Original Article

# Pattern of Fracture Occurrence among Children Aged 1-17 Years Presenting At Solwezi General Hospital in Solwezi District, Zambia

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## ABSTRACT

***Introduction:*** Fractures in children represent a major global health problem and account for 10-25% of all childhood injuries. Childhood fractures are caused by falls, domestic violence and road traffic accidents. Locally, there is a paucity of data on the pattern of fracture occurrence among children in Solwezi District.

***Objectives:*** The objectives of this study were to determine the pattern of childhood fractures in terms of the causes, severity, circumstances and geographical location in which these injuries occur, and recommend strategies for preventing these injuries.

***Materials & methods:*** Data collection was done using a researcher assisted questionnaire in a cross-sectional survey and analysed using the SPSS software version 20.0 for Windows. The Chi-square test was used to test association of variables at the 0.05 level of significance.

***Results:*** The mean age of children with fractures under review was found to be 6.88 years (SE of mean=0.453). Fractures in children were found to occur more frequently in the pre-school age group (48.3%, n=43). A male predominance in childhood fracture occurrence was noted as these fracture injuries occurred in 60.7% (n=54) of the males and 39.3% (n=35) of the females. Fractures of the upper limbs (74.2%) were more frequent than those of the lower limbs (25.8%) with the Radius (51.7%) and Ulna (22.5%) being the most frequently fractured bones. No respondent had an open fracture. Falling was the most frequent cause of injury in 73% of the respondents followed by sports injuries (13.5%). Fifty-six percent (n=50) of the fractures in children were sustained at home followed by school (16.9%) and road (19.1%). Statistically significant associations were found between respondent's age group and mechanism of injury (p-value=0.004) as well as between respondent's area of residence and geographical location of injury (p-value=0.005).

***Conclusion:*** Falls are the most frequent mechanism of injury in childhood fractures seen at Solwezi General Hospital with the Radius and Ulna being the most frequently affected bones. The majority of these fractures occur at home as a result of slight trauma events. Clinically, this implies that the home advice given to patients and guardians should be tailored towards the prevention of these injuries in the settings in which they occur. General safety guidelines and policies for prevention of childhood fractures at home and in schools should be developed.

## INTRODUCTION

The United Nations Convention on the Rights of the Child defines a child as a human being aged below 18 years. Fractures in children represent a major public health problem of global importance as they

**Keywords:** *Intrapartum care, late arrival in labour, early presentation in labour.*

are responsible for 10-25% of all injuries sustained during childhood. Fractures can lead to severe functional deficits that could significantly contribute to the burden of disease in all regions of the world and disability of varying degrees.

The lifetime risk of sustaining a fracture during childhood is around 42-64% in boys and 27-40% in girls[5]. Compared with boys, however, girls typically sustain fractures at a relatively younger age[6]. Most of the fractures in children occur as a result of falling within the home environment[5,7], while others are as a result of trauma from road traffic accidents in which the child is either a vehicle passenger or a pedestrian. In uncommon circumstances, some fractures in children can be caused by a number of systemic, endocrine, or genetic illnesses that affect bone metabolism and dynamics.

Although fracture healing in children is usually effective without any loss of function, there may be serious accompanying costs for the family and child that may include prolonged periods of time away from school, costs incurred in seeking health services and inactivity for extended periods of time as a result of pain, lower indices of bone strength; increased risk of fracture when the child becomes an adult; and bone growth irregularities. The majority of the fractures that occur in children can be prevented by the application of simple measures such as supervision of children as they play, the use of landing surfaces which are even and soft in areas where children play and making sure that equipment children use for play are safe[8].

The 2010 Global Burden of Disease indicates that the growing burden of disease related to childhood injuries is disproportionately higher in Low- and Middle-Income Countries (LMICs)[9]. Modernization and industrialization bring about an associated increase in the incidence of injuries in all age groups in developing countries such as Zambia. Solwezi District in particular has been experiencing major industrialization and a rapid population growth owing to the booming mining activities taking place at the Kansanshi, Lumwana and Kalumbila Copper Mines. These demographic changes have resulted in an increased risk of fracture injuries in all age groups, especially among children.

