

THE SOCIO-ECONOMIC BURDEN OF PAEDIATRIC LONG BONE FRACTURES IN A LOW RESOURCE SETTING

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Abstract

Objective: Paediatric long bone fractures are prevalent and a significant source of direct medical costs and indirect costs resulting from economic production losses within affected families. Our study aimed to describe the occurrence of paediatric long bone fractures and its direct and indirect costs to the affected families.

Methods: A prospective review and follow-up of all paediatric long bone fracture admissions at KATH A&E was conducted from March to June 2018. The study assessed the socio-economic burden of paediatric long bone fractures on the patients and caregivers.

Results: In the period, 97 children presented with mean age of 6.7years (SD=3.9 years) and 63.9% being male. Mechanism of injury was mostly falling during walking or running (39.1%) and 19.6% were pedestrian knockdowns. Most injuries occurred at home (41.2%) and school (30.9%) and 13.4% reported to the hospital

in an ambulance. The most common fracture was both radius and ulna (26.8%) and closed fractures (83.5%) with 10.5% undergoing operative management. Caregivers were mostly females (67.0%) and the mean age was 39.3 years (SD=11.8years). The mean direct cost of treatment was GHS 928.91 (SD=GHS 1683.97) for all patients and GHS 3,587.50 (SD=GHS 3401.87) for surgically managed patients. The mean cost of treatment covered by health insurance was GHS 348.83 (SD=GHS 738.64). Mean missed workdays for caregivers was 24.5days (SD=31.1days)

Conclusion: Fractures of both radius and ulna were common in our paediatric population and occurred mostly at home. Paediatric fractures have a significant socioeconomic burden on the caregivers. There is the need to advocate for injury prevention strategies that target safety at home and in school.

Key Words: Paediatric fracture; Socioeconomic burden

Introduction

Children represent the most vulnerable population in the world and are at a high risk of injuries with up to one in every four children sustaining an injury annually.^{1,2} Fractures are prevalent in the paediatric age group, representing a significant public health problem. The lifetime risk of sustaining a fracture in childhood is about 42%-64% in boys and 27%-40% in girls, with remarkable variation in the estimates worldwide.^{1,3,4} This is a primary preventable and controllable public health concern that affects children in high income and even more in low middle-income countries, including Ghana. It causes morbidity, premature mortality and other related disability and unmeasured family burden and economic cost in families and communities of affected children⁵. Sadly, little attention is given to childhood injuries in developing countries. Often, in low and middle-income countries (LMIC's), people

including children with disabilities as a result of injuries live in poverty and are excluded from playing a full part in society causing them not to reach their full potential in life.⁶

Long bone fractures are a significant source of direct medical costs as well as indirect costs resulting from economic production losses within families of affected children.^{3,7} There is insignificant data on the impact of such injuries on children in Low-Middle Income Countries and on the psychological and social functioning of how children and families are affected.^{3,4} Long bone fractures have negative long- and short-term impact on the development of children, including cognitive development that have a high probability of affecting their educational performances.

Conventionally, the socio-economic burden of long bone fractures have not been considered when making treatment decisions or in the evaluation of outcomes.⁸ Paediatric fracture stabilization has relied on closed reduction techniques in which the fracture is manually reduced and immobilized by an appropriate cast.⁹ Rehabilitation of the children who suffer from long term fractures is often left undocumented. To the best of our knowledge, the economic, psychosocial impact and family burden of paediatric fracture management, especially in the patient with multiple injuries, have not been studied, especially in a low middle-income country.

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This study can help determine the undocumented economic and family burden of long bone fractures among children, mainly in the Ashanti region of Ghana. The study seeks to determine the geographical distribution of children with long bone fractures. This would help measure health gaps as opposed to health expectancies of children with long bone fractures. Documentation of long bone fractures would be instrumental in adding to the body of scientific knowledge on paediatric fractures and improve on cost-effective injury prevention strategies that could save more than a thousand children's lives daily in the country.

