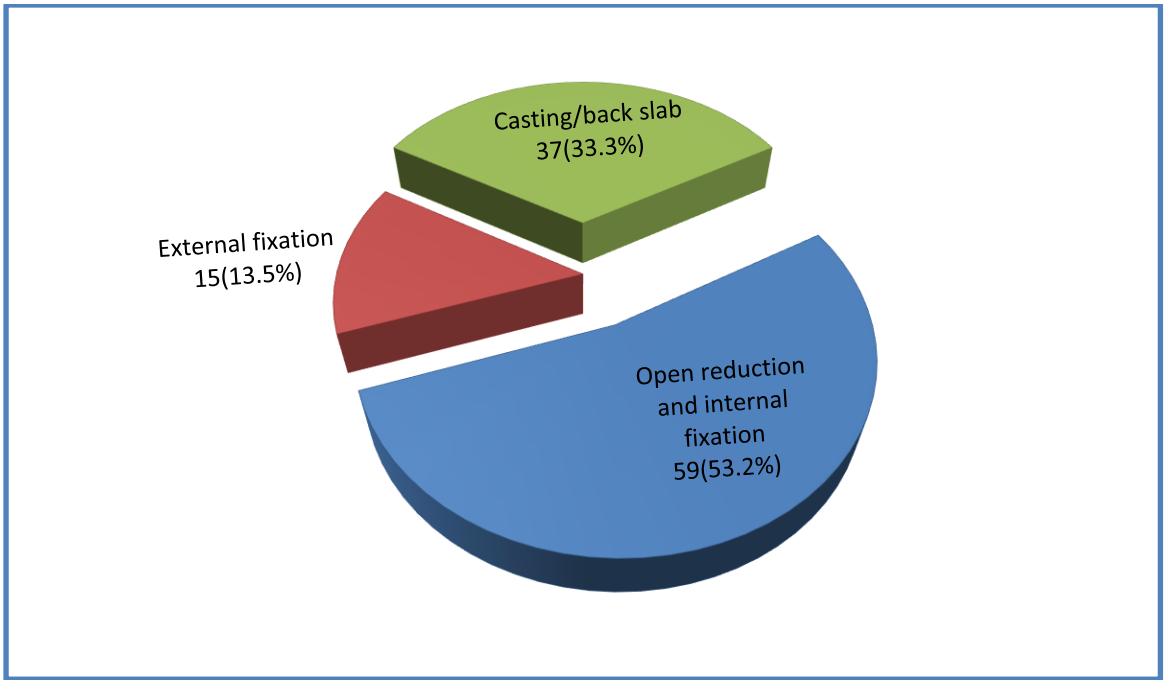

Figure 2: Treatment modalities of paediatric fractures.

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Discussion

In this study, the age incidence was 5–10 years, consistent with the studies done in Cameroon and Kenya by Guifo *et al.* (2017) and Ng'ang'a *et al.* (2017) respectively. This finding is in contrast with a study which was done in Dar Es Salaam, Tanzania in which the majority of children with fractures were under the age of 5 years (Mfinanga *et al.*, 2013). This age range in our study is of special interest in our environment. It coincides with the age of starting primary school and those who are unable to go to school engage in street hawking. These school-aged children are usually very active and are often less supervised than pre-school-age children. In addition, these school-aged children are usually involved in road traffic accidents as they rush through heavy traffic to and from their schools predisposing them to several types of injuries. This observation calls for an improved school transportation system. Gender differences are well-known in the paediatric fractures age group (Nga'ng'a *et al.*, 2017). In keeping with findings from other studies which were done in Cameroon by Guifo *et al.* (2017) and in Kenya by Nga'ng'a *et al.*(2017) and another study in Turkey (Issin *et al* (2015), showed that males were more affected than females. This generalized male predominance in our study is probably due to the experimenting and risk-taking behavior that is more common in boys as compared to girls.

Fall from a height was the most common cause of fractures and this may indicate a lack of proper and safe play areas for children. This finding is comparable with studies done elsewhere (Issin *et al.*, 2015; Guifo *et al.*, 2017; Ng'ang'a *et al.*2017), but contrary to a study done in Tanzania which reported road traffic accidents as being the most common cause of paediatric fractures (Mfinanga et al., 2013). In another study done in Cameroon, the most common cause of paediatric fractures was games in more than half of the cases (Guifo *et al.*, 2017). Regarding the locations where fractures commonly occur, it has been reported in several studies that the home accounts for the majority of all fractures in children (Pitone & Attia., 2006). This observation is in keeping with our study in which the majority of the paediatric fractures occurred at home. In contrast to our findings, the study done in Cameroon by Guifo *et al*(2017) reported roadside accidents as the most common place of occurrence of paediatric fractures. The finding that most of the paediatric fractures occurred at home demonstrates the important role of parental supervision as a key factor in child safety. Provision of daycares at workplaces, public health interventions aimed at improving safety at home and training of nannies on safety could help reduce these fractures.

