CRASH CHARACTERISTICS AND INJURY PATTERNS AMONG COMMERCIAL MOTORCYCLE USERS ATTENDING KITALE COUNTY REFERRAL HOSPITAL, KENYA 2013

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Crash Characteristics and Injury Patterns Among Commercial Motorcycle Users Attending Kitale County Referral Hospital, Kenya 2013

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DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university

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DEDICATION

This thesis is dedicated to my dear wife Rosebella, and lovely children, Tracy and Trevor Baron for their love and cherish. It is also dedicated to my parents, who always inspired me since my childhood days.

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ABBREVIATIONS/ ACRONYMS

A AND E:	Accident and Emergency
ABS:	Australian Bureau of Statistics
AIS	Abbreviated Injury Scale
ATLS:	Advanced Trauma Life Support
ATSB:	Australian Transport Safety Bureau
BACs:	Blood Alcohol Concentrations
CMR:	Centre for Microbiology Research
COHES:	College of Health Science
DALYS:	Disability Adjusted Life Years
GCS	Glasgow Coma Scale
GNP:	Gross National Product
ISS:	Injury Severity Score
JKUAT:	Jomo Kenyatta University of Agriculture and Technology
KEMRI:	Kenya Medical Research Institute
LICs:	Low Income Countries
LMIC:	Low Medium Income Countries
MCI:	Motorcycle Injuries
MPH:	Miles per hour

NHTSA:	National Highway Traffic Safety Administration
NTSA:	National Transport Safety Authority
RTI:	Road Traffic Injuries
RTC:	Road Traffic Crashes
SPSS:	Statistical Packages for Social Scientists
WHO:	World Health Organization

DEFINITION OF OPERATIONAL TERMS

Commercial Motorcycle user: Generally, refers to the driver or operator of a motorcycle; however, in the context of this evaluation, commercial motorcyclist is used more broadly to refer to any person, rider or passenger, associated with the operation of a motorcycle.

County referral hospital: Regional hospital with medical specialists and serves as a referral institution for the region.

Crashes: are here referred to as the road traffic incidence commonly referred to as "accidents". "Accidents" is not an acceptable term in traffic injury research as it implies that the incident is related to fate, chance or the act of god.

Head injury: Damage to structures of the head as a result of trauma.

Highway: Any tarmac road where the speed limit for passenger service vehicles is 80km/hr.

Injury: In this context injury is synonymous with trauma i.e. physical or emotional harm. Injury in this study is referred to as trauma inflicted by road traffic crash.

Mild injury: Injury with injury severity score of less than or equals to 8.

Moderate injury: Injury with an injury severity score of 9-15.

Motorcycle Rider: person operating or in control of the motorcycle

Motorcycle Passenger: Person seated behind the rider and not in control of the motorcycle

Motorcycle injury: defined as one in which the victim was either riding a motorcycle when the crash occurred or was a pedestrian knocked down by a motorcycle.

Motorcycle-related Crash: Motorcycle-related crashes refer to any motor vehicle accident that involves a motorcycle. The categories of motor vehicle accident include traffic and non-traffic, wherein the latter refers specifically to those accidents that do not occur in the operation of the motorcycle on a public highway.

Night time: Time of day between 6pm and 6am.

Road traffic crash: Results from a combination of factors related to the components of the system comprising roads, the environment, vehicles and road users, and the way they interact.

Rural/feeder road: Road which connects/leads to a highway.

Severe injury: Injury with an injury severity score of 15-75.

Systems Approach: A perspective that takes into account the various parts and their relationships as they contribute to the totality of a phenomenon.

ABSTRACT

Globally road traffic injuries contribute significantly to the burden of disease and mortality. Road traffic injuries are ranked 9^{th} among the leading causes of Disability adjusted life years lost and predicted to be 7^{th} by the year 2030. Each year more than 1.25 million people are killed and as many as 50 million are injured. Most vulnerable group that account for half of traffic deaths globally are motorcyclists, passengers and pedestrians. Number of deaths in Kenya from motorcycle injury has been increasing in the past 10 years from as low as 44 in 2005 to 391 deaths in 2014. This descriptive cross sectional study sought to determine crash characteristics and injury patterns among motorcycle users attending Kitale county referral hospital, Kenya. Three hundred and seventy-one commercial motorcycle crash victims were recruited into the study. Data collection was done using a semi structured, interviewer administered questionnaire. The mean age of the motorcycle crash victims was 30.7 years (range 3-80years). Males were 269 (70.1%) and females 115 (29.9%). Motorcycle traffic injuries accounted for 39.4% of all traffic crashes. The most common mechanism of motorcycle crash injury involved motorcycle versus vehicle 175 (45.6%). Majority of the injured patients 240 (69.9%) were assessed as having Glasgow coma scale (GCS) of 9-12, 26% Glasgow coma scale of 13-15 and 7% Glasgow coma scale of 3-8. Pattern of injuries sustained by victims included; head and neck injury 147 (39.9%), lower extremity injury 147 (39.9%) and chest injury 30 (8.2%). Higher proportions of motorcycle riders had severe injuries as compared to passengers (χ^2=127.649, P<0.01). Similarly a statistical relationship existed between age group (25-30 years) and severity of motorcycle crash injuries (χ^2=17.678, P<0.007). Majority of motorcycle riders 167 (45.1%) and passengers 149 (38.9%) who did not have a helmet during the crash injury sustained head injuries. This was statistically significant (χ^2=106.944, P<0.001). Among the motorcycle riders 62.3% had no formal training and this was statistically significant (χ^2=5.72, p<0.001). Head injuries and lower extremity injuries accounted for the major proportion of injuries sustained by

motorcycle users. Non helmet use was associated with increased risk of head injuries. Morbidity can be mitigated by encouraging use of protective gear like helmets and wearing of reflective clothing.

CHAPTER ONE

INTRODUCTION

1.1. Background Information

Road traffic injuries contribute significantly to the burden of disease and mortality throughout the world, but particularly in developing countries (Ameratunga, Hijar & Norton, 2006). Currently Road traffic injuries are ranked ninth globally among the leading causes of disability adjusted life years lost (WHO, 2004). It has been predicted that by the year 2020, they will rank as high as third among causes of disability adjusted life years (DALYs) lost (Peden *et al*., 2002). Worldwide it is estimated that, 1.2 million people are killed in road crashes each year and as many as 50 million are injured (Peden *et al*., 2002). With increasing modernization in many developing countries, road traffic deaths are increasing and traffic deaths are projected to become the third most important health problem by the year 2020 (Odero *et al*., 1997).

