CHARACTERISATION OF MUSCULOSKELETAL INJURIES IN CHILDREN SEEN AT THE UNIVERSITY TEACHING HOSPITAL, LUSAKA

By

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A dissertation submitted to the University of Zambia in partial fulfilment of requirements for the award of the Master of Medicine Degree in Orthopaedic and Trauma Surgery

UNIVERSITY OF ZAMBIA

LUSAKA

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DECLARATION

I, Dr James Nyimbili, do hereby declare that the work presented in this study for the degree of Master of Medicine in Orthopaedics and Trauma Surgery program represents my own work and has not been presented either wholly or in part for any other degree by myself or any other person and is not being currently submitted for any other degree at the University of Zambia or any other university.

Signed ……………………………………………………………………………………………

Dr. James Nyimbili

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APPROVAL

This dissertation by Dr James Nyimbili is approved as fulfilling part of the requirements for the award of the degree of Master of Medicine in Orthopaedic and Trauma Surgery by the University of Zambia.

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ABSTRACT

Musculoskeletal injuries are extremely common in children and may strain health delivery services. Recognition of the extent and nature of the problem is cardinal in formulation of preventive strategies and ensuring good treatment outcome.

This prospective hospital-based cross-sectional study aimed to capture various features of orthopaedic injuries in children. It was conducted at the University Teaching Hospital (UTH) over a period of four months (December 2018-April, 2019). Children aged seventeen years and below, presenting to UTH with a musculoskeletal injury following trauma were recruited via convenience sampling. Information regarding demographics, aetiology/ mechanism of injury, fracture classification, complications, suitable treatment modalities and availability at UTH was noted on recruitment. Data for 242 participants was analysed.

Results of the study indicated that the peak incidence of orthopaedic injuries was in the 5-10 years group. Male: female ratio was 3:1 and most injuries occurred in the home environment during play/sport. Complete fracture pattern was predominant and had direct relation with low socioeconomic status (p value 0.002). We therefore concluded that orthopaedic injuries in children seen at UTH are mostly complete fractures involving boys and that low socioeconomic background is an associated risk factor. Fracture complications are rare at presentation and surgery for definitive management of fractures is not readily available due to equipment challenges.

Keywords: Musculoskeletal injury, child, mechanism of injury, fracture classification, fall, site of injury

DEDICATION

I dedicate this study to all that have suffered musculoskeletal injury at some point in their childhood. Knowledge generated through their anguish continues to be utilized to prevent similar occurrences to other children. It is further hoped that through this work, measures can be put in place to improve the care for children who become victims of orthopaedic trauma.

ACKNOWLEDGEMENTS

Many thanks to my friends, colleagues and the faculty of orthopaedics and general surgery at the University of Zambia's School of Medicine. I particularly wish to acknowledge my supervisors Dr James Munthali and Dr Jonathan Sitali, the co-drivers of this research from inception to completion. You kept me focussed on the task at hand, and without your selfless dedication, I would not rer3have executed this project with the excellence that is required.

Profound gratitude is extended to the Zambia Air Force (ZAF) Command for facilitating my training, and the office of the Senior Medical Superintendent at UTH Adult Hospital for according me the opportunity to interact with the patients. To Dr Mumba Sakala and Dr Jerome Siyambu, you were a great team to work with and your efforts saw to it that the project was kept on schedule.

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To all the individuals and organisations not mentioned, without your support, the completion of this research work would not have been possible. Thank you all.

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LIST OF ABBREVIATIONS

CI	Confidence Interval
CSO	Central Statistics Office.
DALYS	Disability-Adjusted Life Years.
ERES	Excellence in Research Ethic and Science
GCP	Good Clinical Practice
RTA	Road Traffic Accident
SPSS	Statistical Package for Social Sciences
UNZA	University of Zambia
UTH	University Teaching Hospital
WHO	World Health Organization
ZDHS	Zambia Demographic and Health Survey

CHAPTER ONE

INTRODUCTION

1.1 Background

Musculoskeletal injuries are extremely common in children, representing a major public health problem (Valerio et al, 2010). They are responsible for more than half of all injury related children's admissions to the hospital and entail exorbitant costs(Ameh, 2011; Galano et al, 2005).

The developing world bears about 90 % of the global burden of injury. However, there is no specific epidemiologic data about the extent of the burden of trauma, particularly in Sub-Sahara Africa (Ameh, 2011). It is against the backdrop of little information pertaining to either incidence of musculoskeletal injury or its long term impact in the developing world that infectious diseases and malnutrition have predominated as causes of morbidity and mortality, with more resources being channeled their way at the expense of orthopedic trauma (Makasa, 2009).

The care of trauma patients requires comprehensive systems and is a continuous process involving appropriate pre-hospital care and transport, progress through safe and efficient hospital management for the acute phase, and finally rehabilitation and functional recovery. A successful trauma care system requires hospitals, trained personnel, and public agencies such as the ambulance services and efficient communication and transport capabilities. The global resources for such systems are highly variable, and are generally based on the availability of adult trauma services (Ameh, 2011; Sharar, 2012).

In an effort to curb orthopaedic trauma, the immediate focus in the African sub-region should be on properly instituted injury prevention programs. These are known to be effective in reducing the number and severity of paediatric trauma events (LaGrone, 2016). Accurate data on the extent and nature of injuries is required to formulate effective policies targeted at reducing the burden of paediatric orthopaedic trauma. There is need for establishing baseline information on the disease burden which can then be continually updated at regular intervals.

The aim of the study was to expound the factors determining and influencing the frequency and distribution of orthopedic trauma as well as the causes in children seen at the University Teaching Hospital (UTH), in Lusaka.

1.2 Problem Statement

All over the world, orthopaedic trauma in children has emerged as an important public health problem (Makasa, 2009; Valerio et al, 2010). The developing world bears 90 % of the global burden (Ameh, 2010). Standard care of trauma patients is costly, with resources unevenly distributed across the world (Sharar, 2012).

Much of the morbidity and mortality due to trauma is preventable (LaGrone, 2016).Development of intervention measures aimed at reducing the rising incidence requires baseline data, which is however not available in the African subcontinent (Ameh, 2010).

The aim of this study was to provide important insights into the nature and associated risk factors of orthopaedic injuries commonly seen in children presenting to UTH.

1.3 Study Justification

An informed approach is required to curb the rising incidence oforthopaedic trauma in children. Results obtained from this study will add to the much neededlocally generated body of knowledge on the subject. With data, favorable adjustments aimed at both prevention and improved patient care can then be made accordingly.

1.4 Research Question

What are the commonest type of orthopaedic injuries seen in children presenting to UTH following trauma?

1.5 General Objective

To characterize the common musculoskeletal injuries seen in children at UTH.

1.6 Specific Objectives

1.6.1. To establish the prevalence of the various injuries, associated risk factors and availability of definitive modes of treatment for the various patterns of musculoskeletal injuries seen in children at UTH.

1.6.2. To identify and correlate injuries in children with socioeconomic status

1.6.3. To document the associated non-orthopaedic injuries and complications in children presenting with musculoskeletal injuries at UTH.

CHAPTER TWO

LITERATURE REVIEW

2.1 Epidemiology

Trauma is a leading cause of hospitalization, disability and death among children and adolescents globally (Ameh, 2011). Though rarely fatal, orthopedic trauma accounts for 10% to 25% of all childhood injuries and is responsible for most cases of chronic pain and disability (Morrissy, 2006). Around one-third of all children suffer at least one fracture before the age of 17 (Cooper et al. 2004). According to the 2016 Annual Health Bulletin Zambia, national incidence for all ages stands at 48.4/ 1000.

Differences in incidence exist over time and between regions (Erik, 2010). The increasing scarcity of available resources, bed capacity and care facilities, as well as itemized billing and modified remuneration systems mean that society and governments have to bear an enormous financial burden in the management of pediatric orthopedic trauma (Hefti, 2007; Sharar, 2012). People with disabilities (a complication of orthopaedic trauma) and their families often incur additional costs to achieve a standard of living equivalent to that of the non-disabled.

Injuries cause a relatively high loss of disability-adjusted life years (DALYs) and in 2013, they accounted for 10.1% of the global burden of disease (Martinez-Diaz, 2007; Haagsma, 2015). The WHO and World Bank estimate an upward adjustment by 2020, when paediatric trauma is predicted to be the number one disease globally (Ameh, 2011).

In terms of bone involvement, the radius and ulna dominate, taking up 52%. The humerus is second with 16% followed by the tibia and fibula at 13%, with the femur ranking fourth at 7 %. The hand is involved in 6% of the fractures and the ankle takes up 3%. Other sites are involved in 3% of pediatric fractures (Pen, 2013).

2.2 Biomechanics of the immature skeleton

The immature skeleton is porous, with weak points at the physes and metaphyses, respectively. A bone fails when the applied loads exceed the load-bearing capacity (Hedstrom, 2010; Browner, 2003)

According to Forestier-Zhang et al (2016), factors that affect propensity to fracture in children are as follows:

- Smaller bone size- reduced withstanding of applied load
- Reduced mineralization- resulting in reduced stiffness (low moment of inertia), so less able to withstand loading.
- Reduced stiffness, increased ductility and toughness (low modulus of elasticity) - result in ‘greenstick’ fractures due to bone undergoing large displacement but not fracturing completely.
- Increased toughness-comminuted fractures are less common in children.

2.3 Aetiology

Reported mechanisms of injury associated with pediatric trauma include motor vehicle crashes, pedestrian knockdowns, bicyclists either falling off their bicycles or being hit by motorized vehicles, falls, non-accidental trauma (child abuse), sporting accidents, and gunshots (Shavit, 2009). According to Cleves et al, violence is another important cause of traumatic injuries and it may be self-directed, interpersonal, and collective.

