PATTERN OF ADULT APPENDICULAR SKELETON FRACTURES AT A TEACHING AND REFERRAL HOSPITAL.

DR. WAITHIRU PERIS NDUTA

M.B.CH.B. (U.O.N)

A dissertation submitted in part fulfillment for the award of master of medicine in orthopaedic surgery of the University of Nairobi

2015

DECLARATION

Student's declaration

I hereby declare that this study is my original work and has not been presented for a degree in any other university.

Dr. Waithiru Peris Nduta

H58/64128/2010

Signature___________________________ Date _______________________________

Supervisor's declaration

I hereby declare that this research proposal is being submitted with my approval as a university supervisor.

1. **Dr. Edward Gakuya Muthike, MBCHB (Nbi), MMed (Surg).**

   Lecturer

   Department of Orthopaedic Surgery,

   University of Nairobi

   Sign____

   Date --

I hereby declare that this proposal is being submitted with my approval as university supervisor.

2. **Dr. Oburu Ezekiel, MBCHB (Nbi), MMed (Surg), MRCSEd FRCSEd (Tr & Orth).**

   Lecturer

   Department of Orthopaedic Surgery,

   University of Nairobi

   Sign ____

   Date ---

ACKNOWLEDGEMENT

I wish to express my profound gratitude to my supervisor's Dr Edward Gakuya Muthike and Dr Ezekiel Oburu for their guidance, patience and valuable support during this study.

Sincere gratitude to the Department of Orthopaedic and KNH Ethics committee for allowing me to carry out this research.

I would also like to thank my family, colleagues and friends for their help during the study.

Finally, my heartfelt appreciation to all the patients who volunteered to take part in this study, without whom this study would not have been possible.

ABBREVIATION

KNH	**Kenyatta National Hospital**
RTA	**Road traffic accident**
MST	**Musculoskeletal trauma**
GNP	**Gross National Product**
RTI	**Road Traffic Injuries**
LMIC	**Low and Middle income countries**
HIC	**High income countries**
SES	**Social economic status**
OM	**Osteomyelitis**
COM	**Chronic osteomyelitis**
DALYs	**Disability adjusted life year (1 DALY = loss of 1 year of healthy life)**
AO/OTA	(Arbeitsgemeinschaftfu¨rOsteosynthesefragen/ Orthopaedic Trauma Association

DEFINITIONS

Fractures are defined as a complete or incomplete breach of bone cortex.

Long bone fracture complexity assessment classified according to Mu¨ller and OTA.[1]

Open fractures are scored according to the modified Gustillo–Anderson (GA) classification [2]

Appendicular skeleton: includes the humerus, scapula, clavicle, radius, ulnar, the hand (upper limb), femur, tibia, fibular, patella and feet (lower limb)

Intentional/ deliberate injuries include:

Interpersonal: assault, homicide

Self-harm; abuse of drugs or alcohol, self- mutilation, suicide

Legal intervention: action by police

War, civil insurrection and disturbances: demonstrations and riots

Unintentional / accidental injuries include:

Traffic accidents

Falls

Sports injuries

Occupational injuries

Table of Contents

LIST OF TABLES

CHAPTER 1

CHAPTER 3

LIST OF FIGURES

CHAPTER 3

ABSTRACT

BACKGROUND: Trauma is a public health burden resulting in increased morbidity, mortality and disability for the survivors. Musculoskeletal trauma results in dramatic, distracting and life threatening injuries. No study on distribution of appendicular skeleton fractures and severity exists in Kenya. This will permit policy on appendicular skeleton fracture treatment.

OBJECTIVE: The study aims to determine the fracture prevalence of the appendicular skeleton, describing the fracture pattern, severity and common mechanism of injury.

STUDY DESIGN: Cross-sectional study

SETTING : Kenyatta National Hospital: Accident and Emergency department, Intensive Care Unit (ICU) and the orthopaedic wards.

METHODOLOGY: The sample size population was of 385 patients. All patients seen over the period of three months were registered, listed and assigned consecutive numbers. Those who met the inclusion criteria underwent modified systematic random sampling, and were then recruited and consented. Data obtained was stratified and analysed on mechanism of injury, anatomic site involvement and fracture classified based on the AO/OTA classification system. Categorical data is presented in tables, graphs and charts. Chi-square test for proportion was used.

RESULTS: 385 patients seen had sustained 480 fractures. Male 80% and female 20%, with median age of 32 years (24-43years). Majority are isolated 79% and closed (79%) following road traffic accidents (63%) as mechanism of injury. Lower limb fractures (66.7%) were predominant and upper limb (33.3%).

CONCLUSION: Road traffic accident is the common cause of lower limbs and pedestrians sustained more fractures. The tibia/fibula is commonly affected in regional distribution.

CHAPTER 1: BACKGROUND

1.1. INTRODUCTION

Worldwide trauma is considered a public health burden as it results to increase in morbidity, mortality and disability. This translates to increase in health care expenses and reduced productivity due to suboptimal functional outcome. Statistics show young adults are commonly involved, leading to their dependants experiencing untold suffering.

Young males are commonly more involved. Incidences vary with the mechanism of injury. Road traffic accidents are reported to be the main cause of injury. These has been largely attributed to by rapid motorization and advanced industrialization.

Musculoskeletal trauma principally includes injuries occurring to the neck, spine, pelvis, and extremities. They include fractures, dislocations, sprains and strains, contusions, crush injuries, joint injuries, soft tissue trauma, open wounds, and traumatic amputations. The causes of musculoskeletal injuries are sports injuries, playground accidents, motor vehicle crashes, falls, assault, war injuries, stress injuries, over-exertion, and occupational or workplace injuries.

Musculoskeletal trauma injuries attributes to 85% of patients sustaining blunt trauma(3). They can be dramatic, distracting and even life threatening injuries. For example, catastrophic haemorrhage following pelvic fractures and limb injuries can be immediately life threatening. Fractures have three main mechanisms; result from injury, repetitive stress or following an abnormal weakening of bone.

With the projected rise in burden of injury, there is lack of reliable local and international statistics on injury levels and injury control efforts being well below the internationally directed levels, it is important to highlight enormity this neglected health problem, in the developing countries and argue for policy response.

This study aims to avail statistics of fracture injuries as seen at a referral hospital. It aims to identify the common mechanism of injury, anatomical site involved and severity of injury's. With the data collected, urge for policy change to decrease fracture injury by addressing the common mode of injury; redirect resource allocation in the orthopaedic department to facilitate timely adequate effective treatment for the patients, as well as form a platform for further research with regard to trauma resulting in fracture(s).

1.2 LITERATURE REVIEW

Global burden of disease in 1990 estimated 50.5 million deaths occurred annually worldwide. Of these, 5.1 million people died following injury(4). World-wide, 1.2 million people die in road crashes annually and 20 to 50 million more survive with injuries. For every death from trauma, three victims suffer permanent disability(5).

By 2020, WHO projects 8.4 million people will die annually following injury .Road traffic accidents being third to ischemic heart disease and unipolar major depression as the commonest causes of mortality and morbidity world-wide. Fifth in the developed countries for mortality and second in the developing countries(4,6,7,8).

Low and Middle income countries account for 85% of deaths and 90% of (disability-adjusted life-years) DALYs lost annually (7). The major unintentional injury-related causes of DALY's lost annually include road traffic injuries and falls(6). The worldwide burden of injuries is disproportionately concentrated in the low and middle- income countries with unintentional injuries accounting for over 9% total DALY's, often occurring in countries with the weakest evidence to guide intervention strategies, the fewest resources and least developed infrastructure to effect change(9-11). WHO(World Health Organization) 2004 region estimates Africa DALY's 2743 per 100,000(10).

Annually, the average number of injuries resulting in restriction of activities is 30.6 million. 13.4 million of these are severe enough to require bed rest. This translates into 1.54 million acute hospitalizations for an average duration of 7.1 days and about 45000 deaths over one year period(12, 13).The overall fracture incidence in the Scottish population over 12 years, is 11.13 in 1000 per year(14). In the USA 15.3 million fractures occurring annually. Fractures account for 53% of all hospital discharges in the United States(15).These figures are less than those recorded in Norway and England(16). Among the Scottish population above 65 years of age, the fracture incidence is 23.3 per 1000 per year, which compares to results from England and Australia (17, 18).

In a review on adult fractures by Charles and Ben , there was a wide variation in England and Wales fracture incidence for reasons not fully understood. There is also over diagnosis of fracture by inexperienced doctors who cover the Accident and Emergency department and an underestimate from the orthopaedic clinic as most fracture patients referred for follow up, default. The data having been from a single hospital could explain the skewed results (19).

1. 2.1 MECHANISM OF INJURY

Worldwide, 10–15 million citizens are injured every year in RTAs and majority of fatalities occurred in low and middle-income countries (7). In the year 2000, 1.26 million people died in road traffic accidents (RTAs) in the world (6) In many developed countries, RTAs account for a significant cause of trauma and death (8) It is forecasted that in 2020, RTAs will account for almost 23 million deaths and will be the third top cause of mortality and morbidity globally (8)

Charles et al postulated that fracture epidemiology is changing quickly due to improved social economic status and increased life span. The increased aged population results in increased number of fractures in men and women being attributed to osteoporosis (19) McNulty, based on the William and Hamann-Todd osteological collection, compared if aspects of modern life population predispose to different fracture patterns of trauma to the earlier population, as well as patterns and distribution (20). They marched mechanism of injury to anatomic fracture segment as shown in the table below;

Table 1.1: Mechanism of injury marched to anatomic segment

MECHANISM OF INJURY	**ANATOMIC FRACTURE SEGMENT**
Fall from straight height	Upper limb more than lower limb. Distal radius, proximal fracture femur with the later common in advanced age or osteoporosis
Fall from height >6 feet	Feet, ankle, forearms, pelvis and spine
Fall down flight of stairs/ slope	In the young, ankle and distal radius in older age
RTA's ; either occupant, pedestrian, motor cyclist or cyclist	Hand , foot, clavicle, humerus diaphysis, tibial plateau and spine Occupant : femur, tibia, pelvis, spine Pedestrian : lower limb, pelvis, spine Motor cyclist: upperlimb, pelvis and spine Cyclist : upperlimb
Sport	Upperlimb
Stress / fatigue	Common in older people; ankle
Direct blow/ assault/ ballistic	Lowerlimbs, hands, arms

William and Hamann-Todd (20) mechanism of injury vs anatomic segment

Accidental falls account for the highest injury and fracture rates in studies (21-27). MCnulty however described fractures by falls to be common in the cranium, torso and pelvis (20). Pelvic fractures occurred following deceleration injuries, where forces are transmitted via the legs and pelvis on impact and indicate a fall from a height greater than that of a standing height (28,29) Sabiston and Wing described major pelvic fractures to be associated with sacral fractures (30)

RTA's are the hallmark of increasing urbanization (26,31) RTA's account for the largest number of fractures in the lower limb (20). Left tibia highest in number indicating these fractures are "bumper fractures" resulting from being struck at the level of lower leg (32). Associated cranial fractures that follow impact with steering wheel, window or the interior surface of the vehicle (33).

