THE UNIVERSITY OF NAIROBI

TITLE

DISTRIBUTION, PATTERNS AND SEVERITY OF MUSCULOSKELETAL INJURIES AMONG MOTORCYCLE CRASH VICTIMS AT KENYATTA NATIONAL HOSPITAL

BY
KIGOTHO JAMES NG'ANG'A
H58/81464/2015

A dissertation submitted in partial fulfillment of the requirements for the award of degree of Master of Medicine (MMed) in Orthopaedic Surgery in the University of Nairobi

DECLARATION

DECLARATION BY CANDIDATE

1. I understand what plagiarism is and I am aware of the University's policy in this regard.

2. I declare that this dissertation is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other peoples' work or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.

3. I have not sought or used the services of any professional agencies to produce this work.

4. I have not allowed and shall not allow anyone to copy my work with the intention of passing it off as his/her own work.

5. I understand that any false claim in respect of this work shall result in disciplinary action in accordance with University Plagiarism Policy.

Signature .... Date .... 10th Nov 2021

Kigotho James Ng'ang'a.
Registration number: H58/81464/2015
Tel: +254710490850
Email: kigotho@gmail.com

APPROVAL BY SUPERVISORS

This dissertation has been submitted for examination with our approval as university supervisors.

1. Signature..Date....11/11/2021..............

Kirsteen Ondiko Awori: MBChB. MMed (Surgery). Dip. (SICOT). FCS (Orth.) ECSA.

Senior Lecturer. Department of Human Anatomy. College of Health Sciences. University of Nairobi;

And Consultant Orthopaedic & Spine Surgeon. Kenyatta National Hospital.

Email: kawori@uonbi.ac.ke

2. Signature..Date....11th Nov 2021.

Vincent Muoki Mutiso: MBChB. MMed (Surgery). Certificate In Microsurgery (Hand). Fellow AO-International. FCS (ECSA).

Senior Lecturer, Department of Orthopaedic Surgery. College of Health Sciences. University of Nairobi;

And Consultant Orthopaedic & Trauma Surgeon. Kenyatta National Hospital.

Email: mutiso@uonbi.ac.ke

DEPARTMENTAL APPROVAL

This is to certify that this is the original work of Dr. Kigotho James Ng'ang'a, a Master of Medicine in Orthopaedic Surgery student at the University of Nairobi. This research was carried out at the Kenyatta National Hospital.

This dissertation is hereby submitted with approval of the chairman.

DEPT. OF ORTHOPAEDIC SURGERY
COLLEGE OF HEALTH SCIENCES
P. O. BOX 19676 - 00200 KNH
NAIROBI
TEL: 2720940 / 2726300, Ext. 43850

Signature.. Date 16th Nov 2021.

Vincent Muoki Mutiso

Chairman, Department of Orthopaedic Surgery,

College of Health Sciences,

University Of Nairobi.

Email: mutiso@uonbi.ac.ke

DEDICATION

I dedicate this dissertation to my lovely wife, Emily, and our children; Naomi, Jane, Jonathan and Zoey who suffered but tolerated my absence during the process of writing this dissertation. The unwavering support and encouragement from my family was a pillar on which my inspiration lay.

ACKNOWLEDGEMENT

I wish to express my profound gratitude to my supervisors Dr. Vincent Mutiso and Dr. Kirsteen Awori for their guidance, patience and valuable support during this study. During the preparation as well as writing of this dissertation, I immensely benefitted from their vast knowledge and yielded to their valuable guidance. Sincere gratitude to the Department of Orthopaedics and the KNH-UoN Ethics and Research Committee for allowing me to carry out this study. My heartfelt appreciation to all the patients who volunteered to participate in this study, without whom it would not have been possible. Finally, I sincerely thank Kenyatta National Hospital for sponsoring me to study Orthopaedic Surgery at the University of Nairobi. That said, I own with responsibility any errors and omissions in this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

KNH	Kenyatta National Hospital
ERC	Ethics and Research Committee
RTC	Road Traffic Crashes
MSI	Musculoskeletal Injury
MCC	Motorcycle crashes
GNP	Gross National Product
RTI	Road Traffic Injuries
LMIC	Low and Middle Income Countries
HIC	High Income Countries
SES	Social Economic Status
DALYs	Disability Adjusted Life Year (1 DALY = loss of 1 year of healthy life)
AO/OTA	ArbeitsgemeinschaftfurOsteosynthesefragen/ Orthopaedic Trauma Association
SPSS	Statistical Package for Social Sciences
UON	University of Nairobi
ORIF	Open Reduction internal Fixation
MCC	Motorcycle Crash
GCS	Glasgow Coma Scale
KNBS	Kenya National Bureau of Statistics
NTSA	National Transport and Safety Authority
NHTSA	National Highway Transport Safety Administration
WHO	World Health Organization

STUDY DEFINITIONS

Fractures as complete or incomplete breach of the bone cortex.

Fracture complexity was assessed and classified according to Muller and OTA [1].

Open fractures were scored according to the modified Gustilo-Anderson classification [2].

Musculoskeletal injuries referred to fracture/dislocation injuries with or without soft tissue injuries.

Axial skeleton included the spine and ribs.

Appendicular skeleton included clavicle, scapula, humerus, radius, ulna, the hand (upper limb), pelvis, femur, patella, tibia, fibula and foot (lower limb).

Distribution referred to the injury distribution in the anatomical regions, e.g. spine, lower extremity, pelvis, upper extremity among others.

Motorcycle was a two wheeled motorized vehicle with engine capacity of more than 125 cc.

Motor vehicle referred to a four or more-wheeled motorized vehicles.

Motorcycle rider was the person operating the motorcycle.

Motorcycle pillion passenger referred to a passenger on a motorcycle.

Motorcycle crash referred to a road traffic event that lead to injury to the motorcycle rider, motorcycle pillion passenger, pedestrian or destruction of property.

Pedestrian referred to a person involved in a motorcycle crash while using the road used by motorized vehicles.

Motorcycle crash victim referred to a person injured in a motorcycle-related crash.

Bodaboda: A Kiswahili term used in Kenya in reference to motorcycles that used to ferry people across the Kenya-Uganda boarder, referred to a motorcycle used for commercial purposes to ferry goods and/or passengers.

ABSTRACT

Background: Road traffic crash injuries constitute a major public health burden and has led to an increase in morbidity, disability and mortality for the victims. Motorcycle crashes (MCC) contribute a large proportion of road traffic crashes (RTC) in Kenya. Use of motorcycles as a means of transport has increased explosively in the last decade due to their affordability and convenience. Road traffic crashes due to MCC have also concomitantly increased, with an increased burden in trauma management at hospitals and the health care system in Kenya as a whole. The injuries include musculoskeletal trauma which result in debilitating and life threating injuries to the victims. MCC-related musculoskeletal injury distribution, fracture patterns, severity as well as mechanisms of injury are not well described in Kenya and local studies describing the injuries are scarce.

Study objective: To determine the distribution, patterns and severity of musculoskeletal injuries among motorcycle crash victims at Kenyatta National Hospital.

Study design and setting: Descriptive prospective cross-sectional study at Kenyatta National Hospital.

Study population: All motorcycle riders, pillion passengers and pedestrians involved in motorcycle crashes presenting at KNH A&E Department, admitted in Orthopaedic wards and ICU with musculoskeletal injuries between April and June 2021.

Methods: One hundred and twenty six consecutive patients with motorcycle crash-related musculoskeletal injuries were prospectively studied. Data were obtained by interviews, physical and radiological examination and recorded in a pre-designed questionnaire. The data were stratified and analyzed on age, sex, anatomical fracture distribution, mechanism of injury, pattern and severity of fractures classified under AO/OTA classification and Gustilo-Anderson open fracture classification, associated injuries and type of protective gear used by the operators and the pillion passengers. Data analysis was done using Statistical Package for Social Sciences (SPSS®)

version 27.0 software. Descriptive statistics were presented in tables, graphs and charts. Level of statistical significance was set at ≤ 0.05 (p-value less than 0.05).

Results: A total of 126 patients were recruited into the study. Majority (85.6%) of them were males (M:F ratio 6:1). The mean age of the patients was 31.6±10.5 years with an age range of 11-61 years. The patients had sustained a total of 225 fractures. Lower limb fractures accounted for 82.1% (n=225), upper limb fractures 11.2%, with spine and pelvis accounting for 6.7%. The commonest bone injured was the femur (27.7%), followed by tibia/fibula (23.2%) with diaphyseal fractures being predominant. Most of the fractures were closed (57.9% n=225) and more than half of the patients had sustained a single fracture (51.6% n=126). The commonest crash type was collision with motor vehicle (53.2% n=126) and the most common crash mechanism of injury was collision type (61.1%). Head injury among the patients was the most common associated injury with 12.7% (n=126) of the patients suffering concomitant head injury, followed by thoracic and maxillofacial injuries. Use of helmets and luminous jackets among the operators was high (83.1%) but was found to be low (18.8%) among the pillion passengers.

Conclusion: Motorcycle crash-related musculoskeletal injuries are an increasing burden to the healthcare system in Kenya and the young economically active male is predominantly affected. The motorcycle operators suffered the most fractures. Lack of training and licensing was a common finding among motorcycle operators with almost half holding no valid riding/driving license. The lower limbs sustained more fractures, with the femur most commonly affected followed by tibia/fibula in the regional distribution. Most of the fractures were diaphyseal fractures, transverse and oblique in pattern. The tibia/fibula suffered more open fractures, with the most common associated injury being head injury. There was high usage of helmets and luminous jackets among the motorcycle operators, but use of other protective equipment was poor. Use of helmets or other protective gear was almost non-existent among the pillion passengers.

1. INTRODUCTION

1.1. Background

Road traffic crash injuries are considered a public health burden globally due to the resultant increase in mortality, morbidity and disability. This has largely been attributed to the rapid motorization and advanced industrialization. This translates to increase in health care expenses and reduced productivity due to suboptimal functional outcome. Studies show the largest casualty consists of young adult males, with their dependents experiencing untold suffering. Worldwide, an estimated 1.35 million people die in road RTC each year and between 50 and 60 million more are injured or disabled [3,4]. Despite the lower level of motorization, most of the burden of road traffic injuries is borne by the low and middle income countries (LMIC), accounting for more than 85% of the deaths and 90% of the annual disability adjusted life years (DALYs) lost because of RTC injuries. This is despite LMIC having 54% of the worlds motor vehicles [3].

According to WHO Road Safety report, Africa accounted for the highest mortalities in RTC per 100,000 population. The risk of death as a result of RTC is highest in the African region at 26.6 per 100,000 population compared to Europe that had 9.3 per 100,000 population [5]. Over 50% of the world's road traffic fatalities occur among pedestrians, cyclists and motorcyclists. These also include the majority of those who get injured in RTC and consist of categories of least protected road users, with motorcyclists at 23%, pedestrians at 22% and cyclists at 6% [4,5]. In Kenya, RTC contribute highly to cause of death, being second among the youth (15-29 years) and third cause of death among 30-44 years old people [6,7]. Furthermore, more than 3,000 people are killed in RTC yearly and thousands more left incapacitated and maimed with about 24-40% of the deaths resulting from MCC related injuries. This raises important questions as to the gaps existing to curb such high mortality and morbidity rates in MCC despite all the measures put in place to reduce the incidences. The steep rise of MCC has even forced hospitals to allocate special wards to carter for the increasing burden of motorcycle crash related injuries. This poses a significant cost burden on the victims and the health care system as a whole [10].

The motorcycle is a very risky mode of transportation due to its lack of both internal and external protection. It is inherently unstable and poses increased injury risk to the riders [17]. Studies have shown that per vehicle mile travelled, a motorcyclist is 26 times more likely to suffer fatal injuries than a motor vehicle occupant in road traffic crashes, and more than 5 times more likely to be injured in a RTC [33].

Musculoskeletal injuries are responsible for severe morbidity, disability and even death among motorcyclists. Musculoskeletal trauma includes injuries occurring to the spine, pelvis and extremities. The injuries include fractures, dislocations, soft tissue injuries, crush injuries, joint injuries, sprains and strains, contusions, traumatic amputations among others. Musculoskeletal trauma injuries account for more than 85% of patients who sustain blunt trauma [69]. These injuries can be dramatic, debilitating and even life threatening. Fractures in musculoskeletal injuries result from either direct trauma, of which RTC form a large proportion, repetitive stress or following abnormal weakening of bone [62]. In MCC, these injuries result from collisions with other motor vehicles, motorcycles, terrain, handcarts, pedestrians and falls.

There has been an influx of motorcycles as a popular means of transport in Kenyan cities in the last decade. Data from National Transport and Safety Authority shows an increase from 280,000 registered motorcycles in 2010 to more than 2 million registered in 2020 [29]. The infrastructure has remained relatively constant during this time, with no special lanes for motorcycles being constructed. Training of the motorcycle riders on traffic rules and regulations has also not kept up with the rising numbers, with a large number of the motorcyclist riders having no formal training, and thus are not holders of valid driving/riding licenses [26, 31,32]. The situation is made worse by lack of protective gear for the motorcyclist, either out of ignorance or total disregard of the traffic rules and regulations [26]. This has resulted in an increase in motorcycle crashes and thus a rise in burden of injury resulting from these crashes. Most of these injuries are musculoskeletal injuries, and there is paucity of reliable local and regional data on motorcycle crash-related musculoskeletal injury patterns and severity. The enormity of this health problem in Kenya has not received the attention it deserves and needs to be highlighted in an effort to elicit a response in policy formulation.

Motorcycle crash related musculoskeletal injuries are preventable and therefore, it is important that an understanding of the distribution, injury patterns, severity and common mechanisms of injury is established. This will greatly enhance the development of prevention strategies and also development of sound treatment protocols of MCC-related musculoskeletal injuries. Few hospital based studies have been conducted on burden of MCC-related musculoskeletal injuries in Kenya. Therefore, the study sought to avail statistics of MCC-related musculoskeletal injuries as seen at KNH; a level 6 teaching and referral hospital in Kenya. The study also sought to determine the fracture distribution, patterns and severity and mechanisms of injury in motorcycle crash related injuries.

1.2. Problem statement

Motorcycle crash (MCC) related injuries contribute a major proportion of road traffic crash (RTC) injuries globally and cause significant mortality, morbidity and disability with disproportionate numbers occurring in developing countries [12]. In Kenya, there has been a rapid increase in the number of registered motorcycles in the last decade, and a concomitant rise in MCC-related injuries. Hospital based studies have reported motorcyclists represent 19-39% of all RTC injuries in Kenya. Deaths from these crashes have also been on the rise, with motorcyclist accounting for 13.5% of all RTC deaths in 2014, compared to 9.7% in 2013 [37]. Data from the WHO shows in 2018, motorcyclists accounted for 24% of all road traffic crash deaths [5].

Musculoskeletal injuries cause severe morbidity, long term disability and even death among motorcycle users [31]. The socioeconomic implications of these injuries are of research interest in many countries concerning prevalence, distribution, patterns, severity, mechanisms of injury, risk factors and how these may be treated and mitigated. Most of these injuries are preventable, and in order to prioritize the limited resources available, the country needs to formulate policies that focus on prevention so as to reduce their occurrence and severity. This data may play an evidentially role showing the magnitude of the problem. The study therefore aimed to describe the distribution, patterns and severity of musculoskeletal injuries sustained in motorcycle crashes presenting at Kenyatta National Hospital in Kenya.

1.3. Study question

What is the musculoskeletal injury distribution, patterns and severity among motorcycle crash victims at Kenyatta National Hospital?

1.4. Study objectives

1.4.1. Broad objective

To determine the distribution, patterns and severity of the motorcycle crash-related musculoskeletal injuries at Kenyatta National Hospital.

1.4.2. Specific objectives

1. To determine the age and sex of patients with MCC-related musculoskeletal injuries.
2. To determine the anatomical distribution of MCC-related musculoskeletal injuries.
3. To determine the mechanisms of injury in MCC-related musculoskeletal injuries.
4. To determine the pattern and severity of MCC-related musculoskeletal injuries based on AO/OTA classification.
5. To determine the associated injuries in MCC-related musculoskeletal injuries.
6. To determine protective gear use by motorcycle riders and pillion passengers with MCC-related musculoskeletal injuries.

1.5. Conceptual framework

The independent variables of rider class, crash type, crash mechanism of injury, protective gear and training of the motorcycle rider influence the dependent variables. This influences the anatomical site injured, pattern and severity of the injury and even the associated injuries. The intermediate variables including age, sex, occupation and level of education influence the risk taking behaviour of the motorcycle riders and even the pillion passengers. Female sex may tend to be more cautious, with the more educated people being more likely to wear protective gear when using motorcycles, thus mitigating the severity of injuries sustained. Motorcycle riders employed in the sector are more likely to be in a RTC than those who ride for recreational purposes. Analysis of protective gear and the injury pattern and severity sustained showed how the two variables correlate.

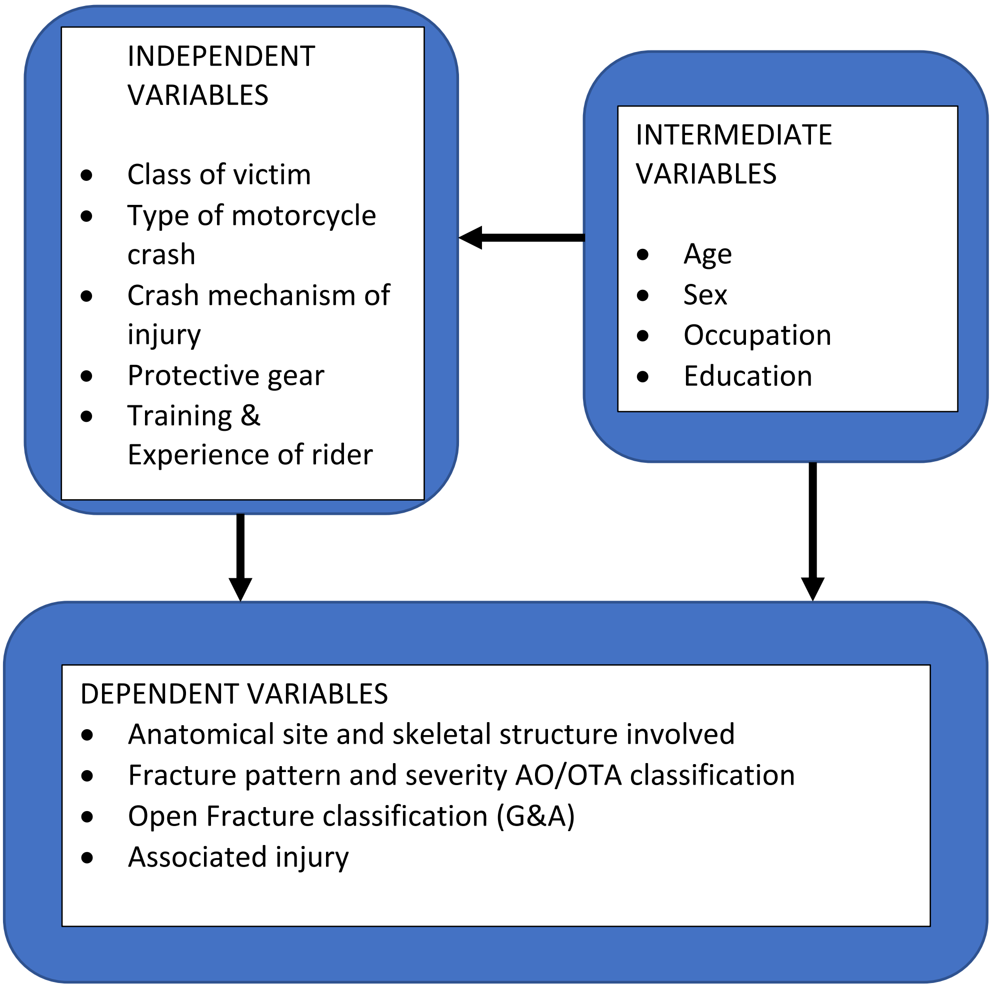


Figure 1: The conceptual framework model for determining distribution, patterns and severity of musculoskeletal injuries in motorcycle-related crashes.