Interestingly, paediatric trauma is mostly absent from child survival initiatives presently on the global agenda, though it is a common cause of morbidity and mortality in all LMICs.¹⁰

Injuries are also the commonest surgical problems affecting children in sub-Saharan Africa, accounting for the highest per cent of paediatric surgical admissions, and causing the most significant number of inpatient hospital days (49.1%), surgical deaths (48%), and life-long disability.^{3,6,11,12} With fractures having a considerable impact on the daily living and activity of affected children, they represent an important topic of public health. Alarmingly, Disability-Adjusted Life Years (DALYs) related to injury is highest in children in sub-Saharan Africa, where 46% of the 1 billion people are under the age of 14 years.¹¹

Materials and Methods

Study Design

A prospective cross-sectional study was conducted at the Accident and Emergency Unit of the Komfo Anokye Teaching Hospital (KATH A&E). The study population included all paediatric patients up to 16 years of age diagnosed with long bone fractures. The study commenced recruitment on 12th March 2018 and ended on 30th June 2018 to allow for follow-ups. Three-month follow up was conducted and ended on 30th September 2018, and a six-month follow-up ended on 31st December 2018.

The study included all patients 16 years and below with a long bone-fracture evidenced by an x-ray. Patients whose injuries were birth-associated were however excluded.

A convenient sampling technique was used to screen and recruit all eligible patients presenting to the KATH A&E during the study period.

Data collection

A research assistant was stationed at the Triage area of the KATH A&E to screen for eligible patients. After informed consent was signed, the research assistants extracted data from the patient notes and from caregivers at presentation and during their stay in the hospital. Data collected included the demographic characteristics of the child and the caregiver, the presentation of the injury and injury characteristics and

the cost of the treatment. Information on injury incidence sites and residence of patients were collected and mapped. X-Ray images were also collected.

Classification of the all the fractures were done by two independent orthopaedic surgeons using the x-ray images and the clinical diagnoses from the patient notes using AO Classification. Differences were resolved through consensus with the surgeons and the consensus classification recorded. Research assistants followed up the patients through phone calls at 3 months and at 6 months after injury to assess their self-reported recovery to normal daily activities.

Data management and Statistical Analysis

Data were collected on tablet computers with a database designed with Research Electronic Data Capture (REDCap). REDCap is a secure web-based system which is access and privileges controlled. Varying levels of privileges were provided to the research assistants, and investigators.

Data collected from the study was exported to STATA version 16.0 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LP) for analysis. Bivariate analysis with chi-square/Fisher's exact test was conducted comparing age category, type of fracture, mode of transport and mechanism of injury. A confidence level of 5% was set for all comparisons. Student's t-test was used to determine significant differences in direct cost between caregiver's gender.

Ethics Considerations

Ethical approval for the study was sought from the Committee of Human Research Publication Ethics (CHRPE) a joint Institutional Review Board of the School of Medical Sciences, Kwame Nkrumah University of Science and Technology and the Komfo Anokye Teaching Hospital. Written informed consent was obtained from the caregivers after the research assistant had explained the purpose of the study before proceeding with data capture. Confidentiality was assured, and respondents were free to withdraw from the study or refuse to answer any questions.

Results

In the study period, 97 paediatric patients presented with long bone fractures and were enrolled. 78 were successfully contacted via a phone call for the 3-month follow-up interview. 70 were successfully contacted after 6 months to complete their surveys. The mean age was 6.7years (SD=3.9 years) with a range of 0-16 years. About 63.9% of the respondents were male. Mean age of their primary caregivers was 39.3 years (SD=11.8years) Most were female (67.0%). About 78.3% of primary caregivers were married. About 83.5% of the caregivers of the children were their parents. Most caregivers had a formal education, 32.9% had junior high education, and 22.6% had senior high education as their highest level of education. Only

10.3% had no formal education. Mechanism of injury included falls from walking and running (39.1%), pedestrian knockdowns (19.6%), fall from a height (15.4%), motor vehicle collisions (7.2%) and sports-related injuries (5.1%) (Fig. 1). Most injuries occurred at home (41.2%) and school (30.9%) (Table 1). The commonest fracture was the fracture of both radius and ulna (26.8%), followed by femur fractures (25.7%) and humerus fractures (22.6%). Most were closed fractures (83.5%) (Table 2). Adolescents (11-16years) were more likely to sustain open fractures (47.3%) p -value=0.003. Preschool children (2years - <6 years) and school children (6years - <11years) were more prone to fractures (74.2%). Diaphyseal fractures (41.2%) and distal metaphyseal fractures (40.2%) were common (Table 3). For epiphyseal fractures, salter-harris 2 pattern was the commonest (55.5%) followed by salter-harris 1. Most patients came to the hospital with a taxi cab (53.6%). Only 13.4% reported to the hospital in an ambulance. About 77.0% of the children were referrals from other health facilities (Fig. 2). Treatment was