Nordberg in a review of injuries in Africa concluded in sub-Saharan Africa, injuries are third to diarrhoea and malaria at 40000 episodes/100 deaths/100,000 population /year (34). Males have a higher incidence and most common causes are fall, RTA's, assault, burns and poisoning. Substantial reduction is possible via prevention programs (34). No data on fracture distribution, appendicular skeleton and axial skeleton association is mentioned.

Injury burden profile in South Africa differs from most regions of the world as intentional injuries exceed unintentional injuries. Self-inflicted injury rates are similar to global rates but SA has by far the highest rates of interpersonal violence related burden. RTA's are second to homicides at 39.7/100,000 people with females being more involved to the males, 32.6% to 24.8% respectively (35). Poverty, development and chronic disease burden especially during the pre-transitional stage attributed to the high death proportion from injury. Equally, lack of reliable health statistics make it difficult to assess rate of injury, injury involving the musculoskeletal system and skeletal distribution (35).

In Pakistan, demonstrated surgical and orthopaedic presentations were 33% of 119,214 people. RTA's contributed a low proportion as cause of injury. Of concern was the information systems used for data collection with underreporting. Most of the patients were seen in the accident and emergency as outpatients (36). Among the Pakistan in Lahore population, the mechanisms of injury were 51-66% RTA's, 30% sport and occupation related, 18% following domestic violence (37).

In Uganda, about 2000 annual deaths secondary to RTA's with 39% of all injuries primarily males aged 16-44 years. Road carnage is thought to be due to rapid motorization and urbanization in poor economy with poor roads, traffic mix of vehicles and humans, alcohol influenced drivers and lack of adherence to traffic rules. The Annual mortality rate in Kampala is 217/100,000 people/ year with 46% of all fatal injuries due to RTA's (38-40).

In our setting, most of the fractures are attributed to road traffic accidents. This being attributed to by motor vehicles and most recently the motorcycles, following a surge of their use as an affordable cheap convenient mode of transport (41).

Kenya has one of the highest road carnage rates in relation to vehicle ownership in the world. These is thought to be due failure of adherence to traffic rules, use of un-roadworthy vehicles, decreased helmet use for the motorbike users, lack of designated human traffic pathways among others(42). Odera et al in a recent survey demonstrated 68 deaths /10,000 registered vehicles with 45-60% admissions into the surgical wards in public hospitals all after RTA's with the vulnerable road users (pedestrians, pedal cyclists, motorcyclists) being the victims(43). This data was obtained from police records who often attend to the accidents but more are thought to be underreported as those who sustain minor injuries never report either to hospital or police stations. Of the hospital based surveys done in Nairobi and other regions, few are published and those published, are without details on injury severity thus underreporting with unreliable statistics to reveal the magnitude of injury in Kenya (42-44).

Reports document the burden of RTI on hospital workload, with respect to facility utilization of radiographs and operating theatre time (45). In the US, expenditure for fracture treatment accounts for nearly half of the $56 billion annual expenditure for trauma (15).

1.2.2 DISTRIBUTION

Urban life is equated to a more sedentary lifestyle than rural communities (46). These is evidenced by changes in Bone Mineral Density seen mostly in fragility fractures acquired by the elderly(18). Rural populations see increase in fragility fractures after 60 years, whereas the urban elderly peak after the age of 60 years (18-25) Archeologically over previous studies, there has been increased susceptibility to fractures among urban population compared to rural communities. Therefore increasing urbanization lends itself to higher incidences of falls and RTA's as well as fragility fractures (24, 25, 46-48).

SES (Social Economic Status) is intricately related to fracture rates as it dictates the social and physical surroundings of urban population. Men and women in low income and metropolitan areas experience domestic assaults and assaults respectively (49,50). Other contributing factors in the low SES include , alcohol consumption which is higher among males in the low income communities. In addition, impaired mobility among elderly females, who must navigate urban landscape, and usually work well beyond traditional retirement years, injuries linger in these communities (23,51).

Bacon and Hadden demonstrated an inverse relationship between hip fracture rates and income levels. As income levels decrease, the number of fractures increases. This is thought to be due to poor diet, tobacco use, lack of exercise, inadequate preventive care that is found in majority of this regions (52).

LMIC mortality rates are higher than in HIC's in part due to increased use of motorized transport and less developed trauma care. HIC decreased incidence by interventions in injury prevention and improved trauma care (18). In a population based survey, 0.83%

Ghanians had injury related disability with 78% due to extremity injuries. These injuries are amenable to low cost improvements in orthopaedic care and rehabilitation. In HIC, disability follows head and spinal injuries which are more difficult to treat (53).

1.2.3 ANATOMIC SEGMENT DISTRIBUTION

Global burden of disease estimates combined rates of extremity injury from falls and RTA's ranged from 1000- 2600/100,000/year in LMIC and 500/100,000/year in HIC.

Injuries among the Pakistans' in Lahore population in decreasing frequency order, involved fractures of the tibia, femur, humerus, ulna and radius. Seventy one percent (71%) were closed, 28% open fractures with 1% dislocation (37).

Among the Nigerian population, 65% of patients with limb injuries were riders of motorcycles (54).) The commonest injury as seen with other studies, were tibia –fibula fractures combined, femur and humerus in descending order of prevalence. Open fractures accounted for 53.3% among the motorcyclists with the tibia commonly involved. This is thought to be so as the tibia is a subcutaneous bone with minimally soft tissue coverage anteriorly. Associated injuries were in 20% of patients. Head injury was common and contributed to 62.5% fatality. Others included hypovolemic shock, chest injury (54- 59). This is consistent with findings in New Delhi where the most common pattern of injury was head 18.9% followed by fractures of lower limb 17.8% (60.)

Of the local studies reported, none describes the magnitude of fractures seen. There is also a tendency to generalize the injuries with the most common region of the body injured among the victims being the head and neck followed by the lower extremity.

A study by Kinoti Mugambi on assault injuries sustained by victims as seen at KNH revealed 32 of 354 (9%) had fractures, with a high male to female ratio. Weapons of assault included blunt object, metallic object, sharp object of which panga was common choice and bullet (61). This study however failed to give the fracture distribution patterns.

In motorcycle accidents, head injuries and limb injuries are the most common injuries sustained. Lower extremity injuries are the most frequent injuries seen accounting for 32.2% of total injuries at Mulago Hospital, Uganda. Of these tibial fractures (open and closed) accounted for 64.3%, foot injuries 14.3% (49.1% metatarsal fractures)(58) and femoral fractures 21.4% of lower extremity injury (56). The lower limbs are prone to injury due to squeezing of the limb between the motorcycle and impacting vehicle, the ground or some other fixed object (55-57,59).

Jivanjee looked into the body region injuries without describing the nature and characteristics of injury (55). Like other African studies, lower limb injuries were over 50% of all injuries. Commonly fracture femur, tibia- fibula, with the upper limb and fractures of the neck (c-spine) in descending order (44, 55-59, 61).

The majority of motorcycle accident victims were passengers (41.1%), with drivers accounting for 36.3% and pedestrians 22.6% of the total. This is in keeping with the study done by Solagberu (52) and Nzegwu (54) in Nigeria but in contrast to Naddumba in Uganda (40) where pedestrians accounted for the majority. The increased proportion of passengers could be explained by the increased use of motorcycles as a means of cheap commercial transport system to ferry passengers hence exposing them to the risk of injuries.

Drivers and passengers are susceptible to injuries of the upper limb (33).[(] According to the William and Hamann osteological collections, most victims' sustained rib, head, pelvic and lower limb injuries. Fracture patterns differ widely from those individuals who died following alcoholism (20).

1.2.4 DISTRIBUTION BY AGE AND GENDER

The global burden of unintentional injuries demonstrated males exceed females with 87 million DALY's and 51 million DALY's respectively in 2004. Unintentional injury rate in males peak at 15-60 years in both HIC and LMIC. DALY's are higher in LMIC and highest in males 15-29 years (6).

Jacobs and Sayer identified juveniles, young adults and middle –aged highest risk groups for RTA's (31). Among the Pakistan in Lahore population 805 of the patients were 14-40 years of age with a male to female ratio of 3.75: 1 respectively (37).

B.R. Singer et al demonstrated a high incidence of fractures in men than women in all age-groups from 15-49 years with male peak age at 20-24 years and 90-94 years. Females have a smaller peak from 20-24years then steady increase from 40-44 years. Under 35 years males are 2.9 times more likely to get fractures than females. Above 60 years females are 2.3 times more likely to get fractures, thought to be secondary to osteoporosis worsened by the decrease in protective estrogen levels (63). Decrease in water content of bone which can drop by as much as 10% in old age is thought to increase the fracture rates in the older generation (64).

Compared to international data, males are more involved in injuries with the age-group being between 20-49 years. The mean age of the patients in the KNH injury severity study was 30.1 years with majority in the 21-30 years age group (55). Three-quarters of the road crash victims in this study were aged 20-49 years. Similar age distribution of road crash victims was reported in other studies in Eldoret, Kampala and in a Kenyan country epidemiologic review (43, 65, 66). The involvement of this economically active and productive age group can result in significant economic loss at individual, family and society. Fractures are common among the 18-44 years of age, with a male preponderance explained by the fact that they engage in more risky behaviour. This may however be changing in our setting, as more women now join the workforce with the aim of increasing family earnings.

Of 146 patients that were enrolled in motorcycle accident injury severity study in KNH 2012, 83.6% were males and 16.4% were females(55). The preponderance of males is similar to that reported by studies done by Naddumba (40) and Galukande in Uganda (38) and Chalya in Tanzania(67). This is due to a wide range of activities engaged in by this young group of people. Most motorcycle riders are also male who do it for commercial purposes. In most studies, majority of the casualties are males. This is consistent with findings from other studies done in Kenya and in other low-income and middle-income countries(44, 68). This could possibly be due to the greater exposure to traffic of the males compared to females as drivers or riders and as frequent travellers in motor vehicles for work-related activities.

1.2.5 DISTRIBUTION BY AGE, GENDER AND ANATOMIC SEGMENT

Wrist fractures in those less than 40 years is 1.4 times more likely in males, with a linear increase in females after this. Forearm fractures are however higher for males 15-44 years. Femoral and tibial shaft fractures are higher in both from 15-34 years and the elderly above 70 years. Metaphyseal fractures have minor differences in rates of elbow and knee fractures but ankle fractures more common in young men. In the elderly, ankle and proximal humerus fractures are common in women. Diaphyseal fractures are more common than metaphyseal fractures only in the femur among young adults. Metaphyseal fractures more common than the shaft in forearm and tibia in all age-groups and in the humerus and femur after age 35 years (18, 25, 63).

Common fractures are distal radius regardless of sex and age. Fractures following osteoporosis are in the older age group and occur in the proximal femur, distal radius, proximal humerus and vertebra bodies(20).