1.6. Study justification and significance

Motorcycle crashes are a major contributor to musculoskeletal injuries in Kenya, with increasing mortality and morbidity albeit implementation of safety measures and road safety campaigns to try and curb the rising number of incidences. Despite the importance of the problem, the musculoskeletal injuries resulting from motorcycle crashes have not received the attention deserved. Young economically active members of the society are impacted heavily in premature disability and mortality especially among the male sex in MCC-related musculoskeletal injuries.

There is limited knowledge with paucity of data on the distribution, patterns and severity of musculoskeletal injuries related to motorcycle crashes locally. Studies on the musculoskeletal fracture patterns and severity have rarely been done as most studies concentrate on general pattern of injuries of road traffic crashes and the associated health burden [11,13]. To add to the body of knowledge on the subject, the study aimed to determine the injury distribution, pattern and severity of musculoskeletal injuries related to MCC at Kenyatta National Hospital. The mechanism of injury, use of safety gear as well as associated injuries were described.

It is hoped the findings of the study may be used to influence policy development on use of safety gear to aid in mitigation of motorcycle crash-related musculoskeletal injuries. Determination of crash mechanism of injury may aid in predicting the severity of the injury, as well as offer pointers on the gaps that exist in an effort to reduce the incidences and mitigate the severity of the injuries. This may also influence development of sound treatment guidelines by clinicians especially in MCC-related orthopaedic injuries. The findings may also provide statistics to influence policy formulation by administrators in health management, and may also be used as a baseline for future related research on the impact of MCC-related musculoskeletal injuries outcomes and related economic burden. The desired outcome is reduction and prevention of MCC-related musculoskeletal injuries, disability and mortality among motorcyclists in Kenya.

2. LITERATURE REVIEW

2.1. The burden of road traffic crash injuries

Globally, road traffic crash injuries are a growing public health problem. The number of road traffic fatalities remains unacceptably high globally. More than 1.35 million people die in RTC annually. In addition between 50 and 60 million more are injured, whilst those suffering major injuries survive with long term adverse health issues [3, 5]. Road traffic crash injuries are the leading cause of death among young people (15-29 years) and eighth leading cause of death across all age groups globally [5]. These injuries are estimated to become the seventh leading cause of death amongst all age groups by the year 2030 [5].

WHO road safety report [5] shows that occurrence of RTC and deaths is as follows: motorcyclists 23%, Pedestrians 22%, bicyclists 6%, motor vehicles 49%. Most of this burden of the global road traffic injuries is borne by the LMIC, which account for more than 85% of the deaths and more than 90% of the annual DALYs lost because of RTC injuries, despite having only 53% of the world's motor vehicles [3]. Africa accounted for the highest mortalities in road traffic crashes per 100,000 population. This was estimated at 26.6 per 100,000 population, compared to Europe that had 9.3 per 100,000 population. The global average rate for road traffic deaths is 17.5 per 100,000 population [3].

In East Africa, Tanzania and Kenya showed the highest RTC mortality rates per 100,000 population at 34.4 and 34.3 deaths per 100,000 population respectively. Other countries in east Africa showed a rate of 31.6, 24.7 and 23.4 deaths per 100,000 population for Rwanda, Uganda and Burundi respectively [9]. About 3,000 deaths occur in RTC annually in Kenya, with thousands more left incapacitated. This exerts a huge burden on the families, the health care systems and the economy as a whole [10].

Worldwide, the economic burden of road traffic crashes is obvious. Around US$518 billion is spent on RTC injuries globally annually. The estimated consumption of this injuries is 1-2% of the gross national product (GNP), with HIC spending more than the LMIC. LMIC spend more resources on road traffic injuries than what was received in development assistance, and is estimated at US$ 65 billion annually [67]. Young families are left impoverished, with loss of breadwinners, added burden/cost of caring for disabled family member resulting from road traffic injury [3]. More than 50% of fatalities in RTC consists of motorcyclists, pedestrians and cyclists. These also include the majority of those who suffer injuries in road traffic crashes and consist of categories of least protected road users, with motorcyclists at 23%, pedestrians at 22% and cyclists at 6% of the fatalities in RTC globally [4, 5].

In developed countries, motorcycles are mostly used as recreation vehicles and leisure activities. Motorcycle racing is a popular sport in high income countries with competition such as Motor Grand Prix and Superbike being among the fan favorites [24]. However, in developing countries, motorcycles have become a popular means of commercial transportation of passengers and goods, and these commercial ventures have resulted in an explosion in their numbers. It is estimated that developing countries consume about 90% of the world motorcycle production each year [25]. This growing use has been attributed to socioeconomic reasons, ease of acquisition and convenience in negotiating traffic in congested cities and poorly maintained infrastructure. Ease of parking in the urban areas and their offer of cheap and convenient means of transport for passengers and deliveries has made motorcycles the transportation means of choice in many LMIC cities and towns [26].

The adoption of motorcycles as a popular means of transportation in the last decade in the developing countries has led to a concomitant increase in motorcycle crash injuries in these countries. In Eastern Africa region, a study in Uganda showed motorcycle crash injuries contribute about 73% of all RTC injuries in that country [35]. A study by Chalya et al. done in Tanzania found motorcycles accounted for more than 58.8% of the RTC injury cases [12]. This has been attributed to the popularity of motorcycles as a means of transportation because of their low cost in terms of fuel consumption, maintenance and fare in that country. In cities where traffic congestion especially during rush hour is a common occurrence, the ease of navigation by these two wheeled motorcycles has made them popular as a convenient means of transport within the cities and their environs [12].

In Kenya, there has been a constant increase in motorcycle registration since 2004, and a proportionate increase in MCC related injuries has also been reported [13, 36]. Comparative statistics trends by NTSA in 2014 reported a significant increase in motorcycle crashes, despite a noted decrease in overall number of accidents and deaths from other categories of vehicles [37]. Hospital based studies in Kenya have reported motorcycle crash related injury prevalence of about 19-39% among all road traffic crash injuries. [10, 27, 30].

2.2. Motorcycle use Kenya

Commonly referred to as 'Bodaboda', motorcycle use in Kenya has seen a steady rise as a popular means of commercial transport in the last decade [27]. The Kenyan Government introduced a waiver on import duty tax on imported motorcycles in 2008 in an effort at job creation for the youth. This led to a leap in motorcycle registration from 3,757 units in 2005 to more than a million 2016, with data from NTSA showing a yearly growth in new registration of 29%. [table 1 and 2] [29], indicating a significant increase in this two wheeled motor vehicle category. A concomitant increase in motorcycle crash related injuries and fatalities has also been noted among this road user category with an increase in fatalities occurring among motorcyclists at 51% annually and pillion passengers at 13% annually [13]. A report from NTSA shows a rising trend of motorcycle crashes (table 3) [6]. This is in agreement with a WHO report that showed between 2005-2011, the registration of motorcycles in Kenya increased almost 40-fold, with motorcycles accounting for more than 70% of all newly registered vehicles in 2011 [30]. The growth of motorcycles continued at a rate of 29% from 2011-2015, but still accounted for more than 50% of the total vehicles registered in Kenya. This was attributed to the rising demand in the popular newly created economic sector in transportation industry [29].

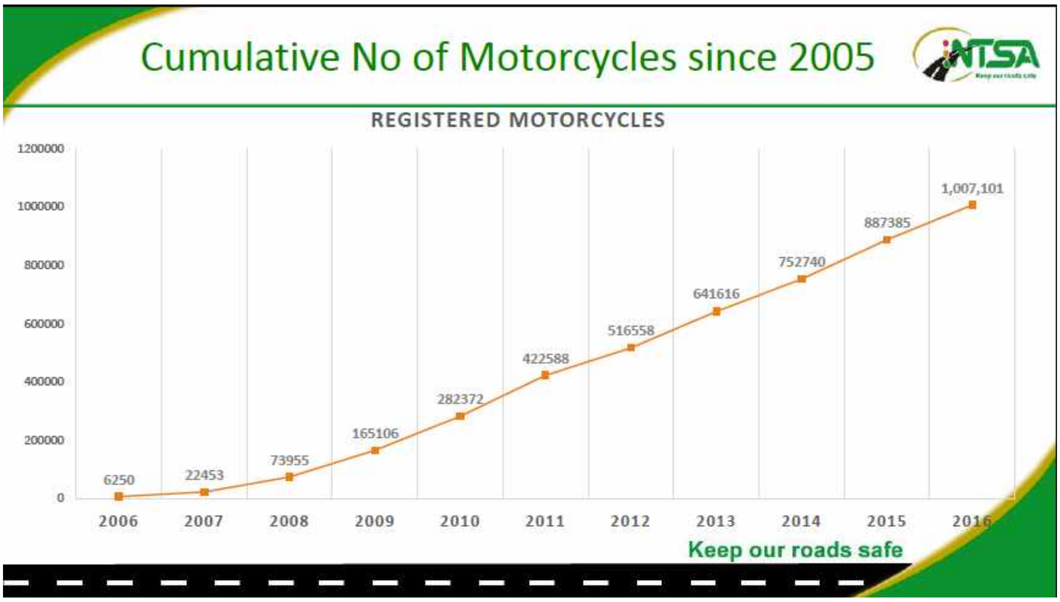


Table 1: Cumulative number of motorcycles registered by NTSA up to 2016

Source: National Economic survey, 2017.[29]

Type of Vehicle/Motor Cycle	2015	2016	2017	2018	2019*
Motor Vehicles					
Saloon Cars	14,369	12,490	11,376	10,504	9,971
Station Wagons	54,120	46,123	55,322	64,179	72,512
Panel Vans,Pick-ups,etc	13,878	12,722	9,866	11,220	10,189
Lorries/Trucks	13,785	9,632	7,460	6,514	6,518
Buses and Coaches	2,342	1,765	1,072	1,065	1,339
Mini Buses/Matatus	581	519	459	812	1,932
Trailers	3,905	2,829	1,953	2,083	1,639
Wheeled Tractors	2,259	2,478	2,703	4,040	1,815
Other vehicles	2,522	1,618	860	1,619	3,836
Sub-Total	**107,761**	**90,176**	**91,071**	**102,036**	**109,751**
Motor Cycles					
Motor and Auto Cycles	134,645	119,724	186,434	188,994	210,103
Three Wheelers	4,775	3,815	5,167	6,259	7,322
Sub-Total	**139,420**	**123,539**	**191,601**	**195,253**	**217,425**
Grand Total	**247,181**	**213,715**	**282,672**	**297,289**	**327,176**

Source: National Transport and Safety Authority

* Provisional.

Table 2: Registration on new motor vehicle and motorcycle 2015-2019

Source: National Economic Survey, 2020 [29]

TRAFFIC ACCIDENTS, 2004-2013

Table 129 — Number

Description	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*
Total Number of Reported Accidents	**10,717**	**12,399**	**12,201**	**12,470**	**11,209**	**12,369**	**9,771**	**8,193**	**6,917**	**6,205**
Persons Killed and Injured:										
Killed	2,264	2,531	2,715	2,921	3,158	4,072	3,055	3,302	3,141	3,191
Seriously Injured	6,751	7,899	8,722	8,932	9,206	10,644	9,327	8,647	7,434	6,299
Slightly Injured	11,858	12,341	11,828	13,735	12,162	11,906	9,739	7,144	5,037	4,834
Total	**20,873**	**22,771**	**23,265**	**25,588**	**24,526**	**26,622**	**22,121**	**19,093**	**15,612**	**14,324**
Vehicles Primarily Responsible:										
Motor cars	3,327	3,800	3,813	4,018	3,521	3,432	3,157	2,184	2,123	2,024
Lorries, buses and taxis	2,087	2,639	2,812	3,126	2,442	2,655	2,327	2,078	1,649	1,475
Motor cycles	313	363	346	432	688	1,292	852	622	496	505
Pedal cycles	1,045	1,146	1,193	927	925	810	554	760	589	360
Animals/Hand Carts	197	151	199	224	112	68	48	36	32	47
Matatus	1,680	1,786	1,749	1,463	1,484	2,099	1,025	905	587	488
Others	1,946	2,456	2,089	2,280	1,879	2,013	1,808	1,608	1,441	1,306
Persons Primarily Responsible:										
Drivers (Incl Motor Cyclists)	4,257	5,444	5,646	5,433	5,087	6,075	5,284	4,259	3,486	3,124
Pedestrians	2,628	3,035	2,676	3,089	2,577	2,450	947	1,071	725	620
Pedal Cyclists	1,369	1,545	1,408	1,288	1,343	1,257	1,159	936	912	819
Passengers	505	466	400	601	376	415	401	423	401	421
Other causes	1,958	1,909	2,071	1,790	1,826	2,172	1,980	1,504	1,393	1,221
Times of Accidents:										
Day	6,860	7,999	7,417	7,752	6,981	7,337	6,429	5,125	4,028	4,005
Nights	3,857	4,400	4,784	4,718	4,228	5,032	3,342	3,068	2,889	2,200

Table 3: Road traffic crashes data for 2004-2013 involving motorcycles in Kenya

Source: Kenya Facts and Figures, 2014; Kenya national bureau of statistics [6]

The motorcycle lacks external and internal protection during a crash. The risk is further increased by its instability in motion and its ability to move at high speed and quick acceleration thus making it a hazard to the rider [17]. Motorcycles also share traffic space with pedestrians and other fast moving heavier and larger vehicles. They are less visible to other road users, with visibility being enhanced by wearing luminous jackets especially at night, and riding with the headlight on during the day to improve visibility. Motorcyclists are often lacking in formal driving training and riding experience and thus often ignore, disregard or are unaware of traffic rules and regulations [26, 31, 32]. Vulnerability of motorcycle riders as road users is well documented even in the developed countries. Studies in the United States of America show that a motorcycle occupant is 26 times more likely to sustain fatal injuries in a road traffic crash than their motor vehicle occupants, and 5 times more likely to get injured when involved in RTC [33]. In developing countries, the poor infrastructure, poor enforcement of road traffic rules and regulations, lack of formal training for the motorcycle riders and lack of protective gear for both the riders and the pillion passengers worsen the situation [5, 34].

2.3. Motorcycle-related road traffic injuries

Motorcycles have become a common transport medium in developing countries which has resulted in an increase in mortality and morbidity in motorcycle-related injuries. Motorcyclists constitute the majority of those injured in road traffic crashes in these countries [31]. In East Africa, these injuries contribute 73% and 58.8% of all road traffic crash injuries sustained in Uganda and Tanzania respectively [35,12]. In Kenya, the proportion of motorcycle crash related injuries showed a significant increase from 1.7% in 2005 to 6.1% in 2009 [36]. Abdulgafoor et al. in a study done in 2012 found an annual increase of 29% in the same period [13]. This trend has continued with data from National Transport and Safety Authority showing a significant increase in 2014 in comparison to 2013, illustrating motorcyclists made up 13.5% of the road traffic crash fatalities in 2014, compared to 9.7% in 2013 [37].

In a study conducted at Naivasha hospital by World Health Organization, it was found that MCC accounted for 36% of the all RTC patients seen at the emergency department in 2012 [30]. Sisimwo et al. in a study at Kitale hospital found MCC-related injuries accounted for 39.4% of all RTC injuries seen at the emergency department [27]. In Kenyatta National Hospital, Saidi et al. found MCC-related RTC accounted for 19% of the patients admitted in the wards [10]. The disparity in the rates of MCC-related injuries may be accounted for by the methodologies used, with the later study only considering the admitted patients, while Sisimwo et al. and the WHO studies considered all victims seen at the emergency department.

2.4. Age and sex distribution of victims of motorcycle crash-related injuries

In several studies, the sex and age of MCC patients show the modal age of being young adults with majority being male. A Kenyan study in 2013 showed MCC-related injuries contributed to 22.3% of all RTC seen at a referral hospital, with a modal age of 21-30 years and a mean age of 30.78 years, with male riders being the most commonly injured with a male to female (M:F) ratio of 7.0:1 [11]. A study by Nyameino et al. found an age range of 3-62 years, a modal age of 21-30 years, with a mean of 29 years among motorcycle crash victims. Male to female ratio was found to be 5.0:1, showing a similar pattern to Saidi et al. [70].

Hashim et al., in a study done in Malaysia found male to female ratio of MCC related injuries was 4.5:1 with a modal age 21-30 years and a mean age of 27.8 years [15]. In Nigeria, Oluwadiya et al. (2004) found that male motorcyclists were more affected, with a modal age group of 20-29 years, mean age of 31.9 years and M:F ratio of 2.8:1. Chalya et al. found a M:F ratio of 2.3:1, the mean age of the patients was 30.7 years, a modal age group of 21-30 years and a range age of 4-87 years [22,14].

In all the studies, the young age male predilection was thought to be attributable their role as bread winners of the family, and more likely to be employed in the motorcycle transportation industry and thus exposed to more risk than their female counterparts.

2.5. Distribution of motorcycle crash-related musculoskeletal injuries

The injuries in the musculoskeletal system in Motorcycle crashes involve both the hard and soft tissues in axial and appendicular skeleton. They vary from soft tissue lacerations to complex fractures in the skeleton and even traumatic amputations. The patterns of these injuries are however not well described in Kenya, with literature mostly describing the regional distribution. The patterns and severity have been shown to depend on the mechanism of injury, with the vectors of the force playing a major role in the severity of the injury sustained. Chalya et al. in a hospital based study done in a Tanzania found that musculoskeletal injuries accounted for 60.5% of all study participants, with 77.3% of these injuries affecting the lower limbs. This was followed by head injuries, with this attributed to low use of helmets [12].

Oluwadiya et al. in a hospital based study in Nigeria on motorcycle crash injuries reported that most injuries were soft tissue injuries at 91.7% followed by injuries to the extremities and then head injuries [14]. Chalya et al. in a hospital based study in Tanzania found out majority of the injuries involved the extremities at 60.9%, followed by head and neck at 55.2%, then blunt abdominal and chest injuries [22]. Galukande et al. in a hospital based study in Uganda on a sample of 124 motorcycle crash related injury victims found that 80.1% of the victims suffered fractures and soft tissue injuries. The fracture distribution was reported as tibia and fibula at 33.1%, femur at 8.9%, ulnar and radius at 4.8% with most of the fractures localized at the extremities. 5.6% had suffered spine injuries, with cervical spine being most affected [38]. Sisimwo et al., in a study of 317 motorcyclists conducted at Kitale level 4 Hospital, found that lower extremity injuries and head injuries accounted for the majority of injuries sustained in motorcycle crash-related injuries [27]. Lower extremity injuries accounted for 39.9% with head and neck injuries accounting for 40% of all the injuries sustained. This is in agreement with a multi centered study done in Tehran by Khaji et al., that reported the commonest musculoskeletal injury was fracture of the tibia at 50% of cases. The study also reported similar injury distribution with the majority of injuries in extremities, then head injuries in descending order of incidents [16].

