PATTERN AND OUTCOMES OF INJURIES FOLLOWING MOTORCYCLE ACCIDENTS IN CHILDREN AT THE KENYATTA NATIONAL HOSPITAL, KENYA

DR FAITH AKINYI BOB
M. MED PAEDIATRIC SURGERY
REGISTRATION NUMBER H58/87850/2016
CONTACT EMAIL: bobfaith.bob@gmail.com

A RESEARCH SUBMITTED AS PART FULFILMENT FOR THE AWARD OF MASTER OF MEDICINE IN PAEDIATRIC SURGERY, UNIVERSITY OF NAIROBI

DECLARATION

This research is my original work and it has not been undertaken before, neither has any publication on the subject matter been done. Whenever I have used any person's work, I have accordingly acknowledged and referenced it.

Dr. Faith Akinyi Bob
Principal Investigator

Signature  Date 10/09/2021

SUPERVISORS' DECLARATION

This research has been submitted with approval of the following supervisors

Dr. Francis Osawa

MBChB (UoN,), M.MED Surgery (UoN)

Lecture and Consultant Paediatric surgeon

Department of surgery

University of Nairobi

Signature ……... Date 10/09/2021……

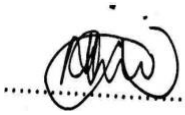
Dr. Peter Mwika

MBChB (UoN), M.MED Paediatric Surgery (UoN)

Lecturer and Consultant Paediatric Surgeon

Department of surgery

University of Nairobi

Signature  Date 10/09/2021……

Dr. Timothy Jumbi

MBChB, M.MED Paediatric surgery (UoN)

Consultant Paediatric surgeon

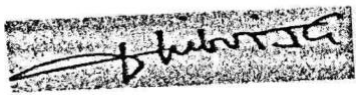
Kenyatta National Hospital

Signature  Date 10/09/2021……

DEPARTMENTAL APPROVAL

This research proposal was submitted at the general surgery department meeting at the University of Nairobi held on 19th November 2021 and is hereby approved for presentation at the Kenyatta National Hospital-university of Nairobi Ethics and Research Committee.

Dr. Julius Kiboi Githinji
MBChB (UoN) M.MED (UoN)
Senior Lecturer and consultant Neurosurgeon
Department of Surgery
University of Nairobi

Signature  Date 10/09/2021

DEDICATION

To my loving family; my parents and siblings for their overwhelming support, encouragement and prayers.

To my supervisors for their guidance and dedication during this process.

To the late Professor Hassan Saidi for the exemplary research work he did in trauma and also for giving me insight to undertake this study.

LIST OF ABBREVIATIONS

AIS	Abbreviated Injury Scale
GCS	Glasgow Coma Scale
ICU	Intensive Care Unit
KNH	Kenyatta National Hospital
LMICs	Low and Middle-Income Countries
MCRI	Motorcycle Related Injuries
MRI	Magnetic Resonance Imaging
RTA	Road Traffic Accidents
RTD	Road Traffic Deaths
RTI	Road Traffic Injuries
WHO	World Health Organization

DEFINITION OF TERMS

Motorcycle is defined as all types and all classes of motorized two-wheelers such as family type, chopper, scooter, touring bike, sports bike, cruiser as well as the standard bike which is the largest class of motorcycle.

Motorcycle related injuries – "fatal or non-fatal injuries incurred as a result of motorcycle accidents.

A motorcycle passenger is a pillion passenger or any person seated on the motorcycle, but not in control of the motorcycle.

A motorcycle rider is any person who drives the motorcycle.

Pattern of injury is a distinct descriptive term used to define both intentional and non-intentional injuries and is characterized by site, type and severity of injury.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

ABSTRACT

Background: Motorcycles have progressively become a common means of transport in low- and middle-income countries and with this, motorcycle injuries have increased in number among children and adolescents. This accounts to a proportionate share in the cause of morbidity and mortality in road traffic accidents (RTA) amongst children. There is paucity of data in regards to motorcycle injuries in children in LMICs where motorcycle use has markedly increased. Therefore, understanding the pattern of injuries and outcome of motorcycle injury in children will help in formulating preventive measures and management protocols.

Study Objective: To determine pattern of injuries and outcomes following motorcycle accidents in children at the Kenyatta National Hospital.

Study design: A retrospective descriptive cross-sectional study

Study setting: Kenyatta National hospital health information department.

Study population: Children below the age of 18 years managed for motorcycle accident injuries between January 2014 to December 2019 at KNH.

Sample size: 254 participants

Data Analysis: Data collected including patient's demographics, pattern of injury and outcome of injury was recorded and analyzed using SPSS version 25 software. Socio demographic and clinical characteristics were presented as proportions, type of injury and the management outcomes will be presented in frequencies and percentages.

Results: 244 participants were enrolled in the study, 70.9 % were male and 29.1% were female. Preschoolers (0-6 years) were the majority at 35.2%. Motorcycle to pedestrian Collison was the most common mechanism of crush (50%) with 51.2% of all the patients injured being pedestrians.54.7% of the pedestrians injured while crossing the road.36% of these accidents occurred in the evening(4pm-7pm). Head injury was the most common site of injury (43.4%), 31.6% patients sustained multiple injuries. Fractures 44% was the most common single type of injury.71% had serious injuries as per the abbreviated injury score (AIS) that required hospitalization.

2.9% mortality rate was observed from the study with 82.4% of patients being on long term follow up. 3,3% of patients who sustained motorcycle injuries developed permanent disability.

Conclusion: Most children 18years and below who sustain motorcycle injuries are pedestrians and are injured while crossing the road. Head injury is the most common sit of injury, children who sustain motor cycle injuries get serious and critical injuries that require hospitalization and long term follow up. Preventive measures and treatment protocols should therefore be developed to protect children from these injuries.

CHAPTER ONE: INTRODUCTION

Background of the study

Trauma has evolved to become the principal cause of morbidity and mortality among children aged between 1-14 years.90 % of these injuries occur in middle- and low-income countries(1). Among these injuries, road traffic accidents (RTA) is the principal cause of hospitalization of children accounting for 46%(2,3).

Fatalities resulting from RTA has increased to 1.3 million per year. Among these 262,000 children die from RTI every year. Millions of children also suffer long term consequences in non-fatal injuries(4)

Furthermore, previous research demonstrate that Road Traffic Deaths (RTDs) are more among pedestrians, vulnerable road users, cyclists and riders of motorbikes as well as their passengers accounting for 46% of global traffic deaths (WHO 2018).Children are considered vulnerable road users and roads are a dangerous place for children(5).

Murumba et. al outlines the rise of motorcycle use in both urban and rural Kenya as a means of transport. This rise is attributed to the fact that motorcycles are easily available, affordable and ease of mobility especially in areas with poorly developed roads. The year 2005 to 2011 saw the increase of motorcycle use by 40 folds in Kenya. In the year 2011 motorcycle made 70% of the new registered motor vehicles in Kenya. Despite the rise, there are minimal policies and regulations present to regulate this growing industry(6).

The increase of motorcycle use has also increased the proportion of injuries in patients involved in RTA. This trend has also been seen among children. This is however different in developed countries where motorcycle use in children is a sport and rarely used as a means of transport (7). In Norway, a high-income country (HIC) 11% of all minor injuries in paediatric patients are motorcycle injuries and 12% of all moderate injuries are caused by motorcycle injuries.

In Finland, 30% of all road traffic injuries are caused by moped/ motorcycle accidents.

A study done in LMIC-Nigeria by Nassir et. al showed a study increase in the number of children involved in motorcycle injuries in 3 years.

In addition, head injury was the most common fatal Injury as seen in previous studies done in Egypt and Saudi Arabia.

World health organization, 2004 concluded that children in LMICs are at increased risk of all road accidents because the road is a shared space for playing, working, walking, cycling and driving.

This therefore pauses a difference in the number of children at risk of motorcycle injuries and also on the predisposing factors(2).

Furthermore, information on pattern of injuries and the treatment outcome in motorcycle accidents is scarce in LMICs. Studies available have been done in developed countries. There are however differences in the prevalence of motorcycle riders, the reason for riding, the level of riding experience, the road network, availability of emergency services incidence that differentiates the pattern of injury and the outcome between developed and developing countries as defined by the Haddon Matrix(2,8).

Previous epidemiological studies have been carried out in adults and emphasis made on fatal injuries(7). This therefore shows that there is paucity of data in LMICs and data collected from this study will help in prevention and guide in management of children involved in motorcycle accidents.