William and Hamann-Todd (20) described fracture distribution by gender, anatomic segment and mechanism of injury from osteological collection as follows:

Table 1.2: Fracture distribution by gender, anatomic segment and mechanism of injury

Pattern of fracture	Gender distribution	Anatomic segment	Mechanism of injury
Type A	Young men; older females	Scapula, tibial diaphysis, distal radius, ankle, metatarsals	RTA, twisting motion, fall
Type B	Young males> females	Hand, wrist	Fall >6 feet, direct blow, assault, RTA, gunshot
Type C	Unimodal male:female ratio	Foot	Sport, RTA especially the cyclists
Type D	Unimodal male; young Bimodal female: young and menopausal	Proximal forearm, forearm diaphysis, proximal tibia	
Type E	Older females few males	Pelvis, distal humerus, distal radius, distal femer	
Type F	Older age unimodal male and female	Proximal humerus, humerus diaphysis, proximal femur, femoral diaphysis, patella	Fall from standing height,
Type G	Unimodal female especially older: bimodal male;	Calcaneus, clavicle	RTA common for the pedestrian

	young and older men		
Type H	Bimodal both sexes	Humerus diaphysis, tibial plateau, spine	Stress, spontaneous injury, RTA in the vehicle occupant
Type I	Linear females (increases with age)male unimodal increases with old age		Fall down stairs or slope

William and Hamann-Todd (20) described fracture distribution by gender, anatomic segment and mechanism of injury

Majority open fractures result from low energy with 22.3% open secondary to RTA's, falls from height. High energy open fractures commoner in younger males and low energy open fractures in older females(19).

Open fractures most commonly occur in the leg and foot, with the tibial diaphysis and distal tibia being most commonly affected. This is explained to be so because the tibia itself has minimal soft tissue coverage and is subcutaneous thus prone to compound fractures. Open fractures of the fingers are also fairly common especially among the industrial workers but are rarely severe. This is in contrast to most of the open fractures of the thigh, leg, and foot, which are associated with a high incidence of Gustilo type III open fractures(16).

Local literature by Osoro Mogaka et al (45)males are more involved in RTA's injuries within the mean age of 32.4 years from the range of 3 -75 years old. 75% of victims are 20-49 years with over 50 years old being 12%. In order of descending occurrence head and neck injuries were most common followed by lower extremities and upper extremities. No mention on description of injury was made.

1.3 CONCLUSION

The epidemiology of musculoskeletal injury is hampered by the discrepancy in definitions, collection and the focus of the studies. In summary there is :

- Lack of uniform classification and diagnostic systems, results in conflicting literature.
- Most studies are retrospective, are either age restricted, focus only on one fracture location or consider specific underlying risk factors such as osteoporosis and not population based, which makes comparison between regions difficult.
- Local studies have not evaluated or described appendicular skeleton trauma
- The settings where most of the literature is from is different from tertiary teaching hospital
- Other studied have failed in strongly linking the variables in this study to appendicular skeleton fracture distribution and severity
- Methodology is deficient in utilization of x-rays.

Consequently, the studies are heterogeneous, and drawing firm conclusions from any one study is hampered.

1.4 JUSTIFICATION

A lack of reliable statistics largely hinders health and development impacts on injury but the global burden of disease assessments identified their substantial role in premature mortality and disability among young adults especially the male gender.

Locally the contribution of fractures following any of the various mechanisms of injury and the magnitude is unknown. Data on the prevalence of fractures will help focus orthopaedic management of patients, eventually minimise the morbidity/ disability and mortality of the victims.

This study aims to determine the magnitude of fracture problem and describe the pattern of bone fractures as seen in a National Referral Hospital. With these, influence policy especially on resource allocation and budget allocation for hospital equipment more especially to facilitate in management of fracture patients

Misperceptions that injuries arise following accidents due to carelessness and bad luck, thus nothing can be done to prevent them, has resulted in decreased funding to injury prevention. However, addressing the spectrum of injury control, there is hope to lower the injury incidence by :

- Improving knowledge base through research and surveillance
- Improving safety and implementing scientifically proven injury prevention strategies,
- Strengthening pre-hospital and hospital –based trauma care via emergency surgical care
- Long-term rehabilitation by capacity building in emergency and essential surgical, anaesthesia services at first existing health facilities.

CHAPTER 2: METHODOLOGY

2.1 RESEARCH QUESTION

What is the appendicular skeleton fracture distribution among adult patient population seen in Kenyatta National Hospital?

2.2 PRIMARY OBJECTIVE

To determine the burden of the appendicular skeleton segment fractures in adults at Kenyatta National Hospital

2.3 SECONDARY OBJECTIVE

1. To determine the distribution of fractures in the appendicular skeleton
2. To determine the severity of fracture based on AO/OTA classification
3. To determine concurrence of appendicular skeleton bone fractures .
4. To describe the common mechanism of injury

2.4 STUDY AREA & POPULATION

Kenyatta National Hospital is the national referral and teaching hospital with a bed capacity of 1800 patients. The orthopaedic department has a floor which has three main firms each a ward with bed capacity of 60 patients and a common ward for the paediatric cases with a bed capacity of 60 patients as well. Critically injured patients are admitted to the Intensive care unit (ICU). Of interest to this study will be the patients presenting to the facility with fractures of the appendicular skeleton. Areas of recruitment will be A&E and the wards.

2.5 STUDY DESIGN

A cross-sectional study

2.6 SAMPLE SIZE

There is no data on musculoskeletal injury in KNH, neither data on magnitude of fractures occurring in the institution. Thus estimated prevalence is 50%

$$N = \frac{(Zc)^2 (P) (1-P)}{d^2}$$

Cochran, W.G. 1977(69)

N = required sample size

Zc = standard normal deviate corresponds to a confidence level of **95%**

P = estimated prevalance : **50%**

d = precision of confidence interval **:0.05**

$$\frac{3.8416 \times 0.5 \times 0.5}{0.0025} = 384.16$$

Rounded off to 385

2.7 INCLUSION CRITERIA

- Patients admitted with appendicular skeleton fractures
- Patients with appendicular skeletal fractures who give written information consent

2.8 EXCLUSION CRITERIA

- Patients who decline consent and have appendicular skeletal fractures
- Missed fractures: Patients whom were admitted to the wards but whose initial fractures were missed but discovered while in the wards were eliminated from recruitment into the study.

2.9 RECRUITMENT & SAMPLING TECHNIQUE

All patients seen over the period of three months were registered, listed and assigned consecutive numbers. Those who met the inclusion criteria underwent systematic random sampling. The sampling fraction (as determined below) was the constant difference between subjects. They were then recruited and consented. The total fracture population average in five years seen at Accident and Emergency department over three months, divide by the sample size gave the sampling fraction. These was used as the constant difference between subjects.

Therefore,

Total average fracture population in 3 months = 810

Sample size = 385

Sampling fraction = $\frac{810}{385}$ **= 2.10 rounded off to 2**

Sampling fraction is 2 (difference between subjects)

2.10 CONSENTING PROCESS

Only after the participant was thoroughly clear on the nature, purpose, potential risks and benefits as well as participant expectations of the study, and agreed to take part, did they endorse consent by signing a consent form with all information given verbally. This process was only undertaken by either the primary investigator or research assistants; the medical officer(s)

2.11 DATA COLLECTION

The principal investigator or the research assistant obtained detailed information consisting of bio-data, mechanism of injury and concurrent fractures on a database platform. Further they performed a thorough clinical exam and requested for radiological exam to determine and confirm diagnosis. Fracture severity was based on AO/OTA classification, from the x-rays films of the involved area. Data collected was then stratified and analysed.

2.12 LIMITATIONS

- Severely injured patients with altered mental status, who qualified for study recruitment but could not give consent.
- Poor x-ray films based on quality of projection and clarity. Clear films facilitated better fracture characterization and severity.
- Inter-observer variability (two different people looking at the same X-ray film may interpret it differently)

2.13 ETHICAL CONSIDERATIONS

Approval to perform the study was sought from the Orthopaedic Surgical Department University of Nairobi and the Kenyatta National Hospital Ethics and Research Committee. All the data obtained was handled confidentially.

All patients selected for the study were requested to sign an informed consent administered by the principal investigator or research assistant. The selected patients were then informed that participating in the study was voluntary and that withdrawing from the study would not interfere with their right to receive treatment at the hospital.

2.14 DATA ANALYSIS AND PRESENTATION

All data was analysed using SPSS 13.5 and output for quantitative data presented as Median (not affected by outliers). Data from all patients was entered in a database on Microsoft Access platform. Categorical data presented in form of frequency tables, graphs, bar charts and percentages. Chi-square test for proportion was used.

CHAPTER 3 : RESULTS

A total number of 385 patients were enrolled into the study, of these 80% were male and 20% were female. The median age was 32 (24-43) years. Below is a summary of the study patients

Table 3.1: Characteristics of the study patients

	Overall (all patients) N = 385
	n (%) IQR(inter quartile range)
Gender	
Male:	306 (80)
female:	79 (20)
Median age (yrs)	32 (24 – 43)
Age (yrs)	
Less than 20 years	10 (3)
20 – 30 years	150 (39)
30 – 40 years	99 (26)
>= 40 years	126 (32)
Fractures	
Single:	303 (79)
Multiple:	82 (21)
Median number of fractures	2 (2 – 2)
Fracture type	
Closed:	305 (79)
Compound:	67 (18)
Both:	13 (3)
Method of injury	
Road traffic accident:	243 (63)
Gunshot:	8 (2.1)
Occupational:	1 (0.3)
Fall:	112 (29.1)
Assault:	19 (5)
Other:	2 (0.5)
Road traffic accident patients	
Pedestrians:	139 (57)
Driver:	47 (19)
Passenger:	57 (24)

Table 3.1: Patients aged between 20 – 30 years formed the larger group of the study patients. Most of the patients (79%) had single fractures. The common fracture type being closed at 79%, with the mechanism of injury being road traffic accidents and most of the patients were pedestrians (57%).

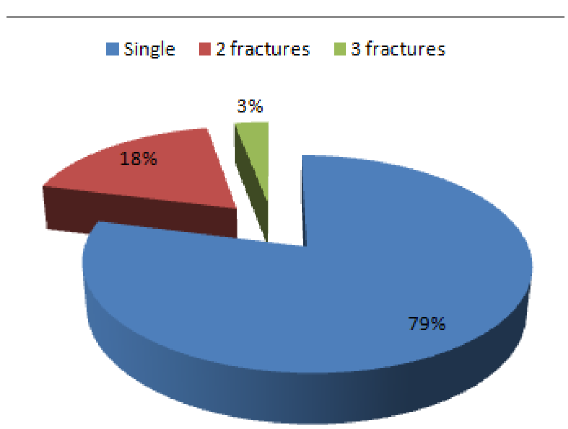
Table 3.2: Burden of appendicular skeleton fractures

Upper limb	33.3 %
Humerus	10.6%
Clavicle	1.7%
Scapula	0
Radius/ ulnar	15.2%
Carpal	0
Metacarpal	5.8%

Lower limb	66.7%
Femur	23.3%
Tibia/Fibula	36.9%
Patella	0.6%
Talus	0.6%
Calcaneus	1.3%
Tarsal	0
Metatarsal	4%

Table 3.2: Total number of fractures in the 385 patients was 480 of this 33.3% were in the upper limb and 66.7% in the lower limb. In the upper-limb, the radio/ulnar segment (15.2%) attributed to the majority with no fractures in the carpal and scapula regions. In the lower limb, the tibia/fibula segment (36.9%) was the majority with no fractures in the tarsal bones.