In the pediatric population, motor vehicle accidents (MVAs) more commonly affect teenagers and adolescents. Falls are the most common cause of injury according to hospital records in developing countries, with the age group 5–9 years affected the most. The WHO estimates that falls account for 20-25 % childhood injury presenting at emergency departments. This mechanism of injury can occur on level ground while playing or running, or from a height. The home environment, school playgrounds, the back or arms of caregivers are implicated in falls (Daley, 2015; Ameh, 2011).

Non-accidental trauma (battered child syndrome) accounts for an estimated 0.3% to 3.0% of all injuries in childhood. It is probably far higher than is generally thought. In recent years, it is becoming more commonly diagnosed, primarily due to heightened societal awareness of the problem. Child abuse rarely occurs as an isolated event, and the result of returning the child to the home may be disastrous. Most cases will involve children younger than 3 years of age, with first-born children, premature infants, stepchildren, and the handicapped at highest risk. (Wiesel, 2010; Ameh 2011).

2.4 Types of Injury and Fracture Patterns

The musculoskeletal system of a pediatric patient has unique anatomic, biomechanical and physiological characteristics that explain the fracture patterns that they sustain. These features usually manifest in 4 unique injury patterns- plastic deformation, torus (buckle) fractures, greenstick fractures, and physeal fractures. The presence of a growth plate, a point of mechanical weakness, the thick and vascular periosteum coupled with its active osteogenic potential, and the lower density and high porousness inferring upon them the biologic plasticity and increased compliance, are the bases for the fracture patterns typically seen (Wiesel, 2010). Additionally, children's ligaments are often stronger than the bone to which they are attached, making ligamentous injuries relatively rarer than in adults (Davenport, 2009).

2.5 Risk Factors Associated with Orthopaedic Trauma

The wide variety of fracture patterns seen in paediatric patients should not be considered as random events or accidents. They are influenced by several predictable factors, such as age, sex, behavior, geographic location/ environment, and socioeconomic status (Ameh, 2011).

Causes of the problem include the pace of economic and technologic development across the globe that has resulted in increased automobile traffic, and the ongoing presence of armed conflicts around the globe that increasingly involve children as both combatants and innocent victims of intentional trauma (Sharar, 2007).

The puberty years are associated with an increased rate of fractures during adolescence. This has been explained by a discrepancy between height gain and the accrual of bone mineralization (Valerio, 2010).

The links between poverty and childhood injury are complex. Whereas most types of injury are more frequent in children of lower social economic status, evidence confirming or refuting the links is contradictory (Gilbride, 2006; Faelker, 2000).

2.6 Treatment and Outcomes

Generally, children's fractures mandate management goals similar to the adult: reduction; maintenance and avoidance of complications. The tolerances to treatment are much greater and successful results require adequate recognition of the unique qualities of the pediatric skeleton and the special problems that may follow trauma to it (Wiesel, 2010).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study Design

This was a prospective hospital-based cross-sectional study

3.2 Study Site

The study was conducted in the Department of Surgery at UTH Adult hospital. Situated in Lusaka, UTH is the largest hospital in Zambia. It offers both inpatient and out-patient care and is a center for specialist referrals from across the country.

Patients were recruited from casualty (emergency department), surgical transit admission ward, and the admission wards. The out-patient department (OPD) was also utilized as a recruitment site for participants. Relevant data on patient demographics, presenting musculoskeletal injury, complications, aetiology and mechanism of injury were collected through a questionnaire administered data collection tool and from medical records and case reports. Standard appropriate treatment was ascertained with regard to fracture classification following review of the images. Availability and non-availability of the preferred mode of treatment at UTH was indicated with due regard to presence of skills, equipment and orthopaedic implants.

3.3 Target population

Patients aged 0-17 years, presenting to UTH with musculoskeletal injuries following trauma.

3.4 Study population

Patients diagnosed with an orthopaedic injury and satisfying the inclusion criteria.

3.5. Inclusion criteria

The inclusion criteria was as follows:

i. Patients aged 0-17 years (immature skeleton)

ii. Patients presenting with an orthopaedic injury secondary to trauma.

iii. Patients whose parents or legal guardians consent to participation in the study.

iv. Patients assenting to participation in the research, where applicable.

3.6 Exclusion criteria

The following considerations were made:

i. Patients whose radiological images reflect skeletal maturity.

ii. Patients categorized as brought in dead at the hospital.

iii. Patients with incomplete data as per data collection tool requirements**.**

3.7 Sample size

According to Cooper et al (2004), around one-third of all children suffer at least one fracture before the age of 17. With this as the basis for prevalence, the sample size was calculated manually using **N= Z2 x P(1-P)/ (E)2** with level of confidence 1.645, confidence interval 0.05, and 0.3 as the expected prevalence, the sample size calculated was **227**.

3.8 Sampling strategy

A convenient sampling technique was used. Patients meeting the inclusion criteria were identified and a written consent was obtained from the guardian/ parent. Thereafter, information was obtained from the guardian/patient through an interview. Diagnostic images, where applicable, were reviewed for purposes of classification and identification of treatment modalities.

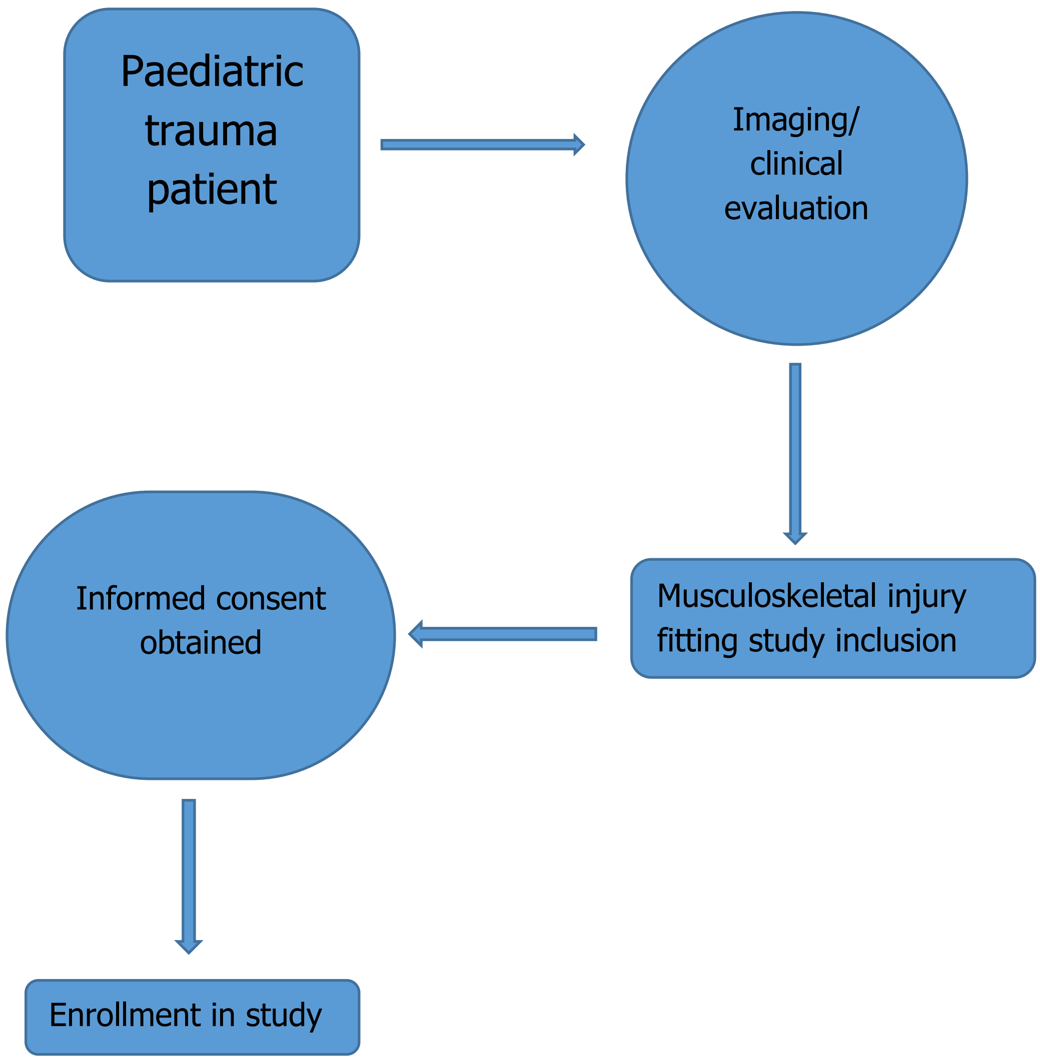
3.9 Procedure

Identification of patients who presented to the department of surgery with history of trauma and were diagnosed with an orthopaedic injury was done through hospital registry records. Enrolment of participants was based on the inclusion and exclusion criteria. The study was explained to the parent/ guardian in detail and in their preferred language after which they were required to sign a written informed consent. Additionally, where appropriate, assent was obtained from the participant.

Data was collected employing a guided questionnaire administered to the parent/ guardian. Consideration was made with the data collection tool as regards language modification to suit the guardian/ participant preferred language. The demographic details were obtained from hospital records and through the questionnaire administered interview. Clinical assessment findings and radiological images were reviewed to ascertain the nature of the injury and determine classification and required standard treatment modalities. Information regarding availability of standard treatment was obtained in liaison with UTH Department of Surgery.

3.10 Flow Chart

Schematic enrolment process in study



3.11 Variables

3.11.1 Dependent variable: mechanism of injury, accident setting, region of body injured, injured bones/ joints, fracture classification, complications, standard treatment and availability.