Motorcycle Injuries constitute a major but neglected emerging public health problem in developing countries and contribute significantly to the overall Road Traffic Injuries (RTI) (Peden *et al.,* 2002). Motorcycle Injuries are among the leading causes of disability and deaths and the main victims are the motorcyclists, passengers and pedestrians in their young reproductive age group (Peden, 2004; Solagrebu *et al.*, 2006). The problem is increasing at a fast rate in developing countries due to rapid motorization and other factors (Galukande *et al.*, 2009).

Motorcycle users are vulnerable on the road and represent an important group to target for reducing road traffic injuries (Solagrebu *et al.*, 2006). Even in developed countries with low morbidity and mortality rates from motorcycle injuries, the risk of dying from a motorcycle crash is 20 times higher than from a motor vehicle crash (Peden, 2004; Solagrebu *et al.*, 2006). The motorcyclists tend to over-speed and over load their motorcycles for quick returns. Recklessness, indiscipline and lack of respect for other road users by the motorcyclists who are mainly youths, are the major cause of road related injuries. The majority of the motorcyclists do not wear any protective gear, hence aggravating the risks of getting severe head injuries (Naddumba, 2004).

The annual production of motorcycles in the world is put at about 45 million with the growth rate in Africa, being between 12%-30% (Oginni *et al.*, 2009). The increasing volume of traffic is one of the main factors contributing to the increase in Road Traffic Injuries in Low Medium Income Countries. Motorization rates rise with income (Kopits and Cropper, 2005), and a number of Low Medium Income Countries experiencing growth have seen a corresponding increase in the number of motor vehicles (Ghaffar *et al.*, 1999). In some Low Medium Income Countries, the growth has been led by an increase in motorized two-wheeled vehicles, one of the least safe forms of travel, which has resulted in concurrent increases in related injuries (Zhang *et al.*, 2004).

In many Low Medium Income Countries, motorcycles are an increasingly common means of transport. In India, for instance, 69% of the total numbers of motor vehicles are motorized two- wheelers (Mohan, 2002). In China it was estimated that more than 67 million motorcycles were registered in the country (WHO, 2004). In Nigeria, commercial motorcycles constitute one of the chief modes of transportation and by far, the most common form of informal transport system (Asogwa, 1996).

In Kenya the number of newly registered Motorcycles increased from 6,250 in 2006 to 641,616 in 2014, compared to 541,537 registered Motor vehicles (NTSA, 2015). Motorcycles registered as a share of total new vehicle registered from 2006 to 2014 represented 53% (NTSA, 2015).
Motorcycle injuries are underreported from developing countries. Globally, Road Traffic Injuries (RTI) are responsible for a significant proportion of overall injury morbidity and mortality and 90% of the mortalities are seen in developing countries (Peden *et al.*, 2002).

1.2. Statement of the Problem

Globally, deaths and injuries resulting from road crashes are a major and growing public health problem. More than 20 million people are severely injured or killed on the world's roads each year and the burden falls most heavily on LMICs in Africa, Latin America and Asia (Zwi, 1993). The motorcycle, commonly called "bodaboda" in Uganda and Kenya (Naddumba, 2004; Galukande *et al.*, 2009) and ''Okada'' in Nigeria (Oluwadiya *et al*., 2004; Solagrebu *et al.*, 2006), has recently become increasingly popular in Kenya as a means of commercial transport. Their operation is characterized by non-helmet use by riders and passengers, passenger overload and lack of valid licensing among riders. Over speeding, reckless driving, poor regulation and lack of law enforcement also characterize commercial motorcycle operations (Museru and Leshabari, 2002).

The popularity of this mode of transport in Kenya can be due to the following reasons; they are a quick means of transport especially for short distances in cities and towns. They are efficient in mitigating traffic jam delays in the cities and they are available throughout the day and night hours. The negative side of motorcycle as a means of transport is the risk of injury as reported in other studies (Naddumba, 2004; Galukande *et al.*, 2009) and they constitute a major public health problem in developing countries like Kenya (Museru and Leshabari, 2002).

In most high-income countries, cars make up the largest proportion of the road traffic, while in LMICs pedestrians, riders of bicycles and motorcycles are more common. These differences in road users have an important impact on the occurrence of injuries among the different types of road users (Galukande *et al*., 2009).

Pedestrians and riders of bicycles, motorcycles and mopeds are less protected from accidents per kilometers traveled. They are at far greater risk than the drivers and passengers of cars and motor vehicles (WHO, 2004). In the Taiwan Province of China, an increase in the use of motorcycles was reportedly associated with increasing deaths and injuries (Chiu *et al*., 2000). Similarly, Barros *et al*., 2003 in Brazil reported that motorcyclists had an eight-fold risk of dying, a fourfold risk of injury and a twofold risk of running over pedestrians as compared to automobile drivers. Motorcyclists and their passengers are vulnerable to speed, poor visibility and those without safety helmets are particularly at higher risk (WHO, 2004).

The number of deaths in Kenya from motorcycle injuries has been increasing in the past 10 years from as low as 44 in 2005 to 391 deaths in 2014 (NTSA, 2015). The high number of Motorcycle crashes has put a strain on the health facilities in the rural areas that are ill equipped to deal with these crashes. Some district hospitals in western Kenya have set up a wing just dedicated for Motorcycle Crash Injuries (Nesoba, 2010).

Most published hospital-based surveys on road traffic injuries in Kenya have been conducted in the capital city of Nairobi as record reviews, but without detail on the severity of the injuries. These limitations have contributed to lack of awareness on the magnitude of the motorcycle road traffic injuries (Nantulya & Reich, 2003).

1.3. Justification of the Study

In many LMICs, commercial motorcycles are an increasingly common means of transport. Users of these two-wheelers make up a large proportion of those injured or killed on the roads. Motorcycle riders are at an increased risk of being involved in a crash because they often share the traffic space with fast-moving cars, buses and trucks. In addition, their lack of physical protection makes them particularly vulnerable to being injured if they are involved in a collision.

Motorcycles are rapidly becoming a major means of public transport and cause of severe injuries and deaths in Kenya. Current road safety strategies do not effectively address this growing use of motorcycles for public transport.

The scarcity of existing data on commercial motorcycle injuries in this environment necessitates a further look into the causative factors influencing the occurrence of such crashes. Studying the morbidity and mortality pattern of these motorcyclists will reveal the burden of the problem, as deaths and injuries due to road traffic crashes have not really been seen as a matter of public health importance.

1.4. Research questions

1. What are the Socio-demographic characteristics of Motorcycle Crash Injury Patients attending Kitale County Referral Hospital?

2. What are the Injury Patterns and Severity among Motorcycle Injury Patients attending Kitale County Referral Hospital?

3. What are the factors associated with injuries among Motorcycle injury patients attending Kitale County Referral hospital?

1.5. Objectives

1.5.1. Broad Objective

To determine the Crash characteristics, Injury Patterns and severity and associated factors among Commercial Motorcycle users attending Kitale County Referral Hospital

1.5.2. Specific Objectives

1. To determine the Socio-demographic characteristics of Motorcycle Crash Injury Patients attending Kitale County Referral Hospital.