<u>**Figure 3.1: Fracture distribution**</u>



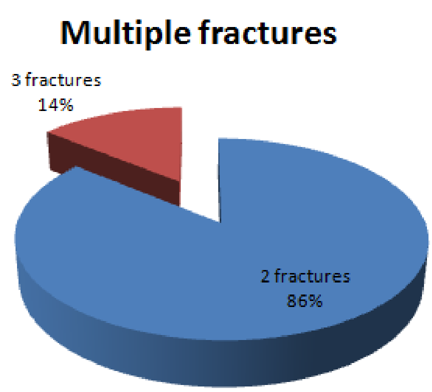


Figure 3.1: Of the 21% patients with multiple fractures, a majority had 2 fractures (86%) while 14% had 3 fractures.

Figure 3.2: Frequency of the age groups

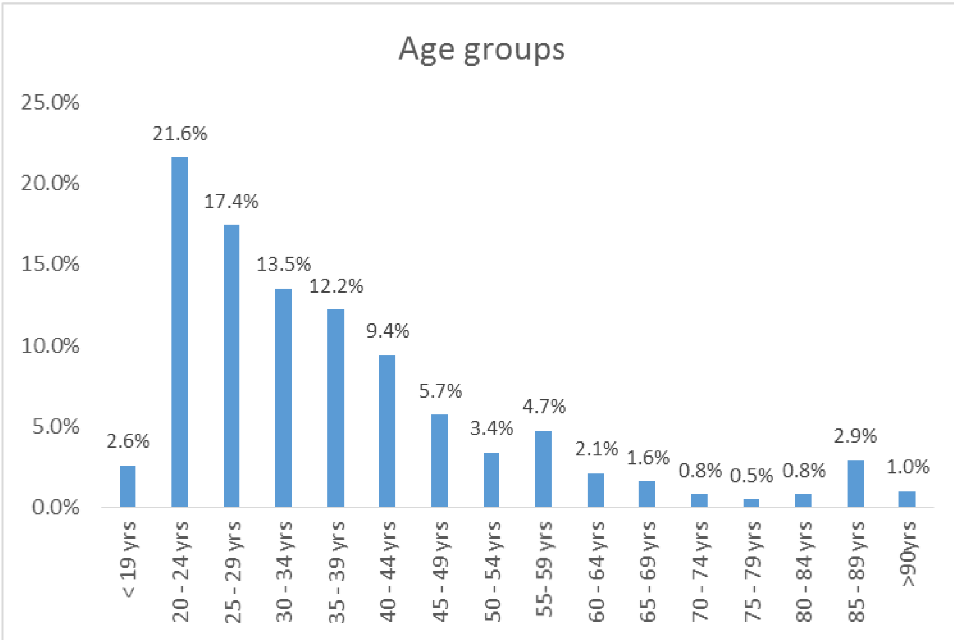


Figure 3.2: The group between 20 – 24yrs had the biggest representation at 21.6%.

Figure 3.3: Frequency of fractures among the upper and lower limb

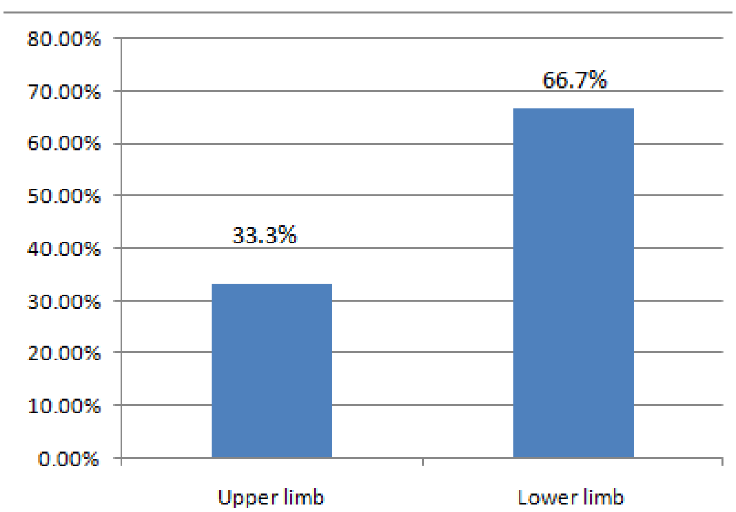


Figure 3.3: Shows the percentage number of fractures in the upper limb and lower limb. The lower limb recorded the highest number of fractures at 66.7%.

Figure 3.4: Frequency of the fractures in each bone

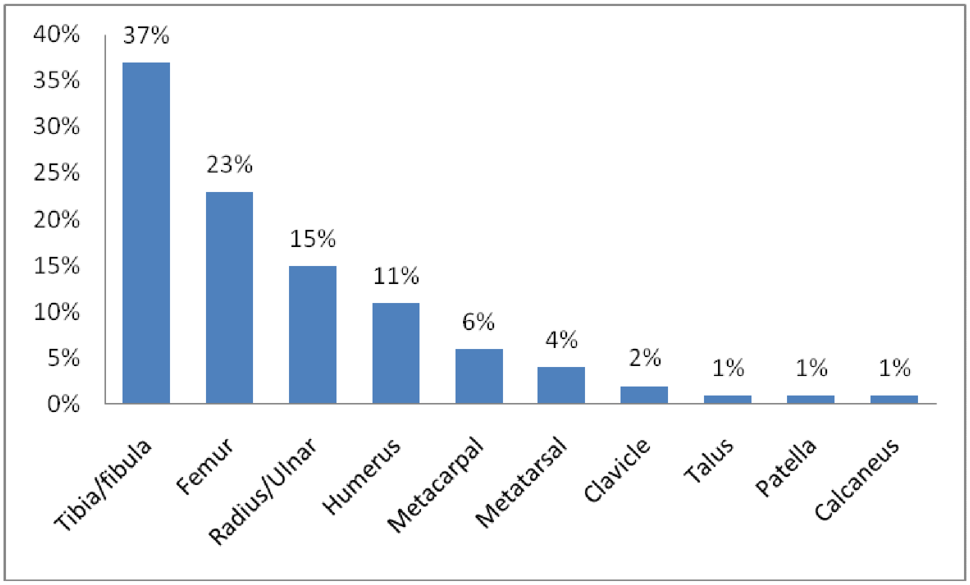
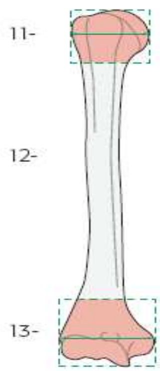
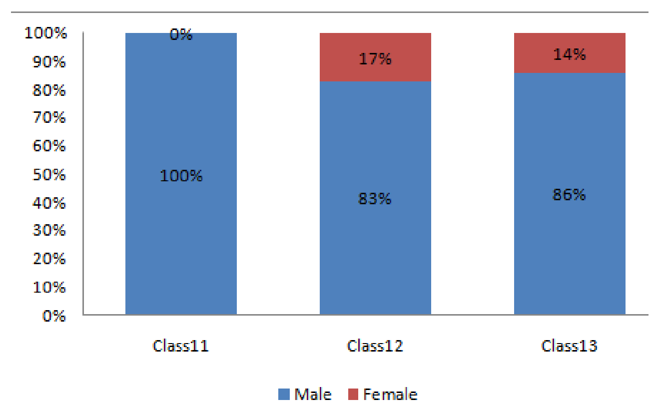
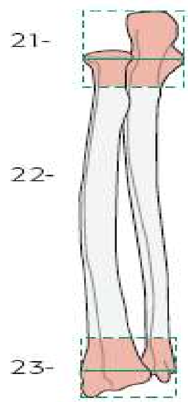
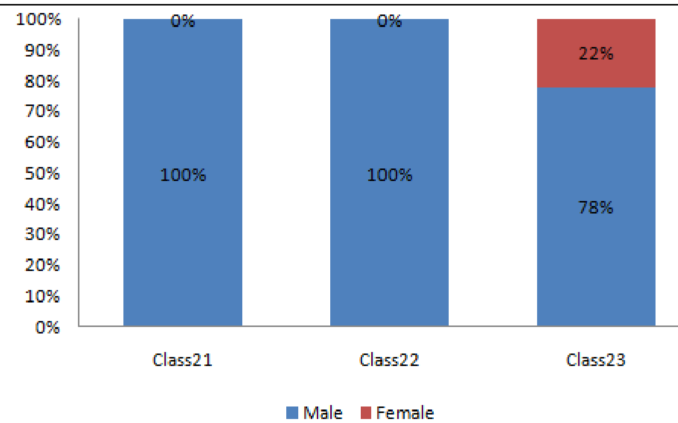
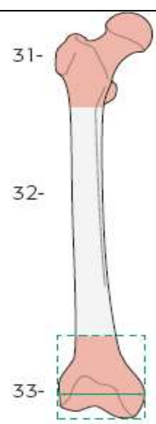
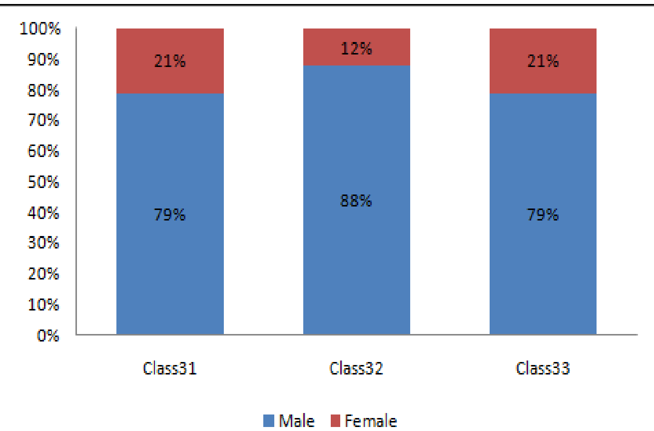
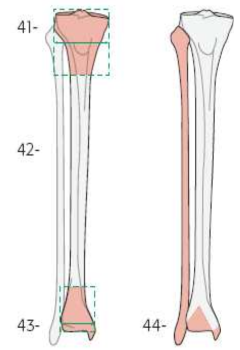


Figure 3.4: The tibia/fibula recorded the highest number of the fractures at 37%. No fractures were reported in the scapula, carpal and tarsal bones.