3.11.2 Independent variables: sex/age of patient, residence, legal guardian, level of education, position in family.

3.12 Data Management

3.12.1 Data entry

Data collected was entered into Excel spreadsheet for analysis which were password protected.

3.12.2 Data analysis

Data analysis was done using SPSS version 16.0 and STATA version 13. The characteristics of the patients were summarized using tables and charts. Quantitative variables were expressed using medians and qualitative variables using proportions. Pearson CHI squared test was used to compare association of the categorical variables.

All analyses were done at 95 % CI and p-value was considered significant if less than 0.05.

3.13 Ethical Considerations

1.13.1. Benefits

Study participants were not remunerated.

1.13.2. Risks

The study did not subject the participants to foreseeable risks or discomfort.

1.13.3. Confidentiality

Data collected was kept confidential and de-identified prior to entry in the database. However it was made clear that the findings of the research would be shared with the public through journal publication.

1.13.4. Voluntarism

The study was conducted in accordance with Good Clinical Practice Guidelines (GCP). Participation was voluntary. Refusal to be a part of the study did not affect the patient's management at UTH and those who consented for their dependents/children to participate in the study were at liberty to withdraw without demand for reasons.

1.13.5. Privacy

Prior to conducting any interview, permission was obtained from each participant. Questions that were deemed personal and those that unsettled the participant did not have to be answered. Seclusion was ensured when administering the data collection tools.

1.13.6. Informed Consent

All eligible patients and guardians/ parents had the study explained to them and written consent was obtained from each one of them. Where appropriate, assent was also obtained.

Permission to conduct the study was obtained from UTH Adult Hospital Management and the Department of Surgery. Ethical approval was granted by ERES Converge IRB office**.**

CHAPTER FOUR
RESULTS

4.1 Enrolment

In this research study, the targeted sample size was 227. However, 252 participants were recruited. From this number, 10 fell off the study due to inadequate demographic information. Hence data analyzed was for 242 children seen at UTH in the department of surgery with an orthopaedic injury during the period December, 2018 to March, 2019. Table 1 below summarizes the demographic characterization of the study participants.

TABLE 1: Frequency table of patient demographic characteristics

DEMOGRAPHICS	**Number**	**%**
Sex		
male	168	69.42
female	74	30.58
Age		
Infant	3.0	1.24
toddler	23	10.33
preschooler	29	11.98
school going	102	42.0
adolescent	85	35.12
Residential area of participant		
Low density residential	7.0	2.89
Medium density residential	31	12.81
High density residential	204	84.30
Participant level of education		
None	59	24.38
preschool	16.0	6.61
Primary	159	65.70
Secondary	8.00	3.31

Relationship with guardian		
Biological parent	213	88.02
Maternal relative	22	9.09
Paternal relative	5.0	2.07
Other	2.0	0.82
Position in family		
First child	81	33.47
Non first child	161	66.63

4.2 Sex distribution of the patients enrolled in the study

The overall ratio of male to female in the group was approximately 2:1. This was based on demographics which revealed that 168 (69.42 %) were male and 74 (30.58 %) were female.

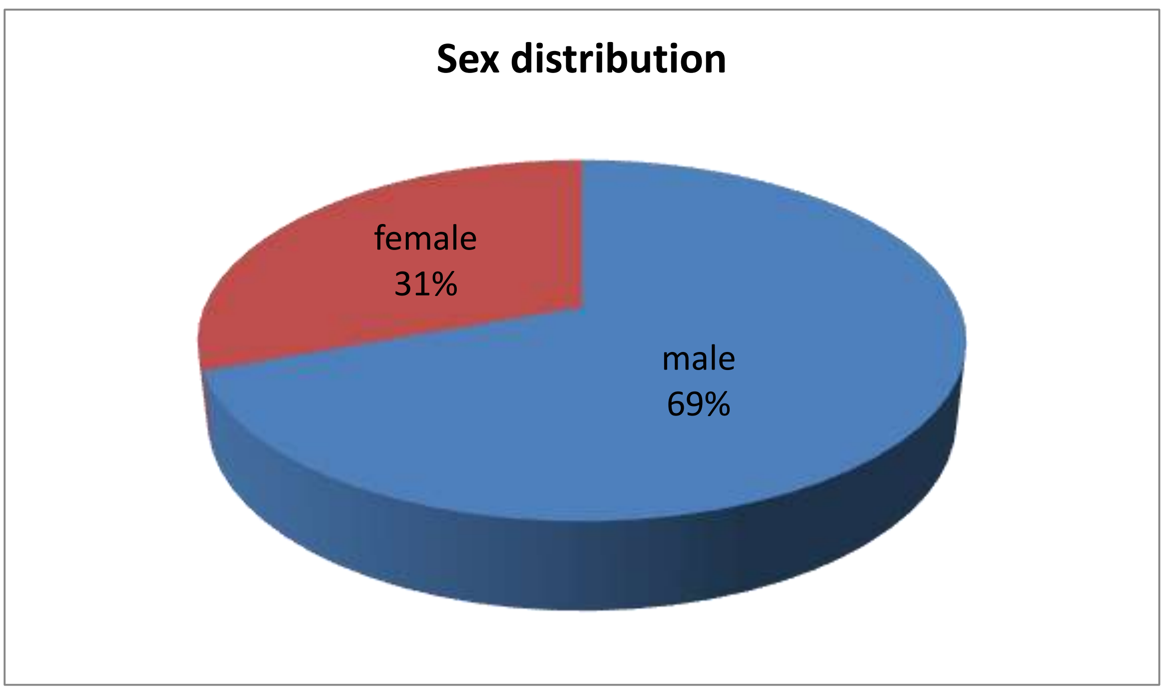


Fig 1: Sex specific orthopaedic injury distribution

4.3 Age distribution of the patients enrolled in the study

In our sample, the highest frequency of fractures occurred at 5-10 years 102 (42.0 %). The lowest frequency of fractures was seen in the 0-3 age group 3 (1.24 %). See age distribution curve in figure 2.

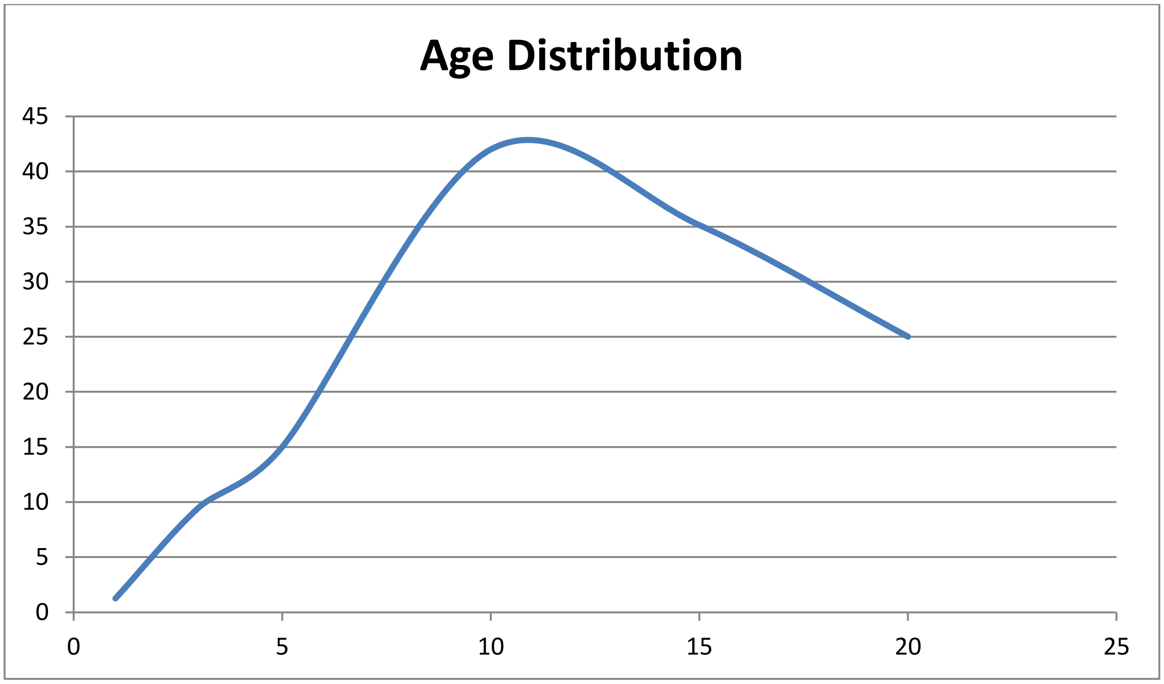


Fig 2: Age distribution of musculoskeletal injuries

4.4 Residence

Of the 242 study participants, 204 (84.30 %) resided in high density residential areas of Lusaka. Status of residence was assigned as per CSO designation. Figure 3 below shows the residence distribution for the participants.