2. To describe the Injury patterns and Severity among motorcycle crash patients attending Kitale County Referral Hospital.

3. To identify the factors associated with injuries among motorcycle crash patients attending Kitale County Referral Hospital.

1.6. Theoretical Framework

Two concepts are addressed in this study, the Systems approach (Figure 1.1) and the Haddon Matrix (Table 1.1). The Systems approach involves tackling problems in an advanced disciplinary manner keeping priorities in mind. While the Haddon Matrix focuses on causal and mitigating factors of crashes in the pre-crash, crash and post-crash stages (Haddon, 1980).

1.7. Systems approach

Traditionally, analysis of risk has examined the road user, vehicle and road environment separately. However, there is a tendency by researchers and practitioners to look for one or a few factors, when in actual fact they should be analyzing multiple factors. Building on Haddon's insights, the systems approach seeks to identify and rectify the major sources of error, or design weaknesses that contribute to fatal crashes or crashes that result in severe injury as well as to mitigate the severity and consequences of injury. The essence of using a systems approach is to consider not only the underlying factors, but also the role of different agencies and actors in prevention efforts. Road traffic injuries are a multidimensional problem that requires a comprehensive view when examining the determinants, consequences and solutions.

Any road traffic system is complex and can be dangerous to human health. Elements of the system include motor vehicles and road users along with their physical, social and economic environments. Making a road traffic system less hazardous requires a systems approach — understanding the system as a whole and the interaction between its elements, and identifying where there is potential for intervention. In particular, it requires recognition that the human body is highly vulnerable to injury, and that humans make mistakes. A safe road traffic system is one that accommodates and compensates for human vulnerability and fallibility (Peden *et al*., 2002).

Each crash and its consequences can be represented by its system of interlinked factors (Figure 1.1). As the components of the road and transport system interact, linkages appear between crash and trauma factors. For example, some road features or vehicle characteristics may have influenced particular aspects of road users' behavior, and the effects of some vehicle defects may have been compounded by particular road Characteristics. For the purpose of planning measures to avoid collisions, it is essential to understand the full complex causation process, as it provides vital information, and usually leads to a wide scope of possible areas of preventive action. There is an opportunity for intervention in all aspects of the transport system, and related systems (Figure 1.1), to reduce the risk of road traffic injuries and deaths. The key message is that a road traffic crash or collision is the outcome of interaction among a number of factors and subsystems (Peden *et al*., 2002).

If road traffic crashes are reduced to one "cause" only, it is obvious that the components of the system – human, infrastructure and vehicle factors – are necessarily considered as independent. Measures addressing any one component can thus be implemented separately, which makes things easier as the decision makers responsible for each area of intervention do not have to coordinate with the others. However, opportunities to influence one type of factor through another are entirely ignored. Moving away from the simplified model for road safety action to a systems approach requires that considerable effort be put into acquisition of knowledge of the nature of crashes. This effort is rewarded by the larger range of opportunities opened up for preventive action and by the more appropriate design of measures. Getting sufficient knowledge of the factors generating hazards in the road and transport system implies analyzing the chain of events leading to crashes and injuries. As crash factors relate to human as well as to physical and technical components of the road and transport system, detailed analysis of road crashes may require a multidisciplinary approach (Muhlrad and Lassarre, 2005).

Figure 1.1 Systems Approach to Road Traffic Crash Prevention (Muhlrad and lassarre, 2005)

Figure 1.1 Systems approach to road traffic crash prevention (Muhlrad and Lassarre, 2005**)**

1.8. The Haddon Matrix

Haddon matrix identifies risk factors before the crash, during the crash and after the crash. This is in relation to the person, vehicle and environment (Table 1.1). Haddon described road transport as an ill-designed ‘‘man-machine’’ system in need of comprehensive systemic treatment. Each phase – pre-crash, crash and post-crash – can be analyzed systematically for human, vehicle, road and environmental factors (Haddon, 1980).

The Haddon matrix is an analytical tool to help in identifying all factors associated with a crash. Once the multiple factors associated with a crash are identified and analyzed, countermeasures can be developed and prioritized for implementation over short-term and long-term periods. For the pre-crash phase, it is necessary to select all countermeasures that prevent the crash from occurring. The crash phase is associated with countermeasures that prevent injury from occurring or reduce its severity if it does occur. Finally, the post-crash phase involves all activities that reduce the adverse outcome of the crash after it has occurred (Haddon, 1980).

Table 1.1 Risk factors for motorcycle crash injuries using Haddon's matrix.

	HUMAN	VEHICLE	ENVIRONMENT
PRE-EVENT	Young age, male, low socio economic status, inexperience, crash history, no driving license, traffic violation history, high risk taking behavior, alcohol and other drug use, motorcycle ownership, excessive and slow speeds, riders in conspicuity.	Motorcycle in conspicuity (e.g. without daytime headlight use)	Night time, poor light condition, rural area.
EVENT	Large amount of riding distance and time, excessive speed, no safety devices e.g. helmet wearing, leg protector, airbag jacket	Motorcycle make	Collision with a heavy object e.g. moving car
POST-EVENT	Elderly person, pre existing medical condition		Slow emergency response, poor rehabilitation programs

Source: Haddon, 1980

CHAPTER TWO

LITERATURE REVIEW

2.1. Global Burden of Road Traffic Crashes

Globally, approximately 3000 lives are lost in road crashes each day, or an estimated 1.2 million deaths per year (WHO, 2004). Each year some 50 million people worldwide sustain serious injuries in road crashes. Road Traffic Crashes were estimated to be the world's 11th leading cause of death in 2002 (Ameratunga *et al*., 2006) and the ninth leading cause of DALYS lost in 1998. If current trends continue road traffic crashes could become the third leading cause of life years lost by 2020 (Murray and Lopez, 1996).

The social health and economic burden of road crashes has resulted in road safety becoming a global health priority issue highlighted by the WHO's focus on road safety for world health day 2004 (WHO, 2004). With these seemingly gloomy figures, it is important to note that there are disparities between high-income, middle and low-income countries (WHO, 2004). 90% of road traffic mortalities occur in the low and middle-income countries where there are 48% of registered vehicles worldwide, while the remaining 10% occur in the high income countries (WHO, 2004).

There is gross underestimation of the global burden of RTI because of under reporting and outright absence of quality data especially in developing countries (WHO, 2009). Furthermore, deaths and injuries from motorcycle crashes also vary from high-income, middle-income and low-income countries (WHO, 2009). For instance, in Malaysia, a middle income country the fatalities amongst road users was found to be 60% and attributed to motorcycle crashes with motorcycles being 47% of the total registered vehicles (Radin-umar *et al*., 1996). In Austria, a high income country, deaths from motorcycle crashes was 17% amongst road users with motorcycle registrations being

11% of the total vehicles (WHO, 2009). The economic costs of road traffic injuries estimated in terms of the GNP has also shown some disparities when comparing high, middle and low-income countries (WHO, 2009).