Saidi et al. in a study at KNH found injuries were mostly to the extremities at 60.7% and then head and neck at 32.07%. Lower limb fractures were the commonest at 42.8% with the femur fractures at 18.7% and leg and foot injuries at 24.1% [11]. Helmet use has been shown to reduce the risk of death and also the incidence of head and cervical spine injuries among motorcyclists [18]. However, the low uptake of helmets in developing countries continues to be an issue of concern [18,19] and represents an important point of intervention. Khanbhai et al. in a study at a level 5 referral hospital on 116 motorcycle crash victims found that tibiofibular fractures predominated at 29.3%, with 75% of these fractures being closed, and the rest open. Femur fractures accounted for 19.8%, soft tissue injuries at 20.7%, foot injuries at 3.4% with ankle, hip dislocation, and forearm bone fractures accounting for 1.7% each. No case of spine injury was found in this study. However, no fracture patterns and severity were described in this study. The study also showed that most injuries occurred when a motorcycle collided with a motor vehicle, and this may explain why the lower extremity trauma was commonest region of injury [28]. Other studies done in Nigeria and Uganda also showed that injuries to the extremities were the commonest [14,23,38].

Kotor et al. in a study done in Nigeria found that out of 429 motorcycle crash victims, 55.5% sustained lower limb injuries [39]. Similar findings by Oluwadiya et al. in Nigeria on a sample size of 145 motorcycle crash injury victims with 79.3% having injuries to the lower limbs, Chalya et al. in Tanzania, Mwanza also coming to a similar conclusion [14,22]. Studies done in Malaysia reported that in falls at high speed, the commonest injury was cervical spine trauma [5]. In this country, however, there are special lanes constructed for motorcycles beside the highways and therefore most accidents are from skidding and falls rather than collisions with other motor vehicles. In Jamaica, a study found the commonest injuries to be soft tissue injuries followed by fractures in the extremities [40]. A follow up study on secondary prevention of motorcycle crash related injuries reported that specialized protective motorcycle gear provided some protection against these types of injuries, leading to a reduction of more than 43% of soft tissue injuries and more than 63% of extremity injuries [41]

2.6. Crash mechanisms, injury patterns and severity in motorcycle crashes

The incidence of MCC in Kenya has seen a rapid rise in the last decade. Motorcyclists are more than 6 times more likely to be involved in a RTC than motor vehicle occupants [42]. Patients in these crashes also tend to have significant musculoskeletal morbidity, with studies showing more than 71.5% of the patients requiring to be reviewed by an orthopaedic surgeon [43]. This results in often complex musculoskeletal injuries, necessitating the orthopaedic surgeon to easily recognize and manage these injuries. Various classifications of the injuries based on the MCC mechanism of injury have been proposed in an attempt to better comprehend how these injuries occur [44].

Motorcycle crash-related musculoskeletal injuries can be categorized into several distinct mechanism types which may enhance prompt recognition and treatment. Bedolla et al. in study in professional racing MCC-related injuries classified the injury patterns into four main crash types; collision, topside, lowside and highside crashes (table 4) [45]. The injury patterns were further categorized to describe how the musculoskeletal injuries relevant to the orthopaedic surgeon were sustained (table 5).

2.6.1. Lowside crash

In this crash mechanism of injury, the motorcycle is navigating a corner or a bend and then skids and falls on the acute side of the bend. This leads to the ipsilateral lower limb being entrapped under the motorcycle, with the ipsilateral upper limb bracing for impact. The entrapped lower extremity and the ipsilateral upper limb sustain injuries with the contralateral extremities being relatively spared.

The limb becomes entrapped when lower extremity is incarcerated between the motorcycle and a fixed object. The lower limb is the most common site of musculoskeletal injuries in MCC, accounting for 40% to 60% [46-49] of MCC-related musculoskeletal injuries. Studies have shown tibia fractures are the commonest (20-30%), followed by foot and ankle injuries [46,49,50].

Crash type	Description
Lowside	Rider falls to the lowside of the lean angle during a turn.
Highside	Rider falls to the opposite side of a turn while trying to correct, causing the motorcycle to flip over and the rider to be thrown from the motorcycle.
Topside	Motorcycle suddenly decelerates and rider flips over the handlebars.
Collision	Rider strikes or is struck by a stationary object and is subjected to blunt trauma and deceleration forces.

Table 4: Crash Types

Source: Petit et al. (2020) [44]

Region of body	Notable mechanism(s)	Crash type
Head	Head-leading collisions	Topside/highside
Upper extremity: shoulder girdle	Direct vertical impact	Collision
Upper extremity: wrist	Motorcycle radius	Topside/highside
Upper extremity: hand	Motorcycle thumb	Collision
Pelvic ring	Fuel tank injuries	Collision
Lower extremity: femur, tibia, fibula	Limb entrapment	Lowside
Lower extremity: heel	Tyre-spoke injury	Lowside
Lower extremity: foot	Crash modifying hyperdorsiflexion manoeuvre	Lowside

Table 5: Notable Crash Mechanisms

Source: Petit et al. (2020) [44]

2.6.1.1. Crash modifying maneuvers

While attempting recovery from a lowside crash, a rider may react by stretching out their lower extremity in an effort to stabilize the motorcycle. This maneuver may lead to lower limb injury. The resultant hyper-dorsiflexion and external rotation of the foot may lead to fracture dislocations of the ankle and foot, or more severe injuries leading to mangled extremities [44].

Figure 1: Crash Modifying Maneuver

Source: Petit et al. (2020) [44]

2.6.1.2. Tyre-spoke Injury

These are a subset of entrapment type injuries which often result in complex soft tissue injuries. The toes or foot may become entrapped within the spokes of the motorcycle wheel. Calcaneal and Achilles tendon injuries are occur commonly, and these injury patterns often require amputation [51].

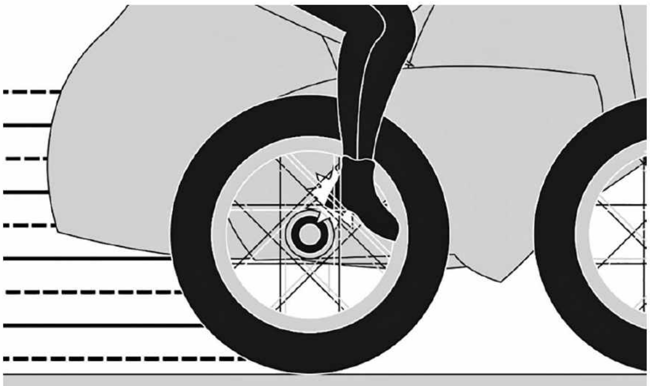


Figure 2: Tyre Spoke Injury

Source: Petit et al. (2020) [44]

2.6.2. Topside/highside crash

In a topside crash, the rider is flung to the front of the motorcycle over the handlebars while in a highside crash type, motorcycle rider is flung to the opposite side that the motorcycle is falling. These crash mechanisms often lead to similar patterns of injuries. The motorcycle rider is violently ejected from the motorcycle, either off the side or to the front over the handlebars.

Figure 3: Topside/Highside Crash

Source: Petit et al. (2020) [44]

2.6.3. Head-leading crashes

Head leading crashes imply that after the rider is violently ejected from the motorcycle in a crash, the longitudinal body axis is parallel with the collision velocity [52]. This crash mechanism is often leads with frontal head trauma, and associated with helmet damage. The prevalence of head injuries in MCC is approximated at 10-50%, and account for the highest proportion of fatalities [45,49,51,53]. Common injuries in this mechanism include maxillofacial injuries, skull fractures and cerebral cortical contusions [54,55]. Transmitted forces through cervical spine as the head hyperextends causes injuries to the upper spine, most notably the cervical spine and basilar skull. Traumatic brain injury (TBI) is also common in these crash types. Studies show that cervical spine injuries occur in 3-8% of patients with head injuries [56,57]. These injuries are primarily concentrated on the upper third of the cervical spine [58]

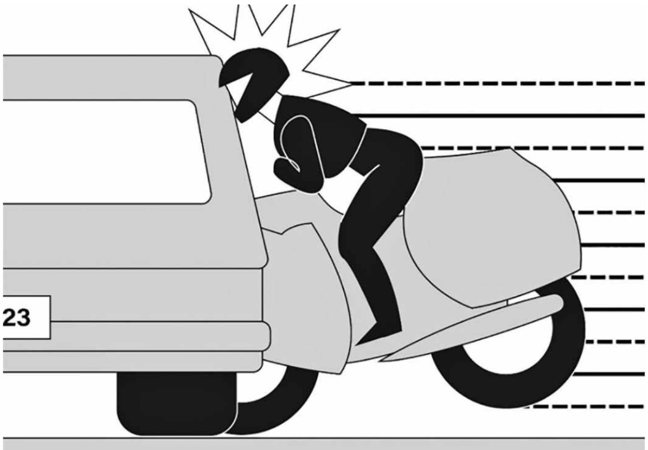


Figure 4: Head Leading crash

Source: Petit et al. (2020) [44]

2.6.3.1. Crumple zone effect

Studies show distal upper limb motorcycle crash related injuries are associated with fewer fatalities. This may be attributed to ‘a crumple zone effect’[59]. During a motorcycle crash, the rider braces himself, by instinctively extending his arms in front prior to the impact after being ejected violently from the motorcycle. The distal upper limbs absorb most of the energy of the crash, mitigating more severe proximal trauma. Distal radius fractures are the most common crumple zone effects, with the term ‘motorcycle radius’ injuries being coined [60].

2.6.4. Collisions

This is described as injury mechanism which causes direct impact with another motorcycle, motor vehicle or a fixed object.

2.6.4.1. Fuel tank injuries

Fuel tank injuries are sustained by the rider when the motorcycle suddenly decelerates, with the drivers inertia creating peak loads between the motorcycle fuel tank and the rider’s pelvis. A study found that fuel tank injuries accounted for 85% of the pelvic injuries sustained by riders [61]. The severity of the injury has correlation with the velocity at the time of impact. Studies have shown fracture patterns similar to Anterior Posterior Compression (APC) types II and III pelvic fractures

[62]. Prevalence of pelvic ring injuries has been shown to be as high as 13% [46,50], with a study showing mortality of 13% [50]

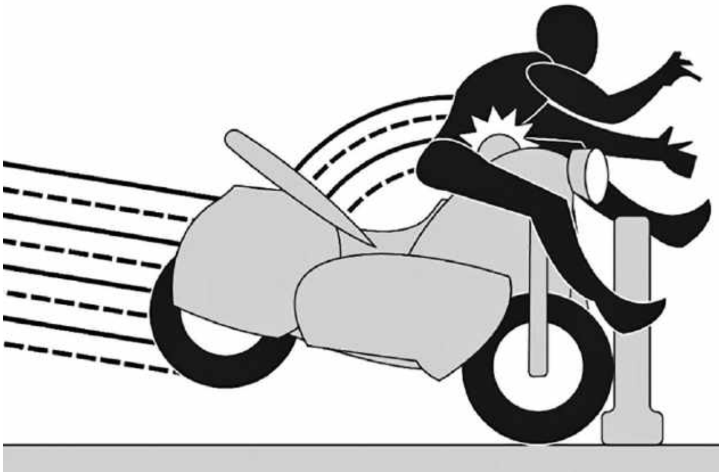


Figure 5: Fuel Tank Injury in motorcycle crash

Source: Petit et al. (2020) [44]

2.6.4.2. Direct vertical impact

This crash mechanism occurs when a rider collides with a roadside object, e.g. a sign post or a pole when traveling at high speed, leading to impact with the shoulder and injury to the upper extremity (figure 6) [63]. This crash mechanism account for almost 30% of motorcycle crashes injuries of the upper limb, with the shoulder girdle accounting for the highest proportion [59]. Injuries associated include brachial plexus injury, clavicular fractures, scapular fractures, and scapulothoracic dissociation. Studies have reported these injuries comprise 15-20% of all upper extremity injuries in MCC [46,49,59]. Forearm fractures account for 10-15% [59,64], with distal upper limb fractures accounting for 5-10% of upper extremity injuries [49, 59, 65].

'Motorcycle thumb' (figure 7) injury occurs due to the rider bracing himself by locking their elbows and griping the handlebars. Force is directed into metacarpal base, with the thumb carpometacarpal (CMC) joint sustaining injuries 50% of the time, and ulnar collateral ligament of the thumb being injured 20% of the time [66].

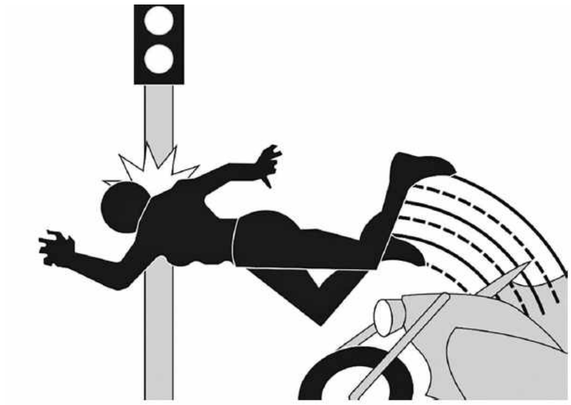


Figure 6: Direct vertical collision

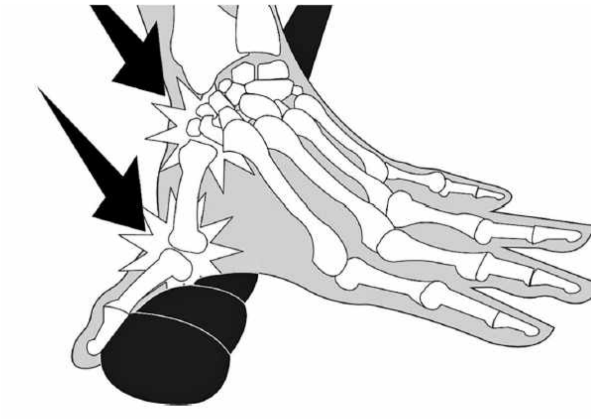


Figure 7: Motorcycle thumb

Source: Petit et al. (2020) [44]

Locally, there is paucity of data of musculoskeletal fracture patterns and severity in motorcycle crash injuries. Most local studies have concentrated on prevalence, distribution and risk factors contributing to motorcycle crash related injuries. The study sought to find out the distribution, fracture patterns and severity using AO/OTA classification and also documented the mechanism of injury of motorcycle crash related musculoskeletal injuries. No other local or regional studies had used the AO/OTA classification and Gustilo Anderson classification to shed light on MCC-related musculoskeletal injury patterns and severity in Kenya.

In evaluating associated injuries, Injury Severity Score (ISS) was used to assess the severity of injury. This standardizes the severity of traumatic injury based on 6 body systems, with each injured region being scored on Abbreviated Injury Scale (AIS) at 0-6, then each score is squired with the sum of the 3 highest AIS being used as ISS. A score of >15 is associated with mortality of 10%.

2.7. Injury prevention in motorcycle crashes

Motorcycle crashes are more commonly caused by riders who are less experienced, with no formal training or hold no valid riding licenses. The Tanzanian, Nigerian and the Kenyan studies showed that few riders had formal riding training with a valid license by the respective licensing bodies. Most of these riders were either self-trained or trained by acquittances. The training was reported to have been for a duration of 1-3 weeks [9,10,12]. Alcohol intoxication was also a major contributing factor with majority of the study participants in two studies volunteering positive history of alcohol consumption [10,12]. The shortfall in formal motorcycle riding training has greatly compromised the riding standards and road safety due to the ill understanding of the traffic rules and regulations by the riders [7].

Studies have shown that enforcement of traffic rules and regulation may significantly assist in curbing the run-away motorcycle crash-related injuries. High risks groups are targeted in campaigns to raise awareness on safety. This helps in reduction of overall road traffic crashes (RTCs) and also improves on road safety [10]. The WHO global status report suggests that helmets and other safety gear must be in tandem with safety standards and be effective in mitigating motorcycle crash-related injuries. Helmets have been shown to reduce the risk of fatal head injuries by 40% and the risk of serious head injury by over 70% [5].

A study in Kenya showed that use of helmets and reflective jackets, as well as running the day headlights has the potential of reducing the severity of the injuries sustained in MCC as this improves visibility of the motorcyclists. In-cooperating the helmet and other safety training in the motorcycle riding syllabus was recommended [11]. Another study in Kenya also showed that 50% of riders and 20% of pillion passengers had their helmets on during the MCC and 63% of riders and 1.3% of the pillion passengers had reflective jackets on at the time of injury [9]. This safety equipment, including the helmets, reflective jackets, heavy riding jackets, riding trousers, sheen guards and riding boot must meet recognized safety standards if they are expected to be effective in injury prevention in MCC. During legislation, the safety gear standards must meet the quality levels and should be suitable for the traffic, hygiene and weather patterns to encourage the usage of the equipment by both motorcycle riders and pillion passengers. Specialized riding gear which has inbuilt airbags that deploy in sudden deceleration is under research. However, such equipment will remain out of reach in the developing countries because of their exorbitant costs, which is currently estimated at US$ 3,000 per set [44].

2.8. Conclusion

Concerns have been raised by the raising numbers of MCC-related injuries because of the significant increase in the trauma admissions. This is of concern because of the limited resources available to manager these recourse intensive injuries. In existing literature, there is deficiency in standard classification and diagnostic systems of MCC-related musculoskeletal injuries resulting in conflicting literature. There are no local studies that describe the crash mechanisms and patterns of musculoskeletal injuries in motorcycle crashes. Most studies are retrospective, and mostly focus on head injuries, maxillofacial injuries and other soft tissue injuries, with musculoskeletal injuries only being considered associated injuries. No local studies on MCC-related injuries have evaluated the musculoskeletal fracture patterns and severity. In most studies, methodology is deficient in use of radiographs in description of the fracture patterns and severity.

3. PATIENTS AND METHODS

3.1. Study design

Descriptive prospective cross sectional study.

3.2. Study site

The study was undertaken at Kenyatta National Hospital (KNH), one of Kenya's tertiary care hospitals with an inpatient bed capacity of 1800 patients. It is located about 3 kilometers west of the central business district of Nairobi, the capital city of Kenya. It has a fully-fledged Orthopaedic Department with three firms. Each firm has a ward with an inpatient bed capacity of 60 patient and a shared pediatrics ward with an inpatient capacity of 60 patients as well. The hospital also has an intensive care unit where critically injured patients are admitted. Average annual outpatient and inpatient attendance is 600,000 visits and 90,000 patients respectively. The first department of contact for these patients is the Accident & Emergency Department. Although the hospital is situated in a metropolitan city, it serves both rural and urban populations from the surrounding counties. The patient population has a wide ranging socio-economic profiles.

3.3. Study population

The study population consisted of all patients presenting at the facility after sustaining MCC-related musculoskeletal injuries with emphasis on fractures of both axial and appendicular skeleton. The patients included motorcycle riders, pillion passengers and pedestrians. Patients of all age groups and sex irrespective of injury severity who presented at the hospital during the study period and meet the inclusion criteria for the study were included. Recruitment areas were A&E, Orthopaedic wards and the ICU.

3.4. Sample size calculation

The sample size was calculated using the Cochran formula [67]. This was used because it determines the number of subjects who allow the estimate of a proportion with a given margin of error. The studies which have been done locally showed the prevalence of motorcycle crash-related injury to be estimated at 9% [13]

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

Cochran, W. G. 1977 [67]

Where;

N = Minimum sample size

Z = Standard of normal distribution at 5% significant level; 1.96

P = Prevalence of motorcycle injury estimated at 9% [13]

d = Degree of accuracy set at 5%

Therefore:-

$$N = \frac{1.96^2 \times 0.09(1-0.09)}{0.05^2}$$

$$= 125.85$$

$$= 126$$

Minimum sample size: <u>126</u>

3.5. Selection criteria

3.5.1. Inclusion

- Patients seen at A&E, ICU and Orthopaedic wards with motorcycle crash-related musculoskeletal injuries.
- Patient with MCC-related musculoskeletal injuries who gave written informed consent or with a legal guardian who gave informed consent on their behalf.