CHAPTER TWO: LITERATURE REVIEW

2.1 Demographic Factors for Motorcycle Accidents in Children

Children are vulnerable road users and are at an increased risk of sustaining RTIs especially in LMICs(5). In spite of children being vulnerable, poorly developed road network, poor planning of our residential areas and improperly controlled traffic predisposes children to RTA and MCRIs. These factors influencing motorcycle accidents are majorly classified as(5):

a) Demographic characteristics including age, gender, area of residence
b) Environmental characteristics including traffic flow, traffic characteristics, zebra crossings, traffic control, pedestrians' paths, visibility conditions and weather.
c) Crash characteristics- Time, place of injury-rural versus urban, type of collision.

Demographic characteristics are very key in determining the risk of sustaining MCIs (2,5).

Male gender has an increased risk of sustaining motorcycle injuries. Being a young male increases the risk and is a predictor for crash injuries (9). Jenifer Oxley et. al reported 89.5% males sustained motorcycle injuries between 2007 and 2011 in Malaysia(10).This also reflects locally as male motorcyclists are majorly involved in motorcycle crushes, as passengers and even as pedestrians. Female are more likely to be injured as passengers(2,11).

In LMICs young road users predominate the group involved in road crashes. Majority of riders within the paediatric age group involved in motorcycle injuries are between10 and 16 years. However most pedestrians involved in motor cycle accidents are children below the age of 10 years(10,11).

Despite minimum age restrictions, there still exist reports of children considerably younger than the age restriction being involved in motorcycle accidents as unlicensed riders. Suggestions have been made that children have inherent psychological and physical inability that may inhibit their ability to safely operate motorcycles. This includes insufficient motor coordination, cognitive immaturity with low stature and low weight and body mass. These affects their ability to safely ride and control a motorcycle(11,12).

Lack of supervision among children has also been identified as a risk to Motorcycle accidents. In Malaysia a study showed that the risk of injury reduced by 57% among children who were using motorcycle under supervision by their parents (13). In Canada lack of parenteral supervision increased the risk of motorcycle injury in children who were pedestrians and cyclists by 2.6%(14).

Helmets are considered effective in preventing motorcycle injuries and non-use of helmets is regarded as a risk factor to motorcycle injuries. There are low rates of helmet use in children compared to adults especially on- road motorcycle us. The availability of good quality, properly sized helmets is a key concern in countries lacking quality control systems or legislation warranting standards-certified helmets for a child passengers(15–18).

In LMICs use of helmets among children motorcycle passengers and cyclists is not common. According to a study done in Nigeria, all the children who were involved in motorcycle accidents and seen in a tertiary hospital had no helmets(19). This is also seen In Asian countries where motorcycle use is also very common and a study showed that only 40.7% of children who sustained MCRIs had helmets(10).

Low and Middle Income Countries (LMICs) have improper land-use planning and residential, commercial and industrial activity evolve in a haphazard pattern and this severely affects the road pattern (11,14). This leads to heavy traffic, long distances commercial vehicles using undesignated roads and high-speed vehicles mixing with pedestrians. The mixed nature of traffic in LMICs with pedestrians, bicycle, handcarts, motorcycles, commercial trucks and cars makes the technical traffic control difficult. These therefore increases the risk of accidents to the vulnerable group (11).

The primary risk factor for unprotected road users is the lack of systems to delineate unprotected people from motor vehicles of high speed. Previous studies also state that the most common type of collision was between motorcycle and pedestrians due to lack of pedestrians walkways(2) . In Nigeria 67.5% of children who sustained MCRIs were pedestrians and 27.5 % passengers. This outlines the vulnerability of children on our roads(19).

Unavailability of Zebra crossings and foot bridges also predisposes the school going child to RTA and also to MCRIs. In urban areas most fatal and serious cyclists' injuries occur at junctions
Poor understanding of the road traffic rules by pedestrians poses a risk in children. A study done in Jordan showed that nearly half the children crossing roads do not check for the oncoming traffic when crossing the road(11).

It is common to see more than one passenger on a motorcycle especially adults carrying children or a number of children under the age of 16 on one motorcycle as pillions(2). Children commonly seat behind the operator but some also seat in front of the operator. No studies however have examined the risk of multiple passengers or the risk associated with different seating positions. It is however hypothesized that carrying passengers with motorbikes with unreachable foot pegs negatively affects the passenger's stability and as well as the riders control(20,21).

Generally, motorcycle accidents occur during the day and during good weather on flat, straight roads and well distributed all through the week. Oxley et. al found 30% of all accidents occurring between 6pm and 9 pm. And an additional 17.4% occurring between 3pm and 6pm(10).
Majority of the MCRIs occur in rural settings in developed countries (7). This is however different in LMICs with poor road networks; lack of pedestrian paths, with poor traffic control. Motor cycle crashes in these areas are almost equal in both rural and urban regions(8).
In Malaysia however, majority of motorcycle collisions occurred in the rural area (75.6%). The mechanism of injury also differs as seen by Sismwo et. al. Motorcycle versus vehicle collision is the most common reported mechanism of crash injuries in a study reported in rural Kenya accounting for 45.6%. followed by motorcycle versus pedestrians 39.6% and motorcycle versus motorcycle(22). This was also reported In Malaysia where most injuries (58.3%) sustained were head on collision with motor vehicles or with other motorcycles (10,22).

2.2 Pattern of Injuries of Motorcycle Accidents

In children, Waddell's triad of injuries occurs more commonly when hit by a motor vehicle. This entails a fracture of the femur , chest or upper abdominal region with a contralateral head injury(14).

Bachulis et. al reported that motorcycle riders often sustain multiple injuries in a crash. In Pakistan a study done in 2017 by Kashif et. al reported 56.8% of patients with MCRIs to have multiple injuries. In multisystem injuries, combined head and orthopedic injuries are the most common. Head and maxillofacial injuries and abdomen and orthopedic injuries follow respectively (8,11)

However some studies report one system injuries to be more common in motorcycle accidents compared to multiple system injuries(11). Fouda et. al reported 72% patients with one system injury and 28% with multiple system injuries in Egypt(23).

Head injuries are the most frequent fatal injuries and the most common cause of death in motorcycle injuries. It is also the most common cause of ICU admission In MCRIs. Isolated head injury are observed more commonly than combined head injuries (skull fractures with one or more types of hemorrhage)(23). Among 61 head injury patients 24 patients required ICU as reported by Fouda et. In Kenya Sisimwo reported majority:39.9 % of patients seen with MCRIs to have head injuries(22). Brain injuries are usually caused by deceleration movement and rotational kinetics as reported by Ritcher et .al 2001.Helmets are known to reduce the incidence as well as the severity of head injuries in motorcycle riders and their passengers. Non helmet riders are at increased risk of severe head injuries(24).

Chest and abdominal injuries remain the second most common cause of fatal injuries comprising 7-25 % causes of deaths associated with motor cycle injuries. Liver laceration and lung contusion are the most common cause of Mortality(8). Non-fatal abdominal injuries are however not commonly seen. Kashif et. al reported 5.1% chest and abdominal injuries while Saad I et.al reported 6.6 % injury to the trunk in Pakistan and Iraq respectively(25). Dongo et. al in Nigeria reported only one patient 0.7% with abdominal injury.

Orthopedic injuries more so lower extremities are the most common non-fatal injury seen in MCRIs (8).

Lateef in 2002 reported 1056 patients among 1809 patients who had MCRIs to have lower limb injuries and suggested that motorcycle use is a risk to the lower limb. Haworth et. al reported lower limb injuries as the most common injury associated with motorcycle accidents. Below knee and below elbow are more common than above knee and elbow(12,14). Tibia and fibula fractures are the most commonly observed pattern of orthopedic injury accounting for approximately a quarter of orthopedic injuries (8)

Two studies in Nigeria and Egypt also reported lower limb to be the most common injured part of the body accounting to 32.7% and 24.4% respectively. Kashif et. al also reported 22.5% involving the lower limb which was the most common site of injury in his study. Peek et .al reported tibia to be the most common site of injury followed by femur, foot and patella(19,23).

The significantly high incidence of lower limb injuries is attributed to multiple factors inclusive of anatomical location, poor assembly of the rare wheel, as well as lack of protection of the extremities. There is no difference between the right and the left sides of injury(12,26).

Upper limb injuries are the second most common injuries orthopedic injury. Upper limb and lower limb extremities together account for the most common injuries(8). In the upper limb radius and ulna are the most common site of fractures(23).

Spinal injuries have been reported in motorcyclist and pedestrians than other road users. Cervical spine is the most common spinal injury. Alghaman et. al reported 4.2% of all the patients in his study to have cervical injury. According to Fouda et. al, most Cervical spine injuries sustained from MCRIs are associated with head injury. Spinal cord injuries are associated with long term impairment(12,23,25).