In the high-income countries, it is estimated that 2% of the GNP is spent on RTI while it is 1.5% and 1% in the middle and low-income countries respectively (Jacobs *et al*., 2000). Global estimates of the economic cost of road traffic crashes are put at US $518 billion while the cost is US$65 billion in low-income countries (Jacobs *et al*., 2000), an amount that far exceeds development aids annually. In the United States of America as at 2000, the human capital cost of RTC was estimated to be US$ 230 billion (Blincoe *et al*., 2002).

In many developing countries majority of injuries from RTC involve cyclists, motorcyclists, pedestrians, elderly and children who are the vulnerable users of the roads (Swaddiwudhipong *et al*., 1994). The case is different in the developed countries where occupants of cars are more likely to be injured in the event of a crash. The group of people mostly injured or who die as a result of RTC are in the 15-44 age group who are the productive people in the economy (Peden *et al*., 2002). This has an obvious disadvantage especially in the LICs where fatalities from RTC is high, with the resultant effect of a diminish contribution to the economy (Peden *et al*., 2002).

In Kenya 75% of road traffic casualties are in the productive workforce group (Odero *et al.*, 2003). Hospitalization due to RTI in middle and low income countries represent between 30% and 86% of all trauma admissions (Odero *et al.*, 1997). This further worsens the economic situation of the injured. Majorities are often poor and accessing health care is expensive when in existence, as user fees are usually charged in order to get the required medical attention. RTI also place a social burden not only on the survivors of crashes but also on their dependents and relatives (Odero *et al*., 1997).

Access to reliable information about the distribution and causes of road crashes is a fundamental step in addressing the global safety problem. While precise statistics may be lacking, it is well recognized that fatality and injury rates differ across countries, demographic groups and types of road users. Around 90% of worldwide traffic fatalities occur in low income countries (WHO, 2004). Many higher income countries including some western European countries, Japan, Canada (Transport Canada, 2006) and Australia have fatalities from crashes as low as 10 per 100,000 populations (ATSB, 2008). In the United States, there were 14.2 fatalities per 100,000 people in 2006 (NHTSA, 2006). These rates are considerably below those observed in many LICs, including rates of above 20 per 100,000 in South Korea, Thailand and areas of Africa. In Latin America countries such as El Salvador and Dominican Republic rates of above 40 per 100,00 are reported (WHO, 2004). In most high income countries fatalities have been decreasing during the past 25 years. Many lower income countries have experienced increased fatality and injury rates over this period (Ameratunga *et al*., 2006).

The description of the motorcycle as the most dangerous of all motorized vehicle for transportation can be attributed to its nature and design such as absence of airbags to reduce impact in the event of a collision and therefore riders and passengers alike are vulnerable victims of road traffic crashes (Heng *et al*., 2006). In terms of miles covered in comparison with other motorized vehicles riders and passengers are prone more to injuries and death by 8 and 34 times respectively (NHTSA, 2007). Factors responsible for this can be classified as host and environmental. Environmental factors include the condition and nature of the roads, traffic flow and visibility. Human factors include attitude and behavior of cyclists on the roads. Ignoring safety measures like speed limit, wearing of crash helmets, protective clothing, and alcohol abuse prior to riding (Alvi *et al*., 2003).

In preventing motorcycle related injuries, the most successful measure is to limit the severity of injuries after the crash which is termed a secondary approach. The secondary approach involves the use of crash helmets. Several studies have documented the effectiveness of the crash helmets in saving lives and the reduction in the severity of the injuries (Bachulis, Sangster & Gorrell , 1988). However, opponents to the crash helmets claim it blocks the peripheral vision of the riders. Risk reduction has been traditionally undertaken because road traffic injuries have been seen as injuries that are unintentional resulting from road accidents. Since the term ‘accident’ has now been replaced with ‘crash’ this approach is no longer tenable because a crash is suggestive of something that can be preventable and subjective to rational analysis (Peden *et al*., 2002)

Kenya has one of the highest road fatality rates in Africa at 68 deaths per 10,000 registered vehicles and between 45-60% of admissions to surgical wards in public hospitals is as a result of road traffic injuries (Odero, Zwi, 2003). Currently, the only nationally available road crash figures in Kenya are based on data collected by the police who attend to RTC or have details reported to them. However, some road crashes are not reported to the police; particularly crashes involving vulnerable road users such as pedestrians, pedal cyclists and motorcyclists, as well as victims who have mild injuries. In addition, few police officers have received medical training; thus, injury severity is classified into one of only three broad categories: slight, serious or fatal (Odero *et al*., 2003).

2.2. Motorcycle injuries in developing countries

Motorcycle riders have especially high rates of injury in developing countries (Ameratunga *et al*., 2006); transfer of effective interventions for motorcycle injuries from developed to developing countries is necessary and highly desirable. However, an understanding of the feasibility, economic costs, and potential barriers to implementing these interventions is vital for successful transfer. In developing countries, particularly in Asia, several special motorcycle-related features are evident. First, motorcycle use has been dramatically growing, and motorcycles are one of the most important means of transportation because of rapid economic development, convenience in congested traffic, and ease of parking on narrow streets (Krishnan and Smith, 1994). For instance, motorcycles comprise 95% of registered motor vehicles in Vietnam (Hung *et al*., 2006), 67% in Taiwan (Ministry of Transport and Communication, 2007), 63% in China (Zhang *et al*., 2004), and 60% in Malaysia (Radin-Umar *et al*., 1996). Moreover, motorcycle crashes accounted for more than 50% of traffic deaths in Malaysia and Taiwan (Radin-Umar *et al*., 1996), and 80% of traffic injuries in Thailand (Ichikawa *et al*., 2003) and 42% in Singapore (Wong *et al*., 1990b). In contrast, motorcycles in the United States comprise about 2% of registered motor vehicles (NHTSA, 2007), and they are often only ridden for recreation. Second, a large proportion of motorcycles in developing countries are scooters with a smaller engine capacity, like those used in some urban areas of European countries (Salatka *et al*., 1990). A scooter is a two- wheeled motorized vehicle with a step-through frame, small wheels, automatic transmission, and an engine located below the rider and to the rear. Characteristics of the crash rate, crash type and time, and injury severity and pattern for scooters seem to differ from those for motorcycles (Salatka *et al*., 1990), even though the differences are rarely reported. Third, there are some unique road environments in developing countries, such as more-congested traffic, intrusive store advertising signs, and traffic mixture of motor vehicles, bicycles, and even rickshaws and animal-drawn vehicles (Sahdev *et al*., 1994). Finally, a great proportion of motorcycle riders in developing countries incorrectly use motorcycle safety devices possibly due to inadequate education and lax law enforcement (Liu *et al*., 2008), for example about one-third of motorcycle riders in China and Indonesia had their helmets fastened improperly or were wearing nonstandard helmets (Conrad *et al*., 1996).

