PATTERNS OF INJURY IN FATAL MOTORCYCLE ROAD TRAFFIC INCIDENTS AND DETERMINANTS OF FATALITIES AT KENYATTA NATIONAL HOSPITAL AND NAIROBI CITY MORTUARIES

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DECLARATION FORM

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APPROVAL

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ABBREVIATIONS

A & E	Accident and Emergency
ACF	Anterior cranial fossa
AIS	Abbreviated injury score
BOSF	Base of skull fracture
CS	Carotid sheath
CT	Computed tomography
EDH	Epidural haematoma
GSRRS	Global status report on road safety
ICU	Intensive care unit
ISS	Injury severity score
IQR	Interquartile range
IVF	Intravenous fluid
KNH	Kenyatta National Hospital
LL	Lower limb
LMIC	Low and middle income countries
MCI	Motorcycle incidents
MRF	Motorcycle related fatalities
MV	Motor vehicle
NCM	Nairobi city mortuary
NHTSA	National highway transport safety administration
NTSA	National transport safety authority
PI	Primary investigator
PPE	Personal protective equipment
PTE	Pulmonary thromboembolism
RTI	Road traffic incident
RU	Radioulna
SAH	Sub arachnoid haemorrhage
SCM	Sternocleidomastoid muscle
SD	Standard deviation
SDH	Sub dural haematoma

STI	Soft tissue injuries
TF	Tibiofibula
UL	Upper limb
UON-ERC	University of Nairobi/ Ethics research committee

DEFINITION OF TERMS

Decedent – An individual who has died

LMCI – Countries with a gross national income per capita of $995 or less in 2017 as defined by World Bank Atlas Method 2017.

Motorcycle incident _ Collision involving a motorcycle

Pillion rider _ Passenger on a motorcycle

ABSTRACT

Background: Fatal road traffic incidents (RTIs) are of global concern accounting for the highest cause of death among the young productive age of 15-49 years. Low and middle income countries (LMIC) being the worst hit despite having lower motorization in comparison to developed countries. The rise in RTIs is also attributable to the increased use of two wheeled motor vehicle, which are a cheaper and more convenient mode of transport. Previous studies done on morbidity and mortality of motorcycle associated accidents have shed some light into preventative measures to reduce such occurrences. Locally the Transport and Safety authority has implemented laws governing safe use of motorcycles, like helmet and reflector jacket use and despite the knowledge and traffic laws governing this, fatalities from two wheeled motor vehicles are still on the rise. This raises concerns about possible contributing factors leading to such high fatalities, whether pre-crash, crash or post-crash factors. There is minimal information locally on autopsy studies on patterns of injury in fatal motorcycle RTIs. This study is designed to establish these patterns and link them to possible contributors to fatalities and provide insight and recommendations that may be applied to try and reduce these injuries and fatalities.

Objective: The main objective of this study was to determine the patterns of injury and contributing factors to mortality among fatal motorcycle RTIs.

Study design: Descriptive cross sectional autopsy study.

Study area: Kenyatta National Hospital (KNH) mortuary and Nairobi City Mortuary (NCM).

Study population: All decedents of fatal motorcycle incidents at KNH and NCM who met the eligibility criteria.

Materials and methods: This was a descriptive autopsy study, involving decedents of fatal motorcycle RTIs at the KNH mortuary and NCM. Enrolment was through informed consent from the next of kin. A well-structured questionnaire was duly filled for information relevant to the study from both the police and next of kin. An autopsy was then carried out by the PI under supervision to identify and describe the injuries sustained and determine any related complications. Findings were documented in a proforma questionnaire, data collection sheets and photographs. The injuries sustained by the decedents were tabled and a severity score calculated using the injury severity score (ISS) calculator and also abbreviated injury score (AIS) for the head and neck injuries sustained.

Results: Males were the majority 91.67%, females were 8.33%. Their age ranged between 16 and 37 years with a median of 30 years (IQR=24-33) for decedents at NRM, and between 17 and 88 years with a median of 30 years (IQR=25-43) for decedents at KNH. Riders accounted for the majority of fatalities 70.8% while pillions were 29.2%. All the riders were male. Frontal and rear – end impacts were the commonest, accounting for 83.3%.

Saloon cars accounted for the most of the collision objects 37.5%, while buses accounted for 9.7% and had 100% mortality within 24 hours. Accidents due to road bumps, road barriers, potholes and tyre bursts accounted for a good number of deaths that occurred after 168 hours of hospital stay.

Helmet use was noted in 26.4% of the decedents riders being the most 84.2% as compared to 17% pillion riders. Head injury was the most commonly reported finding occurring in 86.1% of the victims. Other injuries reported included neck 25%, thorax 23.6%, lower limb 22.2%, abdomen 16.7% and the upper limb 8%.

Conclusion

Head and neck injuries were the most frequent and severe injuries sustained, combined with abdominal and chest injuries accounted for majority of fatalities within 24 hours. Helmet use was very low and even when worn protection from head injury was minimal. Frontal and rear impacts were the commonest considering that most MCIs occurred on major highways with Mombasa road, Thika road and Kiambu road recording the larger proportions. Majority of the incidents occurred over the weekend and mostly in the evenings or wee hours of the night. Saloon cars were the commonest collision objects while buses, matatus and trucks were associated with higher ISS scores, abdominal and thoracic injuries and fatalities within 24 hours.

1.0 INTRODUCTION

1.1 Background of the study

Road traffic incidents (RTIs) are a leading cause of death globally and are still on the rise despite various road safety measures implemented by the government to reduce morbidity and mortality. RTIs are higher in low income and middle income countries (LMICs) disproportionate to numbers relative to the countries level of motorization.

In the recent past, with influx of two wheeled motorcycles into the market, there has been a steep rise in fatalities of RTIs. Motorcycles are cheaper to purchase, convenient (manoeuvre through heavy traffic, easily accessible and ideal for transportation of lighter loads at a fairer price). Disadvantages of motorcycles are an increased risk of fatality and severity of injuries sustained in the unfortunate event they are involved in an RTI.

Attributable factors leading to mortality can be classified as Pre-crash, Crash and Post-crash according to the Haddon Matrix. These factors may be further subclassified as, road user**,** motorcycle and environmental factors**.** According to WHO Global Status Report on Road Safety (GSRRS) 2015, number of road traffic deaths was 1.25 million by 2013 up by 11.3% from 2001. GSRRS 2015 also showed that RTIs were the major cause of death in the 15 - 29 year old age group. This being the productive age group, RTIs therefore has a major impact on the country's economy.

Fatalities were shown to be double in low income countries as compared to high income countries, with 90% occurring in LMICs that have 54% of the world's motor vehicles. Africa accounted for the highest RTI mortalities per 100,000 deaths**.** Africa -26.6/100,000, European – 9.3/100,000. Among all the fatalities 50% were among those with least protection, Motorcyclists -23%, Pedestrians - 22%, Cyclists -4%.

Autopsy records book from the KNH mausoleum indicate that out of 25 forensic post mortems conducted per week, fatalities due to motorcycle associated RTIs account for approximately 30 - 40%. This therefore raises important questions as to the cause of such high fatality rates associated with motorcycle RTIs considering the various measures employed to try and curb this. Motorcycle morbidity and mortality are on the rise with hospitals being forced to allocate special wards to cater for the increasing burden.

Motorcyclists have a 30 times greater risk of fatality from RTIs as compared to car occupants, National Highway Traffic Safety Administration (NHTSA, 2012), this is due to lack of a protective shell and therefore direct contact with hazards in the event of a crash. Head injury is the commonest cause of death in motorcycle fatalities and lack of a helmet increases the risk by 40 times.

The use of helmets was found to reduce the risk of fatality by 37% (NHTSA, 2012). Despite helmet use occupants still suffer some degree of head injury and neck injuries, which may be attributable to use of substandard helmets.

In Kenya there has been a steady rise in motorcycle use with a dramatic increase between 2005 and 2011 of 40 fold. In 2011 motorcycles made up 70% of newly registered vehicles. With this development there has been an increase in motorcycle RTIs related mortality and morbidity.

According to NTSA Kenya, data on fatal motorcycle RTIs, motorcycles accounted for 7% of the 3055 RTI mortalities in 2010, which was 5 fold compared to 2005 data. Recent data showed that, in a three month period, between January and March 2015, 93 motorcyclists, 38 pillion riders died, compared to 139 motorcyclists and 66 pillion riders, in 2016 in the same time frame.

These are alarming statistics, considering the initiatives put in place by NTSA to avert mortalities due to motorcycle RTIs, such as use of helmets and reflector jackets, to at least reduce the risk of severe and fatal injuries, as motorcyclist and pillion riders have a higher risk owing to lack of a protective shell.

Maurice Simiyu et al (3) conducted a verbal study in Kakamega county and concluded that some of the contributing factors to motorcycle RTIs due to ignorance; incompetence; age, with most of the young motorcyclists being more reckless owing to the fact that most are also heavy alcohol consumers and inexperienced; road infrastructure both poor rural and well-built highway roads; inadequate enforcement of existing traffic laws and motorcyclists attitude. Most of these accounting for Pre-crash factors.

Motorcycle occupants upon impact are at a high risk of suffering severe injuries due to blunt force trauma secondary to direct body impact, following the crash. This is obviously due to lack of a shell which would absorb some of the force and also lack of restriction such as seat belts which limit inertia.

The common injuries sustained are head injuries (accounting for most fatal injuries), chest injuries, abdominal, skeletal injuries and soft tissues injuries. The severity of the injuries will be based on force of impact, speed during impact, road infrastructure, use of protective gear, and the object of impact.

In the unfortunate event of a motorcycle RTI, various post-crash factors determine the possible outcomes. The sequence of events from response by police, emergency medical services including availability of an ambulance, handling of the victims at the scene of the incident, distance to nearest medical facility, prompt and accurate diagnosis and medical intervention do have a great impact on the outcomes of the victim.

2.0: LITERATURE REVIEW

2.1 Epidemiology

Road traffic fatalities account for most causes of unnatural deaths globally in the young productive age group of 15 – 49 years. Accounting for approximately 1.25 million, deaths worldwide annually as at 2013. Fatalities from RTIs are double in LMICs at 26.6/100,000 annually as compared to high income countries (Europe) at 9.3/100,000 annually. This is disproportionate to the level of motorization in these countries(4). Fatalities were noted to be higher in those with least protection, **motorcyclists 23%,** pedestrians 22%, and cyclists 4% (2). Increase in motorcycle crashes fatalities from motorcycle crashes were noted in high income countries like USA in the 1990s, coinciding with an increase in motorcycle purchase accounting for 14% of all fatal crashes, yet motorcycles only account for less than 3% of registered vehicles (5).

Two and three wheeled vehicles are in more use in LMICs as they are cheaper and convenient. The downside of these types of vehicles is lack of a protective shell and are therefore prone to serious injuries upon impact. Locally the level of motorcycle registration increased by almost 40 fold in a period of six years from 2005 to 2011, accounting for 71% of all newly registered vehicles in 2011(6). With this rise in motorcycles registration there has also been a direct proportional rise in fatal RTIs (2). The current situation may get worse with the completion of high speed roads.

To emphasize the magnitude of the motorcycle burden, RTI fatality reports filed by NTSA showed that in the year 2015 there were a total of 637 motorcycle deaths. More recent data indicates that between January and March 2016 there were 205 motorcycle fatalities, 139 being riders and 66 pillion riders, compared to 2015 same time frame, 131 deaths, 93 being riders and 38 pillion riders. In 2013 motorcycles accounted for 14.3% (9.8% riders and 4.5% pillion riders) of fatal RTIs as compared to 7 % in 2010.

These statistics indicate a rise in MRFs, despite the various enforcements put in place by NTSA to reduce motorcycle accidents, like use of helmets and reflector jackets, compelling suppliers and dealers to sell motorcycles with a complete set of helmets and protective clothing. Kenya is among the countries in the world that have no laws or if present are not comprehensive on helmet use (4)

Table 1: Comparison of National RTI fatalities based on absolute figures 2014/2015 – NTSA, Kenya road status report 2016

VICTIM TYPE	2015	2014	% VAR
PEDESTRIANS	1344	1340	0.299
DRIVERS	339	268	26.49
PASSENGERS	668	642	4.05
M/CYCLE FATALITIES	637	553	15.19
PEDAL CYCLISTS	69	104	-33.7
TOTAL	**3057**	**2907**	**5.2**

2.2 Patterns of motorcycle injuries

Patterns of injury following a motorcycle RTI vary depending on various factors; whether collision or non-collision, helmeted or non-helmeted rider/pillion, disposition of the occupant, pre-crash speed of either the motorcycle or collision vehicle, age and to a lesser extent and gender(7).

Injuries sustained may be superficial; abrasions, contusions and lacerations; or head injury which accounts for the majority, chest and abdominal injuries and injuries to the extremities. Head injury accounts for majority of fatal cases up to 80% (8), while lower extremity affects 32-80% and is the most common outcome of non-fatal motorcycle accidents(9).

Craniofacial injuries are more severe in non-helmeted occupants as compared to helmeted occupants. They include skull fractures, facial fractures, focal brain injury, diffuse brain injury, cerebral oedema, concussion, epidural haematoma, subdural haematoma and subarachnoid haematoma(9) in some instances the injuries may be as severe as decapitation(7).

Despite severe injuries and implementation of helmet laws most riders and pillions do not wear helmets, 8.6% of riders and 6.7% of pillions were shown to use helmet in an Iran study(9) and 19.6% in an Indian study (10).

In a study by Patricia C. Dischinger et al comparing injury patterns between old and young riders, among 1,253 hospitalized motorcycles accidents of whom 41 died, showed older patients were more prone to suffer from thoracic injuries as compared head injuries in the young (11). Helmet use was shown to have an association with ISS in younger patients compared to older riders in whom there was no association. Spinal injuries were also more significant in in the younger riders. Younger riders who wore helmets had fewer head and facial injuries as compared to older riders who wore helmets and had more head and facial injuries (11). In both riders commonest injuries were both lower and upper extremity.

Injuries that caused death in this study were head injuries (20/41), thoracic injuries (24) and abdominal injuries (15), using 95% CI for death by region, with some of the cases having more than one injury resulting to death.

Talving P et al did a study in 13 trauma centres in Los Angeles, of 6,530 admissions due to motorcycle crashes in which 7.5% were aged 18 years and below, 86% 19 to 55 years and 6.5 % older than 55. An ISS of more than 15 showed a variation in the three groups at 23.5%, 30.3% and 36.2% respectively with ($p<0.05$), and critical ISS of more than 25 being 6.5%, 12.3% and 13.8% respectively.(12)

Head injury was more severe in the older than 55 years age group ($P<0.04$). Risk of sustaining chest injury increased with age being highest in the above 55 years age group. Mortality was twofold and three fold in the 19 to 55 years and above 55 years in comparison to the 18 years and below group (12). Older patients are therefore more prone to severe injuries commonly to the head and chest and higher risk of mortality.

In a study by Michael Fitzharris et al in India among 378 motorcycle users who were involved in MCIs, median age was 31.3 years and there were 42 (11%) fatalities. Open wound and superficial injuries to the head accounted for 69.3% with 11% sustaining intracranial injury and 28% of them with associated skull bone fractures, upper extremity 27% and lower extremity 24% (10).

Helmet use in the same study was at 19.6%, with riders being the greater majority at 29% and pillions at 0.8%. 36% of non-helmeted users as compared to 8.1% of helmeted users died. Female pillions were at a greater risk of fractures of the head and neck and open wound upper extremities, attributable to the sideways sitting position. Upon impact most of the female pillions ejected fall with an outstretched arm with the head and neck bearing much force(10).

2.3 Mechanisms of motorcycle injuries

About 60 to 80% of vehicular crashes are frontal collisions causing violent deceleration, 6% are rear, accelerating the occupants. The remaining few are side sweeps and roll overs. In the case of motorcycle head on collision, violent deceleration will result in either partial or total ejection of the rider or pillion rider from the motorcycle.(7)

Rear impacts, will cause acceleration of the rider or pillion rider. Depending on the type of collision whether acceleration or deceleration then impact with a stationery object; road surface, handle bars, collision vehicle or lack of protective clothing the victims are predisposed to particular injuries.(8)

In an Indian study by Michael Fitzharris et al majority of collisions were multivehicle, and accounted for 59% of injured motorcycle users, while 30% were due to frontal collisions (10).

Head and neck injuries will result if the occupants have no helmets, thoracoabdominal injuries and pelvic and femur fractures may result from striking the handle bars. Skin abrasions and lacerations may result from impact with stationery objects like road surfaces and road barriers.(8). Risk of sustaining moderate to severe head injury by not wearing a helmet was five times higher than had helmet been worn 27% versus 5.2%, 95% CI (10).

Motorcycle users who sustained intracranial injuries accounted for 11%, inclusive of both riders and pillions and 30% of this fraction succumbed compared to 8.7% mortality in users without intracranial injuries. Univariate analysis on association of intracranial injury and mortality showed an increased risk of more than 3.5% in those with intracranial injuries(10). This relationship remained evident even in multivariate models including age, sex and collision partner(10).

The highest AIS severity of the head, chest, abdomen and pelvis and being struck by larger vehicles (bus, truck, van) were shown to be predictors of mortality(10). There may be a variation in mechanism of injury in relation to age, in which older riders(> 40 years) are more predisposed to crashes that involve overturning as compared to younger patients (14%:6%) and the younger patients (< 40 years) are more predisposed to collisions with other vehicles or stationery objects (51%:42%) (11)

2.4 Head and neck injuries

Majority of fatal motorcycle RTIs are due to severe head injuries and more so in riders and pillion riders who have no helmets involved in RTIs with stationery vehicles, with buses accounting for severer multiple injuries and most fatalities. Head injuries have been given more focus as they are more overt to the attending physician. Soft tissue neck injuries which are also a substantial contributor to severe injuries have been given little focus. Some of the cited reasons for these omissions may be due to the fact that diagnostic modalities and awareness by attending physicians is limited (13)

Soft tissue neck injuries though not common, were shown to account for at least one third of fatalities from severe motorcycle injuries. Helmet use was shown to at least reduce the severity of head injuries upon impact but even this was limited as not all helmeted riders had their helmets on at the end of impact (13)

Detailed layer by layer dissection of the neck revealed soft tissue injuries even in decedents who had occult external head and neck injuries, indicating such life threatening injuries may be missed at the point of triage at the A&E.

Vira Kasantikul et al performed detailed neck dissections in 73 fatalities who were part of a larger study of 1481 victims of motorcycle incidents. The study showed a high frequency of occult injuries in both helmeted and non-helmeted motorcycle users. Injuries sustained included haemorrhage into the carotid sheath, vertebral arteries, phrenic nerve and brachial plexus. One third of critically injured riders who survived a few hours showed serious occult soft tissue neck injuries.(13)

Cause of death coded as primary or secondary based on the AIS90, indicated head injury as primary cause in 60% of the cases and neck injuries accounted for 10%. About 43% of the victims who survived for 1 to 15 days had neck injuries which were not captured in the medical records. Neck injury severity had a direct proportional relation to the increase in ISS (13)

The importance of an understanding of neck injuries is to perform lifesaving intervention for crash survivors. Haemorrhage in the carotid sheath may later be associated with thrombosis or aneurysms leading to brain hypoxia and vagal nerve compression with consequent effects on visceral function. Disruption of vertebral arteries may lead to reduced brain perfusion. These therefore are injuries that with appropriate intervention will reduce the rate of mortality. (9)

2.5 Haddon matrix: Factors contributing to motorcycle RTIs morbidity and mortality

There are various factors that come into play contributing to morbidity and mortality associated with motorcycle accidents, which can be classified as **Pre-crash, crash and post-crash** according to the Haddon matrix (14)

The Haddon matrix was developed by William Haddon (1970) to looks at factors related to personal, vector and environmental attributes before during and after an injury or death. Using the matrix then factors contributing to mortality can be assessed in relation to riders attributes, motorcycle attributes and environmental attributes (14).

Some of the attributable factors like motorcycle attributes and **crash factors** will be mentioned but are beyond the scope of this study and will therefore not be covered.

2.5.1 Pre-crash factors (Crash prevention)

Pre-crash analyses factors that preceded the collision and how they may contribute to mortality. These factors according to the Haddon matrix can further be classified as host factors, vehicular factors or environmental factors.

Host factors include use of protective gear, age, alcohol and substance abuse, experience, ignorance or knowledge of traffic laws and to some extent attitude of both motorcyclists and other road users(3)(6) (13).

Helmet use has been shown to be very poor among motorcyclists both locally and internationally even in countries with helmet laws in place. In a study by Michael Fitzharris et al in urban India showed 19.6% (10), M. Zargar et al in Iran showed 15.3% (9) and 18.6% also in Iran in a study by A. Vafaee (15). Some of the reasons motorcyclists and pillion riders cited for not using helmets were, hot weather conditions, poor visibility, hygiene, peer pressure (wearing a helmet is considered a sign of weakness) and, complains of masking of sounds by padding in the helmets. Self-importance, not wearing helmets so they can be seen as the motorcycle owners, claiming the helmet will cover their faces(16)

Among those with helmets, the make also influences its resilience upon impact (17). Other factors include pre-crash speed with high speeds being associated with severer injuries and increased mortality risks.

Seyeed Taghi Heydari et al showed that use of alcohol at least two hours prior to driving was associated with a risky driving behaviour like over speeding, poor manoeuvres thus greater risk of crashing (18)

According to the cause code classification Kenya police reports, 85.5% of RTIs were due to poor driver behaviour with 44% being due to driver errors; over speeding, misjudgement of distance, alcohol intoxication, and traffic rule violation on (6). Other factors are ignorance and inexperience(3)

Vehicular factors contributing to RTIs are defective brakes, tires, steering systems, headlights and overloading. Environmental factors are due to poor road infrastructure, potholes, sharp bends, and slippery roads and pedestrian facilities (6). Some of these factors though may not be assessed in this study as detailed information pertaining the type of road, weather and make or defects of the motorcycle, will not have been taken into account during traffic police statement recording.

2.5.2 Crash factors (Injury prevention during crash)

Factors which will influence severity of trauma during impact are: collision vehicle or object, whether stationery or moving, vehicle type and crash protective roadside barriers. These factors though will be beyond the scope of this study and will therefore not be assessed.

2.5.3 Post-crash factors (Life sustaining)

These factors play a crucial role in the outcome of the crash, and will be dependent on first aid skills and access to medics, fire risk and equipment for transport(19), diagnostic and management modalities and skilled personnel(13).

Victims of motorcycle incidents who make it to hospital need well-structured triage systems to avoid missed diagnosis. In an autopsy study by Vira Kasantikul et al, he showed that at least 43% of victims who survived the crash but later succumbed while in hospital had neck injuries which were not documented in their medical records (13). Therefore rapid response, prompt triage and management would salvage more lives of victims with such injuries.

High income countries have, however, developed policies to curb an increase in these fatalities. Mandatory helmet use has been a big factor in reduction of severe and fatal head and neck injuries. An analytical study assessing mortality among riders in comparison to state laws on helmet use showed rates of 12% cases in those with helmet laws, 64% with partial helmet laws and 79% in those without(20). Some LMCIs that have implemented helmet laws Taiwan noted a 33% decrease in head injuries associated with motorcycle RTIs between 1996 and 1997(21)

LMCIs where motorcycles are the major means of transport in some of its states like Indonesia, put specifications on the motorcycles availed for purchase. Motorcycles imported are 125cc capacity and below, thus less power and reduced incidences of speed related crashes(22)

2.6 Abbreviated injury scale

Developed in 1971 to provide researchers and medical personnel with a simple numerical method for ranking and comparing injuries severity and standardize description of injuries sustained from vehicular crashes. AIS classifies each injury in everybody region according to its relative importance on a six point ordinal scale; Minor, Moderate, Serious, Severe, Critical & Maximum

It may also be documented as a six digit numerical identifier based on body region, type of anatomical structure, specific anatomical structure, level and severity score.

AIS indicates the relative risk of threat to life in an average person who sustains the coded injury as his/her only injury. Despite giving detailed description of injury sustained AIS is not useful in the assessment of multiple injuries. In this study AIS will be used to derive an injury severity score for each individual case and give a detailed description of the head and neck injuries.

2.7 Injury severity score (ISS)

Injury severity score introduced in 1974 was developed by Baker et al to predict probability of mortality in trauma patients post vehicular crashes, was based on anatomical injuries. It describes the anatomic and functional damage in the three most severely injured body regions.

Developed to combine separate AIS ratings into a single measure of overall injury severity (23) ISS is calculated as the sum of squares for the highest values in each of the three most severely injured body regions. Injuries are documented based on six body regions; i) Head or neck ii) Face iii) Thorax iv) Abdomen v) Extremities vi) External.

Documentation of injuries to only the three injured regions was found to give misclassification of the ISS scores allocated to trauma patients and therefore a New ISS was proposed in 1997 as it was a more sensitive predictor of mortality (24).

The NISS is calculated as a sum of the three highest AIS scores from each patient regardless of the body region thus eliminating limited injury measurement to one body region and therefore give a more accurate assessment of severity (24).

2.8 Rationale

Motorcycle accidents are a major contributor to fatal RTIs in Kenya, with the mortality rates increasing albeit implementation of safety measures to try and curb the high fatalities, like use of PPEs and designated paths for two wheeled vehicles.

Considering the age group of majority of motorcyclists being of the productive age, such debilitating and fatal injuries are of great impact on productivity of the nation as a whole. Majority are the family bread winners and therefore the negative impacts trickle down to the average households.

These injuries being on the rise and accounting for majority of hospital admissions are therefore taking away focus from management of other medical conditions, research on cancers and re-emerging infections as allocations to trauma patients have to be increased to cater for the growing numbers.

Economically, considering the average hospital stay of severely injured patients, ranging from emergency care to rehabilitation per patient, is heavy on the tax payer and yet such scenarios can be drastically reduced with implementation and reinforcement of policies, some which are already in place. Cost implications of motorcycle accidents are expensive, as seen in a country like Iran where motorcycles are largely used, they impose cost of upto 2 billion US dollars (15). This is amplified in the Kenya Health Policy 2012 – 2030, shows currently injuries are accounting for at least 10% of fatalities in Kenya and moreover projections into 2030 show an expected increase by 25% (Chapter 3) (25).

There is minimal information on documentation of patterns of injury in fatal motorcycle RTIs which may provide added information in the approach to management of patients post-crash and shed some light into the major pre-crash contributing factors.

This study aims to determine the general patterns of injury, a detailed head and neck dissection and factors that may be contributing to mortality using the Haddon Matrix focusing on the pre-crash and post-crash factors. Crash factors will not be feasible in this study as the PI, will not be involved at the scene of the accident when the crash happens.

Hopefully it will also show gaps that may then prompt more studies in understanding the reasons for the high motorcycle associated incidents.

2.9 Research questions

a) What are the patterns of injury in fatal motorcycle incidents?

b) What are the determinants of fatalities in these incidents?

2.10 Objectives

2.10.1Broad objective

To determine patterns of injury in fatal motorcycle incidents.

2.10.2 Specific objectives

a) To determine patterns of injury in fatal motorcycle injuries at the KNH mortuary and NCM, through post-mortem examination and documentation.

b) To estimate the severity of head and neck injuries among fatal motorcycle injuries using the AIS.

Secondary objective

c) To identify factors that may be contributing to mortality using the Haddon matrix.

3.0: METHODOLOGY

3.1 Study design

This was an analytical cross-sectional autopsy study to determine patterns of injury and factors associated with mortalities from fatal motorcycle incidents during the study period,

3.2 Study sites

The study was conducted at the Kenyatta National Hospital (KNH) mortuary and Nairobi City mortuary. KNH mortuary is located within KNH, located along Hospital road in Upper hill. The mortuary serves KNH, Mbagathi Hospital and other private hospitals. It has both private and general wings with a total body capacity of 126 (30 private, 96 general). It offers a wide range of services, including forensics and post-mortems and also offers training and research opportunities.

City mortuary is the Nairobi county mortuary, located next to round about intersect between Mbagathi way and Ngong road, opposite Daystar University. It was set up in 1956 and has a body capacity of 160 bodies. Bodies from crashes and murder cases are taken to the facility. It's main services are forensics and post-mortems.

3.3 Study population

The study population comprised of decedents of motorcycle incidents at both KNH mortuary and NCM who met the inclusion criteria.

3.4 Inclusion criteria

- Decedents who died from motorcycle incidents at the accident scene and taken to NCM directly or who died at KNH and their bodies preserved at KNH mortuary, during the study period.
- Consented cases. Despite being a forensic autopsy, consent was sought from the next of kin who identified the decedent to be included in the study.

3.5 Exclusion criteria

- Unidentified decedents
- Markedly putrefied bodies

3.6 Sample size calculation

The primary objective of this study was to describe the patterns of injury in fatalities occurring in motorcycle incidents. These patterns were evaluated in terms of proportion of decedents with a particular type of injury. Sample size was determined using the formula (Dancun, 1999) for estimation of a population proportion in a finite population

$$n \geq \frac{N {Z_{\alpha/2}}^2 P(1-P)}{d^2(N-1) + {Z_{\alpha/2}}^2 P(1-P)}$$

Where:

N= minimum sample size

N=Total estimated accessible population=100

$Z_{\alpha/2}$=Standard normal critical value at α-level of significance for a two-sided test (α=0.05, $Z_{\alpha/2}$=1.96)

P= estimated prevalence of a given type of injury (p=0.5 to obtain the maximum sample size)

d= the margin of error (d=0.05)

Substitution into the formula N = 72 decedents

3.7 Sampling method

This was a prospective autopsy study, the PI identified decedents of fatal motorcycle incidents among the forensic autopsies for the day. As stipulated by law, two relatives and the IO identified the decedents. Once identification was done the PI sought consent to recruit the decedent, from the relatives. The PI then conducted an autopsy on the decedents who meet the eligibility criteria.

Consecutive sampling method was used to select the decedents, until the required sample size was achieved.

3.8 Data collection

A detailed questionnaire was duly filled, **APPENDIX I** to include demographic data; circumstances surrounding death, including area of the accident, whether the decedent was a rider, 'ride pillion, pedestrian, use of PPEs, medical intervention. The information on circumstances surrounding the accident and the death of the decedent at the scene were retrieved from the police form 23A. For decedents that died at KNH additional information was sought from case summaries, relatives and investigating police officers.

A comprehensive autopsy was carried out using a standardized autopsy/forensic protocol **APPENDIX II,** including preliminary procedures; summary of known circumstances; documents reviewed; external examination of the body; internal description of the body; general organ description. Findings of the autopsy were dully filled in the Police 23A form, indicating the injuries and extent and ascertain cause of death, **APPENDIX III.** The relevant data required for the statistical analysis of the study was transferred to a separate proforma which corresponded to the decedent's unique study identification code, **APPENDIX IV.** Severity of injuries was determined using AIS for head and neck and ISS charts which were sourced from the internet.

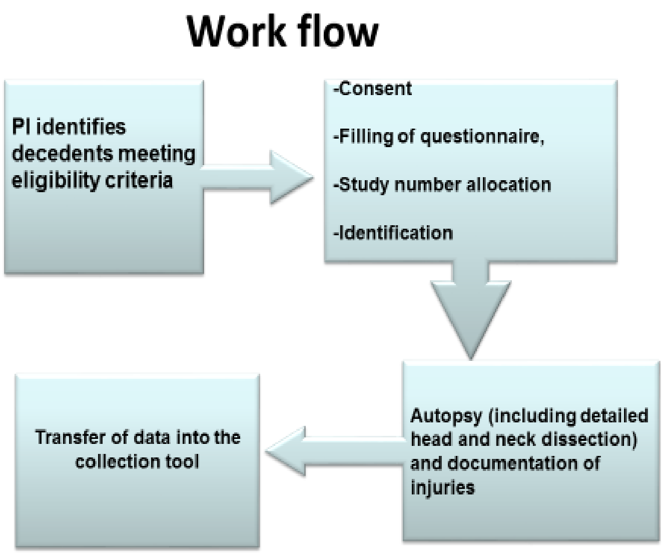


Figure 1: Workflow

3.9 Variables

This study variables were;

- Patterns of injury
- Disposition of the occupant
- Helmet use
- Object of collision (car, truck, fixed objects)
- Length of hospital stay
- Site of death occurrence
- Age
- Gender

3.10 Study limitations

Contributing factors requiring blood analysis, like alcohol intoxication. Decedents underlying comorbidity states which may have contributed directly to the accident, example having an epileptic fit, hypoglycaemic.

Regarding helmet use, the quality of the helmet, whether it stayed on during impact and accounting for the unknown cases.

3.11 Ethical considerations

Permission to conduct the study was sought from KNH/UON-ERC and Nairobi City mortuary through the office of the government pathologist for which approval was granted to conduct the study. Consent was sought from the next of kin of the deceased following detailed explanation on the nature and purpose of the study. Confidentiality was maintained by the PI, supervisors, research assistant and statistician. Data confidentiality was maintained by use of unique number identifiers of the study subjects.

3.12 Data management and analysis

Data collected from the form 23A, next of kin and case summaries where applicable and the autopsy findings was duly filled in a well-structured form, stored safely under lock and key and transferred to Microsoft Excel 2013 secured computer secured using a password, only accessible to PI, supervisors and statistician. Data was cleaned, coded and analysed using STATA 13.

Descriptive statistics were used to summarize the variables. Histograms were plotted to show the distribution of quantitative variables such age and duration of hospital stay. Means and SD or median and IQR were reported depending on the distribution. Bar/pie charts were plotted to show the distribution of categorical variables such as helmet use, injury patterns and object of collision. Frequencies and proportions were reported. Haddon matrix was constructed to present factors contributing to the fatal injury at the scene of accident before and after the accident.

Besides/stack bar plots were used to graphically show the patterns of injury among motorcycle decedents who died at the scene of the accident and at KNH. Chi square tests of association were used to determine if there was an association between the decedents' characteristic (helmet use, disposition of occupant, length of hospital stay and pattern of injury). Chi-square statistics and corresponding p-values were reported.

Stratified analysis were used to check and control for confounding factors like age or gender.

4: STUDY RESULTS

4.1 Age and gender distribution

Over the study period of fifteen (15) months there was a total of 76 fatal cases, a total of 72 post-mortems were conducted on the decedents who met the eligibility criteria. Of the 4 cases not recruited 3 were of Islamic religion, next of kin declined post-mortems be conducted, and for the fourth, consent was declined, to be recruited in the study. Fifteen (15) decedents were from NCM and the remaining fifty seven 57 from KNH. Their age ranged between 16 and 37 years with a median of 30 years (IQR=24-33) for decedents at NRM, and between 17 and 88 years with a median of 30 years (IQR=25-43) for decedents at KNH.

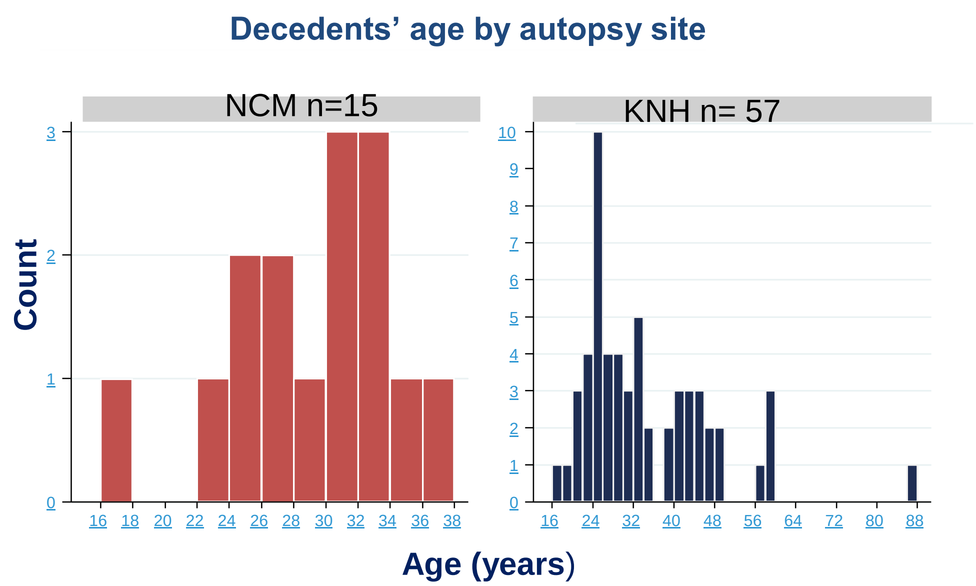


Figure 2: Distribution of decedent's age by autopsy site

Most female decedents were more than 40 years 4/6 (66.6%), compared to males majority of whom were < 30 years, 35/57 (61.4%).

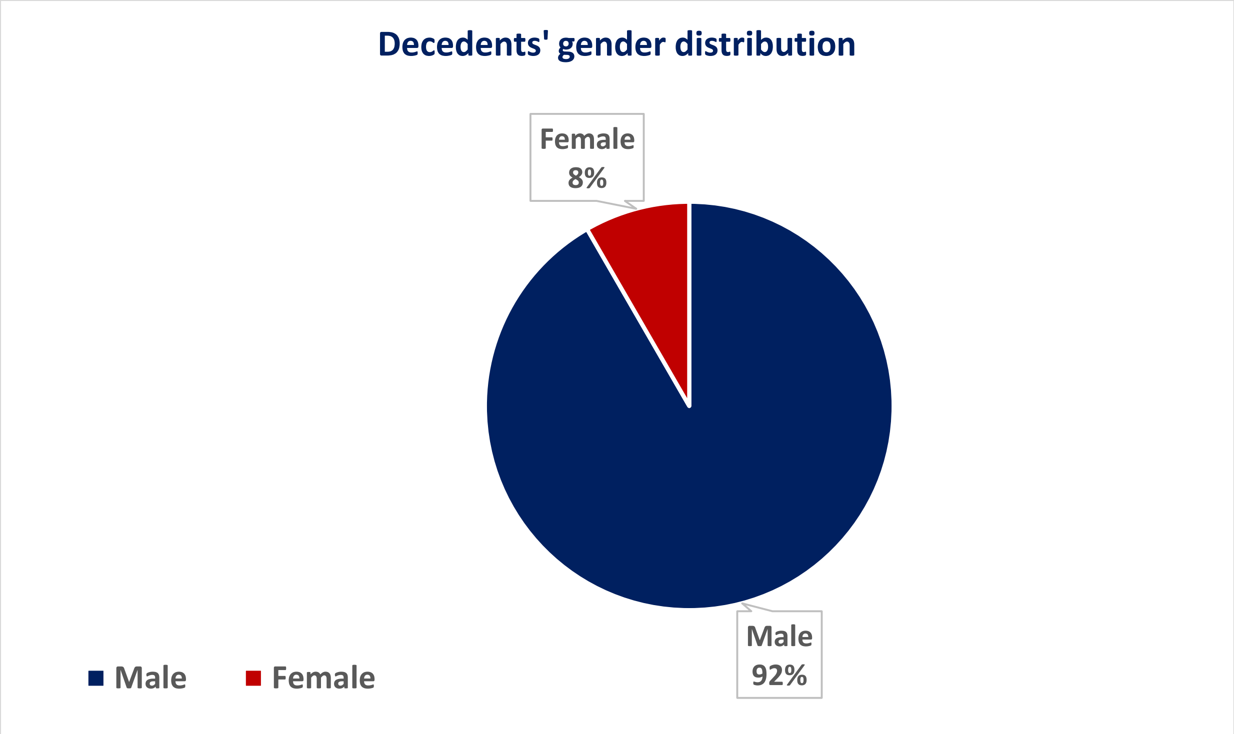


Figure 3: Pie chart showing distribution of gender.

Riders accounted for the majority of fatalities 51 (70.8%) while pillions were 21 (29.2%). All the riders were male.

4.2 Haddon matrix

Riders were the larger group, accounting for 51/72 (70.8%) all of whom were male, while pillion riders were 21/72 (29.2%).

In most incidents either the rider was alone 34/72 (47.2%) or at most carrying one pillion rider 33/72 (45.8%).

Frontal and rear – end impacts were the commonest, accounting for 60/72 (83.3%).

Saloon cars accounted for most of the collision objects 27/72 (37.5%), while buses which accounted for 7/72 (9.7%) and had 100% mortality within 24 hours, accidents due to road bumps, road barriers, potholes and tyre bursts accounted for a good number of deaths that occurred after 168 hours of hospital stay.

Helmet use was noted in 19/72 (26.4%), riders being the most 16/19 (84.2%) as compared to 17% pillion riders.

Table 2 below summarizes the findings described above, in both NCM and KNH mortuaries.

Table 2: History of the accident by Group

Group		NCM Count (%)	KNH Count (%)
Victim's disposition	Pillion	3 (20.0)	18 (31.6)
	Rider	12 (80.0)	39 (68.4)
Number of occupants	1	8 (53.3)	26 (45.6)
	2	6 (40.0)	27 (47.4)
	3	1 (6.7)	4 (7.0)
Collision	Frontal	5 (33.3)	28 (49.1)
	Rear-end	7 (46.7)	20 (35.1)
	Side-impact	3 (20.0)	1 (1.8)
	None	-	8 (14.0)
Collision object	Bus	2 (13.3)	5 (8.8)
	Matatu	2 (13.3)	6 (10.5)
	Motorcycle	1 (6.7)	8 (14.0)
	Salon car	4 (26.7)	23 (40.4)
	Truck/Lorry	4 (26.7)	6 (10.5)
	Pothole	-	1 (1.8)
	Road bump	-	3 (5.3)
	Tyre burst	-	2 (3.5)
	Road barrier	2 (13.3)	2 (3.5)
	Rock	-	1 (1.8)
Helmet worn	Yes	6 (40.0)	13 (22.8)
	No	6 (40.0)	29 (50.9)
	Unknown	3 (20.0)	15 (26.3)

Majority of accidents occurred on tarmacked roads 65/72. Major highways with the most incidents included Mombasa road 10/72, Thika road 9/72 and Kiambu road 5/72.

A comparison between urban versus rural incidents could not be made because the study areas already gave a bias for urban majority.

Motorcycle incidents mostly occurred in the afternoons and evenings accounting for 69% when combined and wee hours of the morning accounted for 24%, as shown in **Figure 4.**

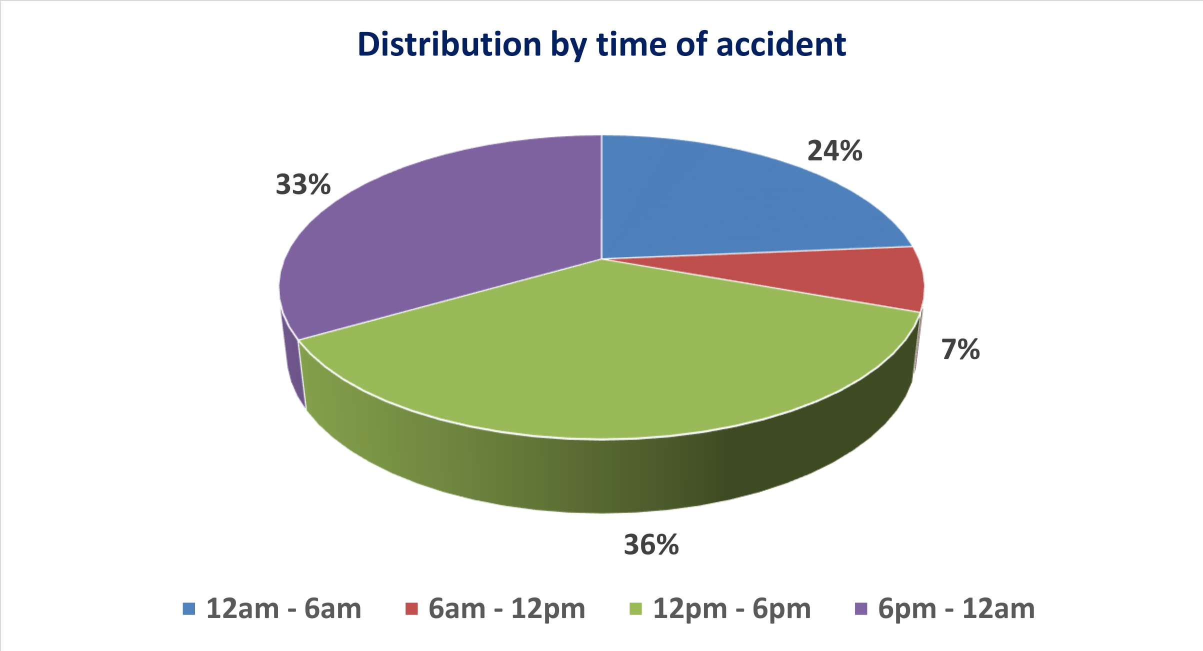


Figure 4: Distribution by timing of accident

Distribution by day of occurrence showed, incidents were more common on Saturday, Sunday and Monday cumulatively contributing to 40/72 (55.6%) of cases, as shown in the column graph below, **Figure 5.**

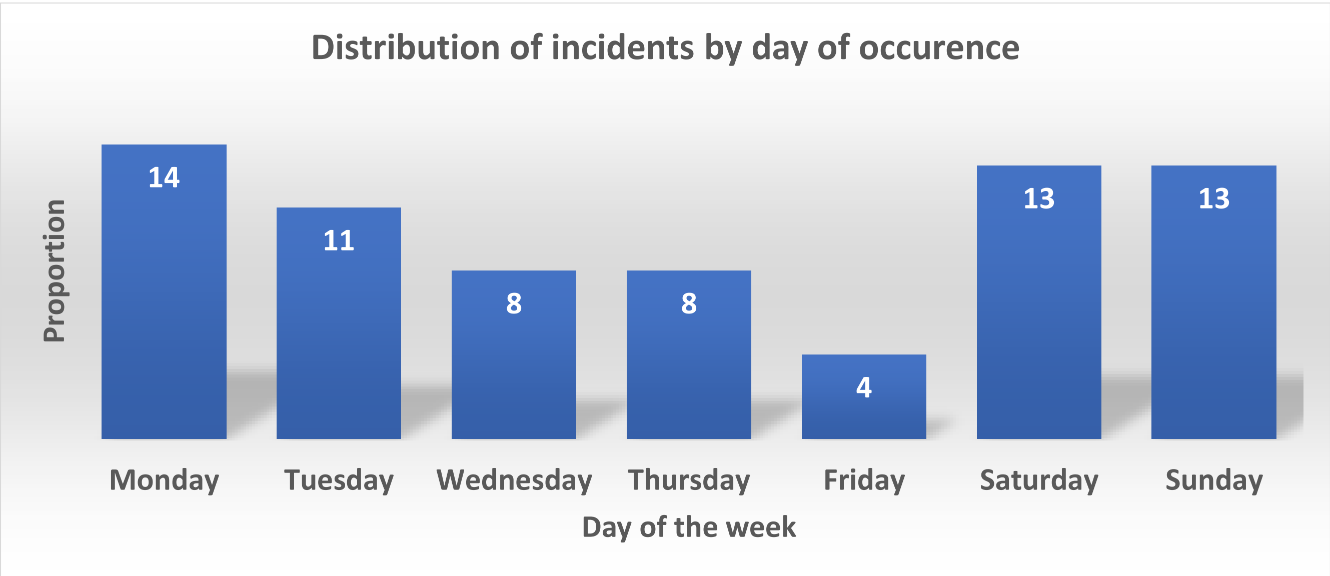


Figure 5: Distribution of incidents by day of occurrence

Of the 57 decedents who survived the impact, 95% had imaging done to assess extent of injury majority being done for X-rays and 27/57 had CT scans all of which were head CTs. IVFs, antibiotics, analgesics were also administered in 45/57 of those who reached hospital.

Surgical interventions done were Craniotomies 6/57, Skull traction 6/57, Skeletal traction 4/57, ORIF 1/57, Chest tube drain 1/57. Other surgical procedures documented were surgical toilet, suturing of lacerations and limb immobilisation.

Among the accident victims that were taken to KNH for treatment, the duration of hospital stay ranged from 1 hour to as long as 28 days with half surviving for less than 72 hours (median). The box plot below shows the distribution of the victims' duration of hospital stay before dying.

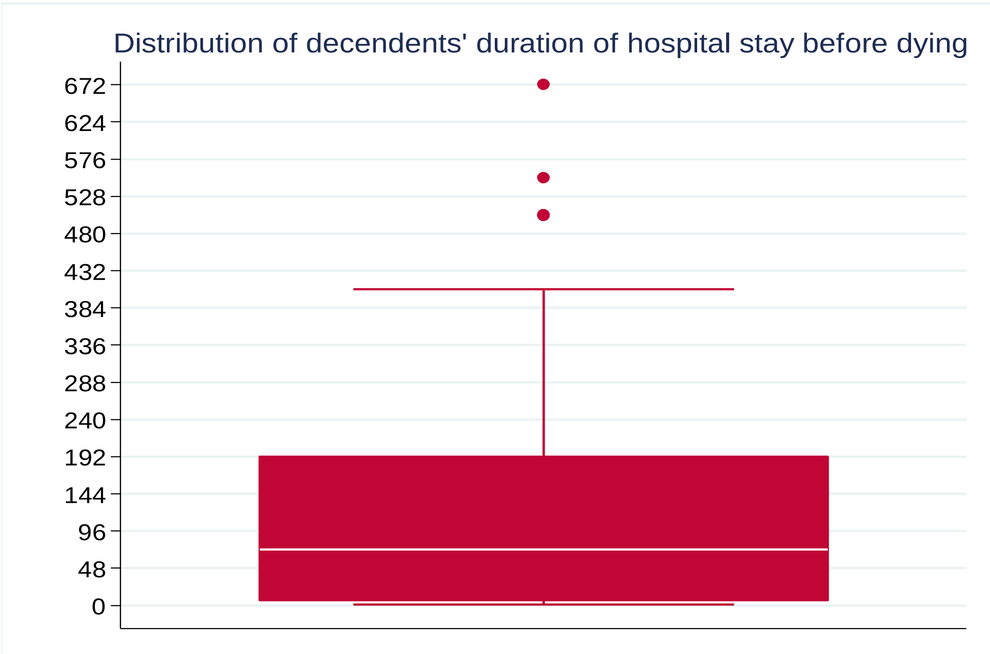


Figure 6: Duration in hours of hospital stay among victims who died in KNH

4.3 Patterns of injury

Injuries sustained were assessed by body regions and each scored using the AIS and ISS calculated based on the body regions with the highest AIS scores.

Table 3: Distribution and types of injuries sustained

Injury sustained	Frequency n= (%)
Head and facial injuries n=62	
Abrasions	45 (72.6 %)
Lacerations	16 (25.8 %)
Subgaleal	23 (37.1 %)
Skull fractures	
Linear	14 (22.6 %) (53.8 %)
Depressed	3 (4.8 %)
BOSF	9 (14.5 %)
Mandibular fractures	3 (4.8 %)
EDH	6 (9.7 %) (8.3 %)
SDH	37 (59.7 %) (51.4 %)
SAH	29 (46.8 %) (40.3 %)
Cerebral contusions	15 (24.2 %)
Cerebellar haemorrhage	1 (1.6 %)
Cerebellar contusions	2 (3.2 %)
Neck injuries n = 18	
Cervical vertebrae fractures	13 (55.6 %)
Carotid sheath haematomas	3 (16.7 %)
Pharynx contusion	1 (5.6 %)
Neck muscles haematomas	4 (22.2 %)
Chest injuries n = 17	
Abrasions	4 (23.5 %)
Rib fractures	12 (66.7 %)
Clavicular fractures	1 (5.9 %)
Lung contusion	7 (41.2 %)
Haemothorax	11 (64.7 %)
Abdominal injuries n = 12	
Abrasions	8 (66.7 %)

Lacerations	4 (33.3 %)
Liver lacerations	3 (25 %)
Liver haematoma	1 (8.3 %)
Splenic rapture	2 (16.7 %)
Duodenal perforation	1 (8.3 %)
Ileal perforation	1 (8.3 %)
Haemoperitoneum	5 (41.7 %)
Abdominal aorta laceration	2 (16.7 %)
Renal contusion	1 (8.3 %)
Bladder contusion	1 (8.3 %)
Axial skeletal injuries n = 29	
UL abrasions	29 (100 %)
LL abrasions	26 (89.7 %)
UL lacerations	4 (13.8 %)
LL lacerations	5 (17.2 %)
Pelvic fractures	6 (20.7 %)
Humerus fractures	7 (24.1 %)
Femur fractures	15 (51.7 %)
Hip dislocation	1 (3.4 %)
TF fractures	10 (34.5 %)
RU fractures	3 (10.3 %)

Some decedents sustained more than one injury and in some more than one system was involved, hence the total number of injuries outnumber the number of decedents.

Of the 72 decedents, 31 had sustained injuries in a single site; 28/31 had head injuries only, 2/31 had lower limb injury and 1/31 had a spinal injury. 41/72 had multiple injuries. Out of the 41 decedents with multiple injuries, 14 had head and neck injuries among other injuries.

Accidents victims who died before reaching hospital had severe head injuries ranging from scale AIS 3 and AIS 6 with AIS 5 being the majority. Among those who died within 24 hours at KNH, AIS 4 head injuries were the most common. For victims that died between day 2 (25 hours) and day 7 (168 hours) head injury ranged from mild AIS 1 to severe form AIS 5 with most having AIS 4 injury.

Notably, among the victims with head injuries and died after one week stay in hospital, majority (8/11) had AIS 5 injuries. A majority of the victims with spine injuries died either within 24 hours in hospital or after one week. **Table 4.**

Table 4: Distribution of accident victims by site of injury and duration of time before dying

Injury site	Never admitted Count (%)	24 hours Count (%)	25-168 hours Count (%)	>168 hours Count (%)
Head (n=62)	13 (21.0)	23 (37.1)	14 (22.6)	12 (19.4)
Spine (n=1)	1(100)	-	-	-
Upper limb (n=6)	-	5 (83.3)	-	1 (16.7)
Lower limb (n=16)	4 (25.0)	5 (31.3)	4 (25.0)	3 (18.7)
Abdomen (n=12)	3 (25.0)	8 (66.7)	-	1(8.3)
Thorax (n=17)	6 (35.3)	7 (41.2)	3 (17.6)	1 (5.9)
Neck (n=18)	1 (5.6)	7 (38.9)	4 (22.2)	6 (33.3)

Among the accident victims who die before reaching hospital, thoracic, abdominal, lower limb and head were the most commonly reported injuries. Among the victims that reached hospital, those with abdominal and upper limb injuries had higher risk of dying within 24 hours compared to the rest. Victims with neck and spinal injuries tended to survive longer in the hospital for more than one week, as shown in **Figure 7.**

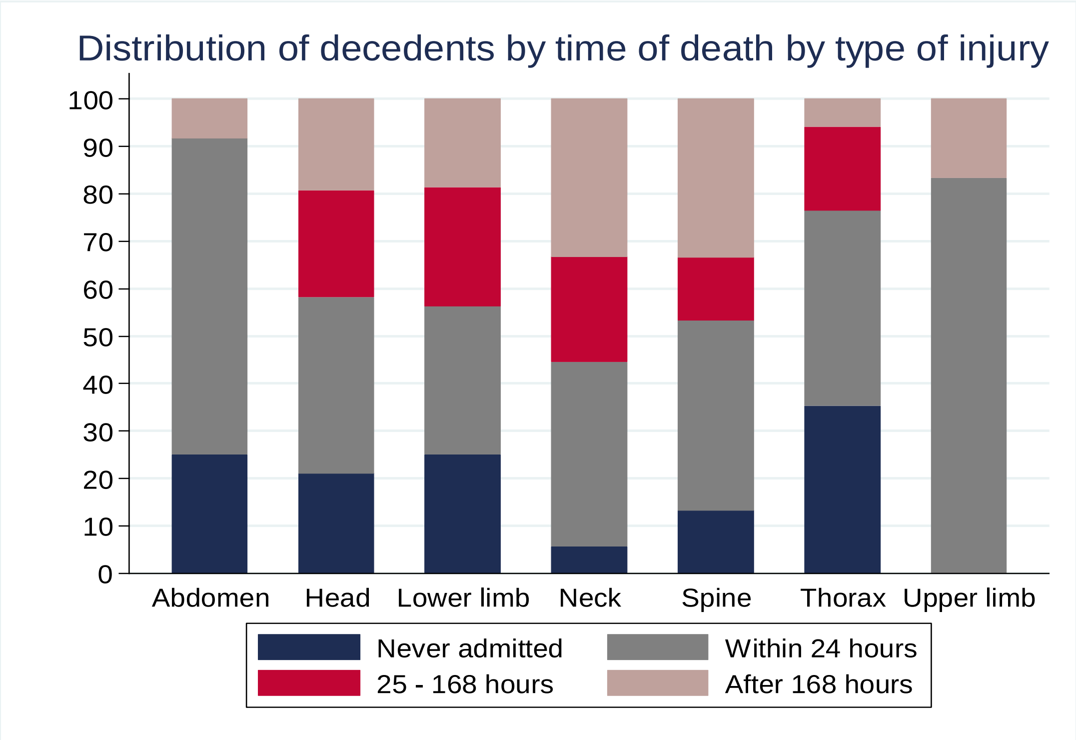


Figure 7: Type of injury by duration of survival period

The ISS ranged from 6 – 75 with a mean of 27.3 and median of 27. Spearman Rank sum test was done to evaluate the correlation between ISS and age in years, There was no statistically significant relationship between the ISS and age (Rho=-0.148; p-value=0.443) **Figure 8**. Majority of the decedents had an ISS score of > 24, 40/72, of the 5 with ISS of > 50, object of collision in 3/5 were saloon cars and all were frontal collision impacts. Two decedents with ISS of 75 were due to crush injury to the head and the other suffered traumatic LL amputation.

Table 5: Distribution of ISS severity

Severity score groups	Frequency	Percentage	Cumulative %
Mild (0 - 24)	**27**	**37.5 %**	**37.5%**
Mod (25 – 49)	**40**	**55.6 %**	**93.1%**
Severe (50 - 75)	**5**	**6.9 %**	**100 %**
TOTAL	**72**	**100 %**	**100%**

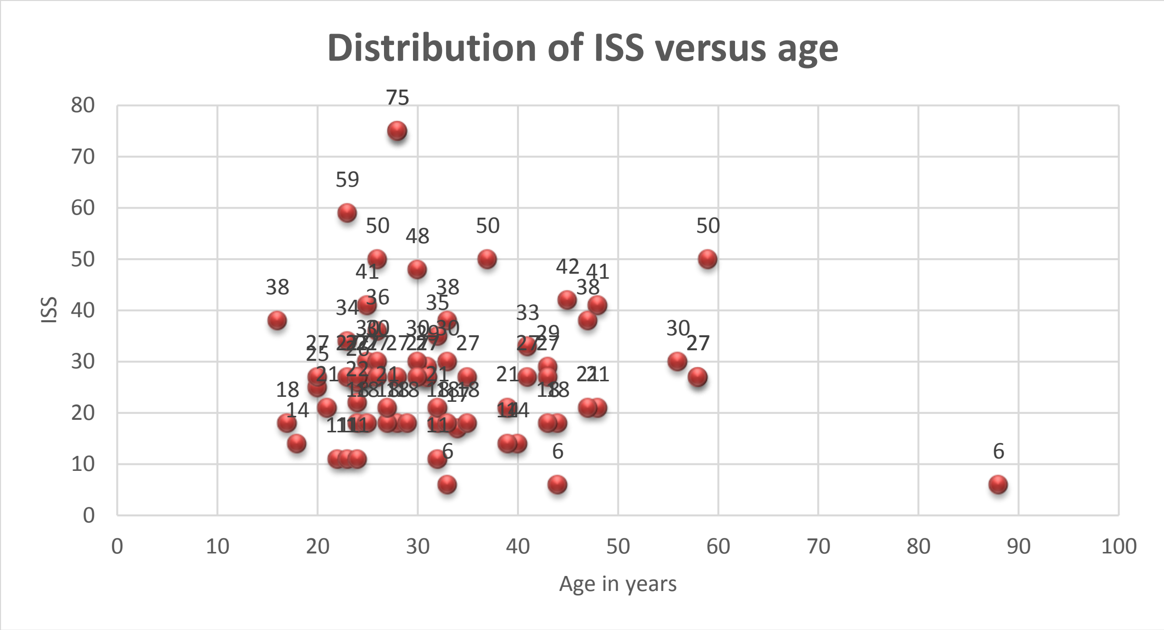


Figure 8: Distribution of ISS versus age of decedent

Head, facial and neck injuries

Head injury was the commonest 62/72, distribution of injuries varied from minor abrasions and lacerations to cerebral lacerations. Abrasions (72.6 %) and intracerebral haemorrhages (54 %) accounted for the majority of head and facial injuries. Of the intracerebral haemorrhages SDH was the commonest at (59.7 %) with 12/62 of decedents having more than one type of haemorrhage. Only 26/62 (41.9 %) of decedents with intracerebral haemorrhage had an associated skull fracture. Lacerations were noted mostly on the forehead and zygomatic areas and 13/16 were decedents who wore helmets, could be due to cut wounds from the glass/plastic facial shields on helmets shuttered during impact. Three (3) decedents had comminuted mandibular fractures, they were all helmeted. There was one crush injury to the head.

Secondary brain injury, suppurative meningitis was seen in 2/62 decedents who at autopsy had linear ACF fractures not picked during management, of note they both came in as referrals from peripheral facilities, managed and discharged home.

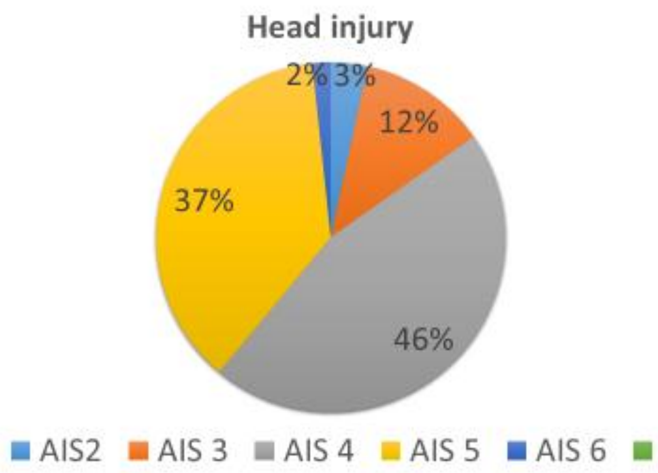
Neck injuries accounted for 18/72 (25 %) of injuries, majority sustaining cervical vertebrae fractures 13/72, of whom 2/13 had more than one vertebral fracture and both had helmets on. C5 and C6 fractures were the commonest at 7/13 and 5/13 respectively. Fractures varied from vertebral body compression fractures to transverse processes and spinous process fractures and cervical spondylolisthesis was noted in 2/13 all of whom had more than one vertebral fracture and died within 24 hours.

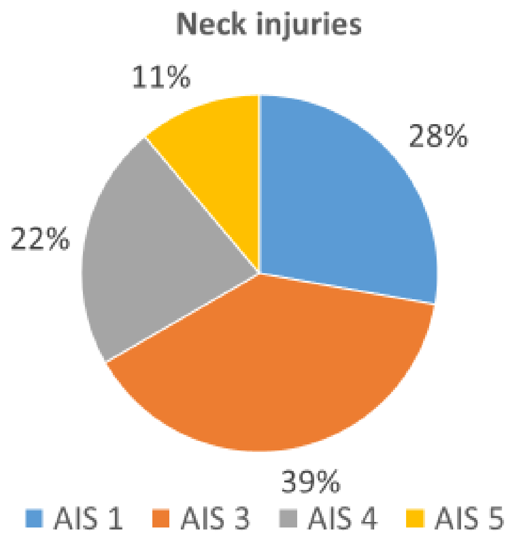
Haematomas of the neck muscles were seen in the Platysma 3/18, SCM 2/18, scalene 3/18 and strap muscles 3/18 prevertebral fascia 7/18 all of which were associated with cervical vertebrae fractures and trapezius 2/18. Other injuries were CS haematomas 2/18 and pharynx contusions 2/18.

Table 6: Severity of the Head, Spine and Neck injuries

Injury Site	Severity	Never admitted Count	24 hours Count	25-168 hours Count	>168 hours Count
Head	AIS 1	-	-	2	-
	AIS 2	-	-	1	1
	AIS 3	2	4	1	-
	AIS 4	3	16	6	2
	AIS 5	7	3	4	8
	AIS 6	1	-	-	-
Spine	C3	-	1	-	
	C4	-	-	-	2
	C5	1	-	2	2
	C5 & C6	-	1	-	-
	C6	-	2	-	1
	C5,C6,C7	1	-	-	-
	T12	-	1	-	-
Neck	0		1	-	1
	1	3	1	2	-
	3	-	1	1	5
	4	-	2	1	-
	5	-	2	-	-

Distribution of the AIS severity of head and neck summarized in the pie charts below.





Accidents victims who died before reaching hospital had severe head injuries ranging from scale AIS 3 and AIS 6 with AIS 5 being the majority. Among those who died within 24 hours at KNH, AIS 4 head injuries were the most common. For victims that died between day 2 (25 hours) and day 7 (168 hours) head injury ranged from mild AIS 1 to severe form AIS 5 with most having AIS 4 injury whereas for victims that died after day 7, most had AIS 5 head injury. Notably, among the victims with head injuries and died after one week stay in hospital, majority

(8/11) had had scale AIS 5 injuries. A majority of the victims with spine injuries died either within 24 hours in hospital or after one week, as summarized in **Table 7**

Axial skeletal injuries

Second most common injuries, accounted for 30/72 (38.9 %), LL fractures 14/30, 8/14 of which were compound fractures, 6 decedents had more than one fracture and 3 had bilateral fractures. One hip dislocation and one traumatic LL amputation. Femur fractures were 9/14.

UL fractures were 6, all involving the humerus, one of which was compound, 2 decedents had an associated compound RU fracture. Pelvic fractures accounted for 8/30, 5/8 involved the pubic rami, 2/8 involved the ilium and one open book fracture. 5/8 of the decedents with pelvic fractures were riders.

Chest injuries

Accounted for 17/72 (23.6 %) of injuries. Fractured ribs were seen in all 17 decedents, 15 of whom had more than one rib fracture and 5 had bilateral fractures, followed by Haemothorax 11/17, contusions in 7/17, with 1 lung collapse. Secondary complications were pneumonia in 2/17 decedents who both had fracture femur and were on skeletal traction while 1/17 admitted in ICU had a PTE.

Abdominal injuries

Constituted 12/72 (16.7 %) of injuries, liver injuries accounted for majority, 3/12 had lacerations, 4/12 had sub capsular haematomas. 5/12 had haemoperitoneum, 2/12 had perforations 1 in the stomach and 1 in the ileum. Splenic rupture was seen in one decedent, abdominal aorta lacerations in one decedent and contusion of kidneys and bladder noted in 2 and 4 respectively. External abdominal wall abrasions accounted for 66.7% of the abdominal injuries.

Associations

Chi-square test of association/ Fishers exact tests were done to check for factors (**Table 5**) associated with site of death (outside or within hospital). There was no significant association between wearing a helmet, gender of the victim, being the rider or passenger, and type of injury with dying before reaching hospital or after (P-value>0.05).

Table 8: Association between victim characteristics and site of death (outside / in hospital)

Variable	Pearson chi2	P-value
Helmet worn	1.809	0.405
Gender	0.069	0.793
Disposition	0.771	0.380
Head injury	0.005	0.944
Spine injury	0.452	0.502
Upper limb	1.723	0.189
Lower limb	0.217	0.642
Abdomen	0.152	0.697
Thorax	2.821	0.093

5.0: DISCUSSION

Fatal MCIs have been on the rise in Kenya with the increase in motorcycle purchase especially for commercial use. In Kenya there has been a steep increase in the number of fatalities, from 152 in 2008 to 704 in 2017, as per NTSA reports, indicating more than fourfold increase. This are alarming figures considering popularity in use of motorcycles due to their convenience is on an upward trend.

Age distribution showed a greater number of decedents were within the economically productive age group of 15 to 49 years, consistent with findings from other studies (4) (28) (29). This is of concern as it translates to a high economic burden from the household to the national level keeping in mind that majority of the decedents were male, who are considered bread winners in most homes.

The main objective of this study was to describe the injury patterns in fatal MCIs. Major injuries in the fatal cases in descending order were, head and neck injuries, axial skeletal, chest and abdominal injuries. Two decedents had crash injuries, 1 to the head and the other on the leg. These findings however do not show a difference in the injuries sustained by either the rider or pillion and also no variation in age versus injuries were noted, this could be due to the fact that the object of collision was the determining factor of severity of injury. Generally there seemed to be no difference in the severity of injuries between the riders and the pillion riders which was in agreement with Michael Fitzharris' study (10).

In this study head injury was shown to be the leading cause of death, which is in agreement with other studies done in LMIC countries within and without Africa, Saidi et al study in Kenya (2), Chalya P L et al in Tanzania (30) and B. A. Solagberu et al in Nigeria (31), and Sarkar S et al in USA (32) . Head injury was either the sole cause of death or contributor in case of multiple injuries, in agreement with findings by Roszalina Ramli et al (33). In the current study an AIS of 5 was the most frequent among decedents with head injury in both helmeted and non-helmeted decedents most of whom had intracerebral haemorrhage, as also documented by Vira Kasantikul et al in Thailand (34), though in his case this was in the non-helmeted group. The reason for this discrepancy could be that, either the helmet used by the decedents in this study was of low quality or the helmet fell off the decedent's head on impact. Intracranial haemorrhage, skull fractures, cerebral contusions and lacerations were the commonest injuries seen, similar to Vira Kasantikul et al (13) , Ankarath et al (26) and Ramli et al (33). Secondary brain infections were seen in three decedents, one post craniotomy, and two who had linear fractures in the base of the ACF, noted at autopsy but were not documented in the clinical notes. Of note though, all the decedents came to KNH as referrals post initial management elsewhere.

Cervical spine injuries were the predominant injuries sustained on the neck followed by haematomas in the neck muscles and CS. Of the cervical injuries C5 and C6 were the commonest. C1 and C2 sublaxation were the majority in J Ouellet et al (35), though C3 to C7 was more in the helmeted riders, similar to the finding in this study. Two decedents had more than 1 cervical vertebral fracture, in both cases involving C5 and 6 and both were in the helmeted group. The injury mechanisms though could not be deduced from the information collected in this study. Unlike the findings by Vira Kanstikul (13), who found CS haematomas to be the commonest occult injuries, in this study neck haematomas and pharyngeal contusions accounted for the majority of soft tissue injuries, similarly in both studies there was no documentation of these injuries in the clinical notes.

Helmet use by motorcycle occupants was poor, more so the pillion riders as compared to riders, as observed in other studies, Saidi et al 50% of riders and 20% of pillion riders (2) , Peter Conrad et al 89% of riders and 20% of pillion riders (22). This could be due to the fact that majority of the commercial motorcycles have only one helmet, which in most cases is worn by the rider. Comparative studies in West Africa though, BA Solagberu et al (31) and M A Nzwegu (29) both conducted in Nigeria, showed helmet use in MI fatalities was at 0%. Information surrounding the state of the helmet during impact whether it stayed on or came off, a small proportion of decedents who had helmets and unavailable information on helmet use in some decedents in the current study made it difficult to correlate head injuries to helmet use. Helmet use in some studies have proved a reduction in head and neck AIS severity and better outcomes clinically (36) (37).

Axial skeletal injuries were the second most common injuries. Long bone fractures especially the femur similar to Ankarath et al (26), were seen in decedents with multiple injuries and was the main injury in three decedents, two of whom had pneumonia as cause of death and one had massive exsanguination, resulting in death. Of note was the two were in the ward on skeletal traction for a period of at least 1 week. Immobility and lying in supine position for prolonged periods could have been a contributing factor in both cases.

Chest injuries and abdominal injuries were associated with highest mortalities within 24 hours a contributing factor to this could be majority of decedents with these injuries were due to collisions with larger vehicles mostly matatus, buses or trucks. Of those with chest injury > 60% were involved in side impact collisions. Age distribution for these injuries in this study was across board, seen in both the young and old. This differs from the findings by Patricia Dischinger et al study (11) which showed that majority of chest injuries were in persons older than 40 years and in non-collision incidents. The severity of the injuries noted in this study in comparison to the object of collision therefore shows that ISS is dependent on other factors other than age and engine capacity as was the case in Dischinger's study which showed that larger engines and older age was associated with lower ISS scores.

In this study frontal and rear collisions accounted for majority of MCI leading to fatalities, with saloon cars being the commonest object of collision, in agreement with Abdul Manan et al (39) and Nunn S et al (40), this could be due to the fact that saloon cars are the predominant MV on our roads. In the high income countries though road barriers are contributing to an increasing rate of fatal MCI (41) Buses and trucks on the other hand were associated with the higher critical ISS >25 and with fatalities within 24 hours. This differs from the statistics noted in Asian LMIC studies which show that side impacts were the majority as most accidents were at road junctions (39) and motorcycle to motorcycle collisions accounted for the highest proportions, owing to the fact that in countries like India, Cambodia and Thailand, motorcycles and three wheeled MV account for > 70% of motorisation. Of note is in most studies the MCI occurred in rural areas (40) (42) (43), this study though has a bias as it was conducted in facilities within the city and therefore a comparison could not be made in this case. Carlos Carrasco et al (44) study in an urban centre in Brazil showed that majority of MCI occurred on highways as was the case in this study. Decedents in non-collision incidents had lower ISS scores and survived for > 168 hours.

The MCIs occurred mostly on Saturday, Sunday and early Monday with timings mostly in the evening or wee hours of the morning as also noted by Muhammad Marizwan et al (39), Samuel Nunn et al (40) and Michael Fitzharris (10). There usually is less traffic during weekend evenings and early mornings and this may be a possible pointer to speed being a factor in the MCI occurring most frequent during these periods.

Head and neck injuries were the commonest cause of death whether solely or contributing to multiple injuries in the decedents, in agreement with Vira Kasantikul et al (13), (29), (45). An average AIS >3 for head and neck injuries may have been observed due to the low helmet use and even questionable quality among those who had helmets on. Abdominal injuries and chest injuries were associated with higher mortality risks as the decedents with these injuries succumbed within 24 hours (10) (9) (38).

In this study more than50% of the decedents had a critical ISS of > 25, indicating expected poor outcomes and protracted duration of morbidity if at all they survived, emphasizing the economic burden associated with MCI on medical costs and lost productive life years, as the age group most affected are 15 – 49 years.

Conclusion

Head and neck injuries were the most frequent and severe injuries sustained, combined with abdominal and chest injuries accounted for majority of fatalities within 24 hours. Majority of the decedents had severe head and neck injuries between AIS 4 and AIS 5. Helmet use was very low and even when worn protection from head injury was minimal. Frontal and rear impacts were the commonest considering that most MCIs occurred on major highways with Mombasa road, Thika road and Kiambu road recording the larger proportions. Majority of the incidents occurred over the weekend and mostly in the evenings or wee hours of the night. Saloon cars were the commonest collision objects while buses, matatus and trucks were associated with higher ISS scores, abdominal and thoracic injuries and fatalities within 24 hours.

Motorcycle fatalities are indeed detrimental to the society, economically, physically and socially. This study is but a tip of the iceberg in understanding the complexities surrounding MCI fatalities. Injuries sustained owing to the fact that the occupants are the shells of these vehicles and upon impact their bodies are on the receiving end of the energies transmitted, emphasize utmost need to employ preventive measures. Crash prevention is therefore more efficient than management of injuries.

Limitations

Lack of radiological equipment in the KNH and NC mortuaries may have contributed to missed fractures for example facial bones and small bones of the hands and feet.

Underlying confounding factors such as comorbidities, alcohol and drug intoxication.

Undocumented findings in decedent’s medical records and inadequate details on police narrations surrounding the MCI circumstances, hence no significant correlations could be made on autopsy findings.

Recommendations

1. Diagnostic modalities that are able to better identify soft tissue injuries, especially to the neck which is often omitted in trauma cases unless overt, like Magnetic resonance imaging especially in patients with head injuries should be considered.
2. Considerations into implementation of helmet laws to help reduce severity of head injuries and consequently reduce mortalities associated with head injuries.
3. A wider study population and study area, to involve a multidisciplinary team, including trauma centres, traffic police, government chemists and engineers could be considered with focus on the Haddon matrix to give a better understanding as to the risks associated with motorcycle incidents, with the aim of establishing preventive strategies.
4. Dissemination of the information gathered from this study to the Traffic police, surgical department and National Transport Safety Authority with the hope of providing strategies to avert these accidents and also prompt and appropriate management in the unfortunate case of an incident.

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APPENDICES

Appendix I: Data Collection Tool

POLICE FILE NO: TAG NO:

DATE OF ACC: TIME OF ACC:

AUTOPSY NO: DATE OF DEATH:

STUDY NO:

AGE:

SEX:

VICTIM'S DISPOSITION
- i) Motorcyclist
- ii) Pillion rider
- iii) Pedestrian

PPE USE

Rider	i) Helmet	Yes	No
	ii) Reflector jacket	Yes	No
Pillion rider	i) Helmet	Yes	No

NUMBER OF OCCUPANTS
- i) Rider only
- ii) Rider and 1 pillion rider
- iii) Rider and more than 1 pillion rider

COLLISION/ IMPACT
- i) Frontal collision
- ii) Rear collision

OBJECT OF COLLISION i) Salon car

ii) Truck

iii) Bus

iv) Matatu

v) Motorcycle

vi) Road Barrier

TYPE OF ROAD i) Highway (specify)

ii) Tarmac road

iii) Murram road

MEDICAL INTERVENTION Yes (specify)

Duration of hospital stay

i) Within 24 hours
ii) 1 – 7 days
iii) More than 1 week

Appendix II: Standardized Forensic Autopsy Protocol

1. Identification of the decedent by relatives indicated on form 23A or/and the IO of the case. Autopsy as expected by will be performed during the day under natural sunlight.

2. Length of the decedent will then be taken and recorded. A detailed examination of the external appearance including decedents clothing, hygiene status, post-mortem changes, nutrition and in this case injuries and any medical intervention where applicable, will be documented in writing, sketches and photographs. External injuries; abrasions, lacerations, will be described in detail and localized using two anatomical landmarks as reference points and dimensions taken.

3. Internal examination to identify and weigh organs and give a detailed description of injuries will be performed using the following procedure;

    a. A wooden block will be placed under the decedent's shoulders to allow for adequate exposure of the neck.

    b. Using a sharp blade a 'Y' shaped incision will be made extending from the shoulders just below the acromion processes and meeting at xiphisternum, then extending downwards to the pubis symphysis, diverting on either side of the umbilicus. The skin flap over the anterior chest wall is then dissected open exposing the rib cage.
    c. Using a pair of scissors the skin is opened up from the xiphoid process extending downwards taking caution not to puncture or lacerate viscera. The omentum is examined and location of the organs confirmed, any obvious injuries, haemoperitoneum at this point will be documented.
    d. The sternum and part of the anterior ribs after examining to check for any fractures are then removed, by cutting through the sternoclavicular and along the costochondral junctions, exposing the thorax. Haemothorax if present is documented and amount measured. Features of fibrosis or adhesions of pleura to chest wall will be documented.
    e. The Letulle method will be applied for evisceration.

Anterior Cervical Dissection

f. The body is placed in a supine position and the head and neck tested for hypermobility of flexion, extension and rotation.

The skin flap from the transverse incision across the acromion processes to and clavicles, were reflected superiorly to the level of the mandible. This will expose the sternocleidomastoid muscles, signs of haemorrhage or any tears will be documented.

They were then be detached from their inferior attachments exposing the inferior part of the carotid sheaths any signs of haemorrhage, lacerations, haematoma and compression of its contents; carotid artery, internal jugular vein and vagus nerve was documented and assigned an AIS code to assess the severity.

The carotid sheath was displaced laterally, exposing the hyoid bone, thyroid and cricoid cartilages, pharynx, larynx, trachea and oesophagus was examined for signs of fractures, abrasions, haemorrhage and haematomas.

The trachea and oesophagus were then be retracted to visualize the root of the neck for brachial plexus and stellate ganglion trauma.

Examine the parotid and submandibular areas. Examine the anterior, lateral, and posterior walls of the pharynx, larynx, trachea, and oesophagus. Section the trachea and oesophagus at the level of the suprasternal notch of the sternum or at the level of the seventh cervical vertebra.

Examine their interiors as they are turned upward. Identify the carotid tubercle (C6) and examine the vertebral vessels as they pass from the subclavian artery and vein into the costotransverse foramen of C6.

Examine the longus coli muscles and the anterior longitudinal ligament, and the bodies and discs of the cervical vertebrae. The prevertebral fascia can now be examined for sub fascial haemorrhage possibly involving the underlying phrenic nerve and sympathetic trunk on the scalene anterior muscle.

The roots and trunks of the upper portion of the brachial plexus were examined.

The posterior triangle, bounded by the sternomastoid and trapezius muscles and the clavicles were examined. Condition of the cervical vertebral were examined at the base of the skull after removal of the cervical viscera.

The tongue, pharynx, larynx, trachea, and oesophagus can now be removed by detaching these structures from the mandible and the base of the skull for more thorough examination of their interior and exterior. The jugular veins and carotid arteries should be left intact if possible to facilitate subsequent embalming of the head and neck. Examine the remainder of the anterior surface of the cervical vertebral column to the base of the skull. The sympathetic trunk and the superior cervical sympathetic ganglion can be seen at this stage.

Posterior cervical dissection

g. The body was then turned to prone position and a wooden block placed across the chest to flex the neck anteriorly exposing posterior structures. A midline incision will be made extending from the occipital protuberance extending to the spine of C7.

   The skin and superficial fascia are reflected laterally to expose the trapezius muscles. Reflect the trapezius muscles laterally to expose the splenius capitus and cervicis muscles. Reflect these muscles to expose the semispinalis capitis and cervicis. Turn the semispinalis muscles laterally and examine the short rotators, cervical spinous processes and sub occipital muscles in the sub occipital triangle. Remove the short lateral rotators and examine the ligaments and soft tissues for lacerations, tears, haemorrhage, and so forth.

   The laminae and spines should be examined for fractures, and so forth. Extend the removal of the short rotators laterally beyond the articular processes to examine the facets and nerve roots. Reflect the sub occipital muscles and examine the atlanto-occipital and atlanto-axial articulations. The ligaments should be carefully examined for tears and haemorrhage indicative of hyperflexion.

   Clean the lateral processes of the atlas and examine the vertebral vessels as they pass along the upper margin of the lateral processes of the atlas. The laminectomy cut should be done bilaterally, approximately 1½ cm lateral to the base of the cervical spinous processes and extend from the base of the skull through the lamina of the seventh cervical vertebra.

Free the posterior part of the atlanto-occipital capsule or ligament from its attachment to the foramen magnum and turn the laminae and spines caudally to uncover the cervical spinal canal. Examine the dura for tears and the epidural and subdural spaces for haemorrhage and hematoma, spinal cord injury or compression, and so forth.

Transect the spinal cord at the level of C7 and the cervical nerve roots bilaterally at their intervertebral exits from the cervical spinal canal.

Carefully cut the dura from its attachment at the foramen magnum to completely free the cervical spinal cord for later removal with the brain as a single unit.

Expose and cut the cervical nerve roots in order to reflect the cervical spinal cord and dura cranially to expose the posterior longitudinal ligamentum flavum, tectorial membrane, and the bodies and intervertebral discs of the cervical vertebral column.

Scalp, Skull and interior of cranium

Reflect the scalp, remove the calvarium, and observe the interior of the cranial cavity, brain, and so forth. Examine the surface of the brain for lacerations, contusions, and evidence of subarachnoid haemorrhage.

Cut any remaining attachments of the dura mater to the margin of the foramen magnum, the petrous, and tympanic portions of the temporal bones and carefully evaluate the brain, removing it posteriorly. Removal of the brain and cervical spinal cord as a unit and reflection of the dura from the anterior, middle, and posterior cranial fossa.

Appendix III: Police Form 23A

POLICE 23A

THE KENYA POLICE

(*Section* 386 *C.P.C.*)

POST-MORTEM FORM

Reference No. .... POLICE STATION ....

TO: THE PATHOLOGIST/MEDICAL OFFICER

....

I have to request that you ascertain the cause of the death of ....

whose body is sent herewith under escort of..

The undermentioned witnesses are able to identify the body to you:—

(1) .... (2) ....

The body was found at (Place) .... on (Date) .... at (Time) ....

Date and Time of Death (if known) ....

The circumstances of the death are as follows:—

(If natural causes is probable, give also a brief medical history, including the name and address of any medical officer consulted.)

Note.—If death from poisoning is suspected, the officer requesting the examination should also give the following details (*see also page 4*).

(*a*) Date and time of onset and duration of symptoms ....

(*b*) Main symptoms. Please put a tick against any of the following symptoms that apply:—

Diarrhoea	Constipation	Shivering	Delirium
Vomiting	Cyanosis	Convulsions	Sweating
Thirst	Jaundice	Eye pupil dilated	Unconciousness
Blindness	Loss of weight	Eye pupil contracted	Internal pains/cramp
Any Odour of Breath	Fever		

(*c*) Details of food, drink or drugs taken before and after onset of symptoms including times and quantities of any medicine given whilst under treatment ....

....

(*d*) Were other persons affected ....

(*e*) Suspect poison, or class of poison ....

Signature .... Date ....

Report of Pathologist/Medical Officer

Address ....

....

Reference No. ....

To: Officer in Charge,

.... Police Station,

Date ....

....

Reference Body of ....

Place of Post-Mortem ....

Date and Time of Post-Mortem ....

General Observations on Body—

Clothing:

Sex:

Race:

Apparent Age:

Nutrition:

Physique:

Height.

Post-Mortem Changes and Assessment of Time of Death-

External Appearance of Body (give details of condition, presence or absence of petechiae, cyanosis, etc., and position, nature and dimensions of all external injuries).

Internal Appearance of Body

(1) Respiratory System:

(2) Cardio-Vascular System:

(3) Digestive System:

(4) Genito-Urinary System:

(5) Head:

(6) Nervous System:

(7) Spinal Column:

(8) Spinal Cord:

As a result of my examination, I formed the opinion that the cause of death was ....

....

....

....

Death Certificate No. ....

The following specimens have been removed for further examination (*see* notes for guidance on page 4).

Signed ....

Designation ....

Appendix IV: Data Entry Form

Patterns of injury

Anatomical site	**Injury noted If yes (√) No(-)**	**Injury description (As per key)**	**AIS score**	**Square of top three injuries**
Head				
Face				
Neck				
Thorax				
Abdomen				
Spine				
Upper limb				
Lower limb				
Pelvis				

Medical intervention (specify) –

Surgical intervention (specify) _

Injury description key

A Abrasions

Am Amputation

B Bruises

Bu Burn

C Contusion

(specify)

E Evisceration

F Fracture

H Haemorrhage

L Laceration

V Visceral injury

Severity of neck injuries

Anatomical structure	**Injury noted If Yes (√) No (-)**	**Injury description As per Key**	**AIS**
Carotid sheath			
Anterior and posterior vertebral arteries (specify)			
Neck muscles (specify)			
Brachial plexus trunk (L/R)			
Pharynx			
Atlanto-axial			
Cervical vertebrae (specify)			
Total AIS score			

<u>Injury description key</u>

C Contusion

F Fracture

H Haemorrhage/ Haematoma

L Laceration

R Rupture

S Sub laxation

CAUSE OF DEATH

Appendix V: Consent Form

Introduction

My name is Dr. Adera Oigo. I am a postgraduate student in the Department of Human Pathology at the University of Nairobi. I am conducting this study to determine the patterns of injury in fatal motorcycle road traffic incidents and determinants of fatalities at KNH mortuary and Nairobi City mortuary.

You as the next of kin of the deceased are invited to participate in this study. In case you do not understand any words used in this information sheet and have any questions, please ask me to stop and explain.

Type of Research intervention

This study involves the analysis of injuries sustained by decedents of motorcycle incidents. The severity of the injuries will be objectively assessed by calculating severity scores.

Participant selection

Decedents of fatal motorcycle incidents will be recruited for the study.

Voluntary participation

Your participation in this research is entirely voluntary and it is your choice whether to participate or not. Whether you choose to participate or not, all the services you and the decedent receive will not change.

Procedures and protocol

Next of kin of eligible deceased participants will be asked to join the study. All will then be requested to sign a consent form. You will then be asked some questions which will be recorded in a questionnaire.

Harmful effects

There are no harmful effects in this study.

Risks

There will be no risks expected with this study.

Benefits

The study will be able to assess severity of injuries and possible determinants of fatalities.

Reimbursements

You will not be given any money or gifts to take part in this research.

Confidentiality

All participants will be identified using a number. All information shared by you during this study will be viewed by the researchers only.

Sharing the results

The results obtained during this study will be shared with you. We will publish the results in order that other interested people may learn from it. However your identity and that of the decedent will never be revealed.

Request to participate in the study

Kindly indicate whether you are interested in joining this study. If you are willing to join the study I kindly request you to fill the consent certificate provided.

Right to refuse

Should you decline to participate in this study, this will not affect services offered to you or the deceased in any way. You will still have all the benefits that you would have had otherwise.

Who to contact

If you have any questions regarding this study at any time you may contact the principal investigator: DR. ADERA OIGO (0722310356) or any of my supervisors below:

Supervisors

1. Prof. Rogena E.A: P.O. BOX 19676-00202, Nairobi. Tel +254721674647
2. Dr. Okemwa M.P: P.O. BOX 19676-00202, Nairobi. Tel +254722790678
3. Dr. Ndiangui F.M: P.O. BOX 19676-00202, Nairobi. Tel +254722883040

You can also contact the Ethics and Research Committee at Kenyatta National Hospital (KNH/UON-ERC): P. O. BOX 20723-00202, Nairobi. Telephone +254 020 726300-9

Certificate of Consent

I have read the foregoing information, or it has been read to me. I have the opportunity to raise any questions about my participation and that of the deceased in the study, and any questions I asked have been answered to my satisfaction. My rights have been explained to me and I consent voluntarily to participate in this study.

Print Name of Participant:

Signature of Participant:

Date:

If illiterate;

A literate witness must sign (if possible, this person should be selected by the participant and should have no connection to the research team). Participants who are illiterate should use their thumbprint in place of a signature.

Print Name of Witness:

Signature of Witness:

Date:

Thumbprint of Participant:

Fomu ya Idhini Kichwa cha Utafiti

Jina langu ni Daktari Adera Oigo mwanafunzi wa chuo kikuu cha Nairobi idara ya Human Pathology. Ningependa kufanya utafitiambayo nitawaelezea. Tafadhali soma ujumbe ufuatao kwa makini. Ujumbe huu utaelezwa kwa lugha ya Kingereza na Kiswahili. Uko na uhuru wa kuchagua lugha ambayo utaelewa vyema.

Maelezo kwa ufupi:

Utafiti unahusu upasuaji wa watu waliofariki kutokana na ajali za pikipiki. Ili kuchambua majeraha waliopata.

Faida na tatizo ya utafiti huu

Utafiti huu utatuezesha kuchambua sababu ya majeraha yanayo waadhiri wanaotumia pikipiki. Hakuna maadhara yoyote yatakayo tokea kutoka kwa utafiti huu.

Taratibu wa Kushiriki

Watakao shiriki katika utafiti huu itakuwa kwa hiari yao. Ukiamua kutoshiriki, hautapoteza kwa njia yeyote haki yako au ya marhemu ya kuhudumiwa unavyostahili. Majibu ya uchunguzi huu utapewa.

Idhini ya mshiriki

Watakaoshiriki katika utafiti huu itakuwa kwa hiari yao. Una uhuru wa kutoshiriki, kutojibu swali lolote kwenye dodoso au kukatiza kipindi cha maswali iwapo hautaridhika na jambo lolote.

Pia waweza kutamatisha ushirika wako kwenye utafiti huu bila kupoteza haki yako ya kushughulikiwa katika chumba cha kuhifadhi maiti.

Anwani

Mchunguzi, Dr. Adera Oigo, Chuo Kikuu Cha Nairobi, SLP 19676-00202 Nairobi

Nambari ya simu 0722310356

Pia unaweza kutafuta wasimamizi wafuatao:

Wasimamizi

1. Prof. Rogena E.A: SLP 19676-00202, Nairobi.

   Nambari ya simu +254721674647

2. Dr. Okemwa M.P: SLP 19676- 00202, Nairobi.
   Nambari ya simu +254722790678

3. Dr. Ndiangui F.M: SLP 20723-00202 Nairobi.
   Nambari ya simu +254722883040

<u>Idhini ya Mshiriki;</u>

Kama utashiriki tafadhali tia sahihi yako kwenye pengo lilioachwa hapa chini

Mimi………………………………………………………………………… nimesoma na nimeelewa nia ya utafiti huu, utaratibu utaotumika kuchukua kipimo, faida na madhara yanayo husika kwa utafiti huu. Nimekubali kushiriki kwa hiari yangu.

Sahihi ya Mshiriki……………………………… Tarehe…………………………………

Sahihi ya Shahidi…………………………………. Tarehe…………………………………

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.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked bt 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 provide to the participant.

Print Name of Researcher/person taking the consent:……………………………………………

Signature of Researcher/person taking the consent……………………………………………

Date: ……………………………………………………………

Dissertation

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PRIMARY SOURCES

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