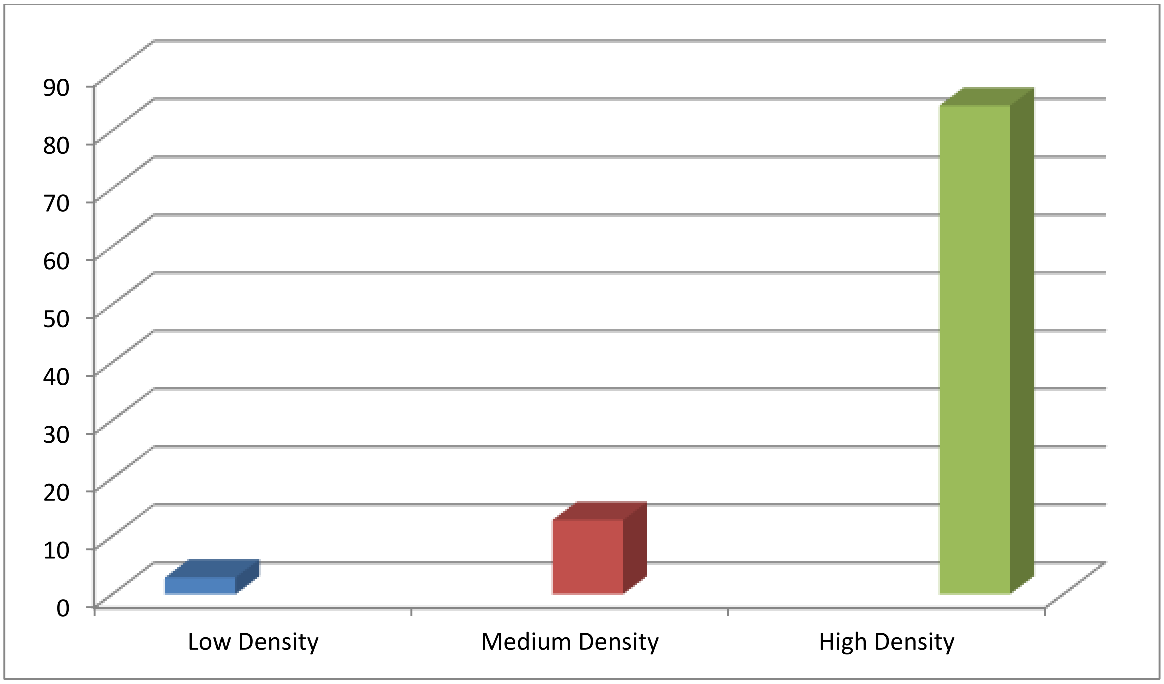


Fig 3: residence of participant

4.5 Family situation

On demographic analysis, 213 (88.02%) of the participants lived with their biological parents. Non first born children accounted for 161 (66.53%) participants in the study (see Fig 4).

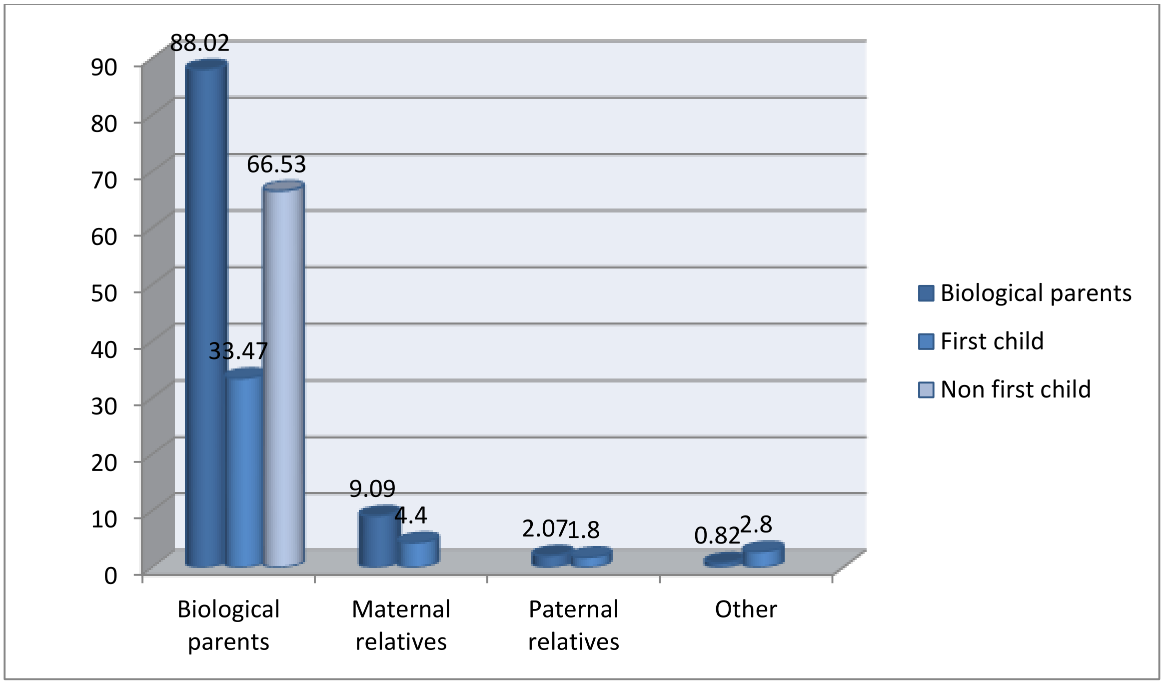


Fig 4: Guardianship and family position

4.6 Level of education

As already illustrated in demographic characterization (**see Table 1**), primary school going children were the majority of participants in this study, representing 159 (65.70 %) of the sample.

4.7 Mechanism of injury

Sport/ play 104 (43 %) accounted for the majority of the injuries followed by fall from tree 61 (25%). RTA s were responsible for 18 (7 %) of the accidents causing injuries. Figure 5 depicts frequency distribution of mechanism of injury.

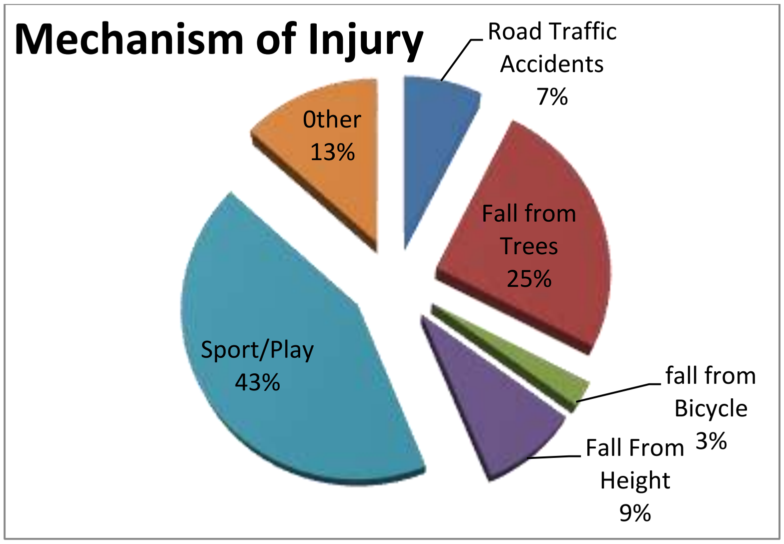


Fig 5: Mechanism of injury

The association (Pearson CHI squared test) between level of education and mechanism of injury was significant (p value 0.044). Figure 6 illustrates the association,

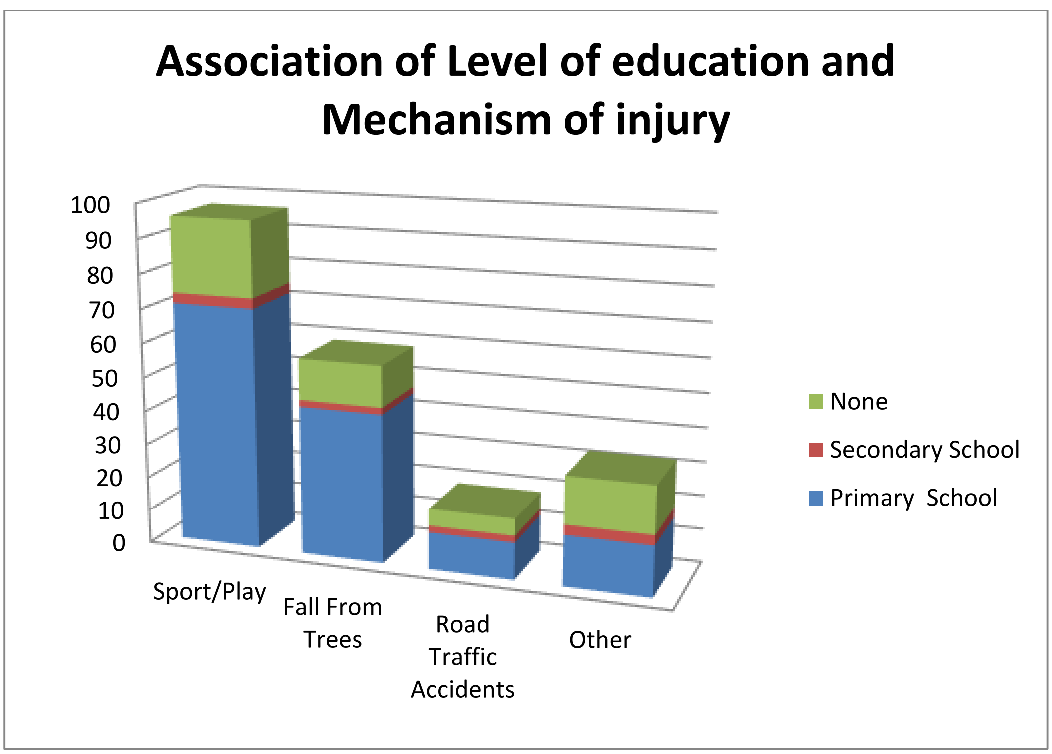


Fig 6: Association of level of education and mechanism of injury

4.8 Accident setting

The home environment was the setting of most of the injury causing accidents 207 (85.54 %). The school environment was responsible for 24 (9.92 %) of all the injuries.