Table 3.3: Frequency of fractures by AO class segments and gender

Segment \ Type		A	B	C	Gender
	Proximal	3	2	3	
	Shaft	21	4	4	
	Distal	9	0	5	
	Proximal	0	2	0	
	Shaft	14	13	3	
	Distal	18	4	19	
	Proximal	31	10	1	
	Shaft	30	21	5	
	Distal	11	2	1	



Proximal	2	8	10
Shaft	29	61	9
Distal	8	2	11
Malleoli	15	18	4

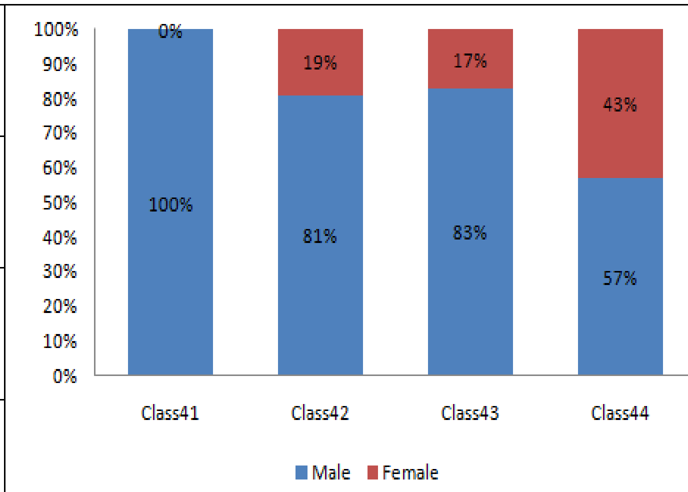


Table 3: Male gender predominantly involved in long bones fractures. Diaphyseal fractures were common in all long bones with exception of the radio/ulnar where distal segment fractures were predominant.

In the humerus, simple diaphyseal fractures were commonest, then distal extra-articular fractures, complete articular fractures and proximally either complete or extra-articular fractures. For the radio/ulnar; distal complete articular fractures commonest, distal extra-articular then simple diaphyseal and wedge fractures. Proximally, partial articular type frequent to the others. In the femur; proximal extra-articular common, then the simple diaphyseal type followed by diaphyseal wedge type and distally the extra-articular type. In the tibia/fibular segment, wedge diaphyseal type predominated to simple fracture type. In the proximal segment and distal segment, complete articular fractures were common. In the malleoli segment, trans-syndesmotic fibula fractures were most common then infra-syndesmotic and supra-syndesmotic the least.

Table 3.4: AO segmental fracture type classification by Gender

Classification	Gender		
	Male	**Female**	**Ratio**
Class11	8 (100)	0 (0)	8:0
Class12	24 (83)	5 (17)	5:1
Class13	12 (86)	2 (14)	6:1
Class21	2 (100)	0 (0)	2:0
Class22	30 (100)	0 (0)	30:0
Class23	32 (78)	9 (22)	4:1
Class31	33 (79)	9 (21)	4:1
Class32	49 (88)	7 (12)	7:1
Class33	11 (79)	3 (21)	4:1
Class41	20 (100)	0 (0)	20:0
Class42	80 (81)	19 (19)	4:1
Class43	19 (83)	4 (17)	5:1
Class44	20 (57)	15 (43)	1:1

Table 3.4: The male gender sustained more injury to the females in all long bones. Among the male gender, long bone fractures were predominant in the proximal humerus, radio/ulnar, tibia/fibular and diaphysis of the radio/ulnar. In descending order among the female population; tibia/fibular malleolar segment, femur proximal and distal segments, humerus diaphysis and radio/ulnar distal segment.

Table 3.5: Long bone fracture by Mode of Injury

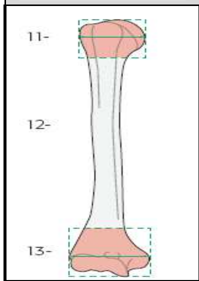
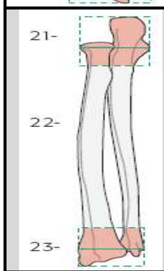
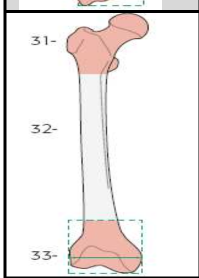
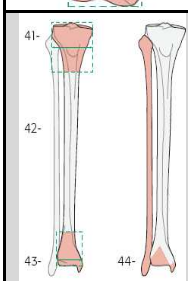
		Road traffic accident	Fall	Assault	Gun shot	Others
	Class11	63%	25%	12%	0%	0%
	Class12	83%	7%	7%	3%	0%
	Class13	57%	29%	14%	0%	0%
	Class21	100%	0%	0%	0%	0%
	Class22	57%	20%	17%	6%	0%
	Class23	30%	70%	0%	0%	0%
	Class31	26%	74%	0%	0%	0%
	Class32	53%	40%	4%	3%	0%
	Class33	43%	36%	21%	0%	0%
	Class41	90%	5%	1%	0%	0%
	Class42	89%	5%	1%	2%	2%
	Class43	52%	48%	0%	0%	0%
	Class44	69%	28%	3%	0%	0%

Table 3.5: Road traffic accident was the commonest mechanism of injury overall, specifically in the humerus, radio/ulnar and tibia /fibular fractures. Falls were associated with fracture femur predominantly the proximal segment. By segment, RTA's caused proximal radio/ulnar, assault distal femur and gunshot injury's radio/ulnar diaphysis.

Figure 3.5: Mechanism of injury by age –group

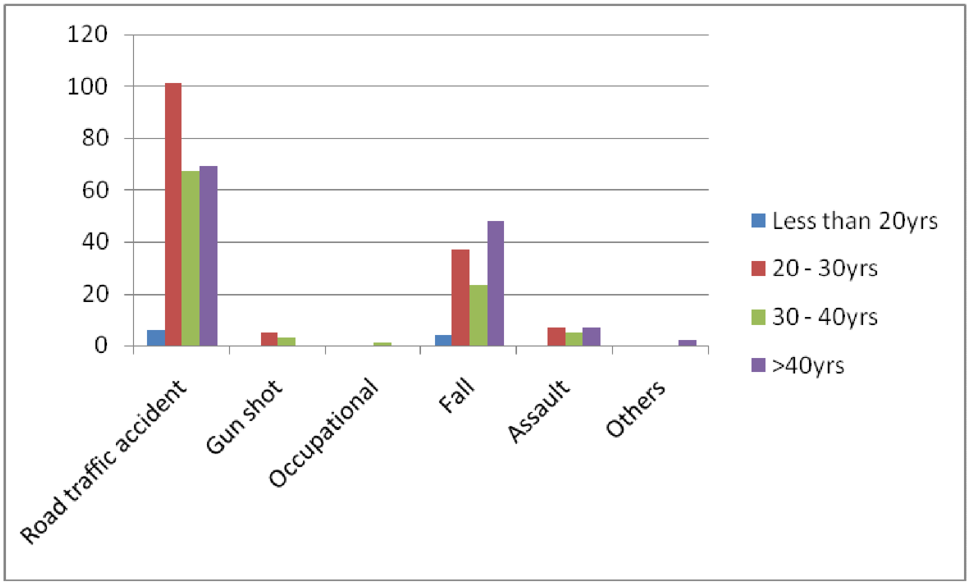


Figure3.5: Road traffic accident was the commonest cause of injury across all the age-groups, more especially among the 20-30 year old age group. Falls were common among the over 40 year old patients.

Table 3.6: Age-group by mechanism of injury

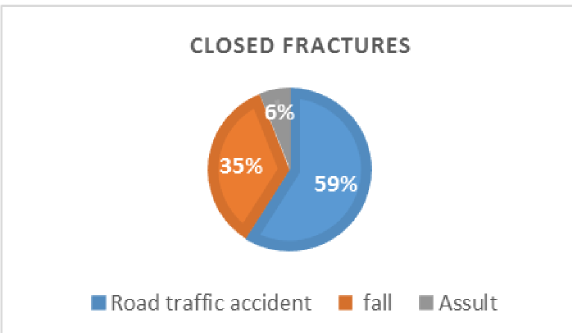
	Mechanism of injury (N = 385)						
	Road traffic accident n =243	**Gun shot n =8**	**Occupational n =1**	**Fall n = 112**	**Assault n = 19**	**Others n =2**	**P value**
Age group							
18 -- 20yrs	6 (60)	0 (0)	0 (0)	4 (40)	0 (0)	0 (0)	0.012
20 – 30yrs	101 (67)	5(3)	0(0)	37(25)	7(5)	0(0)	
30 – 40yrs	67 (68)	3 (3)	1(1)	23 (23)	5(5)	0 (0)	
>40yrs	69 (55)	0 (0)	0 (0)	48 (38)	7 (6)	2 (2)	

Table 3.6: Road traffic accident was the highest cause of injury across all the age-groups. There was statistically significant difference between the mechanisms of injury in the various age-groups.

Table 3.7: Type of Fracture by Mode of Injury

	Road traffic accident	gunshot	occupational	fall	Assault	other
Closed	59%	0%	0%	35%	6%	0%
Compound	76%	12%	0%	9%	0%	3%
Both	100%	0%	0%	0%	0%	0%

Figure 3.6:



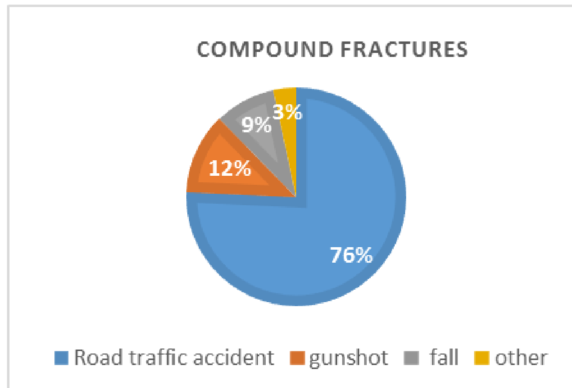


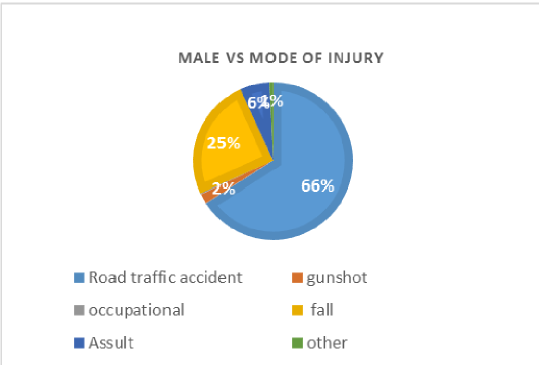
Table 3.7 and figure3.6 shows the type of fractures and the mode of injury. Road traffic accident was the most common mode of injury in both the closed and compound fractures but resulted in more compound fractures.

Table 3.8: Mode of injury Vs Gender

	Gender (n = 385)		
	Male n = 306	**Gender n = 79**	**P value**
Mode of injury			
Road traffic accident:	202 (83)	41 (17)	0.003
Gun shot:	8 (100)	0(0)	
Occupational:	1 (100)	0(0)	
Fall:	75 (67)	37 (33)	
Assault:	18 (95)	1 (5)	
Other	2 (100)	0 (0)	

Table 3.8: shows a comparison of the mode of injury and the patient's gender. There is statistical difference (p = 0.003) in the mode of injury between the two genders.

Figure 3.7: Mode of injury vs gender



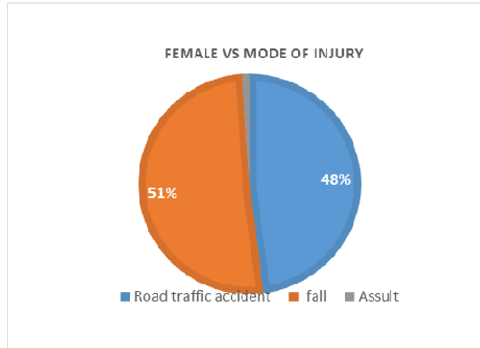


Figure 3.7: Road traffic accident was the most common mechanism of injury among the male, and fall among the female population.

Table 3.9: Type of fracture by age- group

	Type of fracture (N = 385)			
	Closed n =305	**Compound n =67**	**Both n =13**	**P value**
Age group				
18 -- 20yrs	10 (100)	0 (0)	0 (0)	
20 – 30yrs	116 (77)	28(19)	6(4)	0.163
30 – 40yrs	73 (74)	20 (20)	6(6)	
>40yrs	106 (84)	19 (15)	1 (1)	

Table 3.9: shows a comparison of the type of fracture by age group. Closed fractures are most common among all the age groups. There is statistically no significant difference between the types of fracture among the age groups (p=0.163).

Table 3.10: Fractured bone by gender

	Humerus	Clavicle	Radius/ ulnar	Metacarpal	Femur	Tibia /fibula	Patella	Talus	Calcaneus	More than 1 bone
Male	8%	0.30%	15%	2%	18%	31%	1%	0.3%	1%	22%
Female	3%	1%	11%	0%	24%	41%	0%	0%	0%	20%

Table 3.10 shows the anatomical injuries in each gender. Tibia/ fibular bones were the commonest fractures regardless of gender with males having more multiple fractures to females.

Figure 3.8: Fractures among the female gender

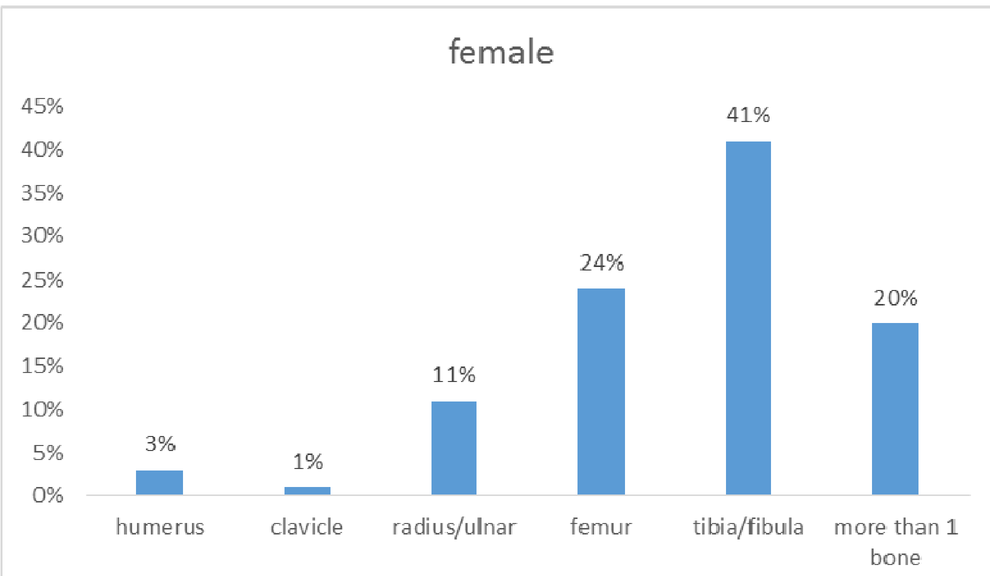
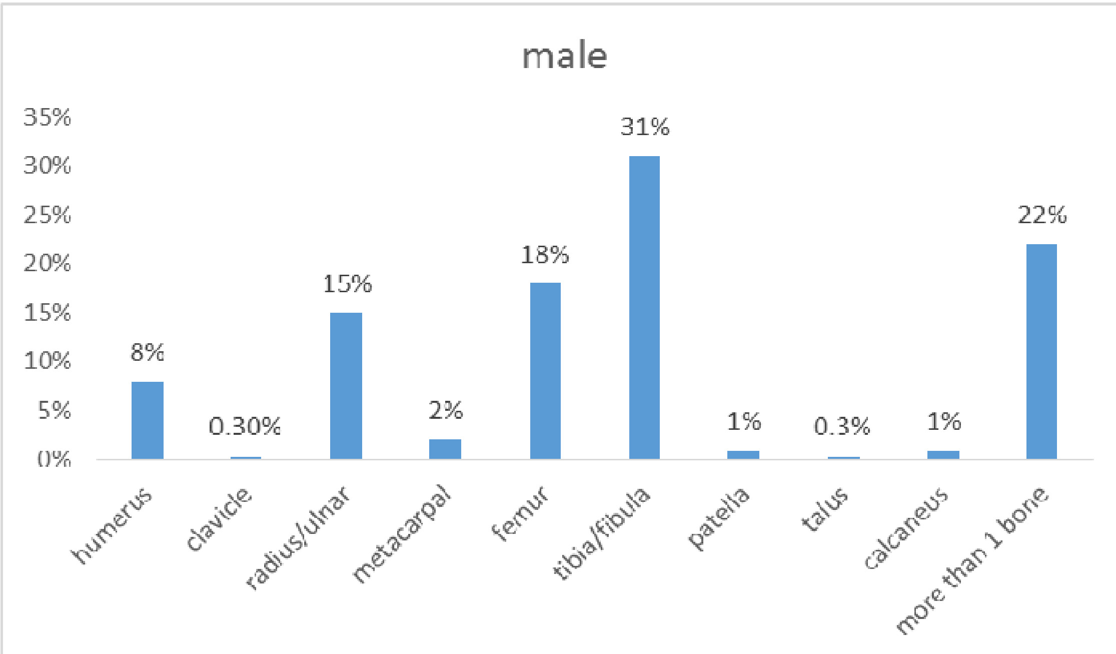


Figure 3.8 shows fractures among the females all involving the long bones except the clavicle.

Figure 3.9: Fractures among the male gender



\

Figure 3.9 shows fracture among the male population; predominantly in the lower limb.

CHAPTER 4: **DISCUSSION**

The distribution of fractures in appendicular skeleton is not known in the Kenyan set-up neither the severity.

Road traffic accidents attributed to fractures in 63% majority being pedestrians. This compares with a Ugandan population study (38-40). In descending order, the common mechanism of fractures follows road traffic accidents 63%, falls 29.1%, assault (5%), gunshot (2.1%) Table 3.1. In Pakistan population; sport, occupation related then assault account for most injury's (37) whereas in South African population RTA's were second to homicides (35).

Lower limb fractures were more common (66.7%) than upper limb fractures (33.3%)(Figure 3.3). The tibia /fibular being commonest and metacarpals least (Table 3.2, Figure3. 4). Among the Pakistanian population, the descending order was the same only that radius/ ulnar fractures were less to humerus (37). The same order was similar to the Nigerian literature (64) and other African studies (44, 55-57, 59). Similar to other studies results, is due to impact and subcutaneous nature of the tibia.

In this study population 79% have closed fractures, 18% were open and 3% of the patients had both compound and closed fractures (Table 1, Figure 1). Of the total, 21% had multiple fractures of which 86% had two fractures and 14% had three fractures. (Figure 3.1) Correlation with mechanism of injury, RTA's resulted in compound fractures especially of the tibia-fibula, proximal segment in the lower limb. In the femur fractures commonly followed falls especially in the proximal segment (Table 3.5). The tibia/ fibular region is thought to be more predisposed to injury due to its subcutaneous nature anatomically (20).

In the upper limb, the humerus accounts for 10.6% of fractures (Table 3.2). Male gender highly at risk with fractures more in the diaphysis, distal then proximal segment in descending order. Among the females the anatomic segments occurrence was shaft, distal rarely proximal humerus (Table 3.4). RTA's was the overall mechanism of injury resulting to fracture simple (A) shaft(2) regardless of gender. The radio-ulnar segment accounted for 15.2% of upperlimb fractures. In the male, the patient would have shaft fracture from a road traffic accident whereas the female would have distal third fracture from a fall. The male: female ratio was higher, distal complex and simple fractures were majority in this region. The metacarpals accounted for 5.8% and the clavicle 1.7% with no fractures observed in the scapular region perhaps due to its anatomic position where it is guarded by the ribcage and muscle layers subcutaneously (Table 3.2; 3.3; 3.4; 3.5).Metacarpal injuries were commoner in the males than the females perhaps due to the fact that most men are predisposed by occupation working with manually operated machinery. The clavicular fractures, were common among the females than the male (Table3.10).

Lower limb accounted for 66.7% of fractures. The tibia-fibular segment accounted for 36.9% with high male female ratio. Majority of the fractures were wedge shaft fractures. RTA's resulting in proximal and shaft injuries and falls resulting in distal fractures (Table 3.5). Among the male, shaft, proximal and malleoli then distal third fractures were common in descending order whereas in the female, shaft, malleoli, distal third and rarely proximal third fractures occurred (Table 3.4). In the femur segment, of the 23.3% fractures, falls resulted in proximal third fractures and RTA's in shaft fractures. The male had more shaft fractures than proximal and distal fractures whereas in the females, proximal, shaft and distal fractures in descending order (Table 3.3; 3.4; 3.5). Metatarsal injuries accounted for 4%, calcaneus fractures 1.3% with both talus and patella 0.6% (Table 3.2).

Majority of the road traffic accident victims were pedestrians 57% unlike in the Nigerian and Ugandan study where the passengers (41.1%) on motorcycles were the victims (40, 54, 62). The road traffic accidents were not categorized as either motorcycle or automobile in this study. Passengers accounted for 24% and drivers 19% in this study population(Table 3.1), the Nigerian/ Ugandan had drivers at 36.3% and pedestrians at 22.6%. However this data was reported for motorcycle accidents only. Most of the pedestrians were either crossing the road or the vehicles vied off the road to bus-stops where pedestrians were. Alcoholism cannot be ruled out for both the drivers and victims as was in the local study on motorcycle accidents (55).

Fracture patterns differed with mode of injury as follows; in the humerus road traffic accidents accounted for especially diaphyseal fractures. Falls contributed to more distal fracture as well as assault. In the forearm, 100% of all proximal fracture were due to RTA's, falls distal radio-ulnar fractures and assault radio-ulnar shaft perhaps in attempt to defend self. In the femur, RTA's contributed mostly to shaft fractures, falls proximal third shaft fractures and assault distal femur fractures perhaps in attempt to immobilize. In the tibia/ fibula segment, RTA resulted in proximal third fractures, falls to distal third fractures and assault malleoli fractures, perhaps in attempt to run but patient trips, with foot getting trapped. Majority of the leg fractures were compound fractures (Table 3.5).

In the humerus, simple diaphyseal fractures were commonest, then distal extra-articular fractures, complete articular fractures and proximally either complete or extra-articular fractures. For the radio/ulnar; distal complete articular fractures commonest, distal extra-articular then simple diaphyseal and wedge fractures. Proximally, partial articular type frequent to the others. In the femur; proximal extra-articular common, then the simple diaphyseal type followed by diaphyseal wedge type and distally the extra-articular type. In the tibia/fibular segment, wedge diaphyseal type predominated to simple fracture type. In the proximal segment and distal segment, complete articular fractures were common. In the malleoli segment, trans-syndesmotic fibula fractures were most common then infra-syndesmotic and supra-syndesmotic the least. The propotions are small to the total fractures thus to improve on statistical significance perhaps a larger sample size will help define the proportions better. Majority of the fractures were shaft fractures (Table 3.3). These fracture patterns inform on the orthopaedic implants required for early, definitive management of the fractures minimizing hospital stay for patients and decreasing costs in the long term.

The median age of fracture occurrence was 32 years. The age group affected most 20-24 years (21.6%)(Figure 3.2). Consistent with local and international literature on trauma injury (6, 43, 55, 63,65), the peak age group was 20-24 years same for fractures in this study. There seems to be a steady decline in fracture occurrence with age but peaks at 55-59 years of age and 85-89 years (figure 3.2). Explained by high risk of fragility fractures in the peak age-group.

RTA's is the frequent mode of injury among all age-groups. 20-30 years was peak for RTA's. 20-30 years was also peak for gunshot injury's. Among those above 40 years, falls accounted for the biggest mechanism of injury for this age-group. Assault peaked in the under 20 years and over 40 year old patients (Table 3.6).

As compares to international and local literature, males are at risk of injury and fractures compared to the female gender (37, 38, 40, 55, 63, 67). Among the male gender in descending order the anatomical segment was tibia fibular (31%), femur (18%), radio-ulnar (15%), humerus (8%). Multiple fractures occur in 22% of cases. In the female gender, tibia fibular (41%), femur (24%), radio-ulnar (11%), humerus (3%) and multiple fractures 20%. (Figure 3.8; 3.9). Distal radius, proximal and distal femur were the segments involved in female gender and this compares to literature on the common sites for fragility fractures (20).

4.1 CONCLUSION

- Lower limb fractures (66.7%) are more common than upper limb fractures (33.3%) mainly closed fractures (79%).
- Tibia/ fibula (36.9%) and femur 23.3% high risk of fractures in lower limb and the radio-ulnar 15.2% and humerus 10.6% in the upper-limb.
- Isolated fracture (79%) occu more often to multiple fractures (21%),
- Diaphyseal (55%) wedge (46%) fractures common especially in the tibia- fibular.
- Road traffic accidents remain the commonest mechanism of fracture, falls then assault in descending order.

4.2 RECOMMENDATIONS

- Modalities as well as policy's need to be enforced on road safety and use to minimize pedestrian accidents.
- Preventive policy formulation and enforcement.
- National, multicentre, prospective and randomized study should be done to assess and compare the magnitude of fracture burden.

CHAPTER 5 : REFERENCES

1. Thomas P. Ruedi, William M. Murphy, Chris L. Colton, et al. Fracture Classification. In: AO Principles of Fracture management. Thieme New york: AO Publishing; 2000. p. 45-57.

2. Kim PH Leopold S. In brief: Gustilo- Anderson classification. Clinical Orthopaedics and Related Research 2012 Nov;470(11):3270-4.

3. Schluter PJ, Cameron CM, Davey TM,et al. Using trauma injury severity score (TRISS) variables to predict length of hospital stay following trauma in New Zealand. New Zealand Medical Journal 2009;122(1302):65-78.

4. Murray CJ, Lopez AD. Mortality by cause in eight regions of the world: Global Burden of Disease Study. Lancet May 1997;349(9061):1269-76.

5. Peden M, Scurfield R, Sleet D,et al. World report on road traffic injury prevention. Geneva: World Health Organization; 2004.

6. Aruna C, Hyder AA, Corinne P.A. The global burden of unintentional injuries and an agenda for progress. Epidemiologic Reviews 2010 April 22;32(1):110-20.

7. World Health Organization. Preventing death and disability due to injuries is both an economic imperative and a health priority. In. Montreal, Canada: World health Organization; 2002 May Press release.

8. World Health Organization. A 5 -year WHO strategy for road traffic injury prevention. Geneva, Switzerland; 2001.

9. World Health Organization. Violence, injuries and disability: biennial report 2006-2007. Geneva, Switzerland: World Health Organization; 2008.

10. Peden M, Oyegbite K, Ozanne-Smith J, et al. World report on child injury prevention. Geneza, Switzerland: World Health Organization unicef; 2008.

11. Krug E.G, Sharma G.K, Lozanor. The Global Burden of Injuries. American Journal of Public Health 2000;90(4):523-526.

12. Wilson LJ, Segal AB, Carvalho DEd, et al. Statistical analysis of infantile-juvenile orthopaedic trauma in a tropical metropolis' orthopaedic emergency room. Acta Ortopedica brasileira 2005;13(4):179-82.

13. Back O, Klinik F. Musculoskeletal trauma in East africa public hospital. Injury 2004;35(4):401-6.

14. Court-Brown CM, Koral KJ. The epidemiology of fractures. 6th ed. Philadelphia: Lippincott; 2006.

15. Bergen G CL, Warner M, Fingerhut LA. Injury in the United States 2007 Chartbook. In. Hyattsville, MD: National Center for Health Statistics; 2008.

16. Buchoz RWH, James D et al. Rockwood & Green's fractures in Adults. 6 ed; 2009.

17. Jones G NT, Sambrook PN,Kelly PJ, et al. Symtomatic fracture incidence in elderly men and women: the Dubbo Osteoporosis Epidermiology Study (DOES). Osteoporosis int 1994 sept;4(5):277-82.

18. O'neill TW, Cooper C, Finn JD, et al. Incidence of distal forearm fracture in British men and women. Osteoporosis international 2001 February;12(7):555-8.

19. Charles M C-B, Ben Caesar. Epidermiology of adult fractures: a review. Injury international Journal of Care injured 2006 April;37:691-697.

20. Mcnulty SL. Pattern and distribution of fractures in the William M. Bass and Hamann-Todd osteological collections [Master's]: University of Tennessee; 2009.

21. Alvrus A. Fracture patterns among the nubians of Semna South Sudanese, Nubia. International Journal of Osteoarchaeology 1999;9:417-29.

22. Busch H.M, Cogbil T.H, Landercasper J et al. Blunt bovine and Equine trauma. The Journal of trauma 1986 June;26(6):559-560.

23. Garraway WM,Stauffer RN,Kurland LT,et al. Limb fractures in a defined population.I. Frequency and distribution. Mayo Clinic Proceedings 1979 Nov;54(11):701-7.

24. Grisso JA,Wishner AR,Schwarz DF,et al. A population -based study of injuries in inner-city women. American Journal of Epidemiology 1991 July;134(1):59-68.

25. Jonsson B, Gardsell P, Johnell O,et al. Differences in fracture pattern between an urban and rural population: a comparative population-based study in southern Sweden. Osteoporosis international 1992 November;2(6):269-73.

26. Matthew PK,Kapua K, Soaki PJ,et al. Trauma admissions in the southern highlands of Papua New Guinea. Australian and New Zealand Journal of Surgery 1996 October;66(10):659-63.

27. Neves W,Barros A,Costa M. Incidence and distribution of postcranial fractures in the prehistoric population of San Pedro De A Tacama, Northern Chile. American Journal of Physical Anthropology 1999;109:253-58.

28. Scalea T,Goldstein A, Phillips T,et al. An analysis of 161 falls from a height: the 'jumper syndrome'. Journal of trauma 1986 Aug;26(8):706-12.

29. Teh J,Firth M,Sharma A, et al. Jumpers and fallers: a comparison of the distribution of skeletal injury. Clinical Radiology 2003 June;58(6):482-6.

30. Sabiston C, Wing P. Sacral fractures: Classification and neurological implications. The Journal of trauma 1986;26(12):1113-15.

31. Jacobs GD,Sayer I. Road accidents in developing countries. Accident analysis and prevention 1983;15(5):337-53.

32. Adams JC, Hamblen D, editors. Outline of fractures, including, joint injuries. 11th ed. New York; 1999.

33. Conroy C, Schwartz A, Hoyt D.B, et al. Upper extremity fracture patterns following motor vehicle crashes differ for drivers and passengers. Injury- International Journal of the Care of the injured 2007;38:350-7.

34. Norberg E. Injuries as a public health problem in sub-Saharan Africa: epidemiology and prospects for control. East Africa Medical Journal Dec 2000;77(12 Suppl):S1-43.

35. Rosana Norman RM, Pam G, Debbie B. The high burden of injuries in South Africa. Bulletin of the World Health Organization 2007;85:695-702.

36. Bhatti AM, Ajaib MK, Masud Ti et al. Road Traffic Injuries in Pakistan: Challenges in estimation through routine hospital data. Journal of Ayub Medical College Abbottabad 2008 Jul - Sep;20(3):108 - 11.

37. Kahlon I.A, Hanif A, Awais SM et al. Analysis of Emergency Care of Trauma Patients with References to the Type of Injuries, Treatment and Cost. Annals Jan - Mar 2010;16(1).

38. Galukande M JJ, Fualal J, Gakwaya A. Boda-boda injuries a health problem and a burden of disease in Uganda: a tertiary hospital survey. East and central African Journal of Surgery 2009;14:33-37.

39. Naddumba EK. Musculoskeletal Trauma Services in Uganda. Clinical Orthopaedics and Related Research 2008 October;466(10):2317-2322.

40. Naddumba EK. a cross-sectional retrospective study of bodaboda injuries at mulago hospital in kampala. East and central African Journal of Surgery 2004;9:44-47.

41. Mwachiro M KN, Karoney M. Analysis of Motorcycle accidents and associated injuries at Tenwek Mission Hospital. In: Tenth Annual Scientific Conference; March 2010; Nyali Beach Hotel, Mombasa; March 2010.

42. World Health Organization. Global status report on road safety: time for action. Geneva: World Health Organization; 2009.

43. Odera W, Khayesi M, Heda PM. Road traffic injuries in Kenya: magnitude, causes and status of intervention. International Journal of injury Control and Safety Promotion 2003;10(1-2):53-61.

44. Saidi HS KP. Experience with road traffic accident victims at the nairobi hospital. East African Medical Journal 2001;78(8):441-4.

45. Eric Osoro Mogaka, Zipporah Ng'anga, Joseph Oundo, et al. Factors associated with severity of road traffic injuries, Thika, Kenya. The Pan African Medical Journal March 2011;8(20).

46. Melton L, Crowson C, o'fallon W. Fracture incidence in Olmsted county, Minnesota: Comparison of urban with rural rates and changes in urban rates over time. Osteoporosis international 1999;9:29-37.

47. Sanders K.M, Nicholson G.C, Ugoni A.M,et al. Fracture rates lower in rural than urban communities: the Geelong Osteoporosis Study. Journal of Epidemiology Community Health 2002 June;56(6):466-70.

48. Soggard A.J,Gustad T.K, Bjerthesse E,et al. Urban-Rural differences in distal forearm fractures: Cohort Norway. Osteoporosis international 2007 August;18(8):1063-72.