3.5.2. Exclusion

- Unconscious/confused patient with MCC-related musculoskeletal injuries without a legal guardian.
- Patient with any key data missing (age, radiographs etc.)

3.6. Ethical considerations

3.6.1. Informed consent

The aims and procedures of the study were explained to the participant in a language best comprehended by the participant. This was done both verbally and in written form. Any questions or concerns by the participant were addressed before obtaining informed consent. Once the participant understood and agreed to take part, they endorsed the consent by either signing, putting their initials down or imprinting their thumb print on the consent form. Those unable to consent for any reason but meeting the inclusion criteria for the study were consented by a legal guardian. Refusal to participate in the study had no effect on the quality of treatment in any way. This process was undertaken by the principal investigator or a trained research assistant who is/was at the level of a medical officer.

3.6.2. Confidentiality

The information that was collected for this study was treated with strict confidentiality. Information obtained about the patient during the study was stored securely and was only accessible to the study investigators and supervisors. Any information about the patient was only identified by a study number instead of the patient's name. Only the investigators were able to link the patient to the patient's number. The Data collected were securely stored under lock and key and will be stored for a period of ten years. The information will later be destroyed by fire after the expiry of the stated period. All the information stored in soft copy was secured using a password. It will not be shared or given to anyone except the Ethics and Research Board and the supervisors.

3.6.3. Ethical approval

Clearance was sought and granted by the Kenyatta National Hospital/University of Nairobi Ethics and Research committee (KNH/UoN-ERC) before the commencement of the study under reference KNH-ERC/A/199 (appendix E). The study objective was explained to the respondents (appendix C). It was made clear that they had the option to participate or to decline, and if they declined, it would not prejudice their management in any way. Voluntary informed consent was sought from the participant.

3.7. Precautions against COVID-19

The Principal investigator ensured that all members of the study team were trained on key aspects of COVID-19 infection prevention. This was aimed at mitigating the risk of infection to both the researchers and the participants. Online training with the help of World Health Organization (WHO) portal (https://www.who.int/emergencies/disease/novel-coronavirus-2019/training/online-training), and also the Ministry of Health guidelines on COVID-19 precautions were utilized in the training. Personal protective gears i.e. disposable gowns, gloves, N95 masks, googles and hand sanitizers were provided as per WHO guidelines of risk stratification by the principal investigator. The participants were also encouraged to wear masks during the interview and examination process during data collection.

3.8. Recruitment and sampling procedure

All patients presenting with motorcycle crash related musculoskeletal injuries at Kenyatta National Hospital between April and June 2021 were recruited into the study. The sampling method used was non-probability (convenience) sampling. The patients were screened for inclusion criteria and those who met the criteria were informed and requested to consent to allow participation in the study.

All the patients recruited into the study were stabilized in the A&E department as per the ATLS protocols. They were managed as per the attending surgeon and then data was collected and recorded as per the pre-designed questionnaire by the principal investigator or a trained research assistant at the level of a medical officer (Appendix A).

3.9. Study Variables

3.9.1. Intermediate variables

a) Age, Gender, Level of education, Occupation.

3.9.2. Independent variables

a) Class of crash victim (Rider, pillion passenger, pedestrian)
b) Type of motorcycle crash
c) Mechanism of crash injury
d) Protective gear
e) Training/experience

3.9.3. Dependent Variables

a) Anatomical Site involved
b) Skeletal structure involved
c) Fracture classification:- AO/OTA classification
d) Open fracture classification:- modified Gustilo-Anderson equivalent
e) Associated injuries

3.10. Methods

3.10.1. Data collection procedure

After the initial management in the accident and emergency department, patients were screened for eligibility. Once a patient was identified by the doctor at A&E as having MCC-related musculoskeletal injuries, the principal investigator or the research assistant was notified and if the patient meets the inclusion criteria, informed consent was obtained. Eligible participant were then interviewed in regard to age (years), sex, occupation, level of education, riding experience (riders), site of injury, patient position (rider/pillion passenger, pedestrian) protective gear used at time of crash, crash type and the crash mechanism of injury. The responses were recorded in a pre-designed questionnaire (appendix A).

A thorough clinical examination was conducted to assess musculoskeletal injuries and any associated injuries and the radiological examinations were reviewed to determine and confirm diagnosis, with results being recorded on a pre-designed data collection form (appendix A). The fracture pattern and severity was recorded based on AO/OTA classification [appendix B] [1] from the radiographs of the involved region, with the open fractures classified using the Gustilo-Anderson classification [2]. Any associated injuries outside the musculoskeletal was also recorded and the injury severity scoring system tool was used to define injury severity [62].

3.10.2. Reliability and validity

The questionnaire/data collection form was pretested with a small number of patients (10% of the sample size) at KNH A&E to test for reliability in a pilot study. Ambiguities were corrected before the actual study begun and the filled questionnaire were checked for completeness and accuracy of data. This enabled the principal investigator to evaluate the data collection tool adequacy and relevant modifications were made before the actual data collection commenced. During consent taking, the patients was assured of confidentiality to encourage them to be as honest as possible when answering questions.

3.10.3. Data analysis, management and presentation

The collected data was analyzed for appropriateness and the accuracy and completeness of the questionnaire assessed by the study supervisors. The data was then cleaned, coded and exported for analysis using Microsoft Statistical Package for Social Sciences version 27 (SPSS®-27). Descriptive statistics (age, sex, fracture AO/OTA) type presented using mean, modes and medians in form of charts, tables and graphs. Pearson's chi-squire test was used to examine relationships between variables (fracture AO/OTA type safety gear, fracture AO/OTA and mechanism of injury, severity of injury and mechanism of injury). A qualified statistician was engaged to help with the data analysis.

3.10.4. Errors and bias

This was minimized by training of the research assistants to ensure there was consistent interpretation of injuries. Standardized diagnostic criteria was used, by following standard radiological principles and clinical examination protocols. The principle investigator was always at hand to offer guidance on radiographic assessment of the injuries. This helped in reduction of errors due to missed injuries. Computer aided analysis of collected data also reduced the number of errors.

3.11. Study results dissemination

The study was presented to the department of orthopaedic surgery faculty for review before dissemination to KNH-UoN ERC and the University of Nairobi research library. The results shall also be submitted for publication in peer reviewed journals for wider readership. Kenyatta National Hospital and UoN department of Orthopaedics will be recognized as affiliate parties in the publications. Whenever the opportunity arises, the findings shall be presented in scientific conferences.

3.12. Study limitations and delimitations

Limitations	Delimitation
1. Honesty of the respondent	The patient was assured of confidentiality of all the information collected.
2. Single site study	Study was done in only one hospital. However, the site is a referral hospital with a large catchment area, and the surrounding facilities mostly refer musculoskeletal trauma patients to KNH.
3. Recall bias by the patient	Follow up of the patient in the ward yielded more information once the patient was settled in the ward for those admitted.
4. Inadequate Radiographs	Repeat radiographic investigations were requested for the benefit of patient care, and as standard of care.
5. Inter-observer variability	Input from the principal investigator was sought for all radiological fracture classification.

4. RESULTS

4.1. Demographic characteristics of MCC-related musculoskeletal injury patients.

A total of 126 patients with MCC-related musculoskeletal injuries were recruited into the study. Among those excluded from the study were those with missing information in their file, e.g. age, radiographs and those who were unable to give consent and had no guardians to consent on their behalf. Majority (85.6%) of them were male and 14.6% were female (M:F ratio 6:1). The mean age of the patients was 31.6±10.5 years, with a median age of 30 years (Table 6) and an age range of 11-61 years. The modal age group affected was 21-30 years (45.2%). Forty-eight (38.1%) presented at the hospital directly from the scene of the crash, while 78 (61.9%) were referrals from other facilities. Majority of the patients (69%) resided within Nairobi County, and had attained primary (49.2%) and secondary (39.7%) level education. Approximately half of the patients (51.6%) were boda-boda riders by occupation. Of these, 36 (55.4%) were operating with a valid driving license. The average years of experience of the riders was 6.1±3.8 years. There were no female motorcycle rider patients found in this study. A third of the patients reported their occupation as casual labourers, and the rest included students, farmers and self-employed persons. Pillion passengers contributed to 25.4% (n=32) of the crash injury victims and pedestrians accounted for 23% (n=29) of the patients.

		Class of crash victim				
Characteristic	**Level**	**All patients**	**Motorcycle rider /operator**	**Pedestrian**	**Pillion passenger**	***p*-value[1]**
Total N (%)		126	65 (51.6)	29 (23.0)	32 (25.4)	
Age	Median (IQR[2])	30.0 (24.0 to 37.0)	31.0 (26.0 to 36.0)	36.0 (24.0 to 50.0)	23.5 (21.0 to 27.5)	**<0.001**
Age group	≤20 years	9 (7.1)	2 (3.1)	3 (10.3)	4 (12.5)	**<0.001**
	21-30 years	57(45.2)	28 (43.1)	7(24.1)	22(68.8)	
	31-40 years	38 (30.2)	26 (40.0)	7 (24.1)	5(15.6)	
	41-50 years	14 (11.1)	7 (10.8)	6(20.7)	1 (3.1)	
	>50 years	8 (6.4)	2(3.1)	6 (20.7)	0 (0.0)	
Sex	Male	108 (85.7)	65 (100.0)	22 (75.9)	21 (65.6)	**<0.001**
	Female	18 (14.3)	0(0.)	7 (24.1)	11 (34.4)	
Occupation	Motorcycle rider	65 (51.6)	62 (94.0)	0(0.)	3 (9.4)	**<0.001**
	Casual Labourer	38 (30.2)	1 (1.5)	19 (65.5)	18 (56.3)	
	Hawker/ Farmer	7 (5.6)	1 (1.5)	5 (17.2)	1 (3.1)	
	Self-employed	5 (4.0)	1 (1.5)	2 (6.9)	2 (6.2)	
	Student/Tourist Housewife	12 (9.5)	1 (1.5)	3 (10.3)	8 (25.0)	
Education level	None	4 (3.2)	2 (3.1)	2 (6.9)	0(0.0)	0.331
	Primary	62 (49.2)	31 (47.7)	18 (62.1)	13 (40.6)	
	Secondary	50 (39.7)	27 (41.5)	8 (27.6)	15 (46.9)	
	Tertiary	10 (7.9)	5 (7.7)	1 (3.4)	4 (12.5)	
Referral Status	No	48 (38.1)	26 (40.0)	11 (37.9)	11 (34.4)	0.866
	Yes	78 (61.9)	39 (60.0)	18 (62.1)	21 (65.6)	
Mode of evacuation	Ambulance	73 (57.9)	39 (60.0)	15 (51.7)	19 (59.4)	0.810
	Police vehicle	2 (1.6)	1 (1.5)	1 (3.4)	-	
	Private vehicle	51 (40.5)	25 (38.5)	13 (44.8)	13 (40.6)	
Time-to-presentation at KNH (hours), median (IQR)	Median (IQR)	3.4 (2.0 to 6.0)	3.0 (2.0 to 6.0)	3.6 (2.0 to 6.0)	3.2 (1.9 to 5.3)	0.641

Table 6: Age, sex and general characteristics of all patients

[1] Chi-Squared (χ^2) or Fisher's Exact test *p*-value; Statistically significant codes are in bold: $p < 0.01$; $p < 0.05$
[2] IQR, interquartile range (25th and 75th percentiles)

4.2. Circumstances of the injuries

Most of the motorcycle crashes occurred within Nairobi County (n=95 patients, 75.4%) (Figure 3). The commonest scenes (road) of MCC were Ngong road (n=13 patients, 10.3%), Juja road (n=11 patients, 8.7%), Mombasa Road (n=9 patients, 7.1%) and Kangundo road (n=9 patients, 7.1%) (Figure 9). Most of the MCC occurred between 07:00 hours and 19:00 hours (n=78, 61.9%). Motorcycle operators (riders) constituted about half of the injured patients (n=65, 51.6%), while pillion passengers and pedestrians comprised 25.4% (32 patients) and 23.0% (29 patients) respectively (table 6). Majority of the injured patients were evacuated from the scene of accident by an ambulance (n=73 patients, 57.9%), while the rest were evacuated by private vehicles (n=51 patients, 40.5%) and police vehicles (n=2 patients, 1.6%). The median time from injury to arrival to hospital was 3.4 hours (IQR 2-6 hours) (table 7).

4.3. Mechanism of injury in MCC-related musculoskeletal injuries

The commonest motorcycle crash type was collision with a motor vehicle (n=67 patients, 53.2%), followed by collision with motorcycle (n=39 patients, 31%), fall from motorcycle (n=19 patients, 15.1%) and collision with a train (n=1 patient, 0.8%). The most predominant mechanism of injury was collision (n=77 patients, 61.1%), followed by high-side/topside (n=32 patients, 25.3%) and low-side injuries (n=17 patients, 13.5%) (Figure 9). Collision with motor vehicles/motorcycles was commonly associated with collision/high-side/top-side injuries, whereas fall from motorcycle was associated with low-side injuries ($p<0.001$).

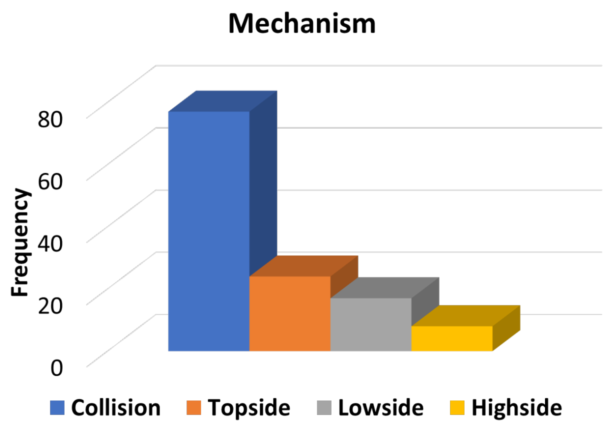


Figure 9: Crash mechanisms of injury by the victims

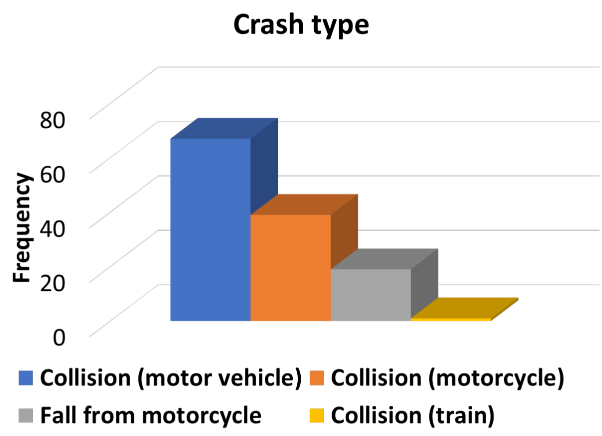


Figure 8: Crash types in motorcycle crashes

			Mechanism of injury				
Variable	**Category**	**Total N (%)**	**Collision n (%)**	**Highside n (%)**	**Lowside n (%)**	**Topside n (%)**	***p*-value**[3]
Total N (%)		126	77 (61.1)	8 (6.3)	17 (13.5)	24 (19.0)	
Age group (years)	≤20	9 (7.1)	6 (7.8)	1 (12.5)	1 (5.9)	1 (4.2)	0.632
	21-30	57 (45.2)	34 (44.2)	4 (50.0)	6 (35.3)	13 (54.2)	
	31-40	38 (30.2)	20 (26.0)	3 (37.5)	8 (47.1)	7 (29.2)	
	41-50	14 (11.1)	9 (11.7)		2 (11.8)	3 (12.5)	
	>50	8 (6.3)	8 (10.4)				
Class of crash victim	Operator	65 (51.6)	29 (37.7)	2 (25.0)	12 (70.6)	22 (91.7)	**<0.001**
	Pedestrian	29 (23.0)	29 (37.7)				
	Pillion passenger	32 (25.4)	19 (24.7)	6 (75.0)	5 (29.4)	2 (8.3)	
Crash type	Collision with motorcycle	39 (31.0)	36 (46.8)		2 (11.8)	1 (4.2)	**<0.001**
	Collision with motor vehicle	67 (53.2)	40 (51.9)	6 (75.0)	3 (17.6)	18 (75.0)	
	Others (specify)	1 (0.8)	1 (1.3)				
	Fall from motorcycle	19 (15.1)		2 (25.0)	12 (70.6)	5 (20.8)	
Fracture type (single/multiple	Multiple	61 (48.4)	39 (50.6)	4 (50.0)	5 (29.4)	13 (54.2)	0.401
	Single	65 (51.6)	38 (49.4)	4 (50.0)	12 (70.6)	11 (45.8)	
Patient Fracture type (closed, mixed, open)	Closed	73 (57.9)	44 (57.1)	3 (37.5)	10 (58.8)	16 (66.7)	0.337
	Mixed	11 (8.7)	6 (7.8)	2 (25.0)		3 (12.5)	
	Open	42 (33.3)	27 (35.1)	3 (37.5)	7 (41.2)	5 (20.8)	

Table 7: Distribution of mechanisms of injury in MCC-related musculoskeletal injuries

[3] Chi-Squared (χ^2) or Fisher's Exact test *p*-value; Statistically significant codes are in bold: p <0.01; p <0.05

4.4. Anatomical distribution of the fractures sustained in the motorcycle crashes

Slightly more than half of the patients (n=66, 52.4%) sustained multiple fractures, while the rest had a single fracture. Of those with multiple fractures, 43 (34.1%) had 2 factures, 14 (11.1%) had 3 fractures while 9 (7.1%) had four fractures. One hundred and seven patients (84.9%) had fractures domiciled within one anatomical region, while another 18 (14.3%) had fractures in 2 anatomical regions and one patient (0.8%) had fractures in 3 anatomical regions. The most common injuries sustained were to the limbs (lower limbs- n=184 fractures, 82.1% and upper limbs- n=25 fractures, 11.2%). Pelvic ring/acetabulum and spine were injured in 3.6% (n=8 fractures) and 3.1% (n=7 fractures) of cases respectively (Table 8).

Across patients who sustained lower limb injuries (n=115 patients), 4 (3.5%) had bilateral injuries while 111 (96.5%) had unilateral presentation, with a right-sided predominance ($p<0.001$). Of the 12 patients (9.5%) who had upper extremity injuries, 2 (16.7%) had bilateral injuries, while 10 (83.3%) had unilateral involvement (right-3 patients, 25%, left- 7 patients, 58.3%) (Table 9).

The most commonly injured bones in the lower limbs were femur (n=62 fractures, 27.7%), tibia (n=52 fractures, 23.2%) and fibula (n=46 fractures, 20.5%), while the most commonly injured ones in the upper limbs were the radius (n=8 fractures, 3.6%), ulna (n=7 fractures, 3.1%) and humerus (n=5 fractures, 2.2%). Most of the spine injuries occurred at the thoracic spine (n=4 fractures, 57.1%) (Table 8). The classification of the fractures as per the AO/OTA classification is provided in (table 13) below.

Most of the fractures were of the closed type (n=127 fractures, 56.7%). The rest were open, and of Gustilo-Anderson class I (n=5 fractures, 2.2%), II (n=40 fractures, 17.9%) and III (n=52 fractures, 23.2%).