mainly non-operative, only 10.5% had operative management. Sixty-nine per cent (69.0%) had reduction and plaster of Paris application. The mean cost of treatment at discharge from the hospital was GHS 928.91 (SD=GHS 1683.97). The mean cost of treatment for patients who had surgical management was GHS 3587.50 (SD=GHS 3401.87) with a maximum cost of GHS 10,846. The mean cost of treatment covered by the national health insurance was GHS 348.83 (SD=GHS 738.64). The mean cost of treatment for children who were treated and discharged from the emergency unit was GHS 89.3 (SD=GHS 97.3) with a maximum cost of GHS 515. Mean missed school days due to fracture was 25.5 days (SD=31.9 days), with the maximum being 120 days. Mean missed workdays for caregivers was 24.5days (SD=31.1days). Two (2) children died on the ward.

Most of them were triaged Yellow (urgent) (78%) followed by Orange (very urgent) (14%) using the South African Triage Scale (SATS).

Table 1: Comparison of location where injury occurred and age category

Where did fracture Location of injury	<2years	2 to <6yrs	6 to<11yrs	11 to 16 yrs	Total n(%)
Home	4 10.0	20 50.0	12 30.0	4 10.0	40 100
School	1 3.3	10 33.3	15 50.0	4 13.3	30 100
Public place/street	1 4.0	5 20.0	10 40.0	9 36.0	25 100
Farm/bush	0 0.0	0 0.0	0 0.0	1 100.0	1 100
playground	0 0.0	0 0.0	0 0.0	1 100.0	1 100
Total n (%)	6 6.2	35 36.1	37 38.1	19 19.6	97 100

Fisher's exact = 0.025

Table 2: Type of fracture

Age Category	Closed Fracture	Open Fracture	Total
<2years	6 100	0 0.0	6 100
2years to <6years	32 91.4	3 8.5	35 100
6years to <11years	33 89.2	4 10.8	37 100
11 years to 16 years	10 52.6	9 47.3	19 100
Total n (%)	81 83.5	16 16.5	97 100

Fisher's exact= 0.003

Table 3: Distribution of fractures according to bone segment and age

Bone segment	<2yrs	2 to <6yrs	6 to <11yrs	11 to 16yrs	Total n(%)
Proximal epiphysis	0 0.0	0 0.0	0 0.0	1 100	1 100
Proximal metaphysis	0 0.0	3 33.3	5 55.5	1 11.1	9 100
Diaphysis	3 7.5	15 37.5	15 37.5	7 17.5	40 100
Distal epiphysis	0 0.0	0 0.0	3 37.5	5 62.5	8 100
Distal metaphysis	3 7.7	17 43.6	14 35.9	5 12.8	39 100
Total n (%)	6 6.2	35 36.1	37 38.1	19 19.6	97 100

Fisher's exact= 0.137

<2years (infants/toddlers)

2 to < 6years (pre-school children)

6 to <11 years (school children)

11 to 16 years (adolescents)