Most of the fractures in the present study occurred during the daytime. This observation agrees with what was previously reported by Guifo *et al*(2017) in Cameroon and Ng'ang'a *et al*(2017) in Nairobi. The increased rate of fractures during the daytime could be explained by the fact that paediatric fractures usually occur at the most active hours of the children which are usually during the day. Increased traffic jams, as well as increased human activities in the City during the daytime, may also explain the increased incidence of fractures during the day. Knowing the time of injury in trauma patients is important for prevention strategies.

The upper limb is more frequently involved in paediatric fractures, accounting for approximately two-thirds of all fractures (Cheng *et al.*, 1999; Jones.,2004). In this study, the upper limb fractures predominated with the majority involving the supracondylar region of the humerus. This finding is similar to that reported by Ng'ang'a *et al* (2017) in Kenya who found that upper limb fractures predominated at 53% with the majority involving the supracondylar region of the humerus (70%). This predominance of the upper limb fractures involving the supracondylar region of the humerus may be explained by the fact that the majority of children in our study reported low-energy fractures, the main cause being represented by falls. Indeed, the arm is more frequently involved after a fall in children of > 5 years of

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age (Pitone& Attia.,2006). In our study, open fractures were reported in 13.5% of cases, a rate which is higher than the 4% and 0.45% that was reported in Kenya and Turkey, respectively (Issin *et al*., 2015; Ng'ang'a *et al.* 2017). This difference in the rates of open fractures in these studies could be attributed to the differences in the injury and anatomic sites of fractures. Open fractures usually occur from high-energy events (i.e., road traffic accidents) involving mainly subcutaneous bones such as the tibia (Gustilio& Anderson., 1976). Open fractures pose a significant challenge to manage for orthopaedic, vascular, neuro and plastic surgeons due to the combined soft tissue damage, bone loss, nerve injury and potential vascular compromise (Cole ., 1995; Naranje et al., 2016). Urgent debridement of open fractures within six hours after the injury has been considered to be of paramount importance for the prevention of infection (Gustilio & Anderson., 1976). In the present study, the majority of the patients with open fractures presented to the EMD more than six hours after the injury. This late presentation is a common phenomenon in developing countries and can usually lead to complications (Gustilio & Anderson., 1976). We could not establish the reasons for the late presentation in this study.

Previous studies have suggested that pre-hospital care of fractured paediatric patients is the most important factor in determining outcomes following injury. Unfortunately, in developing countries, trauma care systems rarely exist, as a result, fractured children are most often taken directly to the nearest hospital by laypeople with no formal training in the transportation of fractured patients. The lack of pre-hospital care systems leads to many fractured children arriving at the hospital clinically compromised due to the time lag, the type of first aid received (or not), and the mode of transportation to the hospital (Mfinanga *et al*., 2013; Ng'ang'a *et al*.,2017). Consistently with previous studies done by Guifo *et al*(2017) in Cameroon and Ng'ang'a *et al* (2017) in Nairobi, the present study found that only 6.3% of paediatric patients with fractures received pre-hospital care. This finding suggests that the development of the pre-hospital emergency care system, including well-trained personnel in our setting, is an area of great need that can improve the care and outcomes of paediatric fractured patients.

Historically, the majority of paediatric fractures have been managed non-operatively due to the high remodelling potential of paediatric bone (Guifo *et al.*, 2017; Ng'ang'a *et al.* 2017). This is in contrast to adult patients in whom these injuries are typically considered 'fractures of necessity with regards to the need for operative intervention (Altay *et al*., 2010; Yaokreh *et al*., 2015; Naranje et *al*., 2016). Recent literature has highlighted the increased rate of treatment for certain paediatric fractures (Issin *et al*., 2015). In this study, two-thirds of our patients were treated operatively. This is in contrast with a study done in Cameroon where non-operative management was common (Joeris *et al*.,2014; Guifo *et al.*, 2017). The high incidence of operative treatment in our study is attributable to the high incidence of displaced distal (supracondylar) humeral fractures, femoral fractures and open fractures, the majority of which required surgical intervention.

The major limitation of this study is the fact that the study employed a cross-sectional design, whereby the cause-and-effect relationship may not be established; this limits the interpretation of the estimated associations. Thus, the findings of this study should be interpreted within this limitation.

In conclusion, this study's findings demonstrated that most of the paediatric fractures in our setting occur due to falls in the home environment and commonly affect the age group of 5-10 years. The most common site of fracture was the upper limb with the majority involving supracondylar humeral fractures of which two-thirds of the patients were treated operatively. It is therefore recommended that:-

- Urgent preventive strategies targeting reducing the occurrence of fall injuries in children are necessary

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to reduce the occurrence of paediatric fractures in this region.

- More strategies like improving caregivers' situational awareness, closer parental attention, child-friendly homes and playgrounds, padding hard surfaces, child-safe windows and covered balconies would go a long way in reducing these fractures. This can be implemented by the provision of health education in the community.
- Similar studies with larger sample sizes with a follow-up component should be conducted to assess the long-term complications of paediatric fractures in this region.

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