49. Breiting V.B,Helweg-Larsen K, Staugaard H,et al. Injuries due to deliberate violence in areas of Denmark. V. Violence against women and children. copenhagen study group. Forensic Science International 1989 June;41(3):285-94.

50. Gunay Y, Acar-Vaizoglu S, Gulen C. Evaluation of non-fatal injuries with relation to where assault occur. Turkish Journal of Medical Science 2001;31:345-354.

51. Alffram P.A, Bauer G.C. Epidemiology of fractures of the forearm. A biomechanical investigation of bone strength. The Journal of Bone and Joint Surgery 1962 January;44(A):105-14.

52. Balon W.E, Hadden W.C. Occurence of hip fractures and socioeconomic position. Journal of Aging and Health 2000;12:193-203.

53. Charles M, Cherian M.N. The Global Burden of Musculoskeletal Injuries: Challenges and Solutions. Clinical Orthopaedics Related Research October 2008;466(10):2306 - 2316.

54. Nzegwu M.A, Aligbe J.U, Banju et al. Patterns of morbidity and mortality amongst motorcycle riders and their passenger in Benin - city Nigeria. Annals of African medicine 2008;7:82-85.

55. Jivanjee M. Accident time and social demographic impact on severity of injuries among patients involved in motorcycle accidents at Kenyatta National Hospital: University of Nairobi; 2012.

56. Zettas JP, Zetta P, Thanosophon B. Injury patterns in motorcycle accidents. Journal of trauma November 1979;19(11):833-6.

57. Cawich S, Rose R, Harding H, et al. Extremity injuriesfrom motorcycle road traffic accidents: the experince from a tertiary refferal hospital in Jamaica. the Internet Journal of emergency Medicine 2009;5(1).

58. Jeffers RF, Boon T, Nicolopoulos C. Prevalence and patterns of foot injuries following motorcycle trauma. Journal of orthopaedic Trauma 2004;18(2).

59. Schuller E, Beir G, Spann W. Disability and impairment of protected and unprotected motorcycle riders. In: SAE international Congress and Exposition Crash Injury Impairment and Disability, Long Term Effects; 1986; Detroit, MI, Warnendale; 1986. p. 51-56.

60. Malhotra C, Singh M, Garg S et al. Pattern and severity of injuries in victims of road traffic crashes attending a tertiary care hospital of Delhi. Anil Aggrawal's internet journal of forensic Medicine and toxicology 2005;6(2).

61. Mugambi K. Pattern and management of assault trauma at KNH. Nairobi: University of Nairobi; 1993.

62. Solagberu B.A, Ofoegbu C, Nasir AA et al. Motorcycle injuries in a developing country and the vulnerability of riders, passengers and pedestrians. Injury prevention 2006;12:266-268.

63. Singer B.R, McLauchlan G.J, Robinson C.M, et al. Epidermiology of Fractures in 15000 adults: the influence of age and gender. Journal of Bone and Joint Surgergy (Br) March 1997;1998(80-B):243 -8.

64. Buhr A.J, Cooke A.M. Fracture patterns. Lancet 1959 March;14(1):531-6.

65. Odero WO, Kibosia JC. Incidence and characteristics of injuries in Eldoret, Kenya. East African Medical Journal 1995;72(11):706-10.

66. Andrews CN K, Lett R. Road Traffic accident injuries in Kampala. East Africa Medical Journal 1999;76(4):189-94.

67. Chalya P, Mabula J. Motorcycle injuries as an emergency public health problem in mwanza city, Tanzania. A call for urgent intervention. Tanzania Journal of Health Research 2006;12(4).

68. Odero W, Garner P, Zwi Road traffic injuries in developing countries. a comprehensive review of epidermiological studies. Tropical Medicine & International Health 1997;2(5):445-60.

69. Cochran, W.G.1977. Sampling techniques. John Wiley & Sons, Inc., New York, 3rd edition., 428pp.

CHAPTER 6 : APPENDICES

APPENDIX 1: STATEMENT OF CONSENT

This Informed Consent form is for patients who present to KNH with fractures during the study period. The title of the study "Pattern of adult appendicular skeleton fractures at a teaching and referral hospital"

Principal investigator: Dr. Waithiru Peris

Institution: School of Medicine, Department of Orthopaedics- University of Nairobi

Supervisors: Dr Edward Gakuya & Dr Ezekiel Oburu

This informed consent has three parts:

1. Information sheet (to share information about the research with you)
2. Certificate of Consent (for signatures if you agree to take part)
3. Statement by the researcher

You will be given a copy of the full Informed Consent Form.

Part I: Information sheet

Introduction

My names are Waithiru Peris, a Post-Graduate student at the University of Nairobi's School of Medicine. I am carrying out a study to determine the distribution of appendicular skeleton fractures among the adult patients who present to Kenyatta hospital.

Study purpose

The purpose of this study is to determine the fracture distribution, severity and risks factors of patients seen at KNH Accident &Emergency department. It also aims to determine the common causes of fractures in our setting. The information gathered will be used to help improve on the care given, improve on policies addressing the common causes of fractures as well as influence management.

Study procedure

I am inviting you to participate in my study and you are free to either agree to participate or decline. You will be given the opportunity to ask questions before you decide and you may talk to anyone you are comfortable with about the research before making a decision. After receiving this information concerning the study, please seek for clarification from either myself or my assistant if there are words or details which you do not understand.

If you agree to participate, you will be asked to provide personal information and will be re-examined by the research assistant (medical officer) or myself Dr Waithiru (primary investigator). All the information which you provide will be kept confidential and no one but the researchers will see it. The information about you will be identified by a number and only the researchers can relate the number to you as a person. Your information will not be shared with anyone else unless authorized by the Kenyatta National Hospital/University of Nairobi – Ethics and Research Committee (KNH/UoN-ERC).

Risk

Your involvement in this research will not expose your to any risks if you consent to participate.

Benefits

By agreeing to take part in the study you will be part of a scientific process that can potentially improve our understanding of circumstances leading to fractures and common sites involved thus influence management.

Compensation

Your participation in this study is voluntary and there will be no compensation in taking part.
All the information that you give us will be used for this research only.

Alternative to participation

Those who decline to participate in this study will not be denied treatment they deserve because of their decision not to participate nor will it affect their future relationship with KNH.

All patients who meet the inclusion criteria are being invited to participate.
This proposal has been reviewed and approved by the KNH/UON-ERC which is a committee whose work is to make sure research participants like yourself are protected from harm. It was submitted to them through the Chairman of the Department of Orthopaedics at School of Medicine of the University of Nairobi with the approval of the two university supervisors. The

contact information of these people is given below if you wish to contact any of them for whatever reason;

- Secretary, KNH/UoN-ERC
  P.O. Box 20723 KNH, Nairobi 00202
  Tel 726300-9
  Email: KNHplan@Ken.Healthnet.org

- Chairman,
  Department of Orthopaedics, School of Medicine– University of Nairobi
  P.O. Box 19676 KNH, Nairobi 00202
  Tel # 0202726300

University of Nairobi research supervisors

- Dr Edward Gakuya,
  Department of Orthopaedics, School of Medicine, University of Nairobi
  P.O. Box 19676 KNH, Nairobi 00202
  Tel #0721932799

- Dr Ezekiel Oburu,
  Department of Orthopaedics, School of Medicine, University of Nairobi
  P.O. Box 19676 KNH, Nairobi 00202
  Tel #0708728060

- Principle researcher:
  Dr. Waithiru Peris,
  Department of Orthopaedics, School of Medicine, University of Nairobi
  P.O. Box 19676 KNH, Nairobi 00202
  Mobile phone # 0721562084

Part ii: Consent certificate

I…………………………………………………..freely give consent of myself to take part in the study conducted by Dr. Waithiru Peris, the nature of which has been explained to me by her/her research assistant. I have been informed and have understood that my participation is entirely voluntary and I understand that I am free to withdraw my consent at any time if I so wish and this will not in any way alter the care being given to me. The results of the study may directly be of benefit to me and may assist in reducing fracture occurrence or improve management.

…………………………………………………………………

Signature/left thumb print (Participant)

Date…………………………………………………………

Day/Month/Year

Thumb print of participant if illiterate (a witness must sign below)

Statement by the witness if participant is illiterate:

I have witnessed the accurate reading of the consent form to the participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness…………………………………………………………………

Signature of witness…………………………………………………………….

Date…………………………………………………………

Day/Month/Year

Part iii: Statement by the researcher

I have accurately read out the information sheet to the participant, and to the best of my ability made sure that the participant understands that the following will be done:

- Refusal to participate or withdrawal from the study will not in any way compromise the care of treatment.
- All information given will be treated with confidentiality.
- The results of this study might be published to facilitate understanding of adult appendicular skeleton fractures mechanism of injury, distribution anatomical and by severity.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this Informed Consent Form has been provided to the participant.

Name of researcher taking consent……………………………………………………

Signature of researcher taking the consent……………………………………………

Date………………………………………………………………………………………

Day/Month/Year

APPENDIX II: FRACTURE DISTRIBUTION QUESTIONAIRE

BIODATA

IP NO **STUDY NO.**

X RAY NO

Fill in the following details:

Patient particulars.

1. **NAME**
2. **AGE**
3. **SEX (tick where relevant) MALE**
   FEMALE
4. **RESIDENCE**
5. **VILLAGE COUNTY**
6. **PHONE NUMBER**

Next of kin/ Guardian

7. **NAME**
8. **RELATION**
9. **PHONE NUMBER**

TRAUMA DETAILS

10. Does the patient have a fracture? *(tick one)*

YES **NO**

11. If yes, is/ are the fracture(s)? *(tick one)*

SINGLE **MULTIPLE**

12. If multiple how many in number?

13. What type of fractures are they? (tick where relevant)

CLOSED **COMPOUND**

ANATOMICAL SITE

14. Which is the fractured bone on x-ray film? (tick where relevant and fill in from the attached map OTA class)

UPPERLIMB	LEFT	RIGHT
Humerus OTA CLASSIFICATION		
Clavicle OTA CLASS		
Scapula OTA CLASS		

Radius/ Ulnar OTA CLASS		
Carpal bones (state which) OTA CLASS		
Metacarpal bones (state which) OTA CLASS		

LOWERLIMB	LEFT	RIGHT
Femur OTA CLASSIFICATION		
Tibia/ Fibula OTA CLASS		
Patella		
Talus		
Calcaneus		
Tarsal bones (state which) OTA CLASS		
Metatarsal bones (state which) OTA CLASS		

MECHANISM OF INJURY

15. How did you get the fracture? (chose one)

- ☐ **Road Traffic Accident (motor vehicle, motorbike, bicycle, tuk-tuk etc)**

  If it was an RTA were you a; (chose one)

  - ☐ **Pedestrian**
  - ☐ **Driver**
  - ☐ **Passenger**

- ☐ **Gunshot**
- ☐ **Occupation related**
- ☐ **Fall**
- ☐ **Sport injury**
- ☐ **Assault/ Direct blow**
- ☐ **Other (specify) ____________________________________**