	Bone	No. of fractures (%)	Overall No. of fractures (%)
Lower limb	Hip	3 (1.3%)	184 (82.1%)
	Femur	62 (27.7%)	
	Patella	6 (2.7%)	
	Tibia	52 (23.2%)	
	Fibula	46 (20.5%)	
	Ankle	6 (2.7%)	
	Foot	9 (4%)	
Upper limb	Scapula	1 (0.4%)	25 (11.2%)
	Humerus	5 (2.2%)	
	Radius	8 (3.6%)	
	Ulna	7 (3.1%)	
	Hand	3 (1.3%)	
	Clavicle	1 (0.4%)	
Pelvic ring/acetabulum	Acetabulum	3 (1.3%)	8 (3.6%)
	Pelvis	4 (2.7%)	
	Sacrum	1 (0.4%)	
Spine	Cervical (C2,5,6)	3 (1.3%)	7 (3.1%)
	Thoracic (T2,4,7,12)	4 (1.8%)	

Table 8: Distribution of musculoskeletal injuries across the four anatomical regions

	Overall	**Bilateral**	**Unilateral**		**p-value**
			Right	Left	
Lower limb	115 (91.3%)	4 (3.4%)	81 (64.3%)	30 (23.8%)	***p*<0.001***
Upper limb	12 (9.5%)	2 (1.6%)	3 (2.4%)	7 (5.6%)	*p*=0.234

Table 9: Distribution of limb injuries across the one hundred and twenty six patients

Characteristic	Level	Total MSIs[4], n (%)	Right Lower Limb, n (%)	Left Lower Limb, n (%)	Right Upper Limb, n (%)	Left Upper Limb, n (%)	Spine, n (%)	Pelvis, n (%)
Total N (%)		225	130 (57.8)	53 (23.6)	12 (5.3)	13 (5.8)	7 (3.1)	10 (4.4)
Age group	≤20	12 (5.3)	7 (5.4)	3 (5.7)	0 (0.0)	0 (0.0)	2 (28.6)	0 (0.0)
	21-30	101 (44.9)	58 (44.6)	26 (49.1)	5 (41.7)	8 (61.5)	2 (28.6)	1 (11.1)
	31-40	66 (29.3)	40 (30.8)	11 (20.8)	4 (33.3)	1 (7.7)	3 (42.9)	3 (33.3)
	41-50	29 (12.9)	14 (10.8)	8 (15.1)	3 (25.0)	3 (23.1)	0 (0.0)	5 (55.6)
	>50	17 (7.6)	11 (8.5)	5 (9.4)	0 (0.0)	1 (7.7)	0 (0.0)	0 (0.0)
Sex	Female	29 (12.9)	21 (16.2)	5 (9.4)			2 (28.6)	1 (10.0)
	Male	196 (87.1)	109 (83.8)	48 (90.6)	12 (100.0)	13 (100.0)	5 (71.4)	9 (90.0)
Occupation	Motorcycle rider	120 (56.9)	60 (50.4)	29 (56.9)	10 (83.3)	9 (69.2)	4 (66.7)	8 (80.0)
	Hawker/farmer	13 (6.2)	6 (5.0)	6 (11.8)	0 (0.0)	1 (7.7)	0 (0.0)	0 (0.0)
	Casual Labourer	70 (33.2)	49 (41.2)	13 (25.5)	2 (16.7)	3 (23.1)	2 (33.3)	1 (10.0)
	Self employed	8 (3.8)	4 (3.4)	3 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	1 (10.0)
	Student/Housewife / Tourist	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Education	None	6 (2.7)	2 (1.5)	4 (7.5)				
	Primary	119 (52.9)	69 (53.1)	25 (47.2)	9 (75.0)	7 (53.8)	4 (57.1)	5 (50.0)
	Secondary	85 (37.8)	49 (37.7)	24 (45.3)	2 (16.7)	6 (46.2)	2 (28.6)	2 (20.0)
	Tertiary	15 (6.7)	10 (7.7)		1 (8.3)		1 (14.3)	3 (30.0)
Referral	No	24 (45.3)	5 (38.5)	2 (20.0)	51 (39.2)	3 (25.0)		85 (37.8)
	Yes	29 (54.7)	8 (61.5)	8 (80.0)	79 (60.8)	9 (75.0)	7 (100.0)	140 (62.2)
Mode of evacuation	Ambulance	135 (60.0)	82 (63.1)	22 (41.5)	7 (58.3)	10 (76.9)	6 (85.7)	8 (80.0)
	Police vehicle	5 (2.2)	1 (0.8)	4 (7.5)				
	Private vehicle	85 (37.8)	47 (36.2)	27 (50.9)	5 (41.7)	3 (23.1)	1 (14.3)	2 (20.0)

Table 10. Anatomical distribution of MCC–related musculoskeletal injuries

[4] MSIs, Musculoskeletal injuries

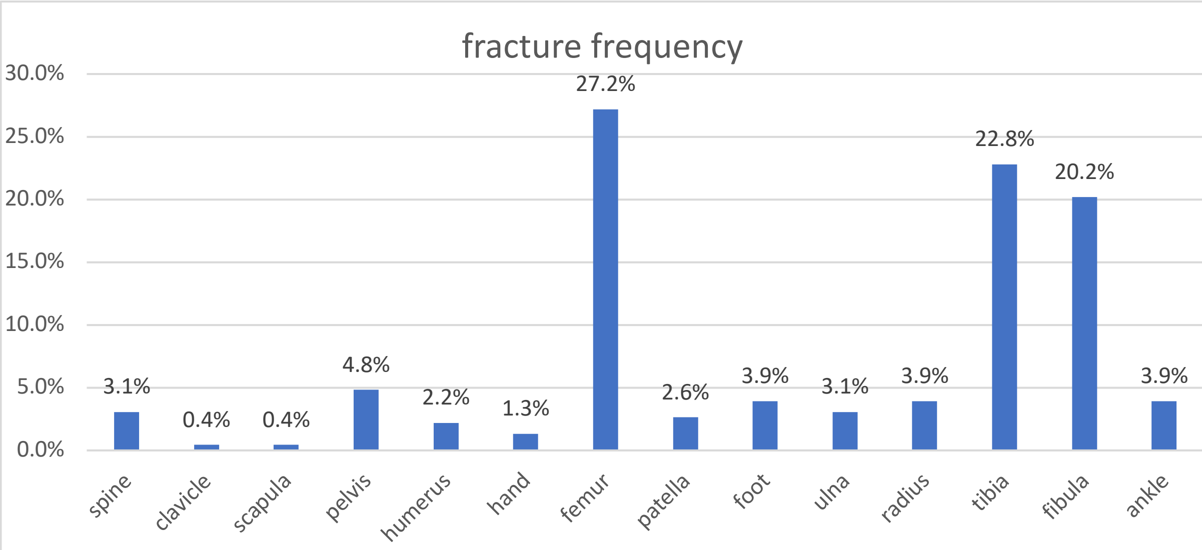


Figure 10. Frequency of different bones with fractures in motorcycle crash patients

Variable	**Category**	**Total N (%)**	**Operator n (%)**	**Pedestrian n (%)**	**Pillion passenger n (%)**	***p*-value[5]**
Gustilo-Anderson/ Equivalent class	Total N (%)	210	107 (51.0)	47 (22.4)	56 (26.7)	
	1	5 (2.4)	3 (2.8)	2 (4.3)		0.147
	2	40 (19.0)	16 (15.0)	9 (19.1)	15 (26.8)	
	3	52 (24.8)	26 (24.3)	8 (17.0)	18 (32.1)	
	Closed	113 (53.8)	62 (57.9)	28 (59.6)	23 (41.1)	
Glasgow Comma Scale (GCS)	Total N (%)	16	10 (62.5)	2 (12.5)	4 (25.0)	
	Minor (GCS ≥ 13)	9 (56.2)	4 (40.0)	2 (100.0)	3 (75.0)	–
	Moderate (GCS 9 – 12)	7 (43.8)	6 (60.0)	–	1 (25.0)	
	Severe (GCS ≤ 8)	–	–	–	–	
	Median (IQR)	13.0 (12.0 to 14.0)	12.0 (12.0 to 13.0)	13.5 (13.2 to 13.8)	14.5 (13.5 to 15.0)	0.117
The Injury Severity Score (ISS)	Total N (%)	19	12 (63.2)	3 (15.8)	4 (21.1)	
	Median (IQR)	14.0 (13.0 to 14.0)	14.0 (13.0 to 14.0)	14.0 (14.0 to 15.0)	10.0 (9.5 to 11.0)	**0.041**

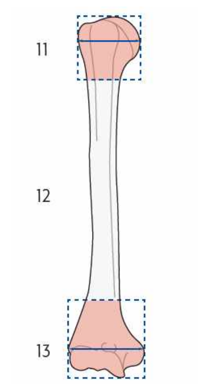
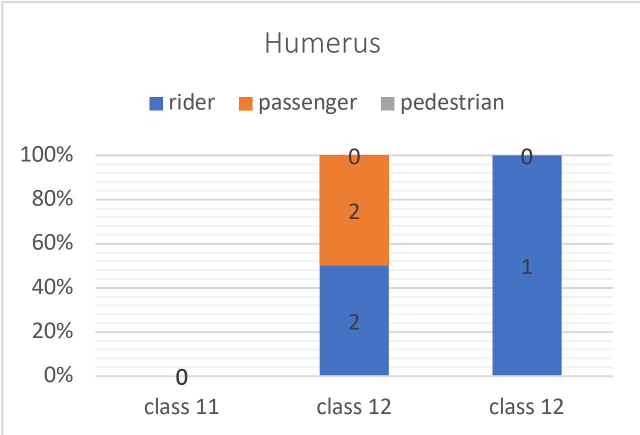
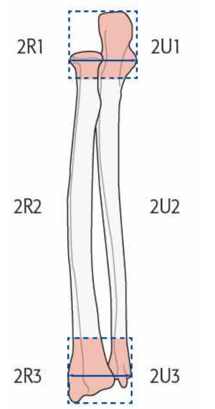
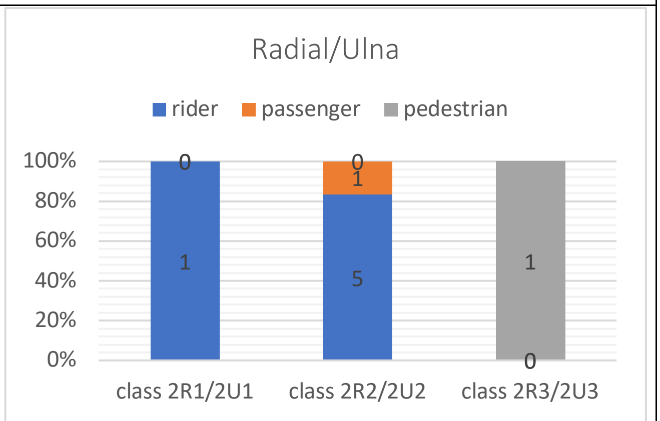
Table 11. Pattern and severity MCC-related of MSI by Gustilo-Anderson/GCS/ISS

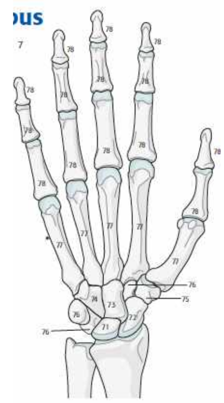
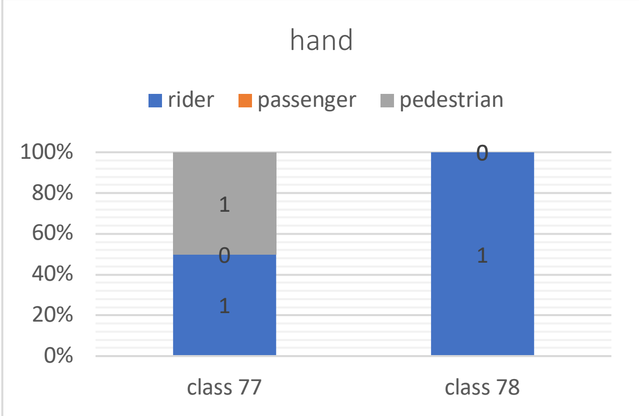
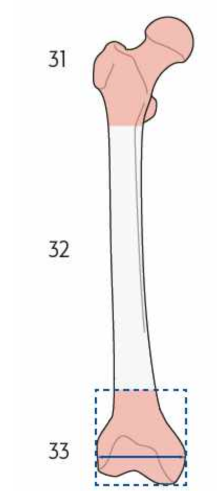
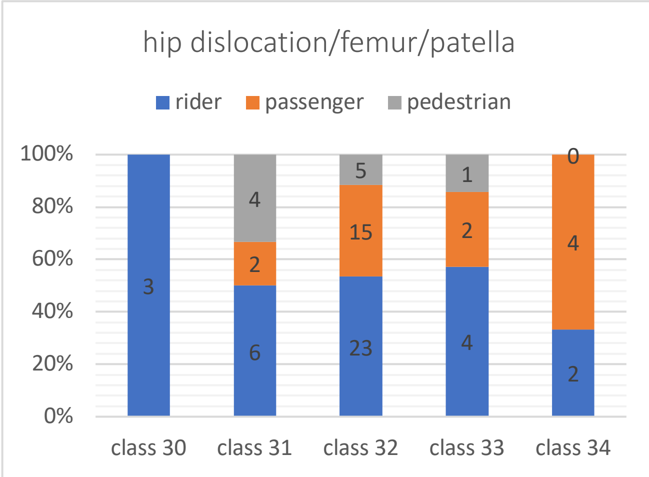
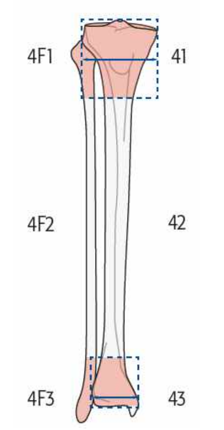
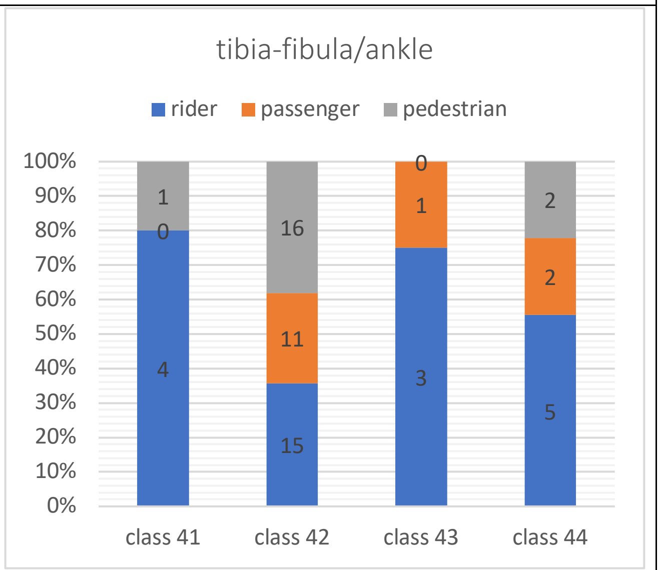
5 Chi-Squared (χ^2) or Fisher's Exact test *p*-value; Statistically significant codes are in bold: $p < 0.01$; $p < 0.05$

4.5 The pattern and severity of MCC-related musculoskeletal injuries based on AO/OTA classification and patient position category

The motorcycle rider predominantly involved in MCC-related musculoskeletal injuries and the injuries mostly involve long bone fractures. Diaphyseal fractures were predominant in the riders in all the long bones but predominated in the lower limb bones with the femur, tibia and fibula being the most injured in the diaphyseal segment. Pedestrians show a predisposition to getting diaphyseal wedge fracture of the tibia in motorcycle collisions (table 12).

In the humerus, the pattern was simple diaphyseal fractures. Both the rider and the pillion riders were equally affected, but no pedestrian was found to have suffered a humerus fracture.

<table>
<tr><th>AO class / Segment</th><th></th><th>A</th><th>B</th><th>C</th><th>Patient position category and number of fractures under AO/OTA classification</th></tr>
<tr><td rowspan="3">
</td><td>Proximal</td><td>0</td><td>0</td><td>0</td><td rowspan="3">
</td></tr>
<tr><td>Shaft</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>Distal</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td rowspan="3">
</td><td>Proximal</td><td>1</td><td>0</td><td>0</td><td rowspan="3">
</td></tr>
<tr><td>Shaft</td><td>5</td><td>1</td><td>0</td></tr>
<tr><td>Distal</td><td>1</td><td>0</td><td>0</td></tr>
</table>

<table>
<tr><th>AO CLASS / SEGMENT</th><th></th><th>A</th><th>B</th><th>C</th><th>Patient position category and number of fractures under AO/OTA classification</th></tr>
<tr><td rowspan="2"></td><td>Crashed multiple fracture hand 79</td><td>2</td><td>0</td><td>0</td><td rowspan="2">
</td></tr>
<tr><td>Phalanges 78</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td rowspan="5">
</td><td>hip</td><td>3</td><td>0</td><td>0</td><td rowspan="5">
</td></tr>
<tr><td>Proxima</td><td>9</td><td>3</td><td>0</td></tr>
<tr><td>shaft</td><td>30</td><td>10</td><td>3</td></tr>
<tr><td>Distal</td><td>4</td><td>0</td><td>3</td></tr>
<tr><td>patella</td><td>0</td><td>0</td><td>6</td></tr>
<tr><td rowspan="4">
</td><td>Proximal</td><td>1</td><td>1</td><td>3</td><td rowspan="4">
</td></tr>
<tr><td>Shaft</td><td>26</td><td>7</td><td>9</td></tr>
<tr><td>distal</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>Ankle</td><td>0</td><td>3</td><td>6</td></tr>
</table>

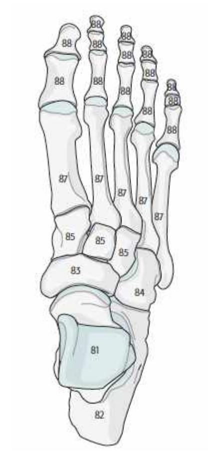
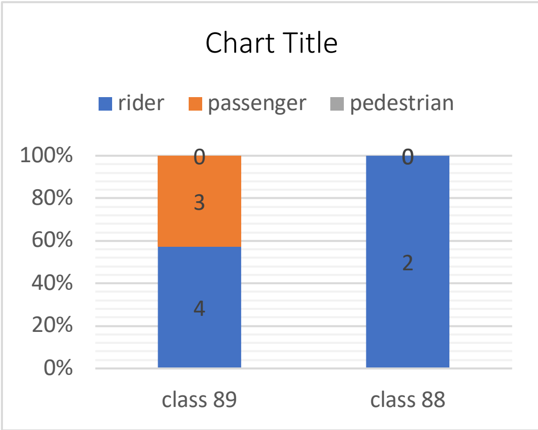
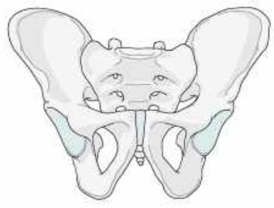
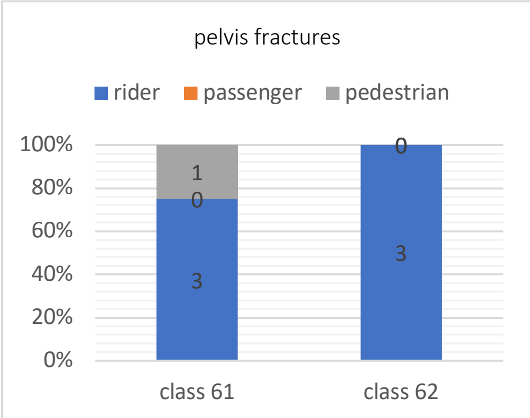
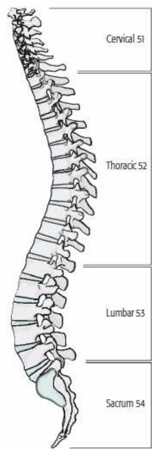
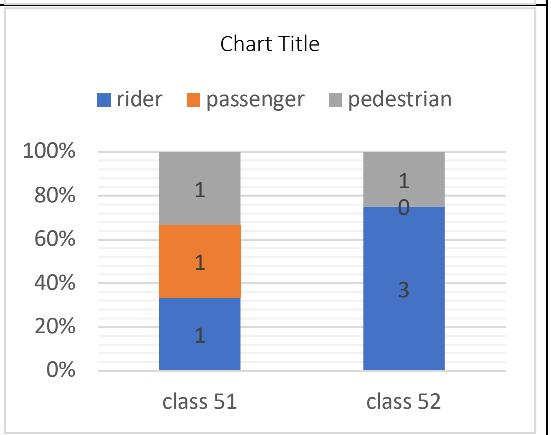
<table>
<tr><td>AO/OTA Class
Segment</td><td></td><td>A</td><td>B</td><td>C</td><td>Patient position category and number of fractures under AO/OTA classification</td></tr>
<tr><td rowspan="3"></td><td>Crashed multiple fractured foot 89</td><td></td><td></td><td></td><td rowspan="3">
</td></tr>
<tr><td>Phalanges 88</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3"></td><td>Class 61 (LC/APC)</td><td>0</td><td>0</td><td>1</td><td rowspan="3">
</td></tr>
<tr><td>Class 62 ACETAB</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">
</td><td>Cervical class 51</td><td>3</td><td>0</td><td>0</td><td rowspan="3">
</td></tr>
<tr><td>Thoracic class 52</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

Table 12: Pattern and severity MCC-related of musculoskeletal injuries by AO/OTA and patient category

4.6 Associated injuries in MCC-related musculoskeletal injuries

A total of 23 patients (18.3%) had injuries in body regions other than musculoskeletal system. Most of these were head injuries (n=16 patients, 12.7%), thoracic injuries (n=3 patients, 2.4%), maxillofacial injuries (n=3 patients, 2.4%) and abdominal injuries (n=1 patient, 0.8%). The Glasgow coma scale (GCS) among patients with head injuries were ≥13 in 9 patients (56%), 12 in 5 patients (31%) and 11 in 2 patients (13%). No significant differences were observed in head injury rate among those who used vs those who did not use helmet (p=0.497).