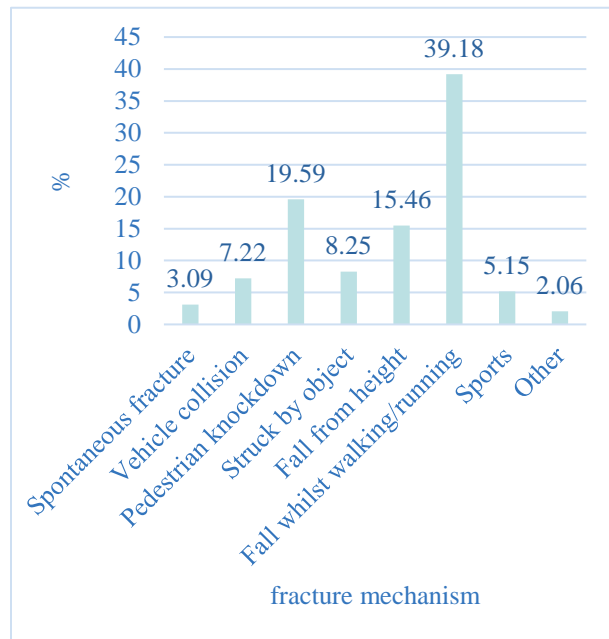


Figure 1: Mechanism of injury

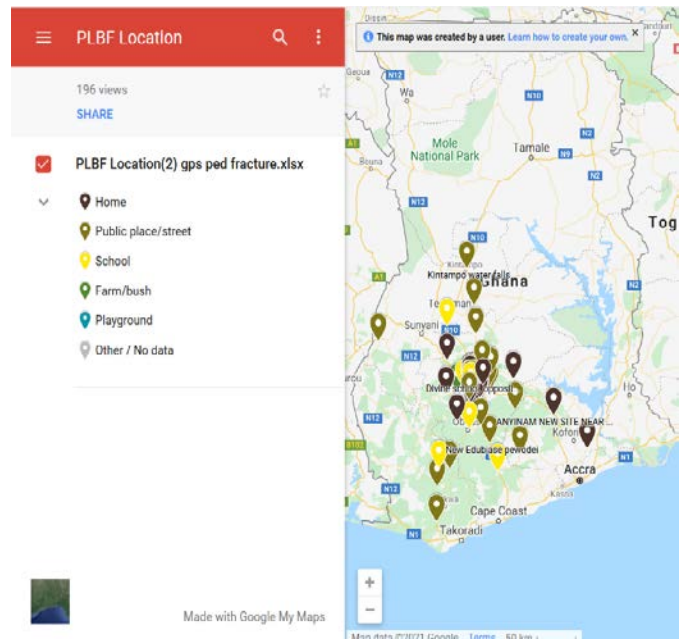


Figure 2: Geographical distribution of children with long bone fractures

Discussion

Demographic characteristics

Children

Males were mostly affected by paediatric long bone fractures. The male predominance of 63.9% in this current study corroborates with the 61.3% identified in Austria by Schalamon et al.¹³ and 60% documented by Joeris et al. in Switzerland.¹⁴ A similar study conducted in Nigeria also showed male predominance of 61.2% which was similar to that of this study.¹⁵ Majority of injuries affect the male gender because they have a higher level of activity and constituent risk in their

activity compared to their female counterparts. Again, due to differences in gender socialisation, boys are allowed to explore their environment without supervision much more than girls.¹⁶

The mean age (SD) of 6.7 (3.9) years in our study was younger than what was found in Austria (9.0 years) and Switzerland (8.2 years).^{13,17} The likely reason was that in both studies, participants included older children.

Caregivers

Majority of primary caregivers were females, usually mothers who had education beyond the basic

level similar to what was found in Singapore.¹⁸ This can be attributed to greater availability of mothers in the house than fathers who would be out working.

Fracture characteristics

Mechanisms of injury

The most common mechanism of injury was falls (54.6%), mainly on level ground while running or walking (39.1%). The same plane falls observed was similar to what was reported in Austria (41.9%)¹³ and Sweden (24%).¹⁹ Our observation also correlated with what Gyedu et al. identified earlier that, falls were the most frequent cause of household and neighbourhood injuries in Ghana.²⁰ Although in Switzerland, falls predominated as the mechanism of injury, unlike the level ground falls we noted, falls were from heights less than 1 metre (57%).¹⁷

Road traffic injuries were the second commonest mechanism of paediatric long bone fractures in our study. Our observation correlated with other studies.^{13,17} However, in a study conducted in Nigeria, road traffic accidents were noted to be the commonest cause of paediatric fractures.¹⁵ Road traffic crash has been identified as the leading cause of paediatric injuries in LMICs including Ghana.²¹ According to Abantanga et al.,²² transportation-related injuries are significant causes of childhood trauma in Ghana

Five per cent (5%) of long bone fractures resulted from sporting activities which were comparable to what Joeris et al.¹⁷ found among Swiss children. It was, however, lower than the over thirty per cent (30%) of sport-related fractures documented in an Austrian study.¹³ Unlike Ghana where soccer is the primary sporting activity children may engage in, the Austrian children engaged in other forms of sporting activities such as skiing and playing rugby which may have increased the percentage of sports-related paediatric fractures. The sports injuries significantly occurred only in children who were 6 years and older in our study. It has been found that children start participating in organised sports after age 5 and that may have accounted for no sports-related injury under 6 years in our study.¹⁹

Place of injury

The fractures mainly occurred at home (41.2%) and school (30.9%). Inadequate adult supervision when children are playing both at home and school may have resulted in this observation.¹⁶ The home was the second place where paediatric fractures occurred in Austria¹³, and the third place in Switzerland.¹⁷ Sixty per cent of children who sustained a long bone fracture at home were less than 6 years old. On the other hand, more than sixty per cent of those who suffered a long bone fracture at school were 6 years and above. Most of the fractures occurred in urban and peri-urban areas (see figure 2) Both parents and teachers have a great responsibility for ensuring that children are safe in these environments.