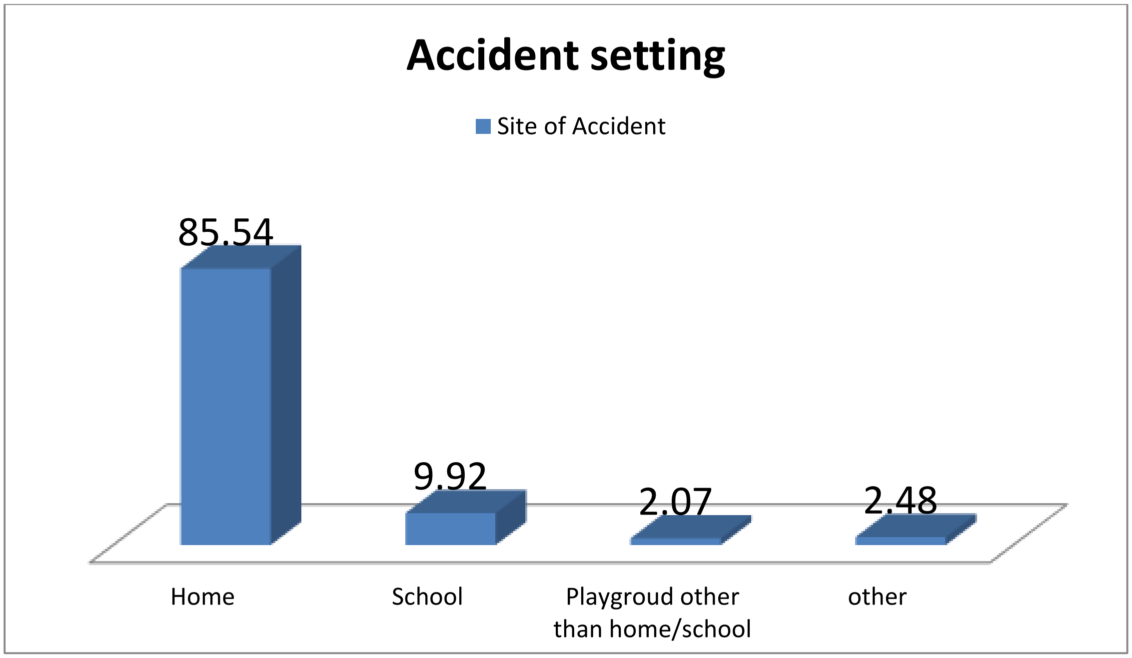


Fig 7: Accident setting

4.9 Region of body involved

The forearm was involved in 101 (41.74 %) of the injuries, with the thigh accounting for 53 (21.90 %). The upper limbs were involved in 155 (64.05 %) of the injuries whereas 87 (35.05%) occurred in the lower limbs. There were no injuries recorded in the axial skeleton. Involvement of more than one body region was recorded in 4 (1.65%) participants.(See table 2)

TABLE 2: Frequency of body region involved

Region	N	%
Shoulder	3	1.24
Arm	15	6.20
Elbow	29	11.98
Forearm	101	41.74
Wrist	6	2.48
Hand	1	0.41
Hip	5	2.07
Thigh	53	21.90
Knee	5	2.07
Leg	22	9.09
Ankle	0	0.00
Foot	2	0.83

4.10 Bones involved

The radius was the most commonly fractured bone 98 (40.49%). In 81 (33.47 %) of the participants, the radius and ulna were fractured in combination. Isolated fractures of the radius and ulna accounted for 7.02 % and 1.24 %, respectively. Isolated femur fracture accounted for 60 (24.90 %) of the injuries with the humerus taking up 36 (14.94 %).

Dislocations were involved in 12 (4.96%) of all the injuries. See table 3 below for distribution of bone involvement.

Table 3: Frequency of bone/joint involvement

Bone	number	%
Clavicle	1	**0.41**
Humerus	36	**14.94**
Radius and ulnar in combination	81	**33.47**
Radius in isolation	17	**7.02**
Ulnar	5	**2.07**
Carpus	1	**0.41**
Phalanges	1	**0.41**
Pelvis	1	**0.41**
Femur	60	**24.90**
Tibia and fibular in combination	7	**2.89**
Tibia in isolation	13	**5.37**
Fibular	4	**1.65**
Metatarsus	2	**0.83**
Dislocation	12	**4.96**
Patella	1	**0.41**

4.11 Fracture classification

Complete fractures accounted for177 (75.64%) of the investigated types of fracture. Greenstick and buckle fractures together accounted for 10% of the fracture patterns. See figure 9 below showing distribution of the different patterns recorded.

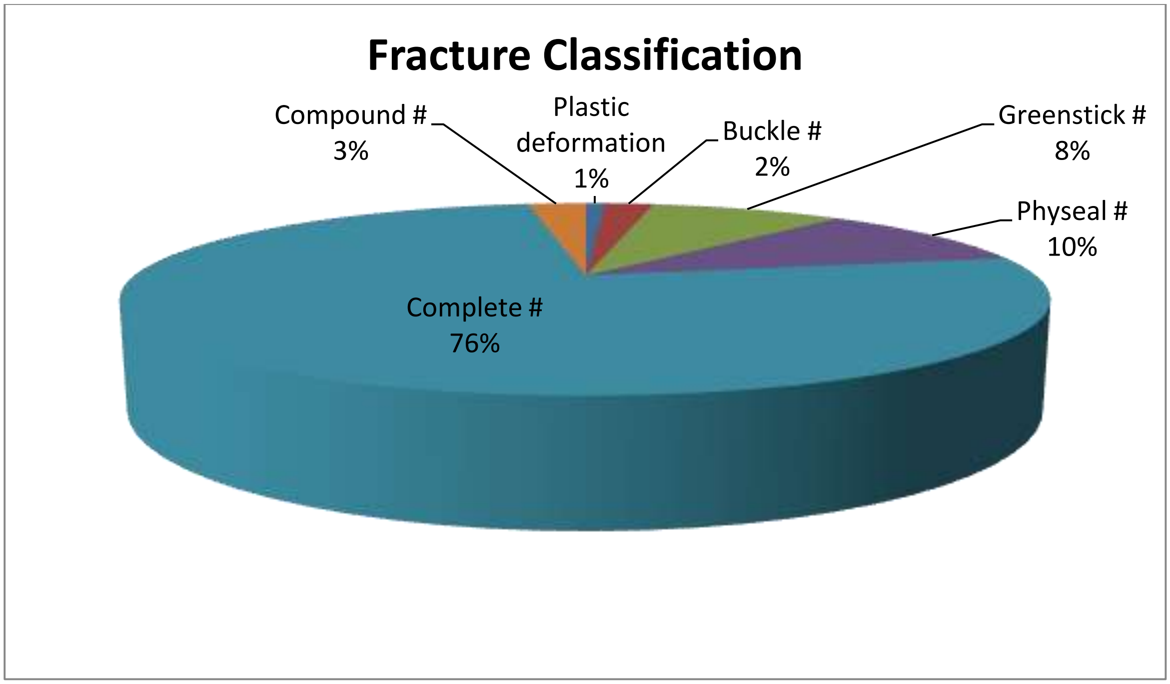


Fig 8: Fracture classification

The classification of the fractures in these children has no significant predictive value on the associated non orthopedic injuries and the complications noted at initial presentation at UTH (p values of 0.896 and 1.000, respectively). On the other hand, the mechanism of injury was noted to have a bearing on the fracture pattern sustained (p value of 0.001). Figure 9 demonstrates this association.

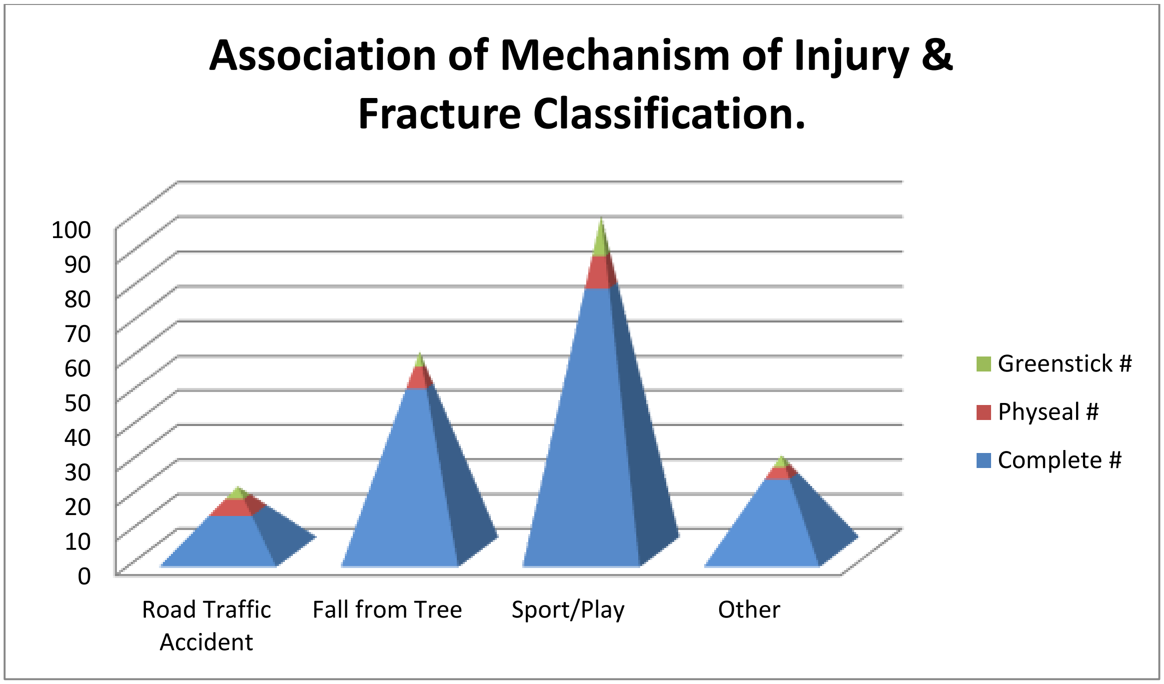


Fig 9 Association of mechanism of injury and classification

4.12 Associated non orthopedic injuries

In 237 (97.93 %) of the participants, there were no associated non orthopedic injuries. Of the 2.07% of the children that presented with associated non orthopedic injuries, all were traumatic brain injury and as a result of road traffic accidents (pedestrians).