Burn injuries are also seen in motorcycle accidents patients. This is as a result to exhaust pipe and other hot metals. The lower limbs are most often burnt followed by the upper limbs, head, chest and abdomen. The right limb is more often involved as compared to the left, however both arms are equally involved. Right-handed exhaust burns often reflect the tendency of motorcycles with

single exhaust pipes to have them located similarly on the right side. Generally, exhaust pipe burns often involve only one body region while petrol fires as well as friction burns often affect several body region(8,27).

Patients with MCRIs sustain different types of injuries as per the format below (5,12)

- Abrasion
- Bruises
- Lacerations
- Crush
- Blunt
- Fractures and
- Vascular injuries

Multiple studies have shown that abrasions and lacerations account for the most common type of injury. Kashif et. al approximately 60% in his study to have abrasion and lacerations. Saaid I et.al reported 37.7% with contusion with soft tissue wounds accounting for 55.9%, Nasir et. al reported abrasion and lacerations in 37.5% and 25% respectively which were the commonest types(28).

Lin and Krause (2009) however also reported soft tissue wounds as the most common type of injury accounting up to 55.9%(8).

Fractures still remain the second most common type of injury after soft tissue injuries. Nasir et. al reported 20.8% fractures among patients seen with MCRIs in children in Nigeria(19).

In Iraq Saad I et.al also reported 49.8% fractures among all the patients with MCRIs which was the second most common type of injury. This study also reported a quarter of patients with vascular injuries(25).

Haworth et. al also reported almost equal numbers of patients with fractures and soft tissue injury. Crush and blunt injuries are also observed, however they are not common(12).

Injuries severity depending on the site of injury are used to grade injuries and predict outcomes.

To allow quantification and comparison of the severity of injuries of different nature and to different parts of the body, the Abbreviated Injury Scale (AIS) has been developed. The Abbreviated Injury Scale (AIS) is an accord derived, anatomically based system that facilitates

classification of individual injuries by body regions on a six-point severity scale which ranges from AIS 1 (minor) to AIS 6 (currently untreatable)(12).

Severe injuries are associated with high mortality and increased complications.

Head injury and spinal injuries have been associated with severe injuries. In chests injuries fail chest, haemothorax are severe injuries with poor outcomes(8,12).

Sisimwo et.al reports severe injuries in motorcycle riders 29.3% compared to passengers6.2% and 3.4% on pedestrians .however patients below 25 years had more moderate injuries than they had severe injuries 64.2% to 12.2% respectively(29).

Alghnam et. al reported 72.2% of all injuries to be minor injuries with 5.2 % having severe injuries(11)

The table below shows the abbreviated injury scale; table 1

AIS	Severity	Type of injury
0	None	None
1	Minor	Superficial
2	Moderate	Reversible injuries; medical attention required
3	Serious	Reversible injuries; hospitalization required
4	Severe	Life threatening; not fully recoverable without care
5	Critical	Non-reversible injury; not fully recoverable even with medical care
6	Virtually unsurvivable	Fatal

2.3 Treatment Outcomes of Motorcycle Accidents in Children

Several studies have showed that children involved in motorcycle injuries are managed in both outpatient and inpatient departments(11,25). Approximately a quarter of patients are admitted in the wards and 1.5% in intensive care unit (ICU) (23). This however is much higher in the middle East where approximately one quarter are admitted in ICU(22,25). Majority of patients are treated conservatively while some undergo surgical intervention. Fouda et. al reported 75.4% of patients who sustained head injury were treated conservatively and 24.6% surgically treated(23).

Most injuries sustained are moderate injuries with some being severe and critical. Head injury is the most common cause of admission followed by orthopedic injuries including spine injuries(8,23). Increased Length of stay is associated with patients who present with loss of consciousness at the time of admission. This is also seen in patients who have been admitted in ICU. The average length of stay also ranges from 1 day to approximately 39 days. There is an

association between times of injury to time of presentation with length of stay. Delayed presentation to the hospital is associated with increased length of stay(22,23).

Permanent disability including limb amputation and paralysis are also seen among MCRIs(5). This adds to the burden of disability and psychosocial effect to both the patient and the caregivers(11). Documented psychosocial effects include, anxiety and depression(5). Alghanam et. al found 9.1% of patients involved in motorcycle accidents were amputated(11). Deaths also make a significant outcome following motorcycle injuries. Higher death rates seen in LMICs compared to developed countries(1,5). Factors affecting mortality include severity of injury, type of injury and the time before presentation to the hospital(2,8).

Head injury is associated with high mortality rate, followed by chest injuries. Extremities have the least mortality rate(23,30).

Dongo et.al reported 6.3% mortality in Nigeria with Fouda et. al reporting In Egypt was 4.5% and this was the same mortality rate by Burns et. al in USA(23,30). In middle East from a study done by Alghaman et. al reported a mortality rate of 2.9 % which was slightly higher than that seen in studies In China and Singapore that have mortality rate of less than 1.5% and 1.9% respectively(11).

2.4 Conceptual Framework

Figurative Presentation

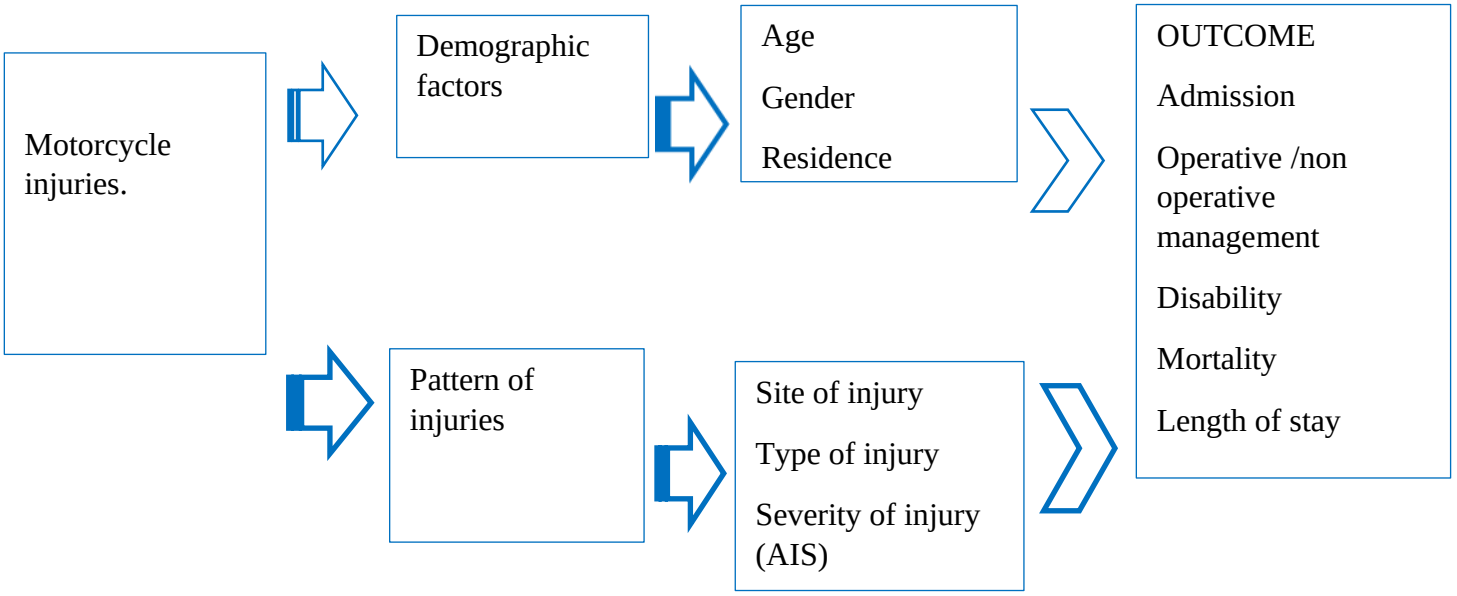


Figure 1

2.5 Justification of the Study

Motorcycle use as a means of transport has increased in developing countries more so in Africa and Kenya in particular. This has also seen an increase of motorcycle accidents among the vulnerable population including children.

Motorcycle use and accidents in developing countries are higher compared developed countries. In LMICs motorcycle is mainly used as means of transport unlike in the developed countries where children use motorcycle as a sport.

This in regards reflects different perils and injuries patterns among children in developed versus LMICs. Therefore, data available from the developed countries does not reflect with LMICs. There is need therefore of collecting and availing data in the LMICs.

There are no local studies that have been done to look at motorcycle injuries specifically in children despite children having unique demographic factors, severity of injuries and outcome following motorcycle injuries.

In addition, there being an increase in motorcycle use and accidents, no policies have been put in place to protect the child from the burden of motorcycle accidents.

Therefore, understanding the demographic factors is important in prevention of these injuries. Moreover, this study will identify pattern of injuries and outcome in children locally that will help formulate management protocols.