Differences in the prevalence of motorcycle riders, the amount of riding exposure, the purpose of riding a motorcycle, type of motorcycle, and intervention programs should account for large differences in the numbers and incidences of motorcycle crashes and injuries between developing and developed countries, even though more empirical evidence is required (Forjuoh, 2003). As a result, if these differences are not considered, applying risk factor analytical results and prevention programs from developed countries, particularly to costly road engineering projects, might not be appropriate or feasible for developing countries (Forjuoh, 2003). Furthermore, road-injury prevention strategies in developed countries only incidentally consider protecting vulnerable road users such as motorcycle riders who comprise the majority of road traffic victims in developing countries. Malaysia provided exclusive lanes for motorcycles that reduced motorcycle deaths by 600% (Radin-Umar, 2002).

Nevertheless, the experience of successful motorcycle-injury prevention programs, particularly policy interventions such as helmet use laws, legal limits of BAC, enforcement of licensure laws, and speed limits, may directly be undertaken by developing countries since these interventions are widely effective (Ichikawa *et al*., 2003; Kasantikul *et al*., 2005) and have a high benefit–cost ratio of implementation (Hyder *et al*., 2007).

2.3. The Growth of Commercial Motorcycle Transport in Kenya

The boda boda bicycle transport business is believed to have originated in the Kenya border town of Busia. Bicycles were used for a very along time in the town before it was spread to the other towns in Kenya. The name boda boda is derived from the operation of the business across the border of Kenya and Uganda. Boda boda transport services are a Ugandan innovation that has grown from small beginnings in the 1960s in the border region with Kenya (Calvo, 1994). The term itself is a corruption of the English “border border”. Boda boda mainly provides a passenger taxi service although they can sometimes be hired to move goods. The original services were provided in a bicycle equipped with a padded cushion fitted over the rear carrier. Starting in the early 1990s, the bicycle based carriers have been complemented by and compete with light motorcycles that have greatly extended the range and load carriage of services (Ambuli, 2008).

The business has spread to the other towns of the country of Kenya and the number of people who are involved in the business has grown. The bicycles have become a major means of transport after the buses and taxis in places like Kisumu, Kitale, Kakamega and Kericho (Ambuli, 2008). The use of bicycles is still spreading towards the central, eastern and coastal regions of the country of Kenya. However, things are changing and motorcycles are taking over the place of bicycles (Ambuli, 2008). The only place that is known where motorcycles are used for taxi purposes is in Nigeria where they are called ‘‘Okada’’ (Oluwadiya *et al*., 2004). Kenyans too seem to be switching to the use of motorcycles for the same purposes (Ambuli, 2008). In Kitale town, the motorcycles have taken over the business from the bicycles and more and more people are joining the business.

Up to the end of 2007, the proportion of motorcycle crash victims made out 1% of Kenya’s annual crash victims (WHO, 2012). All indications are that this proportion has grown exponentially. This should not come as a surprise: the number of motorcycles in Kenya has grown from 3,800 in 2005, to more than 90,000 in 2009. Insurance companies in Kenya maintain that for the same distance travelled, the death rate for motorcyclists is about nine times more when compared to people travelling in a car (WHO, 2012).

In 2008 the government of Kenya removed tax on motorcycles to promote jobs in transport. Some young people who joined this business have increased their earnings with 50%, using these as taxis. Importing cheap motorcycles from China has added to the boom in motor cycle ownership (Nesoba, 2010).

The risk of death or injury to motorcycle drivers and passengers are quite high when compared to vehicle occupants. This risk increases when motorcycle drivers and passengers do not wear protective gear and motorcycle helmets. People are aware of the risk, but still choose the boda boda as transport due to the ease with which these vehicles maneuver through congested urban traffic (Odero *et al*., 2003).

There has been a huge increase in the number of motorcycles in Kenya in recent years. The arrival of cheap motorbikes from China, combined with more moderate taxes and massive latent demand for boda-boda services, has turned a market of a few hundred into many thousands per year (Mwanza, 2010). This situation shows how one decision taken in the economic realm, had an enormous impact on the health sector. Already it is estimated that road traffic injuries provide 60% of admissions in Kenya's surgical wards (Mwanza, 2010). It is also clear that the solution to the problem needs to be sought from different sectors and not dumped solely in the lap of traffic law enforcement officers.

2.4. General Motorcycle injury patterns

A motorcycle rider often sustains multiple injuries in a crash (Bachulis *et al*., 1988; Rogers *et al*., 1991). Head injuries are most frequent in fatal motorcycle crashes, contributing to about one-half of all motorcycle deaths (Kraus, 1989). Chest and abdominal injuries are the second most common cause of fatal motorcycle crashes comprising from 7% to 25% of motorcycle deaths (Ankarath *et al*., 2002). Cervical spinal injuries are more likely to occur in fatal crashes than those to other spinal regions (Wyatt *et al*., 1999).

The lower extremity is the most common site of an injury in all motorcycle crashes (Braddock *et al*., 1992; Wladis *et al*., 2002). The thoracic spine is the most commonly injured spinal region in motorcycle crashes (Ankarath *et al*., 2002), while riders with severe injury to the trunk are likely to have severe injuries in the same or other anatomic regions (Kraus *et al*., 2002). Facial injuries are diagnosed in one-fourth of all injured riders, and they are associated with a risk of traumatic brain injuries (Kraus *et al*., 2003).

2.5. Head injuries in motorcycle crashes

Head injuries are the leading cause of death in motorcycle crashes (Ankarath *et al*., 2002), particularly in single motorcycle crashes and head-on collisions (Peek-Asa and Kraus, 1996b). For instance, in the United States, 53% of motorcycle deaths from 1979 to 1986 were a result of head injuries, and 69% of head injury deaths among motorcycle riders were white males aged 15–34 years (Sosin *et al*., 1990). Among motorcycle riders admitted to the hospital, the most common head injuries are concussions, followed by brain contusions or hemorrhage, facial fractures, and skull fractures (Kraus and Peek, 1995a). Brain injuries are frequently caused by deceleration forces, particularly with rotational kinetics (Richter *et al*., 2001). As the fixed and non-fixed parts of the body such as the skull and brain move differentially, deceleration injuries such as multifocal vascular injury, concussive brain injury, or diffuse axonal injury may occur (Feliciano and Wall, 1991). Brain injuries such as skull base fractures and intracranial hematomas are more frequently observed in patients with upper cervical injury than in those with mid and lower cervical injury. It should be noted that head injuries are still the leading cause of death even in helmeted riders (Aare and von Holst, 2003).