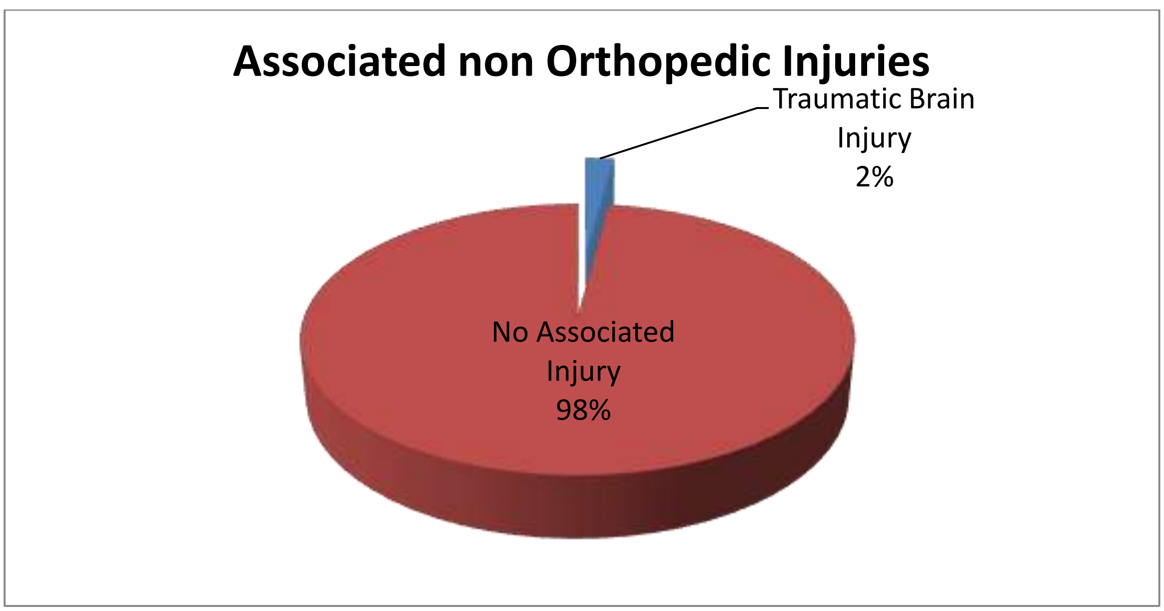


Fig 10 Associated non-orthopaedic injuries

4.13 Complications at presentation

Of the complications that we probed, none were recorded at presentation to UTH in239 (98.76%) of the participants. Figure 11 graphically presents the results.

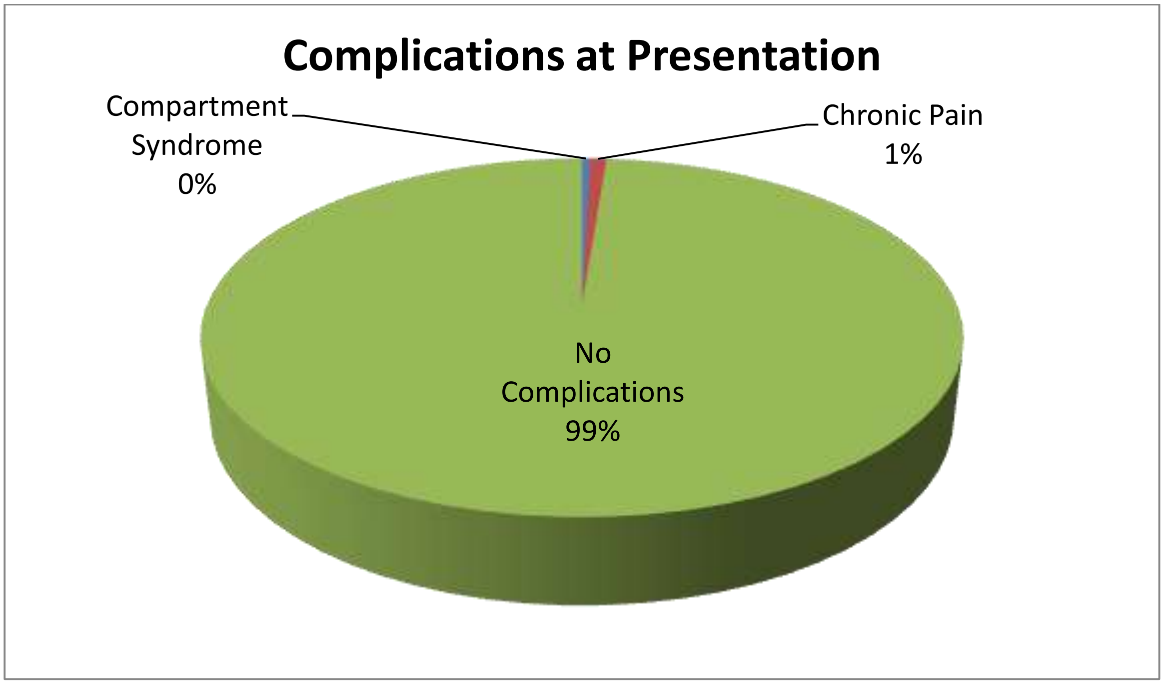


Fig 11 Complications at presentation

4.15 Treat required and availability

Out of the 242 cases analyzed, 98 (40.50%) required operative management compared to 144 (59.50 %) which needed conservation. Table 4 below shows the numbers.

Table 4: Required treatment

Standard treatment	N	%
Operative	98	40.50
Non operative	144	59.50

Standard treatment modalities were not available in 74 (30.58%) cases requiring surgery. In all these instances, the skills set was available. Rather, multiple factors unrelated to human resource were responsible for this finding.

Table 5: Availability of standard surgical treatment

Availability of standard treatment	N	%
Available	168	69.42
Not available	74	30.58

CHAPTER FIVE
DISCUSSION

This study describes the occurrence of orthopaedic injuries in a defined population of children seen at UTH. Analysis was conducted on a larger (242, 18%) sample size than what was projected (227). We were happy to do so with the understanding that the sample size of a study is related to the level of confidence associated with the sample estimates. By overshooting moderately, our results are more reliable and carry greater precision and power to detect differences than what we would have obtained with a smaller sample size. (Faber, 2014).It is worthwhile to note however that it costs more time and money to employ or recruit a large sample.

According to the CSO, the ratio of male –to-female among Zambian children stands at 1: 1. Our study demonstrated that boys suffered more injuries than girls (2:1). These differences in relation to sex are well documented in paediatric trauma. The reason is not clear and could be related to biologic and social factors and more physical factors or higher vulnerability of the male group (Ghaffari, 2010; Udry, 1998)). In our setting, a probable explanation is the cultural tendency in the population, where girls generally spend more time performing house chores than do the boys. A study done by Jennifer Messa (2007) in Lusaka, found that girls spent 30% more hours than boys on household chores. These findings were more applicable to girls with a low socioeconomic background.

For the sake of clarity, we used the UNICEF (2004) definitions to subdivide age into Infant (below 1), toddler (1-3), preschooler (3-5), primary school going (5-10) and adolescent (10-17). The peak incidence of orthopaedic injuries in our study was in the primary school going children. The lowest frequency was seen in the 0-3 years group. The age structure of the Zambian population according to the CSO has the 0-4 age group being the highest among children, followed by 5-9, 10-14 and lastly those aged above 14 years. A steep rise in frequency of injury was noted from infancy to the peak, with a gradual decline into adolescence. We did not observe the increase in fracture rate previously reported during the pubertal years.

This age distribution is to some extent in keeping with what is generally observed in other studies done in different parts of the world. A similar study done in northern Iran found that the lowest incidence of orthopaedic injuries was in the 0-2 years age group whereas the highest incidence was recorded in adolescents aged 14-16 years (Ghaffari, 2018). On the other hand, a Swedish study by Hedstrom and colleagues (2010) found that the peak incidence of fractures occurred in the group aged 11-14 years. Notable differences with our study was that the Iranian study included children aged below 16 years, was conducted over a period of 1 year and had a higher sample size at 525. In the case of the Swedish study, analysed data represented injuries that occurred over an extended period of 4 years (1993-1997).

The differences outlined above confirm the variability in incidence observed in various studies over time and between regions (Erik, 2010). Confounding factors include the size of the paediatric population and its age stratification, the time of the study, social emphasis on encouraging physical activity and non-supervised play. Additionally, the environment, predominant recreational sports activity and generally the social behaviour of children could account for age-related differences seen in paediatric orthopaedic trauma.

The sharp rise in incidence of orthopaedic injuries seen in the 5-10 years age group can be attributed to the enthusiasm characteristically seen in children as they discover and experience new surroundings with little or no experience of the repercussions. The reducing incidence rate into adolescence is attributed to the increased time spent in sedentary behaviours compared to pre-school and primary school children. This is compounded by the lack of sports facilities in schools. The relatively short duration of our study coupled with the fact that most of the participants were in the pre-pubertal stage could skew our findings.