This study will also provide data that will guide in development of policies and public measures to protect children from this growing burden.

2.6 Study Question

What is the pattern and outcome of motorcycle injuries in children in children at Kenyatta National Hospital?

2.7 Study Objectives

To determine the pattern and outcome of injuries following motorcycle accidents in children at Kenyatta National hospital.

2.7.1 Main Objective

To determine pattern and outcome of injuries following motorcycle accidents in children at the Kenyatta National hospital (KNH) in Kenya.

2.7.2 Specific Objectives

1. To determine demographic distribution of children with motorcycle injuries at KNH.
2. To describe pattern of injuries following motorcycle injuries in children at KNH.
3. To determine outcome of motorcycle injuries in children at KNH.

CHAPTER THREE: METHODOLOGY

3.1 Study Design

This is a retrospective cross-sectional study conducted on hospital records among children admitted for management of motorcycle injuries at the Kenyatta National hospital**.**

3.2 Study Site

The study was conducted at the Kenyatta National hospital, health information department. KNH hospital is the principal referral hospital in Kenya in Nairobi County. The hospital has a total bed capacity of 1800 and with functional surgical, pediatric, medical, obstetrics and gynecology units, 24 theaters and a 20 bed HDU/ICU. It also has a functional imaging department with an X-ray, ultrasound, CT scan and MRI.

Management of patients with road traffic accidents including motor cycle accidents is undertaken from the accident and emergency unit and the inpatient departments. On average, a total of 2500 RTA patients are managed in KNH every year. Among these patients 400 are seen with MCRIs and children below the age of 18 years account for 25%.

3.3 Study Population

The study population were children aged eighteen years and below managed at accident and emergency and the inpatient departments for motorcycle related injuries between January 2014 and December 2020 at KNH.

3.3.1 Inclusion Criteria

All records of children aged 18 years and below managed at KNH for motorcycle accidents in both inpatient and accident and emergency department.

3.3.2 Exclusion Criteria

Children who died before reaching the hospital and Parents/guardians or patients who cannot be reached on phone.

3.4 Sample Size Calculation

The sample size for this study will be estimated using the formula of Fisher et al (1991).

$$n = \frac{Z^2 p(1-p)}{d^2}$$

Where n is the calculated sample size

Z is the statistic representing a 95% confidence level of confidence = 1.96

P 20.8% represents prevalence of motorcycle injuries in a similar study conducted in Nigeria (8).

d is the desired level of precision

$$n = \frac{1.96^2 \times 0.208 \times 0.792}{0.05^2}$$

n = 254

Where n is the minimum sample size.

Therefore, 254 participants will be enrolled in the study.

3.5 Sampling Procedure and Study Enrollment

Non-probabilistic consecutive sampling procedure was used where all records from eligible children with motorcycle accidents were enrolled. This was done at the health information department covering both accident and emergency and the inpatient department.

3.6Study Variables

Table 2

The following table shows the study variables for assessment

Objective	Variables	Source of Data
Demographic characteristics	Age, gender, residence, time of injury, type of crash and type of road user	File
Describe the pattern of injuries	Site of injury Type of injury Abbreviated injury score	File
Determine the outcomes of injuries in children.	Mortality, disability, length of stay, Hospital admission, operative or non-operative management	File

3.7 Study Flow

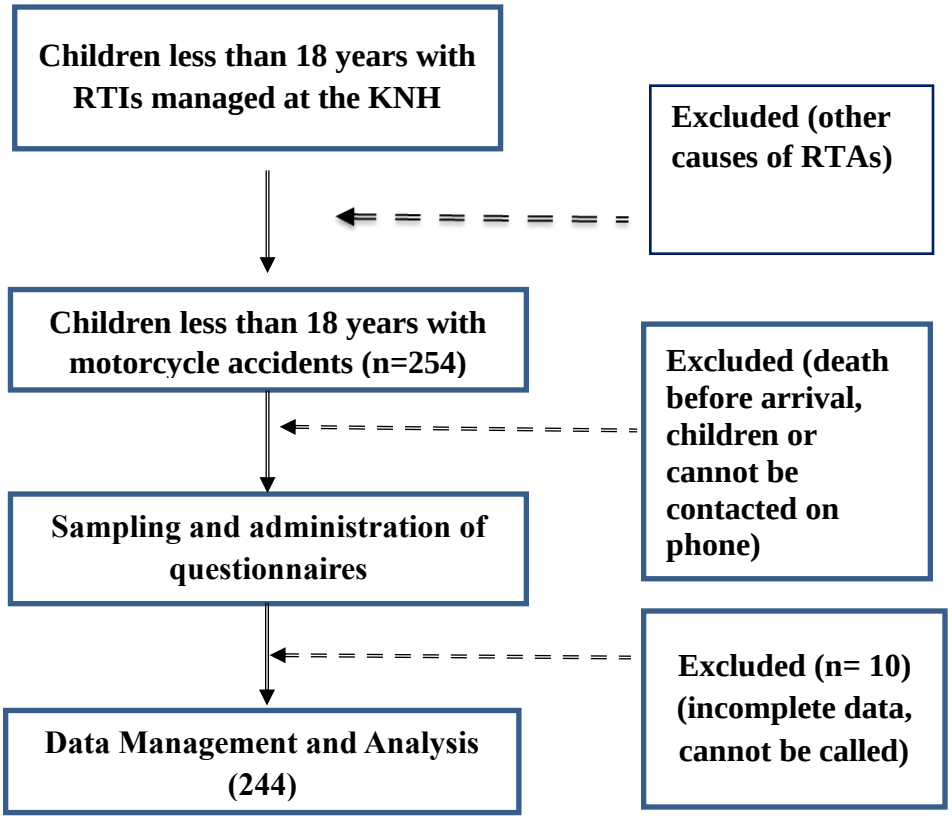


Figure 2: Study Flow Diagram

3.8 Ethical Considerations

The study proposal was submitted to the KNH-UON ethics and research committee (ERC).

All patients' information was held in confidentiality and used for the purpose for which this study is intended for only. This study does not include any invasive processes. There was no extra cost encountered by the patient. The findings of the study shall be disseminated to the KNH and University of Nairobi, presented in medical conferences, and published in medical journals and public media where necessary for the benefit of the medical profession and the lay public.

3.9 Quality Assurance

The researcher trained the research assistants in handling of data to improve the quality of abstracted data. The researcher adhered to the study protocol with the methodology rigorously adhered to. Cleaning and duplication was done before data analysis and the procedures documented.

3.10 Data Collection

This was be done by the principal investigator and research assistants. It was done by collecting clinical information including age, time when patient was treated and other clinical information as captured in the patient's files after receiving permission to access the information from the hospital management.

The files were then isolated from the filing area, and using a separate room, information was extracted from the files before returning them to the filing area. The data extracted was filled in the data collection tool. The collected data was identified by assigning study specific unique identifiers to the study participants. Missing records and inadequate information from the file, permission was sought to seek clarification from the participant's parent/guardian through phone calls. All electronic data was stored in an external hard drive and password protected after encryption.

3.11 Data Management

All data collected from the study questionnaires was uploaded into a password protected excel sheet and stored using non-identifiers so as to maintain confidentiality. The data was compiled, cross-checked and rectified as per the data collection tool. The questionnaires was kept in a lockable cabinet with access restricted to the investigator and supervisors.

3.12 Data Analysis

The collected data was uploaded onto the SPSS version 25 software for cleaning, coding and analysis. Means and standard deviations (SD) will be calculated for continuous variables such as age and time from the accident to the arrival at the hospital. The normal distribution of the socio

demographic variables was analyzed by the Kolmogorov-Smirnov test. The pattern of injuries was be summarized and analyzed in form of frequencies and percentages.

The logistic regression analysis was used to analyze demographic factors associated with motorcycle injuries in children. This was done through inclusion of all variables into the model and calculation of odds ratios. All variables were included in the backward stepwise procedure. Two-sided p values will be considered statistically significant at a p value of < 0.05.

3.13 Reporting of Findings

The study was conducted in three phases: phase one entailed recruitment and data collection, followed by data analysis and presentation to the hospital and the university of Nairobi. The third phase will entail feedback to the key stakeholders. The recommendations from these feedback sessions will be incorporated in to the final report before publication in peer reviewed journals.

3.14 Study Limitations

Some information was missing from the patients' files. Getting information via phone calls may also have had recall bias. Where essential data was missing from the file and patients' parents /guardians could not be accessed on phone, the PI and the research assistants picked the next eligible participant for enrolment in to the study; this decision was made on a daily basis**.**

CHAPTER 4: RESULTS

4.1 Demographic characteristics

Two hundred and forty-four (244) children involved in motorcycle accident were enrolled in the study out of the 254 intended participants.10 participants had missing data therefore not included in the study.

Most participants were male accounting to 70.1% of all the patients evaluated. Preschoolers (0-6 years) were the majority at 35.2%, followed by pre-adults at 26.6%, school going (7-12) at 20.5% and adolescent (13-16) at 17.6% of all the children injured, most were pedestrians (51.2%), passengers/pillions (25.2%) and riders at 23.8%. Of the pedestrian 54.7% were injured while crossing the road, and 34.0% while walking on the roadside. Motorcycle to pedestrian was the most common mechanism of crush (50.0%). Most accidents happened in the evening (36.9%) between 4pm and 7pm. The median [IQR] pre-hospital time reported to 1 [0.5, 2.0] hours. (table3).

Table 3. Demographic characteristics of motorcycle accident victims

		Frequency (%) (N=244)
Age group	Pre-school (0-6 years)	86 (35.2)
	School going (7-12)	50 (20.5)
	Adolescents (13-16)	43 (17.6)
	Pre-adults (17-18)	65 (26.6)
Gender	Male	171 (70.1)
	Female	73 (29.9)
Mechanism of crush	Motorcycle to motor vehicle	43 (17.6)
	Motorcycle to motorcycle	22 (9.0)
	Motorcycle to pedestrian	122 (50.0)
	Motorcycle to loan	57 (23.4)
Type of road user	Pedestrian	125 (51.2)
	Passenger/pillion on a motorcycle	61 (25.0)
	Rider	58 (23.8)

Pedestrian RTA	Crossing the road	29 (54.7)
	Walking on the roadside	18 (34.0)
	Playing on the roadside	6 (11.3)
	Unknown	72
Time of accident	Early morning (6am-10am)	36 (14.8)
	Mid-morning (10am-1pm)	46 (18.9)
	Afternoon (2pm-4pm)	40 (16.4)
	Evening (4pm-7pm)	90 (36.9)
	Night (7pm-6am)	32 (13)
Pre hospital time	Median [IQR]	1 [0.5, 2.0]

Children between age 0-6 years and those between 7-12 years are mostly injured as pedestrians 78.8% and 74% respectively. It was observed that (Pre adults (17-18 years) involved in motorcycle injuries were mostly riders (69.2%). Of all the children injured, those below 12 years were mostly injured while crossing the road. 50 % of all the children injured below 6 years and 60% of the school going children were injured while crossing the road. A number of children (35.7%) below 6 years and (35%) between age 7-12 years were injured while walking on the road side.

Motor cycle to pedestrian collision was mostly observed in children below 6 (72.9 %) years and schools going children (78%). Pre- adults were mostly injured in motor cycle to motor cycle collision (38.5%) and motor cycle to loan collisions (32.3%).

Most injuries occurred in the evening especially those involving pre-school, school going children and adolescents.

School going children injured had the highest (58 %) number of all the injuries that occurred in the evening.Injuries occurring at night were mostly observed in pre-adults (27.7%). (Table 4)

Table 4. Relationship between age group and demographic characteristics

		Pre-school (0-6 years)	School going (7-12)	Adolescents (13-16)	Pre-adults (17-18)
Type of road user	Pedestrian	67 (78.8)	37 (74)	15 (34.9)	5 (7.5)
	Passenger/pillion	18 (21.2)	12 (24)	18 (41.9)	15 (22.4)
	Rider	0 (0.0)	1 (2)	10 (23.3)	47 (70.1)
Type of pedestrian	Crossing the road	14 (50)	12 (60)	2 (66.7)	2 (100)
	Walking on the roadside	10 (35.7)	7 (35)	1 (33.3)	0 (0)
	Playing on the roadside	4 (14.3)	1 (5)	0 (0.0)	0 (0)
Time of accident	Early morning	14 (16.5)	8 (16.0)	3 (7.0)	11 (16.9)
	Mid-morning	22 (25.9)	4 (8.0)	8 (18.6)	12 (18.5)
	Afternoon	15 (17.6)	8 (16.0)	8 (18.6)	8 (12.3)
	Evening	30 (35.3)	29 (58.0)	15 (34.9)	16 (24.6)
	Night	4 (4.7)	1 (2.0)	9 (20.9)	18 (27.7)
Mechanism of crash	Motorcycle to motor vehicle collision	2 (2.4)	4 (8.0)	12 (27.9)	25 (38.5)
	Motorcycle to motorcycle collision	1 (1.2)	2 (4.0)	6 (14.0)	13 (20.0)
	Motorcycle to pedestrian collision	62 (72.9)	39 (78.0)	14 (32.6)	6 (9.2)
	Motorcycle to loan	20 (23.5)	5 (10.0)	11 (25.6)	21 (32.3)

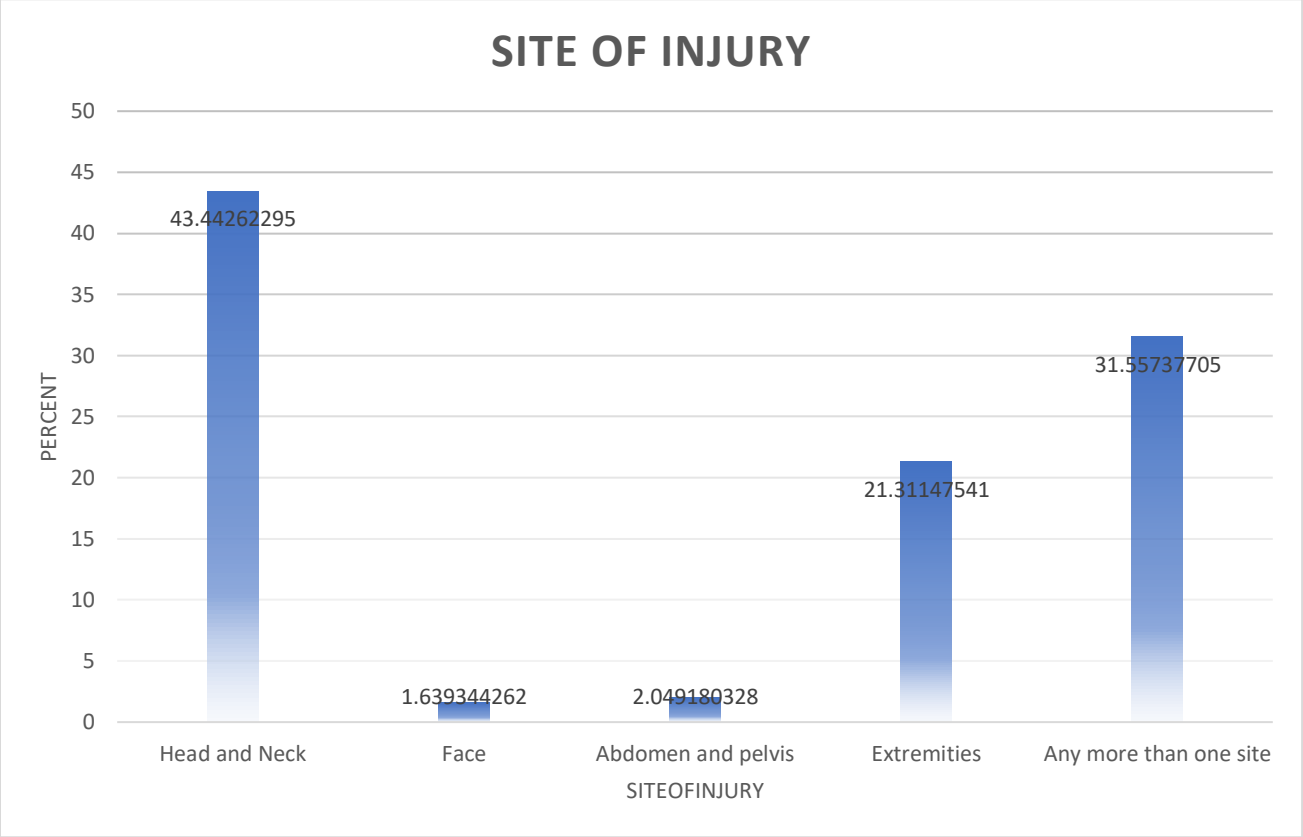
4.2 Pattern of injury

4.2.1 Site of injury

A majority of patients had head and neck injuries (43.4%). Injury to the extremities (21.3%) was the second most common site. It was observed that 77 patients had injuries had multiple injures (31.6 %) with head injury and injury to the extremity being the most common combination. Abdominal pelvic injuries were the least common injuries (2.0%).

Most of these injuries (70.9%) were serious injuries that required admission and medical/surgical intervention.

Figure 3. Site of injury



4.2.2 Type of injury

Injuries of more than one type was the most common with 155 out of the 244 children having multiple types of injury (63.5%). Of the combinations that occurred fractures and soft tissue were the most common.