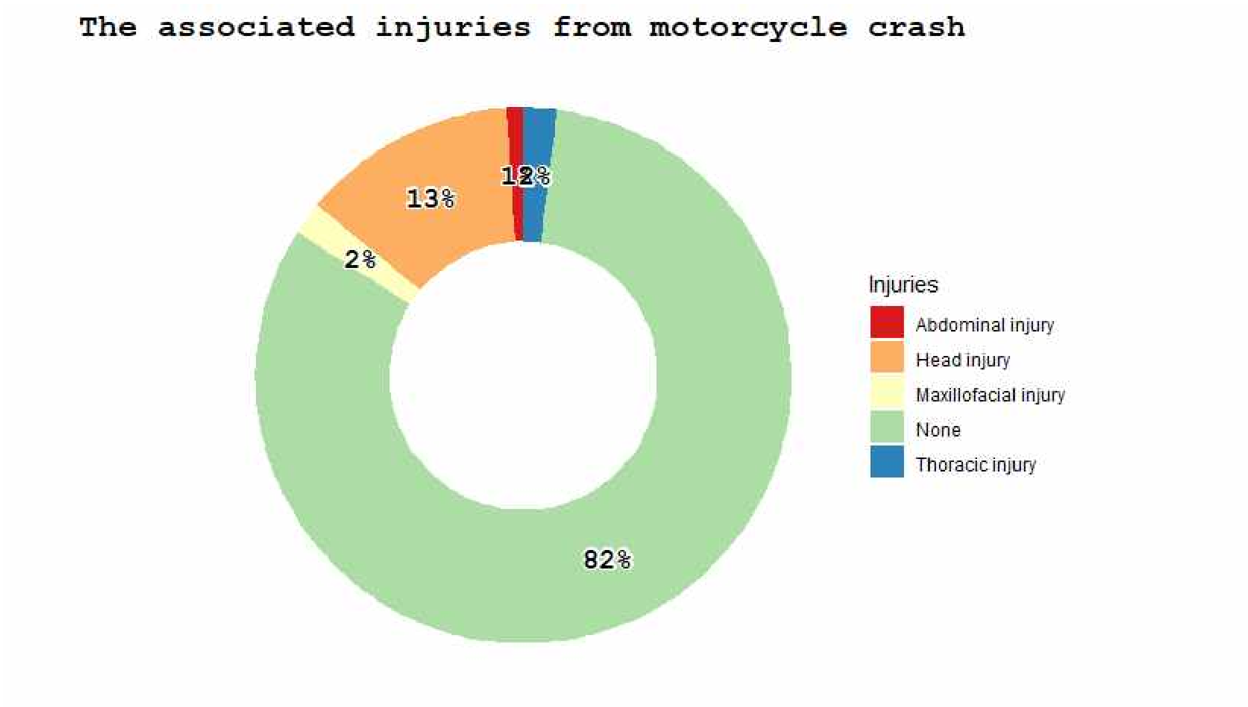


Figure 11: Associated injuries in motorcycle crash-related musculoskeletal injury patients

4.7 Type of protective gear used by motorcycle riders and pillion passengers with MCC-related musculoskeletal injuries

The use of protective gear that included at least a helmet, a luminous jacket and a heavy riding jacket was high (83% n=54) among the motorcycle riders but went down to 63% among both riders and the pillion passengers (figure 12). However, examination of the pillion passengers revealed poor use of safety gear, with only 18.8% (n=6) found to have worn at least one protective equipment, which was in all cases a helmet and a luminous reflective jacket. More than 60% of the motorbikes involved in the MCC had the day headlights on at the time of the crash.

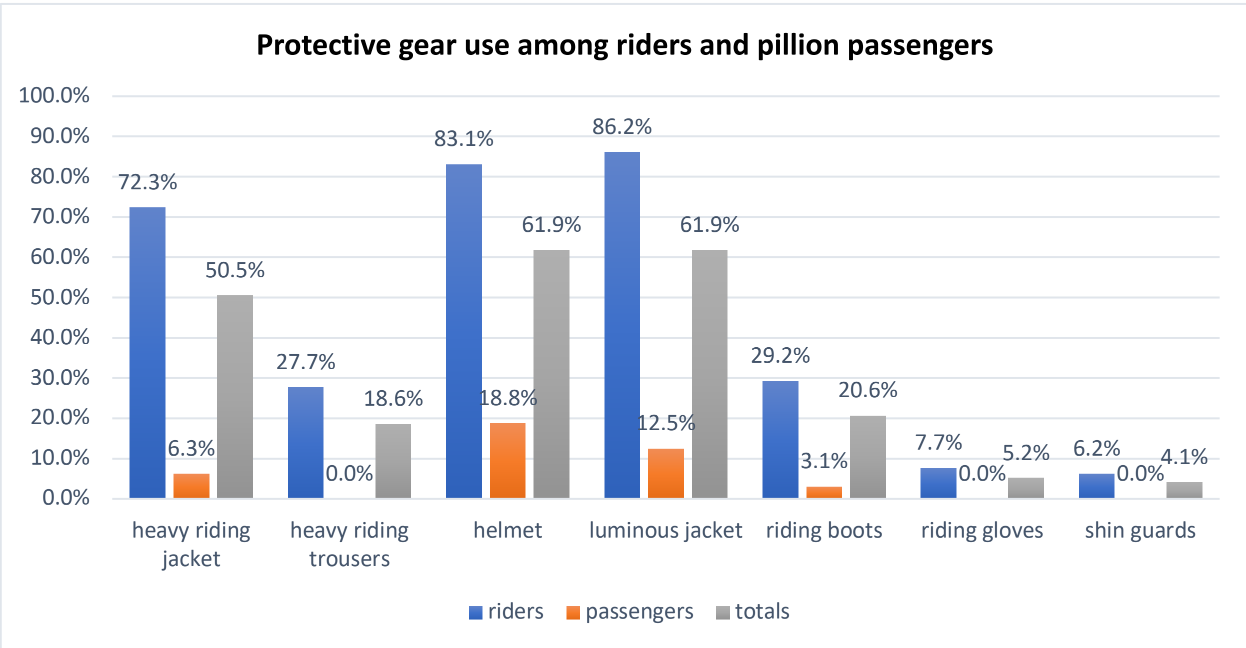


Figure 12: Protective gear use among riders and passengers involved in motorcycle crashes

5. DISCUSSION

Motorcycle crashes contribute a large proportion of road traffic crashes. In Kenya, the use of motorcycles has increased explosively in the last decade, with a concomitant increase in MCC-related injuries. Distribution, patterns, severity and mechanism of injury in MCC-related musculoskeletal injury has not been studied in the Kenyan set-up. Existing studies done have focused on prevalence, risk factors, and general injury distributions and severity in head injury and maxillofacial injuries, with the musculoskeletal system being evaluated as associated injury. The aim of this study was to determine the distribution, patterns and severity of musculoskeletal injuries among motorcycle crash victims at Kenyatta National Hospital. The objectives were to determine the age and sex, anatomical distribution, mechanism of injury, pattern and severity of fractures, associated injuries and use of safety gear in patients with MCC-related musculoskeletal injuries at KNH. The study highlighted that MCC are an important cause of musculoskeletal trauma and mainly involve economically active young men, with the motorcycle riders being the most frequently injured category in these crashes. Lower extremity fractures are the commonest injury type, with the femur being the predominantly injured bone followed by tibia/fibula. While use of safety gear including helmets among the motorcycle riders was high, it was very low amongst the pillion passengers. Other safety gear was poorly used across all carders of motorcycle users.

4.8 Age and sex of patients with MCC-related musculoskeletal injuries.

In the current study, patients with MCC-related musculoskeletal injuries comprised operators (51.6%, n=65), pillion passengers (25.4%, n=32) and pedestrians (23.0% n=29). Other studies done both locally and regionally in relation to MCC-related injuries have also observed a high rate of operators in their cohorts [23, 27, 32]. This may be explained by the fact that most motorcycle operators are always on the road transporting passengers and goods as they use these motorbikes as a means of gainful employment. They are exposed to a higher risk of road traffic injury than the pillion passengers and pedestrians. The motorcycles are also commonly used as couriers, transporting small parcels, food deliveries and even groceries, and therefore, a solitary motorcycle rider is a frequent finding on the roads.

The current study shows a male predominance in the victims (85.6%, n=108), and a male:female (M:F) ratio of 6:1. Previous studies done locally, and regionally had found similar male preponderance [11,14-16,22]. The young male predilection may be attributable to their role as bread winners for the family, and are more likely to be employed in the informal motorcycle transportation sector and thus exposed to higher risks than their female counterparts. This observation is supported by this study, as most of the motorcycle riders (93.8%, n=62) reported motorcycle transportation business (boda boda) as their occupation. It was also noted that all the motorcycle riders in this study were male, with the female patients being either passengers or pedestrians.

The pattern of age distribution demonstrated that people of all ages were affected, with a mean age of 31.6 ± 10.5 years, and an age range of 11-61 years. The peak age group affected was 21-30 years (45.2%), followed by 31-40 years (30.2%). More than 75% of those affected were aged between 21 and 40 years, showing most patients with motorcycle crash related musculoskeletal injury were young people in the economically active age group. This is also highlighted in that the majority of those injured were involved in some form of economic activity at the time of the crash. This is not peculiar in the current study. Other studies from developing countries have shown a similar picture, implicating the young ages between 20 to

40 years as the most commonly affected by motorcycle road traffic crash injuries [11,20,27,28,35]. Motorcycle use as a means of passenger transportation has flourished in many urban centers as they offer a convenient means of circumventing the traffic congestions and poor infrastructure [14]. In the face of lacking formal employment, the youth have been encouraged to join commercial motorcycle commercial driving as a source of income [14].

There were no children under the age of 10 years reported in this study. The youngest was 11 years old, and those below the age of 18 years were all pedestrians and accounted for 7.1% of the patients. Kigera et. al and Naddumba et. al in Uganda reported a comparative figure (about 10%) for victims below the age of 18 years [20, 35]. This shows no one is spared from this MCC-related injuries scourge with the associated morbidity, disability and mortality, depriving the economy of the much needed human resource.

4.9 Crash characteristics and mechanism of injury in MCC-related musculoskeletal injuries.

The current study found that the commonest motorcycle crash type was collision with a motor vehicle (53.2%, n=67), followed by collision with other motorcycles (31% , n=39). This observation has been noted in other studies [20, 23, 27, 28]. Theories advanced for that is motorcycles are not visible to other road users when in traffic [27]. Moreover, motorcycle riders have been reported to disregard road traffic laws, further exposing themselves to higher risk of collisions with other road users [26,31]. Various efforts have been made to increase the visibility of the motorcycle and the rider when on the road. Safety measures aimed at improving the visibility including use of reflective jackets, keeping the headlights of the motorcycle on at all times and enforcement of road traffic rules and regulations may assist in reduction of the motorcycle-motor vehicle collisions in an effort to reduce the number of motorcycle crash-related injuries. In the current study, 62% (n=78) of the participant reported having the day running light/headlight on during the crash, and 86.2% of the riders and 12.5% of the passengers had a reflective jacket on during the crash. The study found that the number of riders with a valid riding/driving license was 55.4% (n=36) with the riders years of experience being 6.1±3.8 years. This is in agreement with an earlier study done by Saidi and Mutiso [11]. However, the finding indicates that almost half of the motorcycle riders are not legally allowed to be on the roads as they do not have valid riding/driving licenses. Enforcement of the traffic laws needs to be upscaled to root out the unqualified riders in an effort to curb the rising incidences of motorcycle road traffic crashes.

The predominant mechanism of injury was collision type (61.1%, n=77) followed by highside/topside (25.3%, n=32). Collision with motor vehicles/motorcycles was commonly associated with collision/highside/topside injuries, where fall from motorcycle was associated with low-side injury ($p<0.001$). The predominance of the collision type mechanism of injury may be explained by the fact that the poorly visible motorcycles share the same roads space with much larger vehicles, and thus are at risk of being involved in a collision with motor vehicles [26,31,32,33]. When these collisions occur, the operator or passenger suffer direct impact traumatic injury since the motorcycle lacks external protection in crashes [44]. This will often cause injuries to the extremities, and the current study shows injuries to the lower limb dominate at 81.4% of all injuries sustained in the participants. A right side lower limb injury preponderance was also noted in the current study. This has not been reported in any other local or regional studies. This may be due to the Kenya traffic laws and regulations that require driving on the left lane unless overtaking another vehicle. This may expose the motorcycle riders and pillion passenger right side when being overtaken, and also during a crash with an oncoming vehicle as the rider will try and swerve to the left to avoid a head-on collision with an oncoming vehicle, thus sustaining right sided collision injuries in a crash.

Falls from motorcycle crash type of injury accounted for 15.1% (n= 19) of all injuries sustained in this study. This accounted for 70.6% of all lowside mechanism of injuries with injuries being on the side of fall. The most frequent injuries in this mechanism are lower limb injuries with tibia-fibula bone being most commonly injury [44,46-49]. This mechanism of injury may be attributed to overloading the motorcycle with either passengers or heavy loads, leading to loss of balance and fall on the lowside of the motorbike, leading to injury on the ipsilateral lower limb, as the motorbike body crashes the lowside limb.

Most of the MCC occurred during the day [1200-1800 hours] at 34.1% of all crashes, followed by early evening [1800-000 hours] at 32.5%. similar findings were reported by Saidi et. al and also by Sisimwo et. al [11, 27]. The findings may be related to an increase in transport activities associated with urban residents coming from work in late afternoon. This period is often associated with traffic jams which may force the commuters to use motorcycles for transportation. In an effort to maximize profits, the riders may overspeed and be more careless in regard to traffic laws and regulation incurring a higher risk of MCC. Sisimwo et. al hypothesized that the high numbers of crashes in the afternoon maybe attributed to rider fatigue, traffic rush hours and poor visibility [27]. There was no statistically significant difference on number of crashed and the day of the week.

5.3 Fracture distribution in MCC-related musculoskeletal injuries.

Slightly more than half of the patients (52.4%, n=66) had sustained multiple fractures in this study, while the rest had a single fracture. The ones with multiple fractures sustained 2, 3 or 4 fractures at 34.1%, 11.1% and 7.1% respectively. Majority (84.9%) of the fractures were domiciled within one anatomical region. The commonest injuries sustained were to the lower limbs (81.4%, n=184), with 96.5% of the fractures being unilateral and 3.5% with bilateral lower limb fracture. The upper extremities injuries contributed to 11.2% (n=25), with pelvis and spine at 3.6% (n=8) and 3.1% (n=7) respectively. The findings of the fracture distribution among the body regions was similar to other local and regional studies on motorcycle crashes. Chalya et. al in Tanzania found motorcycle crash related injuries to the lower extremities accounted for 77.3%, with Oluwadiya et. al in Nigeria, Khaji et. al in Iran, and a local study by Saidi et. al coming to the same conclusion [11,12,14,16]. The most common motorcycle crash type was collision with other motor vehicles, and the commonest mechanism of injury was found to be collision type in the current study. In this mechanism, it is likely that the motorcycle rider and the pillion passenger may suffer lower extremity injuries due to direct high energy impact during collisions leading to the injury distribution described. The preponderance of the injuries mostly affecting the right lower extremity (57.8%) may be explained by the left side driving traffic rule of the commonwealth countries. Other injuries sustained in motorcycle crashes are also influenced by the mechanism of injuries, with the topside and high side leading to upper extremity injuries and spine injuries [45,49,51,53-57]. One patient with scapular fracture and a brachial plexus injury had suffered a topside mechanism of injury, where he was flung off the motorbike and hit a light post with the shoulder, sustaining a direct vertical collision injury. This is in agreement with studies done on motorcycle racing patients by petit et. al in the United States of America[44, 59].

5.4 Patterns and severity of MCC-related musculoskeletal injuries.

In the current study, the most commonly injured bone in the lower limb was the femur (27.7%) followed by tibia-fibula (23.2%). This is in contrast with the findings by Galukande et. al in Uganda where it was found the tibia-fibula were the most commonly fractured bones followed by femur [38]. Lutomia et. al also found tibia-fibula was the most commonly fracture bones followed by the femur in motorcycle crash victims [28]. The difference may be explained by the fact that KNH is a tertiary hospital, and most of the patients in this study were referrals from other hospitals (62%, n=78). The high number of referred patient may indicate the severity of the injury, where the less severe injuries are treated in the primary healthcare facilities as they may not need an orthopaedic surgeon consult. Most closed midshaft tibia-fibula fractures may be treated conservatively with a cast, which can be done in the primary health care centers and thus only the need to refer the patient who may need ORIF, leading the high number of femur fractures seen at the referral hospital.

The review of the fracture patterns in the AO/OTA classification system (table 12) demonstrates the distribution of the fractures in the different segment of the fractured bone. In the femur, majority of the fractures were simple diaphyseal fractures transverse configuration (12%, n=27) followed by proximal femur (5%). The most severe injuries were in the distal femur (2.5%) and the patella fracture were also found in 2.7% of the cases. Hip dislocations were found in 3 patient accounting for 1.3% of injuries. Upper extremity injuries accounted for 11.2% (n=25), with 2 fractures involving the clavicle and the scapula. The pelvic and acetabula fractures accounted for 3% of all fracture, were all closed and on the right side. This again highlight the theory of traffic laws of driving on the left side exposing the motorcycle riders and pillion passengers to right sided musculoskeletal injuries during collision crash mechanism of injury.