The home environment was the setting for the majority of the accidents. This finding corresponds with what Valerio and his colleagues (2010) found in a study conducted in Southern Italy where the home environment was reported as the accident setting for the majority of the injuries that were analyzed. As discussed later, the reason could be attributed to the fact that more time is spent in the home environment. Our study found that the predominant mechanism of injury in this environment was play/sport. Zambian parenting widely encourages play, either independently or with friends. It is considered a key way through which children learn and a means of fostering curiosity and creativity. During these activities, which include games and sports in the home environment, older siblings are the ones who care for the younger (non-first born) children (UNICEF, 2016). There is thus less adult supervision during physical play with resultant high rate of injuries. A significantly lower rate of injury occurred in the school environment. Teacher supervision of play and probably less time at sports activities as a consequence of lack of sports facilities could be the reason why the frequency of injury is less in this environment.

The majority of the victims of injury in our study were primary school going children. Data from CSO indicates that 80.3 % of eligible children (7-13 years) attend primary school whereas 40.3 (14-18 years) attend secondary school. This class of children is the highest grouping at risk of injury in the general population taking into consideration the fact that infants and toddlers have more parental care and supervised play with less susceptibility to injury.

Non-first born children experienced more trauma in comparison to the first. The injury related activities included fall from trees and road traffic accidents in addition to play/ sport. As explained above, the phenomenon of sibling care in our setting is pronounced. By extrapolation, responsibility and self-care are assumed much earlier in first born children thereby explaining the lower rate of injury frequency in this group. The level of parental care could also be higher among first born children, especially when they are the only child. However, due to a limitation in our study design, we could not measure this variable.

The majority of the participants in our study resided in the densely populated neighbourhoods of Lusaka. It will be useful to note that these areas are highly associated with citizens who are recognized to belong to the lower end of the socioeconomic spectrum. In a 2010 study done in Zambia, Phiri and his colleagues found that the rich have higher visits to public hospitals like UTH than people with a low socioeconomic background. According to Faelker and colleagues (2010), there is evidence of a consistent relation between poverty and injury. Other authors have contradictory evidence (Valerio et al, 2010). Speculation about the mechanisms underlying our findings is multifactorial. The risks associated with injury in these areas are significantly higher. There is high motor vehicle traffic against fewer safe playgrounds. Application of safety measures at play is relatively less. These and other factors may add to the stresses of parenting and reduce the knowledge and experience needed to provide a safe environment for the child.

Therefore it is not surprising that children from the densely populated areas of Lusaka are at a higher risk of sustaining a fracture.

Fractures accounted for the majority of orthopaedic injuries followed by dislocations. Greenstick and torus fractures are acknowledged as the commonest types of fractures in children, accounting for 50% of all fractures (Lovell, 2006) with growth plate and complete fractures taking up the rest. Our findings were contrary as complete fractures predominated. This picture coupled with the fact that most of the victims had a low socioeconomic background could be attributed to an acquired susceptibility of the immature skeleton to fracture in this group. A study looking at quality of bone in relation to nutrition and comparing prevalence of orthopaedic injuries in populations with different socioeconomic standings would provide more information.

As already observed above, most injuries occurred during sport/ play. Falls, with the exclusion of those occurring during play, were the second most common cause of injury followed by RTAs. It is also prudent to note that this study was conducted at a time when the perennial wild mango fruit which is common in Zambia was in season. The high rate of fall from tree is attributed to children plucking the fruit. This fact may possibly contribute to seasonal variation in the mechanism of injury in the Zambian setting. Literature reports that RTAs affect adolescents more than any other age group. We found that primary school children are in the majority of those affected as pedestrians. Unsupervised crossing of roads, lack of walk ways, and rampant abrogation of traffic rules by motor vehicle road users are the factors implicated in injury causation on the roads.

The low frequency of complications at presentation could signify effective institution of first aid in the community, good health seeking behaviors by parents/guardians following trauma and timely referrals by primary care facilities. As already alluded to, definitive surgical fixation of the fractures was in some instances not possible because of various challenges which included equipment and implant availability. These challenges were not related to skills set and human resource limitations.

As regards associations, there was no significant link between sex and age (p value 0.254). Similarly, sex and mechanism of injury did not show significant association (p value of 0.186). These findings are in agreement with previous reports (Ghaffari, 2010) and demonstrate that musculoskeletal injuries in children are distributed equally among the two genders in the different age groups and that sex does not increase or decrease the likelihood of a musculoskeletal injury in children of a similar age range.

Our findings revealed a strong association between area of residence and fracture pattern with the complete type being significantly common in participants coming from high density areas (p value 0.002). As already stated, greenstick and buckle fractures are expected to be the commonest fracture type in children. Nutritional factors could be at play in this association and more research is required in our setting to gain better understanding. The association between the residential area a child came from and the mechanism of injury was found to be insignificant (p value of 0.193).

There was no significant association between the site of the accident and any other variable under study. The implication of this finding is that the home was just the commonest environment in which the child spends its time and interacts with environmental factors that potentially may cause musculoskeletal injury. It had no bearing on any demographic predisposition of musculoskeletal injury. In as much as the frequency of injury was high in non-first born children, there was no significant association between guardianship and mechanism of injury (p value 0.297) as well as family position of child among siblings and mechanism of injury (p value 0.297).This data suggests a very weak association between musculoskeletal injuries in children and the battered child syndrome. We emphasize, though that more research would need to be done to conclude with absolute certainty that non-accidental trauma is linked to orthopaedic injuries in children in our setting.

Associative analysis revealed significant predictive value (p value 0.000) between mechanism of injury and body region affected. Fall related mechanisms in more instances, lead to upper limb injuries as a result of outstretching the arm to break the fall in a conscious victim. This association is in line with and could explain the high frequency of fracture observed for the radius. Pedestrian cases of RTA will on the other hand more likely cause injury to the lower limbs and trunk because of the direct nature of energy transmission in relation to proximity of body part.

Further, the mechanism of injury is significantly related to associated non-orthopaedic injuries (p value 0.000). The high energy associated with RTAs and fall from height mean that beyond what the immature skeleton can absorb, the excess energy is dissipated to other organs like the brain and intra-abdominal organs. Mechanism of injury has no significant bearing on the associated complications when a child presents to UTH (p value 0.054).

The validity of our findings is dependent on the accuracy of information that was given to us by the parents/ guardians and the patients in some instances. Other limitations included the relatively short period over which the study was conducted. A protracted period has the advantage of maligning seasonal variations in a population. It was not possible to ascertain whether fall was involved in injuries occurring during play/sport as accurate information would require actual observation of the injury occurrence. The study needed more data to define socioeconomic status more comprehensively. This is an area that could be addressed better in follow-up studies.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Our study found that fractures are encountered more than any other type of orthopaedic injury in children seen at UTH. The forearm and thigh are the body regions which are injured the most with the radius and femur fractured more often than any other bone. The complete fracture pattern supersedes compound, physeal, greenstick and torus injuries. A combination of male gender, low socioeconomic background, 5-10 years of age bracket and physical play/ sport are factors highly associated with increased fracture frequency. Surgery is not readily available for definive management of these injuries as conservative management is adopted in most cases.

Associated non-orthopaedic injuries are rarely encountered as most of the injuries seen in children at UTH are low energy related trauma cases. RTAs however are a risk factor for associated injuries. Complications as a direct consequence of orthopaedic injury are rare at presentation.

6.2 Recommendations

The findings of our study have implications for setting priorities aimed at ensuring good outcome of childhood injury care and prevention. The following submissions are made:

i. Hospitals and Ministry of Health

- Hospital preparedness should primarily focus on care for upper limb injuries in primary school going children.
- Anticipation should be of radius, femur and humerus fractures with a complete fracture pattern.
- Ensure availability of equipment and consumables required for non-operative management of various types of fracture.
- Hospital provisioning should cater for adequately equipped operating theatres availability of orthopaedic implants for the optimal care of injuries requiring surgery.

- Digitalisation of capturing and storing data to facilitate ease of conducting wide ranging research.

ii. Traffic Police, Road Safety Agency, Ministry of Education and Ministry of Health

- Involve parenting in development of injury prevention modalities with emphasis on supervision of play and safety of playground.
- Pedestrian use of roads by children should be with the accompaniment of an adult.
- Engage school teachers in spreading injury prevention messages targeting all school going children, especially primary school children.
- Engage regulators of road transport so that roads are made safe for all children who are pedestrians and passengers likewise.

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APPENDICES

Appendix I: Participant Information Sheet

Participant Information Sheet in a Research Study atUniversity Teaching Hospital (UTH) Lusaka

Title of Study:	**CHARACTERIZATION OF MUSCULOSKELETAL INJURIES IN CHILDREN SEEN AT UTH**				
Principle Investigator:					
Name:	**Dr James Nyimbili**	**Dept.:**	Surgery	**Phone:**	0971232819

Introduction

- We are asking for your child's participation in a research study of injury patterns in children seen at UTH.

- Your child was selected as a possible participant because he/ she has sustained an injury to the musculoskeletal system as a result of trauma and he/she is in the age group 0-17 years.

- We ask that you read this form and ask any questions that you may have before granting consent for the child's participation in the study.

Purpose of Study

- The purpose of the study is to understand the various patterns of injury occasioned by trauma in children seen at UTH.

- Ultimately, this research will be published and presented as a paper.

Description of the Study Procedures

- If you agree to your child's participation in this study, you will be asked to do the following things:
    - Sign the consent form.
    - Respond to questions as laid down in the attached data collection tool. The questionnaire takes about 5 minutes to administer.
    - Allow us to review of the patient's medical records/ diagnostic images.

Risks/Discomforts of Being in this Study

The study does not subject the participant to foreseeable risks.

Benefits of Being in the Study

The benefits of participation are that the child's injuries will be subjected to second opinion following the initial assessment. This may bring about injuries that may have been missed initially which will then be communicated to the attending surgeons and managed accordingly.