Mode of transport to the hospital

Compared to Taxis and private cars (74%), only 13% of children with long bone fractures arrived at the KATH A&E in ambulances. It contrasted the 60% Emergency Department attendance by ambulance in an unpublished study at the same facility.²³ The disparity may have arisen from the fact that the unpublished study involved paediatric traumatic brain injury patients who may have had a relatively more severe injury and were therefore transported in ambulances. With close to eighty per cent of the children with long bone fractures being referred from another health facility, it can be assumed that health care providers in referral facilities were flexible with the mode of transportation when the injury severity was considered mild but recommended ambulance when they considered the injuries severe.

Severity of injury

In this current study, most of the long bone fractures were closed (83.5%), which was significantly associated with younger children. Only one per cent of children in Switzerland sustained an open fracture.¹⁷ What may have accounted for the difference is that relatively more of our participants were involved in road traffic crashes (27%) compared to the Switzerland study (11%). Road traffic crashes tend to transfer a lot more energy to the patient resulting in more severe injuries (such as an open fracture) unlike most falls.²¹

Most of the children with long bone fractures were triaged Yellow (urgent) (78%) followed by Orange (very urgent) (14%) according to the South African Triage Scale (SATS)²⁴. All children with open long bone fractures were up-triaged to higher triage colour, Orange, according to the SATS.²⁴

Site of fracture.

The frequent site of long bone fracture was the radius and ulna (27%), followed by the femur (26%), and humerus (23%). In most childhood fracture studies; the radius and ulna are identified as the common site of paediatric long bone fractures.^{13,17,19,25,26} When children are falling, they try to break their fall or protect their heads with their upper limbs and they sometimes sustain fractures to their radius and ulna.¹⁶ A study done in Nigeria however had femur fractures (33%) as the commonest site of long bone fractures in children.¹⁵ Over forty per cent of fractures occurred in the diaphysis and the metaphysis of the long bones in children. It corroborated with the 47% metaphyseal fractures Joeris et al. found in a recent study in Switzerland.²⁶ In the same study, close to half of the epiphyseal fractures were classified as Salter-Harris type-II, which was very similar to our study (56%).

Treatment

Majority of the long bone fractures in the study were managed non-operatively with closed reduction and application of plaster of Paris (POP). Eleven per cent of children with long bone fractures in the study had

operative management compared to 22% in an Austrian study.¹³ Other unpublished studies at our facility have shown an unexpected lower operative rate. Reasons accounting for this may be inadequate resources including human resource (orthopaedic surgeons, perioperative staff), materials (theatre gowns, drapes, power drills and implants) and money (unaffordability of operative management especially for patients who are not members of a health insurance scheme) as was found in Nigerian study.²⁷

Socio-economic burden

Cost

The average cost of treatment at discharge from hospital was GHS 928.91 (USD162.97). The amount escalated to GHS 3,587.50 (USD629.39) for children who had operative management and could go as high as GHS10,846.00(USD1,903.78). Non-operative management by Emergency Physicians at the emergency room had an average direct cost of GHS 89.30 (USD15.67). Participants who had health insurance had a percentage of their hospital bills paid by the insurance company. However, the direct cost to caregivers was always higher than what the insurance companies paid. Elderly caregivers (above 60 years) had a higher direct cost compared to caregivers in the working-age group. Although male caregivers had a higher direct cost compared to their female counterparts, the difference was not significant. Childhood injuries in LMICs have been found to deplete the already meagre family resources due to the cost of treatment.¹⁶

Missed school and workdays

Children who suffered from long bone fractures almost missed a third of a term's work in school while their caregivers also missed a whole month of work. The missed days in school have been found to impact the child's academic work negatively. Coupled with lower income due to caregiver's absence from work, the children drop out of school.¹⁶

Limitations

This study had some limitations regarding data collection and participants. The sample size was small because of the short period of the study. It was a hospital-based study, and a more appropriate study would have been a population-based study. Seasonal variability may have also influenced the results.

Conclusion

Falls at home were the most common cause of paediatric long bone fractures leading to hospital admission. Fractures of both radius and ulna are the most common fractures among participants. Paediatric fractures have a significant socioeconomic burden with caregivers losing about a month's income in addition to out of pocket payments. The average cost of treatment was a significant financial burden to the caregivers. The children also missed a substantial part of the school term

due to long bone fractures. Implementation of injury prevention strategies that target safety at home, school and better child supervision will reduce the impact of long bone fractures on children and their family.

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