In this study, most fractures were closed (53.8% n=113). Of the open fractures, 24.3% were Gustilo type IIIA/B, with type I and type II being 2.4% and 19% respectively. The injuries to the tibia-fibula were more associated with the open fracture type and this can be attributed to the collision crash mechanism of injury. The severity of the lower extremity injury during the crash may have influenced the referral to the tertiary facility as only the Gustilo II and III were more commonly seen at the hospital. Open tibia-fibula fracture accounted for 63.7% (n=72) of all the open fractures in this study. This echo the study by Lutomia et. al that showed the that tibia-fibula accounts for the highest proportion of open fractures [28]. This may be explained by the subcutaneous nature of the bone and also by the commonest mechanism of injury in the motorcycle crashes being collision. The lower limbs are relatively exposed with the leg dangling precariously and hence likely to be caught between the motorcycle and motor vehicle, and suffer open fracture injuries due to crash injuries.

5.5 Associated injuries in MCC-related musculoskeletal injuries.

Twenty three (23) patients suffered other body region injuries other than musculoskeletal system. Most had suffered head injuries (12.7% n=16), thoracic injuries at 2.4%, maxillofacial injuries at 2.4% and abdominal injuries at 0.8%. The GCS for the among the patients with head injuries was >13 in 56% (n=9), 12 in 31% (n=5) and 11 in 13% (n=2) of the patients. No significant differences were observed in head injury rate among those who used vs those who did not use a helmet. (p=0.497). Topside crash mechanism of injury have been shown to have high rates of head injury [44]. The patients who had associated head injuries had other multiple fractures and most of them had suffered collision with a motor vehicle (81.3%, n=13)

5.6 Use of Safety gear in MCC-related musculoskeletal injuries.

The use of safety gear by the motorcycle riders was notably higher than in other local and regional studies [11,22,20,28]. Use of helmets by the motorcycle riders was 83.1% (n=60), reflective jacket use was at 86.2% (n=62) among the motorcycle riders. This may have been influenced by the various road safety campaigns and better traffic law enforcement by the authorities. However, use of safety gear by the pillion passengers remain very low with helmet use among the passengers being only at 18.8% and reflective jackets use at 12.5%. This finding is echoed by other studies in the region, with Saidi et. al reporting helmet use of less than 5% amongst passengers and similar usage reported from a study in Nigeria by Solagberu et. al, and Chalya et. al in Tanzania [11,22,23]. The low usage of safety gear has been attributed to weather conditions in the tropics, motorcycle riders complaining it is too hot to wear heavy leather riding gear, and also hygiene concerns on sharing of the safety gear like helmets amongst the pillion passengers. The cost of this safety gear is also prohibitive among the motorcycle riders who don't see the value in incurring the expense. The issue of ignorance among the riders also comes into play as many riders have no formal training and do not hold valid riding/driving licenses.

CONCLUSIONS

- Motorcycle crash-related musculoskeletal injuries were most common in males aged between 21-40 years, mostly affecting motorcycle taxi operators and casual labourers.
- Lower extremity fractures were the most common occurring musculoskeletal injuries in MCC (81.4%), followed by upper extremity injuries (11.1%) with the rest being spine and pelvic fractures. These were mainly closed fractures (57.9%).
- The most common crash type in MCC were collisions with motor vehicles (53.2%), followed by collisions with other motorcycles (31.0%), with the commonest mechanism of injury being collisions (61.1%), followed by topside crashes (19.0%).
- The most commonly fractured bone was the femur, followed by tibia/fibula. There was a preponderance of right lower extremity fracture. Diaphyseal fractures were the commonest, with transverse and oblique pattern being predominant.
- Open fractures occurred most commonly in the lower extremity, specifically on the tibia/fibula.
- Lack of training and licensing was common among motorcycle riders, with unlicensed riders accounting for more than 45.0% in the current study.
- Head injury was the most common associated injury sustained in MCC-related musculoskeletal injury.
- Overall use of safety gear was poor, with very low usage of at least a helmet highlighted among the pillion passengers.

RECOMMENDATIONS

1. There is need to focus on strategies that help in prevention of MCC, with emphasis on enforcement of the existing law to ensure adequate training and licensing of the riders.
2. Use of good quality protective gear including helmets, heavy riding trousers and shin guards by motorcyclists to derive maximum protection must be enforced and emphasized.
3. Construction of pedestrian walk ways on major roads/highways and promotion of appropriate road safety practice to all road users.
4. A similar national, multicentered, prospective and randomized study should be conducted so assess and compare the magnitude of the MCC-related musculoskeletal injury burden.
5. Further studies on cost and outcomes of MCC-related musculoskeletal injuries recommended.
6. The most commonly fractured bones were found to be the femur and tibia/fibula. This may inform policy on budgeting and fund allocation for ORIF hardware procurement for better management of these patients.

REFERENCES

1. Buckley RE, Moran CG, Apivatthakakul T, et al. *Fracture Classification. AO Principles of Fracture Management.* Thiem New York: AO Publishing; 2017. p. 39-50.
2. Kim PH, Leopold S. *In brief: Gustilo-Anderson classification.* Clinical Orthopaedic and related Research. *2012* 470(11):3270-3274.
3. Peden M, *World Report on Road Traffic Injury Prevention*. World Health Organization, Geneva. 2004.
4. Liu B, Ivers R, Norton R, Blows S, Lo SK. Helmets for preventing injury in motorcycle riders. The *Cochrane database of systemic reviews 2004*;(2):CD004333.
5. World Health Organization: *Global Status report on road safety*. Geneva, World Health Organization; 2018; 4-10.
6. Kenya Facts and Figures: Kenya National Bureau of Statistics: *Government Printers 2014*; 53-55.
7. Government of Kenya, *Government Printer: Economic survey: 2014*; 53-58.
8. World Health Organization *Global health estimates*. Geneva; 2014; 48-53.
9. Peltzer K, Road use behaviour in Sub-Saharan Africa. *Public Health, 2011; 122*(12): 1399-1406.
10. Saidi H, Mutiso BK, Ogengo J. Mortality after road traffic crashes in a system with limited trauma data capability. *Journal of Trauma Management & Outcomes. 2014;8(1):44-50.*
11. Saidi H, Mutiso BK, Motorcycle injuries at a tertiary referral hospital in Kenya: Injury patterns and outcome. *European Journal of Trauma and Emergency Surgery. 2013;28:20-23.*
12. Chalya PL, Mabula JB, Dass RM, Mbelenge N, Ngayomela IH, Chandika AB, Gilyoma JM. Injury characteristics and outcome of road traffic crash victims at Bugando Medical Center in Northwestern Tanzania. *Journal of Trauma management & outcomes. 2012;6(1):69-75.*
13. Abdulgafoor MB, Pranali K, Hadley KH, Road Traffic Injuries in Kenya: The health Burden and Risk Factors in Two Districts; *Traffic Injury Prevention. 2012;13:24-30.*
14. Oluwadiya KS, Oginni LM, Olasinde AA, Fadiora SO. Motorcycle limb injuries in a developing country. *West African Journal of Medicine. 2004;23(1):42-47.*

15. Hashim H, Igba S: motorcycle accidents is the main cause of maxillofacial injuries in the Penang Mainland, Malaysia: *Denta Traumatology 2011;3(6):27-22.*
16. Khaji A, Karbakshsh M : Pattern of motorcycle related injuries in Tehran, 1999 to 2000; a study in 6 hospitals: *East Mediterranean Health Journal 2006; 12:81-87.*
17. Blincoe L, Miller T, Zaloshnja E, Lawrence B, The economic and societal impact of motor vehicle crashes. *2010, Report No. DOT HS 812 013,* NHTSA Washington DC.
18. John Hopkins Medical Institutions. "Motorcycle helmets reduce spine injuries after collisions; helmet weight as risk to neck called a 'myth'." *ScienceDaily, 10 February 2011. www.-sciencedaily.com/releases/2011/02/11209124141.htm.*
19. Crompton JG, Bone C, Oyetunji T, Keshia M, Oluwaseyi P, et al. Motorcycle Helmets Associated with Lower Risk of Cervical Spine Injury: Debunking the Myth. *Journal of the American College of Surgeons*, 2011;212(3): 295-300.
20. Naddumba EK, A cross-sectional retrospective study of Boda Boda injuries at Mulago Hospital Kampala, Uganda. *East Cent Afr J Surg. 2004;9(1):44-48.*
21. Bachani AM, Koradia P, Herburt HK, Mogere S, Akungah D, Nyamari J, Osoro E, Maina W, Stevens K. A. Road traffic injuries in Kenya: the health burden and risk factors in two districts. *Traff Inj Prev.* 2012;13(1): 24-30.
22. Chalya PL, Mabula JB, Ngayomela IH, Kanumba ES, Chandika AB, Giiti G, Mawala B, Balumuka DD. Motorcycle injuries as an emerging public health problem in Mwanza city, North-Western Tanzania. *Tanz J Health Res.* 2010;12(4):214-221.
23. Solagberu BA, Ofoegbu CPK, Nasir AA, Ogundipe OK, Adekanye AO, Abdur-Rahman LO. Motorcycle injuries in a developing country and the vulnerability of riders, passengers and pedestrians. *Injury Prevention* 2006;12:266-268.
24. Broughton P, Walker L, (2009). Motorcycle and leisure: Understanding the recreational ptw Rider. Farnham, UK: *Ashgate Publishing.* 2009; p. 74-79.
25. Dinye RD, The significance and issues of motorcycle transport in the urban areas in northern Ghana. *Scientific Journal of Review* 2013;2(10): 256-272.
26. Rugut J, Makori B, Determinants influencing performance of alternative public transport in Kenya: A case of motorcycle transport, Nakuru county, *The strategic journal of business and change management. 2015;* 2(6): 436-471.

27. Sisimwo PK, Mwaniki PK, Bii C. Crash characteristics and injury patterns among commercial motorcycle users attending Kitale Level IV District Hospital, Kenya. *The Pan African Medical Journal. 2014;*19:296-302.
28. Khanbhai M, Lutomia MBL, Motorcycle Accident injuries seen at Kakamega Provincial Hospital in Kenya. *East and Central African Journal of Surgery, 2012;*17(1): 43-46.
29. National Economic Survey, *Kenya National Bureau of Statistics;* Nairobi. 2016; 46-49.
30. World Health Organization, Motorcycle-related road traffic crashes in Kenya; Facts and Figures. *RS10 Kenya project* Nairobi. 2012; 113-120.
31. Helmets: A road safety manual for decision makers and practitioners. Geneva, *World Health Organization, 2006; 119-122.*
32. Aikins m, et al. Economic burden of motorcycle accidents in Northern Ghana, *Ghana medical Journal, 2011;* 45(4): 135-142.
33. NHTSA. Traffic safety facts 2013: Motorcycles, Washington DC. 2015; 712-721.
34. Charles GM. Combating road traffic accidents in Kenya: a challenge for an emerging economy, *Kenya After 50: 2016;101-122.*
35. Kigera JW, Naddumba EK, Patterns of injuries After Road Traffic Crashes Involving BodaBodas, *The Annals of African Surgery, 2010;*5:12-14.
36. Odero W, Motorcycle injuries in East Africa: Magnitude, Risk factors and Prevention. *A paper presented at th RTIRN Regional Workshop. Accra, Ghana in 2009*.
37. Comparative statistics Trends for 2013 and 2014. *The National Transport and Safety Authority, Nairobi 2014;* 5: 96-101.
38. Galukande, Jombwe M, Fualal et al: Bodaboda injuries a health problem and a burden of Disease in Uganda: A tertiary Hospital Survey. *East and Central Africa Journal of Surgery 2009;*14: 33-37.
39. Kotor J, Yinusa W, Ugbeye M. Lower limb injuries arising from motor cycle crashes, *Nigeria journal of Medicine. 2010;*19(1):41-44.
40. Cawich S, Rose R, Harding H, Ivor C. Extremity Injuries From Motorcycle Road Traffic Accidents: The experience from a Tertiary referral Hospital In Jamaica. *The internet journal of emergency and intensive care medicine. 2008*;5(1):111-115.
41. Cawich S, Harding H, Evans N: strategies for Secondary Prevention of Motorcycle Road Traffic Accident Injuries: *Internet journal of emergency medicine. 2010;*12(11):188-196.

42. US Department of Transportation, National Highway Traffic Safety Administration; Federal Highway Administration, Traffic Safety Facts, NHTSA's National Center for Statistics and Analysis, 2019; 55(11): 233-239.
43. Amin NH, Jakoi A, Katsman A, Harding SP, Tom JA, Cerynik DL. Incidence of orthopaedic surgery intervention in a level I urban trauma center with motorcycle trauma. *J Trauma 2011;*71:948-951.
44. Petit L, Zaki T, Hsiang W, Leslie M, Wiznia D; A review of common motorcycle collision mechanism of injury. *EFORT open reviews 2020; 5*:544-548.
45. Bedolla J, Satelli J, Sabra J, Cabanas JG, Olvey S. Elite motorcycle racing; crashtypes and injury patterns in the MotoGP class. *AM J Emerg Med 2016;* 34:1872-1875.
46. Alicicioglu B, Yalniz E, Eskin D, Yilmaz B. 'Injuries associated with motorcycle accidents" *Acta Orthop Trauma 2008;*42:106-111.
47. Eid HO, Bars P, Adam SH. Factors affecting anatomical region of injury severity, and mortality for road trauma in a high income developing country: lessons for prevention. *Injury 2009*;40:703-707.
48. Wick M, Muller EJ, Ekkernkamp A, Muhr G 'The motorcyclist; easy rider or easy victim/ An analysis of motorcycle accidents in Germany. *AM J Emerg Med 1998;*16:320-323.
49. Batsista F, Silveira LO, Castillo JJ, Pontes JE, Villalobos LD. "Epidemiological profile of extremity fractures in victims of motorcycle accidents' *Acta Ortop Bras 2015*;23:43-46.
50. Ankarath S, Giannoudis PV, Barlow I, Bellamy MC, Matthews SJ, Smith RM. Injury patterns associated with mortality following motorcycle crashes' *Injury 2002;*33:473-477.
51. Zhu YL, Li J, Ma WQ, Mei LB, Xu YQ, 'Motorcycle spoke injuries of the heel' *Injury 2011;*42:356-361.
52. Kraus JF, Peek-Asa C, Cryer HG. 'Incidence, severity and patterns of intrathoracic and intra-abdominal injuries in motorcycle crashes. *J Trauma 2002;*52:548-553.
53. Talving P, Teixeira PG, Barmparas G. 'Motorcycle-related injuries: effect on age on type and severity of injuries and mortality' *J Trauma 2010;*68:441-446.
54. Peter K, Krantz G. 'Head and neck injuries to motorcycle and moped riders: with special regard to the effect of protective helmets'. *Injury 1985;*16:253-258.

55. Bambach MR, Mattos GA ‘ Head and spine injuries sustained by motorcyclists in head-leading collisions with fixed roadside objects. *Traffic Inj Prev 2015;*16:168-176.
56. Holly LT, Kelly DF, Counelis GJ, Blinman T, McArthur DL, Cryer HG. ‘Cervical spine trauma associated with moderate and severe head injury: incidence, risk factors, and injury characteristics’ *J Neurosurg 2002*;96:285-291.
57. Lam C, Lin MR, Chu SF, Tsai SH, Bai CH, Chiu WT ‘The effects of various types of motorcycle helmets on cervical spine injury in head injury patients: a multicenter study in Taiwan’ *Biomed Res Ins 2015;*2015:487985.
58. Lin M-R, Kraus JF. ‘ A review of risk factors and patterns of motorcycle injuries’ *Accid Anal Prev 2009;*41:710-722.
59. Paryavi E, Gilotra MN, Johnson AJ, Pensy RA, Eglseder WA, Abzug JM. Upper extremity injuries in motorcyclists: implications for mortality and need for rehabilitation services. *J Trauma Acute Care Surg 2015;*78:1021–1025.
60. Zettas JP, Zettas P, Thanasophon B. Injury patterns in motorcycle accidents. *J Trauma 1979*;19:833–836.
61. Meredith L, Baldock M, Fitzharris M, et al. Motorcycle fuel tanks and pelvic fractures: a motorcycle fuel tank syndrome. *Traffic Inj Prev, 2016;*17:644–649.
62. Rockwood CA, Green DP, Heckman JD, Bucholz RW. Rockwood and Green’s fractures in adults. Philadelphia, PA: *Lippincott Williams & Wilkins, 2001; p.363-364.*
63. Soldado F, Ghizoni MF, Bertelli J. Injury mechanisms in supraclavicular stretch injuries of the brachial plexus. *Hand Surg Rehabil 2016;*35:51–54.
64. Kosola S, Salminen P, Laine T. Heading for a fall: moped and scooter accidents from 2002 to 2007. *Scand J Surg 2009*;98:175–179.
65. Rubin G, Peleg K, Givon A, Rozen N. Upper extremity fractures among hospitalized road traffic accident adults. *Am J Emerg Med 2015*;33:250–253.
66. Alexander C, Abzug JM, Johnson AJ, Pensy RA, Eglseder WA, Paryavi E. Motorcyclist’s thumb: carpometacarpal injuries of the thumb sustained in motorcycle crashes. *J Hand Surg Eur Vol 2016*;41:707–709.
67. Jacobs, G. Aeron-Thomas, A. Astrop, A. Estimating Global Road Fatalities; *Crowthorne Transport Research Laboratory, 2000;* 445(1):1342-1350.

68. Cochran WG. Sampling techniques. John Wiley & Sons, Inc., *NewYork;* 1977, p. 428

69. Schluter PJ, Cameron CM, Davey TM. Using trauma injury severity score (TRISS) variables to predict length of hospital stay following trauma in New Zealand. *New Zealand Medical Journal. 2009*;122(2):65-78.

LIST OF APPENDICES

APPENDIX A: Data collection sheet/Questionnaire

MOTORCYCLE CRASH INJURY DISTRIBUTION QUESTIONNAIRE

Study topic: Distribution, patterns and severity of musculoskeletal injuries among motorcycle crash victims at Kenyatta National Hospital.

Fill in the following details:

IP/OP NO: ……………….………. STUDY NO: ………………….

X-RAY NO: ……………………..

Demographic information

1. Age: [..………] years
2. Sex: (a) Male: [....] (b) Female: [….]
3. Area of residence: ……………………………………………
4. Occupation: ……………………………………………
5. Level of Education: None: […] Primary: […] Secondary: […] Tertiary: […]
6. Contact information: ……………………………..…..

Motorcycle crash information

7. Crash location:
   County…………..…..…. City/Town……………..………. Road……………..………
8. Date/Day/Time of crash: Date ……………(dd/mm/yyyy), Day …....Time ……(24hrs)
9. Arrival at KNH: Date ……………(dd/mm/yyyy), Day ……Time …….(24hrs)

10. Referral: (a) Yes […] Referring hospital: ………………………………….
    (b) No […]
11. Mode of evacuation to KNH: (a) Ambulance: […] (b) Police vehicle: […]
    (c) Private vehicle: […] (d) other (specify) ……………………..…………

Mechanism of injury

12. Patient position during crash: (a) Operator: […] Valid license (i) Yes […]

(iii) Riding Experience: [.......] years [......] months

(ii) No: […]

(b) Pillion passenger: […]

(c) Pedestrian: […]

13. Crash type:
    - (a) Collision with motor vehicle: […]
    - (b) Collision with motorcycle: […]
    - (c) Collision with terrain: […]
    - (d) Fall from motorcycle: […]
    - (e) Others (specify) ....