Fractures were the most common single type of injury (18%).

Blunt injuries were observed in 5.7% and abrasions and lacerations were seen in 1.6% and 2.5% respectively.

Table 5: Type of injury

Type of injury	Abrasion/bruises	4 (1.6)
	Laceration	6 (2.5)
	Soft tissue wound	5 (2.0)
	Fracture	44 (18.0)
	Vascular injury	8 (3.3)
	Blunt injury	14 (5.7)
	Crush injury	1 (0.4)
	Others	7 (2.9)
	Any more than one type	155 (63.5)

4.2.3 Severity of injury

Abbreviated injury scale (AIS) was used to assess the severity of injury, Of the 244 patients assessed, 173 patients had a serious AIS score (70.9%), and these injuries were reversible but required hospitalization.

57 patients (23.4%) had severe AIS score; life threatening injuries that were not fully recoverable with care. Critical and fatal injuries were observed in 3.7% and 1.6% respectively.

No patient had minor injuries. (Figure 4)

63% of all head and neck injury patients had serious injuries and 34% had severe injuries. Serious injuries were observed in 90.4 % of all the patients who presented with injuries to the extremities.

Fatal injuries were seen in patients with head and neck injuries (5.7%) and multiple injuries (2.6%). (Table 6)

Figure 4. Abbreviated injury scale.

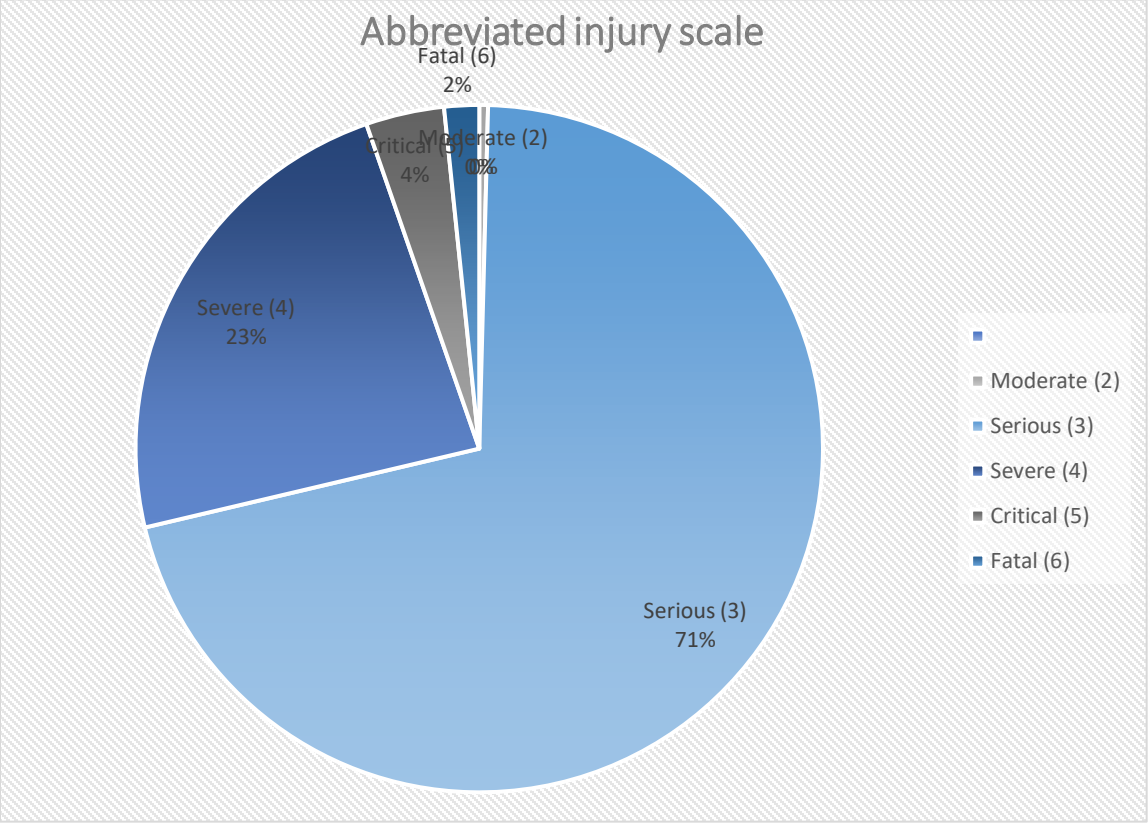


Table 6: Relationship between site of injury with severity

Site of injury		Frequency	Percent
Head and Neck	Moderate (2)	1	.9
	Serious (3)	63	59.4
	Severe (4)	34	32.1
	Critical (5)	6	5.7
	Fatal (6)	2	1.9
	Total	106	100.0
Face	Serious (3)	4	100.0
Abdomen and pelvis	Serious (3)	4	80.0
	Severe (4)	1	20.0
	Total	5	100.0
Extremities	Serious (3)	47	90.4
	Severe (4)	4	7.7
	Critical (5)	1	1.9
	Total	52	100.0
Any more than one site	Serious (3)	55	71.4
	Severe (4)	18	23.4
	Critical (5)	2	2.6
	Fatal (6)	2	2.6
	Total	77	100.0

4.3 Outcome of injury

All participants were inpatient (100%). Most underwent major surgery (60.2%) with 34.8% of patients manged conservatively.201 (82.4%) patients of all the patients are on long term follow up. 43.3 % of all the patients on follow up had head injury and 31.3% had multiple injuries. These patients had serious (73.1%), severe (23.9) and critical injuries (3%).
8 patients (3.3%) got permanent disability. This was most commonly seen in patients who had multiple injuries (50.0%). 4 patients (50.0%) with permanent disability had severe injuries and 3 patients (37.5%) had critical injuries.

7 patients died accounting to 2.9% mortality rate. Of these patients 4(57.1%) had multiple injuries and 3(42.9%) had head and neck injuries.
The median {IQR] length of hospital stay was 13 [5, 32] hours (table 7, 8, 9)
Table 7. Outcomes of participants

		Frequency (%) (N=244)
Place of management	Inpatient	244 (100)
Surgical operative	Minor surgery	12 (4.9)
	Major surgery	147 (60.2)
	Conservative	85 (34.8)
Treatment outcome	Discharged with no disability	28 (11.5)
	Permanent disability	8 (3.3)
	Long term follow-up	201 (82.4)
	Death	7 (2.9)
Length of hospital stay	Mean [IQR]	13 [5, 32]

Table 8: Relationship of Site of injury and treatment outcome

Treatment outcome		Frequency	Percent
Discharged with no disability	Head and Neck	12	42.9
	Face	1	3.6
	Abdomen and pelvis	1	3.6
	Extremities	8	28.6
	Any more than one site	6	21.4
	Total	28	100.0
Permanent disability	Head and Neck	3	37.5
	Extremities	1	12.5
	Any more than one site	4	50.0
	Total	8	100.0
Long term follow up	Head and Neck	88	43.8
	Face	3	1.5
	Abdomen and pelvis	4	2.0
	Extremities	43	21.4
	Any more than one site	63	31.3
	Total	201	100.0
Death	Head and Neck	3	42.9
	Any more than one site	4	57.1
	Total	7	100.0

Table 9: Relationship of severity of injury and treatment outcome.

		Frequency	Percent
Discharged with no disability	Moderate (2)	1	3.6
	Serious (3)	24	85.7
	Severe (4)	3	10.7
	Total	28	100.0
Permanent disability	Serious (3)	1	12.5
	Severe (4)	4	50.0
	Critical (5)	3	37.5
	Total	8	100.0
Long term follow up	Serious (3)	147	73.1
	Severe (4)	48	23.9
	Critical (5)	6	3.0
	Total	201	100.0
Death	Serious (3)	1	14.3
	Severe (4)	2	28.6
	Fatal (6)	4	57.1
	Total	7	100.0

CHAPTER 5: DISCUSSION

Motorcycle use and motorcycle accidents have increased in Kenya and this poses a risk of sustaining motorcycle injuries especially to the vulnerable population including children.
The increased use of motorcycle in Kenya is due to its affordability, readily available and its ability to be used in areas with poor road networks.(5,6)
Children are unique and are vulnerable road users with low cognitive capability and poor judgement when using the road.(12)
This study to our knowledge is the first study in Kenya that has specifically looked at children related motorcycle injuries. It sought to look at the demographic characteristic, pattern of injury and the treatment outcome in the national referral hospital in Kenya (KNH) with the aim of better understanding the magnitude of MCRIs in children.
The study provides new information, some expected and some unexpected and this will give insight in pediatric related motorcycle injuries.