2.6. Lower-extremity injuries in motorcycle crashes

Lower-extremity injuries are most common in non-fatal motorcycle crashes, affecting about 30–70% of injured riders (Shankar Ramzy, & Soderstrom 1992). In lower-extremity injuries, fractures are most frequent and have the most severe outcomes (Peek *et al*., 1994), in terms of permanent disability, economic costs, and the return to work (Clarke and Langley, 1995). Of these fractures, the tibia is the most common site, followed by the femur, foot, and patella (Peek *et al*., 1994). Femoral fractures are the most common long bone injury in motorcycle deaths (Ankarath *et al*., 2002).

2.7. Forms of motorcycle crash injury severity

Injury severity is often used as a measure of health consequences of road traffic crashes. Injuries are classified as fatal, serious or slight on the basis of information available to the police within a short time after the crash. Classifications may not reflect results of a medical examination and are largely influenced by whether a casualty is hospitalized or not. Injury is reported as fatal if death occurs on the spot or any time after hospitalization

(Odero *et al*., 1997). On average 10.3% of crash victims die, 32.5% are seriously injured and 57.2% slightly injured each year in Kenyan roads. Most severe injuries result from vehicle pedestrian collisions which also account for a higher case fatality rate (24%) than other types of collisions, 18% in a single vehicle, 17% in vehicle-bicycle, 12% in vehicle-vehicle and 8% in vehicle Motorcycle (Odero *et al*., 1997).

Kraus *et al*., (2002) in a study of the incidence of thoracic and abdominal injuries among injured motorcyclists in California, reported that multiple intra-thoracic and intra-abdominal injuries were common. The number of rib fractures and whether they were bilateral was strongly associated with serious injuries to the thoracic and abdominal organs. In a British study of injured motorcyclists, Ankarath *et al*., (2002) showed that thoracic and abdominal trauma as well as pelvic ring fractures associated with long bone injuries were the major contributors to reduced survival following head injury.

In Thailand, hospital records show that 75–80% of road traffic injuries and 70–90% of road traffic deaths are among users of Motorized two-wheeled vehicles (Santikarn *et al*., 2002). In all countries, such road users tend to sustain multiple injuries to the head, chest and legs. Head injuries contribute to most deaths and leg injuries to most cases of long-term disability (Mackay, 1985).

When patients of two wheeler accidents were analyzed in Nigeria, they represented 18% of all accidents, 13.5% were struck by articulated vehicles. Others were struck by buses or sustained secondary injuries after a fall from the motorcycle. An overwhelming 68% of victims who were riding motorcycles were knocked down by cars (Nzegwu *et al*., 2008). The commonest musculoskeletal injury has been documented to be fracture of the tibia comprising almost 50% of cases (Zargar, Khaji & Karbakhsh, 2006).

In a study from Western Maharashtra which analyzed the pattern of injuries in road traffic crashes the authors made a number of observations (Patil, Kakade, Durgawale, & Kakade, 2008). Majority of the victims were males and they were in the age group of

20-29 years. As much as 10% of the victims were children. Of all the road traffic crashes 35% were caused by two wheelers. Of the pedestrians who were injured almost 32 percent were injured by two wheelers. Riding without a license was found to be prevalent amongst two wheeler riders (Patil *et al*., 2008). There were 190 fractures and the commonest site was the lower limb (46.3%), followed by upper limb (24.7%) and the skull (22.3%). No positive correlation existed between category of road user and severity of injury. They did note that studies involving motorcycle crashes report that upper limbs are more commonly involved than lower limbs in road traffic incidents (Patil *et al*., 2008).

In another study from south India it was found that majority (83%) of victims were male of which laborers constitute the highest number. Of the motorized vehicles involved two wheeler riders were almost 31%. The authors noted that majority of victims were in the third decade of life. It was interesting to note that there were nearly ten percent victims aged below 10 years, 22% were pedestrians, 35% were drivers and another 45% were occupants of the vehicles. The largest group amongst the riders was bicyclists followed by motorized two wheelers (Jha, Srinivasa, Roy, Jagdish, *200*8).

Among moped and motorcycle riders, head injuries account for about 75% of deaths in Europe (Motorcycle safety helmets, 2001) and 55–88% in Malaysia (Radin-Umar, *2002*). One study (Kulanthayan, Umar, Hariza Nasir &, Harwant , 2000) found that riders without helmets were three times more likely to sustain head injuries than those with helmets. Another study found that helmets reduced fatal and serious head injuries by 20–45% (Servadei *et al*., 2003).

2.8. Modifiable factors for motorcycle crash injuries

Many factors are associated with the risks of the incidence and/or severity of motorcycle injuries, even though determinants of the injury incidence were rarely differentiated from those of injury severity in previous studies of motorcycle injuries. Some risk factors such as age groups (young age or recently reported those aged ≥40 years in the United States) (NHTSA, 2006), male gender, a low socioeconomic status (Zambon and Hasselberg, 2006a), nighttime (Nakahara *et al*., 2005), and summer period (Lin *et al*., 2003a) cannot be directly modified to prevent the occurrence of motorcycle injuries and reduce their severity; in addition, their effects can often be accounted for by the amount of riding exposure (Lourens *et al*., 1999) as well as modifiable factors such as helmet wearing, alcohol and other drug use, inexperience and driver training, conspicuity of the motorcycle and rider, licensure and ownership, riding speed, and risk-taking behaviors. These modifiable factors have more relevance for developing and designing prevention programs.

2.9. Motorcycle helmet use among riders

Helmets usually made of a rigid fiberglass or plastic shell, a foam liner, and a chinstrap, have been the principal countermeasure for preventing or reducing head injuries from motorcycle crashes (Kraus and Peek, 1995b). Based on police reports, helmets reduced the risk of motorcycle deaths by 29% during 1972–1987 (Wilson, 1989), and their effectiveness increased to 37% during 1993–2002 possibly due to improvements in helmet design and materials (Deutermann, 2004). After adjusting for age and crash characteristics, non helmeted riders were 2.4-times more likely than those wearing a helmet to sustain brain injuries or skull fractures (Gabella *et al*., 1995). After adjusting for collision type, posted speed limits, and environmental factors, no helmeted riders had a 3.1-fold increased risk of head injuries or death compared with helmeted riders (Rowland *et al*., 1996). Moreover, after stratification by crash severity measured by the Injury Severity Score (ISS) for other than head injuries or repair costs of motorcycle damage, the protective effect of helmets on head injuries remained significant (Lin *et al*., 2001).

While three types of helmets (full-face, full-coverage, and half coverage) are effective in reducing head injuries (Tsai *et al*., 1995), differences in the effectiveness among various types of helmets have not been well examined. In addition, detachment of helmets during motorcycle crashes is not uncommon (Richter *et al*., 2001), and head injuries seem to occur more frequently and are more severe for riders who wear a nonstandard helmet than those who wear a standard helmet (Peek-Asa *et al*., 1999). These findings reflect the importance of helmet fixation for maximal protection against head injuries during motorcycle crashes; nevertheless, the use of nonstandard helmets in terms of preventing head injuries or increasing potential side effects has not been examined. There are possible side effects from helmet use. First, there has been speculation as to whether helmet use increases the risk of cervical spinal cord injuries in a crash, because injuries to the neck and base of the skull are occasionally found in helmeted riders (Konrad *et al*., 1996). However, those findings were from studies with small sample sizes, lack of comparison group(s), or small numbers of fatal injuries, or they failed to adjust for confounders such as age and alcohol consumption (Villaveces *et al*., 2003). Conversely, many more studies have found no evidence for such an association (Goslar *et al*., 2008). Second, the influence of a helmet on the rider's vision and hearing has been raised. Although helmets have a small effect on the lateral vision of motorcycle riders, studies have shown that riders compensate for this restriction by increasing head rotation when making turns, and thus hearing and visual acuity are not overly restricted by helmet use (McKnight and McKnight, 1995). The third question infrequently raised is whether helmets increase the risk of a crash due to the added mass on the head or the increased size of the helmeted head (Bishop *et al*., 1983). In a prospective cohort study, no increased risk of motorcycle crashes occurring to helmeted riders was found, even after adjusting for riding distance, riding time, risk-taking level, and many other human, vehicle, and environmental factors (Lin *et al*., 2003a).

2.9.1. Alcohol and other drug use among motorcycle riders

While alcohol is the drug associated most frequently with all kinds of motor vehicle crashes (Villaveces *et al*., 2003; Williams, 2006), motorcycle riders are more likely to have consumed alcohol than are other motor-vehicle drivers in fatal and non-fatal crashes (McLellan *et al*., 1993). For example, 49% of motorcycle crash deaths in United States police reports were attributable to alcohol use, in contrast to 26% of other motor-vehicle crash deaths (Villaveces *et al*., 2003). Compared with multiple-vehicle crashes, single-vehicle crashes account for a greater proportion of motorcycle deaths with a blood alcohol concentration (BAC) of 0.1 g/dl, particularly at night (Kasantikul *et al*., 2005). While the risk of being involved in a fatal crash increases with increased BAC levels for all age groups (Mayhew *et al*., 1986), more than 60% of motorcycle deaths among young riders aged 15–29 years involved alcohol (Holubowycz & McLean, 1995). However, in the United States, the peak rate of deaths among motorcycle riders involving alcohol has recently shifted from this group to those aged 40–44 years (Paulozzi and Patel, 2004). Drinking motorcycle riders involved in a crash are more likely than nondrinking riders to have lost control of their vehicle, and have lower rates of helmet use, more-severe head injuries, and higher ISS levels (Zambon & Hasselberg, 2006b, Peek-Asa & Kraus, 1996a). Since motorcycle riders are more vulnerable than other motor-vehicle drivers to alcohol's effects on balance, motor coordination, and judgment and more-basic skills are needed to operate the inherently unstable vehicle, a lower legal limit of BAC for motorcycle riders has been suggested (Sun, Kahn, & Swan, 1998). Non helmeted riders are also more likely to have been legally intoxicated in a fatal crash (Nelson, Sklar, & Skipper, 1992), and the protective effect of helmets on severe head injuries among intoxicated riders is reduced (Luna *et al*., 1984), probably because alcohol increases susceptibility to hemorrhage shock by eliminating the rider's homeostatic response mechanism (Phelan *et al*., 2002). Alcohol use also confounds the measurement of injury severity because the severity levels of head injuries in intoxicated persons are often overestimated, and a better prognosis for the intoxicated may be incorrect (Waller, 1988). There is a positive association between culpability and BAC levels in motorcycle riders (Soderstrom, Dischinger, Kerns, 1995).

As for drugs other than alcohol, 32% of motorcycle drivers treated in Maryland trauma centers during 1990–1991 had used marijuana (cannabis) prior to the crash, which was significantly higher than the 2.7% of car drivers (Soderstrom *et al*., 1995). Among fatally injured young motorcycle drivers, about one-third had used combinations of alcohol and other drugs such as cannabis, benzodiazepines, or cocaine (Cimbura *et al*., 1990). Of motorcycle riders admitted to trauma centers, 24% had used both marijuana and alcohol vs. 16% of car drivers (Soderstrom *et al*., 1988). No statistically significant interactive effects among alcohol, marijuana, benzodiazepines, cocaine, or other drugs on injury severity were detected (Stoduto *et al*., 1993).

2.9.2. Inexperience and training among motorcycle riders

Lack of riding experience is associated with a higher risk of motorcycle crashes and injuries (Ballestros and Dischinger, 2002, Wong *et al*., 1990a). Formal training is expected to increase riding skills and reduce the risk of motorcycle crashes and injuries. However, riders who received training had no significant reduction in the risk of motorcycle crashes compared with those who did not receive a training course (Rutter and Quine, 1996). In addition, no significant differences in traffic violations, costs of medical treatment, or motorcycle damage per crash were detected between trained and untrained riders (Mortimer, 1988).

There are several possible explanations for the lack of benefits of training courses on reducing motorcycle crashes and injuries. First, riding experience might not be a determinant of motorcycle crashes and injuries, since it is often correlated with age, particularly in young riders (Mullin *et al*., 2000). The protective effect of experience was not sustained when a rider's age was included in the analysis (Mullin *et al*., 2000). However, a national prospective survey of 4101 riders in the United Kingdom found that youth played a greater role in motorcycle crashes and injuries than inexperience through a pattern of risk taking behaviors such as willingness to break the law and violate the rules of safe riding (Rutter and Quine, 1996). Second, the lack of a preventive effect of training programs on motorcycle crashes may result from differences in demographics, riding experience, and crash involvement between trained and untrained groups.

Nevertheless, when matched by age, gender, location of licensing, time to obtain a license, and previous driving record, no significant difference in the incidence of motorcycle crashes was found between trained and untrained groups (McDavid *et al*., 1989). Third, the theory of risk homeostasis or risk compensation provides another possible explanation. When new safety measures are introduced, riders may adjust their behaviors to maintain the previous level of individual acceptable risk, and the crash rate should not change, if the level of individual risk is not modified (Wilde, 1998); in other words, trained riders may have more confidence for their operating skills and thus ride with more risk-taking behaviors. Finally, some unmeasured, selective factors for a training group may play a role and weaken the effect of driver training on motorcycle crashes and injuries. Nevertheless, no study has directly examined the interpretability of the theory of the ineffectiveness of training programs (Wilde, 1998). To resolve the controversy about the effectiveness of motorcycle training in reducing the occurrence of motorcycle crash injuries, a better design such as randomized controlled studies to eliminate possible selective factors between trained and untrained riders is required (Wong *et al*., 1990b).