There are very few strategies that have been put in place in the home or school environments aimed at reducing the risk of children sustaining fracture injuries possibly because there is poor understanding of the pattern of these fractures, the mechanisms of injury, and the circumstances in which childhood fractures occur. Therefore, this study was set to determine the pattern, mechanisms of fracture injury in children, and the circumstances in which these fractures occur in children presenting at Solwezi General Hospital.

## MATERIALS AND METHODS

*Study design*: This was a descriptive cross-sectional study.

*Study site:* The study was carried out in the Physiotherapy Departments, Orthopaedic Clinic, and Children's Surgical Wards at Solwezi General Hospital in Solwezi District, which is the largest referral hospital in the North-western Province of Zambia.

*Study population:* All children and adolescents aged between 1 and 17 years of age presenting at Solwezi General Hospital with a fracture injury between June and July 2019 were included in the study. The age range of 1-17 years was appropriate in studying childhood fractures as it is characterized by rapid development, and heightened involvement in play and sports activities. The age range is also consistent with the United Nations definition of a child.[1]

Exclusion criteria included:

1. Children below the age of 1 year of were not included in the study because of the difficulty in analysing the lifestyle behaviours for such a young age
2. Children with pathological fractures
3. Children on long-term treatment with steroids
4. Children with fractures whose parents or guardians did not give permission for them to undergo X-Ray examination

*Sample size:* A sample of 123 participants was used and calculated based on the Cochrane formula.

*Sample selection:* Convenience sampling method was used to select study participants as and when they presented to the Physiotherapy/Orthopaedics out-patient clinics. Follow-ups were also made in the children's surgical ward to capture patients who may have been admitted straight from the out-patient or emergency departments.

*Data collection:* A researcher-assisted questionnaire was used to collect data, in four major sections as follows: Section A (sociodemographic); Section B (injury details); Section C (mechanisms of injury); and Section D (possible complications from fractures). Fractures were confirmed through radiographs by a trained and skilled clinician.

*Data management and analysis:* Completed questionnaires were checked for completeness and consistency, coded, entered in Statistical Package for Social Sciences (SPSS) Version 20.0 software for analysis. Descriptive and inferential statistics were performed to obtain frequencies and establish associations, respectively. Chi-Square test was used to assess statistical significance of variables at the 0.05 level of significance.

## RESULTS

Eighty-nine participants were successfully interviewed using a researcher-assisted questionnaire between June and July 2019. The study reported a participant response rate of 72.4%. The findings of this study have been presented in the form of frequency tables and charts for ease of interpretation.

### Sociodemographic characteristics

A male predominance over females was noted with a ratio of 3:2. The age of the respondents ranged from 1 to 17 years with a mean of 6.88 years. Over half of the respondents (54.5%, n=48) of the respondents came from rural/village settings. The rest of the respondents were from either densely-populated compounds (25.0%, n=22) or high-class residential areas (20.5%, n=18). The majority of respondents' household heads were self-employed (33.7%, n=30) while 24.7% (n=22) of them were subsistence farmers. Ten percent (10%, n=9) of the respondents had household heads who were involved in informal employment. The average number of children under 18 years in households was 3.96. Other sociodemographic characteristics are summarized in Table 1 below:

***Table 1: Respondents' sociodemographic characteristics***

| Characteristics | | Proportion (n) | Percentage (%) |
|---|---|---|---|
| Gender | Male | 54 | 60.7 |
| | Female | 35 | 39.3 |
| Age groups | Pre-school (1—5.9 years) | 43 | 48.3 |
| | Middle school (6—10.9 years) | 26 | 29.2 |
| | Adolescents (11—17 years) | 20 | 22.5 |
| Area of residence | Rural | 48 | 54.5 |
| | Densely populated compound | 22 | 25.0 |
| | High class | 18 | 20.5 |
| Accompanying guardian | Biological parent | 70 | 78.7 |
| | Aunt/uncle | 5 | 5.6 |
| | Grandparent | 5 | 5.6 |
| | Others (neighbours/school teachers) | 5 | 5.6 |
| | Sibling | 4 | 4.5 |
| Occupation of household head | Business person | 30 | 33.17 |
| | Farmer | 22 | 24.7 |
| | Unemployed | 15 | 16.9 |
| | Formal employment | 13 | 14.6 |
| | Informal employment | 9 | 10.1 |

**Respondents' Injury Details**

The number of days between the sustaining a fracture injury and presenting at the hospital was reported between 0 and 8 days (Mean=2.36 days). Most of the respondents (77.5%, n=69) had fractures involving a single bone while 22.5% (n=20) had fractures involving multiple bones. The most commonly fractured bone was the radius (51.7%, n=46), especially the distal one-third, while the metatarsal was the least fractured bone occurring only in a single respondent (1.1%). Transverse fractures occurred in one-third of the respondents (n=18), and avulsion fracture in one respondent (1.1%). The rest of the respondents had fracture types ranging from oblique to growth plate fractures as shown in Table 2 below.

***Table 2: Respondents' injury details***

| Characteristics | | Proportion (n) | Percentage (%) |
|---|---|---|---|
| Nature of fracture injury | Single fracture | 69 | 77.5 |
| | Multiple fractures | 20 | 22.5 |
| | Closed fracture | 89 | 100 |
| | Open fracture | 0 | 0 |
| Fracture region | Upper limb | 89 | 79.5 |
| | Lower limb | 23 | 20.5 |
| Type of fracture by bone involved | Radial fracture | 46 | 51.7 |
| | Ulnar fracture | 20 | 22.5 |
| | Humeral supracondylar fracture | 17 | 19.1 |
| | Tibial fracture | 15 | 16.9 |
| | Fibular fracture | 5 | 5.6 |
| | Clavicular fracture | 4 | 4.5 |
| | Femoral fracture | 2 | 2.2 |
| | Metacarpal fracture | 2 | 2.2 |
| | Metatarsal fracture | 1 | 1.1 |
| Type of fracture injury by radiological appearance | Transverse fracture | 28 | 31.5 |
| | Greenstick fracture | 18 | 20.5 |
| | Torus fracture | 14 | 15.7 |
| | Spiral fracture | 11 | 12.4 |
| | Oblique fracture | 8 | 9.0 |
| | Epiphyseal fracture | 7 | 7.9 |
| | Impaction fracture | 2 | 2.2 |
| | Avulsion fracture | 1 | 1.1 |
| Year of previous fracture injury | 2019 | 2 | 2.2 |
| | 2018 | 3 | 3.4 |
| | 2017 | 3 | 3.4 |
| | 2016 | 1 | 1.1 |
| | 2015 | 1 | 1.1 |
| | 2011 | 1 | 1.1 |
| Injury severity based on Landin trauma scale | Slight trauma | 47 | 52.8 |
| | Moderate trauma | 39 | 43.8 |

### Respondents' Mechanism of Injury

The majority (56.2%, n=50) of the fracture injuries occurred at home and its surroundings. Sixteen percent (16.9%, n=15) of the injuries occurred at school while one case (1.1%) occurred at church. Eighty-four percent (84.3%, n=75) of the respondents sustained their fracture injuries while in the company of other children; 13.5% (n=12) were alone while only 2.2% (n=2) were in the company of an adult, as shown in Table 3 below:

*Table 3: Respondents' mechanism of injury*

| Characteristics | | Proportion (n) | Percentage (%) |
|---|---|---|---|
| Place of injury | Outdoors | 85 | 95.5 |
| | Indoors | 4 | 4.5 |
| Geographical location of injury | Home surrounding | 50 | 56.2 |
| | Road | 17 | 19.1 |
| | School premises | 15 | 16.9 |
| | Public playground | 6 | 6.7 |
| | Other (church) | 1 | 1.1 |
| Company of child at time of injury | With other children | 75 | 84.3 |
| | Alone | 12 | 13.5 |
| | With adult(s) | 2 | 2.2 |
| Cause of injury | Fall | 65 | 73.0 |
| | Sports injury | 12 | 13.5 |
| | Direct trauma | 7 | 7.9 |
| | Road traffic accident | 5 | 5.6 |

### Causes of fracture injuries (n=89)

Figure 1 below indicates that falls (73%, n=65) were the most frequent mechanism of injury while the least reported were road traffic accidents (5.6%, n=5).

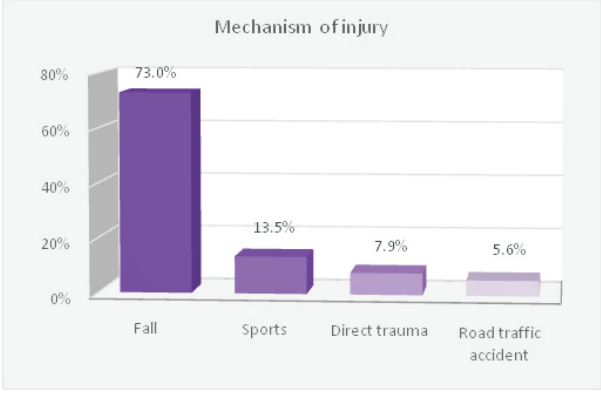


*Figure 1: Bar chart showing causes of fracture injury*

### Severity of fracture injury (n=89)

Using the Landin trauma scale, Figure 2 below indicates that more than half of the respondents (52.8%, n=47) sustained their fracture injuries from slight trauma while the rest had moderate trauma (43.8%, n=39). Only 3.4% (n=3) of the respondents had fractures caused by severe trauma.

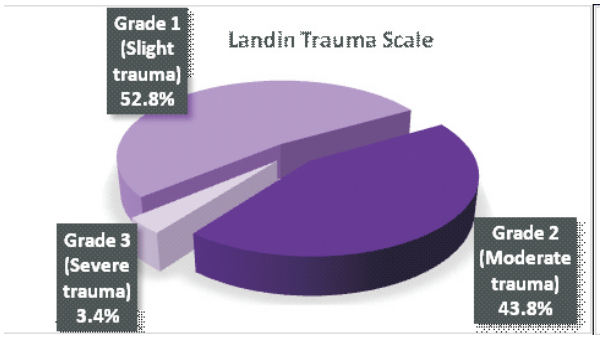


*Figure 2: Pie chart showing level of trauma according to the Landin scale*

### Complications of Fractures in Children

No complication was reported to have arisen from previous or current fracture injuries in this study.

### Cross tabulations

Table 4 below summarises the outcomes of cross tabulations interpreted based on the 0.05 level of statistical significance. Statistically significant associations were found between respondent's age group and mechanism of injury; as well as

respondent's area of residence and geographical location of injury. The association between respondent's gender and age group was statistically insignificant.

*Table 4: Cross tabulations of variables*

| Cross tabulation variables | p-value | Degrees of freedom (df) | Statistical significance |
|---|---|---|---|
| Respondent's age group and mechanism of injury | 0.004 | 6 | Significant |
| Respondent's age group and gender | 0.305 | 2 | Insignificant |
| Respondent's area of residence and geograp location of injury occurrence | 0.005 | 8 | Significant |

## DISCUSSION

While childhood is an important period of rapid growth and discovery, it is also a period of increased risk for injuries that could affect a child's adult life. Understanding the pattern in which childhood fractures occur is important in the formulation of preventive strategies that aim at minimizing the impact that these injuries may cause in children. The aim of this study was to establish the pattern of fracture occurrence in children presenting at Solwezi General Hospital in Solwezi District between June 2019 and July 2019. Below is a discussion of the findings:

### Respondents' sociodemographic characteristics

The mean age of participants in this study is consistent with what other studies have found.[15,18,19] This study reported a higher frequency of childhood fractures in a pre-school age group, and this may be attributed to increased mobility and explorative nature of pre-school children. In contrast, other previous studies have found either a bimodal distribution of fractures in age groups 4-6 and 12-14 years[15], or a trimodal distribution with peaks in the age groups 4-5, 8-11 and 16 years. Healthcare providers should provide information, education and communication (IEC) to parents and guardians regarding fractures in children as they come to seek child health services.

A male predominance in the occurrence of fractures in children, a finding that is in line with results of previous studies.[15,18,19] This could be because boys are more adventurous and likely to participate in risky physical activities compared to girls. As for the girls, the relatively lower occurrence of fractures could be because in typical Zambian settings, girls are expected to display more feminine behaviour as early as primary school and so they may not be involved in high impact play activities compared to the boys.

This study found that most of the fractures in children that occurred in the rural settings involving falling off a bicycle in the road or around the home. This is because bicycles are the most common mode of transport in most parts of the study setting, and often children play with bicycles unaccompanied by adults. In contrast, Ng'ang'a *et al.*[15] established that most children with fractures were from high class residential areas, and often sustained fractures at school. This difference could be attributed to the differences in the settings in which these studies have been conducted.

Worth noting in this study is that the majority of children with fractures were from households whose heads were predominantly self-employed and only few were in formal employment. This finding correlates with what Williams *et al*. found that the occupation and general socioeconomic status of a child's parents or guardians were related to the circumstances in which children sustain fractures due to lack of adequate supervision as parents tend to spend most of their time away for work or business. In this regard, fractures in children can be prevented by ensuring that children

have adequate adult care and supervision at home or school.

**Respondents' injury details**

Findings of this study show that children who sustained fractures presented to the hospital for treatment within a week. On the contrary, Hoytema van Konijnenburg *et al*. concluded that childhood fractures are an emergency requiring immediate treatment. This discrepancy could arise because this study was conducted at a referral hospital, therefore patients would have had to first go to a local clinic before being referred. There is need to improve our referral systems so that fractures in children can be recognized as emergencies early enough for appropriate intervention.

Like in other previous studies, childhood fractures of the upper limb were found to be more frequent.[19,21,,] In contrast, a study conducted in Saudi Arabia by Alomran *et al.* found that fractures of the lower limbs were the most common among children. This contrast could be due to the fact that unlike this study, the study by Alomran *et al.*[27] concentrated on paediatric patients who were admitted only and so it is possible that children with upper limb fractures were treated in the out-patient department without need for admission.

The rate of fractures involving the tibia and fibula in this study was lower than what other studies have reported.[5,21] In Britain, Cooper *et al.*[5] reported a steady age-related decline in fractures of the tibia and fibula in girls whilst in boys, there was an increase in the age-related rate of fractures of the tibia and fibula. This may be because boys are often involved in high-energy contact sports as they grow while girls are not. Therefore, greater effort should be directed at making playing environments and contact sports safe for children, especially the boys.

A lower rate of growth plate fractures in children was found in this study, possibly because most of the injuries in this study occurred from mild or moderate trauma which is not likely to cause severe growth plate disruption. Practically, growth plate fractures are serious because they can lead to significant growth abnormalities in the child if mismanaged.

**Mechanism of injury**

This study found the home surroundings to be the most frequent place of fracture occurrence in children. This is in line with other studies' findings.[15,18,19]Children in the pre-school age group tend to spend more time at home than older children and adolescents. There is need for better supervision of children while they play in safe home environments. Falls were the main mechanism of injury in this study, a finding that is congruent with that reported by previous studies.[8,15] Practically, fractures from falls could be prevented by improving situational awareness among care givers, paying closer attention to children, closer supervision of children by guardians, ensuring safe homes and playgrounds, and padding of hard uneven surfaces.

The proportion of childhood fractures caused by road traffic accidents in this study is consistent with figures from studies conducted in developed countries.[,] Contrary to previous research[18,21,], no vehicular accident was reported in this study. Nonetheless, road safety campaigns should be consistently conducted in schools and communities, as well as advocacy for traffic restrictions in populated areas or school zones, speed limit enforcement, and mandatory use of child car seats.

This study found a relatively higher rate of childhood fractures caused by sports injuries compared to other previous studies.[5,18,29] This could be because majority of children in this study were in the pre-school age group children participate sports activities, especially football. Therefore, safety awareness should be promoted during sports. The rate of fractures in children caused by slight trauma in this present study is similar to the corresponding results of previous studies.[15,18] This indicates that high energy traumatic events are not usual in causing fractures in children.

No case of childhood fracture was attributed to assault or child abuse in this study, in agreement with a study by Ng'ang'a *et al.*[15]This could be because participants were accompanied by parents/guardians who could be potential abusers. Health systems should have child-friendly services and victim support units where cases of assault or child abuse can be handled without interference from guardians.

No case of open fracture was recorded in this study. This observation contradicts findings of previous studies which established that open fractures in children constitute 4-5% of all childhood fractures.[15,18,] This observation could be attributed to the low-energy trauma associated with childhood fracture injuries in this study compared to high-energy trauma events such as road traffic accidents that caused open fractures in the other studies.

This study did not record any complications arising from childhood fractures, a finding that is consistent with what other studies have found.[10,11,12,19,]This absence of complications arising from fractures in children might be attributed to the related mechanisms of injury established in this study and the effectiveness of treatment modalities, operative and conservative, used in managing these fractures in children presenting at Solwezi General Hospital.

**Implication to Practice**

Understanding the pattern in which childhood fractures occur is important in formulating strategies aimed at minimizing the impact of fractures in children. Various stakeholders should institute appropriate strategies to prevent fractures in children such as sensitization campaigns in schools and communities. Evidence-based approaches should be set in the forefront of clinical practice, especially in the care of children with fractures.

## CONCLUSION

This study established that fractures in children were more frequent in male, pre-school aged children, which are often caused by mild—moderate trauma from falls in the home surroundings.

## RECOMMENDATIONS

The study makes the following recommendations:

I. Future study to cover a wider setting and a longer period of time so that a comprehensive picture of the pattern of fracture occurrence in children can be determined over changes in climatic and school-holiday seasons
ii. Ministry of Health and other stakeholders need to develop policies and guidelines on safety and prevention of fractures in children in the home, community and school environments
iii. Communities should work together to ensure that children's play areas are safe and are away from traffic

## LIMITATIONS

A number of limitations were noted in this study including the following:

I. Period of study was not long enough to meet the calculated sample size of 123 through convenience sampling, and this could have reduced the study's reliability and validity
ii. This study was conducted over a short period of time which may not have been long enough to determine what effects changes in the school and holiday seasons as well changes in climatic seasons would have on the pattern of fracture occurrence in children
iii. Information on injury details depended on the account given by the child, which could have led to recall bias

## DECLARATIONS

*Ethics approval*

Ethics approval for the study was granted by the University of Lusaka (Reference IORG0010092/MPH17210410).

*Consent for publication*

Not applicable

*Availability of data and study materials*

Not applicable

*Conflict of interest*

No competing interest is declared

*Funding statement*

Not applicable

*Acknowledgements*

The contribution of the research supervisor Dr Loveness Yanila Nkhata (PhD); the Management, Physiotherapy and Orthopaedic teams at Solwezi General Hospital is acknowledged.

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