Confidentiality

- This study is anonymous. We will not be collecting or retaining any information about your identity.

- The records of this study will be kept strictly confidential. Research records will be kept in a locked file, and all electronic information will be coded and secured using a password protected file.

- We will not include any information in any report we may publish that would make it possible to identify the participant.

Payments

- There will be no payment for participation in this study.

Right to Refuse or Withdraw

- The decision for your child's participation in this study is entirely up to you. You may refuse to have your child take part in the study *at any time* without affecting your relationship with the investigators of this study or UTH. Your decision will not result in any loss or benefits to which you are otherwise entitled. Youhave the right not to answer any single question, as well as to withdraw completely from the interview at any point during the process; additionally, you have the right to request that the interviewer not use any of your interview material.

Right to Ask Questions and Report Concerns

You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have any further questions about the study, at any time feel free to contact me, Dr James Nyimbili at jnyimbili@yahoo.com or by telephone at 0971232819. If you like, a summary of the results of the study will be sent to you.If you have any other concerns about your rights as a research participant that have not been answered by the investigators, you may contact then you should contact **ERES Converge IRB office** at the following physical address: 33 Joseph Mwilwa Road, Rhodes Park, Lusaka, Zambia. You can also email to eresconverge@yahoo.co.uk or phoning the office on +260 955 155633/+260 955 155634

Appendix II: Assent Form

Title of Study:	CHARACTERIZATION OF MUSCULOSKELETAL INJURIES IN CHILDREN SEEN AT UTH				
Investigator:					
Name:	Dr James Nyimbili	Dept.:	Surgery	Phone:	0971232819

- We are doing a research study about the various injury types sustained by children and occasioned by trauma. If you decide that you want to be part of this study, we will ask you to give us details about yourself as well as a description of how you sustained your injuries. We may also want to examine you and review your medical records.

- You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too. Your parents know about the study too.

- When we are finished with this study, we will write a report about what was learned. This report will not include your name or indicate that you were in the study.

- If you decide you want to be in this study, please sign your name.

I, ________________________________, want to be a participant in this research study.

__________________________________ ______

(Sign your name here) (Date)

Appendix III: Consent Form

<u>Consent to Participate in a Research Study atUniversity Teaching Hospital (UTH) Lusaka</u>

Title of Study:	**CHARACTERIZATION OF MUSCULOSKELETAL INJURIES IN CHILDREN SEEN AT UTH**				
Investigators:					
Name:	**Dr James Nyimbili**	**Dept.:**	Surgery	**Phone:**	0971232819

Consent

- Your signature below indicates that you have decided to volunteer as a research participant for this study, and that you have read and understood the information provided above. You will be given a signed and dated copy of this form to keep, along with any other printed materials deemed necessary by the study investigators.

Participant's name (print):			
Participant's parent/ Legal guardian's signature/ thumb print:		Date:	
Investigator's Signature:		Date:	

Appendix IV: Data collection sheet.

Data Collection Form

This is a data collection form. The information collected in this form is intended to be used for purposes of research- Characterization of Musculoskeletal Injuries in Children seen at the University Teaching Hospital, UTH in Lusaka. *If you would like to include additional information on any field collected on this form, please use the Notes section at the end of the form.*

Questionnaire number: ______________

Name of person administering tool: ____

<table>
<tr><th colspan="6">Section 1: Patient Demographics</th></tr>
<tr><td>1.0 Age (completed years):</td><td>2.0 Sex:
1. Female 2. male</td><td colspan="2">3.0 Position in family (among living siblings):</td><td colspan="2">4.0 Home residence (indicate place) :
………………………..
1. low density
2. medium density
3. high density</td></tr>
<tr><td rowspan="2">5.0 Relationship with guardian: check one box:
1. biological parent
2. maternal relative
3. paternal relative
4. other</td><td rowspan="2">6.0 Education level – check one box:</td><td>1. pre school</td><td colspan="2">2. primary school</td><td>3. secondary school</td></tr>
<tr><td>4. college</td><td colspan="2">5. Nil</td><td></td></tr>
<tr><th colspan="6">Section 2: Aetiology of injury</th></tr>
</table>

7.0 Mechanism:

1. □ Motor Vehicle Accident (pedestrian)   2. □ Motor Vehicle Accident (passenger)

3. □ Motor Vehicle Accident (driver)   4. □ Motor Vehicle Accident (cyclists)

4. □ Fall from tree   5. □ Fall off bicycle

6. □ Fall from height (specify)   7. □ Assault/violence

8. □ Sport/play   8. □ Other (specify)

7.8 Environment (site of accident):

1.□ home   **2.** □ School   **3.** □ Playground other than school   **4.** □ Other (specify) ………………………..

Section 3: Location of musculoskeletal injury I		
9.0 Region of body injured– check *applicable* boxes:		
1. Shoulder	2. Arm	3. Elbow

4. Forearm	5. Wrist	6. Hand
7. Hip	8. Thigh	9. Knee
10. Leg 13. Spine	11. Ankle 14. Pelvis	12. Foot
Section 3: Location of musculoskeletal injury II		
9.0 Region of body injured– check *applicable* boxes:		
1. Shoulder	2. Arm	3. Elbow
4. Forearm	5. Wrist	6. Hand
7. Hip	8. Thigh	9. Knee
10. Leg 13. Spine	11. Ankle 14. Pelvis	12. Foot
Section 3: Location of musculoskeletal injury III		

9.0 Region of body injured– check *applicable* boxes:		
1. Shoulder	2. Arm	3. Elbow
4. Forearm	5. Wrist	6. Hand
7. Hip	8. Thigh	9. Knee
10. Leg 13. Spine	11. Ankle 14. Pelvis	12. Foot
Section 3: Location of musculoskeletal injury IV		
9.0 Region of body injured– check *applicable* boxes:		
1. Shoulder	2. Arm	3. Elbow
4. Forearm	5. Wrist	6. Hand
7. Hip	8. Thigh	9. Knee
10. Leg 13. Spine	11. Ankle 14. Pelvis	12. Foot

11.0 Fractured bone/ soft tissue injury I – check applicable boxes:		
1. No fracture	2. Scapula	3.Humerus
4. Radius 7. Metacarpals 10. Femur 13. Tarsus 16. Clavicle 19. Muscle	5. Ulna 8. Hand phalanges 11. Tibia 14. Metatarsus 17. Tendon 20. Dislocation	6. Carpus 9. Pelvis 12. Fibula 15. Foot Phalanges 18. Ligament 21. Spinal column
11.0 Fractured bone/ soft tissue injury II – check applicable boxes:		
1. No fracture	2. Scapula	3.Humerus
4. Radius	5. Ulna	6. Carpus

7. Metacarpals	8. Hand phalanges	9. Pelvis
10. Femur	11. Tibia	12. Fibula
13. Tarsus	14. Metatarsus	15. Foot Phalanges
16. Clavicle	17. Tendon	18. Ligament
19. Muscle	20. Dislocation	21. Spinal column
11.0 Fractured bone/ soft tissue injury III– check applicable boxes:		
1. No fracture	2. Scapula	3.Humerus
4. Radius	5. Ulna	6. Carpus
7. Metacarpals	8. Hand phalanges	9. Pelvis
10. Femur	11. Tibia	12. Fibula
13. Tarsus	14. Metatarsus	15. Foot Phalanges
16. Clavicle	17. Tendon	18. Ligament
19. Muscle	20. Dislocation	21. Spinal column

11. Fractured bone/ soft tissue injury IV– check applicable boxes:		
1. No fracture	2. Scapula	3. Humerus
4. Radius 7. Metacarpals 10. Femur 13. Tarsus 16. Clavicle 19. Muscle	5. Ulna 8. Hand phalanges 11. Tibia 14. Metatarsus 17. Tendon 20. Dislocation	6. Carpus 9. Pelvis 12. Fibula 15. Foot Phalanges 18. Ligament 21. Spinal column
11. Fractured bone/ soft tissue injury V – check applicable boxes:		
1. No fracture	2. Scapula	3.Humerus

4. Radius	5. Ulna	6. Carpus
7. Metacarpals	8. Hand phalanges	9. Pelvis
10. Femur	11. Tibia	12. Fibula
13. Tarsus	14. Metatarsus	15. Foot Phalanges
16. Clavicle	17. Tendon	18. Ligament
19. Muscle	20. Dislocation	21. Spinal column

13.0 Fracture Classification I-check applicable boxes

1.Plastic deformation 2.Buckle Fracture 3. Greenstick Fracture

4.Physeal5.Complete 6. Compound

13.0 Fracture Classification II-check applicable boxes

1.Plastic deformation 2.Buckle Fracture 3. Greenstick Fracture

4.Physeal5.Complete 6. Compound

13.0 Fracture Classification III-check applicable boxes

1.Plastic deformation 2.Buckle Fracture 3. Greenstick Fracture

4.Physeal5.Complete 6. Compound

13.0 Fracture Classification IV-check applicable boxes

1.Plastic deformation 2.Buckle Fracture 3. Greenstick Fracture

4.Physeal5.Complete 6. Compound
14.0 Associated non-orthopedic injuries – Please state: • **Traumatic Brain Injury** • **Chest Injury** • **Abdominal injury** • **Genitourinary injury**
Section 4: Complications at Presentation
1.Vascular injury requiring repair2. Nerve injury 3.Compartment syndrome 4. Hypovolemic shock 5. Volkmann's ischemic contracture 6. Chronic pain
Section 5: Definitive Treatment type
16.0 Required treatment – check *one* box:

1. Operative	2. Non-operative	

17.0 Availability at UTH: 1.Available2. Not Available
18.0 Section 7: Notes
7.1 Add any notes pertaining to the fields above – attach additional sheets if needed: