THE HEALTH BURDEN AND COST OF MOTORCYLE CRASH INJURIES PRESENTING TO TIER III HOSPITALS IN KISUMU CITY, KENYA

BY

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DECLARATION

This Research thesis is my original work and has not been presented for a degree in any other University or institution. No portion of this work should be reproduced without my permission or of the university.

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This Research thesis is acceptable in quality and form and therefore submitted for examination with our approval as supervisors.

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DEDICATION

To God for his grace and power that has made me what I am.

To my wonderful and loving family; My wife Violet Khaveri, My chidren Dunamis, Koinonio and Betzaleel

ABSTRACT

Globally, there are more than 1.35 and 50 million road traffic fatalities and injuries repectively that occur each year, of which 28% are motorcyclists deaths. About 3000 die due to road traffic fatalities, with estimated loss of US$4 billion annually in Kenya. The growth of motorcycles usage for public transport in Kenya has resulted in corresponding surge in fatalities in the last 15 years. Motorcycle related fatalities increased from 6% in 2005 to 36.6%, in 2021. There is no national data on non-fatal motorcycle injuries. In Kisumu City, motorcycle fatalities increased by 51.2% between the year 2010 and 2016. To date, there is no study specifically focusing on health burden and cost of motorcycle crash injury cases in Kisumu City. Understanding the burden of motorcycle crash injuries can serve as a reference point for resource allocation and priority setting and ensure that motor vehicle crashes are ranked equitably in terms of safety investment. This study assessed the health burden and cost of motorcycle crash injury cases presenting to Tier III hospitals in Kisumu City for a period of six months (May, 6th 2019-November 6th 2019). These hospitals are: Jaramogi Oginga Teaching and Referral hospital, Kisumu county hospital, and Agha-khan University hospital. Specific objectives were to: determine the pattern of motorcycle injuries presenting to the hospitals; to determine the burden imposed on the health care services by motorcycle injuries; to quantify the cost incurred by the motorcycle injury patients, and; and to determine factors influencing the cost of motorcycle injuries. This was prospective study using both quantitative and qualitative strategies involving total population sampling technique which enrolled all 1073 motorcycle injury patients that presented to the hospitals. Inferential statistics including; Analysis of Variance was used to test for mean length of stay, and and associated factors. Multivariate logistic regression was used to assess factors influencing cost of injuries. Data were presented in tables, graphs, and charts. A total of 1073 motorcycle injured patients representing 50.3% of all the road traffic crash injuries, out of which 73.6% were males (M: F ratio= 2.8:1). The average age was 29.6 years (±standard deviation [SD] 12.19; range=2–84). Majority of crashes occurred during the day (79.1%), and week days (82%). Helmet non-use was 69.3% among motorcycle users. Head injuries and injuries to the limbs were overriding (63.8%). There were a remarkable proportion of deaths in both (70.5%) motorcycle rider and pillion passenger than other types of road users. Motorcycle crash injury cases represented 2.0%, 12.0%, and 13.6% of total emergency visits, total injuries, and total admissions to the hospitals, respectively. On average motorcycle injury cases were warded for 19.8 days± SD 8.23 and was the highest compared to other injuries. Surgery was required by 89.3% of those admitted. The total cost was Ksh. 158,236,383(US $ 1276099.9) with indirect cost representing 69.3%. The medical costs contributed 40% of direct costs. The mean value of preventing motorcycle injuries (VOSI) and fatalities (VOSL) was Kshs. 32,825,719,250 (US$ 26,472,354.23). Human factors like being Males (OR = 6.27, CI = 3.15-14.47; Married couples (OR = 4.571, CI = 1.60-13.06), alcohol use (OR = 4.67, CI = 1.55-8.51), helmet non use (OR = 6.964, CI = 3.32-14.86) being motorcycle rider (OR = 6.04, CI = 0.60-60.48.), influenced significantly the total cost and willingness to pay. In addition hospital factors like the principal diagnosis, head injuries (OR=7.470 CI=0.21.15.18); radiological investigation carried out (OR= 109.08 CI=4.001-2223.93) were more likely to pay higher costs than those who do not, hospital length of stay(OR= 109.017 CI=4.001-2223.93), craniotomy (OR=10.25; CI=-2.17—19.28) admission to intensive critical care unit (OR=2564.68 CI=503.61-13060.82); impacted significantly on the medical cost and willingness to pay for the reduction of road traffic fatalities. These findings confirmed substantial morbidity, mortality and cost of motorcycle injuries, comprehensively described the spectrum of the impact of crashes on motorcycle injured cases, health system, provide information to the body of literature on motorcycle transport and potentially will assist in policy decisions on road safety focusing on motorcycle use.

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LIST OF ABBREVIATIONS

AIS	:	Abbreviated Injury Score
DALYs	:	Disability Adjusted life years
DVLA	:	Drivers Vehicle and Licensing Authority
GNP	:	Gross National product
FGD	:	Focused Group Discussion
GRSP	:	Global Road Safety Partnership
HIC	:	High Income Country
ISS	:	Injury Severity Score
LIC	:	Low Income Country
ITDP	:	Institute for Transportation and Development Policy
MCA	:	Motorcycle Accident
NTSA	:	National Transport and Safety Authority
NRSC	:	National Road Safety Commission
OPD	:	Out Patient Department
QALYs	:	Quality Adjusted Life years
RTA	:	Road Traffic Accidents
RTC	:	Road Traffic Crashes
RTI	:	Road Traffic Injury
SPSS	:	Statistical Package for Social Scientists
TBI	:	Traumatic Brain Injury
UN	:	United Nations
VOSL		is an ‘anonymous indicator’ that is used to place a monetary value upon a change in the estimated number of fatalities in traffic over a certain period of time under given circumstances. In fact a value is put on risk, and this risk is multiplied by traffic or travel volumes
WHO	:	World Health Organization

OPERATIONAL DEFINITION OF TERMS

Base **:** Assembly points where riders congregate to wait for passengers.

Burden **:** is the impact of a health problem as measured by financial cost, mortality, morbidity, disability and Disability Adjusted Life Years(DALYS).

Health burden: for the purpose of the study it referred to the i. incidences of injuries consisting the pattern of injury occurrence such as nature of injuries by person, place and time, injury severity, and mortalities. ii. health care service utilization that captured information on hospital bed days, bed occupancy, total units of blood used, intensive care unit (ICU), length of stay (LOS), days on a ventilator, number of procedures during hospital stay, number of laboratory tests carried out, radiological investigations, laboratory tests, treatment procedures, were gathered to establish the burden imposed by motorcycle injuries on health service

Casualties : Person killed or injured in crash.

Cost This is the economic value of damages or *losses* due to *crashes*

In the interest of this study, costs consisted of both direct costs and indirect cost

Direct costs were cost that were incurred due to the crash

Indirect costs were costs not directly linked to the crash for instance, lost output, cost incurred by the family or relatives of the victims;

Medical cost were the sum of money paid for treatment of injuries from the time of the crash to the time of discharge, or for deaths. In this study medical costs comprised the cost of first aid, transport to hospital, cost of investigation and treatment, hospitalization, rehabilitation.

Loss of productivity: also known as lost output was described as the amount of working time lost for the casualties when dead and was considered as the time they spent into future if they do not die multiplied with the income of casualty, it involves quantifying economic value to work because of motorcycle crash injury. This is estimated by tracing records on the duration that the victims are hospitalized or given medical leave of absence from work. It also refers to the contribution that crash victims have forgone due to injury or death. In the case of an injured victim, the economic loss is measured in terms of the loss in productivity throughout the period of incapacity.

Injury: damage or harm: an act or event that causes someone or something to no longer be fully healthy or in good condition. An injury is caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance

Injury Severity Score: (ISS) is scoring system that provides an overall score for patients with multiple injuries and was ascertained by the attending doctor based on clinical diagnosis (Baker et al., 1974; Baker and O& Apos; Neill, 1976);(Committee on Medical Aspects of Automotive Safety, 1971).

Motorcycle: is a two wheeled motor vehicle similar to a bicycle (but motorized) and bigger in size.

Motorcycle crash: a fatal or non-fatal injury caused by collisions involving at least one moving motorcycle

Pattern: refers to the distribution of health events (injuries and fatalities) in this case motorcycle injury in terms of place, time and persons characteristics (Porta et al., 2014).

Pillion passenger: refers to motorcycle passengers

Road users:are all individuals or parties who use road for transport and include; the pedestrians, motorcyclists, cyclists, cart pullers, passengers and drivers.

Safety: it is a condition of freedom from injury, risk or danger. For this study safety means, non-involvement in *boda boda* motorcycle crashes.

Tier III hospitals: County health system with comprehensive in patient, diagnostic, medical, surgical and rehabilitative care facilities, includes all Level 4 and Level 5 hospitals (KHPF, 2014).

VOSL: Is an ‘anonymous indicator’ that is used to place a monetary value upon a change in the estimated number of fatalities in traffic over a certain period of time under given circumstances. In fact a value is put on risk, and this risk is multiplied by traffic or travel volumes

Willingness to Pay (WTP): is an approach used to quantify the amount of money that individual or a whole society is willing to pay for a reduction of risk and result s in the derivation of value of a statistical life (VOSL).

Non English words

Boda boda: refers to a motorcycle used for transporting passengers and goods at a fee. The term originated from the English word ‘border to border’ *Boda boda* (originally, bicycle taxi) mainly provide passenger taxi services.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

This Chapter describes the study background, problem statement and justification for the study. It also states the objectives of the study, research questions, and the scope and significance of the study.

1.2 Study Background

Every year, road traffic crash injuries result in over 1.36 million deaths and nearly 50 million non fatal injuries that result in hospital visits globally, making them the eighth and the principal source of death among people of all ages and young adults respectively (WHO, 2018). In 2015, road traffic crash injuries were the nineth principal source of the burden of disease; it is projected that they will be the fourth prime source of Disabilty Adjusted Life Years (DALYs) by 2030 (Kassebaum et al., 2016). The burden of road traffic crash injuries are endured inordinately by underdeveloped countries with nearly 85% and 90% of deaths and DALYs lost respectively (WHO, 2018). The World Health Organization reported that road traffic fatality rate in Low-Income Countries is three times higher than in High Income Countries (HICs)(WHO, 2018). Sub-Saharan Africa has road traffic death rate of 26 fatalities in every 100,000 population which is three times greater compared to Europe (9.3 deaths per 100,000 populations) (WHO, 2018). The rate of fatalities is even higher at 34.4 per 100000 persons in Kenya (Ehebrecht, Heinrichs, & Lenz, 2018). Road traffic injuries is approximated to cost between 1.3% to 5.0% of gross domestic product (GDP) annually (Wesson, Boikhutso, Bachani, Hofman, & Hyder, 2014); (Ross Silcock, 2003); WHO., 2018). In 2010, road traffic injuries represented 76 million DALYS worldwide of which 12% were from motorcyclists' in the Sub Saharan Africa.

Globally, vulnerable road users comprise 54% of all road deaths consisting of pedestrians (23%), bicyclists (3%), and 28% occur among motorcyclists, (Lin & Kraus, 2009); (WHO, 2018). In the World Health Organization Africa region, motorcycle related deaths comprise 7-16% of all road traffic fatalities (WHO, 2017). Motorcycle riders and their passengers, during a crash, endure and absorb high energy impact occasioned by the collision; consequently, sustain injuries to the head and brain, extremities, spine and making them more susceptible and vulnerable to severe injuries, hospitalization and fatalities (Marín-Léon et al., 2012; Hsieh et al., 2017). The intensity of injury is determined by human, agent and environmental factors that interact during the pre-crash, crash, and post-crash phases to produce various pattern of injuries. Unfortunately, skimpy researches have delved into the patterns and types of injuries sustained in many developing countries. Moreover, there is poorly developed post-crash and pre hospital emergency systems which are known to increase the severity of injuries (Wankie et al., 2020). Consequently, hardly any crash victims receive care at the scene in many Sub Saharan Countries (WHO, 2016).

Motorcycle injuries strains health care system, demanding additional use of health resources and escalated degree of care (Jackson, 2009). Furthermore, public health systems are not adequately equipped to meet the additional motorcycle trauma care needs and face major gaps in coordinated emergency response (Isaakidis et al., 2002). Traditionally, public health resources have been more prioritized towards health system development for communicable diseases (Koka et al., 2018). The sequel of these injuries occasion enormous costs (Pincus et al., 2017).

The cost of motorcycle injuries is greatest per person per unit distance travelled compared to other road users (Miller et al., 2011). This is due to huge costs associated with deaths, disabilities, income loss, loss of bread winners and increased medical care (Liu et al, 2016). This makes them a crucial cohort of road users to focus on to curtail road traffic injuries (WHO., (2020). In many Least and

Middle Income Countries (LMCs), there is inadequate insurance and social protection schemes, leading to debts, catastrophic expenditure and poverty (Yamey et al., 2015). In addition, motorcycle crash victims suffer adverse social, physical, and psychological impacts resulting to significant reduction of quality of lives leading to high intangible costs.

The cost burden of motorcycle related injuries has been documented in High-Income Countries (HICs) (Papadakaki et al., 2017), (Rochette, Conner, & Smith, 2009); Christensen et al., 2008) and little researches previously carried out and reported from LMICs (Mashreky et al., 2010) and (Híjar, Arredondo, Carrillo, & Solórzano, 2004; Olukoga 2004; Allen Ingabire et al., 2015). The costs for motorcycle crashes range between $14 193 per injury in Rwanda and $ 12 845 in South Africa, and $178 634 per death in South Africa and $ 2160 000 in the US (Allen Ingabire et al., 2015; Parkinson 2014; Olukoga 2004; Blincoe et al., 2015). These studies have used different methods of costing that consolidate various cost elements to quantify cost of motorcycle crash injuries (Miller et al., 2011; Kudebong et al., 2015; Miller et al., 1994; Sapkota et al., 2016). The Gross output or human capital and willingness to pay are two commonly used methods in injury costing that quantify direct and in-direct costs and the amount of money that people wish to part with inorder to avoid fatalities or injuries respectively (Sebagalla et al., 2017). Human capital method involves quantifying the sum of various identifiable costs (WHO, 2018; ADB, 2003). On the other hand, willingness to pay approach quantifies the costs individuals wish to bear so as to reduce injury or fatality risk and thus provide information on the neccessity to develop an effectual intervention (Widyastuti, & Mulley, (2005a). Willingness to pay has been used to establish the strength of peoples' preferences on the safety measures. Studies that combine the two approaches are recommended.

Despite the associated high burden, 98% of these crashes and injuries are preventable (WHO 2018: Liu et al., 2008). Interventions to curtail these crashes include infrastructural and behavioural adjustments. However, the former are less enthralling due to insufficient funds; intervention that increase personal safety and adherence to relevant regulations, such as, helmet use, reflective clothing and reduction of use of alcohol while riding and driving are indispensable. In addition, effective prehospital care reduce sequelae, disabilities, and mortality from crashes. Regretably, there is poor helmet and protective clothing usage among motorcycle users and inadequate prehospital care system to provide emergency transportation and injury management in Kenya (Sisimwo and Onchiri, 2018).

In Kenya, about 3,000 people annually die from road traffic crashes with an estimated cost of Kshs. 14 billion (NTSA, 2013; KNBS, 2018). The use of motorcycle as mode of transport in the country increased 26-fold between 2004 and 2018 from 53,508 to 1,393,390, and with a 30% increase in deaths (NTSA, 2018). 1n 2021, 20625 people were injured in Kenyan roads, 34.2% were motorcycle crashes, 36.8% were passengers while pedestrians and drivers constituted 17.8% and 10.2% respectively (KNBS, 2022). The rise in motorcycle crash injuries has been attributed to excessive speeding, overloading for quick financial returns, riding under the influence of alcohol, poor quality of roads, and improper passing of other vehicles (Wankie et al., 2021). In addition, most motorcycle riders disregard traffic rules, lack appropriate riding competencies, and seldom wear helmets (Chalya et al., 2010; Singoro, Wakhungu, Obiri , 2016).

Despite the forgoing, many people prefer motorcycles as a mode of transport because they offer a fast means to get around in cities, towns, and rural areas; are efficient in navigating around traffic jam delays; and are available day and night (Chalya 2010). Previous studies on motorcycle injuries in Kenya have focused on prevalence of motorcycle injuries in Kakamega General Hospital (Khanbhai and Lutomia (2012), showed that motorcycle injuries constituted 51% of all the injuries; a study at Kitale General Hospital (Sisimwo, Mwaniki, & Bii, 2014) reported that motorcycle riders accounted for 39.4% of injury patients. Other studies which focused on factors influencing motorcycle injuries, characteristics and outcomes reported that; riders' age, being male, and daring riders influence crash injury occurrence. Riding experience has also been shown to affect motorcycle crash and outcomes (Sisimwo et al., 2014); Cholo and Olela (2016);(Matheka, Omar, Kipsaina, & Witte, 2015); (Saidi, Mutiso, & Ogengo, 2014); (Walter, 2018) but no studies have been published on cost, hospital burden and factors influencing cost of motorcycle injuries in Kenya.

Motorcycle crash injuries apply additional strain on the health care system, especially Tier III hospitals in Kenya, that is not adequately accoutered to provide the required health services (Macharia et al., 2009). The vast majority of motorcycle crashes result in injury to the rider or pillion passenger, and pedestrians with over 40% leading to emergency department treatment or hospitalization (Nesoba, 2010). Hospital injury data in Kenya on the burden of motorcycle crash injuries on hospital visits, trauma admissions, and surgical interventions are scanty (Saidi and Mutiso, 2013; Sisimwo , Mwaniki , and Bii, 2014). According to the traffic police, the motorcycle accidents in Kisumu have shown a rising trend. For instance, in 2017 the police in Kisumu reported that there were 52.7% increase in deaths of motorcycle injuries between 2010 and 2016 in Kisumu City (NTSA. 2017). Further, the proportion of motorcycle crash injuries is the second highest in the country ranging from 41% to 62% (Cholo et al., 2016; Walter, 2018; Nyachieo et al., 2015; Poehler, 2019; Bojana et al., 2022), yet, there are limited data on the cost and burden of motorcycle injuries on the public health system and associated factors.

Therefore, there was need for a comprehensive study that establishes the pattern, quantifies the burden on health system, and costs of motorcycle related injuries and the amount of money affected members of the society would pay to improve their safety. Various stakeholders including policy makers, and Government agencies need valid and reliable data on the pattern of injuries, cost burden and how much saving can be made by executing road safety improvements to combat the burden of motorcycle crashes. Further, computing the complete spectrum of impact of motorcycle injury, may prove beneficial for forging context decisions for motorcycle safety financing in Kisumu City and Kenya at large.

The purpose of this study was to assess health burden and cost of motorcycle crash injuries presenting to Tier III hospitals in Kisumu City. Tier III hospitals are health facilities with comprehensive in patient, diagnostic, medical, surgical and rehabilitative services which were formerly known as Levels 4 and 5 hospitals in the old system of classification of health facilities (Kenya Health Policy Framework 2014-2030). In this study, the hospitals classified in this category are Kisumu County Hospital, Agha-Khan Hospital and Jaramogi Oginga Odinga Teaching and Referral Hospital.

1.3 Statement of the Problem

More than 1.35 million people die each year on the world's roads, making road traffic injuries the leading cause of death among the young adults globally with the annual cost of US$1·8 trillion and $834 billion globally and in developing countries respectively (Wang et al., 2019;WHO, 2018; United Nations, 2008; Mathers and Lonchar, 2002). However, the financial burden that individuals, their families, employers, public health system and societies bear as a consequence of RTIs in under developed countries is underreported (WHO, 2018).

Virtually, a third of all global road traffic deaths are motorcycle related (WHO, 2018). Motorcycles are the most hazardous means of transport since they provide minimal protection. During a motorcycle crash, victims are subjected to various forms of injuries. The gravity of these injuries are affected by various factors that interplay at different phases of crash occassioning distinct injury patterns. Unfortunately, researches exploring into injury patterns and types in cities from developing countries are scanty. Moreover, despite evidence showing that riding motorcycle has higher risk than motor vehicle driving, there is minimal improvements on motorcycle user safety (NHTSA, 2016). Motorcyclists are more likely to be seriously injured in a crash than drivers or passengers of other motor vehicles (NTSA, 2016). A study by Daniel et al, (2017) indicated that each motorcycle crash causes 10 times more severe injuries, 34-fold higher risk of death and 6 times the medical costs of each automobile (Daniel et al, 2017; NHTSA, 2007; Solagrebu *et al.*, 2006; Lin and Krauss, 2009). According to Miller et al, (1999), motorcycles are the most hazardous highway vehicles because they are capable of high speeds but offer minimal occupant protection; they also have the highest crash costs per person per-mile (Miller et al, 1999). The cost of dealing with the consequences of these crashes runs to billions of dollars (WHO, 2013). In 2010, motorcycle crashes cost $12.9 billion in economic impacts, and $66 billion in societal harm as measured by comprehensive costs (Blincoe et al, 2015). Compared to other motor vehicle crashes, these costs are disproportionately caused by fatalities and serious injuries due to motorcycle crashes (Blincoe et al, 2015).

Motorcycle injuries strain a country's health system and health finances, necessitating the use of additional resources and increased levels of care. Previous studies from Brazil, Jamaica, Rwanda, Taiwan, and the United States reported that 65%, 73.6%, 50%, 31.6%, and 36% of motorcycle injury cases, respectively, were admitted to the hospital, of which 95%, 71.6%, 71.6%, 31.6%, and 36% required surgical interventions, respectively (Miki et al., 2014; Fletcher et al., 2019; Allen Ingabire et al., 2015; Liu et al, 2016). However, public health systems are not adequately equipped to meet the additional trauma care needs and face major gaps in coordinated emergency responses (Kihubi et al., 2014). Reliable estimates of motorcycle-related morbidity, hospitalization, severity, and fatalities, as well as their impact on the public health system, are essential for evidence-based policymaking, advocacy, and priority-setting for appropriate and effective interventions, resource mobilization, and future research. Unfortunately, health information systems are inadequate in many cities, in LMICs (Kihubi et al., 2014).

Cost estimation studies in Africa and other developing countries are scarce and the few available have used only human capital approach (Kudebong et al. 2011; Ingabaire, 2015). Other studies did not specify costing methods components(Saidi, 2013, Sangowawa et al., 2014 Agbor et al., 2015; Urua et al., 2017). There has been difficulty in quantifying cost of disability and quality of life downturn. Moreover, there is in-adequate data on costs associated with lost productivity (Urua et al., 2017). This leads to a great variation between the actual costs borne and the estimated or computed costs. Further, other studies have been restricted to single hospital records centres (NHTSA, 2016; NHTSA, 2003). Cost quantities computed using reviews from such records are incomplete and do not include other costs. This highlights the need for better understanding the true cost burden of motorcycle injuries so as to better address the problem.

In Kenya, the increased use of motorcycles for transport has led to increased morbidity, mortality, and disability. Motorcycles are the leading cause of RTI and deaths in Kenya at 34.7% and 37.2% respectively (KNBS, 2022). These injuries deploy weight on the public health system, yet little information exists on health care resource usage by motorcycle crash injury patients. Motorcycle crash related injuries exert additional pressure on the already strained Kenyan health system, which is poorly developed to dispense the required services (Macharia et al., 2009). However, there is lack of comprehensive national and County health surveillance system to collect, catalog and report motorcycle related crash injury data. Further, there is paucity of data on the degree of use of hospital services by motorcycle injury patients. This greatly curtails the validity of data and their use in designing context specific intervention strategies to reduce the repercussions associated to motorcycle crashes.

There is paucity of cost data in Kenya. The only available study in Kenya on costs of motorcycle injuries published in 2013 by Saidi and Mutiso, showed that cost of treatment was Kenya Shillings (Kshs) 31,783. However, this study did not give a complete view of cost components and magnitude of costs of motorcycle injuries since it only focused on the hospital charges, and did not specify method of costing. In Kisumu City, where the proportion of motorcycle crash injuries is the second highest in the country ranging from 41% to 62%, there are limited data on epidemiological pattern, burden imposed on the public health system by motorcycle injuries, cost of injuries and associated factors that would form data-driven and context specific safety planning, care, and intervention strategies. No published information exists on burden imposed on health services, and cost by different types of motorcycle crash injuries and severity levels in Kisumu City. Furthermore, no published information exists on factors influencing the total cost (direct, indirect) and willingness to pay of some money to support safety efforts in Kisumu city and Kenya. This research sought to determine the health burden of injuries involving motorcycles and the associated direct, and indirect costs, Value of Statistical Life (VOSL), value of statistical injury (VOSI) together with associated factors.

1.4 Study justification

The growing number of motorcycle related deaths and injuries pose a considerable challenge to health managers, policy makers, and traffic police departments. Little information is currently available on health burden and costs of motorcycle crashes in Kenya. A lack of studies means that the actual burden, cost and cost effectiveness of intervention measures are not elucidated. The few studies quantifying cost using the human capital approach have also not adequately addressed the total costs of motorcycle crash injuries. Policy makers, Government agencies and other stakeholders require accurate data and evidence on costs and the savings that can be made by executing road safety improvements to combat the burden of motorcycle crashes.

Motorcycle injury costs data may furnish an innovative monetary impulse to attenuate the threat of motorcycle crashes. Moreover, decisions on apportionment of scarce resources should be based on the predeliction and aspiration of those affected by the decision. The study provided information on the burden of motorcycle injuries on the hospitals and their implications in socio-economic terms and further provided information of their willingness to pay for identified prevention strategies and factors that influenced cost and willingness to pay for prevention. The anticipation is that these results will be used by decision makers and road safety practitioners to improve road safety intervention, allocations for motorcycle road safety and management of casualties in Kisumu City.

Also cost quantities per case of motorcycle crash and injury generated from the study can be used in economic evaluation such as cost benefit and cost effectiveness analyses. This is the primary step towards exploring the benefits of potential interventions aimed at preventing motorcycle crashes and injuries and ensuring that the most cost-effective intervention is applied in Kisumu City and other cities and Kenya at large.

Data on the pattern, burden on health system, and cost are crucial instruments to demonstrate the complete spectrum of the repucursions of motorcycle related crash injuries on individuals, societies and could aid in focused prevention exertions. Due to varrying nature of motorcycle related injuries and degree of severity that ranges from minor injuries to major injuries (e.g., polytrauma) that require different degree of management; it is imperative to make realize the burden and costs per injury category and severity in order to enable a judicious preference for both care and prevention, again, such data are required by hospitals, county governments, policy makers and advocates to take informed decisions on motorcycle road safety and injury prevention. Moreover, underlying factors influencing costs due to increased crash and injury severity should be determined in order to develop context specific prevention and intervention programs.

1.5 Study Objectives

1.5.1 General objectives

To assess the health burden and cost of motorcycle injuries in Tier III Hospitals in Kisumu City

1.5.2 Specific Objectives

1. To determine the pattern of motorcycle crash injuries in Tier III hospitals in Kisumu City
2. To determine the burden imposed on health services in Tier III hospitals by motorcycle injuries in Kisumu City
3. To quantify the cost incurred by motorcycle injury patients seeking care in Tier III Hospitals in Kisumu City
4. To identify factors influencing the cost of motorcycle injuries in Tier III Hospitals in Kisumu City

1.6 Research Questions

1. What are the patterns of motorcycle crash injuries in Tier III hospitals in Kisumu City?
2. What burden do motorcycle injuries impose on the health services in Tier III hospitals in Kisumu City?
3. What are the costs are associated with motorcycle related injuries in Tier III hospitals in Kisumu City?
4. What factors influence the cost of motorcycle related injuries in Tier III hospitals in Kisumu city?

1.7 Significance of the Study

Currently there is limited information on health and cost burden of motorcycle injuries. Previous studies on road traffic crashes involving motorcycles in Kenya have not focused on health burden and costs implication of motorcycle injuries. Cost quantities of motorcycle crash injuries will help Kisumu City realize the heavy economic losses being incurred. This will encourage them to invest in road safety improvements to reduce these losses.

This study adds knowledge by providing information on the burden of motorcycle injuries on health services and their associated costs, and contributes to the body of knowledge on motorcycle transport research.

It also provides policy makers, hospital management, planners, researchers and Government agencies in Kisumu City with important information for allocating appropriate investment to road safety. Since any decision made on scarce wealth should portray preferences of those individual citizens impacted by the decision. Results from cost studies are a practical instrument demonstrating the complete scope of repurcussions of motorcycle crash injuries and enable prioritization of crash deterrence endevours.

1.8 Study scope

This study was confined to assessing the pattern of motorcycle crash injuries, burden imposed on health services by motorcycle injuries, both direct and indirect costs of motorcycle injuries attended to in Tier III hospitals in Kisumu city during the study period. Further, the study quantified the sum of money the motorcycle injury patients were inclined to part with in order to lessen their risk of road fatality or severe injuries. The three hospitals in this Tier located in Kisumu City are; Kisumu County hospital (Level IV) and Jaramogi Oginga Odinga Teaching and Referral Hospital (Level V), Aga khan Hospital. The study population were motorcycle crash injury patients that obtained care in the named hospitals in Kisumu City, during a six-month period, from May 6, through to November 6, 2019.

It was achievable to determine the distribution of various motorcycle related injury types and characteristics of casualties, estimate their impact on health services, and the related factors. The study quantified cost of injuries using both human capital and willingness to pay methods. The Human capital method computed the indirect and direct costs. The direct cost constituted (i) Medical treatment cost (In-patient treatment cost, Out-patient treatment cost,), (ii) Property damage cost (i.e. repair/replacement cost, loss of valuables) (iii) Administration Cost; (iv) Funeral Cost and indirect cost comprising of lost productivity cost. The indirect cost comprised the loss of productivity cost and the DALYS. Willingness to pay approach was used to compute the Value of Statistical Life (VOSL) and Value of Statistical Injury (VOSI). Finally factors influencing cost of motorcycle crash injuries in Tier III hospitals were also assessed focusing on the human, health related and safety practices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive review of literature on motorcycle injuries. It starts with an analysis of literature on the pattern of motorcycle injuries globally, in Africa and Kenya, the burden of motorcycle injuries on health services, followed by a discussion on their social and economic costs and factors influencing the cost of motorcycle injuries. The chapter ends by presenting a conceptual framework for the study.

2.2 Pattern of motorcycle injuries

The pattern of motorcycle injuries are discussed focusing on the global,Africa, Kenya as well as the distribution by sex and age.

2.2.1 Global burden of motorcycle related injuries

Every year, crashes on roads occassion over 1.36 million fatalities and 20-50 million injuries that result in hospital visits globally (GBD 2019; WHO, 2018). World Health Organization reported that road traffic crashes constitute the eighth primary source of fatalities for people of all ages (GBD 2019; WHO, 2018). There is considerable variation in RTI mortality across the world's regions; with Africa and South-East Asia having the highest at 26.6 and 20.7 deaths per 100,000 populations respectively; followed by Eastern Mediterranean and Western Pacific regions, with 18 and 16.9 deaths per 100,000 populations respectively. The Americas and Europe have the lowest regional rates of 15.6 and 9.3 deaths per 100,000 populations respectively (WHO, 2018). The variation in RTI mortality rates observed across the regions correlates with differences in the types of road users affected. The demographic, economic, and urbanization differences may explain some of the variations in road traffic mortality data between regions (Wang et al., 2019).

More than 50% of all global traffic deaths occur among the bicyclists, motorcyclists and pedestrians. Bicyclists and pedestrians account for 24% while motorcyclists represent about a third of global road traffic deaths annually (GBD 2019; Araujo, Illanes, Chapman, & Rodrigues, 2017).

The global RTI burden is less quantified due to inadequate quality data emanating from under reporting noted from many countries (WHO, 2015; WHO, 2018). The burden of motorcycle related injuries and fatalities is distributed differently between emerging economies and the developed countries (WHO, 2018). For instance, in the high income countries, the proportion of motorcycle related deaths vary from 14% in Britain (Webb, 2018), 17% in Austria (WHO, 2018), 17.3% in China (Li, et al , 2018). In USA, motorcycle fatalities increased by 8.3% from 4,594 people in 2014 and 4,976 people in 2015 and in 2017, respectively, motorcycle related deaths represented 14% of the total road deaths (Webb, 2018). In the upper middle income countries, the proportion of motorcycle fatalities of the total road traffic fatalities account for 33%-56.1% in India, nearly a quarter (22.5%) in Brazil, (Chandran & Pérez-Núñez, 2012), 54% in Singapore (Leong, Shyen, Appasamy, & Chiu, 2009), 73% in Indonesia, (Santosa, Mahyuddin, and Sunoto 2017); 60% in Malaysia (Rahman, Baharuddin, & Mohamad, 2015); and 13.14% in Mexico (Berrones-Sanz, 2017). Another study reported that 41,881 motorcycle accidents in the Mexico, resulting in 34.98 per 100,000 population (Coria, 2020).

Motorcycle users have 35 times more odds of dying than car drivers and passengers in a crash (Webb, 2018). Further, motorcycles riders and pillion passengers are endangered and subjected to varrying road hazards compared to car users (Martin & Carter, 2017). In addition, motorcycle injuries are attributed to traffic disorientation, failure of road and documents inspection, poor maintenance of roads, reckless cycling and the impunity of riders, all significantly lead to accidents particularly for motorcycle operators (Owino, 2018). In addition to this, some studies have noted that motorcyclists often do not take precaution, increasing their crash susceptibility (Rahman et al., 2015; Salum, Kitali, Bwire, Sando, & Alluri, 2019).

2.2.2 Motorcycle fatality rate and injuries in Africa

Each year, African region has road fatality rates of 28.1 deaths per 100,000 population which is the highest globally, of these almost 30% are among motorcycle rider related deaths (WHO 2018). Motorcycle related fatalities occur varriedly throughout the globe. World Health Organization indicate that South-East Asian Region and Western Pacific Region each reperesent 34% of the motorcyclist fatalities while African Region represent 23% (WHO, 2018). Due to inadequate public transport and road infrastructure in many developing countries, motorcycles have been accepted as means of conveyance due to their flexibility, convenience and relatively affordability (Cholo, Menya, & Odero, 2015) (WHO, 2018) (Olumide & Owoaje, 2015) (Oxley et al., 2013) (Raynor, 2014) (Singoro, Wakhungu, & Obiri, 2016). Increased use of motorcycles for public transport is a major cause of injuries, fatalities and disabilities in LMICs among motorcyclists, pedestrians and passengers aged 15-49 years (Adeloye et al., 2016;Cebecauer & uboš Buzna, 2015; Kardamanidis, Martiniuk, Ivers, Stevenson, & Thistlethwaite, 2010; WHO, 2015;Mpirimbanyi et al., 2017). Motorcycle safety is therefore a huge public health problem in Africa.

In Mwanza City, Tanzania, 37.2% -53.4% of all traffic injuries are motorcycle related injury cases (Boniface, Museru, Kiloloma, & Munthali, 2016; Chalya et al., 2010). Another study in Nigeria by Udoh, Aghahowa, and Obeta (2018), reported that motorcycle injury accounted for 67% of road crash injury victims. In Cameroon, McGreevy et al. (2014), reported an incidence of 29%. Another study in Cameroon by Monteiro, Almeida, Bonfim, and Furtado (2020), however reported that motorcycle injuries accounted for 89.9% out of which 47.7% were as a result of collision between motorcycle and other vehicles. However other studies, by (Omoke, Lasebikan, Onyemaechi, & Ajali, 2019; Twagirayezu, et al., 2008), noted that the common form of mechanism of injury occurrence was between motorcycle and pedestrians which could have been due to absence of pedestrian walkways. A study by Kigera and Naddumba (2010), in Kampala, Uganda, found that MIs constitute 25% of all RTIs.

In Ghana, a study by Konlan et al. (2020), reported that motorcycle injuries represented 64% of all road traffic injuries and that 50% of the crashes were collisions involving motorcycles and other vehicles, motorcycle crashes involving animal collission accounted for 24.7%, and 6.8% were collision with other motorcyclists.

In Rwanda, Allen Ingabire et al., (2015) noted that 73.1% of all crash injuries are motorcycle related injuries of which approximately 96% were extremities fructures (Allen Ingabire et al., 2015). Motorcycle injury studies in Africa report that head injuries and musculoskeletal injuries are most common (Allen Ingabire et al., 2015); (Ehebrecht, Heinrichs, and Lenz, 2018); (Aidoo, Bawa, and Yirenkyi, 2018).

2.2.3 Motorcycle injuries and fatalities in Kenya

In Kenya, Road traffic crashes kill over 3,000 people annually with an estimated cost of 4 billion Kenya shillings (KNBS 2018, NTSA 2018; Onsomu, 2017). Road traffic death rate in Kenya is 34.4 per 100,000, approximately 1.4 times and 4 times higher than the WHO African Region and HICs (WHO, 2018). In Kenya, the exact emmensity and cost burden of RTI is undetermined. Road traffic injuries and deaths data are inaccurate due to underreporting, resulting in a huge variation between the National and WHO estimates (WHO 2018; WHO. 2014). For example, in 2016, road traffic deaths reported by World Health Organization was 4.5 times greater than the country's official police statistics (13463 versus 2,965, respectively) (WHO, 2018; NTSA, 2017). This could be due to the limited scope of definition of road traffic deaths by National Transport and Safety Authority (NTSA) and poor data systems. Further, according to Poehler, (2019), most fatalities cases and their causes are not accurately recorded and reported (Poehler, 2019). Hospital fatality estimates stratified by type of road user are unavailable. However, Kenya Bureau of Statistics, reported that in 2021, of the total 20,625 persons reported injured on Kenyan roads, 48.7% and 29.1% were slightly injured, and serious injuries while 22.2% died. Of these 34.2% and 37.6 % were due to motorcycle related injuries and deaths respectively (KNBS, 2022). Motorcycle crash deaths is a growing public health concern in Kenya because of increasing number of motorcycle crash deaths in recent years. For example, between the year 2005 and 2021, the reported motorcycle crash deaths, as a proportion of total reported road deaths, rose over sixfold in a period of just sixteen years, from 6% to 37.6% respectively (Cholo et al., 2023). The observed increase in the motorcycle crash deaths has accompanied correspondingly expanding use of motorcycle as a daily mode of transport in Kenya. For example, the proportion of motorcycle as mode of transport in the country has increased by 26 folds from 53,508, in 2004 to 1,393,390 in 2018 and has been accompanied by a 29.9% increase in deaths in this category of road users (Cholo et al., 2023; KNBS, 2022). Some of the factors that have been documented to contribute to motorcycle crash injuries include over-speeding, over-loading for quick returns, lack of respect for other road users, non-use of helmets and alcohol consumption (Bachani et al., 2012, Sisimwo and Onchiri, 2018). Other studies have also reported being male, younger age and driving inexperience as other important factors that also contribute to motorcycle crashes (Bachani et al., 2012). Previous studies have demonstrated that 98% of crashes are preventable (Nimako, Bawa, Amoako, 2018) and that use of helmets are effective in reducing motorcycle deaths and head injury by 42% and 69% respectively (Kuo et al., 2017). Unfortunately, there is poor helmet usage among motorcycle users in Kenya (Sisimwo and Onchiri, 2018). Injury to the head and extremities are the most common nature of injury and a leading cause of death amongst motorcycle crash victims.

The proportion of motorcycle related injuries of the total road traffic injuries reported by various hospital studies from different settings indicate that motorcycle injuries varies from 36.2% in Kakamega, 39.4% in Kitale (Sisimwo et al., 2014), and 65% in Thika (Matheka et al., 2015). These studies also found that the majority of crashes, 20- 38% happened during the daytime (Matheka et al., 2015; Sisimwo et al., 2014)).

In Kisumu city, the third largest City motorcycle crashes account for between 41% and 62% (Cholo et al., 2016; Walter, 2018; Nyachieo et al., 2015; Poehler, 2019)**.** Kisumu County Government has put in place road safety intervention strategies (Kisumu County government, 2014). However, Kisumu city has limited data on motorcycle crash injuries that would form data-driven safety planning and intervention strategies.

2.2.3.1 Motorcycle Casualty Characteristics

2.2.3.1.1 Sex distribution

Previous studies agree of males preponderance in motorcycle related injuries (WHO, 2018). Table 2.1, shows that the mean proportion of males reported in 39 studies conducted in various countries is 75.5% ranging from 57.1% to 98.0%. Previous studies on motorcycle injuries in Lower and Middle Income (Nesoba, 2010); (Konlan et al.,2020); Konkor et al., 2019); (Weiss, Agimi, & Steiner, 2010) have reported higher proportion of males than females. This predominance is pronounced even in studies carried out in developed countries. This predominance of male is due to their high level of exposure to traffic. Men are also known to be risk takers, ride under the influence of alcohol, and more often overspeed (Chalya et al., (2012); (Abdi, Amiri, Sadeghi-Bazargani, & Khorasani-Zavareh, 2015; Konlan et al., 2020; Konkor et al., 2020; Oltaye et al., (2021); Adebayo et al., (2021) observed that males have higher chance to be injured or killed compared to females but according to Zangooei Dovom, Shafahi, & Zangooei Dovom, 2013), women have a greater chance of dying at the crash scene than men.

The preponderance of males is more frequent in countries where the most available means of transport are motorcycles and non-motorized, such as in Indonesia, Taiwan, India and other South-East Asian countries (WHO, 2018).

2.2.3.1.2 Age of motorcycle casualties

Table 2.1 presents motorcycle -related injuries by age and sex. The World Health Organization reported that globally, road crash injuries are the principle source of fatality in population of 5-29 years and 15- 44 years (Baru, Azazh, Beza, 2019; WHO, 2018). Mortality of young adults in their most productive years, results in substantial loss of resources (WHO, 2018). Motorcycle injury related data reported in 39 studies from various countries (illustrated in Table 2.1) shows that largely, 57% (ranging between 51.0% -62.9%) of casualties are aged between 15 and 44 years, 45.5% (37.1%-56%) are between 20-30 years of age, 61.2% (30.6% - 84.2%) are aged 20-39 years; and approximately 50% (37%-59%) are within the age bracket of 20-40 years. Children aged under 15 years account for less than 15%.

Table 2.1: Motorcycle -related injuries by age and sex (in 39 countries)

Age group (year)	1 st Author Year	Country	% male	mean+-SD (Years)	% in age group
15-44	Nzegwu 2008	Nigeria	73.4	(33+-13)	51
	Oluwadiya 2009	Nigeria	80.7	32+-8.2	62.9
	Liping li 2016	China	72.49	38.21 ± 17.32	43
	Tandi 2019	Cameroon	73.24	33±13	49.3
18-24	Gahdipasha	Iran	95.2	33 ± 13	33
	Marnah, 2022	Ghana	99.0		
	Adebayo, 2023	Nigerai	89.1	32.8s± 10.9	42.2
21-30	Chalya, 2012	Tanzania	76.1	30.7	56.3
	Adeleye, 2019	Nigeria	83.1	33.1± 18.3	
	Nwadiaro 2011	Nigeria	61.8	32.4 ± 14.0	-
	Joses, 2017	Uganda	92.4	29.01 ± 9.5	-
	Itodo, 2014	Nigeria	61.8	32.4 ± 14.0	-
	Lawal, 2019	Nigeria	82	28.6+-7.03	49
	Obimakinde 2018	Nigeria	64	23.52 ± 9.61	50
					56
	Sameh 2017	Egypt	67	30.7+-105	38.7
	Berrone , 2017	Mexico	76.6		46.1
	Fletcher, 2019	Jamaica	98.7	28 ±16	
	Tadesse 2019	Ethiopia	72	29.2+-11.2	42.6
	Hassan 2016	Egypt	94.7	24.8±12.72	43.8
	Olufonso, 2019	Nigeria	79.3	41±16	50.6
	Solagrebu, 2006	Nigeria	88.4	28.7±11.5	61.2
	Mohammed, 2017	Pakistan	93	21.95	62.1
	Sarfaraz, 2016	Packistan	96.5	-	-
	Kigera , 2012	Uganda	81	-	-
20-29	Cavalcanti, 2013	Brazil	62.2	29.5+-11.5	47.2
	Cavalcanti, 2013	Brazil	72.8	-	-
	Barzagani 2018	Brazil	85.5	30.5+- 10.3	66.7
	Monteiro, 2020	Brazil	87.5	29.9 ± 12.4	
	Fitzharnis 2009	India	88.1	30.5+-10.2	62.1
	Silvia, 2020	Uganda	73.05	30.5+-10.4	30.6
	Kudebong 2011	Ghana	71.0	-	-

	Konlan 2020	Ghana	66	30.5+-13.5	-
	Abeidi, 2015	Iran	99	29.3 ± 11.8	-
	Fletcher 2020	Ghana	98.7	28.1+-16.1	-
	Fouda 2017	Egypt	90.5	30.7+-10.5	-
	Oltaye et al, 2021	Ethiopia	86.8		50.3
30-39	Zhao 2012	China	76	35+-12	52
	Poehler 2019	Kenya	82	-	
					36
	Tumwesigwe 2016	Uganda	89.7	29.3+-12.7	-

2.2.3.1.3 Road-user category

The prevailing tendency of road-user category involved in motorcycle crashes has been reported in numerous studies although variations exist between regions, countries and type of crash. Motorcycle rider endure the thrust of motorcycle related morbidity and fatality over virtually all regions representing the largest category of road-user who die due to motorcycle related crashes. They account for between 38.9% and 78% of all motorcycle-related injuries reported in 24 studies (Table 2.2). On average the greatest proportion of motorcycle injuries; 58.3 % (50-69.05%) are found in the South East Asia, while they comprise on average 46.9% in most East African countries, and in Ghana, Kudebong et al., (2011), reported that 78% of all road-users injured were motorcycle riders. Sixty-five-point eight percent of motorcycle injuries that occurred in Egypt were among motorcycle riders. Motorcycle rider and their pillion passengers are susceptible to injury due to lack of protection from the energy transferred during a collision (WHO, 2018; Oltaye et al., 2021). The probability of a motorcycle rider and passenger's death in a crash is 34 fold higher than one occupying a car (WHO, 2018; NHTSA, 2007). Due to motorcycle riders recklessness, they engage in over-speeding and over loading, subjecting them to fatal crashes. Moreover, most motorcycle riders and their passengers fail to put on protective instruments (Naddumba, 2004, Wankie et al., 2019). However, this knowledge on differential exposure to risk has not translated to advancement of safety of motorcycle users (NHTSA, 2016).

Passenger morbidity rank second. They account for on average 26.9% (12-39.4%), this is attributed to overloading where motorcycle riders often carry more than one passenger. One crash result in many deaths and injuries. Pedestrians rank third with the exception of three studies; Mcharo (2012); Naddumba (2004); Allen Ingabire et al. (2015), in Tanzania, Uganda and Rwanda respectively and accounted for between 8.3% in China and 37% in Uganda. This is in contrast to the General Road traffic injuries studies that have reported pedestrian as the most affected road user in traffic crashes (Odero et al., 2003; WHO, 2018).

Table 2.2. Motorcycle injuries by category of road user and and country

Country	Source	Pedestrian	Passenger	Motorcycle rider	Bicycle
Africa					
Uganda	Nandumba, 2010	37	22	41	-
Tanzania	Chalya 2010	10.9	33.9	55.2	-
Tanzania	Mcharo, 2012	29.4	24.2	46.4	
Rwanda	Ingabaire 2012	28.7	24.5	46.8	-
Nigeria	Oluwadiya, 2013	13.8	39.4	46.8	-
Nigeria	Nwadirio 2011	22.5	37.7	39.8	-
Nigeria	Olufonso 2015	14	36.7	49.3	-
Nigeria	Obimakinde 2018	10	29.1	64.9	
Guinea	Alexandre 2020	9.8	35.5	50.7	-
Ghana	Kudebong, 2011	10	12	78.0	-
Egypt	Asem, 2016	17.1	17.1	65.8	-
Kenya	Sisimwo, 2014	16.0	38.9	45.1	-
Ethiopia	Seid 2015	13.8	39.4	46.8	
India	Sharma 2007	18	30	52	-
Pakistan	Mohammed, 2017	15.4	29.4	55.3	-
Pakistan	Sarfaraz, 2016	-	-	-	-
China	Liping Li, 2016	8.3	18.05	69.05	4.6
U SA	Coben, 2001	-	7	93	
Nigeria	Adebayo, 2021	-	-	-	
Ethiopia	Oltaye, 2021	35.5	25.5	42.0	-

2.3 Burden of Motorcycle Injuries on Health system

Globally, motorcycle related injuries are a public health problem (WHO, 2018). The effects of motorcycle injuries in underdeveloped countries are twice as high as developed countries (Özdöl, Gediz Aghayev, 2019). These injuries present remarkable morbidity, morbidity; exerting a striking strain on the public health system, economy, society and individual as demonstrated by increased pressing requirements on resources for health, prolonged medical expenditure, and elevated intensity of management (WHO, 2018; Yamey, Fewer and Beyeler, 2015).

Previous studies from Brazil, Jamaica, Rwanda, Taiwan, and the United States reported that 65%, 73.6%, 50%, 31.6%, and 36% of motorcycle injury cases, respectively, were admitted to the hospital, of which 95%,71.6%, 71.6%, 31.6%, and 36% required surgical interventions, respectively (Miki et al., 2014; Fletcher et al., 2019; Allen Ingabire et al., 2015; Liu et al, 2016) (Table 2.2). However, public health systems are not adequately prepared to meet the additional motorcycle trauma care needs and face major gaps in coordinated emergency response (Isaakidis et al., 2002). Traditionally, public health resources have been more prioritized towards health system development of communicable diseases (Koka et al., 2018).

Hospital morbidity statistics from Kenya (Saidi et al., 2014; Sisimwo et al., 2014), Uganda Kamulegeya, Kizito, Nassali, Bagayana, and Elobu (2015), and Uganda (Kigera and Naddumba (2010), show that injuries from motorcycle traffic crashes account for 2 to 3% of all hospital attendances, 22.3%-64% of the total number of trauma admissions, and 41%-82.5% of injuries requiring hospitalization. Other studies have shown that motorcycle-related injuries account for between 40% and 85% of all trauma admissions exerting serious constrain on the scarce health service resources (Nesoba (2010); Sisimwo et al. (2014); Fouda et al. (2017); Fletcher, Mcdowell, Thompson, and James (2019).

Hospital admission due to motorcycle related injuries, remain gruelling incase of protracted warding. Previous studies in Jamaica, Tanzania and Brazil show that motorcycle injured patients on average stay in the hospital for 10 days (Fletcher et al.,(2019), 18.3 days (Chalya et al. 2010) and 19.2 days(Araujo et al., 2017) respectively. Gorski, Gorski, McLeod, and Suh (2003), in their study 66% of motorcycle injuries were admitted of which 36% demanded surgical management. In another study, almost one in three patients required hospitalization (surgical wards or the intensive care unit). Of all trauma cases presenting in a teriary hospital in Uganda, 21.4% are motorcycle related (Kamulegeya et al., 2015). Kigera and Naddumba (2010), in their study in Kampala, Uganda reported that of the total hospital budgetary allocations, approximately 4.2% is assigned to management of motorcycle injuries and which account for 15% of all hospital services. Also motorcycle injuries contribute to 62.5% of the budget allocation for all surgeries in the hospital (Kigera & Naddumba, 2010). Motorcycle injuries contribute a critical proportion of emergency presentation, hospital admissions and deaths in Kenya. For example, in Naivasha sub county hospital of all road traffic crash emergency department presentations, 36% were motorcycle related of which 28.9 % were admitted (WHO, 2013); however, the report does not indicate the fatalities.

The mean hospital stay for motorcycle related injury cases was between 6 - 24 days, except for motorcycle injury cases with spinal and head injuries who stay for remarkably longer period (Table 2.3). For instance, motorcycle related injury patients were on average warded for 3 months in a Spinal Injury Hospital in Kenya (Saidi et al., 2014), while admissions to surgical wards in Tanzania (Chalya et al., 2010), used a duration of over one month on average (42.2 days).

Studies undertaken from Iran and Tanzania reported that the utilization of intensive care unit by motorcycle injury patients varied from 4.6%-16.1%. The studies indicated length of stay in the unit of between 1-28 days with 67.7% requiring ventilator support (Chalya et al., 2010). In Taiwan 20%

of motorcycle injuries were admitted in Intensive Care Units (Liu et al., 2016) as shown in Table 2.3. A study by Saidi et al. (2014), found that, of the total road traffic admissions in Kenyatta hospital, 22.3% were motorcycle injury admissions of which 9.0 % of motorcycle injured patients died after two weeks. Sisimwo et al. (2014) indicated 38.5% that presented to emergency department were motorcycle injury cases out of which 85.4% of motorcycle injuries were admitted with a mean hospital stay of 13.07 days and only 14.6% treated as outpatient while 5.1% died and required mortuary services (Sisimwo et al., 2014).

Table 2.3 Studies with hospital utilization indicators in relation to motorcycle injuries

Source. 1st Author, Year	Country	INDICATORS			
		Admissions (% of motorcycle injured cases admitted)	**Mean LOS (days)**	**Duration**	**Others**
(Fletcher et al., 2019)	Jamaica	73.6% admissions	10±8 days	1-89 days	71.6% surgery
(Adeloye et al., 2016)	Brazil	-	15.4±34.5	1-125 days	-
Monteiro, 2014	Brazil	-	14.1±5.3	1-193 days	-
(Monteiro et al., 2020)	Brazil	51.9	15.9 ± 23.8	1-161 days	Surgery 40.4% ICU- 8.4% 6.4% died-mortuary services
Zabeu 2013	Brazil	26.3	-	-	43.8% emergency, 24.3% sent to orthopedic and ambulatory center
Eroglu, 2013	Istanbul, Turkey	-	-	-	X- ray-85.7% blood testing (71.4%), computed tomography 28.6%), 1% died-mortuary services
Miki , 2014	Brazil, Sao Paolo	-	-	-	95% surgery
Fouda, 2016	Egypt	82.5	13.7±	-	14.6% emergency department
Hsieh, 2016	China	55	10.6±11.5	-	-
Gorski, 2003	USA	66	-	1-9 days	36% surgery
Pai, 2018	Taiwan	60	14±12.5	-	-
Liu, 2016	Taiwan	60	10.6±10.9	1-111 days	ICU admission-20% 31.6% surgery
Liu, 2015	Taiwan	-	12.2±7.5	1-140 days	-
Zargar, 2006	Iran	45	6.9±10	1-105 days	4.6% admitted to ICU
Chalya, 2010	Tanzania	-	19.23	1-120 days 1-28 days	16.1% ICU admission 67.7%; ventilator support, 63.5%

					surgical intervention
Ingabaire, 2012	Rwanda	50	15.41	1-120	50% emergency;71.6% surgery
Sisimwo, 2014	Kenya	82.5	13.07	-	82.5% admissions 50% surgical interventions
Saidi, 2013	Kenya	75	24.3	-	, 51.7% surgical intervention
Kigera, 2010	Uganda	41,	8.3	-	62.5%
Rahman, 2015	Malaysia	79.9	-	-	79.9% admission
Fouda	Egypt	74	-	-	74% admission

2.4 Cost estimation of motorcycle injuries

The costs of road crashes and their outcomes are varied and many. There are costs that are more tangible including, medical and non-medical, recovery, repair and replacement of agent of collision, damaged property and the administration (Miller et al., 2011).

The non tangible costs are associated with value of life or the cost incurred for reduction of risk of injury or premature fatality, and misery and agony by victim and their relatives and friends. Two stages are required to quantify the cost of road crashes and injuries. One most important stage is to quantify the prevalence or incidences of the crashes and injuries. This is followed by computing or assigning monetary value to the crashes and injuries **(**Ministry of Transport, New Zealand Government, 2017**)**. There are various techniques available for valuing road casualties, including the gross output method (human capital approach), the net output, the life insurance, the court awards (the amounts awarded by courts for compensation to survivors or surviving dependents in the case of a fatality), friction-cost approach (valuing the cost involved in replacing the killed or injured person to restore the previous production level) and the willingness-to-pay approach (Sebagala et al, 2017). Other studies including (Ross Silcock, 2003); (Jacobs & Aeron-Thomas, 2000); (Downing, 1991); (Miller et al., 2011), (Sebaggala et al, 2017), have also cited these methods. The two methods frequently utilized in crash evaluation are the Gross Output method or the human capital and the Willingness to Pay (WTP) method (Jacobs & Aeron-Thomas, 2000).

2.4.1 Willingness to pay (WTP) for motorcycle injuries

Cost estimation using Willingness to Pay (WTP) method was first reported by Jones Lee Circa in 1989. As a result of that study, the UK, which originally applied the Gross Output method, or human capital initiated the conversion towards using the WTP method.

Willingness to Pay also known as the ex-ante method of road crash costing has two interpretations. First, this approach attempts to find out if the society is better off as a result of some safety interventions. Cost quantities generated constitute the degree to which the society is willing to pay to circumvent injury, death, and damage due to road crashes (Widyastuti, 2012; Widyastuti & Mulley, 2005a). It quantifies the amount of money the affected members of the society are prepared to pay so as to enhance their safety hence produce data on the necessity to advocate for potent prevention strategies. Second, the method evaluates how individuals value safety, rather than reacting to how much a crash could cost (Widyastuti, 2012; Widyastuti & Mulley, 2005a). This method yields cost quantities that are accurate and therefore is appropriate manner to quantify total cost so that stakeholders can easily curtail the number of traffic crashes and combat the attendant predicaments (Unataka and Widyastuti, 2019).

The WTP (or WTA) can be assessed by stated or revealed preference methods (Unataka and Widyastuti, 2019). For stated preference methods, the contingent valuation method (CVM) is used to estimate the costs of road crashes. The CV method results to more or less directly asking members of a representative sample of the population at risk to state their willingness to pay for a (typically small) hypothetical improvement in their own (and possibly other people's) safety.

This valuation methodology is well-suited for valuing risk of injury from automobile crashes (Dionne & Lanoie, 2004; Unataka et al., 2019). The results of a WTP study are used to derive the Value of Statistical life (VOSL) and Value of Statistical Injuries (VOSI). This VOSL and VOSI is subsequently used to calculate human costs of fatalities.

The estimates produced from the techniques applicable to the ex -ante method/ willingness to pay for road crash costing show considerable variation. Some of these results are shown in Table 2.4.1. The estimates are not consistent. Except for the Sebaggala et al. (2017), and Le Henry, 2011 in Uganda and Singapore which were almost similar at approximately 1.7 million US Dollar. It's worth noting that only one such study using willing to pay approach has ever been done in Africa by (Sebaggala et al., 2017) in Uganda but no studies have used a combination of two or more methods though has been recommended.

As indicated in Table 2.4.1, studies in a number of countries in the last three decades to establish Willingness to Pay based on value of life quantities used a contingent valuation technique (Miller et al., 1990; DTLR (UK) 2001; Viscusi and Aldy, 2002; Chaturabong, 2011; Unataka 2019; Unataka et al., 2019). Miller et al., 2011 shows that questions in contingent valuation surveys have sought to determine how much people value reductions in risk and these valuations are consolidated over the population so as to quantify the value of a statistical life (Miller et al., 2011). Studies in India and Iran produced the highest amounts representing US $25.7B and US 13.4B respectively **(Table 2.4.1)**.

Table 2.4.1. Ex-ante Motorcycle Road crash costs (Willingness to pay)

Author Year of publication	Country	Method	Type of risk	Estimate
Chaturabong 2011	Thailand	CV	Fatality	US $ 223856.7
Ainy 2016	Iran	CV	Fatality	US $ 104874178
Sebaggala , 2012	Uganda	CV	Injury	US$ 30127985
Pham, 2008	Vietnam	CV	Fatality	US$1.78m
Unataka 2019	Indonesia	CV	Injury Fatality	US $ 4068.01 US$17628.07
Ainy 2014	Iran	CV	Fatality	US $13.4Bl
Bhattacharya 2007	India	Stated preference	Injury Fatality	US $25.7B US $ 1.426M
Le Henry, 2011	Singapore	CV Stated preference	Severity	US $ 1.711M
DETR(UK) 2000	UK	CV	Fatality	£ 1.089M
DTLR(UK) 2001	UK	CV	Injury Fatality	£ 122300 £1.145M
Miller (US) 1990	USA	CV	Fatality	US $3.472M
Kneisner and Leeth 1991 .	Aus.	CV	Fatality	£ 700
Litchfield, 2016	Australia	CV	Injuries	$ 13.58B

Legend: CV- Contingent Valuation, M- Million, B- Billlion, £- pound, US $- dollar, UK- United Kingdom, USA- United States of America

2.4.2 Human capital approach for estimating cost of motorcycle injuries

This approach is based on establishing the elements which are involved in road traffic crashes, and resulting to a loss either directly or indirectly, and summing them up to a concrete value (Sahu & Pani, 2020).

The traffic crash costs are grouped into two: direct costs and indirect costs. Previous studies indicate that direct cost constitutes, property damage, administrative, and medical costs (Asian Development Bank (ADB, 2003); TRL. 1995; (Miller et al., 2011); (Alfaro, Balasubramaniam, Bergado, & Chai, 1994)**;** (Yusof, Nor, & Mohamad, 2013); (Ross Silcock, 2003).

Direct costs comprised estimating the property damage, administrative cost, and medical cost, while indirect cost comprised loss of productivity due to motorcycle crash injuries as discussed below.

2.4.2.1 Medical Costs

BTRE, (2003) ; (ADB, 2003) and (Alfaro et al., 1994), noted that the medical costs are charged for out-patient or in-patient hospital treatment and any expenses on goods and services relating to the medical care of patients arising from the occurrence of the crash until the time of healing or discharge, or for deaths, including the cost of first aid, ambulance, hospital costs (food, bed, nursing care, laboratory tests, x-rays & imaging, surgery, and medicine/drugs) and the cost of healing or rehabilitation.

Alfaro et al., 1994), described medical costs as being the sum of first aid and ambulance costs, accident and emergency services costs, in-patient and out-patient treatment, non-hospital treatment and the cost of aids and appliances. (Tervonen, 1999) and Islam, Wakai, Ishikawa, Chowdhury, and Vaughan (2002), reported that the medical costs only comprise of four components: ambulance, first aid, hospital treatment and home treatment. Silcock, (2003), noted that all of these cost components are needed to quantify the cost of medical services of the serious casualties, whereas for slight injury in which the casualty has not spent time in hospital, the only data needed is the out-patient costs (Ross Silcock, 2003).

2.4.2.2 Data Sources

The literature provides evidence on how and from where the data needed to value crashes should be collected. Dawson (1967); Transport Research Laboratory (TRL) (1993); Ross Silcock (2003); collected the medical costs data from hospitals, while the non-medical data was collected from several companies such as insurance companies, garages and large fleet operators; however, Dawson (1967), suggested the need to be careful in using such sources of data since many vehicles may not have had insurance. Unlike vehicle damage and medical costs, data that can be readily collected directly from insurance companies, garages, hospitals or General Practitioners, other administration costs are difficult to obtain. (Amoako, Ockwell, & Lodh, 2003), noted that hospital data is the most important source of information about the cost of seriously-injured crash casualties in Australia. This has the advantage that casualties presenting to hospital are classified medically. Hospital data are also more likely to capture information on road user category; pedestrian, cyclist and motorcyclist casualties (BTRE, (2003) (Table 2.4.2).

Table 2.4.2 Data Sources

Cost component	Authors	Source of data
Medical cost	A Garcı´a-Alte´s, K Pe´rez, 2007	Hospital and society
	Kudebong et al 2011	Hospital and society
	Ministry of Transport, Newzealand Government, 2017	Hospital and government reports
	Sapkota, 2016	Society and hospital
	Ingabaire, 2015	Hospital
	Ross Silcock and Transport Research Laboratory (TRL) (2003)	Hospital expenditure estimates, insurance payment claims by casualties. Hospital casualty surveys or household surveys were also used.
	Transport Research Laboratory (TRL) (1993)	Hospital and government reports.

2.4.3 Property damage

In each motorcycle accident, there is some amount of damage to motorcycle and property damage on a side street. The largest portion of property damage is the things that relate to damage to the motorcycle (Silcock, 2003). It is made up of motorcycle repair cost, cost of lost valuables and motorcycle replacement cost.

Property damage costs data can be derived from Insurance companies/claims assessors, Fleet owners, and Motor repair businesses Owner surveys (Silcock, 2003).

2.4.4 Administrative costs

Administrative costs comprise of Police investigation costs, insurance costs, (Silcock, 2003). Insurance costs arise from addition of all insurance claims costs and police cost were estimated by estimating the gross hourly wage rate of a police officer multiplied by the number of reported cases investigated by the police within the duration of study.

2.4.5 The lost output

Loss of productivity is associated with a loss of economic value to work because of an accident. The amount of working time lost for the death of the victim is the time they spent into the future if they do not die multiplied with average income of crash victim (Silcock, 2003; Sakopta et al., 2015). For severely injured and slightly injured lost productivity is calculated as the length of time they cannot work multiplied by the income of the casualty if they work.

The total average lost output for a fatal motorcycle crash is aggregate of every lost output for the future, (Anh, Dao, & Anh, 2005).

2.5 Social and Economic Cost of Road Traffic Accidents

The costs due to road crashes and injuries are huge. In 2012, the annual global cost of road traffic accident as estimated by World Health Organization is $ 1.8 trillion and $ 834 billion lost in developing countries, accounting for 21.5% of the global Road Traffic Injury costs (UN, 2008; Safety – Net, 2006; WHO 2012). According to WHO, (2017), the costs as a percentage of the gross domestic product in most African countries range from Zero point eight (0.8%), to five (5%) for instance in Ethiopia and Kenya respectively. Nigeria loses 80 billion Naira annually on treatment of road traffic crashes casualties (Juillard, Labinjo, Kobusingye, & Hyder, 2010); (Atubi, 2012). In Kenya, the cost of RTAs is estimated to be US$ 4 Billion annually (NTSA, 2019).

2.5.1 The Cost of Motorcycle Accident Injuries

The cost of motorcycle injuries could be huge and varies from country to country considering that motorcycles provide less protection, and are the most dangerous vehicles (Miller et al., 2011). According to (Hahn et al., 2020), the cost of traumatic brain injury (TBI) resulting from motorcycle crashes in Hanoi, Vietnam was USD 2,365 for severe, USD 1,390 for moderate and USD 849 for minor TBI. According to (Max et al., 1998), the estimated aggregate hospital costs of motorcycle-related head injuries in California was $15.9 million.

National Highway Traffic Safety Administration indicated that the average hospital charges associated with motorcycle accidents ranged from $7,000 to $30,000 (NHTSA, 2007). According to Braddock, Schwartz, Lapidus, Banco, and Jacobs (1992), The medical charges due to motorcycle related injuries constitute 6% the total motorcycle crashes, while work accounts for 29%, and reduced quality of life and suffering account for 63%.

A study by Kamulegeya et al. (2015), in Kampala, Uganda, found that motorcycle crashes represent 25% of the RTIs. The costs accounted for approximately 4.2% of the total hospital budget, and 62.5% of the hospital's budget allocation for directorate of surgery. Ingaibire and his colleagues reported that the total cost of motorcycle crashes in Kigali was US$1,236,207.31 (Allen Ingabire et al., 2015). In Ghana, Kudebong et al. (2011), found that the total costs of motorcycle crashes in Northern Ghana was US$1,216,827.69 (Kudebong et al., 2011).

The methods used in costing, costs and results of the reviewed studies are summarized in Table 2.4.3. All 16 studies reported medical or direct or direct and indirect cost. Overall, 10 studies (62.5%)

did not report costing method used. Of the 5 studies that reported costing methodology, 60% (3) used the gross output or human capital method (Kudebong et al., 2011; Allen Ingabaire et al. 2015; Sakopta et al. 2016) while Mixed methods (bottom-up and top-down) and Micro-costing were utilized in one study each (Matiwane and Mohamed, 2018 and Parkinson et al. 2014) respectively. Nearly half of the studies stated more than one type of cost, of which 85% denoted direct and indirect costs distinctively.

In the last decades medical cost has been rising and varies from country to country. The cost of motorcycle related injury varry between US $ 119 per injury in Nigeria and US$ 5825 in USA, (Julliard et al. 2010 and Pincus et al 2017). The total cost ranged between US $ 329024.87 in Nepal and $ 16 767 037 in the Argentina (Sakopta et al., 2016 and Besse et al., 2018). The unit of cost reported in the studies varied from cost per injury, hospitalization, patient and severity, fatality and total cost. 6 (40%) studies reported result as mean cost per hospitalization, which indicated that the mean cost per hospitalization was US $ 5417(range US$488- US$12845). Two studies identified costs per injury severity differently (Hahn et al., 2020; Olukoga, 2004).

Table 2.4.3 Costing methodology and cost elements of the reviewed studies

Principal author, year of publication	Country	Costing method used	Cost in US dollars	Unit Cost	Type of cost
Olukoga, 2004	South Africa	Not indicated	10 906 40 578 178 634	per slight injury per severe injury per fatality	Direct and indirect
Ipingbeni, 2008	Nigeria	Not indicated	1454	hospitalization	Direct and indirect
Julliard, 2010	Nigeria	Not indicated	119	Per injury	Direct and indirect
Sangowawa, 2011	Nigeria	Not indicated	187	Per injury	Not indicated
Saidi, 2013	Kenya	Not indicated	1129	hospitalization	Only medical cost
Kudebong, 2011	Ghana	Gross output or human capital	3 879 647	Total cost	Direct indirect
Agbor, 2014	Cameroon	Not indicated	486	Per hospitalization	Direct
Parkinson, 2014	South Africa	Micro-costing Y	12 845	Per hospitalization	Direct
Allen Ingabaire, 2015	Rwanda	Gross output or human capital	1,236,207.31	Total cost	Direct and indirect
Matiwane, 2018	South Africa	Both bottom-up and top-down	6005	hospitalization	Direct and indirect
Urua et al., 2017	Nigeria	Not indicated	588	Per hospitalization	Direct
Pincus et al 2017	USA	Not indicated	5825	Per injury	direct medical costs
Besse et al., 2018	Argentina	Not indicated	16 767 037 17 936	Total cost Per patient	Medical cost
Baptistella, 2023	Brazil	Not indicated	465,614.82 3,083.54	Total cost Per patient	Total medical cost
Sakopta, 2016	Nepal	Gross output or human capital	329024.87	Total cost	Direct and indirect costs

Hahn, 2020	Vietnam	Not indicated	846 1,390 2,365	per minor injury per moderate injury per severe injury	Medical cost

2. 6 Factors influencing cost of motorcycle injuries

Reports by various studies have indicated that age, ethnicity, income, education, motorcycle license insurance status, helmet use, alcohol use, riding experience, road condition, number of passengers and weight carried, speeding, and othe environmental conditions influence the occurrence of motorcycle crashes (Mullin, Jackson, Langley, & Norton, 2000); (Langley, Mullin, Jackson, & Norton, 2000); (Wells et al., 2004); (Woratanarat, Ingsathit, Chatchaipan, & Suriyawongpaisal, 2013); (Cheng, Gill, Sakrani, Dasu, & Zhou, 2017); (Tumwesigye et al., 2016). However, a review of the previous studies from Kenya and other LMICs revealed the dearth of data on factors influencing cost incurred by motorcycle injury patients (Karau, 2019; (Zuma, Yonge, Msanzu, & Yussuf, 2021); (Owino, 2018); (Ngari, 2020); (JWM Kigera & Naddumba, 2010); Kitara et al, 2012; (Olumide & Owoaje, 2015); (Sisimwo et al., 2014); (Luchidio, Kahuthia-Gathu, & Gatebe, 2013); (Oxley et al., 2013); (Raynor, 2014). Other factors that have been shown to be associated with cost are discussed below.

2.6.1 Prehospital factors influencing the cost incurred by motorcycle injury patients

2.6.1.1 Motorcycle Training, Experience and safety knowledge

Studies have revealed that motorcycle riders involved in road crashes are without training (Hurt, 1981). In addition, motorcycle rider training experience reduces crash involvement and is related to reduction of injuries in the event of crash (Hurt, 1981). In 2010, Moraa in her study indicated that three quarters (75%) of drivers were not adequately trained (Moraa, 2010). This may be the case with riders of motorcycles, otherwise known as boda boda in Kenya. In the case of motorcycle riding in Kenya, it is not yet clear what percentages of motorcyclists actually attend driving schools (Moraa, 2010). This is despite the increasing cases of motorcycle accidents among this group of riders.. Again, as the contribution of motorcycle riders training, experience and safety knowledge to crashes have been reported in previous studies (Hurt, 1981); (Moraa, 2010); however, their precious contribution to the cost of motorcycle injuries has not been established.

2.6.1.2 Demographic factors

Table 2.5.1 shows the few researches indicating various characteristics of road crash victims that influence cost crash injuries but none of studies have been focused on motorcycle injuries (Table 2.5.1)**.** Age particularly older age, low socio-economic status, and clinical diagnosis affect significantly hospital cost (Devos, et al, 2017). This was also examined and confirmed by another study in Belgium where male victims and motorcyclists were also identified to have higher costs (Achit, 2015).

Table 2.5.1. Studies describing factors influencing cost

Author, year	Country	Source of data	Factor
Achit, 2015	France	Insurance , survey	Gender, age, road user type, injury severity
Devos et al., 2017	Belgium	Hospital data	Sociodemographic and hospital diagnosis
Devos et al 2017	Belgium	Hospital insurance linked	Road user and injury severity

2.6.1.3 Helmet use

Brown and his colleagues concluded that prevention of motorcyclists’ injuries and protecting them against injuries through helmet use results in economic costs saved (Brown et al., 2011).

Karlson, Bigelow, and Beutel (1998), noted that universal helmet use by all motorcyclists in Wisconsin saved society more than $400,000 in medical charges.

2.7 Post crash factors influencing cost incurred by motorcycle injury patients

2.7.1 Clinical diagnosis

Previous studies have as illustrated in Table 2.5.1 above show that clinical diagnosis affect significantly hospital cost (Devos, et al, 2017). For instance, Riewpaiboon & Piyauthakit, 2008); (Yuan et al., 2012); (Papadakaki et al., 2017), reported that head injuries were associated with greater hospitalization and medical costs compared to other types of injuries.

2.7.2 Injury severity

The costs of road crashes can be reduced by reducing crash frequency and reducing injury severity. Primary safety measures reduce crasht frequency. In Purbalingga crash severity type influenced cost where by the Cost of fatal crash was US$40,144), serious injury was US$2,104, and slight injury costed US$878 (Sugiyanto & Santi, 2017).

2.7.3 Hospital length of stay

Duration of hospital stay is a crucial indicator to gauge trauma care (Moore et al., 2014). There is corresponding relatioship between duration hospital stay and the cost incurred so that, increase in the duration of hospital stay lead to increase in costs (Fakhry, Sugar, D'Souza, & Gillison, 2010; Moore et al., 2014; Yousefzadeh-Chabok, Kapourchali, & Ramezani, 2019). A study by Yousefzadeh-Chabok et al. (2019), Bried et al.; Bray et al. Offner et al. reported mean duration of stay of 18 days, 21.2 days, 15.5 days respectively which confirmed significant relationship between duration of hospital stay and cost incurred. A study in Iran by Al Ibran, Mirza, Memon, Farooq, & Hassan, (2013) also confirmed that duration of hospital stay affect hospital.

2.7.4 Factors influencing willingness to pay for motorcycle injuries

To reduce the risk of injury, age, gender, income, household income, frequency of using motorcycles, accident experience, and alcohol-impaired riding significantly affect WTP (Ainy et al., 2014). The trends of age, gender, and income are similar to the results found from the analysis of WTP to reduce the fatality risk (Jomnonkwao, 2021). Further, people who always use motorcycles, those who have had accidents, and those who are often impaired by alcohol while riding are not willing to pay more to reduce their risk of severe injury. Surprisingly, motorcycle users who always ride at higher speeds tend to be more willing to pay for saving their lives from accidents (Ainy et al, 2014).

2.8 Theoritical framework

The theoretical framework used in this study is adapted from Haddon Matrix which is one of the most crucial paragon used in injury prevention. This model was developed by William Haddon. This paragon provides a plan for comprehension of the genesis of crash injuries so as to design effectual intervention programs (Haddons, 1980; Barnette et al., 2005). This model combines the principle of epidemiological triangle that constitute the interaction of host and agent/vehicle, within an environment together with time sequence of phases of crash (pre-event, event, and post-event) (Haddons, 1980; Runyan, 2015). Haddon demonstrated that injuries occur in a manner similar to the occurrence of simple communicable diseases like malaria that have definite agent; Plasmodium Spp. which must be transferred via mosquito bite to humans as the host within an environment to cause malaria. Likewise, injuries result from an interaction between a vehicle, host and environmental factors. Putting it into context, motorcycle related injured cases comprising of the pedestrians, motorcycle riders, pillion passengers are the susceptible host, while motorcycle and its collision is the vehicle and agent respectively, and the environment comprise the roads in Kisumu city. The phases in the matrix are spectrum of events that happen before, during, and after motorcycle crash. The pre- event interactions between the susceptible host, agent and environmental determinants results in crash. These factors influence the occurrence of crash. However, not all crashes results into injury. During the event phase, the interaction between susceptible host, agent and environmental factors continue strengthening the elements of the phase before the crash to influence the occurrence of motorcycle related injury. This describes likelihood of the host to sustain injury after a crash. The phase after the crash underlines the determinants of crash and injury intensity and degree of care and treatment required. The framework provides critical information for designing injury interventions and prevention strategies by event time and phases taking into consideration the applicable host and environmental chararacteristics in cities in the developing economy. Table 2.6 illustrates the use of the Haddon matrix for motorcycle crash injury patients.

Table 2.6 Haddon matrix for motorcycle crash injury patients

	Human	Vehicle	Environment
Pre-crash	Sex, age, educational level, alcohol use, conspicuity, overloading, speeding,	conspicuity, helmets, motorcycle, mechanical status, pillion passenger and load carried on the motorcycle,	traffic lighting and signage safety policies, riding laws, traffic laws, weather, Road condition, time of operation, urban/rural, speed limits, road marking, helmet use
Crash / Injury	Helmet use, sex, age, response by pillion passenger, pedestrian, motorcyclist or driver, response duration by the motorcycle related injury cases, defensive apparatus and clothing	Speeding, type of collision, collision impact,	Road-side protection Roadside objects, In-road objects, road intersection,
Post-crash / Injury Severity	Motorcycle Casualty's material loss, medical related cost, non medical charges, Pre-existing conditions, Lost out put,	Fire risk, damage, loss, motorcycle repair charges,	support by police, trauma care staff, , trauma facilities for management, hospital charges, diagnostic and surgical procedures,

2.9 Conceptual Framework

This framework illustrates the links between various independent variables and injury outcomes including cost of motorcycle related crashes and injuries. Crash cost quantification involves two steps. First, enumerate; the crashes and injury occurrances, severity of injuries, fatalities. and then assign monetary value. It is also necessary to monetize market costs, such as motorcycle damages, medical expenses and lost output. The conceptual framework below, derived from literature reviewed, summarizes the links between the relevant characteristics of patients involved in motorcycle crashes and the associated injury outcomes, health service utilization and costs.

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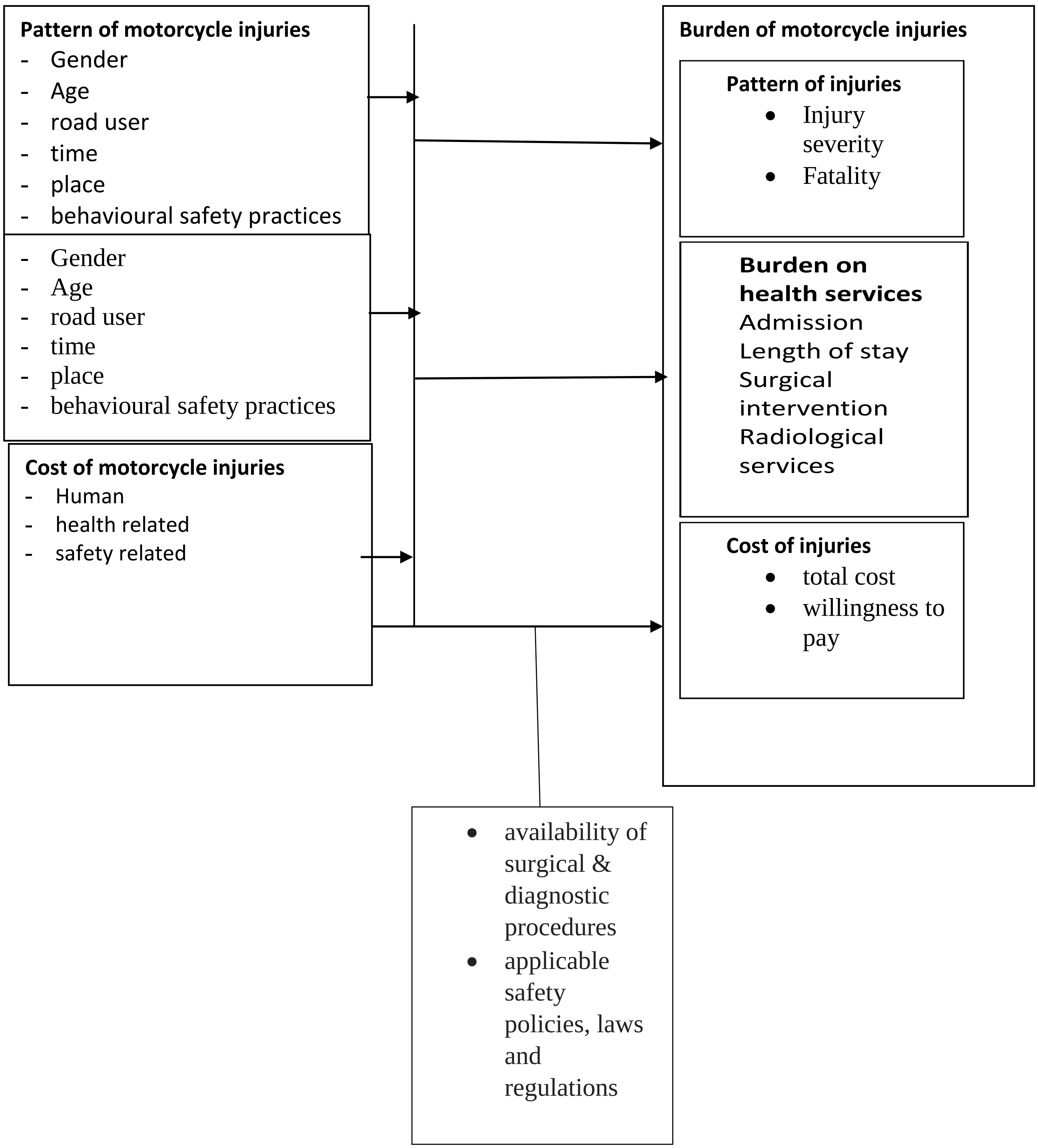
Figure 1: Conceptual framework. Source: Investigator

Independent variables **intervening variables** **Dependent variables**



CHAPTER THREE

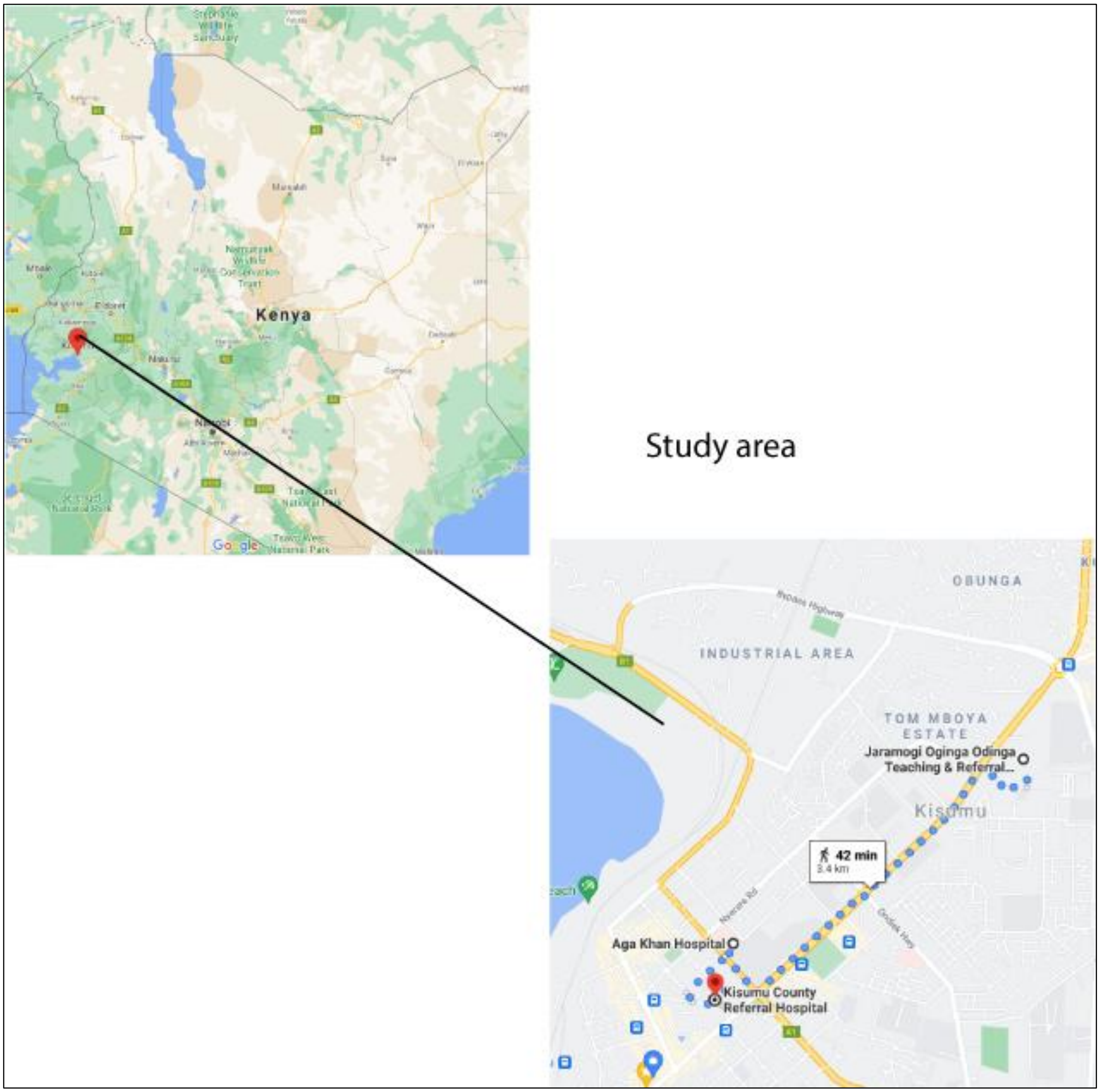
METHODOLOGY

This chapter describes the design of the study and the procedures that were undertaken to collect and analyze data. It includes the study site, study design, study population, sampling procedures, data collection and analysis methods, and ethical considerations.

3.1 Study Site

This study was conducted in Tier III Hospitals in Kisumu City (Figure 3.1). Kisumu City is the third largest City in Kenya, after Nairobi and Mombasa. It is located in Western Kenya within the low land surrounding the Nyanza Gulf. The latitude of Kisumu, is -0.091702, and the longitude is 34.767956. Kisumu, is located at place category with the gps coordinates of 0° 5' 30.1272" S and 34° 46' 4.6416" E. The estimated population in the City is 610,082 persons (KNBS, 2020). A high proportion of the population is young people aged 0-19 years, which comprise 52.3%, while 36.2% is between 15-45 years (KNBS, 2020). Persons aged 45-65 and 65 and above comprise 8.18% and 3.4% of the total population respectively (KNBS, 2020; USAID, 2016). Approximately 48% of the urban population lives within absolute poverty bracket almost double the national average which is 29% (USAID, 2016).

Figure 3.1: Location of JOOTRH, Kisumu County, and Agha Khan Hospitals in Kisumu City



Health services in the City are provided through a multifaceted system consisting of central government, county government of Kisumu, non-governmental organizations, church missions, and array of private medical practitioners and traditional healers (MOH, 2014).

Both preventive and curative health services are organized in a hierarchical pyramid-shaped system, with dispensaries and health centres at the base, Sub-County hospitals at the intermediate level, and

County Teaching and Referral hospitals at the peak (MOH, 2014). Patient referrals are supposed to originate from the bottom to the facility above, but in practice other factors, such as accessibility, cost, quality and efficiency of services, dictate a patient's choice (KNBS, 2015; County Government of Kisumu, 2018). Altogether, Kisumu City has a total of 15 health facilities, consisting of public and private health facilities providing health care (KNBS, 2019). The study focused on the three hospitals, namely, Jaramogi Oginga Odinga Teaching & Referral Hospital, Kisumu County Hospital and Aga Khan Hospital, ranked in Tier III in hierarchical pyramid-shaped system (MOH, 2014). The first two; Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH), Kisumu County Hospital are public hospitals run by the County Government of Kisumu. Aga Khan Hospital is a private hospital run by the Aga Khan Foundation. These hospitals were purposively selected for this study based on the fact that they all have active Emergency Departments that provide care to the crash patients and operate on 24-hour basis. These facilities provide comprehensive medical, surgical and rehabilitative care services in the County and neighboring Counties (MOH, 2014).

The top five leading causes of hospitalization in Kisumu County are: malaria (16.7%); skin diseases (13.5%); respiratory diseases (11.2%); diarrheal diseases (7.3 %) and road traffic Injuries contributes (5.9%) (KNBS 2020; KHIS 2019).

Jaramogi Oginga Odinga Teaching & Referral Hospital (JOOTRH), situated along the Kisumu – Kakamega road, is the largest public health facility in the City of Kisumu (MOH, 2014). It was established in the early 1900s to cater for the health needs of the workers at the then port Victoria (County Government of Kisumu, 2018; MOH, 2014). The hospital has evolved to become the Teaching and Referral Hospital that serves several Counties in Western Kenya. The Hospital is the major Referral Hospital serving Kisumu, Siaya, Vihiga, Homabay and Migori Counties, with a population of over 5 million. The hospital receives an average of 197,200 outpatient visits and

21,000 inpatient admissions annually (KNBS, 2015). Its prime charge is the provision of promotive, preventive, curative, and rehabilitative health services (KNBS, 2015; MOH, 2014; County Government of Kisumu, 2018).

The hospital has an active Emergency department that handles on average 8 patients with road traffic injuries per day, of which 3 (37.5%) are motorcycle injuries (Health records Department, 2019 KCIDP, 2018-2022). The hospital has a bed capacity of 710 with bed occupancy of about 94.8% (KNBS, 2019; County Government of Kisumu, 2018). Surgical and maternity wards are overstretched with the highest bed occupancy of 148.7% and 146% respectively (Health records department, 2019). The hospital has six operating theatres. Services offered include: Internal Medicine, Paediatrics, General Surgery, Obstetrics and Gynecology, Radiology, Ophthalmology, Intensive Care Medicine, Radiotherapy, Dental services and trauma care.

Kisumu County Hospital is a public health facility located in Winam Division, Kisumu Town East Constituency. The hospital was established over 100 years ago during the building of Kenya – Uganda Railway (KNBS, 2015; County Government of Kisumu, 2018; MOH, 2014). It has 20 wards with a bed capacity of 158, and bed occupancy of about 94.8%. The hospital has an active Emergency department that operates on a 24 hour basis daily (KNBS, 2015).

Established in 1952, Aga Khan University Hospital in Kisumu is a 61-bed acute care facility offering general medical services, specialist clinics and high-tech diagnostic services, and has a well-equipped 24-hour Emergency Department. The hospital provides, Surgical, Paediatrics, Obstetrics & Gynaecological and Acute Care services (KNBS, 2015; County Government of Kisumu, 2018). It also provides comprehensive laboratory and radiology services, and has a well-stocked pharmacy (KNBS, 2015).

The main mode of transportation used within the Kisumu City is walking which comprise slightly more than one half (53%) of daily trips (Institute for Transportation and Development Policy, 2020; County Government of Kisumu, 2018). Motorcycles, matatus and bicycles comprise 19%, 13% and 4 % of urban transport respectively (Institute for Transportation and Development Policy, 2020).

It is estimated that there are over 50000 motorcyclists operating in the Kisumu City (KNBS, 2013; KICDP 2018-22).). Motorcycles offer quick access but pose a safety risk for other road users (Institute for Transportation and Development Policy, 2020). Motorcycle crash-related deaths and injuries have become major public health problems in Kisumu city (County Government of Kisumu, 2018).

3.2 Study Design

This was a descriptive prospective design in which quantitative and qualitative data collection strategies were used to gather information on the burden and cost of motorcycle injuries. A descriptive study is one that is designed to describe the distribution of one or more variables, without regard to any causal relationship. The study was conducted from registration desks and examination rooms in Emergency Departments of the participating hospitals. Consecutive trauma patients presenting to the hospitals, over a six-month period (between May 6, 2019 and November 6, 2019) were recruited.

The quantitative approach enabled the researcher to describe the pattern of injuries and quantified the cost of injuries using both human capital and willingness to pay. The human capital approach quantified the impact of life loss or injury on current and future levels of output. This approach has been recommended as a practical instrument for costing road traffic injuries as a starting point (Alfaro et al., 1994); (Miller & Galbraith, 1995); ADB 2003; TLR, 1994; Taficom et al., 2023); since it is simple to use and the required data are readily available to produce consistent and transparent results (BTE, 2000). The approach captured information on direct and indirect costs which composed of income lost, medical costs, vehicle damage (BTCE, 1996; Miller & Galbraith, 1995). Willingness to pay quantified the amount of money the motorcycle injury patients are prepared to pay so as to enhance their safety (Downing, 1991); (Miller & Galbraith, 1995); (Al-Masaeid, Al-Mashakbeh, & Qudah, 1999); (Peden et al., 2004); (Sigua & Palmiano, 2005).

The qualitative approach used key informant interviews and enabled an in-depth understanding of the cost implications of motorcycle crashes and injuries on health system (Appendix 5). Key informant interviews were carried out with hospital administrators, Health professionals, officials from insurance companies in Kisumu City to gather more information on burden of motorcycle injuries on health services in the three hospitals of study. The interview captured data on hospital services utilization; bed occupancy, change of responsibilities, sudden loss of income, strained medical resources, sudden unexpected expenditure, debts and cost of hospitalization, services offered to motorcycle injuries.

Health records were also reviewed for the period of the study to obtain denominator data on all the conditions presenting to the EDs in order to enable assessment of the magnitude of motorcycle injuries on health services.

3.3 Study variables

The study variables are as indicated in table 3.1

Table 3.1: Study variables

Objectives	Dependent variable	Independent variable(Covariates)
Pattern of motorcycle injuries and fatalities	Severity Fatality	Demographic, behavioral – Helmet use, alcohol consumption, wearing reflective jacket (clothing), place, time, and injury characteristics, injury outcome
Burden of motorcycle injuries on health services	ED and admission Length of stay, radiological, surgery	Demographic, -age, sex, road user category injury- anatomic injury site, severity-helmet use Strained medical service, overcrowding and congestion, overstretched staff
Cost of motorcycle injuries	Cost- Direct, indirect and VOSI and VOSL	Age, sex, road user category injury-anatomic injury site, severity-helmet use
Factors influencing costs of motorcycle injuries	Total cost, Willingness to pay	human factors Health care factors safety factor

3.4 Study population

Study population comprised patients with motorcycle-related injuries treated at the Emergency Departments of Tier III hospitals in Kisumu City. These were motorcycle riders, pillion passengers, bicyclists and pedestrians involved in a motorcycle crash. Records of cases of road traffic injury cases attended to in the hospitals in which the study were conducted were obtained from each hospital and are presented in Table 3.1. The table shows motorcycle injuries cases from the previous year (2018) record where it was established that approximately 3, 2 and 1 resulting into 2150 motorcycle injured patients that presented to the Jaramogi Oginga Odinga Teaching and Referral hospital, Kisumu County and Aghakhan hospital respectively as shown in Table 3.1.

Table 3.2 Distribution of injury cases: Source Health Records office

Hospital	Approximate Number of cases/ day	For 12 months
Jaramogi Oginga Odinga Teaching and Referral Hospital	3	1095
Kisumu County Hospital	2	710
Aga Khan Hospital	1	310
Total	6	2150

3.5. Sample size determination

Census method was used in which all 1073 motorcycle injury patients who presented to the Jaramogi Oginga Odinga Referral Hospital (JOOTRH), Kisumu County hospital (KCH), and Agakhan hospitals were consecutively enrolled for a period of six months. Using G. power analysis the sample size had sufficient effect size and power of 95% to answer research questions and detect meaningful differences at 5% level of significance using Chi square, Analysis of Variance and regression analysis. Enrolling all the population elements in this case motorcycle crash injury patients helps in reducing the risk of missing insights from those not included and help paint a much complete picture of the study population and the magnitude of the problem thereby reducing sampling error (Lavrakas, 2008). The method has been recommended for injury cost analysis studies to avoid missing incidences or casualties and associated costs (Karlson & Quade, McSwain & Belles, Shankar et al., Wang et al., and NHTSA, 2007; Miller et al., 2011; Miller, 2000).

The distribution of number of motorcycle injury cases per hospital were as indicated in Table 3.2

Table 3.3 Distribution of motorcycle injury cases

Hospital	For 6 months
Jaramogi Oginga Odinga Teaching and Referral Hospital	610
Kisumu County Hospital	310
Aga Khan Hospital	150
Total	**1073**

3.5.1 Sampling Methods and Procedure

Purposive sampling was used to select Kisumu City and Tier III Hospitals respectively. Kisumu city has the second highest proportion of motorcycle injuries at 40-62% and has the highest proportion of population using motorcycles as a mode of transport at 19% in Kenya (Cholo et al., 2016; Walter, 2018; Nyachieo et al., 2015; Poehler, 2019; Bojana et al., 2022; County Government of Kisumu, 2018). Kisumu County Hospital, Jaramogi Oginga Odinga Referral Hospital and Aga khan hospitals were purposely selected because they are the only Tier III hospitals in the city and have active emergency departments that operate on 24 hour basis.

Total population sampling technique was used to recruit participants for the study. Total population sampling is a sampling technique in which every population element is recruited as samples in a study (Kothari et al., 2014). The study enrolled all the patients presenting with motorcycle crash injuries in the Emergency Departments of the named hospitals for a period of six months from 6 May to November 6, 2019. Several studies on injuries and associated costs have applied similar sampling approach (NHTSA, 2007: Wanume et al., 2019; Miller & Galbraith, 1995; Joshi and Shrestha, 2009; Odero et al., 1995; Wang et al., 2007). This is because enrolling all motorcycle injury patients helps in reducing the risk of missing insights from those not included and help paint a much complete picture of the study population and the magnitude of the problem thereby reducing sampling error (Lavrakas, 2008). This method has been recommended for injury cost analysis studies to avoid missing incidences or casualties and associated costs (Karlson & Quade, McSwain & Belles, Shankar et al., and NHTSA, 2007; Miller et al., 2011; Miller, 2000).

Further, this type of sampling has been documented to provide a much more representative assessment of crashes than alternative methods (Karlson and Quade, 2007; Miller, 2000; Miller et al., 2011).

Fourteen key informants were purposively sampled based on their insights on motorcycle road safety and motorcycle injury care.

3.6 Inclusion criteria

All motorcycle crash injury patients that obtained care at the Accident and Emergency Departments of the 3 study hospitals in Kisumu City during a six-month period, from May 6 to November 6, 2019. The study covered motorcycle crash related injuries resulting in an Emergency Department presentation, hospital admission or fatality in the Hospitals. It included all pedestrians, pillion passengers, motorcycle riders and bicyclists who were injured in crash involving motorcycles.

Fourteen key informants were included in the study based on their understanding of motorcycle injury management and safety.

3.6.1 Exclusion criteria

All RTI not associated with motorcycle were excluded.

3.7 Data Collection Instruments

Both structured questionnaire and key informant interview guide were used to gather information as described below.

3.7.1 Structured questionnaire

The structured questionnaire used to obtain quantitative information was designed based on a standard instrument obtained from the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation (Westant and dynamic Science, 2010). The questions were also adopted and modified from similar studies to improve comprehension (Wankie, et al., 2019; Chalya et al., 2010). The instrument had five sections corresponding to the demographic characteristics and study objectives respectively (Appendix 2) namely, A, B, C, D and E. Section A, gathered information on demographic characteristics of motorcycle injured patients; and included; gender, age, marital status, education level, income status; section B, focused on anatomic site of injuries, category of road user (rider, pillion passenger or pedestrian, bicyclists); mechanism of injury; mode of transportation of injured to hospital; day of the week injury occurred; time of the injury; behavioural safety practices, included variables on use of protective equipment (e.g., helmets; reflectors,), reflective clothing and alcohol use; severity of injury; injury diagnosis, injury outcome to address objective one questions on the pattern of motorcycle injuries. Section C was focused on objective 2 and gathered information on the burden of motorcycle injuries on hospital services including radiological investigation, laboratory investigations, surgery and length of hospital stay. In section D, information was gathered on post-crash management which included medical care, payment mechanism, types of costs consisting of the medical cost, property damage costs, and administrative costs to address objective three on cost of motorcycle injuries using both human capital and willingness to pay approaches. The last section E, gathered data on factors that influence total cost and willingness to pay for motorcycle injuries comprising of human factors, hospital and physical factors. Predesigned form checklist was used to collect information on hospital records and billing information (Appendix 6).

3.7.2 Key informant interview

Key informants were chosen based on conviction that they had a deeper understanding of motorcycle crashes, injuries sustained, relevant policies and practices relating to their respective clients.

They comprised the followings: Kisumu County Traffic Police Superintendent, head of the Accident and Emergency Unit of each hospitals; Medical superintendent of public hospitals; the Director Medical Services at Agha-khan hospital, in-charges of the radiological services in each of the three hospitals; the in-charges of ambulance services and, head nurses in the three hospitals. Information were gathered on burden motorcycle injuries on hospitals and patients. It captured data on hospital services utilization; bed occupancy, change of responsibilities, sudden loss of income, strained medical resources, sudden unexpected expenditure, debts.

3.8 Research assistants training

Research assistants were chosen based on their ability to gather information relevant for this research. The research assistants must have undergone a three year medical training course from a Medical training College leading to a Diploma in Nursing or Clinical Medicine. The selected research assistants comprising 3 nurses and 3 clinical officers stationed in the Accident and Emergency Department were recruited based on their understanding and knowledge of research and must have worked in the hospitals for more than two years. The research assistants were trained for two days, from 3rd and 4th April, 2019. Training of research assistants were done by the Investigator and were focused on regulatory and ethical requirements, counselling skills, process of obtaining informed consent and conduct of study as indicated in the proposal. Training also addressed interviewer-administered processes which were conducted by the investigator, and involved illustrations and presentations with trainees. Throughout the training session, live illustrations, representations, didactics and hands on- learning were utilized to impart skills required.

3.9 Pilot Study

A pilot study was conducted to pre-test the data collection tools in order to ascertain the reliability and validity of the research instruments. A pilot study refers to rehearsal of the main study aimed at identifying any weakness of the study instrument and the study techniques (Polit &bBeck, 2017). This was conducted in Vihiga County Teaching and Referral Hospital since it's a public Tier III hospital having emergency department. The pilot study used 100 participants as suggested by Isaac and Michael (1995). These results were excluded from the main study report. The pilot test helped the researcher to identify poorly constructed questions in the questionnaire, remove ambiguities, simplify the questions and further develop questions for easier coding and focus analysis according to the objectives. The pilot study enabled the researcher to improve the validity and reliability of the instruments.

3.10 Data collection procedure

This section describes the procedures that were undertaken in generating data using the tools discussed above.

3.10.1 Structured questionnaire administration

After ethical and administrative permission was granted, data collection was carried as follows: Data were obtained on all motorcycle crash injury patients that presented to the accident and emergency units of the hospitals over the study period. The study was conducted from registration desks and examination rooms in Emergency Departments of the participating hospitals. Motorcycle trauma patients presenting to study hospitals were recruited successively from May 6 to November 6, 2019. Injured patients gave their informed consent either after they were stabilized or relatives who brought motorcycle injury patients for care assented. Patients were initially assessed according to Advanced Trauma Life Support guidelines and contemporary standards of trauma care. The study obtained information on epidemiological characteristics including; socio-demographic, category of road user (rider, passenger, or pedestrian, bicyclists), time of the injury, day of the week injury occurred, behavioral (helmet use, reflective clothing, alcohol consumption), place and injury characteristics; injury disposition, length of stay (LOS), anatomic site of injury, diagnosis, mechanism of injury, diagnostic procedures performed, and treatment procedures conducted. For patients who were admitted, hospital bed days, use of ICU, type of treatment given, and injury outcome were obtained from the inpatient notes. Casualties who were admitted and discharged on the same day were considered to have been hospitalized for 1 day. Data on anatomic site of injury and diagnosis were also collected: the pelvic girdle and the rest of the lower limb were categorized as lower extremities; the pectoral girdle constituted upper extremities; head injuries constituted injuries to the face, neck, and head including concussions; and thoracic injuries including rib fractures and visceral organs within the thorax were considered as chest injuries.

For each casualty, the hospital attending physician assessed the severity of injury sustained using the Abbreviated Injury Scale (AIS), Injury Severity Score (ISS) scale and Glasgow Coma Scale (GCS) based on the clinical diagnosis. The ISS measures the severity of the injury based on the AIS, which was quantified by taking the highest score in the 3 body regions most affected (AIS-2019; Gennarelli & Wodzin, 2006). The ISS score ranges from 0 to 75 (Baker et al. 1974; Sharma 2005), and was categorized as follows: ISS 1–8, 9–15, 16–24, and 24 above. Injuries were classified using the following injury groups: pelvic injury, hip fracture, and tibia fracture/complex foot fracture or distal/shaft femur fracture (lower extremity injury groups); shoulder and upper arm injury, and radius, ulna, or hand fracture (upper extremity injury groups); mild traumatic brain injury (TBI) (AIS 1–2), serious TBI (AIS 3), and severe TBI (AIS≥4) (head injury groups); face injury group; thorax injury and rib fracture (thorax injury groups); mild abdominal injury (AIS_2) and severe abdominal injury (AIS≥3) (abdomen injury groups); and spinal cord injury and stable vertebral fracture/disc injury (spine injury group). The injuries were further divided into minor and major injuries. Therefore, motorcycle injuries were classified into minor (ISS<16) and major injuries (ISS≥16) (Javali, Krishnamoorthy and Patil, 2019). Glasgow Comma Scale (GCS) was also used to measure the severity in-terms of physiological characteristics which were categorized as mild, moderate and severe injuries.

Patients were followed up from the time of presentation till discharge from the hospital, referral or death, or 3 months and 6 months after discharge for survivors. The management of patients, final outcome, and available post-mortem findings for mortality cases were documented.

Data were collected on the health service utilization and constituted; length of stay, radiological, surgical, blood transfusion, Intensive care unit services. Records for all emergency and injury cases presenting within same period were accessed and reviewed in order to enable assessment of the burden of motorcycle injuries on selected health services in the hospitals. Data on the total number of emergency cases, emergency admissions, radiological investigation and surgical procedures were collected. The study compared these with motorcycle injury cases to establish the extent or magnitude of usage in relation to other emergency cases, including assaults, other road traffic cases, falls, and other injuries consisting of drownings, pricks, bites (e.g., dog or snake), and burns.

Motorcycle fatal cases data were obtained from the post-mortem reports and death registers. The person in charge of each mortuary within the participating hospitals was requested to arrange death registers and post-mortem reports at the hospital mortuaries. The death register number and the death notification number in the files were noted to enable case follow-up and counter-checking of errors.

Motorcycle crash injury costs were quantified using human capital (Miller & Galbraith, 1995); (Alfaro et al., 1994); Asian Development Bank (ADB, 2003) and the willingness to pay approaches.

Estimation of cost that combines the two approaches has been recommended as the most comprehensive cost estimation strategy (TRL, 1995); (Silcock, 2003); (Miller & Galbraith, 1995).

In this study both direct and indirect cost of motorcycle crash injuries were assessed using human capital approach. This approach has been used and recommended for use in Least and Middle-Income Countries (Asian Development Bank (ADB), 2003; Transport Research Laboratory of the United Kingdom (TRL, 1995); (Gito et al., 2015); Kobelt, 2002; (Miller & Galbraith, 1995); (Wijnen et al., 2017).

Direct cost was measured by quantifying cost incurred as a result of the following: medical expenses, the property damage; administrative, due to motorcycle crash injuries. Medical costs were obtained from bills served to the patients from the hospital billing section. Information was sought and obtained on the following; the costs of first aid services, consultation or observation, laboratory tests, radiological tests, medicines, surgical procedures, cost of hospital bed per day, cost of food and bed oocupancy. These were summed up for each injury patient as the cost of treatment for the period of stay in the hospital accordingly. Also included were the cost of transport to the hospital as reported by the patient or care takers and ambulance where applicable. This strategy has been used in previous works (ADB, (2003) and Transport Research Laboratory (TRL), (2003); (Miller & Galbraith, 1995); (Peden et al., 2004); (Miller & Galbraith, 1995); (Wijnen et al., 2017).

Administrative costs data comprised of police investigation costs (Silcock, 2003). Police cost were measured by quantifying the gross hourly wage rate of a police officer multiplied by the number of reported cases investigated by the police within the duration of study.

The study gathered information on the cost of motorcycle repair, cost of lost valuables like laptops, hand bags, wallets lost with money, cell phone and motorcycle replacement cost to obtain data on property damage cost. In each motorcycle crash, there is some extent of damage to motorcycle and property on a side street (BTCE, 1996; (Miller & Galbraith, 1995); (Wijnen et al., 2017).

To quantify indirect costs, lost working days, and mean wages were used to compute lost productivity cost for severely injured and slightly injured motorcycle injuries which were calculated by multiplying the length of time motorcycle injury patients were unable to work by the average income of the motorcycle patients (Silcock, 2003).

Lost of output (severe injuries) = no. of inpatients days and + no. of days taken to recover.

The lost output by motorcycle crash injury patient who died was calculated and measured based on the following formula adopted from (Anh et al., 2005)

$$Loss=\Sigma Wi(1+g)/i(1+r)$$

Where W represent gross domestic product per year

g - Annual economic growth rate – 5.6% (KNBS, 2019)

r - Discount rate (standard value given by the Global Burden of Disease – 0.03) (Murray, 1996).

i - the average years lost due to death (age of those who died subtracted from standard life expectancy)

The average and median age of motorcycle fatal crash cases was established as 28 and 32 years respectively. The retirement age in Kenya is 60 years average and life expectancy of Kenya population is 67.03 years. Loss of productive years in this study was computed based on a retirement age of 60 years. Therefore, the average number of years lost by a fatal motorcycle accident is 32. respectively. The Gross Domestic Product per capita in Kenya was last recorded at 1839.1 US dollars in 2018 at exchange rate (1 US dollar= 101.3)(KNBS, 2019).

Disability-Adjusted Life Years(DALYs) are the sum of years of life lost and years of life lived with disability (YLDs). And was quantified using the formula by Murray as indicated below.

$$YLLs[r,K,\beta] = \frac{KCe^{ra}}{(r+\beta)^2}\{e^{-(r+\beta)(L+a)}[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a}[-(r+\beta)a-1]\} + \frac{1-K}{r(1-e^{-rL})}$$

The formula for YLDs [*r*, K, β] differs only in the addition of *D* (the disability weight) and is given as follows:

$$YLDs[r,K,\beta] = \frac{KCe^{ra}}{(r+\beta)^2}\{e^{-(r+\beta)(L+a)}[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a}[-(r+\beta)a-1]\} + \frac{1-K}{r(1-e^{-rL})}$$

Where:

K = 1

C = 0.1658

e = 2.7183

r = 0.03

a = 34.6

β = 0.04

L = 67.3

For the base case recommended and used by Murray and Lopez,

Discount rate (*r*) = 0.03,

Age-weighting modulation constant (*K*) = 1,

Parameter from the age-weighting function (β) = 0.04, and a

Age-weighting correction constant (*C*) = 0.1658 (all these are the standard values given by Global Burden of Disease Study)

In case of YLL,

Age of death (years) is denoted by "*a*" and

Standard life expectancy at the age of death (years) is denoted by "*L*".

In case of YLD, age of onset (years) is denoted by "*a*" and duration of disability (years) is denoted by "*L*". Disabilities were assigned severity weights ranging from 0 (representing perfect health) to 1 (representing death) and were adapted from the table given by Murray in 1996.

Willingness to Pay values were determined using contingent valuation where two scenarios were used. The first scenario was to evaluate the willingness of motorcycle injury patients to pay for lessening the probability of dying due to motorcycle crash; the second scenario was to evaluate if they were ready to pay to reduce exposure to severe injury. Motorcycle crash injury patients were asked if they were willing to pay Kenya shilling (Kshs.) 4000 amount of money to reduce risk of dying in motorcycle crash from 8 to 4 fatalities in every 100,000 people or 50% reduction in fatality risk. The proportion was arrived at by dividing the total number of road traffic deaths in the year 2018 by the total population (4750000) and the quotient was multiplied by 100000 to obtain the rate of road traffic deaths in the year. In the year 2018, the fatality rate was 8 deaths per 100000 persons. In the second scenario, motorcycle crash injury patients were requested to envisage a situation where they are required to wear a helmet and reflective jacket while using motorcycles. The cost of helmet and reflective jacket is 4000 Kenya shilling per helmet, and reflective jacket. The probability of sustaining severe injury due to motorcycle accident was 13/100,000 in the year 2018. Using structured questions, motorcycle crash injury patients were questioned whether they were inclined to pay Kshs 4000 shillings to buy a helmet and refelective jacket which help in reducing the risk of sustaining severe injuries from 13 to 5 severe injured people in every 100,000 people or reduce by 60% the likelihood of sustaining severe injury. Using open questions motorcycle injury patients were asked what is the maximum amount of money they were ready to pay to reduce risk of severe injury by 60%. To determine factors influencing cost of motorcycle injuries, information on human factors - demographic characteristic, mechanism of injury, alcohol use, helmet use, and hospital characteristics; clinical characteristics, organ involved, cost of investigations, cost of procedures undertaken and length of stay in hospital were gathered.

3.10.2 Conducting Key informant interviews

Key informants interviews were carried out in their offices after making appropriate appointments. Upon identification of the various stakeholders in road safety, hospital care, consent were sought after introduction and allowing them to read informed consent form. They were then requested to append their signatures on consent forms. They were asked open ended questions systematically, probing as were appropriate to obtain in-depth information on consequences of motorcycle injuries in the health facility and society. Data captured were hospital services utilization; bed occupancy, change of responsibilities, sudden loss of income, strained medical resources, sudden unexpected expenditure, debts. Information were tape recorded (See Appendix 6).

3.11 Quality Control of the study

Quality control of the study is discussed in terms of reliability and validity as follows.

3.11.1 Reliability

Reliability is the degree to which research method applied produces stable and consistent results (Mugenda & Mugenda, 1999). Structured questionnaire was designed based on a standard instrument obtained from the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation(Westant and dynamic Science, 2010). The questions were also adopted and modified from similar studies to improve comprehension (Wankie, et al., 2019; Chalya et al., 2010). Besides, secondary data from health records were recorded from the standardized checklist which was used as a main source of information and were cross checked and verified several times.

During the data analysis, all the collected data were checked and cleaned for completeness and consistency at the same time, incomplete records were rejected.

3.11.2. Validity of study

Validity refers to the degree that an instrument actually measures what it is designed or intended to measure (Netemeyer, Bearden, & Sharma, 2003); (Bolliger & Inan, 2012; Teredoost, 2016). To achieve content validity for the tools used in the study, a comprehensive literature review was conducted to obtain relevant items to measure as variables as indicated in the conceptual framework. Expert opinions from the supervisors on the clarity, readability, relevance and comprehensiveness of the instruments were sought and obtained to ascertain the face validity. In addition, pilot study was carried out to ensure suitability of the instruments used and were refined accordingly to ensure that questions would preciously address the objectives as indicated in section 3.8. The research assistants were trained to go through the questionnaire after every interview to ensure consistency and to make sure that no space was left unfilled. To ensure generalizability of the results, the tool were administered to all the motorcycle crash injury patients who successively presented for treatment in Tier III hospitals. Further, the administration of questionnaires was conducted using face-to-face and supervised by the researcher to minimize errors and ensure high quality of data.

The investigator ensured that the structured questionnaires were also coded correctly and were entered in ascending order marked with numbers to reduce the risk of multiple entries. Close scrutiny of data was done to identify records that could have been entered more than once and which were removed to avoid duplicated records.

Triangulation was done to test validity through the convergence of information from different sources. Through triangulation, attempts were made to enhance their validity and credibility, as findings from the different information sources supported each other.

3.12 Data Analysis

The quantitative data were, coded and entered into SPSS version 21 programme (IBM® SPSS® Statistics Traditional License packages and features, 2021). Data cleaning were done to check for any discrepancy or errors in data entry.   Data analysis was done using various techniques that involved descriptive and inferential statistics according to objectives;

Descriptive statistics were used to generate frequency distribution of socio-demographic, and behavioral injury characteristics. Chi square test was used to analyze the association between helmet use and sex; anatomic injury site. To assess the relationship between fatality and demographic, injury and behavioral characteristics(p-value < 0.05), Logistic regression analysis was used to obtain Crude Odd Ratio. Further, Adjusted Odds Ratios (AOR) was computed using multivariable logistic regression model at 95% confidence interval. Hosmer-Lemeshow goodness-of-fit statistic was used to assess model adequacy.

Descriptive statistics to examine usage of services by motorcycle injury cases, anatomic injury site, and severity in relation to road user. Chi square was used to identify factors associated with radiological services. Odds ratio and its confidence level were estimated using logistic regression model to assess factors influencing ED, admission and length of hospital stay.

Cost of motorcycle crash injuries was assessed using descriptive statistic to obtain the cost quantities and mean difference between different types of cost with anatomic site, gender, injury severity was assessed using Analysis of Varaiance. Stratification in the analysis was carried, direct or in direct costs.

Generalized Linear models was utilized to explore factors that could affect total cost and WTP of motorcycle crash injured patients using the structured and unstructured questions. Logistic and multivaraiable regression with robust standard errors was fitted in Generalized linear model to determine factors that inform these cost outcomes. These factors considered were categorized as demographic, health related factors and road safety practices. Stepwise variable selection technique was employed to best determine which variables would be retained in the final optimal model. This is a commonly used method for cost data since costs are constrained to be positive and the distribution is right skewed (Barber and Thomson, 2004). To account for uncertainty associated with missing data in regression analysis, multiple imputation was used by chained equations (MICE) to impute missing values. Hosmer-Lemeshow goodness-of-fit statistic was used to assess the model adequacy (Hosmer et al., 2013 and David et al., 1991). Covariates considered as potential confounders were added into a logistic regression model by use of a statistical backward elimination technique. Covariates were considered confounders and retained in the final model if the association between factor and costs and willingness to pay parameters was significant at $p < 0.10$ or if their removal changed the parameter estimate by 15% or more. For all tests, the threshold of significance was $P<0.05$.

The analyzed data were summarized in tables and graphs, upon which the inferences drawn.

Data from the Key informants interviews were analysed with NVivo 12.5 (International, 2020) using the principles of thematic analysis process (Braun & Clarke, 2006); (Charmaz & Mitchell, 2001); (Glaser & Strauss, 1967). Data were categorized and Frameworks identified based on the issues in the interview guide and coding plan was developed to explore interactions. Each segment of the transcript (textfile) was coded. The coded transcripts were then exported to QSR NVIVO 12.5 statistical software for analyzing qualitative data; this software give opportunity to organize, store, retrieve and process data with 90% level of output accuracy (QSR NVIVO 12.5 full version). The analysis was accomplished by first familiarizing with data by reading verbatim and noting significant themes. Emerging themes were identified and coding categories were developed according to the views of the respondent. Each segment of the transcript (text file) was coded according to each category to describe burden of motorcycle injury on patients attending Tie III hospitals in Kisumu City. The codes comprised hospital services utilization; bed occupancy, change of responsibilities, sudden loss of income, strained medical resources, sudden unexpected expenditure, debts (See Appendix 8). Data credibility was ensured by consistently comparing and checking at the data several folds in the course of analysis to verify categories and member check (Lincoln & Guba, 1990). Analyzed data were then summarized in tables illustrating matrices of frequencies and patterns of emerging issues on burden of motorcycle injuries on health system mentioned by the different informants were prepared. Both descriptive and interpretational analysis were subsequently undertaken.

Table 3.2: Summary of data analysis plan

Objectives	Dependent variable	Independent variable(Covariates)	Test
Pattern of motorcycle injuries and fatalities	Severity Fatality	Demographic, behavioral, place, time, and injury characteristics	Frequencies, Mean and Chi square and logistic regression, Multivariable logistic regression using backward elimination retained if significant at $p<0.25$ or changed parameter by 15% or more
Burden of motorcycle injuries on health services	ED and admission Length of stay, radiological, surgery	Demographic, -age, sex, road user category injury- anatomic injury site, severity-helmet use Strained medical service, overcrowding and congestion, overstretched staff	Frequencies, Mean and standard deviation, Analysis of Variance, logistic regression, Thematic analysis in NVIVO
Cost of motorcycle injuries	Cost- Direct, indirect and VOSI and VOSL	Age, sex, road user category injury- anatomic injury site, severity-helmet use	Frequencies, Mean, ANOVA
Factors influencing costs of motorcycle injuries	Total cost, Willingness to pay	human factors Health care factors safety factor	General Linear Models, Multivariable logistic regression retained if significant at $p<0.25$ or changed parameter by 15% or more Adequacy of the model was assessed using Hosmer-Leshemow test

3.13 Ethical Considerations

Ethical issues were considered under the following;

3.13.1 Permission and approvals

Ethical and Research approvals were sought and obtained from the Maseno University School of Graduate Studies, Maseno University Ethics Review Committee (MUERC), Jaramogi Oginga Odinga Teaching and Referral Hospital Ethical Review Committee, School of Post Graduate Studies and National Commission for Science, Technology & Innovation (NACOSTI). Permission was also sought and obtained from the County Health Director, Administrators from the three Tier III hospitals in Kisumu City to allow the study proceed for six months, from 6th May, 2019 to 6th November, 2019.

3.12.2 Consent Process

The research assistants explained the study purpose, objectives, procedures, risks, and benefits, alternatives to participation in the study to the potential subject, providing all pertinent information and provided the subject or care giver ample opportunity to ask questions. Following this verbal explanation, the study consent form was given to the subject and was given enough time to consider whether or not to participate in the research.

After allowing the potential subject time to read or (read to) the study consent form, the Investigator and or approved research assistants and (or) the attending doctor answered any additional questions the subject might have had and obtained verbal agreement to participate in the research. The information in the sheet was read to those who could not read. This was important for the respondents to give consent without coercion, pressure or undue enticement. For participants who were unable to give informed consent due to injury, consent was sought from the patient when he or she was able to give or withdraw it. Consent was also sought from the parent /guardian, for the children aged under 18 years and other caregivers accordingly. Only patients who consented were enrolled in the study.

Research fairness was observed, where a procedure of enrolling study participants was done as outlined in inclusion criteria. The participants were treated with dignity and utmost respect. The decision for those declining to participate were respected and that they were not to be un-duly mistreated, manipulated to participate.

The potential participants (victims or their care givers) were assured that there were no risks; they were not exposed to adverse outcomes or harm and were purely observational. The study did not in any way subject them to any harm. The study did not involve any procedures or administration of treatments that might have inflicted adverse effects. They were also assured that there were no individual benefits or monetary incentive, but the result may prove beneficial for the formulation of future road safety policies or supporting decisions concerning motorcycle safety investment and management of motorcycle injury patients in Kisumu City and Kenya as whole.

The study participants were assured that their participation was purely voluntary; they were not coerced, that no respondent was forced to participate. Those declining to participate were not to be punished or denied any appropriate services. The respondents were assured that they could withdraw from the study at any time if they felt unable to continue because of some reasons.

Confidentiality was ensured during and after the study, no identifying information such as name or ID number were recorded, analyzed and disseminated. Confidentiality was also ensured on the information accessed from the health records data. No content was to be revealed. Data in hard copy were kept under safe custody in lockable cabinet. Data in soft copy was secured using a secret password and kept in flash discs, CD and laptop.

CHAPTER FOUR

RESULTS.

4.1 Introduction

This section presents details of the analyses and results obtained per the study objectives. It provides relevant data and interpretation for each objective.

4.2 Objective I: Pattern of motorcycle crash injuries in Tier III hospitals in Kisumu City.

This objective was addressed by focusing on the motorcycle injury distribution in terms of place, time of occurrence of injuries and personal characteristics of injuries. It captured the number of injury as characterized by demographic characteristics, place of occurrence, environmental conditions during the crash, time dimensions including the day and time of occurrence, pre-hospital care and transportation mechanism, mechanism of injury, Anatomic site (body region) of injury, injury diagnosis, severity, fatalities, and outcome/disposition.

4.2.1 Socio-Demographic Characteristics of motorcycle injuries

The socio-demographic characteristics of the cases are shown in Table 4.2.1. During the study period 2129 road traffic injury cases presented for treatment to the 3 hospitals in Kisumu City; Of these, 1073 (50.4%) were motorcycle injury cases,790 (73.6%) were male and 283 (26.4%) female (M: F ratio= 2.8:1). The ages ranged from 2 years to 84 years with a mean of 29.6 (±SD 12.19). Most (45.5%) of the motorcycle injury cases were in the age group of 15-29 years; this was followed by 249 (23.2%) who were in the age bracket of 31-44 years More than half 683 (63.7%) of the motorcycle injured victims were motorcycle riders 363 (33.8%) and their pillion passengers 321 (29.9%). Pedestrians with motorcycle-related injuries comprised 373 (34.8%).

Table 4.2. 1. Socio-Demographic Characteristics of motorcycle injuries

Characteristic	Variable	Frequency (Percent %)
Gender	Male	790 (73.6)
	Female	283 (26.4)
Age group (yrs.)	0-4	23(2.1)
	5-14	127(11.8)
	15-29	488 (45.5)
	30-44	256(23.9)
	45-59	104(9.7)
	≥60	75(7.0)
Level of education	None	31(2.9)
	Primary	271(25.3)
	Secondary	516(48.1)
	Tertiary college	245(22.8)
	University	10(0.9)
Employment status	None	150(14.0)
	Non formal	590(55.0)
	Formal	333(30.3)
Average income	None	150(14.0)
	Less than 10000	25(2.3)
	10000-20000	293(27.3)
	21000-30000	342(31.9)
	41000-50000	110(3.8)
	51000-60000	139(13.0)
	Above 50000	14(1.3)
Road user Category	Motorcycle rider	363(33.8)
	Passenger	321(29.9)
	Pedestrian	373(34.8)
	Bicyclist	16(1.5)
	Total	1073

4.2.2. Road safety compliance of motorcycle injury cases

Of the 684 motorcycle riders and passengers, 474 (69.3%) did not wear helmets at the time of the crash. The helmets wearing rate was 30.7% among both motorcycle riders and passengers. Approximately, 353 (32.9%) of all motorcycle injury cases admitted to have consumed alcohol before the crash. Only 29.2% of motorcycle injuries patients used reflective jackets (Table 4.2.2).

Table 4.2.2: Road safety compliance of motorcycle injury cases

Characteristics	Variable	No (%)
Helmet use	Yes	210 (30.7)
	No	474 (69.3%)
	Total	684
Reflective jacket use		
	Yes	200(29.2)
	No	484(70.8)
Alcohol use		
	Yes	353(32.9)
	No	673(62.7)
	Not Known	47(4.4)
	Total	1073(100)

4.2.3 Motorcycle crash injury occurrence by time, day and place of the crash

As indicated in Table 4.2.3, most crashes (27.1%), occurred in the evenings, between 6 pm and 9 pm followed by morning hours (26.7%) between 6am-9am., 25.3% occurred between 2-5pm, and only 0.5% occurred between 2-5am. The highest number of crashes (85.6%) occurred on roads within urban areas

Table 4.2.3: Motorcycle crash injury by time, and place of the crash (n=1073)

Characteristics	Varaiable	Frequency NO. (%)
Time of injury crash	6am-9am	286(26.7)
	10am-1am	211(19.7)
	2pm-5pm	258(24.0)
	6pm-9pm	291(27.1)
	10pm-1am	23(2.0)
	2am-5am	4 (0.5)
Place where injury crash occurred	Urban	918(85.6)
	Rural	155(14.4)

4.2.4 Day of occurrence of motorcycle crashes

There were three peaks of motorcycle crashes in a week; on Monday, 277 (25.8%), Friday 239 (22.3%) and Saturday 124 (15.9%), but Sunday was having the lowest proportion of crashes (5.1%). (Figure 4.2.1).

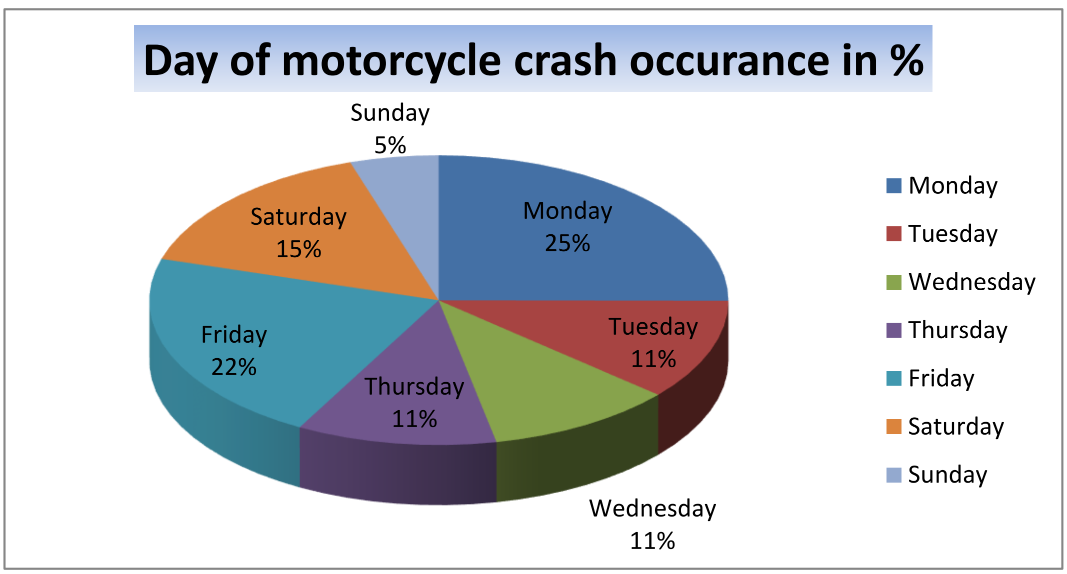


Figure 4.2.1 Day of occurrence of motorcycle crash

4.2.5 Pre hospital care, transportation mechanism and time taken to the hospital

Table 4.2.4 shows the pre hospital care status, transportation mechanism and time taken to the hospital. Fifty three percent of the motorcycle injury patients (n=1073) received some form of prehospital care. Nearly 92% of the motorcycle crash injury patients were transported to hospital by either relatives, self or bystanders. Only 6.8% were transported by ambulance. Of all the patients with motorcycle crash injuries, only 318 (29.6%) arrived at the health facilities within 1 hour from the time of the crash and nearly half of the cases 531 (49.5%) reported to the hospitals within 1-6 hours after the crash, while about 10.1% took 7-12 hours to reach hospitals.

Table 4.2.4: Pre hospital care, transportation mechanism and time taken to the hospital (n=1073)

Characteristics	Variable	NO. (%)
Pre hospital care obtained		
	Yes	570 (53.1)
	No	503 (46.9)
Transportation to the hospital		
	Relatives	379 (35.9)
	Self	323 (30.1)
	Ambulance	71 (6.8)
	Bystanders	196 (18.1)
	police	104 (9.7)
Times taken before the injured cases reach the hospital		
	Less than1 hour	318 (29.6)
	1- 6 hours	531 (49.5)
	7- 12 hours	108 (10.1)
	Above 12 hours	116 (10.8)
Total		1073 (100)

4.2.6 Distribution of motorcycle injuries by mechanism of occurrence

Motorcycle-pedestrian collisions were the commonest accounting for 328 (30.6%) of the motorcycle injury cases that presented at the facilities during the study period, followed by motorcycle-motorcycle collissions with 271 cases (25.3%). Motorcycle-motor vehicle constituted 19% (204) and motorcycle crashes alone (loss of control) were 94 cases (8.8%) as shown in Table **4.2.6.**

Table 4.2.6 Distribution of motorcycle injuries by Mechanism of occurrence (n=1073)

Mechanism of motorcycle injuries	No.	%
Motorcycle by motorcycle	271	25.3
Motorcycle by Motor vehicle	204	19.0
Motorcycle by pedestrian	328	30.6
Motorcycle vs animal	65	6.1
Lone	94	8.8
Motorcycle vs bicycle	29	2.7
Others	82	7.6

4.2.7 Anatomical site or body region affected by motorcycle injury

The distribution of nature of injuries was assessed according to classification method presented by Baker et al., (1974), as shown in Table 4.2.7. In this classification mode, body regions are categorized as follows; Head and neck, upper and lower extremity injuries, chest, abdomen, pelvic, spine. Head and neck and Lower extremity injuries of the patients were the most sustained injuries representing 468 (43.6%) and 214 (19.9%) of patients respectively. On the lower extremities the femur, tibia, fibula and ankle were most affected. One hundred and thirty three (12.4%) of the motorcycle injury patients sustained injuries to the abdomen. Upper extremity injuries affected 85 (7.9%) of the patients while 125 (11.6%) of the casualties from motorcycle crash sustained injuries to multiple sites affecting more than one body region while 48 (4.5%) had variable chest injuries, including rib fractures and various forms of abrasions and laceration to the lung and the heart.

Table 4.2.7 Anatomical site or body region affected by motorcycle injury (n= 1073)

Injury site	No	%
Head and neck injuries	468	43.6
Chest	48	4.5
Abdomen	133	12.4
Pelvis	8	0.7
Spine	2	0.2
Upper extremities	84	7.9
Lower extremities	214	19.9
Multiple sites	115	10.7
Total	**1073**	**100**

4.2.8 Injury Severity

Severity of injury sustained was assessed using the Abbreviated Injury Scale (AIS) and Injury Severity Score (ISS) scale on the basis of the clinical diagnosis according to guidelines by Baker et al., 1974. Injury Seventy Scores (ISS) ranged from 1 to 51. The overall mean ISS was 12.9, with a median of 10.7. Majority 815 (73.0%) of the motorcycle injury cases sustained mild -moderate injuries (ISS<16). Severe injuries, (ISS >16), occurred in more than a quarter (27.0 %) of the cases, with a mean ISS of 24.6 (range 16–51). Of the motorcycle injury cases that presented to the hospitals, nearly half 494 (46%) were admitted in the surgical wards. The length of stay (LOS) in hospitals ranged from 1 to 235 days with a mean of 19.8 days± SD of 8.23, median of 9 days. Fifty two (4.9%) of the cases were admitted in the ICU.

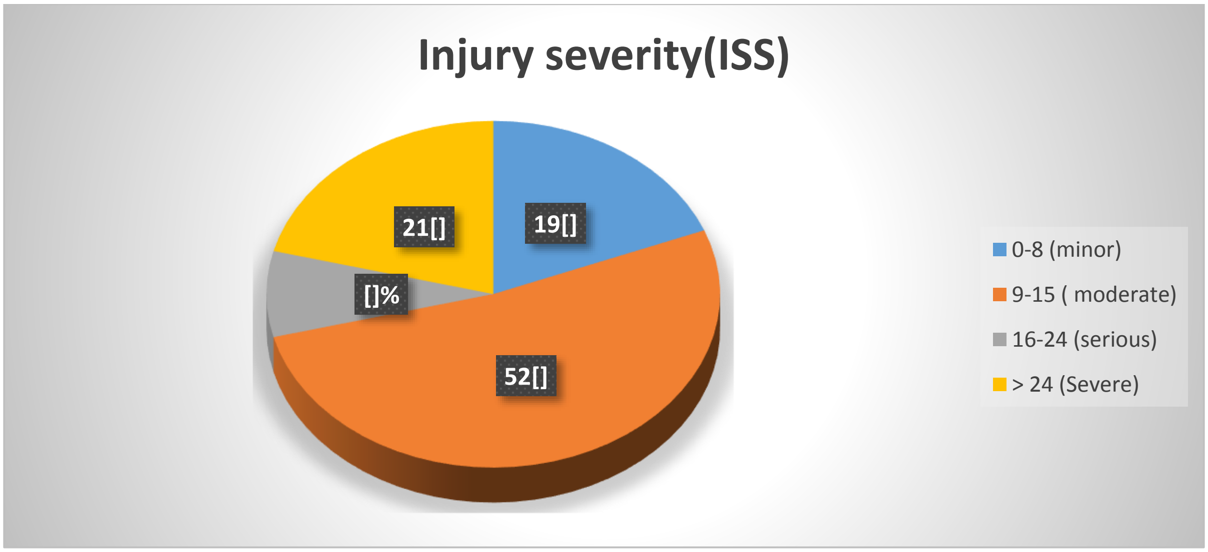


Figure 4.2.2. Injury severity (ISS)

4.2.9 Injured Anatomic Region by Injury Severity (ISS) and Helmet Use

Table 4.2.9**,** shows the injury severity, as defined by maximum ISS, by anatomic region comparing motorcycle injured patients focusing only on motorcycle riders and pillion passenger who wore or without helmets. There was increased proportion of severe injuries (ISS >16) on the head and neck region 75(55.1%) among the un- helmeted (P=0.001), and multiple site injuries (P=0.001). Even with less severe injuries (ISS<16), nearly half 176 (49.2%) of motorcycle riders and pillion passengers who sustained head and neck injuries did not wear helmets, followed by 59(16.0%), and 53(15.6%) who sustained lower extremities and then abdominal injuries respectively. Among both helmeted and un-helmeted motorcycle injury cases, head and neck injuries contributed 110 (34.1%) of severe injuries (ISS>16), followed by Abdomen and lower extremities injuries. Almost three quarters 70.1% of the motorcycle riders and their pillion passengers who sustained severe injuries (ISS>16) were un-helmeted.

Table 4.2.9: Injured Anatomic Region By injury severity (ISS) and Helmet Use (n=684)

	ISS<16			ISS>16			
	Helmet use			Helmet use			
Anatomic injury site	Yes	No	P	Yes	No	P	Overall p
Head and Neck	44(28.9)	176(52.1)	0.001	23(39.7)	75(55.1)	0.001	0.001
Thorax/Chest	3(2.0)	1(0.2)	0.35	2(3.5)	0(0)	0.52	0.46
Spine	0	0	0.0	0	1(0.7)	0.48	0.97
Abdomen	7 (4.6)	59(17.5)	0.06	3(5.2)	11(8.1)	0.15	0.46
Upper extremities	27(17.8)	23 (6.8)	0.83	5(8.6)	9(6.6)	0.02	0.02
Lower extremities	43(28.2)	53(15.7)	0.73	16(27.5)	17(12.5)	0.01	0.02
Multiple sites	28(18.4)	26(7.7)	0.03	9(15.5)	23(16.9)	0.02	0.001
Total	152(22.2)	338(57.2)		58(8.5)	136(22.3)		

4.2.10: Pattern of injury severity by sex, age, type of road user, day of the week,, time of crash, helmet use and alcohol use, prehospital care (n= 1073)

Table 4.2.10 shows the adjusted odds of injury severity among motorcycle injured patients. Motorcycle injury patients were at significantly higher odds of sustaining severe injuries if they were male (AOR = 3.2, 95% CI = 1.95-6.38), motorcycle rider (AOR = 1.4, 95% CI = 1.10-1.80), used alcohol (AOR = 3.0, 95% CI = 1.34-5.70), did not use helmets (AOR = 5.2, 95% CI = 3.36-12.70). Further injury occurrence during the day and weekend were also associated with severe injuries.

Table 4.2.10: Pattern of injury severity by sex, age, type of road user,, day of the week,, time of crash, helmet use and alcol use, prehospital care (n= 1073)

	Severity					
Sex	**1SS<16 NO (%)**	**ISS>16 NO.(%)**	**Odds Ratio (95% Cl)**	**P value**	**Adjusted Odd Ratio (95% cl)**	**P value**
Males	571(72.9)	214(73.8)	3.5(3.15-7.47)	0.001	3.2(1.95-6.38)	0.001
Females	212(27.1)	76(26.2)	-		-	-
Age						
<15	133(17.0)	17(5.9)	0.5(0.26-1.06)	0.07	0.9(0.36-1.54)	0.1
15-29	371(47.4)	117(40.3)	0.6(0.39-0.86)	0.003	0.6(0.41-0.85)	0.002
30-44	166(21.2)	90(31.1)	0.9(0.54-1.33)	0.49	2.9(0.28-7.13)	0.51
45-59	59(7.5)	45(15.5)	1.1(0.10-2.77)	0.79	0.6(0.16-1.16)	0.42
≥ 60	54(6.9)	21(7.2)	-	-	-	-
Type of road user						
Bicyclist	8(1.0)	8(2.8)	-	-	-	-
Motorcycle rider	228(29.1)	145(50.0)	1.4(1.20-1.80)	0.008	2.4(0.17-6.67)	0.03
Passengers	247(31.5)	74(25.5)	0.6(0.48-3.36)	0.45	1.1(0.74-2.02)	0.9
Pedestrian	288(36.8)	85(29.3)	0.7(0.19-3.99)	0.55	0.9(0.14-2.06)	0.6
Helmet use						
Yes	231(29.5)	124(42.8)	-	-	-	-
No	552(70.5)	166(57.2)	4.9(3.32-10.29)	<0.001	5.2(3.36-12.70)	<0.001
Alcohol use						
Yes	169(21.6)	101(34.8)	-	<0.001		<0.001
No	614(78.4)	189(57.2)	3.0(1.34-5.70)		1.2(0.8-1.69)	
Pre hospital care obtained						
Yes	440(56.2)	140(55.5)	-	-	-	-
No	343(43.8)	150(44.5)	1.8(1.25-2.67)	0.004	1..8(1.36-2. 2.3)	0.001
Time of the crash						
Day time	561(71.6)	204(70.3)	2.1(1.36-2.89)	0.001	2.0(1.32-2.98)	0.001
	222(28.4)	86(29.7)	-	-	-	-

Night						
Day of the crash						
Weekday	577(73.7)	214(73.8)	2.5(1.64-3.26)	0.001	2.4(1.46-3.12)	0.001
Weekend	206(26.3)	76(26.2)	-	-	-	-

- reference variable

4.2.11 Association between road user category and Injury severity (ISS) and injury disposition

Most of the motorcycle injury cases (52.0%) sustained moderate injuries followed by 21.0% who had minor injuries as shown in Table 4.2.10. The frequency distribution by ISS varied by category of road user. Approximately a half (44.5%) of all minor injuries (ISS, 0-8) were sustained by motorcycle riders, and nearly three-quarters (73.0%) of all motorcycle injuries were classified as minor or moderate. Most of the patients 193 (60.0%) who sustained moderate injuries were pillion passengers. Motorcycle riders also contributed to 32 (46.4%) of all fatal injuries and 25 (51.0%) of critical injuries, 193 (60.0%) of the pillion passengers had moderate injuries. Nearly three quarters 66 (74.2%) of all injuries classified as serious were sustained by motorcycle riders and their pillion passengers. Further analysis using regression analysis showed that when the proportion of motorcycle injury patients with ISS of less than 16 was compared to those having ISS of 16 or greater, by road user, motorcycle riders were found to be significantly over-represented among the severely injured group. They were 5 times as likely to have sustained serious and severe injuries as pedestrians (OR=5.5; 95% Cl, 2.4 to 9.2; =48.7, p<0.001).

Patient disposition is mirrored in outcome patterns and discharge status of the injury cases which, 251 (73.4%) of the motorcycle riders were treated and discharged routinely, 271 (84.4%) of the pillion passengers were treated and discharged and 16 (0.9%) died, 333 (89.0%) of the pedestrians were treated and discharged and 11 (2.9%) died. There was a significant associations between the severity of injury as measured by Injury severity Score (ISS) score and the type of road user (p-value=0.019), and between the injury outcome and the type of road user (p-value<0.0001).

Table 4.2.11: Association between road user category and Injury severity (ISS) and injury disposition (n=1073)

Road user	Motorcycle rider	Pillion passenger	Pedestrian	Bicyclist	Total	P-value
Injury Severity Score(ISS)						
0-8 (Minor)	70(19.0)	54(17.0)	99(27.0)	1(6.0)	224(21.0)	
8-15 (Moderate)	160(47.0)	191(59.0)	180(51.0)	7(44.0)	538(50.0)	
16-24 (Serious)	41(11.0)	23(7.0)	31(8.0)	0(0.0)	95(8.0)	<0.0001
>24(Severe/ Critical)	100(22.0)	51(16.0)	57(15.0)	8(50.0)	216(19.0)	
Injury Outcome(disposition)						
Routine discharged	274(74.8)	280(87.2)	333(89.0)	8(50.0)	895(83.4)	
Referred	51(15.8)	23(7.2)	24(6.4)	7(43.8)	105(10.2)	<0.0001
Died	37(9.3)	18(5.6)	17(4.2)	1(6.2)	73(3.4)	

4.2.12 Estimation of mortality risk caused by motorcycle crashes based on sex, age, type of road user, length of stay, anatomic injury site, Injury severity (ISS), and Glasgow Coma scale (GCS)

The study variables were entered into regression model using forward method. The variables remaining in the final regression model were included and presented in Table 4.2.11. The odds of mortality was significantly influenced by sex. Fatality were 3.2 times higher for males (AOR =3.17; CI=1.95-6.38) than females. The odds for mortality were 2.9 times greater in age group 30-44 years (AOR=2.89; CI=0.28-7.13) than in <15 years and risk of fatality were increased by 91% in the 19-30 age group (AOR=0.91; CI=0.18-1.92) compared to those aged below 18 years. Mortality was 2.42 times higher among the motorcycle riders (AOR=2.42; CI=0.17-6.67) than bicyclist. Motorcycle injury patients who were hospitalized for ≥15 days were 5 times more at risk of death

(AOR=5.23; CI=2.83-20.15) than those who were not hospitalized. Motorcycle injury patients who did not put on their helmets were 5.2 times greater mortality risk than those who put helmets at the time of crash (AOR=4.8; CI=2.36-12.70).

In terms of anatomic injury site, motorcycle injury patients who sustained head-neck injuries had significantly higher odds of mortality than those who sustained upper extremities injuries (AOR=3.46; CI=0.74-7.15).

Table 4.2.12: Estimation of mortality risk caused by motorcycle crashes based on sex, age, type of road user, length of stay, anatomic injury site, Injury severity (ISS).

Charateristic	Fatality YES NO (%)	No NO.(%)	Odds Ratio (95% Cl)	P value	Adjusted Odd Ratio (95% cl)	P value
Sex						
Males	64(90.1)	725(72.5)	3.5(3.15-7.47)	0.001	3.17(1.95-6.38)	0.001
Females	9(9.9)	275(27.5)	-		-	
Age						
<15	2(2.7)	67(6.7)	-		-	-
15-29	6(8.5)	107(10.7)	1.46(0.66-3.8)	0.03	0.91(0.18-1.92)	0.046
30-44	17(23.9)	445(44.5)	2.72(0.54-5.38)	0.006	2.89(0.28-7.13)	0.002
45-59	22(31.0)	227(22.7)	1.0(0.10-2.77)	0.34	0.56(0.16-1.16)	0.42
≥ 60	19(26.8)	75(7.5)	1.0(0.83-1.26)	0.32	0.93(0.36-1.54)	0.1
Type of road user						
Bicyclist	1(1.4)	15(1.5)	-	-	-	-
Motorcycle rider	35(43.7)	328(32.8)	1.4(0.60-2.18)	0.008	2.4(1.17-4.67)	0.03
Passengers	19(26.8)	302(30.2)	0.62(0.48-3.36)	0.45	1.1(0.74-2.02)	0.9
Pedestrian	18(25.4)	355(35.5)	0.77(0.19-3.99)	0.55	0.98(0.14-2.06)	0.6
Length of stay in days						
≤15	11(26.2)	139(13.3)	-	-	-	
≥ 15	31(73.8)	761(73.0)	14.4 (3.85–23.68)	0.01	5.2(3.83-8.15)	0.001
Helmet use						
Yes	10(15.5)	200(19.9)	-	-	-	
No	63(84.5)	800(80.1)	4.9(3.3-10.29)	<0.001	5.2(2.36-8.70)	<0.001
Alcohol use						
No	33(45.2)	660(66.0)	-	<0.001		<0.001
Yes	40(54.8)	340(34.0)	1.8(0.9-2.29)		1.2(0.8-1.69)	
Anatomic injury site						
Upper extremities	2(2.7)	86(8.6)	-	-	-	-
Head, face and neck	56(76.7)	392(39.2)	5.1(1.46-20.67)	<0.001	3.5(0.74-7.15)	<0.001
Chest/thorax	3(4.1)	46(4.6)	0.4(0.23-1.15)	0.008	0.61(0.13-1.35)	0.08
Abdomen	1(1.4)	125(12.5)	0.6(1.65-6.67)	0.09	1.01(0.14-3.15)	0.52
Lower extremities	(0)	214(21.4)	0.3(0.09-1.08)	0.5	0. 5(0.24-0.95)	0.02

Multiple injuries	11(15.1)	137(13.7)	0.8 (0.71-0.98)	0.02	0.8 (0.71-0.92)	0.01
Injury severity(ISS)						
≤16	2(2.70)	510(51.0)	-	-	-	-
≥16	71(97.3)	490(49.0)	3.2(1.25-14.67)	0.01	6.45(2.24-13.95)	<0.001
Glasgow Coma Scale						
9-15	0(0)	515(49.4)	-	-	-	
4-8	16(21.9)	233(22.3)	1.5(1.2-5.18)	0.05	2.05(1.34-4.25)	0.041
1-3	57(78.1)	294(28.2)	13.5(7.01-18.67)	0.01	14.0(8.24-16.95)	<0.001
Pre hospital care obtained						
Yes	16(19.7)	555(55.5)	-	-	-	-
No	57(80.3)	445(44.5)	4.10(1.25-7.67)	0.004	4..0(2.25-7.62)	0.001

4.3 Objective II: The burden of motorcycle injuries on Tier III hospitals in Kisumu City

4.3.1 Introduction

The study gathered information on hospital facility utilization by motorcycle injury cases in Kisumu city. The variables of interest included, emergency department cases and admissions, laboratory and radiological investigations, use of surgical procedures, hospital stay, bed occupancy, and utilization of intensive care unit (ICU)

4.3.2 Proportion of motorcycle crash injury in relation to other injuries Emergency Department Visits

A total of 52,417 Emergency Department Visits were recorded in the study hospitals during a six month period. **Table 4.3.1** presents a summary of the data showing the relative proportions of the five leading causes of ED visits. Motorcycle injuries were the 2nd cause of ED visits accounting for 2.04% of the total emergency visits and 12.04% of all injuries . They were also the second most common cause of injury admissions in the hospitals (13.6%).

Table 4.3.1. Types of Injuries at Hospital Emergency Departments in Kisumu, Kenya

Type of injury	ED Attendance, No. (%)	Hospital Admissions, No. (%)
Assaults	2368 (26.6)	813 (22.4)
Other road traffic injuries	658 (7.4)	398 (11.0)
Fall injury	987 (11.1)	433 (11.9)
Motorcycle injury	1073 (12.0)	494 (13.6)
Other injuries	3815 (42.9)	1416 (39.0)
Total	8901	3627

Other injuries constitute; burns, drowning, bites-dog, snake, poisonings

4.3.3. Proportion of motorcycle crash injury patients ED visits and admissions by Age and Sex, road user, anatomic injury site and helmet use

The proportions of motorcycle injury patients Emergency department visits and admissions by Age, sex, rod user, anatomic injury site and helmet use are presented in Table 4.3.2. Hospital utilization by motorcycle injury cases stratified by sex and two age-group categories; as children aged 0-14 years, and adults aged 15 years and over. There was significant over-representation of males in all categories of hospital attendees *(* $p<0.001$).

Pedestrians hit by motorcycles were the most numerous ED patients 208 (38.0%), followed by motorcycle riders 168 (30.7%). Among hospital admissions, motorcycle riders were most common (190 (38.5%), followed by pedestrians 156 (1.5%). Pillion passengers ranked third among both ED visits (29.8%) and admissions (29.0%). The odds of motorcycle casualty being admitted was three times greater for motorcycle rider- than for bicyclist (OR=3.3; 95% Cl, 13.9 to 18.5; $P<0.001$).

There was increased rate of hospitalization for motorcycle injuries to the Head and neck region (OR=2.6; 95% Cl, 0.345.9 to 3.345; $P<0.001$) and multiple sites (OR=1.7; 95% Cl, 0.268 to 3.129; $P<0.001$) than from injuries to the lower extremities. Motorcycle injury to the Head and neck region 490 (47.0%) comprised the bulk of injury presentations with over half (55.2%) resulting in hospital admission. Injuries to the pelvis and spine affected less than 1% of motorcycle injury patients. Analysis of the relationship between helmet use and hospital presentation by motorcycle riders and pillion passengers indicates that most motorcycle injured patients (73.6%) were un-helmeted at the time of the crash. Non-helmet use was significantly associated with increased hospital admissions (OR= 8.2; 95% CI 4.273-17.539).

Table 4.3.2. Proportion of motorcycle crash injury patients ED visits and admissions by Age and Sex, road user, anatomic injury site and helmet use

Characteristics	ED Attendances, No. (%)	Hospital Admissions, No. (%)	Total (%)	OR (95% CI)
Age in years				
<15	38(6.9)	47(9.5)	85(8.2)	-
>15	510(93.1)	447(90.5)	957(91.8)	4.6 (3.1- 7.8)
Total	548(100)	494(100)	1042(100)	
Sex				
Male	392(71.5)	430(87.0)	822(78.9)	1.3 (1.1-1.5)
Female	156(28.5)	64(13.0)	220(21.1)	-
Total	548(100)	494(100)	1042(100)	
Road user				
Motorcycle rider	169 (30.7)	190 (38.5)	359(34.4)	3.3 (1.83-4.98)
Passenger	164 (29.8)	143 (29.0)	307(29.5)	0.98(-0.32-4.72)
Pedestrian	206 (37.4)	156 (31.5)	362(34.7)	0.89 (-0.32-3.81)
Bicyclist	9 (1.7)	5(1.0)	14(1.3)	-
Total	548(100)	494(100)	1042(100)	
Helmet Use				
Yes	121 (33.7)	59 (18.2)	180 (26.4)	-
No	238 (66.3)	266 (81.8)	504 (73.6)	8.2 (4.27- 17.12)
Total	359 (100)	325 (100)	684 (100)	
Anatomic Injury site				
Head and neck	205 (37.7)	285 (57.7)	490 (47.0)	2.6 (1.35-4.35)
Chest	26 (4.5)	22(4.5)	48 (4.5)	0.3(0.46-0.68)
Abdomen	69 (12.6)	61 (12.9)	130 (12.5)	0.3(0.46-0.68)
Pelvis	8 (1.1)	0 (0)	8 (0.8)	0.9 (-0.40-3.94)
Spine	1 (0.0)	1(0.4)	2 (0.2)	1.2(-4.26-2.03)
Lower extremities	131 (23.9)	33(6.6)	164 (15.7)	0.3 (0.09-1.16)
Multiple sites	61 (10.3)	54(10.9	115 (11.0)	1.3 (0.19-3.90)
Upper extremities	47 (8.6)	38 (7.7)	85 (8.2)	Ref
Total	548(100)	494(100)	1042(100)	

4.3.4 Hospital services utilization by motorcycle crash injury cases

Utility of various services offered among the motorcycle injury cases showed that 90.1% and 58.7 % used theatre for minor and major surgical procedures. Radiological services were utilized by 84.9% of the patients. In addition, of the 123 patients admitted in ICU, 42.3% were due to motorcycle injury as shown in Figure 4.3.1.

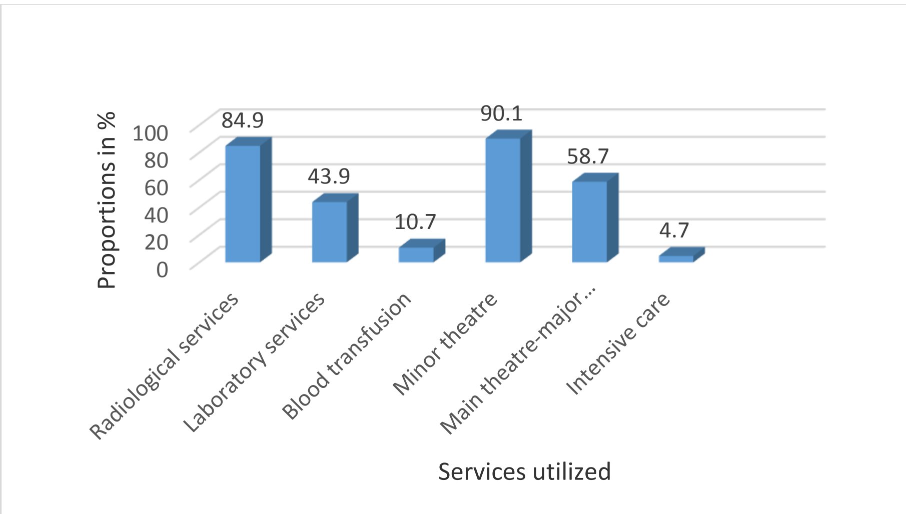


Figure 4.3.1: Hospital services utilization by motorcycle crash injury cases

4.3.5 Hospital length of stay in the hospital by motorcycle injury cases

The length of stay (LOS) in hospitals ranged from 1 to 235 days with a mean of 19.8 days (SD± 8.23) and median of 9 days. Altogether the motorcycle injury cases had a total of 9781.2 hospital days during the study period which was 42.1% of the total bed days of all admissions in the hospitals. The highest proportion of admitted cases (53 %) spent 7-14 days in the hospitals (Figure **4.3.2**).

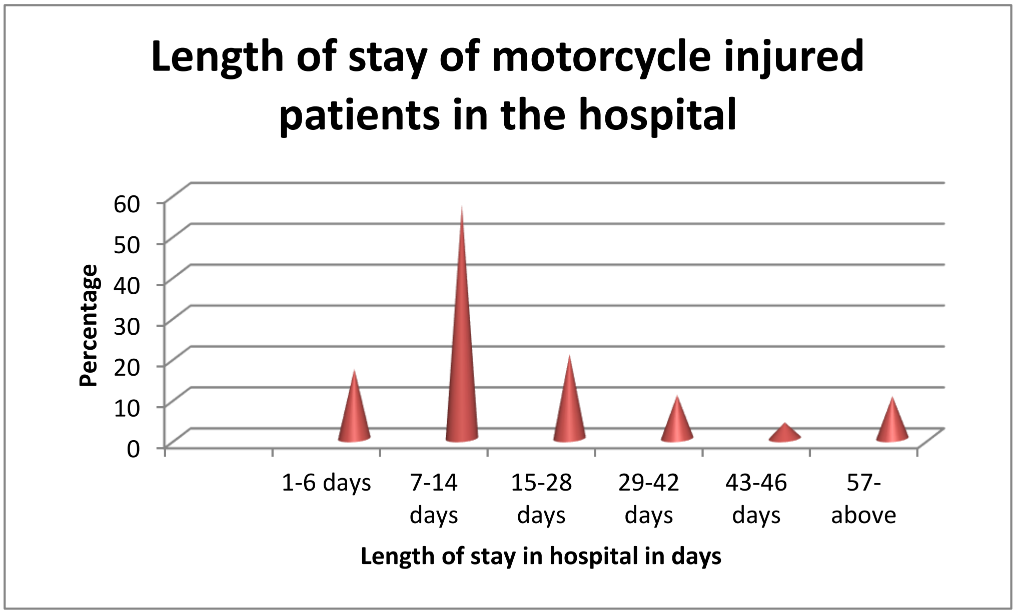


Figure 4.3.2: Number of days of motorcycle casualties in hospital

4.3.6 Length of stay of motorcycle injuries in relation to other injuries

In comparison to injuries that presented in the hospitals, motorcycle-related injury cases had the highest mean length of stay of 19.8 days± SD of 8.23 days representing, 42.1% of the total number of bed days, followed by other road traffic injuries (12.6 days SD± 6.3). Assault cases had the least mean length of stay in the hospital of 4.1 SD± 8.3.. Motorcycle injury cases and other road traffic injury cases had the longest hospital stay(Fig. 4.3.3).

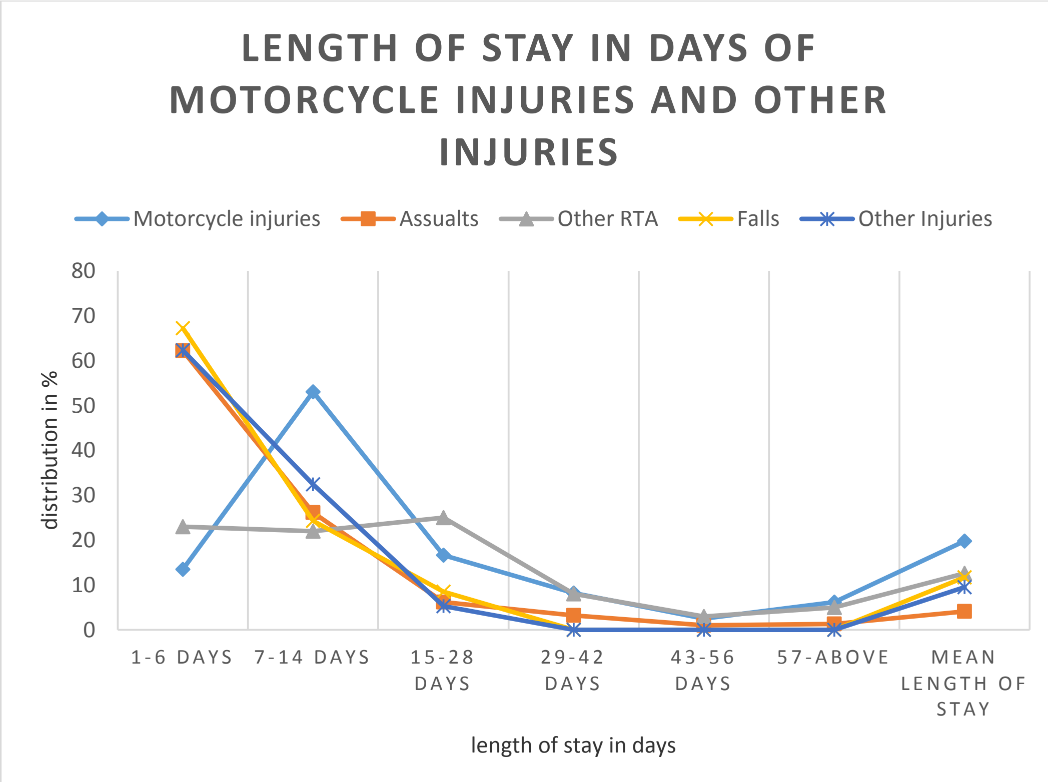


Figure. 4.3.3: Length of stay of motorcycle injuries in relation to other injury conditions

4.3.7 Relationship between Length of Stay and ISS

Injury Severity Score (ISS), as a measure of the severity of an injury, was computed for all motorcycle injured patients. The ISS scores were categorized as: 0-3, minor; 4-8, moderate; 9-15, serious; and 16 and over severe. ISS were regrouped into two groups of; ISS <16 and ISS equal > 16 or greater, as was appropriate, to allow for statistical analyses of proportions.

An assessment of the relationship between mean length of stay and **ISS** scores and the hospitals attended showed that motorcycle injured patients with high **ISS** levels **(ISS** >16+) were hospitalized for significantly longer periods than those with less severe injuries (mean LOS=43.0 days versus 4.8 days for ISS 1-3 ; F= 213.6, p<0.001). However, when analysed with respect to each participating hospital, the F-test results showed highly significant differences between the ISS<16 and **ISS** >16 (p<0.001); among admissions at Agha-khan (38.5 days for ISS>16 versus 7.3 days for ISS<16), JOOTRH (38.2 versus 5.2 days) and KCH (16.4 versus 2.3 days).

4.3.8 Number of days (Length of stay) of motorcycle injuries in hospital in relation to age, sex, level of education road user category, injury diagnosis, helmet use, alcohol use (n= 494)

The majority 197 (68.9%) of the cases were admitted in the Jaramogi Oginga Odinga teaching and referral Hospital which is the largest public hospital in the region with mean length of stay of 25.3 days for all the motorcycle injury patients. The mean length of hospital days varied significantly with the principal diagnosis ($F=7.66$: $P<0.001$); severity of motorcycle injuries ($F=59.002$: $P<0.001$), type of road user ($F= 151$; $P=0.002$) and medical/ surgical procedures appropriated ($F= 1419.5$; $P< 0.001$). There was no significant difference between the mechanism of injury and mean length of stay ($F=1.23$: $P=0.234$) as shown in Table 4.3.3.

Table 4.3.3:Number of days (Length of stay) of motorcycle injuries in hospital in relation to age, sex, level of education road user category, injury diagnosis, helmet use, alcohol use (n= 494)

Characteristics	No.	%	Mean LOS	F(ANOVA)	P-value
Age of the participant					
0-10	10	3.5	15.7		
11-20	33	11.2	26.2		
21-30	104	36.4	19.8	4.474	<0.001
31-40	63	22.0	20.2		
41-50	40	12.7	23.2		
Above 50	13	10.1	22.6		
Gender					
Male	222	77.6	21.5		
Female	64	22.4	19.3	4.546	<0.001
Alcohol use					
Yes	99	34.6	26.3	5.656	0.001
No	187	66.4	14.2		
Helmet use					
Yes	31	10.8	21.3		
No	255	89.2	24.1	2.045	0.039

4.3.9 Multivariable regression analysis of mean length of stay, as a dependent variable with ISS, demographic and mechanism of injury, injury diagnosis, road user, Helmet use, Anatomic injury site, Glasgow Coma Scale, Surgical intervention, Pre hospital care obtained, Health insurance

From the initial results from univariate analysis, significant predictors of Hospital length of stay with p value of <0.05 were further analysed. Multivariate logistic regression with enter method was performed. Analysis of the crude odds ratios for factors associated with hospital length of stay (Table 4.3.11) shows that injury severity, higher injury severity score of ISS > 16, and lower Glasgow Coma Scale (GCS=3-8); had 6 and 5 times increased influence on length of stay than lower injury score ISS < 16 and higher Glasgow Coma Scale respectively, Patients who sustained injuries that required surgical intervention were 5 times (OR =5.3; 95% CI=0.9-10.27) more likely to stay longer in the hospital than those who did not, helmet nonuse (OR =4.9; 95% CI=3.3-10.29) motorcycle rider (OR =1.7; 95% CI=0.467-3.771), also increased hospital length of stay. In terms of anatomic injury site, motorcycle injury patients who sustained injuries to the head were 5 times more likely to stay longer in the hospital than those who sustained injuries to the extremities.

After adjusting for the effects of all the variables, surgical intervention (AOR =6.5; CI=1.9-20.47), higher injury severity score (ISS>16), lower Glasgow Coma Scale; GCS=3-8 (AOR =5.5; CI=2.24-16.82) were the main factors influencing hospital length of stay. In the final model, demographic factors, being male (AOR =1. 7; CI= 1.95-3.38), age groups of 19-30 years (AOR =2.91; CI=1.48-7.92) and 31-40 years (AOR =1. 2; CI= 0.28-1.73) increased significantly the length of stay. In relation to anatomic injury site; Head, face and neck (AOR =4.6; CI= 2.74-6.15) and multiple injuries (AOR =3.01; CI= 0.14-9.15) significantly increased the likelihood of staying longer in the hospital than injuries to extremities (Table 4.3.4).

Table 4.3.4: Matrix of multivariable regression analysis of mean length of stay, as a dependent variable with ISS, demographic and mechanism of injury, injury diagnosis, road user, Helmet use, Anatomic injury site, Glasgow Coma Scale, Surgical intervention, Pre hospital care obtained, Health insurance

Gender	**Odds Ratio (95% Cl)**	**P value**	**Adjusted Odd Ratio (95% cl)**	**P value**
Males	1.2(0.466-2.211)	0.001	1.7(1.95-3.38)	0.001
Females	-		-	-
Age				
<15	0.4 (0.02-4.29)	0.35	0.3 (0.06-3.49)	0.28
16-29	2.6 (0.66-5.82)	0.030	2.9 (1.48-7.92)	0.01
30-44	0.9 (0.54-5.38)	0.106	1.2 (0.28-1.73)	0.05
45-59	0.2 (0.150-1.39)	0.45	0.16 (0.16-1.16)	0.42
≥ 60	-		-	-
Type of road user				
Motorcycle rider	1.7(0.467-6.171)		1.4(0.17-3.28)	0.03
Passengers	1.4(0.400-4.900)	0.003	1.0 (0.74-1.42)	0.9
Pedestrian	1.6(0.193-3.999)	0.56	1.7(0.14-4.36)	0.6
Bicyclist	-	0.455 -	-	-
Helmet use				
Yes	-		-	-
No	4.9(3.3-10.29)	<0.001	5.2(0.36-12.70)	0.001
Anatomic injury site				
Head, face and neck	5.4(0.567-11.17)	0.05	4.6(2.74-6.15)	0.001
Chest/thorax/abdomen	2.5(0.26-7.16)	0.08	2.6(0.23-8.35)	0.18
Multiple injuries	4.2(1.70-10.57)	0.001	3.01(0.14-9.15)	0.05
Extremities	-	-	-	-
Injury severity(ISS)				
>16	6.0(2.06-11.047)	0.001	6.2 (1.04-12.65)	0.001
<16	-	-	-	-
Glasgow Coma Scale				
3-8	5.3(2.20-10.73)	0.001	5.5(2.24-16.82)	0.001
9-12	0.8(0.07-1.708)		1.05(0.37-4.36)	0.041
13-15	-	-	-	-
Surgical intervention				
Yes	5.3(0.9-10.27)	0.001	6.5(1.9-20.47)	0.001

No	-	-	-	-
Pre hospital care obtained				
No	3.10(1.18-8.58)	0.004	2.2(1.25-6.74)	0.001
Yes	-	-	-	-
Health insurance				
Yes	0.7(0.39-1.38)	0.61	0.6(0.26-1.67)	0.07
No	-	-	-	-

4.3.10 Burden of motorcycle injuries on radiological services in the hospitals

Of the total number of radiological investigations (3502), 63.6% were X- rays. Motorcycle injury patients comprised 62% of all the patients X-rayed, and were the second leading cause of radiological investigations, after assaults. Motorcycle injuries were the leading cause of CT scan representing 31.3% (Figure 4.3.4). Utilization of radiological services varied significantly with hospital attended by the motorcycle injury cases (χ^2= 222.091: P<0.001); severity of injuries (χ^2= 260.78: P<0.001), type of road user (χ^2= 97.8; P=0.002) and medical/ surgical procedures appropriated (χ^2= 530.5; P< 0.001); alcohol use (χ^2= 61.35: P<0.001); age of the motorcycle injured patients (χ^2= 123.01: P<0.001), helmet use (χ^2= 1419.5; P< 0.001).

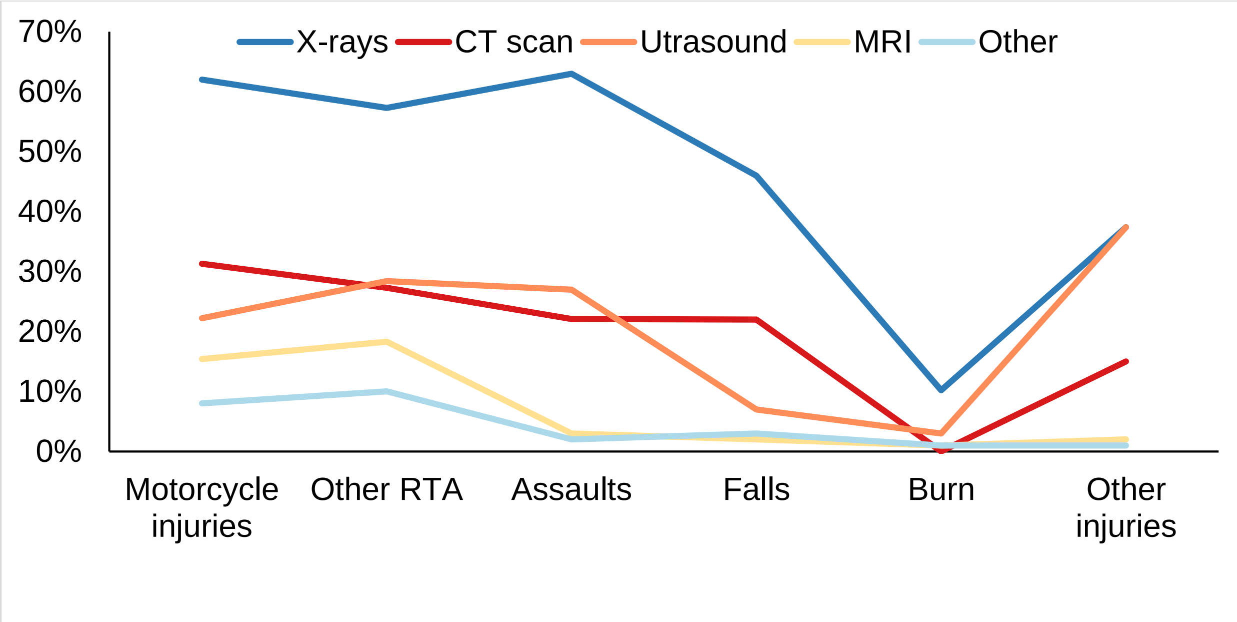


Figure 4.3. 4. Burden of motorcycle injuries on radiological services in the hospitals

4.3.11 Burden of motorcycle injuries on surgical department

Analysis of motorcycle injury data was done on various surgical interventions that were undertaken by external cause of injury. Of the 3652 surgical procedures conducted within the hospitals during the study period, 1939 (53.09%) procedures were performed on the 939 motorcycle injury cases that presented to ED and those admitted. A third (30.5%) of those who required minor surgeries had been assaulted, whereas motorcycle related injuries, other RTIS and falls affected patients constituted 22%, 17.1% and 15.2%, respectively while motorcycle related injury patients were the leading cause of major surgical interventions representing 35.1% as indicated in Figure 4.3.5**.**

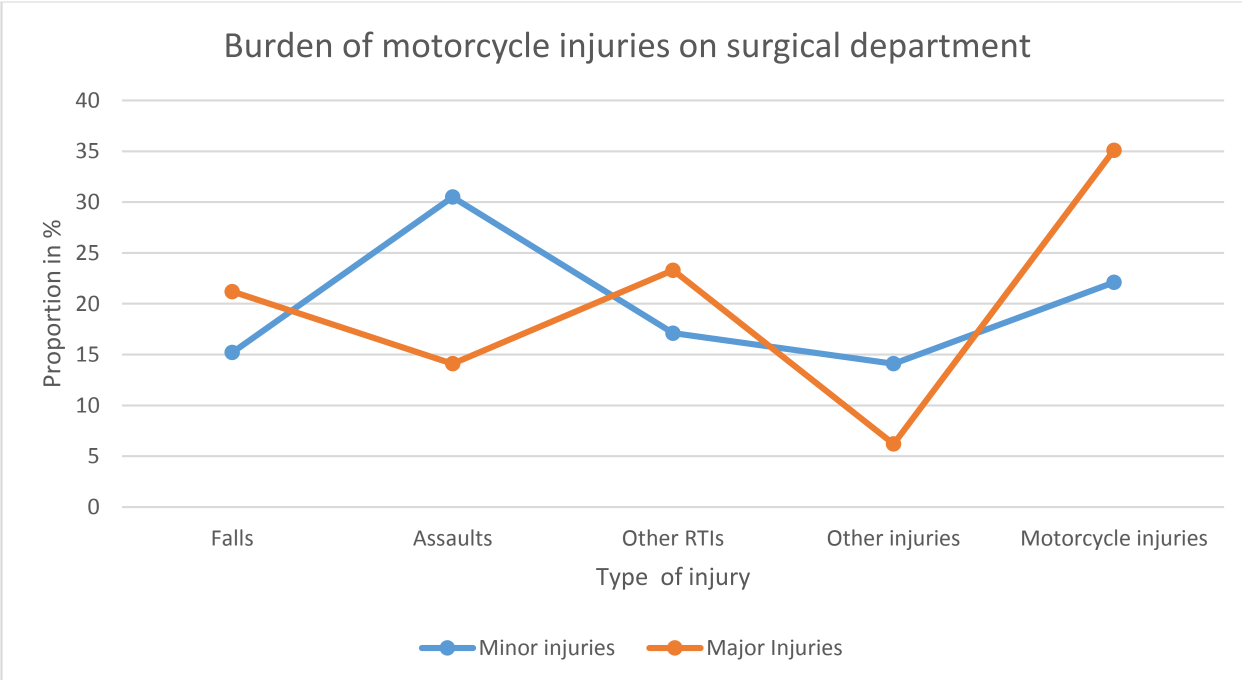


Figure 4.3. 4. Burden of motorcycle injuries on surgical department

4.3.12 Distribution of Surgical procedures undertaken on motorcycle injury patients

Figure **4.3.5:** shows the distribution of the various surgical procedures: wound debridement, suturing and cleaning were in the most common (52.8 %) (495). Six motorcycle crash injured cases were amputated on the lower extremities.

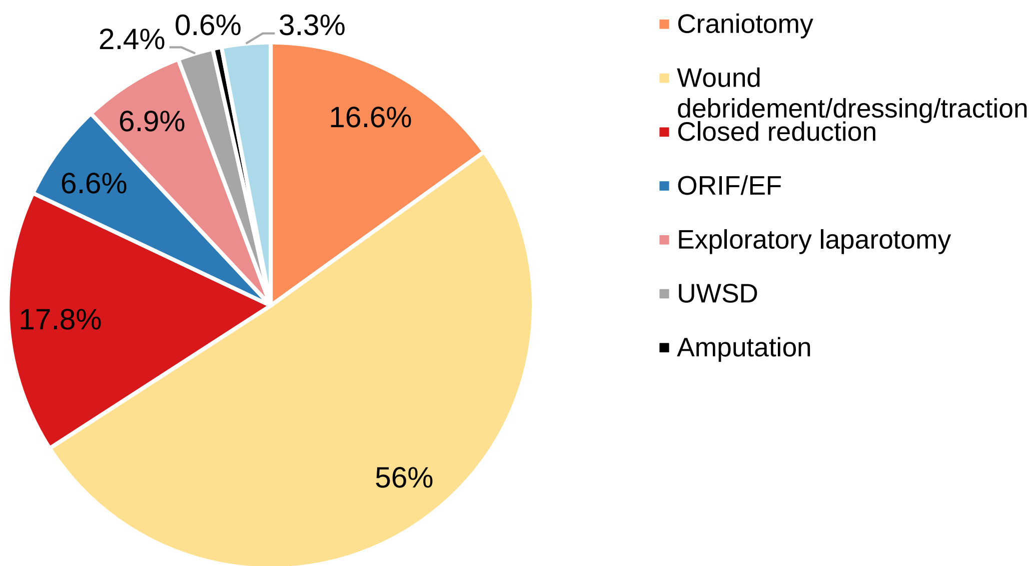


Figure 4.3.5: Distribution of Surgical procedures undertaken on motorcycle injury patients

4.3.13 Isolated Medical/Surgical procedures by type of road-user (n=939)

The type of surgical intervention undertaken varied considerably by the type road user (χ^2= 11.86; P=0.032***)***. Of the 156 cases who sustained injuries requiring Craniotomy 67 (42.9.5%) were motorcycle riders, whereas a large proportion of motorcycle injury cases whose conditions required closed reduction 68 (41%) were basically pedestrian. There was increased probability of amputation (OR=1.9; CI 0.2-4.1) and multiple injuries (OR=2.6; 0.4-4.6) among motorcycle riders than bicyclists (OR=1.9; CI 0.2-4.1). Two thirds (66.7%) of those who underwent amputation and 56.6% who sustained injury leading to under water sealed drains (UWSD), were motorcycle riders.

Table 4.3.5: Isolated Medical/Surgical procedures by type of road-user (n=939)

	Road user category					
Surgical procedure	**Motorcycle rider**	**Passenger**	**Pedestrian**	**bicyclist**	**Overall**	**OR (95% Cl)**
Craniotomy	67 (20.3)	40 (15.6)	47(13.9)	2(12.8)	156 (16.6)	1.8(1.2-2.3)
Wound debridement /dressing/	134 (40.6)	123 (48.2)	168 (49.7)	11(68.8)	436(56.0)	1.2 (0.2-4.2)
Closed reduction	58 (16.6)	39 (15.3)	65(19.2)	1(6.3)	166(17.8)	1.6 (1.1-2.0)
ORIF/EF	24 (7.3)	17(6.7)	16(4.7)	1(6.3)	56(6.6)	1.1(0.2-1.99
Exploratory laparotomy	16 (4.8)	24(9.4	25(7.4)	0(0)	65(0.6)	0.9 (0.3-1.8)
UWSD	13(3.9)	4(1.6)	6(1.8)	0(0)	23(2.4)	2.2 (0.6-4.1)
Amputation	4 (1.2)	1 (0.4)	1(0.3)	0(0)	6(0.6)	1.9 (0.2-4.1)
Multiple surgeries	14(4.2)	7(2.7)	10 (3.0)	0(0)	31(3.3)	2.6 (0.4-4.6)
Total	330(100)	255 (100)	338(100)	16(100)	939(100)	

Abbreviation; OR, odds ratio

4.3.14 Relationship between Isolated Medical/Surgical procedures and severity of motorcycle injuries

An assessment of the relationship between ISS and type of surgical intervention showed that patients with ISS levels ≥16 were more likely to undergo a craniotomy (OR=2.5; 95% CI=1.8, 4.3) or closed fracture reduction (OR=1.8; 95% CI=1.1, 2.5) than those with low ISS levels (<16)

All the six who were amputated had Injury Severity Score of ISS >16. This indicates that there was significant association between types of surgical procedure and the Injury severity score.

Table 4.3. 6: Relationship between Surgical Procedures and Severity of Motorcycle Crash Injuries at Hospitals in Kisumu, Kenya

Surgical Procedure	Patients With ISS <16, No. (%)	Patients With ISS >16, No. (%)	Total, No. (%)	OR (95% CI)
Craniotomy	89 (13.0)	67 (25.9)	156 (16.6)	2.5 (1.8, 4.3)
Wound debridement/dressing	383 (56.3)	53 (20.5)	436 (56.0)	1.1 (0.2, 2.3)
Closed fracture reduction	119 (17.5)	47 (18.1)	166 (17.8)	1.8 (1.1, 2.5)
ORIF/EF	28 (4.1)	28 (10.8)	56 (6.6)	1.4 (0.2, 2.91)
Exploratory laparotomy	43(6.3)	22 (8.5)	65 (0.6)	0.9 (0.1, 1.6)
UWSD	13 (1.9)	10 (3.9)	23 (2.4)	1.1 (0.6, 2.1)
Amputation	0 (0.0)	6 (2.3)	6 (0.6)	2.8 (1.2, 4.1)
Multiple surgeries	5 (0.7)	26 (10.0)	31 (18.4)	3.2 (1.4, 5.6)
Total	680 (100)	259 (100)	939 (100)	

Abbreviations: CI, confidence interval; ISS, injury severity score; OR, odds ratio; ORIF/EF, open reduction and internal fixation/external fixation; UWSD, underwater seal drain.

Utilization of medical/surgical procedures varied significantly with hospital attended by the motorcycle casualties (χ^2= 222.091: P<0.001) whereby 53.3% of all major surgeries on motorcycle injured patients were conducted in JOORTH and only 9% were conducted in KCH., Injuries requiring radiological investigations influenced significantly the type of major surgical procedures conducted (χ^2= 1035.38: P<0.001), medical/surgical procedures were also statistically associated with: severity of injuries (χ^2= 218.91: P<0.001), type of road user (χ^2= 11.86; P=0.032) and Anatomic site of the injury (χ^2= 46.72; P< 0.001); injuries to the head contributed to 67% of all major surgeries. There was also significant association between Injury diagnosis (χ^2 =107.586; P

<0.001); Alcohol use (χ^2= 41.58: P<0.001); age of the casualties (χ^2= 45.95: P<0.001), helmet use (χ^2= 1419.5; P< 0.001); gender of the motorcycle casualties (χ^2= 13.00: P<0.001) and major surgical procedures. Motorcycle injury cases with severe fractures on the head, chest and abdomen on males and motorcycle riders and their pillion passengers who did not put on helmets significantly increased the probability of major surgical procedures. The performance of major surgery on motorcycle injured patients differed significantly with the patients being subjected for specialized care in the intensive (χ^2= 266.036; P<0.001).

4.3.16. A qualitative study of the burden of motorcycle injuries on health facility and individual motorcycle injury cases

This section presents an analysis of motorcycle crash information captured by qualitative survey methods. It describes findings from key informant interviews. The key informants are noted as study particiants in Table 4.3.8

The burden of motorcycle injuries on health facilities and individual cases were clearly articulated by a cross-section of key respondents (N=14). In response to question to illicit views on how motorcycle injuries have impacted on health care and individual motorcycle cases various issues were mentioned. Most respondents felt that burden exerted on health facility was higher representing 52.5% of 101 citations than on individual or family. (Table 4.3.7).

Of the impact of motorcycle injuries mentioned with the highest frequency, strained medical resources ranked first, cited by 92.8 % of the respondents, followed by loss /depletion of income (78.6%), overcrowding and congestion and frustration, despair and powerlessness ranked third accounting for 71.4% of the respondents each; Increased utilization of medical resources comprising of investigations, surgical procedures comprised 64.3%, and Prolonged hospitalization/ overstay were mentioned by 57.1%. Other issues raised were 60%, Change of roles and responsibilities, over stretched staff, catastrophic expenditure and sudden unexpected expenditure each being mentioned by 50% of the respondents.

Table 4.3.7: Perceived burden of motorcycle on hospital facility and individual by type informants

	INDIVIDUAL KEY INFORMANTS														
	NUJ	NAG	NKC	RAJ	RAA	RAK	EMJ	EMA	EMK	DIJ	DAG	MEK	TP	IPS	NO.(%)
Hospital burden															
Strained medical resources	√	√	√	√	√	√	√	√	√	√	√	-	√	√	13(92.9)
Overcrowding and congestion	√	√	√	√	√	-	√	√	√	√	√	-	-	-	10 (71.4)
Over stretched staff	√	-	√	√	-	√	√	-	√	-	-	√	-	-	7 (50.0)
Utilization (increased)	√	√	√	--	√	-	-	-	√	√	-	√	√	√	9 (64.3)
Commotion and confusion	-	√	-	√	√	-	√	√	-	-	√	-	-	-	6 (42.90
Prolonged hospitalization	√	-	-	√	-	-	√	√	√	√	-	√	√	-	8(57.1)
Family /individual burden															
Loss /depletion of income	√	-	√	-	√	-	√	√	√	√	√	√	√	√	11(78.6)
Loss of assets	√	-	√	-	-	√	-	√	-	-	√	√	-	-	6(42.9)
Sudden unexpected expenditure	√	-	√	-	-	√	-	√	-	√	√	-	√		7(50.0)
Frustration, despair	√	√	√	√	√	√	√	√	-	√	-	√			10 (71.4)
Change of roles	-	√	-	√	-	√	-	√	-	√	-	√	-	√	7(50.0)
Catastrophic expenditure	√	-	√	-	-	√	-	√	-	√	√	-	-	√	7(50.0)

Table 4.3.8. Study participants (Key informants)

1.	NUJ	Nurse at Jaramogi Oginga Odinga Teaching and Referral Hospital
2.	NAG	Nurse at Aga Khan University
3.	NKC	Nurse at Kisumu County hospital
4.	RAJ	Radiologist at Jaramogi Oginga Odinga Teaching and Referral Hospital
5.	RAA	Radiologist Aga Khan University Hospital
6.	RAK	Radiologist at Kisumu Hospital
7.	EMK	Emergency department at Kisumu County Hospital
8.	EMA	Emergency head at Aga Khan University Hospital
9.	EMJ	Emergency head at Jaramogi Oginga Odinga Teaching and Referral Hospital
10.	DJ	Director, Jaramogi Oginga Odinga Teaching and Referral Hospital
11.	DAG	Director, Aga Khan University Hospital
12.	TP	Traffic Police Officer
13.	MEK	Medical superintendent at Kisumu County Hospital
14.	IP	Injured Patient survivor

Views concerning the implications of motorcycle injuries on the health facilities varied between informants. Nurses, for example, felt that motorcycle injuries results in increased utilization of health services, and prolonged hospitalization resulting in overcrowding in the wards. For instance, when asked what they thought were the main effect of motorcycle injuries on health care a nurse said,

> "*the burden exerted on health facility is not just on the finances but also on the level of utilization of health services. Motorcycle injury cases do exhibit increased demand for specialized investigation, care, surgical procedures and medication; motorcycle injured patients stay longer (over stay) within the hospital, causing ward congestion and overcrowding; there is always an average of 140 patients in the surgical wards each time and bed capacity is 107. So the bed occupancy rate is higher than (far outweigh) the capacity mostly due to motorcycle injury patients. Due to over stay some motorcycle injury patients due to limited mobility, pressure sores, develop complications like deep vein thrombosis, and cross infections."(NAG).*

In addition, another nurse said,

> "*One severe motorcycle injury case can have multiple body injuries requiring several investigations and multiple surgical procedures. Such cases again stay longer in the hospital demanding many other medical materials and equipment for care."(*NUJ).

A different view was expressed by the head of the emergency department, who attributed the main impact of motorcycle injuries on health facilities to be overcrowding and congestion, commotion and confusion, and over stretched staff. The moment that reports of mass casualty, staff are mobilized from all the departments that is x-ray, theatre, surgical wards so that they can prepare the emergency (outpatient) department to care for the motorcycle injury cases.

> "*The number of motorcycle injury cases demanding minor or major surgical procedures are huge consequently causing overcrowding on out patients department and surgical wards due to repeated and continuous and delayed bookings of injury patients for elective or emergency surgery because of inadequate space, moreover one patient may require several surgeries and bookings depending on the nature and severity of the crash injury."(NKC).*

> *"The huge number of motorcycle injury cases has resulted on overstretched staff (burn out) due to shortage of human resource, consequently causing frustration among staff handling emergencies potentially compromising quality of care*."(EMA).

The reports of depletion of medicines and medical equipment, and the limited availability of staff for more personalized attention in places where the motorcycle injury cases were treated were frequently reported by the respondents.

Other respondents cited the burden of motorcycle injury in hospital care in terms of human resources and physical facilities. There is a huge strain on human resource and basic trauma equipment and materials.

"*Our biggest problem is inadequate human resource, infrastructure and resuscitation equipment; the chest tube, suction tubes, cervical collars, oxygen…*" (RAK).

In addition to the hospital burden, the motorcycle injuries also have impacts on individuals and their families. The major issues in this category were problems of caring for the injured people (skills, costs, the stamina of caring), loss /depletion of income, loss of assets, sudden unexpected expenditure, catastrophic expenditure and change in roles of the family members such as the breadwinner role of the mother of children due to injury of the father, and cut or reduction of family income.

A key informant (KI) reported that most of the motorcycle injury cases are the bread winners of their families; any injury incidents that affect on them gravely impacts on the entire family in diverse ways. The informant reported that, some family members are made to stop their work to cater for the injured victims, further reducing the overall earning ability of the entire family. Some school going children cease their schooling because of the financial predicament imposed on their parents or guardians due to the crash. Below is the KI's expression:

> "*Since the crash, our lives as a family has changed, as you can see, no mobility, cannot do anything, everything I desire must be done for me—you can name them! You see, my brother taking care of me was admitted to pursue a course in the University, but 7 months down the line, he has been with me; he just reported and came back. We have also sold*

all the cows we had to cater for the medical bills, it has become difficult- all the savings depleted and no income."

Testimonies repeatedly stressed the important role played by family members during hospitalization. The family members and caretaker to participate actively in the care of motorcycle injured cases in the hospital; in their absence, important complications and even death can occur. When relatives did not have the opportunity to intervene in the care of their deceased relatives, therefore the feelings of helplessness, frustration and regret set in.

A police officer and selected patients, were in agreement that that the effect of motorcycle injuries are greater among individuals and families. They mentioned that individual patients and their families suffer great loss of income, loss of assets, incur huge unexpected expenditure. Others suffer despair and frustrations due to unexpected changes due change of roles.

4.4: Objective III: cost incurred by motorcycle injury cases attended to in Tier III Hospitals in Kisumu City

The study in this section was to quantify the cost of motorcycle injuries using human capital approach and willingness to pay approaches.

4.4.1 Cost of motorcycle injuries using the human capital and willingness to pay approaches

As shown in Table 4.4.1; during the study period the total costs for motorcycle injury cases who attended the hospitals was Kshs. 158,236,383. Of these, the indirect cost was Kshs. 109,308,240 representing 69.1%. Of the total direct cost, medical cost was the highest Kshs. 19,134, 259 (39.5%). Property damage and funeral cost accounted for 10.6 % and 8.1% respectively of the total cost.

Table 4.4.1.1: Cost of motorcycle injuries using the human capital approach

Cost	Kshs.	%	Mean
Direct cost			
Medical/treatment cost	19, 134, 259	12.1	18363.01
Property damage cost	16,786, 442	10.6	156,644.40
Administrative cost	166,400	0.1	2279.45)
Funeral cost	12,841,042	8.1	175,904.45
Indirect cost			
Lost productivity	109,308,240	69.1	101871.61
Total	158,236,383	100	
Disability Adjusted Life Year	4569.66		

4.4.1.2: The distribution of cost of motorcycle injuries by age, road user, sex, injury severity and helmet use

Table 4.4.2 represents the cost f motorcycle injuries by sex, age, road user, injury severity and helmet use. The total cost of injury for males was Kshs. 96,989,578, higher than that of females. Males accounted for approximately 61.3% of the total cost with indirect costs representing nearly 58.5% of the total cost for males. In contrast female demonstrated a greater mean motorcycle injury costs as compared to male counterparts (Kshs. 216,384 vs Kshs. 122,771.1 respectively). Considering costs by age group**,** the motorcycle injury patients in the 15-29 years paid the highest total injury costs, representing 45.9% the total costs. However children under 15 years had the highest mean cost of Kshs. 233,248.8. Indirect costs were over-represented among under 15 year (Kshs. 233,248.8) with a decreasing tendency with increasing age except for patients above 50 years (Kshs. 156, 324.7); in particular, indirect costs represented 75.7%, 67.8%, 65.1% of the total costs in persons aged under 15 year, 15-29 years, and 30-44 years respectively. Strikingly indirect costs were more than the direct costs in all age groups.

With respect to motorcycle injury costs by road user, pedestrians paid the highest total injury costs (Kshs. 70071704) and total indirect costs (Kshs. 51744966) representing 44.2% and 47.3% of the total cost and indirect costs respectively while the total direct costs were higher for motorcycle rider (Kshs. 20668907); Motorcycle rider had the highest overall injury mean costs (Kshs. 90543.6) which means, on average they presented the highest cost per person. They also had the highest direct and indirect costs per person (Kshs.56939).

Analysis of motorcycle injury cost by severity of the injuries in terms of ISS as indicated in Table 4.4.3**;** demonstrated significant overall differences between the costs of motorcycle injury patients and injury severity. Motorcycle injury patients with ISS>16 incurred higher total costs (Kshs. 113,520,944) representing 71.7% of the total cost of motorcycle injuries. They also had greater proportion of indirect cost (Kshs. 80,090,098) accounting for 73.2% of the total indirect cost. The mean injury costs (Kshs.112204.6) for motorcycle injured patients with injury severity score (ISS>16) was significantly higher (P<0.005) than for those with injury severity score (ISS<16)).

The un-helmeted motorcycle injury patients had the highest cost compared to the helmeted (Kshs. 83968011 and Kshs. 3885798 respectively). Similarly, the mean total cost for the un-helmeted group were significantly higher than the helmeted (P<0.001). Of the total direct costs 92.9% were incurred by un- helmeted motorcycle injuries.

Table 4.4.1.2: Table The distribution of cost of motorcycle injuries by age, road user, sex, injury severity and helmet use.

	Direct Cost	mean	ID. Cost	mean	Total cost	Mean	P value
Sex							
Male	33,104,681	41905	63,884,897	80867	96,989,578	122771.1	0.001
Female	15,823,462	55913	45,413,343	160471	61,236,805	216384	
Age in years							
<15	4,740,632	52095	14,738,261	233248.8	19478893	129859.3	0.01
15-29	25,153,533	51544.12	52,997,264	108600	78130797	160,104.1	
30-44	12,970,752	50667	24,145,436	94318.1	37116188	1441,987.1	
45-59	3,454672	33218	9,279,685	89227.7	12734357	122445.7	
>60	2,608,554	34780.7	8,147,594	108634.6	10756148	71707.7	
Road user							
Motorcycle rider	20668907	56939)	40,988,150	112915	61,607,057	169,716.4	0.005
Passenger	9875432	30765)	16321320	50845	26196752	81,609.8	
Pedestrian	18326738	49133)	51744966	138726.5	70,071,704	187,859.7	
Bicyclist	57066	3566)	253804	15863	310870	19,429.4	
Injury severity							
ISS<16	15,394,351	22539)	29,218,142	12750	44,612,493	30743.3	0.001
ISS>16	33534792	11603)	80090098	82490	113,520,944	198527.6	
Helmet use							
Yes	2157945	1027)	1727853	8227.9	3885798	18504	<0.001
No	28386394	5865)	55,581,617	117260	83968011	177148	
Total	30544339		57309470		87853809	75934	

4.4.1.3 Cost of motorcycle injuries by Anatomic body region

When the cost by anatomic body region were analysed; injuries to the head, necks and face region (Kshs. 71214399) accounted for nearly half (45.0%) of the total motorcycle injury cost, and was highest for in- direct costs (Kshs. 46, 084,905) than direct cost (Kshs. 25,129,494) followed by motorcycle injuries to the central region comprising chest, abdomen, spine, pelvis and upper extremities which represented 21.3% of the total motorcycle injury cost. However, on average injury cost were higher for persons who sustained injuries on multiple regions of the body (Kshs.112204.6). The differences in cost by anatomic body region were statistically significant (P<0.001).

4.4.1.4 Who pays for treatment of motorcycle injuries?

Of all motorcycle injury patients majority were not insured (self-pay) constituting 615 (57.3%). followed by National health Insurance Fund(NHIF) (26.2%), and Universal health Coverage (9.4%), private insurance (7.1%). The proportion of riders and pillion passengers who did not use any insurance (ie, self-pay) was nearly triple among un-helmeted motorcycle users (27.6%), compared to helmeted users(7.8 %).

4.4.2 Willingness to pay (WTP) for risk reduction

The study examined the willingness to pay Kshs. 4000 shillings to obtain a reflector jacket and helmet to reduce by 50% and 60% the number of motorcycle deaths and severe injuries in Kisumu city respectively. Helmet use and reflective clothing are some of the road safety strategies advocated and known globally to reduce motorcycle fatalities and severity. Nearly half 48.6% (521) of motorcycle injury patients interviewed were willing to pay for road safety; and that majority 208 (19.4%) were willing to pay Kshs. 3000-4000. Only 12 (1.1%) and 25 (2.3%) were willing to pay over Kshs. 4000 and less than Kshs. 1000 respectively for open ended study. The participants were willing to pay Kshs. 2638 and Kshs 2855 on average to reduce the fatalities and severe injuries by 50% and 60% respectively.

Table 4.4.2.1: Willingness to pay WTP for risk reduction

Injury Type	Closed-Ended	Open-Ended
Fatality	4000	2638
Severe injury	4000	2855

4.4.2.2: Value of Statistical Life (VOSL) and Injury (VOSI) calculated according to the WTP approach

The VOSL and VOSI were calculated by dividing the mean WTP for risk mitigation by the change in risk (Fauzi et al., 2004; Chaturabong t al., 2011: Jones et al., 1995). The VOSL and VOSI are the net WTP by an individual to avoid one occurrence of the indicated injury type (Fauzi et al., 2004; Chaturabong t al., 2011: Jones et al., 1995). The quantities of VOSL and VOSI were computed from the responses of the valuation questions (closed-ended and open-ended methods) as shown in the following **Table 4.4.2.2**.

Table 4.4.2.2: The value of statistical life (VOSL) and Value of statistical injury per case

Description		
Marginal rate of substitution (MRSi)	Income change due a unit change in a risk given by: *b*i/4/100,000 *bi*100000/4* =2368*100000/4 bi-represent the average amount the participants were willing to pay	Mean MRS give the WTP for reducing risk of dying by half(4)
Total WTP	This value is referred to as the value of saving statistical life or marginal value of safety for an individual victim	65,950,000/-.
Marginal rate of substitution (MRSi)	Income change due a unit change in a risk given by: *b*i/4/100,000 *bi*100000/4* =4000*100000/4 bi-represent the amount participants were willing to pay	100,000,000/-
Description		
Marginal rate of substitution (MRSi)	Income change due a unit change in a risk given by: *b*i/4/100,000 *bi*100000/8* =2855*100000/8 bi-represent the average amount the participants were willing to pay	Average of MRS give the WTP for a risk reduction which reduces expected deaths by 60%(8)
Total WTP	This value is referred to as the value of saving statistical injury or marginal value of safety	35,567,000
Marginal rate of substitution (MRSi)	Income change due a unit change in a risk given by: *b*i/8/100,000 *bi*100000/8* =4000*100000/8 bi-represent the average amount the participants were willing to pay	Average of MRS give the WTP for a risk reduction which reduces expected deaths by 60%(8)
Total WTP	This value is referred to as the value of saving statistical injury or marginal value of safety	50,000,000

4.4.2.3: Value of statistical life and Value of statistical injury

The motorcycle injury patients were also willing to pay on average Kshs. 43,329,975,000 and Kshs. 17,314,635,000 respectively for reduction of fatalities and injuries.

Table 4.4.2.3: Value of statistical life and Value of statistical injury

Willingness To Pay	Value of Statistical life years (VOSLs)(Kshs)	Value of Statistical injury years(VOSIs)(Kshs)
Closed	52,100,000,000	26,050,000,000
Open	34,559,950,000	18,592,927,000
Total	86,659,950,000	34,642,927,000
Mean	43,329,97500	17,314,635,000

4.4.2.4 Value of statistical life and Value of statistical injury by gender, road user, helmet use, health insurance and injury severity

Table 4.4.2.4 shows the distribution of VOSL and VOSI among motorcycle injury patients who were willing to pay for injury prevention using the closed and open ended willing to pay cost estimation strategies computed for all injury categories. The VOSL and VOSI were the multiplied by the number of injury patients in each category of motorcycle patients. Overall, the proportion of VOSLs were greater than the VOSIs in all the categories of patients. The average total VOSLs and VOSIs were greatest in patients who did not wear helmets (Kshs 26,409,285,000) followed by patients with higher injury score (ISS>16) (Kshs. 24,453,770,000), among males (Kshs. 23,905,515,000), and patients who sustained injury to the head and neck region (Kshs. 14,587,896,000).

Table 4.4.5: Value of statistical life and Value of statistical injury by gender, rod user, helmet use, health insurance and injury severity

	Value of Statistical Life		Value of Statistical Injury	
	Closed(Kshs.)	Open (Kshs.)	Closed(Kshs.)	Open(Kshs.)
Sex				
Males	38,000,000,000	25,061,000,000	19,000,000,000	13,561,060,000
Females	14,100,000,000	9,298,950,000	7,050,000,000	5,031,867,000
Road user				
Motorcycle rider	16,700,000,000	11,013,650,000	8,350,000,000	5,959,729,000
Passenger	17,000,000,000	11,211,500,000	8,500,000,000	6,066,790,000
Pedestrian	17,800,000,000	11,739,100,000	8,900,000,000	6,356,053,200
Bicyclist	600,000,000	395,000,000	300,000,000	210,412,200
Helmet use				
Yes	10,100,000,000	6,660,950,000	5,050,000,000	3,592,267,000
no	42,000,000,000	27,699,000,000	21,000,000,000	14,938,140,000
Injury severity				
ISS<16	13,700,000,000	9,035,150,000	6,850,000,000	,872,679,000
ISS>16	38,400,000,000	25,324,800,000	19,200,000,000	13,657,728,000
Health insurance				
Yes	20,700,000,000	13,651,650,000	10,350,000,000	7,362,369,000
No	31,400,000,000	20,708,300,000	15,700,000,000	11,168,038,000
Anatomic site of injury				
Head & neck	23,200,000,000	15,300,400.000	1160000000	8,251,544,000
Chest, abdomen,& Upper extremities	14,300,000,000	9,430,850,000	7,150,000,000	5,086,081,000
Lower extremities	8,400,000,000	5,539,800,000	4,200,000,000	2,987,628,000
Multiple region	6,100,000,000	4,022,950,000	3,050,000,000	2,169,587,000
Total	**52,100,000,000**	**34,559,950,000**	**26,050,000,000**	**18,592,927,000**

4.5: Objective IV: Factors influencing the cost of motorcycle injuries in Tier III Hospitals in Kisumu City

This section evaluates the factors affecting the cost of motorcycle injuries generated using the human capital and willingness of motorcycle injury patients to pay to avoid crash involvement and risk of death. These factors considered were categorized as human, health related factors and road safety practices and the cost of motorcycle injuries. Stepwise variable selection technique was employed to best determine which variables would be retained in the final optimal model.

4.5.1 Human factors influencing the cost of motorcycle injuries

Examination of influence of different human factors on cost of motorcycle injuries compared to respective reference categories shows that the odds for higher total costs were significantly increased with higher age groups (above 50) (OR = 1.7; 95% CI: 0.83-3.26), being male (OR =6.265;95% CI:3.149-14.47); the employed (OR 3.6; 95% Cl; 1.20-9.13) and highest among high income earners (>Kshs 50,000 per month, equivalent to US$600) (OR = 11.4, 95% CI: 4.355–24.08). Further, the odds of paying higher total costs were 6 times, 5 times and twice greater for a motorcycle rider, pillion passenger, pedestrian (OR = 6.043, CI = 0.60-60.476.), (OR = 5.320, CI = 0.477-63.364) (OR = 1.971, CI = 0.193-20.099) compared to a bicyclist respectively. Strikingly there was also greater likelihood of motorcycle injury patients who had consumed alcohol and those who did not put on their helmet at the time of crash to incur higher total cost (OR=4.67, 95%; 95% Cl; 1.655-8.607 and (OR = 6.964, CI = 3.319-14.864) than those who did not drink alcohol and those who put on their helmets respectively. This could have been due to having suffered more serious non-fatal injury.

Furthermore males (OR = 15.27; Cl= 3.95-27.47; p=0.05); motorcycle riders (OR = 5.22; CI= 3.07-12.67; P=0.03), age above 50 years (OR = 0.89; cl= 0.36-1.54; p=0.04); and being divorced had significant association and increased willingness to pay for road safety (OR = 2.1; CI= 0.27-16.46); p=0.05) using the stated preference method. In model 2 using open questions willingness to pay for road safety was significantly influenced by age 40—50 years (OR = 0.7; CI= 0.4-1.2; p=0.05), being employed (OR = 0.7; cl= 0.4-1.2; p=0.04), being motorcycle rider (OR = 3.5; CI= 0.98-12-79; p=0.013), average income of Kshs > 60000(OR = 1.5; Cl= 0.3-4.23; p=0.05). Motorcycle injury casualties who wore helmets (OR = 1.0; CI= 0.68-1.53; p=0.05) and used alcohol (OR = 0.4; Cl= 0.28-129; p=0.04) were less likely to be willing to pay.

Table 4.5.1 Human factors influencing the cost of motorcycle injuries

Human factors	**Human capital**		**Willingness to pay**			
	Model I: Total cost		**Model 2: Open-ended**		**Model 3: Closed ended**	
	OR(95% Cl)	**P value**	**OR(95% cl)**	**P value**	**OR(95% Cl)**	**P value**
Gender						
Males	6.3(3.149-14.47)	0.04	15.27(3.95-27.47)	0.05	0.9(0.59-1.27)	0.46
Females	-		-	-	-	
Age						
<18	-	-	-	-	-	-
19-30	0.66(0.26-2.28)		0.81(0.38-1.83)	0.046	0.3(0.069-0.77	0.07
31-40	0.73(0.54-2.38)	0.446	0.56(0.28-1.13)	0.22	0.5(0.11-1.06)	0.21
41-50	1.1(0.10-4.77)	0.03	0.65(0.36-1.16)	0.09	0.7(0.4-1.2)	0.05
above 50	1.7(0.83-3.26)	0.02	0.89(0.36-1.54)	0.04	0.5(0.3-1.02)	0.2
Employment						
Unemployed	0.72(0.1.53-3.92)	0.8.	0.63(0.27-1.76)	0.47	0.8(0.48-1.48)	0.56
Employed	3.6(1.20-9.13)	0.001	2.5(0.87-6.58)	0.05	2.7(0.70-6.56)	0.04
Student		-	-	-	-	-
Type of road user						
Motorcycle rider	6.04(0.604-60.176)	0.008	5.22(3.07-12.67)	0.03	3.5(0.98-12-79	0.013
Passengers	5.32(0.48-63.36)		4.8(2.47-6.36		4.32(2.48-6.36)	0.03

Pedestrian	1.97(0.19-3.10)		1.8(1.09-4.29)		2.0(1.2-5.00)	0.18
Bicyclist	-	-	-	-	-	-
Average Income						
<1000						
10000-20000	1.36(0.74-2.15)	0.31	1.26(0.74-2.15)	0.026	1.1(0.47-1.28)	0.31
21000-30000	1.48(0.74-1.85)	0.06	1.08(0.63-1.85)	0.36	0.9(0.50-1.50)	0.42
31000-40000	1.33(0.93-3.14)	0.001	1.33(0.83-2.15)	0.02	0.8(0.30-1.50)	0.59
41000-50000	1.18(0.58-2.60)	0.13	1.18(0.58-2.40)	0.01	1.2(0.50-2.79)	0.03
51000-60000	11.4 (4.35–24.08)	0.01	2.45(1.18-5.10)	0.79	0.4(0.6-1.48)	0.68
above 60000	3.95(0.93-6.71)	0.14	2.95(0.33-5.71)	0.118	1.5(0.3-4.23)	0.05
NIL	-	-	---		-	

- reference

4.5.2 Health care related influencing the cost of motorcycle injuries

Examination of influence of different health related factors on the cost of motorcycle compared to respective reference categories indicated in table 4.5.2 in model I shows that patients who were admitted were 4 times more likely to have paid higher total costs than those who were not (OR = 4.45; Cl= 0.11-19.18; p=0.001 $p < 0.005$). Length of stay in hospital with hospitalization for 7-28 Days and 29-57 days (OR = 17.7; 1.23-90.72; P=0.016), and (OR = 8.1; Cl=1.62-51.83; P=0.016), respectively, had increased odds for paying higher cost. In addition, admission for care in Intensive Care Unit (ICU) had the highest odds for paying higher cost (OR = 2564.7; Cl=503.612-13660.82; P=0.016), suggesting that admission for care in Intensive Care Unit (ICU) increased the cost of care more than any other factor. Similarly, patients on whom radiological investigation were undertaken were 116 times (OR = 116.47; Cl= 0.79-342.75; p=0.001) more likely to pay higher costs than those were not. Specifically, the odds of paying higher total cost among patients on whom X- rays and CT scan were carried out respectively were over 577 and 225 times (OR = 577.54; Cl= 13.22-2525.5;

p=0.001) and (OR = 225.11; Cl= 5.4-9691.5; P=0.001) more than those who had not. Motorcycle injury patients who sustained major injury ISS>16 were 5.5 times (OR = 5.5; 1.37-9.36; P=0.01) more likely to pay higher cost than those who sustained minor less severe injuries (ISS<16). Patients who sustained injuries demanding major surgeries also had increased chance of paying higher total cost than those who did not (OR = 14.19; Cl= 5.37-37.48; P=0.001), in such way that patients that required craniotomy, open reduction and Internal Fixation and External Fixation (ORIF/EF), Multiple surgeries and Exploratory laparotomy were 10 times, 5 times, 6.8 times and 4.6 times (OR = 10.017; Cl= 1.23-63.21.48; P=0.001); (OR = 5.21; Cl= 0.95-10.95; P=0.001),(OR = 6.8; 1.02-24.21; P=0.01) and (OR = 4.6; 0.73-9.36; P=0.01) respectively more likely to pay greater total cost than those who did not require major surgeries. Motorcycle injury patients who sustained head injuries, Chest, abdominal injuries and multiple injuries also had increased odds of paying greater cost (OR = 5.63; 1.65-12.33; P=0.01), (OR = 6.35; Cl= 2.24-14.48; P=0.01), OR = 4.2; Cl= 4.32-13.29; P=0.01) than those who sustained lower extremities injuries.

Willingness to pay using model 2 were affected mainly by being an in-patient, radiological services, Injury severity. Motorcycle injury patients who were admitted and sustained major injuries ISS>16) and injuries demanding radiological investigation were 9 times, 20 times and 2.5 times (OR = 8.8; Cl=0.46-19.32; P=0.02); (OR = 20.3; Cl=3.36-43.26; P=0.01), (OR = 2.5; Cl=0.24-0.73; P=0.02), respectively more likely to be willing to pay than those were not admitted, those who sustained minor injuries and injuries who did not require radiological investigations respectively. Further, there was increased willingness to pay for motorcycle injury patients who were hospitalized for more than 1 day and those who sustained head injuries (OR = 20.84; Cl= 10.05-44.34; P=0.04) and (OR = 4.14; Cl= 2.48-8.73; P=0.01) respectively than those who were not admitted and sustained lower extremities respectively.

In model 3 for the closed ended method patients willingness to pay was significantly influenced by hospital admission (OR = 5.7; Cl= 1.67-9.61; P=0.01). The odds of paying higher total costs were 6 times, 4 times, 8 times, 5 times, 4.7 times and 1.6 times greater for patient who were admitted, subjected radiological services, sustained severe injury with (ISS); sustained major surgery, staying in the hospital for 7-28 days(OR = 5.7; Cl= 1.67-9.61; P=0.01)(OR = 4.4; Cl= 2.96-18.30; P=0.04), OR = 4.4; Cl= 4.73-12.52; P=0.01) OR =3.8; Cl=1.46-10.09;P=0.4; OR = 8.3; Cl=1.73-29.52)**,** OR =4.7;Cl= 1.23-9.72; p=0.016) and (OR =1.6(1.16-2.38; p= 0.03) respectively than respective reference categories as indicated in Table 4.5.2.

Table 4.5.2: Health related factors influencing the cost of motorcycle injuries

Health related factors	**Human capital**		**Willingness to pay**			
	Model I: Total cost		**Model 2: Open-ended**		**Model 3: Closed ended**	
	OR(95% Cl)	**P value**	**OR (95% cl)**	**P value**	**OR(95% Cl)**	**P value**
Hospital attended						
JOORTH	0.26(0.13-0.52) .	0.005	1.5(1.00-2.19)	0.12	1.2(0.62-2.20)	0.63
KCH	0.17(068-0.44)	0.790	1.0(0.63-1.71)	0.01	0.9(0.55-1.63)	0.3
AGHAKHAN	Ref		Ref		Ref	
Type of treatment						
Out patient	-	-	-	-	-	-
In patient	4.4(1.11-9.18)	0.001	8.8(0.46-163.2)	0.02	5.7(1.67-9.61)	0.002
Radiological Services						
Yes	116.4(79.36-134.75)	0.000	2.5(2.24-2.73)	0.002	4.4(4.73-12.52)	0.04
No	-	-	-	-	-	-
Types of radiological						
X-rays	577.54(13.22-2525.5)	0.001	1.3(0.93-3.14)	0.2	3.8 (1.46-10.09)	0.4
CT - Scan	225.11(5.4-9691.5)	0.001	1.2(0.58-2.60)	0.08	2.2(0.82-5.76)	0.9

Imaging	0.8(1.2-2.80)	0.001	1.3(1.03-3.14)	0.06	2.5(1.85-6.71)	0.5
Na	-		-	-	-	-
Severity (ISS)						
>16	5.5(1.37-9.36)	0.02	20.3(3.36-43.26)	0.04	8.3(4.73-12.52	0.002
<16	-	-	-	-	-	-
Days in the hospital						
< 28 days	-	-	-	-	-	-
>28 Days	17.7(1.23-90.72)	0.016	0.5(0.12-2.59)	0.05	1.6(0.16-2.38)	0.03
Days in ICU						
Yes	2564.7(503.61-13660.82)	0.001	1.6(1.05-5.27)	0.01	1.9(1.18-2.40)	0.00
No	-		-	-	-	-
Major surgery						
Yes	14.19(5.37-37.48)	0.05	2.4(1.55-10.75)	0.001	4.7(1.23-9.72)	0.016
No	-	-	-	-	-	-
Type of surgery						
Craniotomy	10.017(1.23-63.21)	0.01	1.1(0.48-2.72)	0.03	0.5(0.08-0.88)	0.001
Wound dressing/debridement/traction	2.6.1(0.82-6.21)	0.152	1.5(0.64-3.40)	0.69	0.5(0.09-3.11)	0.500
Closed reduction	5.1(1.24-10.41)	0.65	1.8(0.55-3.04)	0.61	0.5(0.08-2.64)	0.403
ORIF/EF	5.2(0.95-10.95)	0.01	2.5(0.92-6.70	0.95	0.8(0.13-5.12)	0.809
Exploratory laparotomy	4.6(0.73-9.36)	0.015	1.15(0.43-3.07)	0.74	0.6(0.09-3.51)	0.839
Multiple surgeries	6.8(1.02-24.21)	0.05	1.4(0.43-0.4.52)	0.63	0.9(0.11-7.05)	0.03
UWSD	2.3(0.57-10.59)	0.23	1.05(0.63-2.15	0.42	0.4(0.05-3.29)	0.92
Amputation	1.4(0.25-4.75)	0.03	1.2(0.47-3.23)	0.04	0.9(0.33-2.71	0.05
N/A	-	-	-	-	-	-
Injury site						
Head and neck	5.6(1.65-12.33	0.001	4.14(0.478-8.73)	0.03	2.1(1.22-0.4.82)	0.03

Chest , abdomen, spine and upper extremities	6.4(2.24-14.48)	0.01	3.6(2.12-5.24	0.743	1.6(1.43-4.52)	0.02
Lower extremities	1.74(0.97-3.14)	0.03	0.8(0.37-1.2+)	0.001	2.1(0.23-0.43)	0.05
Multiple site	4.24(1.32-13.29	0.065	1.5(0.95-2.45)	0.02		0.02
Upper extremities	-	-	-	-	-	

- reference

4.5.3 Road safety practices and the cost of motorcycle injuries (modifiable factors)

Examination of influence of different modifiable factors on the cost of motorcycle compared to respective reference categories indicated in table 4.5.3 shows that short time riding experience < 2 years (OR = 12.74; Cl= 0.75-30.55; P=0.001), Bajaj (OR = 2.25; Cl= 0.12-9.12; P=0.01), lower engine capacity 50-99cc (OR = 3.3; Cl= 0.37-8.40; P=0.001), riding a motorcycle everyday (OR = 23.0; Cl= 1.76-319-95; P=0.017), no training (OR = 4.6; Cl= 0.83-26.44; P=0.05), Carrying more than one passenger (OR = 3.22; Cl= 1.71-6.08; P=0.017), motorcycle injury victims that sustained injuries on Friday and Monday which had 2.5 and 1.5 times more likely to pay higher total cost (OR = 2.5; Cl= 1.3-7.34) and (OR = 1.5; Cl= 0.98-2.42) respectively; Night crashes were 4 times more likely to result into higher total cost (OR = 3.9; Cl= 0.55-8.68; P=0.009). Moreover, alcohol consumption and inconsistence/ nonuse of helmets were 5 and 7 times more likely to result into greater total cost (OR = 4.67; Cl= 1.655-8.607; P=0.05) (OR = 6.96; Cl= 3.3-14.9; P=0.02) respectively. Furthermore, riding for 11- and above years (OR = 20.7; Cl= 3.09-150.23; P=0.001), victims of crashes at night (OR = 1.9; Cl= 0.12-5.70; P=0.001), Carrying more than one passenger (OR = 2.4; Cl= 0.55-10.75; P=0.01), alcohol use (OR = 3.77; Cl= 1.66-8.61; P=0.01) were the factors that influenced willingness to pay in open method. Those who did not use helmets were 80% less willing to pay for road safety investments (OR = 0.2; Cl= 0.36—1.30; P=0.01). in model 3 using closed method willingness to pay for identified road safety activities were greater among victims who had ridden motorcycle for more than 11 years (OR = 19.5; Cl= 3.5-109.70; P=0.001), those who used boxer a type of motorcycle (OR = 5.7; Cl= 1.67-9.61; P=0.01),Carrying more than one passenger (OR = 4.7; Cl= 1.23-9.72; P=0.01), and those who had crashes during the day(OR = 2.6; Cl= 0.68-5.74; P=0.05),2.6(0.68-5.74). Respondents who were not trained were less likely to pay for identified road safety (OR = 0.01; Cl= 0.15 -4.45; P=0.82).

Table 4.5.3 Road safety practices and the cost of motorcycle injuries

	Human capital		**Willingness to pay**			
	Model I: Total cost		**Model 2: Open-ended**		**Model 3: Closed ended**	
	OR(95% Cl)	**P value**	**OR (95% cl)**	**P value**	**OR (95% Cl)**	**P value**
Number of years riding in years						
0-5	0.93(0.13-0.96)	0.04	4.4(1.70-11.60)	0.003	4.4(1.96-9.93)	0.001
6-10	0.80(0.30-2.21)	0.64	3.7(1.34-10.65)	0.012	5.5(2.32-13.37)	0.001
11- and above	-	-	-	-	-	-
Experience of riding						
0-2 years	12.74(0.75-30.55)	0.010	1.28(0.26-6.934)	0.73	5.3(0.28-46.67)	0.002
More than two years	-	-	-	-	-	
Type of motorcycle						
Boxer	0.21(0.02-0.85)	0.80	2.1(0.24-4.38)	0.12	1.0(0.68-1.53	0.63
Bajaj	2.25(0.12-9.12)	0.001	4.4(0.46-15.25)	0.04	5.7(1.67-9.61)	0.002
N/A	Ref			Ref		
Engine capacity						
50-99	3.3(0.37-8.40)	0.691	1.6(0.56-4.93)	0.36	1.5(0.57-3.92)	0.403
100	0.75(0.35-1.82)	0.37	0.9(0.33-2.20)	0.75	0.9(0.40-2.03)	0.813
NA	ref			ref		
Frequency of riding						
Every day	23.0(1.76-319-95)	0.017	0.4(0.09-3.1.82)	0.25	0.2(0.17-1.91)	0.5
Weekend only	7.2(0.78-66.72)	0.080	0.24(0.05-1.12)	0.07	0.3(0.08-1.28)	0.3

1-3days/week	6.43(0.64-63.62)	0.12	0.2(0.05-1.03)	0.05	0.4(0.13-1.62)	0.4
4-6 days/week	3.0(0.32-29.84)	0.33	0.3(0.07-1.56)	0.05	0.7(0.2-2.70)	0.7
N/A	ref	ref				
Received training						
Yes	-	-	-	-	-	-
No	4.6(0.83-26.44)	0.05	1.0(0.16-7.36)	0.20	0.01(0.15 - 4.45)	0.82
Carrying more than one passenger						
Yes	3.22(1.71-6.08)	<0.001	2.4(0.55-10.75)	0.001	4.7(1.23-9.72)	0.016
No	-	-	-	-	-	-
Day of the crash						
Monday	1.5(0.98-.2.42)	0.06	1.0(0.65-1.72)		0.5(0.08-2.88)	0.001
Tuesday	1.2(0.71-2.30)	0.40	1.2(0.67-2.14)		0.1(0.09-3.11)	0.500
Wednesday	1.0(1.17-3.54)	0.012	0.6(0.30-1.03)		0.1(0.08-2.64)	0.403
Thursday	0.9(0.59-1.53)	0.84	0.7(0.39-2.24)		0.2(0.13-2.12)	0.809
Friday	2.5(1.3-7.34)	0.002	0.9(0.58-.1.60)		0.6(0.09-3.51)	0.839
Saturday	0.6(0.35-0.95)	0.032	0.8(0.49-1.41)	0.63	0.9(0.11-7.05)	0.03
Sunday	-	-	-	-	-	-
Alcohol Use						
Yes	4.67(1.65-8.61)	0.02	3.77(1.66-8.61)	0.49	0.4(0.28-129)	0.09
No	-	-	-	-	-	-
Helmet use						
Yes	-	-	-	-	-	-
No	6.96(3.3-14.9)	0.05	0.2(0.36—1.30)	0.74	0.3(0.06-0.73)	0.21
- reference						

4.5.4 Results of most important factors influencing costs and willingness to pay using multivariable logistic regression

Table 4.5.4 shows the adjusted odds of incurring higher total cost (Model 1), Willingness to pay closed ended (Model 2), and open ended only (Model 3). The Hosmer Lemeshow goodness-of-fit test statistic of the adjusted logistic regression in model 1 (total cost) was 0.80, with 8 degrees of freedom and a p-value of 0.46, indicating no evidence of poor fit. In model 1, motorcycle injury patients were at significantly higher odds of incurring greater total cost if they were male (AOR = 6.5, 95% CI = 3.25-11.65), motorcycle rider (AOR = 6.0, 95% CI = 2.30-10.16), used alcohol (AOR =5.9 (116.4, 95% CI = 2.72-8.81), did not use helmets (AOR = 7.0, 95% CI = 4.21-11.60), sustained severe injuries (ISS) >16 (AOR = 5.1, 95% CI = 2.25-8.18), Radiological investigation conducted (AOR = 116.4, 95% CI = 79.36-134.75), and Length of stay>28 Days (AOR = 17.7, 95% CI = 6.23-25.91), had major surgery (AOR = 17.7, 95% CI = 6.23-25.91), ICU admitted (AOR = 2622.7, 95% CI = 512.18-13580.34). The Hosmer-Lemeshow goodness-of-fit test statistic of the adjusted logistic regression in model 2 (Willingness to pay closed ended) was 8.5, with 8 degrees of freedom and a p-value of 0.38, indicating no evidence of poor fit. In model 2, factors influencing willingness to pay using closed ended questions were indicated higher odds of crash involvement among being males (AOR = 15.1, 95% CI = 1.00, 4.94),) motorcycle riders (AOR = 6.0, 95% CI = 2.30-10.16) alcohol use (AOR = 3.50, 95% CI =2.55-8.23) injury severity (ISS) >16, AOR = 20.0, 95% CI = 2.63-38.13), Major surgery **(**AOR = 2.2, 95% CI = 1.65-3.55), Radiological investigation **(**AOR = 2.5, 95% CI = 11.28-4.73)**, c**arrying, two or more passengers on the same trip (AOR = 2.4, 95% CI = 1.52-5.72). The Hosmer-Lemeshow goodness-of-fit test statistic of the adjusted logistic regression in model 3 (willingness to pay- open ended questions) was 4.25, with 8 degrees of freedom and a p-value of 0.82, indicating no evidence of poor fit. Model 3 that factors influencing willingness to pay were being motorcycle rider (AOR = 3.2, 95% CI = 1.82-10.18) and alcohol users (AOR = 4.32, 95% CI = 2.48-6.36). Other factors include; radiological investigation, injury severity, major surgery, experience of riding and carrying two or more passengers on average.

Table 4.5.4 Results of most important factors influencing costs and willingness to pay using multivariable logistic regression

	Human capital		**Willingness to pay**			
	Model I: Total cost		**Model 2: Open-ended**		**Model 3: Closed ended**	
Sex						
Male	6.5(3.25-11.65)	0.04	15.1(6.21-24.58)	0.001	1.0(0.79-1.29)	0.46
Female	-	-	-	-	-	
Type of road user						
Motorcycle rider	6.0(2.30-10.16)	0.001	5.0(3.12-7.52)	0.001	3.2(1.82-10.18)	0.01
Passengers	5.3(0.48-63.36)	0.19	4.8(2.24-6.58)	0.02	4.32(2.48-6.36)	0.03
Pedestrian	2.0(1.22-3.02)	0.001	1.8(1.09-4.29)	0.001	2.0(1.2-5.00)	0.18
Bicyclist	-	-	-	-	-	-
Severity (ISS)						
>16	5.1(2.25-8.18)	0.01	20.0(2.63-38.13)	0.04	8.3(5.42-15.56	0.002
<16	-	-	-	-	-	-
Radiological Services						
Yes	116.4(79.36-134.75)	0.000	2.5(1.28-4.73)	0.002	4.8(2.68-8.30)	0.01
No	-	-	-	-	-	-
Length of stay						
< 28 days	-	-	-	-	-	-
>28 Days	17.7 (6.23-25.91)	0.012	0.56(0.12-2.59)	0.15	1.5(0.86-2.15)	0.03
ICU admission						
Yes	2622.7(512.18-13580.34)	0.001				
No	-		-	-	-	-
Major surgery						
Yes	14.2 (6.18-27.52)	0.05	2.2(1.65-3.55)	0.001	5.2(2.16-8.65)	0.01
No	-	-	-	-	-	-
Alcohol Use						
Yes	5.9 (2.72-8.81)	0.002	3.50(2.55-8.23)	0.05		

No	-	-	-	-	-	-
Helmet use						
Yes	-	-	-	-	-	-
No	7.0(4.21-11.60)	0.05			0.3(0.07-0.81)	0.21
Received training						
Yes	-	-	-	-	-	-
No	4.6(0.83-26.44)	0.05	1.0(0.16-7.36)	0.20	0.01(0.15 -4.45)	0.82
Experience of riding						
0-2 years	12.32 (2.75-15.14)	0.010	2.1 (1.12–11.91)	0.13	3.76 (1.95–5.98)	0.002
< 2 years	-	-	-	-	-	
Carrying more than one passenger						
Yes	3.22(1.71-6.08)	<0.001	2.4(1.52-5.72)	0.001	4.7(1.23-9.72)	0.016
No	-	-	-	-	-	-

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This section presents appraisal of methods of the study, details of the results obtained as per the study objectives with focus on the significance of motorcycle injuries and their related cost. It provides relevant data and interpretation for each objective. This study examined health burden and different types of costs incurred by person and their families involved in motorbike crashes, described the full spectrum of consequences that crashes place on societies ranging from the point of crash to the hospitals, the cost and associated factors.

5.2 Methodological Appraisal

The main aim of this study was to generate information on the burden and cost of motocyle injuries that is potentially useful for developing policy and interventions for prevention of motorcycles injuries in Kenya. The methods used were designed to generate data that quantified the burden of motorcycle on injuries, highlighting the morbidity, fatalities, costs and factors influencing the cost of injuries as to described the full spectrum of consequences that crashes place on societies ranging from the point of crash to fatalities and to the quality of life of survivors of the motorcycle crashes. The various methodological approaches used were interrelated (Chapter 3).

In the current study, all the Tier III hospitals with functional emergency hospitals that operate on 24 hour basis daily were included, so as to obtain information about motorcycle injury patients seeking treatment and also to allow for an estimation of case-load at each hospital. It was possible to determine the distribution of different motorcycle injuries and fatalities and the characteristics of motorcycle injury cases, quantify their burden on hospital workload, the cost of motorcycle crashes and factors influencing the cost of injuries through data obtain from the hospital.

A combination of the human capital approach and willingness-to-pay approach was used as described in previous studies (Widyastuti & Mulley, 2005b); Transport Research Laboratory (TRL, 1995);(Millar & Guria, 1991). Data obtained from the human capital approach are considered to be reliable and readily available; and produce consistent and transparent results (Alfaro et al., 1994); (Millar & Guria, 1991); (ADB, 2003); (Miller, 1994). Willingness to pay measured how much the motorcycle injury cases were ready to pay' in order to improve their safety and thus provided information on the extent of the need to promote an effective intervention for the affected community. Estimates from willingness to pay approach is closer to the real injury cost, more accurate and makes it easier for stakeholders to address the traffic associated problems (Downing, 1991); (Millar & Guria, 1991); (Al-Masaeid et al., 1999); (Peden et al., 2004); (Sigua & Palmiano, 2005); (De Blaeij et al., 2003); (Dionne & Lanoie, 2004).

5.3 Study limitation

This study focused only on motorcycle injury patients who sought and obtained care in 3 major referral hospitals, and nothing is known about those seeking care elsewhere. Therefore, motorcycle injury cases are likely to be underestimated. Nevertheless, useful data on the epidemiological characteristics of injured patients seeking care in hospitals could be obtained since all cases were enrolled. Enrolling all cases has been documented to provide a much more representative of the burden of motorcycle crashes and provide greater statistical power; thus the results could be generalized for studies conducted in referral hospitals.

The findings of study are limited to motorcycle injury patients seeking care in Tier III health facilities in Kisumu City during the study period. To this extent, the findings may not reflect the full extent of societal burden of injury. There was hospital bias, as casualties who choose not to attend or those slightly injured who get treated in doctors' surgeries. This was purposely done in order to focus on motorcycle casualties with injuries severe enough to actually require hospital treatment: also, Emergency departments provide the best opportunity for capturing data on a wide range of non-fatal injuries. Unfortunately, it limits the application of study findings to hospital attenders only as nothing is known about those seeking treatment elsewhere, the calculated population injury rates from the figures are therefore likely to be under-estimates. Nevertheless minimum incidence rates of those requiring or choosing to use hospitals for treatment can be identified.

The most important limitation of the cost calculations was inability to capture ongoing care costs for patients requiring outpatient rehabilitation after discharge, such as those with acquired brain injury who may come to hospital for follow up treatment for duration longer than the study period. Accordingly, the cost calculations may not capture details over time as patients, and their care, may have moved from the hospital setting and into the community. So it may not be able to quantify the long term consequences of the injuries. The indirect cost may also have been underestimated given that the average wages reported by the casualties were used in the estimation. Accurate and reliable data on income of the casualties was not accessible except to rely on what they mentioned as their wages and salaries.

5.3.1: Objective I: Pattern of road traffic crashes and road traffic injuries involving motorcyclists in Tier III hospitals in Kisumu City.

Road transportation plays an important part in a society for the movement of people and goods. The attendant consequences of road crashes cannot be overemphasized as it leads to morbidity, mortality, disability and increased economic cost in terms of managing injuries and hospitalization. Despite the high burden, there has been low targeted public policy responses to address the rising problem because of inadequate reliable data on motorcycle road safety. The study found that motorcycle injuries are more prevalent in Kisumu city, and are responsible for over half of all road traffic-related injuries and deaths. Death among all motorcycle injury victims was significantly higher among those aged 31 to 40 years, and those with low Glasgow Coma Scores. Similar to other studies, majority of people of productive age group were involved in motorcycle crashes (Fletcher et al., 2019; Manzwan et al., 2017). The young adults are most involved in motorcycle crashes with mean age of 29.83 years ± SD 12.19 with a peak in the 15 – 34 years group. This age-group is the most productive age group, and thus, probably indicates that health promotion strategies on road safety should target this group. Males outnumbered females with the proportions of male motorcycle injury and fatality being as high as 73.6% and 90.1% respectively, and if current trend continues, more adult young men in economically productive group will continue to die or get injured as a result of motorcycle crashes, thus reducing productivity. The young male preponderance in this study concurs with findings reported in other settings (Solagberu et al., 2006; Mafi and Hosseinzadeh, 2016). This has been attributed to a number of reasons; namely, they are more likely to engage in high risk activities such as overloading, reckless riding, over speeding, adventurous, and alcohol use. In many occasions males travel for longer distances. In agreement with previous studies, majority of motorcycle crash injuries and fatalities occurred among motorcycle riders and pedestrians (WHO, 2018; Fuduyule et al., 2017). Motorcyclists are particularly vulnerable to injury, as they do not have the protective steel car frame to absorb the transmitted forces imparted during a collision. There is a massive amount energy transferred to the motorcyclists upon impact.

The analysis of accidents based on time of occurrence pointed out that most motorcycle crashes happened during the day. The study finding agrees with studies in Tanzania (Chalya et al., 2010) in Ghana (Kudebong et al., 2011) in UK (Poulter 2008), and, in Iran (Munzberg et al., 2010). Increased proportion of injuries during the day can be explained by increased traffic density as well as increased human activities in the City during the day time. Knowing the time of injury in trauma patients is important for prevention strategies and resource allocation.

Nearly half of the motorcycle crash injury patients (49.5%) arrived at the hospitals within 1-6 hours after the crash. The delay in seeking medical care contributes significantly to morbidity and mortality among trauma patients (WHO, 2018). The pre-hospital care of trauma patient has been reported to be the most important determinant in the ultimate outcome after injury (Ingaibire et al., 2015). Among the motorcycle injury patients, 53.1% were given some form of pre-hospital care. In agreement with a study by Boniface et al. (2016), care offered to those who reported to have had some care varied from splinting of fractures using pieces of wood, compression dressing to arrest bleeding to insertion of intravenous line (Boniface et al. (2016). However, over 90% of the motorcycle crash injury patients were transported to hospital by either relatives, self or bystanders, only 6.8% of the motorcycle injury patients were transported by an ambulance. This agrees with previous studies in Rwanda, and Tanzania indicating that motorcycle injury cases were brought in by relatives and police who are not trained in healthcare or patient transport (Boniface et al., 2016; Gunchan et al., 2018). Prompt effective, rapid and competent pre-hospital care reduces significantly the consequences of crashes. Hospital arrival after 1 hour was associated with a higher likelihood of severe head injuries and femoral bone fractures and high mortality. These findings highlight the need for an adequate functional post-crash and pre-hospital care system.

The motorcycle crash injuries ranged from minor abrasions to poly-trauma cases and the life-threatening head injuries and fractures. The head and extremities are often the first point of anatomic contact with an object after motorcycle ejection (Raman et al, 2015; Chalya et al., 2014). Injuries to the head and extremities accounted for most cases, and was consistent with findings in studies elsewhere (NTSA 2019; Boniface et al, 2020; Barzegar et al., 2020; Rubin et al., 2020). Further, 74.2% of all admitted cases had either head injuries and/or injuries to extremities. This was comparable to studies conducted in Rwanda (Barzegar et al., 2020); Uganda (Kigera, Nguku, and Naddumba 2010; UK (Rice et al., 2016), and Nigeria (Nwadiro et al., 2011).

Head was the most frequent anatomical region injured among the fatal cases and contributed to 78.9% of all fatalities, and 43.7% who sustained severe head injuries. This finding is comparable to studies by Nwadiaro et al., and Faduyile et al., which reported that head injury constituted 40.1% and 41.4% of the injuries in Jos and Lagos respectively (Nwadiaro et al., 2011) and (Faduyile et al., 2017).

Injuries to the lower extremities were more common among motorcycle riders and pedestrians. Patterns of injury risk suggest that the lower limbs are the body parts most likely to be injured in motorcycle crashes particularly among the motorcyclist and pedestrians. The susceptibility of lower limbs is due to anatomical location and lack of protection on the extremity since the limbs are often squeezed between the motorcycle and impacting vehicle, the ground or some other fixed object. Interventions to prevent lower limb injury such as wearing protective boots, kneepads, and padded gears should be emphasized.

Injury severity score provides a valid measure of morbidity status of a casualty and the prognosis of survival or death from multiple injuries (Baker et al., 1974). ISS remains the most widely used method for determining overall injury severity (Baker et al., 1974). Patients with low ISS have less forms of injuries, and generally, recover fast, while those with greater scores are more likely to have a longer period of recuperation. In this study, most patients (72%) presented with injuries of minor and moderate character (ISS 0-16), with nearly over 27% of participants sustaining a severe injury in a motorcycle crash.

Previous studies have indicated that motorcycle riders are more likely to have consumed alcohol before crashes than other vehicle drivers (Maistros, Schneider IV, and Savolainen (2014). This study found that 31.8% (330) of the injury patients had consumed alcohol before the crash. Further analysis showed that 91.3% of those with minor injuries did not use alcohol compared to 45.5% with fatal injuries who used alcohol. Alcohol usage causes carelessness and loss of concentration as well as over speeding and neglecting to use safety equipment such as helmet (WHO, 2018). According to Tumwesigye et al. (2016) alcohol consumption impairs judgment and this explains the correlation with road injury. This is because riding a motorcycle needs balance, operating two brakes, steering, and shifting while navigating through potential hazards such as rough pavement. As noted by Kakkar, Aggarwal, Kakkar, Deshpande, and Gupta (2014) alcohol consumption is a major determinant of motorcycle crashes; therefore a decrease in alcohol consumption, will reduce the number of motorbike crash injuries and deaths.

Previous studies globally have reported that wearing helmets by both the motorcyclists and their pillion passengers significantly reduce the incidence of fatal head injury (Kuo et al., 2017; Cohen et al., 2017, Liu et al, 2008). However, the use of crash helmets is still very low in Kenya (Bachani et al., 2017; Sisimwo and Onchiri 2018). In this study the self-reported prevalence of helmet use was 30.7% among the motorcycle riders and pillion passengers, much lower than 56%, 51.4%, 72.8%, 82.8% and 99 % reported in Nigeria (Olakulehin et al 2018), Jamaica (Crandon et al., 2009), China, (Xuequn, 2011), Spain (Hidalgo et al 2019), and Vietnam (Olson et al., 2016), but was higher than 4% reported in Ghana (Nimako et al., 2018) respectively. These variations in the proportions of helmet use show an impression on the differences in levels of awareness on injury occurrence, their severity and associated factors between these countries and poor enforcement of traffic laws. Rice et al., found that the risk of sustaining a moderate to severe head injury by not wearing a helmet was

5 times higher than had a helmet been worn (Rice et al., 2016). In this study, 84.5% of the fatal cases did not wear helmets at the time of the crash and were 5 times more likely to die compared to those who wore helmets. Almost three quarters (70.1%) of the motorcycle riders and their pillion passengers who sustained severe injuries (ISS>16) were un-helmeted. The effectiveness of Helmet laws in increasing use of helmets by motorcycle riders and passengers and reducing head injuries has been shown in other studies (WHO, 2015; WHO, 2018: Chalya et al., 2010). In Kenya, mandatory helmet law was enacted in 2009 and 2012 in the Traffic Act in 2012 (Traffic Act, 2009; Traffic Act, 2012), but the wearing rate remains low because of non-compliance and poor enforcement by the traffic police. There is need for strict enforcement and increased publicity of the law to improve compliance.

5.3.2: Objective II: The burden imposed on Tier III hospitals by motorcycle injuries in Kisumu City.

A review of the previous studies from Kenya and developing countries revealed the dearth of data on the burden of motorcycle injuries on health care system. This study is the first to establish the burden of motorcycle injuries on the public health system in Kenya and WHO Africa region. Assessment of use of various services offered among the admitted cases showed that motorcycle injury cases demanded several critical clinical services including close monitoring by clinicians, radiological investigations and major surgical procedures. Compared to assaults and other injuries, motorcycle injured patients had increased demand for radiological services, theatre for minor and major surgeries, laboratory investigation, transfusion and intensive care unit; and longer duration of hospital stay making motorcycle injuries one of the leading users of hospital services exerting a heavy burden on the health care system.

Few studies undertaken in developing countries have attempted to present the mean length of hospital stay as an indicator of hospital utilization attributable to motorcycle injuries (Koka et al., 2018). Hospital length of stay (LOS) is used as an indicator of public health systems' efficiency by researchers, clinicians, administrators, and policy makers and can also be used in planning the delivery of public health system. This study has demonstrated the importance of length of stay and its variability by age and sex of a motorcycle casualty, hospital of treatment and by road user category. Motorcycle riders and pedestrian hit by motorcycles result in a greater period of hospitalization (mean LOS 24.4 days) than bicyclists. Even when the total trauma related bed-days are considered by age, injuries to motorcycle riders and their pillion passenger are the most important, especially in adolescents and adults who were responsible for 76.9% of their total in-patient days. None of the assault cases which is the most prevalent condition stayed in the hospital for more than two weeks; only motorcycle injury cases were in the hospital for more than 57 days extending up to 235 days.

Prolonged hospitalization exerts pressure on resources for health and undermines the productive capacity of the population through time lost during hospitalization and disability. The burden exerted on health care system is not just on the cost but on the level of utilization of services, due to increased demand for specialized investigation, care, surgery and medication; motorcycle injured patients stay longer (over stay) within the hospital, causing ward congestion and overcrowding and overstrained staff. motorcycle injuries results in increased utilization of health services, and prolonged hospitalization resulting in overcrowding in wards.

In comparison to reports on road traffic crashes in developing countries with the mean hospital stay of 19.8 days, this study found higher mean LOS than other studies from Tanzania, Brazil, USA and Jamaica (Chalya et al, 2010); Koka et al., 2018; Aruajo et al., 2017; (Coben, 2001); Rifaat, Tay De barrow , 2012; (Araujo & Whitaker, 2016); (Fletcher et al., 2019). Prolonged LOS observed in this study is partly attributable to severe head injuries and lower limb fractures. These differences may also be due to variations in case severity and availability of technology, operating theater time and staff, and bed capacity/occupancy and hospital attended.

Motorcycle injury to the head and neck region (42.5%) comprised the bulk of injury presentations with over half (55.2%) resulting in hospitalization. The healthcare utilization and cost implication of head injuries is enormous. This finding should be considered in the planning of emergency trauma service delivery, especially in reference to human resources, bed capacity, equipment and supplies.

The lack of helmet wearing by the motorcyclists impacted on hospital admission and length of stay. This study showed that non-helmet use increased significantly hospital admissions and length of stay. This was in agreement with previous studies by Cavalcanti et al., and Fletcher et al. that demonstrated that un-helmeted motorcycle riders were more likely to sustain serious head-related injuries, which resulted in longer hospital stay (Cavalcanti et al., 2013); (Miki et al., 2014); Fletcher et al. (2019). Compared to patients who had worn helmets during the crash, a greater number of motorcycle injury patients who did not wear helmets presented with low GCS (≤7) and high ISS (>16) with increased odds of admission, longer duration of stay and admission to the ICU. On average, the mean LOS for un-helmeted motorcycle injury cases was 27.4 days compared to 8.6 days for those who used helmets. Similar findings have been reported in previous studies (Cheng, Liu, & Tulliani, 2015; and (McSwain Jr & Belles, 1990) and further reinforce the importance of wearing helmet to prevent severe head injuries and subsequent hospitalization. Prevention of head injuries and lower limb injury would require advocacy on measures such as wearing protective helmets, protective boots, kneepads, and padded gears. Evidence exists that demonstrates the effectiveness of enactment and enforcement of helmet laws in increasing helmet use and reduction of head injuries. However, mere legislation alone without effective enforcement is not adequate (WHO, 2018). For instance, in Kenya, the Traffic Amendment Bill passed by legislators in 2009 and Traffic Amendment Act in 2012 constituted mandatory helmet use for all motorcycle riders and their passengers (Ali and Shepherd, 1994). However, data in studies done in 2017 and 2018 on helmet wearing in Kenya reported average helmet use prevalence of 36.3% and 28% respectively indicating there was very little improvements in helmet use after its implementation (Bachani et al., 2012; Sisimwo and Onchiri 2018; Bachani et al., 2016). It is therefore important that focused efforts be made to understand the fundamental reasons for the low use of helmets, in order to develop targeted approaches to improve the uptake. According to Bachani et al, motorcycle users do not wear helmets due to various reasons, including being unhygienic to share, inconvenient or uncomfortable (Bachani et al., 2016). Therefore developing appropriate intervention plans to increase the wearing of helmets is recommended.

In addition to the implementing safety interventions, the World Health Organization has recommended the implementation of emergency medical systems to improve injury care and outcomes in LMICs (WHO, 2018). Studies have shown that early quality Prehospital care and hospital care prevent and reduce the probability of death and adverse sequelae (Malvestio et al., 2008; Sanchez et al., 2010; Ray et al., 2016). However, there is inadequate prehospital care system that facilitates emergency transportation and injury management in the prehospital setting in Kenya. This partly could explain why there were high proportions of prehospital deaths in this study, and only 6.8% of the motorcycle injury patients arrived in the hospitals by ambulance. Arrival to the hospital beyond one hour was associated with a higher likelihood of severe head injuries and femoral bone fractures and high mortality.

Injury severity score (ISS) provides a valid indicator of morbidity status of an injury patient and the prognosis of survival or death from multiple injuries (Malvestio et al., 2008). Patients with low ISS have less forms of injuries, in general, recover rapidly, whereas those with higher scores are more likely to have a longer period of recuperation. An assessment of the relationship between mean length of stay and **ISS** and the hospitals attended showed that motorcycle injured patients with high **ISS** levels and lower GCS were hospitalized for significantly longer periods than those with less severe injuries. The mean ISS for motorcycle injured patients who were admitted was significantly higher than for those treated on an outpatient basis. Previous studies by Kashkooe, Yadollahi, and Pazhuheian (2020) provide consistent evidence of the association between injury severity and Length of Stay with regard to motorcycle injury patients. This implies that the length of stay may be used as a proxy measure of injury severity. However, this needs to be cautiously applied for three reasons: firstly, some patients with minor injuries may remain in hospital for more days due to other complications; secondly, other patients may be detained for personal reasons (such as inability to promptly settle hospital bills, or not having bus fare or relatives nearby to help with transportation); and finally, seriously injured patients may stay for only a short period before being transferred to tertiary hospitals, such as those with ICU facilities for specialized care. It is also important to be aware of the potential limitations when comparing hospitalization rates between different types of hospitals. For instance, a private hospital which is basically profit making may have a tendency to retain patients with less severe injuries for disproportionately longer days: this is likely to falsify the relationship between Injury Severity Score (ISS) and the actual Length of Stay (LOS). It would therefore be useful to establish and maintain minimum admission criteria, standardized inpatient management practices and patient discharge procedures across all hospitals whether private or public in order to improve the validity of using the mean length of stay as an indicator of both injury severity and hospital utilization. Hospital length of stay and discharge destination are significant outcome measures used in public health system evaluation (Morgan and Beech 1990; Marshkey et al., 2010);(Shojania, Showstack, & Wachter, 2001); (Brasel, Lim, Nirula, & Weigelt, 2007; Fletcher et al., 2019). In addition Hospital length of stay (LOS) has been used as an indicator of efficeiency in health system by various stakeholders such as hospital management, health researchers, government ministries for arrangements for health care and community service. Health statisticians and epidemiologists also utilize the duration of hospital stay as an important parameter for appraising service delivery in hospitals.

The mean injury severity scores between in- and outpatients also differed significantly across all types of road users and was greater for motorcycle rider and pedestrian than for bicyclists and passengers. This pattern gives some indication of the relative importance of each injury mechanism in terms of the likelihood of hospitalization, survival or death, as well the range and amount of resources likely to be required for treatment. And for those affected by traffic crash trauma, a greater proportion of motorcycle rider and pedestrians sustain more severe forms of injuries than other road-users: the fact that motorcycle-pedestrian, motorcycle- motor vehicle collisions are more likely to be fatal or critical (due to crash impact force) and use more public health system resources.

A striking feature of the currentfindings is the demonstration of the extent to which motorcycle crashes contribute to increased utilization of public health systems resources: motorcycle injuries are the single most important utilizer of the radiological diagnostic services such as X-rays, CT scan, MRI, and ultrasound. Similar findings have been reported in other studies in Tanzania and Nigeria (Komolafe, Komolafe, & Amusa, 2005); (Chalya et al., 2010);(Ogbeide & Isara, 2015)). Due to the dynamics of motorcycle trauma and the numbers involved, the urgency and priority for X-rays demand result in immediate overload in the department at the expense of patients with other conditions.

Motorcycle injuries are characterized by the high utilization rate of operating theatres (approximately 53% of all major surgeries) which has implications for the costs of medical services in terms of resource inputs and staff requirements. The study revealed that motorcycle injuries accounted for 96.1% major surgery among cases hospitalized and 80.3 % requiring minor surgeries among the outpatients. Altogether 87.5% of motorcycle related injuries requiring surgical interventions requiring different medical -surgical procedures including; wound debridement, suturing and cleaning, closed reduction and Open Reduction Internal Fixation (ORIF) surgery; exploratory laparotomy and amputation of lower extremities. The numbers of motorcycle injury cases demanding minor or major surgical procedures are huge consequently causing overcrowding in the emergency department and surgical wards. This finding is similar to that reported in Brazil by Liu et al., and Rifaat et al., that showed that, motorcycle injuries had high proportions demanding surgical intervention.(Rifaat, Tay and De Barrow, 2012; Liu et al., 2016).

5.3.3: Objective III: Cost incurred by motorcycle injury cases attended to in Tier III Hospitals in Kisumu City

The cost of motorcycle injuries was established using human capital approach and willingness to pay approaches showed that motorcycle-related injuries exert a considerable economic cost on health care services, individuals and society. The total cost of motorcycle crashes was Ksh. 158,236,383 . This is a huge burden as approximately 48% of the City population lives within absolute poverty bracket (USAID, 2018). To put it in perspective, this cost is equivalent to 67.5% and 34.7% of the budgetary expenditure on health and sanitation and road infrastructure respectively in 2019. Further, the leakage is equivalent to losing 1.5% of the Kisumu County's total expenditure on all the economic sectors in the same year (County Government of Kisumu, 2019). Moreover, these findings indicate that on average it costs Kshs. 18,363 to treat a motorcycle crash victim; and more than Kshs. 109, 308,240 was lost due to lost productivity from severe motorcycle injuries and deaths. The huge cost burden underscore the need for every member of society to recognize the importance prevention of motorcycle injuries and road safety. In addition, the findings provide rich information that is helpful for evidence-based advocacy to change behaviour for motorcycle users' safety. Information on the cost of accidents to the individual and society as a whole can be used by motorcycle associations, Local administrations and authorities and civil society organizations to influence behaviour change among road users.

The study highlights the direct and indirect cost of motorcycle accidents as well as the Value of Statistical Life and Injury. The financial burden associated with motorcycle injuries in high-resource settings is significant (Garcı´a-Alte´s, Pe´rez (2007), Finkelstein, Corso, Miller, 2006). In concurrence with other studies, the indirect cost incurred in terms of lost productivity was high, representing 69.0% of the total cost. This is due to the consequent disabilities and treatment, emphasizing the long-term effects of these injuries on the economic welfare of society (Wesson et al. 2014; Kudebong et al. 2011; Xie et al., 2008). The resulting reduced productivity due to deviations in ability to work or conduct normal activities and long-term disability suffered by the victims make them a social and financial burden to families and society at large and can push the families into poverty (Ericsson, (2008). Híjar et al, 2004; Bhalla et al., 2013). However, the lost productivity cost, computed using ‘‘human capital’’ approach, undervalues injuries to children, women, and the elderly since these cohort either have no salary or earn lower wages. This effect may be even more pronounced in Low and Middle income countries. The human capital approach also places lower values on the work of full time homemakers than on the work of people participating in the labor market, which might further depress the value placed on women's productivity losses relative to men's productivity losses.

Like other studies, medical costs of motorcycle crash injuries contributed 40% and 12.1% of direct costs and total cost respectively, which are greater in case of survival of the victim demanding continuous follow up rehabilitation (Miller,. 1994; Bhalla et al., 2013; Wijnen, 2021; Taficom, 2021). Motorcycle injuries used 3.7% and 3.2% of the 2 public hospitals' annual budgets, which represent large sums of money to spend on a single preventable health problem. This demonstrates the huge economic burden exerted by motorbike crashes on health care systems. The study also established that these costs from motorcycle injuries are met by different entities including the victims, private and public insurance. Therefore, the general public insured, tax payers, insurers and the governments should be concerned with understanding not only the size of these costs, but also their impact on the economy and contribution to health care costs.

The study also provided costs of the value of preventing motorcycle crashes based on the willingness-to-pay method using a contingent evaluation and stated preference. Nearly half of the motorcycle injury victims were willing to part with Kshs 4000, and on average were willing to cede Kshs 2628 and Kshs 2855 for reduction of risks of mortality and severe injuries associated with motorcycle crashes that translate into Kshs. 43,329,975,000 and 22,321,463,500 the value of statistical life (VOSL) and Value of statistical injury, respectively. This implies that motorcycle injury victims are willing to relinquish Kshs. 43,329,975,000 per year for a risk reduction which reduces the expected number of motorcycle fatalities by 50%. This represents the monetary value of increased safety and shows that motorcycle injury victims or motorcycle users are concerned about traffic safety and willing to relinquish a substantial amount of money for improved safety. The findings are comparable to other studies in Iran (Ainy et al., 2016).

However this value is higher compared to studies conducted in Thailand and Malaysia (Thongchim, Taneerananon, Luathep, and Prapongsena (2007) and Suwanrada (2005); Chaturabong et al. (2011) (Fauzi, Ghani, Umar, and Hariza (2004) but was lower than results from a study in Kampala Uganda (Sebaggala, Matovu, Ayebale, Kisenyi, & Katusiimeh, 2017). The difference in VOSL could be due to different methods applied in the calculation of the crash cost and different time periods when the studies were conducted.

Patients who had not worn helmets at the time of crash contributed to over 80% of the total VOSL and VOSI. Indicating that they had the greatest willingness to pay for initiatives that reduce risks of road traffic crashes and translated to the greatest amount that would be saved had they been wearing helmets. The results of this study indicate that the cost obtained by using the WTP method showed a considerably higher figure compared to the results obtained from the human capital approach. This indicates that losses due to crashes are higher than they were actually accounted for. Due to this, the investments in road safety based on the human capital approach, are somewhat lower than what is actually required. However, data obtained from the human capital approach is been known to be reliable and readily available; and produce consistent and transparent results, moreover it has been proved to be simple to use (Kobelt, 2002; Silcock, (2003). On the other hand, costs quantities from willingness to pay approach is closer to the real injury cost, more accurate and makes it easier for stakeholders to address the traffic associated problems. WTP is a proper method for determining cost of injuries; it is conceptually correct and provides a better reflection from the social value of safety. The results obtained from this study are expected to make a significant contribution when it comes to updating cost figures for slight and serious casualties generated by motorcycle accidents. This will potentially lead to decisive future investment decisions on road safety in Kenya, in particular, and developing countries.

The study further demonstrated a significant disparity in gender in-terms of motorcycle injury costs with male having greater overall costs compared to females representing 64%. Men incurred higher indirect cost than females. The gender disparity in the motorcycle injuries and fatalities can be attributed to several factors associated with increased exposure to risk factors such as risk taking, alcohol use, being male's results in high proportion of fatalities and non-fatalities, hospitalizations leading to higher costs (Devos et al., 207). Public health interventions focusing on behaviour change targeting reduction of risks such as stoppage of alcohol while riding or using motorcycles should be encouraged and enforced.

Motorcycle rider had the highest mean cost which means, on average they presented the highest cost per injury case. Previous studies have indicated that motorcycle riders, particularly those un-helmeted, are more likely to sustain injuries resulting in greater hospitalization costs than regular passengers' vehicles (Achit et al., 2015). On the contrary pedestrians incurred higher in-direct costs than other road users since they are more vulnerable and sustain severe injuries with greater hospitalization cost (Papadakaki et al., 2017). Pedestrians also had the greatest Value of Statistical life and injuries (VOSL and VOSI). These differences by demographical characteristics and road user category indicate the need for injury prevention programmes to focus on particular road users when targeting prevention programmes for motorcycle injuries. However, there is need for a more comprehensive study that includes all injury data from all hospitals within the City to describe injury epidemiology and provide data that can be used to develop specific community-wide interventions.

According to Blankson (2017), traffic crashes result in very wide spectrum of injuries, which may range from less serious bruises and lacerations to severe morbid states requiring extensive management. Thus, direct costs associated with these injuries are expectedly to varry among the different aetiologies. Motorcycle injury cases who sustained to head, chest, abdomen, spine, pelvis and upper extremities were the most common, represented 70.2% of all motorcycle injury patients treated at the study hospitals.On average injury costs were higher for persons who sustained injuries on multiple regions of the body and head injuries. The costs were higher for head injury and lower limbs than for other body regions. Head injuries have been associated with greater hospitalization and medical costs compared to other types of injuries (Yuan et al., 2012; Kleiven, Peloso & Holst, 2003). Higher cost for head injuries can be attributed to greater use of Computer Tomography scans and complicated surgical procedures (Ainy et al., 2016). Further, expenditure for care for patients with thoracic injuries due to increased length of stay and ICU services,

Previous studies have indicated that property damage, loss of valuables, cost of repairs, are used as indicators to assess cost burden of crashes. These measures are used to inform road users of the value road safety. Likewise, local transportation and insurance stakeholders can be informed of economic benefits from a comprehensive crash cost assessment. In each crash, there is a high probability of damage to motorcycle and property on the side of the road, and loss of personal items. Studies in Indonesia and in Ghana by Kudebong et al., (2011) and Widyastuti & Mulley (2005); indicated that property damage cost accounted for 50.2 % and 60% of direct costs, respectively.

When a crash occurs, the probability of losing materials is very high; in this study variety of valuable materials were lost including cell-phones, laptops, hand bags, money, food stuff, books etc. Loss of valuable items contributed considerably to property damage costs. Severely injured motorcycle riders spent more, on average, for repairs compared to riders with minor injuries. According Ross Silcock (2003) the largest portion of property damage is the things that relate to damage to the motorcycle (Ross Ross Silcock (2003). In concurrence with Kudebong et al. (2011), the huge monetary loss of these valuables not-withstanding, their loss constitutes a serious socio-economic and security threat not only to the victims, but also to their immediate families and the institutions for which they work. It is therefore important to include them in the estimation of the cost of accidents so as to attract more necessary attention and resources to confront road safety interventions.

Funeral cost also contributed to the direct costs in this study. In this study there were 73 fatal cases, accruing funeral costs totaling Kshs. 12,841,042 representing 16.7% of the total costs. These costs encompassed the cost of postmortem, embalment, preservation, caskets, mortuary fee, transportation and other burial expenses. As already been observed, these costs cannot be ignored; their incorporation in the computation of the total cost is crucial. According to Kudebong et al. (2011), in fatal crashes where victims die on the spot, the non-inclusion of funeral cost greatly under estimate the real cost because if any cost is to be incurred at the health facility, it will be the mortuary charge which is minimal compared to the medical charges. In this study the mortuary cost accounted for 2.45% of the total cost of motorcycle injuries.

The results of this study have shown that motorcycle crashes result in a huge cost to the society. Their intervention therefore requires the concerted efforts of all stakeholders with health personnel playing the lead role. Road traffic crashes are among the leading preventable causes of illnesses and premature deaths, policy makers should implement effective road safety policies to encourage people to adapt a more responsible way of riding.. Public health officers in the city should be encouraged to approach Road safety education with the same vigor used in their campaign for most childhood diseases.

5.3.5: Objective IV: Factors influencing the cost of motorcycle injuries in Hospitals in Kisumu City.

5.3.5.1: Factors influencing Total Cost of motorcycle injuries

The study provides the first indicators of issues influencing the cost of motorcycle injuries that include the human, demographic, health and behavioral (road safety practices). The identification of these factors are critical for determination of targeted interventions that could have greater impact in burden reduction. The study found that the total cost is higher for males than females with motorcycle injuries. The gender disparity in the motorcycle injuries and fatalities can be attributed to several factors which could also be advanced for the variations in the costs. Increased exposure by men to risk factors such as risk taking and alcohol use results in high proportion of fatalities and non-fatalities, hospitalizations leading to higher costs (Granie, 2009). Therefore the huge burden of motorcycle injuries among the males need concerted efforts to address. Public health interventions focusing on behaviour change targeting reduction of risks should be encouraged and enforced.

Furthermore, alcohol use by road users had significant influence on the total cost trajectory contributed by high medical and property damage costs attributable to motorcycle crashes. Prior use of alcohol was associated of 78.6% of fatalities, and 34.6% of hospitalizations. In Kenya drink driving is prohibited by The Traffic Amendment Act Cap 405. More emphasis has been made on drivers of motor vehicles by enforcement officers than on motorcycle riders. There is need for amendment of the law to prohibit riders from riding under the influence of alcohol coupled with appropriate campaigns targeting motorcycle riders.

Further analysis revealed that helmet use was low at 30.7%. Helmet non-use lead to greater total cost and was also associated with 90.4 % motorcycle related fatalities, 89.2% hospitalization and 78% emergency department resulting into a total medical cost of Kshs. 17, 017, 254; with a mean cost of Ksh. 20,138.76 almost twice the mean cost of Kshs. 10,789 for those who wore helmets. This agreed with a study by Brandt, et al. (2002) which reported average costs for un-helmeted riders to be twice of the costs for helmeted riders. Failure to wear a helmet adds to the financial burden created by motorcycle-related injuries. The authors concluded that individuals who do not wear helmets should therefore be required to pay higher insurance premiums (Brandt et al., 2002).

Evaluation of data on medical treatment of motorcycle crash victims show that while helmeted victims are always found to have lower rates of head injury than non-helmeted victims, they often have higher rates of injury to the extremities and roughly equal short-term medical costs. One might conclude that wearing a helmet does not reduce the victims' overall medical costs. Helmet-wearing motorcycle injured patients are likely to have serious injuries in some body location not protected by a helmet. While motorcycle injuries to the extremities may not carry the potentially severe long-term consequences of a head -brain injury, they can be quite expensive to treat. Other studies show that most of the expensive head injuries are sustained by non-helmeted motorcycle riders who are also more likely to be uninsured, and the public pays for a higher percentage of their medical costs (Kelly et al, 1991; Hartunian et al, 1983). According to a meta-analysis systematic review , the hospital cost of a patient that had been in a motorcycle crash with no helmet is $ 12,239 higher than that of a patient who was using a helmet.

Motorcycle injury patients hospitalized were 8 times more likely of paying more greater costs than motorcycle injury patients treated as outpatients.

The study revealed that cost patterns among motorcycle injury patients, had a large increase in total costs for patients who were subjected to radiological investigation. A comparison of the cost trajectories of radiological investigation indicates similar patterns. The increase in cost seem to be much greater for injuries that require X-rays, followed by CT scan and MRI imaging.

Increase in total cost were significantly associated with hospital length of stay and admission to ICU, head injuries, fractures and multiple injuries. Hospital length of stay and ICU admission has been reported in previous studies to be associated with acute treatment costs (Curtis et al., 2012; Marik et al, 2002; McGarry et al., 2002). Admission to ICU as a predictor of cost has been demonstrated previously **(**Pape 2009).

The study found that a large increase in the total costs attributed to cases who sustained fractures, head injuries and multiple injuries. Injury patients presenting with head injury, fractures and multiple injuries required specialized surgical care and procedures, longer hospital stay which result in higher medical costs. Multiple injuries often require, multiple radiological and laboratory investigations, multiple surgical interventions, and prolonged ICU and hospital stay. This was consistent with findings in previous studies (Allen Ingabire et al., 2015) (Ghee et al, 1997).

The hospital facility attended had significant influence on the medical cost charged or payed. Patients who go to JOOTRH were less likely to afford and pay a higher medical cost compared to those who went to Aga Khan, whereas patients who were treated at KCH had even decreased probability of paying a higher medical cost compared to those who went to Agha Khan and JOOTRH. This means that patients treated at the two public hospitals (JOOTRH and KCH) are not able to afford higher costs expended at the private hospital (Agha Khan Hospital). Again the attraction of motorcycle injured patients to public hospitals could have been due to the implementation of Universal Health Coverage programme by the government of Kenya where patients who are registered do not to pay any amount for treatment.

The study also found that the principle diagnosis and the severity of injuries influenced significantly the medical cost. A motorcycle injury case that had fractures and head injuries had increased likelihood of paying higher medical expenses. The cost was even higher for severe injuries.This was consistent with findings from other studies (Allen Ingabire et al., 2015, Ghee et al.,, 1997).

The number of days a patient stayed in hospital, in the intensive care unit and whether he or she uses ventilators also increased the medical cost. This study found an average length of stay of 19.6 days and was comparable with other studies by Bried et al. (1987); Bray et al. (1985) and Offner et al (1992) which provided evidence of significant relationship between length of stay and cost. Furthermore, patients who spent more than 1 week in the ICU were more likely to pay for higher cost compared to those who spent less .

The study showed that type of treatment received, and whether the treatment was minor or major in patient or outpatient, surgery, prescription drug offered, radiological investigations, physiotherapy, and type of test undertaken had a significant impact on the total cost charged on a motorbike motorcycle injury patient. While patients who undertook X rays, CT scan and MRI diagnostic procedures were more likely to pay higher medical costs than those who did not. Once a motorcycle injury case presents to the hospital, every service offered from registration to treatment has a price tag, and the more services rendered in terms of diagnostic investigations and various surgical procedures are more expensive. One motorcycle injury case would require several radiological and laboratory investigations, several medical/surgical procedures resulting in increased costs.

When all these factors are taken into account, the most important determinants of total costs were found to be being male, motorcycle rider, pedestrian, sustaining major surgery(ISS≥16), hospital length of stay, ICC admission, alcohol use, helmet non use, received training, riding experience and carrying more than one passengers.

5.3.5.2: Willingness to pay for interventions

The monetary quantification of profits associated with road safety measures has for a long time been limited to the valuation of the number of avoided deaths. Most literature focused on the estimation of the WTP for a reduction of the risk of fatal accident and on the calculation of the value or the price of the risk, more collectively named as " the value of a statistical life" (VOSL): This represents the monetary value of the potential increased safety, and shows the extent to which motorcycle injury patients are concerned about traffic safety and willingness to trade a sizeable amount of money for improved safety. This estimate was higher compared to studies done in Thailand by Thongchim, et al., (2007) , Suwanrada (2005) and Chaturabong et al. (2011), and in Malaysia by Fauzi, Ghani, Umar, and Hariza (2004) but was lower than results from a study in Kampala Uganda Sebagalla et al., 2019). The differences in VOSL could be due to different methods applied in the calculation of the crash cost and different time periods the studies were conducted. The study has highlighted the monetary value of increased safety from motorcycle accidents and presents both social and economic rationale for safety investments and interventions to improve the road traffic safety for motorcycle users. The key policy implication of the study is that reducing motorcycle casualties and fatalities will reduce social and economic sufferings of victims, unlock growth and free resources for more productive use. The findings provide the cost- benefit analysis of any investment in areas that will promote the prevention, treatment, care and management of motorcycle accidents in Kenya.

Type of road user had a significant impact on willingness to pay for road safety interventions. The study revealed that the type of road user at the time of crash had a significant role in influencing the level of willingness to pay for higher intervention costs; a motorbike rider with less monthly income were less willing to pay for higher intervention expenses than would a bicyclist, while a passenger would be more likely to pay than a pedestrian.. Respondents with lower incomes are less willing to pay than those with higher incomes. There was significant influence of age on the probability of contribution to road safety initiatives:young people, particularly those aged 20-30 years, had greater willingness to contribute than those aged above 50 year. Similarly,studies, victim of motorcycle vs vehicle crash was three times as much willing to pay for higher costs of interventions as compared to a victim of other accidents (OR = 2.828, CI = 1.340-5.969). in Thailand, France, Uganda (Chaturabong et al., 2011), (Mohammed, Ambak, Mosa, & Syamsunur, 2019) and (Sebaggala et al., 2019), respectively show that age is a significant factor affecting willingness to pay to reduce the risk of fatality—younger respondents are more likely to be willing to pay than older respondents.

At the same time, the level of education was a significant determinant of willingness to pay; a primary school level individual was four times more likely to be willing to pay for higher expenses relative to an individual without any education, whereas those with university level education were more likely to pay for the higher expenses for interventions as compared to not having gone to school at all. Marital status had some influence on willingness to pay for safety intervention; motorcycle injured patient who were divorced, widowed and single people were less likely to contribute to road safety initiatives compared to those who were married.

Alcohol use were significant factors affecting the willingness to pay for reduction of risk of death and severity of injuries. This was in agreement with (Mohammed et al., 2019) (Chaturabong et al., 2011) (Sebaggala et al., 2019). While usual alcohol use propelled the willingness to invest in reflective wear, alcohol use 5 hours prior to motorcycle crash hindered.

Lighting condition and road condition significantly influenced the willingness to pay to reduce the motorcyle injury; crashes that occurred during daytime lowered the odds of willingness to buy protective wear by 59.2% as compared to those that happened during the night.

The level of severity of motorcycle injury had significant impact on the willingness to pay. Motorcycle injury cases with severe injury conditions reported greater willingness to pay potentially to hedge the risk of serious sequelae compared to low severity levels and fatal injuries. This concurred with a Mohamed (2016) who reported that a variations in patients willingness to pay corresponds to the various levels of injuries severity: and that severe permanent injuries requiring hospitalization and resulting in irreversible consequences portrays superior a WTP to major or minors injuries without impairment. Type of injury also had significant influence on the level of willingness to pay: those fractures were 5 times more likely to be willing to pay for identified interventions than those diagnosed of abrasions. The individuals are more ready to invest and willing to pay more greater amounts of money to reduce their risk of severe injuries in comparison to less severe ones.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

6.1.1 Pattern of motorcycle injuries presenting in hospitals in Kisumu city

The study conducted in Kisumu city reveals a concerning prevalence of motorcycle-related injuries, constituting over half of all road traffic-related injuries and fatalities. The majority of victims fall within the productive age group of 15 to 34 years, emphasizing the need for targeted health promotion strategies for road safety in this demographic. The disproportionately higher involvement of males, particularly young adults, in motorcycle crashes raises alarm about potential impacts on productivity, with risk factors such as reckless riding, overloading, speeding, adventure-seeking, and alcohol use being identified. The vulnerability of motorcyclists due to the absence of protective car frames is highlighted, emphasizing the need for enhanced safety measures. Furthermore, the analysis of accidents based on the time of occurrence underscores the importance of considering daytime prevention strategies due to increased traffic density and human activities during those hours. Overall, the findings suggest a critical need for comprehensive road safety initiatives, particularly targeting the identified high-risk demographic and addressing contributing factors to reduce the burden of motorcycle-related injuries and fatalities in Kisumu city

The study sheds light on critical aspects of motorcycle-related injuries in Kisumu City. The findings highlight the significance of timely medical care, as nearly half of the patients arrived at hospitals within 1-6 hours post-crash. However, the delay in seeking medical care remains a concern, emphasizing the need for improved pre-hospital care systems. While over half of the patients received some form of pre-hospital care, the majority were transported to the hospital by non-professionals, underscoring the importance of enhancing emergency medical services.

The nature of injuries varied from minor abrasions to life-threatening head injuries and fractures, with the head and extremities being the most frequently affected anatomical regions. Head injuries were particularly prevalent among fatal cases, emphasizing the critical need for interventions to promote helmet use. The study reveals a low prevalence of helmet use among motorcycle riders and passengers, indicating a significant area for improvement in road safety measures.

Alcohol consumption was identified as a contributing factor to motorcycle crashes, with a notable correlation between alcohol use and the severity of injuries. Efforts to decrease alcohol consumption could potentially reduce the number of motorcycle crash injuries and fatalities.

The burden of motorcycle injuries on the healthcare system was explored, demonstrating increased demand for critical clinical services, radiological investigations, major surgical procedures, and longer hospital stays. Prolonged hospitalization poses challenges to healthcare resources and productivity, indicating the need for comprehensive strategies to address both the immediate and long-term impacts of motorcycle-related injuries on individuals and the healthcare system.

The study underscores the urgency of implementing targeted interventions, including improved pre-hospital care, increased awareness on the importance of helmet use, and measures to reduce alcohol consumption. Additionally, addressing the burden on the healthcare system requires a multi-faceted approach, encompassing efficient resource allocation, enhanced hospital services, and comprehensive road safety measures.

6.1.2 The burden imposed by motorcycle injuries on hospitals in Kisumu City

This study provides valuable insights into the impact of motorcycle-related injuries on hospital utilization, length of stay, and healthcare resources in the context of a developing country. The findings highlight the significant burden placed on public health systems by motorcycle injuries, particularly in terms of hospitalization duration, surgical interventions, and radiological diagnostic services.

The mean length of hospital stay (LOS) is identified as a crucial indicator of hospital utilization and efficiency. The study reveals that motorcycle riders and pedestrians involved in motorcycle crashes experience a substantially greater period of hospitalization compared to bicyclists, with motorcycle injuries being responsible for the majority of in-patient days, especially among adolescents and adults. Prolonged hospitalization not only contributes to increased healthcare costs but also leads to overcrowding, strained staff, and heightened demand for specialized care. The study emphasizes the importance of considering LOS variability by age, sex, road user category, and hospital attended when planning healthcare delivery and allocating resources.

The lack of helmet usage by motorcyclists is identified as a significant factor impacting hospital admissions and length of stay. Non-helmet use is associated with a higher likelihood of severe head injuries, longer hospital stays, and increased odds of admission to the intensive care unit (ICU). The study reinforces the importance of enforcing helmet laws and promoting preventive measures to reduce the severity of injuries and subsequent healthcare utilization.

The study also sheds light on the inadequacies in prehospital care systems in Kenya, with a high proportion of prehospital deaths and limited ambulance utilization. Early and quality prehospital care is identified as a crucial factor in preventing adverse outcomes and reducing mortality rates. Additionally, injury severity scores (ISS) are found to be significantly associated with length of stay, indicating that LOS can serve as a proxy measure of injury severity. However, caution is advised in interpreting LOS as a sole indicator, considering potential confounding factors such as personal reasons for prolonged stays. Motorcycle injuries emerge as the leading utilizers of radiological diagnostic services and operating theatres, further highlighting the strain on healthcare resources. The study underscores the urgent need for targeted interventions, including the promotion of helmet use, improvement of prehospital care systems, and the development of standardized admission criteria to enhance the efficiency of healthcare delivery. The findings from this study provide valuable information for policymakers, healthcare professionals, and stakeholders to implement evidence-based interventions and allocate resources effectively. Addressing the challenges posed by motorcycle-related injuries requires a multi-faceted approach, encompassing legislative measures, enforcement of safety laws, improvements in prehospital care, and community education to enhance road safety awareness.

6.1.3 The cost of motorcycle injuries in hospitals in Kisumu City

The study highlights the substantial economic burden imposed by motorcycle-related injuries on health care services, individuals, and society in the context of Kisumu County, Kenya. The total cost of motorcycle crashes, amounting to Ksh. 158,236,383, and Mean VOSL of Kshs. 43,329,97500. This underscores the urgency of addressing road safety and preventing such incidents. This financial burden is particularly significant considering the high poverty rate in the region, affecting nearly half of the city's population.

The findings emphasize the importance of adopting preventive measures and promoting road safety awareness. The economic impact is not only reflected in direct medical costs but also in the indirect costs associated with lost productivity, disabilities, and long-term effects on the economic welfare of individuals and families. The study reveals that motorcycle injuries place a considerable strain on health care systems, consuming a substantial portion of public hospital budgets.

Moreover, the study provides insights into the willingness of motorcycle injury victims to pay for safety improvements, indicating a collective concern for traffic safety. The willingness-to-pay approach presents a higher cost figure compared to the human capital approach, suggesting that the true losses due to crashes might be underestimated and that a significant amount would be saved if safety measures are adhrered to. This information is crucial for informing stakeholders and policymakers about the actual economic impact of motorcycle accidents and the need for adequate investments in road safety initiatives.

Gender disparities in injury costs, with males incurring higher overall costs than females, highlight the need for targeted interventions, especially considering the risk factors associated with male road users. Motorcycle riders, particularly those without helmets, contribute significantly to the overall costs, emphasizing the importance of enforcing safety measures such as helmet usage.

The study also sheds light on the diverse nature of injuries, with head injuries and injuries to multiple body regions incurring higher costs. Additionally, property damage, loss of valuables, and funeral costs contribute significantly to the direct costs associated with motorcycle crashes. Acknowledging and including these various components in the estimation of the cost of accidents is essential for comprehensive road safety interventions.

The motorcycle injury patients were willing to pay for reduction of risk to severe injuries and fatalities.

In light of these findings, it is evident that concerted efforts from various stakeholders, including the public(road users- motorcycle riders, pedestrians, pillion passengers and bicyclists), health personnel, policymakers, motorcycle associations, local administrations, and civil society organizations, are necessary to address the multifaceted challenges posed by motorcycle-related injuries. Implementing effective road safety policies, promoting behavior change, and investing in preventive measures are crucial steps to mitigate the economic and societal impact of motorcycle accidents in Kisumu County and other developing regions.

6.2 RECOMMENDATION

Due to the multi factorial nature of traffic injuries, tackling the problem of road safety is context-specific and requires development of a range of policy options with the involvement of key stakeholders and access to relevant information. The study recommendations are as follows as organized by objectives.

6.2.1 Pattern of motorcycle injuries presenting in hospitals in Kisumu city

1. Educating riders, pedestrians and passengers about the essentiality and benefits of conspiquity as a road safety measure to increase visibility. In addition to wearing a highly-visible reflective vest, conspicuity can be increased by wearing other reflective clothing and helmet, installing reflective stripes on different surfaces of the motorcycle, and running the headlamps when riding. Advocacy through road safety campaigns on the cruciality of conspicuity to motorcycle users. Fluorescent yellow-greenor red-orange vests are readily available and should be included as a gift to riders who register their motorcycles.
2. Improve prehospital care trauma system ;

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   - ✓ The by- standers should be engaged in the provision of prehospital care:
   - ✓ Train motorcycle riders as primary responders: Trained primary responders can collect valuable data used to identify cause of crash, frequency and type of injuries, and crash locations.
   - ✓ Secure essential equipment and supplies for first responders. Provision of ambulance vehicles to transport crash victims.
3. Increase rider, pedestrian and passenger protection: Head injuries and limb injury are the leading cause of death and major trauma injury for motorcycle injury victims. Prevention of

head injuries and lower limb injury would require advocacy on measures such as wearing protective helmets, protective boots, kneepads, and padded gears. Helmet use has proven to be effective in prevention of motorcycle crash-related injuries. One public health measure to reduce such injuries is increased commercial access and availability of these protective items by reducing or waiving associated consumption taxes.

4. There is need for strict enforcement and increased publicity of the law to improve compliance inoder to reduce occurrence and severity of motorcycle injuries.

6.2.2 The burden imposed by motorcycle injuries on hospitals in Kisumu City

1. Documentation of motorcycle-related injuries and hospitalizations and their impact on health services is essential for evidence-based policymaking, advocacy, and priority-setting for interventions, resource mobilization, and future research. A comprehensive recording system for collecting motorcycle injury data in Emergency departments, including cause of injury, nature and severity, gender and actual age of casualty should be established. This would help in identifying the burden of motorcycle -related injuries (and particular types of injuries) on the health service and the community.

2. The hospital utilization information by motorcycle injury cases in-terms of emergency department presentation, hospitalization, radiological investigations laboratory investigation and surgical interventions on various types of motorcycle injuries should be taken into account by hospital management, health care workers to ensure accurate, appropriate, relevance, adequate, and responsiveness of trauma delivery services. This therefore calls for renewed vigorous adherence, enforcement of laws, promotion and mobilization for appropriate identified interventions like helmet and reflective use for both rider and passenger to address the high loss of life and resources by public health system.

3. Effective enforcement of drink riding /driving measures by police officers; as the study has established that these factors influence significantly the principle injury diagnosis, severity and consequent health service demand, injury outcome, cost of medical care.

4. Advocating for increased use of protective gear for lower limb protection to reduce high rates of injuries to the extremities.

5. Lack of helmet use by more than 80% of motorcycle riders and passengers and their increased usage of hospital resources convey an urgent need for improved preventive strategies and enforcement. Effective enforcement of helmet laws for riders and pillion passengers to improve helmet use

6. Policymakers, hospital administrators, and trauma center managers should consider motorcycle injuries when planning for emergency trauma service delivery, including resources for health; equipment and supplies, and operations to ensure accurate, appropriate, relevance, adequate, and responsive trauma management and prevention efforts

6.2.3 Cost incurred by motorcycle injury cases attended to in Tier III Hospitals in Kisumu City

1. The key policy implication of the study is that reducing motorcycle casualties and fatalities will reduce social and economic sufferings of victims, unlock growth and free resources for more productive use. The findings provide the cost- benefit analysis of investment in helmet use and wearing reflective jackets that will promote the prevention, treatment, care and management of motorcycle accidents in Kenya.

2. The political will and funding levels for motorcycle related road safety and injury management should be commensurate with the scale of crashes and associated economic costs.
3. The huge impact of motorcycle injuries as confirmed by the study on the lives of the people involved, health care system and the society and the government must therefore be considered for purposes advocacy, planning and evaluation of the government's road safety intervention measures.
4. The results of this study has indicated that road safety has a huge cost to the society. Its intervention therefore requires the concerted efforts of all stakeholders with health personnel playing the lead role, community and government working together to mobilize resources for road safety initiatives. Public health officers in the city should be encouraged to approach Road safety education with the same vigor used in their campaign for most childhood diseases.
5. There is need for active community led programmes to promote measures that reduce risk of crashes as the study revealed that motorcycle injuy patients were willing to pay for presention measures.
6. There is need to enhance routine collection of hospital injury admission and fatality data, using a uniform system such as the E-codes of the International Classification of Diseases, Injuries and Causes of Death or other simplified version, to allow for accurate assessment of trends, regional and international comparisons, and the burden of different types of injuries on hospital services as well as their short and long-term outcome.
7. The study has highlighted the monetary value of increased safety from motorcycle accidents and more specifically, the study presents both social and economic rationale for safety

investments and interventions to improve the road traffic safety for motorcycle users. Motorcycle injury costs data may furnish an innovative monetary impulse to attenuate the threat of motorcycle crashes. Moreover, decisions on apportionment of scarce resources should be based on the predeliction and aspiration of those affected by the decision.

8. The study also found that road condition, weather condition and light condition contributed significantly in raising the levels of medical expenses, and thus the study recommends that the roads be maintained at a higher level of safety by ensuring street lights are always on especially at night and drainage system always be under check since wet roads are prone to accidents.
9. Motorcycle riders should be encouraged to carry only one passengers; The design of motorcycles allows for a rider and a passenger. There is tendency for motorcycle riders to carry more than one passengers to maximize profit. The study showed that motorcycle riders who carried two or more passengers were at increased odds of crash involvement and paying higher costs. Motorcycle riders should be encouraged to carry a single passenger per trip and avoid carrying passengers who may be impaired.

Research

i. Further research should explore the actual social and economic benefits of mandatory helmet use.
ii. Study to be done in a representive sample of Tier III hospitals in the country in order to provide a more representative burden of motorcycle injuries
iii. A longitudinal study of motorcycle survivors to assess the longterm effect of injuries in the society and family

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APPENDICES

APPENDIX I: CONSENT FORM

THE HEALTH BURDEN AND COST OF MOTORCYLE CRASH INJURIES PRESENTING TO TIER III HOSPITALS IN KISUMU CITY, KENYA

Principal Investigator- Wilberforce Cholo, (B.Sc. MPH) School of Public Health, Maseno University

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2. Dr. Japheths Ogendi, (B.Sc. MPH, PhD) School of Public Health, Maseno University

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Location: The study was carried out in Tier III hospitals in Kisumu City; consisting of Jaramogi Oginga Odinga Hospital, Kisumu County Hospital, and Agha-khan Hospital

Purpose: I am a PhD student in the School of Public Health, Maseno University. As part of the requirements for the award of this degree I am undertaking a study titled, "Health burden and cost of motorcycle crash injuries in Tier III hospitals in Kisumu City". Ethical approval has been obtained from Maseno University Ethical Review Committee. I am inviting all consecutive road traffic injury cases involving motorcycles presenting to the Emergency Department of the Tier III hospitals in Kisumu City within 3 months beginning May 6th 1019 – November, 6th 2019. The objectives of the study are to determine the pattern of road traffic injuries involving motorcyclists, the burden imposed on Tier III hospitals by motorcycle injuries, to quantify costs incurred by motorcycle injury cases and model for factors influencing the cost of motorcycle injuries in Kisumu City.

Description of the research study: The Investigator (or research assistant) and or the attending doctor requested to assist in the study, explained the study to you, providing all pertinent information (purpose, procedures, risks, benefits, alternatives to participation, etc.), and will give you opportunity to ask questions for clarification. The motorcycle injury cases were asked to complete a questionnaire or answer some questions which took approximately 30-45 minutes to complete or answer and after examination by the doctor, information about the nature, diagnosis and severity of the injuries, were captured by me and (or) research assistants and or the attending Doctor who was requested to assist in the study; the participants were informed that It was important that you complete the questionnaire or answer questions with complete honesty; there was no right or wrong answer. The information obtained was to be handled confidentially; it was not going to be possible for them to be identified personally. Their **participation was purely voluntary**, there was no coercion, neither were they forced to participate; and they reserved the right to refuse to take part or withdraw from study at any level or any time. The participants were not subjected to any further injuries, risk, harm or pain by taking part in the study. Again they were also not to receive any monetary incentive for participating in this research. Any changes made to the study were to be communicated as appropriate. The information that was to be given was purely for research purposes of fulfilling academic requirement and nothing else. All the data collected are kept secure and no other person besides me and my supervisors would have access to the completed questionnaire. The thesis would be submitted for marking at the School of Public Health. It is intended that one or more articles would be submitted for publication in scholarly journals.

I hereby confirm that I have explained the nature and conditions for the study to the participant and I guarantee to keep the information collected confidential.

Signature ____________________ Date __________________

I ------------------------------------- agree to participate in this study. I had a copy of this form, read it, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction and have understood the nature, procedures and conditions involved in the study. In case of further questions, comments or complaints relating to the research, I will contact the investigator through 0720395726 or right to refuse or withdraw.

Signature: ____________________ Date: ___________________

If you have any questions or clarifications about the research or in the event of a study related injury, please contact Wilberforce Cholo – 0720395726, P.O. Box - Kisumu. For any questions pertaining to rights as a research participant, the contact person is The Secretary, Ethics Review Committee, JOOTRH Kisumu P.O. Box Kisumu; Telephone 0723421452

Swahili

Mimi________________________________kutoka________________________natoa idhini ya kushiriki katika utafiti wa kutathmini maono katika madereva wa pikipiki za abiria katika mji wa Kisumu. Ninatambua kuwa taarifa abayo nitakayotoa yatashughulikiwa kwa siri. Mimi ninaelewa kwamba nina haki ya kujiondoa kwenye utafiti huu wakati wowote kama nipendavyo bila vikwazo vyovyote. Naelewa pia kwamba sitapokea pesa kama motisha kushiriki katika utafiti huu. Sahihi _______________________Tarehe _______________________ Ninakubali kuwa nimemueleza kinaganaga mshiriki huyu kuhusu utafiti huu naninamuhakikishia kuwa taarifa yake atakayotoa yatashughulikiwa kwa siri.

Sahihi: ___________________ Tarehe: __________________________

Kama uko na swali lolote kuhusu utafiti huu, unaweza kuwasiliana name kwa hii numbari ya simu 0720395726.

Sahihi___________________

Terehe_________________

APPENDIX II: STRUCTURED QUESTIONNARE

FORM FOR COLLECTION OF DATA FROM THE HOSPITAL

1. Identification OP/IP NO………………………….. Hospital------------------------

Study Number ___________

Date ___________ Arrival time ___________

1. Demographic Data

(1). Gender. Male------------------ Female--------------------

(2). Age ----------------- years

(3). Religion -----------------------

(4). Level of education --

(5). Marital status --

(6). Occupation ---

(7). Average income--

(8). Place of interview--

PATTERN OF INJURIES IN THE HOSPITALS

2. How long did it take before the casualty was brought to the hospital?___________

3. Pre hospital care given after the crash

(1). Yes (---)

(2). No (---)

4. Pre hospital transportation

(1). Police (---)

(2). Relative (---)

(3). Bystanders (---)

(4) Hospital ambulance

5. Weather conditions at the time of the crash

(1). Cloudy /overcast (---)

(2). Light rain (---)

(3). Heavy rain (---)

(4). Fog (---)

(5). Clear / fine (---)

6. Light conditions at the time of the crash

(1). Daylight (---)

(2). Dusk or dawn and street lights on (---)

(3). Dusk or dawn and no street lights on (---)

(4). Night time and street lights on (---)

(5). Night time and no street lights on (---)

7. Road condition at the time of crash

(1). Wet (---)

(2). Dry (---)

(3). Other (---)

8. Motorcycle carrying more than two people at the time of crash?

(1). Yes (---)

(2). No (---)

9. Motorcycle Crash Injury Data

(1). Time of injury crash ---

(2). Day of the week crash occurred-------------------------------------

(3). Exact place where injury crash occurred---------------------------

(4). Activity at the time of injury crash ______________________

10. Mechanism of the motorcycle crash injury

(1). Motorcycle vs motorcycle (---)

(2). Motorcycle vs vehicle (---)

(3). Motorcycle vs pedestrian (---)

(4). motorcycle vs animal (---)

(5). motorcycle vs bicycle (---)

(6). lone vs motorcycle (---)

(7). motorcycle vs pole/tree (---)

11. Type / Category of road user

(1). motorcycle rider (---)

(2). passenger of motorcycle (---)

(3). pedestrian (---)

12. Type of treatment received

(1). Outpatient (---)

(2). Inpatient (---)

13. Patient waiting time

(1). 0- 10 minutes (---)

(2). 11-20 minutes (---)

(3). 21-30 minutes (---)

(4). >31 minutes (---)

14. If outpatient type of treatment /service received

(1). Physician services (---)

(2). Nursing (0-23hrs) (---)

(3). Minor surgery/ dressings/suturing (---)

(4). Pharmacy (---)

(5). Radiological investigations (---)

(6). Laboratory tests (---)

15. If inpatient type of treatment /service received

(1). Nursing (>24hrs) (---)

(2). Major surgery (---)

(3). Radiological investigations (---)

(4). Physician services (---)

(5). Laboratory services (---)

16. Anatomical /Site of injury

(1). Head and neck (---)

(2). Chest (---)

(3). Abdomen (---)

(4). Pelvis (---)

(5). Spine (---)

(6). Upper extremity (---)

(7). Lower extremity (---)

17. Diagnosis

1). Fracture

2). Abrasion

3). Head injury

4). Leg injury

BURDEN IMPOSED BY MOTORCYCLE INJURIES ON HEALTH SERVICES

18. If outpatient type of treatment /service received

(1). Physician services (---)

(2). Nursing (0-23hrs) (---)

(3). Minor surgery/ dressings/suturing (---)

(4). Pharmacy (---)

(5). Radiological investigations (---)

(6). Laboratory tests (---)

19. If inpatient type of treatment /service received

(1). Nursing (>24hrs) (---)

(2). Major surgery (---)

(3). Radiological investigations (---)

(4). Physician services (---)

(5). Laboratory services (---)

20. Type of surgical procedures performed

(1). Craniotomy (---)

(2). Wound debridement (---)

(3). Closed reduction and POP (---)

(4). external fixation (**EF**) with open reduction internal fixation (**ORIF**)ORIF/EF (---)

(5). Exploratory laparotomy (---)

(6). under water sealed drainage UWSD (---)

21. Length of hospital stay (-----------------------)/Date of discharge?

22. Units of blood used---------------------------

23. Taken to Intensive care unit(ICU)

1. Yes
2. No

24. Number of days in intensive care unit(ICU) (----------------)

25. Use of ventilators

1. Yes
2. No

26. What was the outcome

1. Died 2. Referred 3. Followed up 4. Treated and Discharged.

27. Discharge status /patient disposition

(1). Home /self (---)

(2). Rehabilitation (---)

(3). Long term care (---)

(1). Referred (---)

(2). Died (---)

28. Mode of payment

(1). Public (NHIF) (---)

(2). Private / self (---)

(3). Other (---)

29. Do you have health insurance plan/scheme?

1. Yes (---)
2. No (---)

Casualty related Cost- cost of treatment/Direct cost

30. Can you please provide the following information on the costs you incurred (out of pocket) concerning the treatment of the injury sustained as a result of the accident? ITEM COST

If outpatient type of cost of service received

(1). Physician services (--------------------------------------)

(2). Observations (0-23hrs) (---------------------------------)

(3). Minor surgery/ dressings/suturing (--------------------)

(4). Prescription drugs (---------------------------------------)

(5). Radiological investigations (----------------------------)

(6). Laboratory tests (---)

7). Others (specify)--)

31. If inpatient type of treatment /service received

(1). Observations (>24hrs) (----------------------------------)

(2). Major surgery (--)

(3). Radiological investigations (----------------------------)

(4). Physician services (---------------------------------------)

(5). Laboratory services (-------------------------------------)

(6). Feeding ---)

(7). Transport--)

8). Ambulance cost--)

(9). Others (Specify) ……… **Total medical charges =**

Property damage cost

32. Damaged the motor bike as a result of the accident,

(1)Yes (---) (2) No (---)

33. Extent of damage?

(1) Beyond repairs (---) [ ] (2) Repairable (---)

34. If repairable, about how much will it cost in total to repair it? ___________________

35. Damage or lost any valuable item(s) at the time of the accident?(1) Yes (---) (2) No(---)

36. If yes, list them **ITEM VALUE** 1. ....2 ....

37. Are you willing to pay a certain amount of money to reduce the fatality risk from 8 to 4 deaths in every 100,000 people or 50% reduction in fatality risk?.

38. Are you willing to pay Kshs 4000 shillings to buy a helmet which can reduce the risk of severe injury from 13 to 8 severe injured people in every 100,000 people or reduction in risk of severe injury by 60%?

39. If not how much would you be willing to pay?

FACTORS INFLUENCING COST OF MOTORCYCLE INJURIES

40. If rider how long have you been riding a motorcycle?

(1). 0-5 years (---)

(2). 6-10 years (---)

(3). 11-20 years (---)

(4). >21 years (---)

41. What's the engine size of your motorcycle?

(1). < 500cc (---)

(2). 501-1000cc (---)

(3). 1001-1500cc (---)

(4). >1500cc (---)

42. How frequently do you ride a motorcycle?

(1). every day (---)

(2). Weekend only (---)

(3). 1-3 days /week (---)

(4). 4-6 days /week (---)

43. Are you legally entitled to ride a motorcycle?

(1). Yes (---)

(2). No (---)

44. Have you undergone a formal training in motorcycle riding?

(1). Yes (---)

(2). No (---)

45. Do you have a valid driving license?

(1). Yes(---)

(2). No(---)

46. Did you have training on motorcycling as a business?

1. Yes (---)

2. No (---)

47. Where did you learn how to ride a motorcycle?

1. Driving school (---)

2. In the field (---)

3. Not established (---)

48. Is your motorcycle insured to carry passengers?

(1). Yes (---)

(2). No (---)

49. If passenger, reason for boarding a motorcycle

(1). Commuting to work (---)

(2). Personal errands (---)

(3). Quick and faster (---)

(4). Other (---)

50. What were the road characteristics where the crash occurred?

1) Junction
2) Curve only
3) Bridge
4) Slope
5) Not established

51. Helmet use/ Were you wearing a helmet at the time of the crash?

(1). Yes (---)

(2). No (---)

52. If Yes type of helmet worn

(1). Full face rigid (---)

(2). Full face flexible (---)

(3). Open face (---)

(4). Other (---)

53. If No, reasons for not wearing helmets…………………………………………………

54. How often do you wear helmets while riding/ using a motorcycle?

(1). Always (--)

(2). Sometimes (---)

(3). Seldom (---)

(4). Never (---)

55. Do you use alcohol?

1. Yes(---)
2. No(---)

56. Had you taken alcohol or bhang in the last five hours before the crash?

(1). Yes (---)

(2). No (---)

57. What other safety gear do you use other than helmets while riding a motorcycle?

(1). Reflective jacket (---)

(2). Flashing lights (---)

(3). Gloves (---)

(4). Special shoes (---)

(5). Other (---)

58. Abbreviated Injury score (AIS)

(1). Minor (---)

(2). Moderate (---)

(3). Serious (---)

(4). Severe (---)

(5). Critical (---)

(6). Fatal (---)

59. Glasgow coma scale on arrival at the hospital

(1). 13-15- mild or no traumatic brain injury (---)

(2). 9-12 - moderate injury (---)

(3). 3-8 - severe injury (---)

60. While riding/ using the motorcycle were headlights turned on?

(1). No (---)

(2). Yes (---)

(3). High beam (---)

(4). Low beam (---)

61. Impact of the accident on your working ability?

(1) Can still work(---)

(2) Working ability reduced (---)

(3) Cannot work at all(---)

62. Did you suffer any form of disability, partial or permanent as a result of the crash?

(1)Yes (---) (2) No (---)

63. If yes, which of the following disabilities did you suffer? Disability in: (1) Seeing [ ] (2) Communicating (---) (3) Amputation of part of arm. (---) (4) Amputation of part of leg. (---) (5) Deformity of spine. (---) (6) pains (---) (7) Stress (---) (8).Others please specify...

64. Did you under go any type of test when you reported in the hospital?

65. If Yes which one?

66. How long have you taken in the hospital?

67. What kind of services have you been offered since you attended the hospital?

68. What was the experience of the victim/survivors

1. Physical pain (---) 2. Disability (---) 3. Loss and Grief(---)

4. Vulnerability (---) 5. Sudden simultaneous change (---)

69. What were the emotions and feelings?

1. Anger (---) 2. Bitterness (---) 3. Blame (---) 4. Fear (---)

5. Embarrassments (---) 6. Hurt regrets (---)

70. What are the psychological challenges faced

1. Anxiety 2. Detachment and estrangement 3. Death wish

4. Foreshortened future

APPENDIX III : FORM FOR COLLECTION OF DATA FROM THE POLICE

1. Age ………………………… years
2. Gender 1) Male 2) Female
3. Occupation ………………………………………………
4. who was involved

1. Passenger 2. Commercial bicyclist 3. Pedestrian 4. Driver

5. Where did the crash/ accident occur……………………………………….
6. When did the crash occur ……………………………………………………..

Date 1. Monday 2. Tuesday 3. Wednesday 4. Thursday 5. Friday 6. Saturday 7. Sunday 8. Unknown

7. At what time did the crash occur …………………. Hours
8. what type of vehicle(s) were involved

1. Lorry 2. Bicycle 3. Car 4. Motorcycle 5. Bus 6. Matatu

9. What was the nature of injury?..
10. What was the nature of treatment……………………………………………………

………………………………………………………………………………………………111.

What was the outcome of crash/injury?

1. Admitted ( ) 2. Not admitted ( )

1 Minor in juries 2. Serious injuries 3. Killed

11. Do you take part in accident investigation? I. Yes 2. No
12. Can you estimate the amount of money used in accident investigation--------------------
13. Estimate other resources used during investigation

    1. Fuel---
    2. Communication----------------------------
    3. Stationary----------------------------------

APPENDIX IV:THE ABBREVIATED INJURY SCALE

BODY REGION	SEVERITY SCORE CODE					
	1. Minor	2. Moderate	3. Severe/not life threatening	4. Severe (life threatening)	5. Critical	Highest score
Head and face	Headache with no loss at consciousness. Abrasions and confusion of the eye. Fracture and dislocation of teeth.	Cerebral injury with or without skull fracture with unconsciousness for less than 15 minutes. Undisplaced skull fracture.Undisplaced fracture of facial bone. Compound fracture of the nose. Eye lacerations. Disfiguring lacerations	Cerebral injury or without skull fracture with unconsciousness for > 15 minutes. Displaced skull fracture. Loss of eye or emulsion of optic nerve. Displaced facial bone fracture.	Cerebral injury with without skull fracture with unconsciousness for > 15 minutes. Compound skull fracture	Cerebral injury with without skull fracture with unconsciousness f« > 2 4 hrs. Intracranial hemorrhage. Signs of increased intrastromal pressure. Mai« airway obstruction.	
Neck	Whiplash injury without anatomical or radiological evidence.	Severe whiplash with anatomical or radiological evidence.	Cervical spine fractures without damage. Thoracic « lumbar spine fractures without neurological involvement.	Thoracic and/« lumbar spine fractures with paraplegia	Cervical spine injury .	
Chest	Muscle ache or chest wall stiffness	Fracture of Rib or sternum Major chest wall contusions without haemothorax or pneumothorax.	Multiple rib fractures Lung contusion without respiratory embarrassment, haemothorax pneumothorax.	Open chest wounds. Fled chest. Pericardial injuries. Myocardial contusion.	Chest injuries with major respiratory embarrassment.	

			Rupture of diaphragm. .		Aortic laceration. Myocardial rupture contusion with .	
Abdomen	Muscle ache Superficial abrasions	Contusion of abdominal wall.	Contusion of abdominal organs, bladder rupture Retroperitoneal hemorrhage Avulsion of ureter. Laceration of urethra.	Mina lacerations of intra-abdominal Intrapentoneal bladder rupture. Avulsion of the genitals.	Rupture, emulsion or severe lacerations of intra abdominal organs or vessels.	
Extremities	Minor abrasions and fractures and dislocation	Compound fracture of digits. Undisplaced long bone « pelvic fractures. shoulder and upper arm injury, and radius, ulna or hand fracture tibia fracture/complex foot fracture or distal/shaft femur fracture	Displaced sample long bone fractures. Multiple hand and foot fractures. Single open long bone fractures, Dislocation of major joints. Multiple amputations of Lacerations of major nerves	Multiple closed long bone fractures Amputation of limbs	Multiple open limb fractures	
Scores of the three most severely injured regions						

APPENDIX V: CONSENT FOR KEY INFORMANTS

HEALTH BURDEN AND COST OF MOTORCYLE CRASH INJURIES PRESENTING TO TIER III HOSPITALS IN KISUMU CITY, KENYA

Principal Investigator- Wilberforce Cholo, (B,sc. MPH) School of Public Health, Maseno University.

Contact-O720 395 726

Supervisors: 1. Professor Wilson Odero, (MD, MSc, PhD) School of Medicine, Maseno University.

Contact-0724699732

2. Dr. Japheths Ogendi, (B.Sc. MPH, PhD) School of Public Health, Maseno University.

Contact-0736521092

Location: The study was carried out in Tier III hospitals in Kisumu City; consisting of Jaramogi Oginga Odinga Hospital, Hisumu County Hospital, Agha-khan and Avenue Hospital.

Purpose: I am a PhD student in the School of Public Health, Maseno University. As part of the requirements for the award of this degree I am undertaking a study titled, "Health burden and cost of motorcycle crash injuries in Tier III hospitals in Kisumu City". Ethical approval has been obtained from Maseno University Ethical Review Committee. I am inviting all consecutive road traffic injury cases involving motorcycles presenting to the Emergency Department of the Tier III hospitals in Kisumu City within 3 months, the objectives of the study are to determine the pattern of road traffic injuries involving motorcyclists, the burden imposed on Tier III hospitals by motorcycle injuries, to quantify costs incurred by motorcycle injury cases and model for factors influencing the cost of motorcycle injuries in Kisumu City.

Procedure I am going to give you information about the study and then invite you to participate in the study. I asked you questions about yourself, the burden of motorcycle crashes and injuries and circumstances around its occurrence and costs associated with the injuries.

Risk/Benefits

The benefit of this study to the community is that it shall help us know the risk factors of severe motorcycle injuries. This will help when sharing the outcomes of the study with stakeholders in the division of non-communicable diseases and traffic police so as to help in formulation of policy that will lead to the minimization of these factors. There was financial reward or pay for participating in the study. Participants were not subjected to any risk or harm.

Voluntary Participation Your decision to participate in this study is entirely voluntary and you are free to choose not to consent or opt out at any stage of the study. You are also free to choose not to answer any question you feel uncomfortable with. The entire interview is expected to take about 20 minutes of your time.

Confidentiality The information that we collect from this research were kept confidential. questionnaire were assigned a number instead of name to ensure the information provided could not be traced back to the participant and the questionnaires kept in a locked drawer in the principal investigator's office and were to be destroyed on completion of the study. Data from the questionnaires stored in password protected computers at the principal investigators office. Only the principal investigator have the passwords and access to the data. Participant who could have had questions or clarifications about the research or in the event of a study related injury, were to contact Wilberforce Cholo – 0720395726, P.O. Box - Kisumu.

Declaration I…………………………….. having been given information and time to be asked questions, have understood the consent I am giving and by my signature or thumb print below give consent for the study to be carried out on me.

Signature ______________________ Date ____________________

APPENDIX VII: INTERVIEW GUIDE FOR KEY INFORMANTS

1. Age ………………………… years

2. Gender 1) Male 2) Female

3. Level of education /Cadre?

4. Occupation ………………………………………………

5. What are the problem associated with motorcycle injuries?

6. How can you categorize the problems that motorcycle injuries cause?

7. What is the impact of motorcycle crash injuries in the facility?

8. How does motorcycle injuries affect the society?

9. How does motorcycle injury influence allocation of resources in the facility?

10. How does motorcycle injuries affects operations in your section?

11. How has motorcycle injuries influenced operations in your department?

APPENDIX VII: GLASCORE COMA SCALE

ASSESSED RESPONSE	SCORE
Best eye response	
Spontaneously	4
To verbal stimulation or touch	3
To pain	2
No response	1
Best verbal response	
Smiles, oriented to sound, follows object, interacts	5
Cries but is consolable, inappropriate interaction	4
Inconsistently consolable, moaning	3
Inconsolable, agitated	2
No vocal response	1
Motor	
Normal spontaneous movement	6
Withdraws to touch	5
Withdraws to pain	4
Flexion abnormal	3
Extension, either spontaneously or to painful stimuli	2
Flaccid	1

APPENDIX VIII: CODE BOOK- INDICASTING THE THEMES ANALYSED QUALITATIVELY.

Theme	Definition	Example
Strained medical resources	• a time-varying imbalance between the supply of available beds, staff and/or resources and the demand to provide high-quality care for patients	• *'Motorcycle injury cases do exhibit increased demand for specialized investigation, care, surgical procedures and medication; motorcycle injured patients stay longer (over stay) within the hospital,'*
Overcrowding and congestion	• as a situation in which the performance of the emergency department is compromised, mainly due to the excessive number of patients waiting for consultation, diagnosis, treatment, transfer, or discharge. • overcrowding is characterized by an imbalance between supply and demand	• *"The number of motorcycle injury cases demanding minor or major surgical procedures are huge consequently causing overcrowding on out patients department and surgical wards due to repeated and continuous and delayed bookings of injury patients for elective or emergency surgery because of inadequate space"*
Over stretched staff	• Health staff work beyond capacity due to increased workload	• *'…The huge number of motorcycle injury cases has resulted on overstretched staff (burn out) due to shortage of human resource, consequently causing frustration among staff handling emergencies potentially compromising quality of care…'*
Utilization (increased)	• Upsurge in the use of health resources and services	• *'…One severe motorcycle injury case can have multiple body injuries requiring several investigations and multiple surgical procedures…'*
Commotion and confusion	• A feeling of bewilderment, perplexed and disturbed	

Prolonged hospitalization	• prolonged hospital stay increases the indirect costs faced by the patients, compromises patient in-hospital experience, and makes hospital beds unavailable	• *'motorcycle injured patients stay longer (over stay) within the hospital'* • *'Causing ward congestion and overcrowding…'* • *'…Such cases again stay longer in the hospital demanding many other medical materials and equipment for care…'*
Catastrophic expenditure	• if the money spent exceeds a certain fraction of household prepayment income and consumption	•
Loss /depletion of income	• is the exhaustion of resources as a result of their removal •	• *We have also sold all the cows we had to cater for the medical bills, it has become difficult- all the savings depleted and no income*."
Sudden unexpected expenditure	• are expenditures that come as a total surprise • Common unexpected expenses examples include medical emergencies, traffic challans, urgent home repairs, car breakdowns, spontaneous travel plans,	• *"…We have also sold all the cows we had to cater for the medical bills, it has become difficult- all the savings depleted and no income*."

APPENDIX IX: APPROVAL OF THE RESEARCH BY SCHOOL OF GRADUATE STUDIES

MASENO UNIVERSITY
SCHOOL OF GRADUATE STUDIES

Office of the Dean

Our Ref: PHD/PH/00095/2016

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 04th December, 2018

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR CHOLO WILBERFORCE ODIWUOR — PHD/PH/00095/2016

The above named is registered in the Doctor of Philosophy Programme Epidemiology in the School of Public health and Community Development, Maseno University. This is to confirm that his research proposal titled *"Health Burden and Cost of Motorcycle crash injuries presenting to tie 111 hospitals in Kisumu city, Kenya"* has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

Prof. J.O. Agure
DEAN, SCHOOL OF GRADUATE STUDIES

SCHOOL OF GRADUATE STUDIES MASENO UNIVERSITY 05 DEC 2018 P.O. Box PRIVATE BAG, MASENO

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED
FOUNTAIN OF EXCELLENCE

APPENDIX X: MASENO UNIVERSITY ETHICAL REVIEW COMMITEEE APPROVAL

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

FROM: Secretary - MUERC

DATE: 11th April, 2019

TO: Wilberforce Odiwuor Cholo
PG/PhD/PH/00095/2016
Department of Public Health
School of Public Health and Community Development
Maseno University
P. O. Box, Private Bag, Maseno, Kenya

REF: MSU/DRPI/MUERC/00649/18

RE: Health Burden and Cost of Motorcycle Crash Injuries Presenting to Tier III Hospitals in Kisumu City, Kenya. Proposal Reference Number MSU/DRPI/MUERC/00649/19

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 11th day of April, 2019 for a period of one (1) year. This is subject to getting approvals from NACOSTI and other relevant authorities.

Please note that authorization to conduct this study will automatically expire on 10th April, 2020. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 15th March, 2020.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 15th March, 2020.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

MASENO UNIVERSITY SECRETARY
11 APR 2019
ETHICS REVIEW COMMITTEE

Dr. Bernard Guyah
Ag. Secretary,
Maseno University Ethics Review Committee.

Cc: Chairman,
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED

APPENDIX XI: PERMIT BY NACOSTI TO CONDUCT RESEARCH

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/19/18883/28808**

Date: **25th April 2019**

Wilberforce Odiwuor Cholo
Maseno University
Private Bag
MASENO.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Health burden and cost of Motorcycle crash injuries presenting in Tier iii Hospitals in Kisumu City, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Kisumu County** for the period ending **25th April, 2020.**

You are advised to report to **the County Commissioner and the County Director of Education, Kisumu County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kisumu County

The County Director of Education
Kisumu County.

APPENDIX XII : APPOVAL BY JARAMOGI OGINGA ODINGA TEACHING AND REFERRAL HOSPITAL – ERC

Telegrams: "MEDICAL", Kisumu
Telephone: 057-2020801/2020803/2020321
Fax: 057-2024337
E-mail: ercjootrh@gmail.com
When replying please quote

Ref: ERC.IB/VOL.1/578

JARAMOGI OGINGA ODINGA TEACHING & REFERRAL HOSPITAL
P.O. BOX 849
KISUMU

Date 20th May, 2019

Cholo Wilberforce Odiwuor

Dear Cholo,

RE: REQUEST FOR ETHICAL APPROVAL TO UNDERTAKE A STUDY TITLED: "HEALTH BURDEN AND COST OF MOTORCYLE CRASH INJURIES PRESENTING TO TIER III HOSPITALS IN KISUMU COUNTY, KENYA"

The JOOTRH ERC reviewed your protocol and found it ethically satisfactory. You are therefore permitted to commence your study immediately. Note that this approval is granted for a period of one year (w.e.f. 20th May, 2019 to 20th May, 2020). If it is necessary to proceed with this research beyond approved period, you will be required to apply for further extension to the committee.

Also note that you will be required to notify the committee of any protocol amendment(s), serious or unexpected outcomes related to the conduct of the study or termination for any reason.

In case the study site is JOOTRH, kindly report to the Chief Executive Officer before commencement of data collection.

Finally, note that you will also be required to:-
- Share the findings of the study in both hard and soft copies upon completion.
- Give the progress of the study as you begin every quarter to the end of the study.

The JOOTRH – IERC takes this opportunity to thank you for choosing the Institution and wishes you the best in your future endeavours.

Yours sincerely,

WILBRODA N. MAKUNDA
SECRETARY- IERC
JOOTRH - KISUMU

APPENDIX XIII: APPROVAL BY THE COUNTY GOVERNMENT OF KISUMU

COUNTY GOVERNMENT OF KISUMU

Telegrams: "PRO.(MED)"
Tel: 254-057-2020105
Fax: 254-057-2023176
E-mail: kisumucdh@gmail.com

County Director of Health,
Kisumu.
P.O. Box 721-40100,
KISUMU.

HARAMBEE

DEPARTMENT OF HEALTH

REF: GN.133.VOL.III/533

Date: 3/05/2019

To: **Private hospital;Avenue hospital, Aga khan Hospital**

CEO - JOOTRH

Medical Superintendents - KCH

RE: **APPROVAL TO CONDUCT RESEARCH**

We are in receipt of your request for research approval.

The purpose of this letter is to grant you approval for the study on **'Health burden and cost of Motorcyle crash injuries presenting in Tier iii Hospital in Kisumu City, Kenya"** (Approval No NACOSTI/P/19/18883/28808)

The Department of Health has reviewed your proposal to conduct the above study and support it's implementation.

I therefore grant him permission to undertake this research

Dr. Onyango D. O.
County director of Health
Kisumu County

COUNTY DIRECTOR
OF HEALTH
KISUMU

From the County Director of Health office

APPENDIX XIV: RESEARCH AUTHORIZATION AT AGHAKHAN HOSPITAL, KISUMU

The Aga Khan Hospital, Kisumu

An institution of the Aga Khan Health Service, Kenya

P.O. Box 530, Kisumu, Kenya
Telephone: +254 57-2024374 ,0722 203 622
Fax: 057 - 2024 412
E-mail: ksm.admin@akhskenya.org

ADM/007/2013

7th May 2019

Wilberforce odiwuor cholo
Maseno University
Private Bag
MASENO

Dear Mr Cholo

RE: RESEARCH AUTHORIZATION

Following your request for authority to carry out research on " **health burden and cost of motorcycle injuries presenting in Tier iii hospitals in kisumu city, Kenya**" am pleased to inform you that you have been granted the permission to conduct the research in our hospital for the period ending **25th April, 2020.**

As discussed with you earlier we shall limit your study to interviews with the patients that meet the inclusion criteria and hospital staff that may have relevant information. Kindly note that we shall not grant you access to patient files and at all times we expect you to observe confidentiality when you conduct the study.

We anticipate that you will share the findings of your research with our institution.

Yours truly

Dr Eshiwani Patrick

AG. MEDICAL DIRECTOR