From the study male patients predominantly sustained MCRIs compared to female at 70.1% and 29.1 respectively. This was observed in all types of road users' pedestrians 57.6%, passenger 67.2 % and riders 100%. Similar findings showing high incidence in males were reported in previous studies done in Nigeria by Nasir et. al (57.5%), in Egypt by Fouda et.al (90.5%) and in Malaysia by Oxley (89.5%).(10,19,23)
Children below the age of 6 years (pre-school) were the most common age group (35.2%) and adolescents (13-16 years) were the least involved at 17.6% in motor cycle accidents. These findings were different from a study done in Malaysia by Oxley et. al which reported most injuries in children between 10-16 years and in Nigeria where most injuries were among children aged between 5-9 years.(10,19)
Most of these children were pedestrians (50.0%) and were hit while crossing the road (50.0%). Similarly, Nasir et. al found that 67.5 % of children involved in motorcycle accidents were pedestrians. Different from the results found in this study, studies done in Iran by Saad et. al and from a systemic review by Julie Brown et.al reported most children with MCRIs to be passengers/pillions.(2,25)
70.2% of all the Pre-adults (17-18 years) which accounted to 19.6 % of the total MCRIs were riders. Saad et. al also reported similar findings were out of the 114 MCRIs between the age of

15-19 ,80 were riders. Most of these injuries (36.9%) occurred in the evening between 4pm and 7pm which were also similar results observed by Oxley et. al in Malaysia.

Among the 58 riders who sustained MCRIs there were no female riders and this could explain one of the reasons for the high incidence of injuries among males. Children below 6 years do not have proper judgment and require supervision and well labelled designated areas for crossing the roads. Kenya being a middle-income country has improper road networks with poor designated pedestrians' crossings and walk ways available on all roads. This puts children and other road users vulnerable to sustaining RTAs. There is also mixing of different road users including heavy commercial vehicles, motorists, cyclists and pedestrians and this poses a risk to children. (11). These could be some of the reasons that predisposed these children to sustaining motorcycle related injuries. In Kenya, anyone below the age of 18 years is not licensed to control any motor vehicle or any commercial motor cycle this is due to insufficient motor skills, physical inability and cognitive impairment. From my study it shows that children below18 years are motorcycle riders which indicates that unlicensed children illegally ride motorcycles. This was a significant finding as unlicensed road users have been shown to cause an increased risk of road traffic accidents as seen in previous studies done by Alghaman et. al in Saudi Arabia in 2019 and Haworth et.al in 1994.(11,12)

As seen that most injuries occur in the evening, which correlates with the time most children are leaving school for home and this could explain the increased number of motor cycle accidents and injuries seen at this time. Poor vision by the motorcycle users and increased numbers of road users in the evening may also predispose road user to motorcycle accidents and injuries.

Head and neck injuries were the most common injuries observed (43.4%). These injuries were mostly serious and severe injuries 36.4 % and 59.6% respectively as per AIS score. Previous research done by Oxley et. al found similar findings with head and neck injuries accounting to 44 %.

However, several studies showed that injuries to the extremities was the most common injury. Lin and Krause found injuries to the extremities contributing to 50% of all injuries, Alghanam

reported 62.2% and Lateef also found similar results and suggested that motorcycle use is a risk to the lower limb.(8,11,26). Multiple injuries were the second most common pattern of injury (31.5%) with head and injury to the extremities being the most common combination. As observed by Kashif et. al in Pakistan children involved in motorcycle accidents had multiple injuries (56.8%) and by Fouda et. al where most patients had polytrauma.(8,23)
As reported in previous studies, head injury and injuries to the extremities were the most common cause of morbidity and mortality, this study also found that head injury was associated with critical and fatal injuries. We observed that children involved in motorcycle related injuries sustained serious, severe, critical and fatal injuries as per the AIS score that required admission, medical and surgical management.

Lack of use of helmets by motorcycle users have been shown in previous studies to cause a significant risk in sustaining head injuries. In children, use of helmets among pillions is rare especially in LMICs and this predisposes them to getting head injury.(16,18,29)
In this study however, we did not look at the use of helmets among pillions and riders who sustained head injuries and we cannot ascertain if this was a risk factor.
Multiple injuries are seen due to lack of protection gears and number of passengers carried on one motorcycle. From studies done before, children have been found to be carried as multiple passengers when using the motorcycle and this would put these children at risk of sustaining multiple injuries.(20,21)
Pedestrians are also likely to get serious and severe injuries due to high impact from the motorcycle and from our study most children injured were pedestrians. From previous studies multiple injuries were also associated with high mortality rate and this was similar in our study.

We also found that, 82.4 % of the children who sustained MCRIs from 2014 to 2019 were still on long term follow up in the hospital. This indicates that even after discharge most patients still have to come to the hospital for medical attention. Long term follow up has significant financial implications as both parents /guardians have to travel to the hospital and incur hospital charges for a period of time. Children also miss significant number of school days to come to the hospital.

Permanent disability is a significant sequalae of MCRIs.3.3 % of all the children who were evaluated had permanent disability. This included among others loss of a limb/limbs and paralysis. This may require long term rehabilitation or long-term change in the physical ability. Moreover, there are psychosocial burden to the patients and the care givers including anxiety and depression among the victims of MCRIs and their care givers. This increases the burden of the injuries. Branche et.al, Haagsma et. al and Alghaman reported disability following MCRIs as a significant consequent with both financial and psychosocial burden.(4,5,11)

The mortality rate from this study was 2.9% comparable to what was observed in Saudi Arabia and Egypt. This mortality rate however, may not be a true representation of the overall mortality due to missing patients records and manual storage of files and consecutive sampling method used. Nonetheless, this was significantly higher than those seen in developed countries including China at 1.5% and Singapore at 1.9 %. (11)

This higher mortality rate could be due to poor emergency services, prolonged pre-hospital time and unavailability of hospitals that can handle serious and severe injuries. Limited resources within the hospitals such as intensive care unit (ICU) and lack of expertise could also play a role.

Study limitations

This study had a number of limitations as it only looked at records of hospitalized patients and this could give an underestimate of the true burden of MCRIs. There are also some records that were missing in the files due to improper documentation. Some patients were also keyed in the electronic system with the primary diagnosis and not motorcycle injury and this may have made us miss a significant number of patients.

Recommendations

A follow up study that looks at the risks of MCRIs in children is recommended as this would capture the unique factors that predisposes children to these injuries.

With the increase in use of motorcycles and increased number of recorded motorcycle accidents there should be improved measures to protect the vulnerable population.

Preventive measures including

1. Construction of proper roads and proper road signage including

a) pedestrians' crossing,
b) walk ways
c) broad road shoulders

2. Children should be supervised by parents, teachers or guardians whenever using the road.

3. Law enforcement should ensure that only licensed motorcycle users ride motorcycles.

4. Use of helmets especially in children is rare therefore, laws and policies should be developed and enforced to ensure that all motor cycle users regardless of age uses a helmet.

5. Public awareness and teachings should be done to enforce preventive measures.

Treatment protocols should be developed in our hospitals to be able to manage the serious, severe and critical injuries associated with motorcycle injuries.

The government should also come up with ways and measures to carter for this overwhelming physical, psychosocial and financial burden that are associated with motorcycle injuries in children.

CONCLUSION

Motorcycle injuries have increased among road users including children. Injuries sustained from motorcycle accidents are severe, critical and fatal and require hospitalization for medical and surgical care. These patients are also on long term follow up and some have permanent disability which has physical, psychosocial and financial burden to the victims involved.

Proper preventive measures, policies and treatment protocols should be developed to protect children from this burden.

3.15 Study Timelines

	DURATION						
	Oct 20	Nov 20	Dec 20	Jan 20	Feb 20	Mar 21	Apr 21
Proposal Development							
Ethical Review							
Data Collection							
Data Analysis							
Publication							

3.16 Study Budget

ITEM	**COST(KSHS)-estimated**
Ethics Review/NACOSTI	15,000
Stationery	5,000
Printing	10,000
Research Assistants	40,000
Statistician	40,000
Airtime	10,000
Record Retrieval	2,000
Miscellaneous	5,000
Total	127,000

REFERENCES

1. Wesson HKH, Boikhutso N, Bachani AM, Hofman KJ, Hyder AA. The cost of injury and trauma care in low- and middle-income countries: a review of economic evidence. Health Policy Plan. 2014 Sep 1;29(6):795–808.

2. Brown J, Schonstein L, Ivers R, Keay L. Children and motorcycles: a systematic review of risk factors and interventions. Inj Prev. 2018 Apr 1;24(2):166–75.

3. Tracy ET, Englum BR, Barbas AS, Foley C, Rice HE, Shapiro ML. Pediatric injury patterns by year of age. J Pediatr Surg. 2013 Jun 1;48(6):1384–8.

4. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. Inj Prev. 2016 Feb 1;22(1):3–18.

5. Branche C, Ozanne-Smith J, Oyebite K, Hyder AA. World report on child injury prevention. World Health Organization; 2008.

6. Murumba J, Micheni E. Big Data Analytics in Higher Education: A Review. Int J Eng Sci. 2017 Jun;06(06):14–21.

7. Nesje E, Valøy NN, Krüger AJ, Uleberg O. Epidemiology of paediatric trauma in Norway: a single-trauma centre observational study. Int J Emerg Med. 2019 Dec;12(1):1–10.

8. Lin M-R, Kraus JF. A review of risk factors and patterns of motorcycle injuries. Accid Anal Prev. 2009 Jul;41(4):710–22.

9. Jandhyala S. Paediatric motorbike accidents: the need for stricter regulation to reduce the frequency of injuries. ANZ J Surg. 2011 May 1;81(5):312–3.

10. Oxley J, Ravi MD, Yuen J, Hoareau E, Hashim HH. Identifying contributing factors to fatal and serious injury motorcycle collisions involving children in Malaysia. Ann Adv Automot Med. 2013 Sep; 57:329.

11. Alghnam S, Alsulaim HA, BinMuneif YA, Al-Zamil A, Alahmari A, Alshafi A, et al. Injuries following motorcycle crashes at a level-1 trauma center in Riyadh. Ann Saudi Med. 2019 Jun;39(3):185.

12. Haworth N, Ozanne-Smith J, Fox B, Brumen I. Motorcycle-Related Injuries to Children and Adolescents. 1994 Jan 1;

13. Manan M, Varhelyi A. Motorcycle fatalities in Malaysia. IATSS Res. 2012 Jul 1; 36:30–9.

14. Organization WH. Global status report on road safety 2015. World Health Organization; 2015.

15. Liu BC, Ivers R, Norton R, Blows S, Lo SK. Helmets for preventing injury in motorcycle riders. Cochrane Database Syst Rev [Internet]. 2003 [cited 2020 Oct 24] ;(4). Available from: https://www.cochranelibrary.com/es/cdsr/doi/10.1002/14651858.CD004333.pub2/full/es

16. Yunus SSM, Ngeow WC, Ramli R. Pediatric craniomaxillofacial injuries after road traffic crashes: characteristics of injuries and protective equipment use. Am J Emerg Med. 2015 Sep 1;33(9):1253–7.

17. Pervin A, Passmore J, Sidik M, McKinley T, Hong Tu NT, Nam NP. Viet Nam's mandatory motorcycle helmet law and its impact on children. Bull World Health Organ. 2009 May; 87:369–73.

18. Fong MC, Measelle JR, Dwyer JL, Taylor YK, Mobasser A, Strong TM, et al. Rates of motorcycle helmet use and reasons for non-use among adults and children in Luang Prabang, Lao People's Democratic Republic. BMC Public Health. 2015 Dec;15(1):1–6.

19. Nasir AA, Bello JO, Ofoegbu CKP, Abdur-Rahman LO, Yakub S, Solagberu BA. Childhood motorcycle-related injuries in a Nigerian city - prevalence, spectrum and strategies for control. South Afr J Child Health. 2011 Jun 29;5(2):48–50.

20. Paiman NF, Syazwan SM, Aqbal Hafeez A, Mohd Isa MH, Mohd Khairudin R, Jawi ZM, et al. Prevalence of Carrying Multiple Pillion Riders on the Route to School [Internet]. Vol.

10, Advanced Engineering Forum. Trans Tech Publications Ltd; 2013 [cited 2020 Oct 24]. p. 351–6. Available from: https://www.scientific.net/AEF.10.351

21. Sivasankar S, Karmegam K, Bahri MTS, Naeini HS, Kulanthayan S. Safety System for Child Pillion Riders of Underbone Motorcycles in Malaysia. Traffic Inj Prev [Internet]. 2014 May 27 [cited 2020 Oct 24]; Available from: https://www.tandfonline.com/doi/abs/10.1080/15389588.2013.861596

22. Sisimwo PK, Mwaniki PK, Bii C. Crash characteristics and injury patterns among commercial motorcycle users attending Kitale level IV district hospital, Kenya. Pan Afr Med J [Internet]. 2014 Nov 17 [cited 2020 Oct 24];19(296). Available from: https://www.panafrican-med-journal.com/content/article/19/296/full/

23. Fouda EY, Youssef M, Emile SH, Elfeki H, Thabet W, Abdallah E, et al. Pattern of major injuries after motorcycle accidents in Egypt: The Mansoura Emergency Hospital experience. Trauma. 2016 Jun 21;19(1):39–45.

24. Richter M, Otte D, Lehmann U, Chinn B, Schuller E, Doyle D, et al. Head Injury Mechanisms in Helmet-Protected Motorcyclists: Prospective Multicenter Study. J Trauma Acute Care Surg [Internet]. 2001;51(5). Available from: https://journals.lww.com/jtrauma/Fulltext/2001/11000/Head_Injury_Mechanisms_in_Helmet_Protected.21.aspx

25. Saad I. Al-Ghabban*, Mahdi.Abdul-Sahib, Waleed M. Risk Factors and Pattern of Injuries in Motorcycle Accidents in Holy Karbala. Karbala J Med [Internet]. 2013 [cited 2020 Oct 24];6(1). Available from: https://www.iasj.net/iasj/article/84505

26. Lateef F. Riding motorcycles: is it a lower limb hazard? Singapore Med J. 2002;43 11:566–9.

27. Otte D, Schroeder G, Richter M. Possibilities for load reductions using garment leg protectors for motorcyclists -- a technical, medical and biomechanical approach. Annu Proc Assoc Adv Automot Med. 2002; 46:367–85.

28. Barzegar A, Ghadipasha M, Forouzesh M, Valiyari S, Khademi A. Epidemiologic study of traffic crash mortality among motorcycle users in Iran (2011–2017). Chin J Traumatol. 2020 Aug;23(4):219–23.

29. Liu B, Ivers R, Norton R, Blows S, Lo S. Helmets for preventing injury in motorcycle riders. In: The Cochrane Collaboration, editor. Cochrane Database of Systematic Reviews [Internet]. Chichester, UK: John Wiley & Sons, Ltd; 2003 [cited 2020 Oct 24]. p. CD004333.pub2. Available from: http://doi.wiley.com/10.1002/14651858.CD004333.pub2

30. Dongo AE, Kesieme EB, Eighemherio A, Nwokike O, Esezobor E, Alufohai E. Motorcycle Related Injuries among Rural Dwellers in Irrua, Nigeria: Characteristics and Correlates [Internet]. Vol. 2013, Emergency Medicine International. Hindawi; 2013 [cited 2020 Oct 24]. Available from: https://www.hindawi.com/journals/emi/2013/569103/

ANNEXES

Annex 1: Data collection tool

Study Title: Pattern and Outcomes of Injuries Following Motorcycle Accidents in Children at Kenyatta Hospital, Kenya

Date:…….

Time:……

Serial number:…….

Section I (demographic factors for motorcycle injuries)

1. Age in years……

2. Gender Male ☐

   Female ☐

3. Residence ……

4. Time of accident Early morning (6am -10am) ☐

   Mid-morning (10am – 1pm) ☐

   Afternoon (2pm – 4pm) ☐

   Evening (4pm -7pm) ☐

Night (7pm -6am) ☐

5. Mechanism of crash

Motorcycle to motor vehicle collision ☐

Motorcycle to motorcycle collision ☐

Motorcycle to pedestrian collision ☐

Motorcycle to loan ☐

6. Type of road user

Pedestrian ☐

Passenger/pillion on a motorcycle ☐

Rider ☐

7. Pre-hospital time (in hours)…….

Section II: (pattern of injury)

8. Site of injury and injury severity score

Site of injury	Tick (where appropriate)
Head and Neck	
Face	
Chest	
Abdomen and pelvis	
Extremities	
External injuries	

9. Type of injury (tick where appropriate)

Abrasion/bruises	laceration	Soft tissue wound	fracture	Vascular injury	Blunt injury	Crush injury	others

10. Abbreviated injury scale (AIS)……..

Site of injury	
Minor (1)	
Moderate (2)	
Serious (3)	
Severe (4)	
Critical (5)	
Fatal (6)	

Section III: Outcome of motorcycle injury

11. Place of management

Outpatient ☐

Inpatient ☐

12. Surgical/operative management

Minor surgery ☐

Major surgery ☐

Conservative ☐

13. Treatment outcome

Discharged with no disability ☐

Permanent disability ☐

Long term follow up ☐

Death ☐

14. Mean length (in hours) of hospital stay

……..