14. Mechanism on injury
    - (a) Lowside: […]
    - (b) Highside: […]
    - (c) Topside: […]
    - (d) Collision: […]
    - (e) Not specified […]

15. Protective gear worn during the crash: (tick the protection worn)
    - (a) Helmet: […]
    - (b) luminous riding jacket: […]
    - (c) Heavy riding jacket: […]
    - (d) Heavy riding trousers: […]
    - (e) riding boots: […]
    - (f) Riding gloves: […]
    - (g) Sheen guards: […]
    - (h) Others (specify): ....

16. Were the motorcycle headlights on during the crash? (tick one)(a) Yes:[…]

(b) No: […]

Clinical examination findings

17. Patient has a fracture? (Tick one): (a) Yes: […] (b) No: […]

18. If yes, are the fracture(s)? (tick one): (a) single: […] (b) multiple: […]

19. If multiple how many in number?: [……]

20. Type of fractures: (tick one): (a) closed: […] (b) open: […]

Anatomical site and fracture classification on radiological findings

21. Which is the fractured bone on the x-ray film (fill in from the attached map of AO/OTA class and Gustilo-Anderson classification)

No.	**ANATOMICAL REGION**	**BONE**	**AO/OTA CLASS**		**Gustilo-Anderson/ Equivalent class**
			RIGHT	**LEFT**	

22. Associated injuries: (specify injury type)

(a) Head injury […] …………………………GCS score ……………………

(b) Maxillofacial injury […] ………………...

(c) Thoracic injury […] ……………………..

(d) Abdominal injury […] …………………..

(e) Ophthalmic injury […] ………………….

(f) Soft tissue injuries: […] …………………

(g) Others (specify) ………………………….

ISS …………/75

Diagnosis

MUSCULOSKELETAL INJURY DIAGNOSIS *(based on clinical and radiological evaluation)*

……………………………………………………………………………………………

APPENDIX B: AO/OTA Fracture Classification map

AO/OTA fracture and dislocation classification system. This is a classification system published by Orthopaedic Trauma Association Committee for classification and coding in 2006 and revised in 2018.

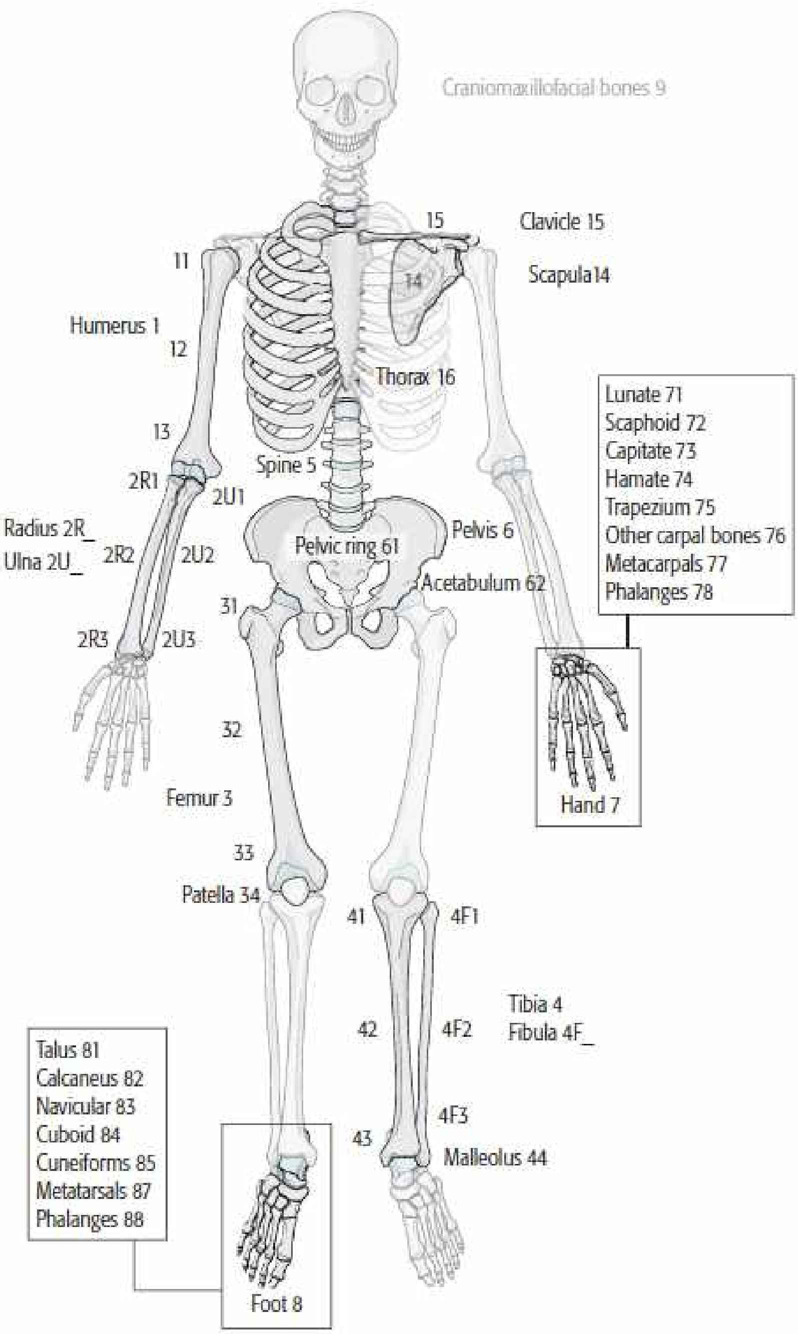


Figure 13: The AO/OTA coding system for the skeleton

Adapted from: Fracture and Dislocation Classification Compendium -2018 JOT 2018 [1]

APPENDIX C: Consent information form

PART I: CONSENT INFORMATION DOCUMENT

The informed consent is for the patients who present to KNH A&E, Orthopaedic wards or ICU/HDU with motorcycle crash related musculoskeletal injuries during the study period.

Title of the study: Distribution, patterns and severity of musculoskeletal injuries in motorcycle crash victims at Kenyatta National Hospital.

My name is Dr. James Kigotho, a postgraduate student in the Department of Orthopaedic Surgery at the University of Nairobi. I am conducting a study to determine the distribution, patterns and severity of motorcycle crash related musculoskeletal injuries in Kenyatta National Hospital. This is a prospective cross sectional study.

Study benefits

- The findings of this study may not be of direct/immediate benefit to you but may help in management and prevention of similar motorcycle injuries in the long run.
- All the questions you will be asked in the study and the subsequent physical examination are part of routine diagnostic process of your injuries. Refusal to participate in the study will not affect the quality of your treatment in any way.
- There will be no financial benefits for participating in this study. You will also not incur any extra financial costs for participating in this study. The information obtained will be used for research only.
- The findings in this study will provide data for health planning, improvement of management of motorcycle injuries and development of programs to reduce the incidents of motorcycle road traffic crash related injuries.

Inconveniences and risks of the study

- You may experience inconvenience due to the many questions in the interview and the physical examination. We will kindly ask to interview your relatives or attendants to collect the data where your condition does not warrant the interview.
- There are no dangers or risks associated with participating in this study.

Voluntariness of Participation and right of withdrawal from the study

- Your participation in this study is purely on voluntary basis and you may choose to participate in the study or not. Your refusal to participate will not affect the quality of your treatment in any way.
- You may decide to withdraw from the study at any time, temporarily or permanently as your involvement in the study is purely voluntary. Withdrawal from the study will not affect the quality of your treatment in any way.

Duration

- The history taking and physical examination by the investigator will take about 30 minutes. It will involve asking questions relating to your motorcycle injury and examinations of the sites of injury. If you accept to participate, you will be asked to provide personal information. You will also be examined by the research assistant (medical officer) or myself; Dr. James Kigotho (principal investigator).

Confidentiality

- Strict confidentiality and privacy of the patient participating in this study shall be maintained. The questionnaire will not bear your name and all the data obtained shall be securely stored. The information about you will only be identified by a study number.
- We will seek to share our findings with other people undertaking similar studies. Any publication of our findings in scientific journals or presentations in scientific meetings will not have no information that can identify you. Your identity will not be revealed in any publication.

Questions and choices

- Any questions you may have may be addressed to the principal investigator via the contact information provided below.

PART II: CONSENT CERTIFICATE

I, …..…………………………………………………………………………………… freely give consent of myself to take part in the study conducted by Dr. Kigotho James, the nature of which has been explained to me by him/his research assistant. I have been informed and have understood that my participation is entirely voluntary and I understand 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 not directly be of benefit to me and may assist in reducing injury occurrence or improve management in motorcycle related musculoskeletal injuries.

………………………………………..
Signature/Thumb print of (participant)

Date: ………………………………….
DD/MM/YYYY

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

Statement by the witness if participant 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: …………………………………….
(DD/MM/YYYY)

STUDY CONTACTS

Dr. Kigotho James Ng'ang'a [Principal Investigator]
Department of Orthopaedics, School of Medicine, University of Nairobi.
P. O. Box 19676 KNH 00202, Nairobi.
Tel: 0710490850
Email: kigotho@gmail.com

The Secretary
KNH/UoN-ERC
P. O. Box 19676-00202 KNH, Nairobi.
Tel: 0202726300-9 Ext 44355
Email: uonknh_erc@uonbi.ac.ke

The Chairman
Department of Orthopaedics, College of Health Sciences, University of Nairobi
P. O. Box 19676-00202 KNH, Nairobi.
Tel: 0202726300

UNIVERSITY OF NAIROBI RESEARCH SUPERVISORS:

Dr. Kirsteen O. Awori
Department of Orthopaedics, School of Medicine, University of Nairobi
P. O. Box 19676 KNH 00202, Nairobi
Tel: 0722812499
Email: kawori@uonbi.ac.ke

Dr. Vincent M. Mutiso
Department of Orthopaedics, School of Medicine, University of Nairobi
P. O. Box 19676 KNH 00202, Nairobi.
Tel: 0723289922
Email: mutiso@uonbi.ac.ke

PART III: STATEMENT OF THE RESEARCHER/PERSON TAKING CONSENT

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands what the research is all about.

- Refusal to participate or withdrawal from the study will not in any ways 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 motorcycle related fractures mechanism of injury, distribution anatomically 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 document has been provided to the participant.

Name of Researcher taking consent: ………………………………………..

Signature of researcher taking consent: ……………………………………….

Date: ……………………………………… DD/MM/YYYY

APPENDIX D: Fomu ya kibali (Kiswahili)

FOMU YA MAELEZO KUHUSU IDHINI

Lengo

Mimi naitwa Daktari Kigotho James Ng'ang'a, mwanafunzi katika Chuo Kikuu cha Nairobi, Idara ya mifupa (Orthopaedic Surgery). Nafanya utafiti unaolenga kupata Habari kuhusu matukio na muundo wa majeruhi ya mifupa kwa viungo yanasosababishwa na ajali za pikipiki kwa majeruhi wanaofika kutibiwa katika Kenyatta National Hospital. Nakualika kushiriki kwa utafiti huu kama mmoja wa majeruhi wa ajali ya pikipiki ukiwa na majeraha ya mipupa.

Faida ya utafiti

- Matokeo ya utafiti huu huenda yasikufaidi wewe kibinafsi kwa wakati huu lakini Habari tutakayopata itasaidia kuzuia na utibabu bora ya majeraha yanayotokana na ajali za pikipiki.
- Maswali utakayoulizwa na ukaguzi utakaofanyiwa ni wa kawaida na itasaidia kuelewa bora majeraha yako na pia kudumisha matibabu yako.
- Kutoshiriki kwa utafiti huu hakutadhuru matibabu yako kwa njia yoyote.
- Hakuna malipo ya kifedha kwako kwa kushiriki kwa utafiti huu. Pia, hakuna malipo yoyote utakayolipa kwa kushiriki.
- Habari tutakayopata kwa utafiti huu utasaidia kuweka mikakati mwafaka katika kuzuia na kupunguza ajali za pikipiki.

Hatari na Madhara zinazokusudiwa katika utafiti

- Ukikubali kushiriki, utahitaji kujibu maswali mengi na kufanyiwa ukaguzi wa majeraha. Huenda ukawa na maumivu katika ukaguzi. Mikakati ya kupungaza maumivu itapewa kipao mbele.
- Hakuna hatari wala madhara yoyote yanayokusudiwa kwa kushiriki katika utafiti huu.

- Huenda ikahitakika kuwahoji wanaokuhudumia ama waliokuleta kuhusu ajali na pia majeraha yako. Tutakuomba ruhusa kabla kufanya hivi.

Kushiriki kwa hiari na kujiondoa katika utafiti

- Uko huru kushiriki ama kutoshiriki kwa utafiti huu. Unaweza kujiondoa kwa utafiti huu wakati wowote ule. Kutoshiriki au kujiondoa kwa utafiti huu hakutadhuru Matibabu yako kwa vyovyote vile.

Muda utakaotumia

- Mahojiano na ukaguzi na mtafiti itachukua wakati wa dakika thelathini. Itajumuisha maswali kuhusu ajali ya pikipiki and kukagua kiungo ulipoumia. Habari hii and ukaguzi utafanywa na mpelelezi mkuu, Dr. Kigotho James, ama mpelelezi msaidizi ambaye pia ni daktari.

Usiri wa Mahojiano

- Usiriwa wa mahojiano utapewa kipao mbele na kutiliwa maanani. Hakuna jina lolote litandikwa kwa nakala ya maswali na majibu yote yatawekwa kwa usalama bila kuonyeshwa yeyote. Hii Habari itatambulika tu kwa nambari ya utafiti. Kama tutachapisha matokeo yetu kwenye vitabu vya sayansi, ama kutangaza matokeo haya kwa mikutano vya kisayansi, hakuna majina yoyote yataandikwa kwenye machapisho hayo, kwa hivyo hayatajumuishwa katika vitabu na mikutano hii ya kisayansi. Nafsi yako itabaki siri.

Ukiwa na maswali ama jambo lolote ungependelea kujua kuhusiana na haki zako kama mshiriki katika utafiti huu, jisikie huru kuwasiliana watafiti ambao anwani zao zimeandikwa hapa.

PART II: Cheti cha kibali (Consent certificate) [KISWAHILI]

CHETI CHA KUKUBALI KUSHIRIKI KATIKA UTAFITI

Mimi, ………………………………………………………………………………………….……..

(Jina kamili kwa herufi kubwa)

kwa hiari yangu nakubali kushiriki katika utafiti huu unaofanywa na Dr. Kigotho James, kuhusu majeraha ya mifupa yanayotokana na ajali za barabarani za pikipiki kwa majeruhi waoonekana katika hospitali kuu ya Kenyatta. Nimeelewa ya kwamba kushiriki kwangu ni kwa hiari yangu na nikipenda naweza kujiondoa wakati wowote katika utafiti huu bila kuadhiri matibabu yangu kwa vyovyote vile. Matokeo ya utafiti huu huenda yasinifaidi kibinasi kwa sasa lakini Habari itakayopatikana itasaidia kupata njia nzuru zaidi za kupunguza, kuzuia na kutibu majeraha ya mifupa yanayotokana na ajali za pikipiki.

………………………………………..

Sahihi/Kidole gumba (mshiriki)

Tarehe: ………………………………….

DD/MM/YYYY

Kidole Gumba cha mshiriki)

Nakala ya mshahidi/mlinzi kama mshiriki hajui kusoma:

Nimesoma na kuelewa maelezo yote amayo yameandikwa kwenya fomu hii ya utafiti. Nimeshuhudia mshiriki amepata nafasi ya kuuliza maswali na amekubali kushiriki kwa utafiti kwa hiari yake.

Sahihi: ……………………………………….. Tarehe: …………………………………….

(DD/MM/YYYY)

ANWANI ZA WATAFITI

Dr. Kigotho James Ng'ang'a [Mtafiti Mkuu]
Department of Orthopaedics, School of Medicine, University of Nairobi.
SLP 19676 KNH 00202, Nairobi.
Tel: 0710490850
Email: kigotho@gmail.com

Karani
KNH/UoN-ERC
SLP 19676-00202 KNH, Nairobi.
Tel: 0202726300-9 Ext 44355
Email: uonknh_erc@uonbi.ac.ke

Mwenyekiti
Department of Orthopaedics, College of Health Sciences, University of Nairobi
SLP 19676-00202 KNH, Nairobi.
Tel: 0202726300

Wasimamizi wa utafiti wa Chuo Kikuu Cha Nairobi:

Dr. Kirsteen O. Awori
Department of Orthopaedics, School of Medicine, University of Nairobi
SLP 19676 KNH 00202, Nairobi
Tel: 0722812499
Email: kawori@uonbi.ac.ke

Dr. Vincent M. Mutiso
Department of Orthopaedics, School of Medicine, University of Nairobi
SLP 19676 KNH 00202, Nairobi.
Tel: 0723289922
Email: mutiso@uonbi.ac.ke

APPENDIX E: KNH-UoN ERC research approval

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/189

9th June 2021

Dr. Kigotho James Ng'ang'a
Reg. No.H58/81464/ 2015
Dept. of Orthopaedic Surgery
School of Medicine
College of Health Sciences
University of Nairobi

KENYATTA NATIONAL HOSPITAL
APPROVED
09 JUN 2021
KNH/UoN-ERC
P. O. Box 20723 - 00202 NAIROBI

Dear Dr. Kigotho

RESEARCH PROPOSAL – DISTRIBUTION, PATTERNS AND SEVERITY OF MUSCULOSKELETAL INJURIES AMONG MOTORCYCLE CRASH VICTIMS AT KENYATTA NATIONAL HOSPITAL (P421/05/2021)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is 9th June 2021 – 8th June 2022.

This approval is subject to compliance with the following requirements:

i. Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
ii. All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
iii. Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
iv. Any changes, anticipated or otherwise
v. e that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours
vi. Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
vii. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
viii. Submission of an *executive summary* report within 90 days upon completion of the study

Protect to discover

This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

For more details consult the KNH- UoN ERC website **http://www.erc.uonbi.ac.ke**

Yours sincerely,

PROF. M. L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Senior Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information Dept, KNH
The Dean, School of Medicine, UoN
The Chair, Dept.of Orthopaedic Surgery, UoN\
Supervisors: Dr. Kirsteen Ondiko Awori, Dept.of Human Anatomy, UoN
Dr. Vincent Muoki Mutiso, Dept.of Orthopaedic Surgery, UoN

Distribution, patterns and severity of musculoskeletal injuries among motorcycle crash victims at Kenyatta National Hospital

ORIGINALITY REPORT

11%	6%	5%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Logan Petit, Theodore Zaki, Walter Hsiang, Michael P. Leslie, Daniel H. Wiznia. "A review of common motorcycle collision mechanisms of injury", EFORT Open Reviews, 2020 Publication	2%
2	pdfs.semanticscholar.org Internet Source	1%
3	Submitted to Mohave Community College Student Paper	1%
4	www.ncbi.nlm.nih.gov Internet Source	1%
5	Khanbhai, M. and Lutomia, M.B.L.. "Motorcycle Accident injuries seen at Kakamega Provincial Hospital in Kenya.", Association of Surgeons of East Africa and College of Surgeons of East Central and Southern Africa, 2012. Publication	1%
6	erepository.uonbi.ac.ke Internet Source	1%

DEPARTMENT OF SURGERY
COLLEGE OF HEALTH SCIENCES
P. O. Box 19676 - 00202 KNH
NAIROBI
TEL: 2722890 / 2726300 Ext. 43773

11/11/2021

11/11/2021