2.9.3. Conspicuity and daytime headlight laws among motorcycles

In car–motorcycle collisions, two-thirds of car drivers claimed not to have seen the motorcycle or to have seen it too late to have avoided the collision (Hodgdon *et al*., 1981). Among a number of ways to improve the conspicuity of motorcycles or their riders, the use of high- or low-beam headlights during daytime hours was better than other devices designed to raise conspicuousness such as wind fairing and reflective fluorescent jackets (Olson *et al*., 1981). In New Zealand, high-visibility clothing and white- colored helmets were also found to reduce the risk of having a crash compared to other measures (Wells *et al*., 2004). Daytime headlight use has been advocated to increase motorcyclists' safety; however, laws governing this have not consistently been found to reduce motorcycle crash injuries (Yuan, 2000). There are several reasons for these inconsistent findings. First, conflicting assumptions were used across those studies to evaluate the impacts of daytime headlight use on motorcycle crash injuries. If the potential benefit of motorcycle daytime headlight use is assumed to prevent motorcycles and riders from being hit by other motor vehicles, those including all single and multiple-vehicle crashes in the preventive outcome may have underestimated the effectiveness of daytime headlight use (Radin-Umar *et al*., 1996). However, a substantial portion of single-motorcycle crashes is the consequence of avoiding being hit by another motor vehicle (Shankar, 2001). If so, the use of single crashes as a control group to evaluate the reduction in multiple-vehicle crashes would underestimate the effect of headlight use in reducing daytime crashes (Muller, 1984). Daytime headlight use is assumed to be effective only for fatal and other serious-injury crashes (Quddus *et al*., 2002); thus the power to detect its effectiveness may be weakened when including all kinds of crashes. Second, the estimated effect of daytime headlight laws is often confounded by regional variations in motorcycle crashes (between-state comparisons) (Muller, 1985) or factors such as changes in speed limits, helmet use laws, alcohol use, and the minimum legal drinking age (within-state comparisons). Finally, increased visibility can be at the expense of other riders who do not use their lights, since car drivers may adopt a strategy of looking for a light rather than a motorcycle per se (Hole and Tyrrell, 1995). Moreover, motorcycle conspicuity may also be affected by the daytime headlight use of other motor vehicles.

2.9.4. Licensure and ownership among motorcyclists

Riding a motorcycle without a valid license is associated with higher risks of crashing and serious motorcycle injury in the United States and other countries (Dandona *et al*., 2006; Lardelli- Claret *et al*., 2005). Among fatally injured motorcycle operators, only 75% had a valid license (NHTSA, 2007), and the lowest licensure rate often occurs in younger riders aged 20 years (Kraus *et al*., 1991). Compared with licensed operators, unlicensed ones were less likely to report using the low-beam headlight in daytime, wearing body protection, or riding without drinking alcohol (Reeder *et al*., 1996). Motorcycle riders who crashed and who did not own the motorcycle were more likely to be unlicensed than those owning the motorcycle, and owners involved in a crash were less likely to have a license than those not in a crash (Kraus *et al*., 1991). Lack of a license, ownership, and youth are correlated, and all of these factors are associated with higher risks of motorcycle crashes and injuries. For instance, in New Zealand where the minimal legal riding age is 15 years, only 36% of 18-year-old riders had a valid license, and 72% did not own the motorcycle they were riding (Reeder *et al*., 1995). Riders were more likely to have a crash at night, while attempting to execute a turn, riding at slower speeds, or committing a traffic violation compared with those who owned the motorcycle (Dandona *et al*., 2006). Countermeasures for lack of a valid license include proof of a valid license as a prerequisite for purchasing a motorcycle, stringent enforcement of licensure laws, severe penalties for lack of a license, and mandating an older age to obtain a motorcycle license (Kraus *et al*., 1991; Reeder *et al*., 1995). In a randomized trial using an educational mailing to unlicensed owners, the licensure rate in the intervention group over a 6 month period was 10.4% compared with 7.9% in the control group (Braver *et al*., 2007). Despite this difference in percentages being statistically significant, the licensure rate in the intervention group still remained low. Graduated rider licensing systems in the United States and New Zealand were effective in reducing motorcycle injuries and deaths (Baldi *et al*., 2005; McGwin *et al*., 2004), particularly for riders aged 15 to 9 years (Reeder *et al*., 1999). The effect of the graduated rider licensing system may result from a reduction in exposure to motorcycle riding (Reeder *et al*., 1999) and from appropriate education (Baldi *et al*., 2005).

2.9.5. Risk-taking behavior among motorcyclists

The risks of motorcycle injury and death are highest for the young (Braddock *et al*., 1992; Lardelli-Claret *et al*., 2005), even though riders aged 40 years are the fastest-growing group experiencing fatal motorcycle crashes in the United States (NHTSA, 2006). Originally, the overrepresentation of young riders in motorcycle injuries was attributed to inexperience in operating a motorcycle or a higher exposure to riding (Chesham *et al*., 1993). There is evidence that the risk-taking characteristics of young riders contribute to the high risk of motorcycle injuries, and risk taking behaviors among motorcycle riders may include speeding, drinking while riding, not using a helmet while riding, unlicensed riding, running yellow lights, and riding with too little headway (Lin *et al*., 2003a; Rutter and Quine, 1996), and these behaviors are correlated with each other (Boyce and Geller, 2002; Jonah *et al*., 2001). Risk-taking can be grouped under the rubric of risk perception and risk utility (Hodgdon *et al*., 1981; Jonah, 1986). Motorcycle riders aged 25 years perceived their crash risk as being medium or high, those aged 26–39 years as being medium, and those aged 40 years as being low; the perceived crash risk was associated with experience, gender, distance ridden, and geographic region (Mannering and Grodsky, 1995). Young riders tended to underestimate the risk of being in a crash in the next 2 years but overestimated the risk of being killed (Leaman and Fitch, 1986). The risk perception of adolescent riders corresponded to the actual risk of motorcycle crashes (Reeder *et al*., 1996), but they neither modified their risk-taking behaviors nor reduced risk-taking levels, even after experiencing a crash or injury (Lin *et al*., 2004; Mangus *et al*., 2004). On the other hand, risk-taking behaviors among very young persons may represent an outlet or utility for stress and aggression, an expression of independence or impressing other people (Hodgdon *et al*., 1981). As a result, health-promotion education only using negative consequences of motorcycle and other motor-vehicle crashes intended to reduce high risk-taking behaviors among young person's might not readily succeed, even if these educational materials do increase risk perception (Rutter *et al*., 1998).

2.9.6. Riding speed among motorcyclists

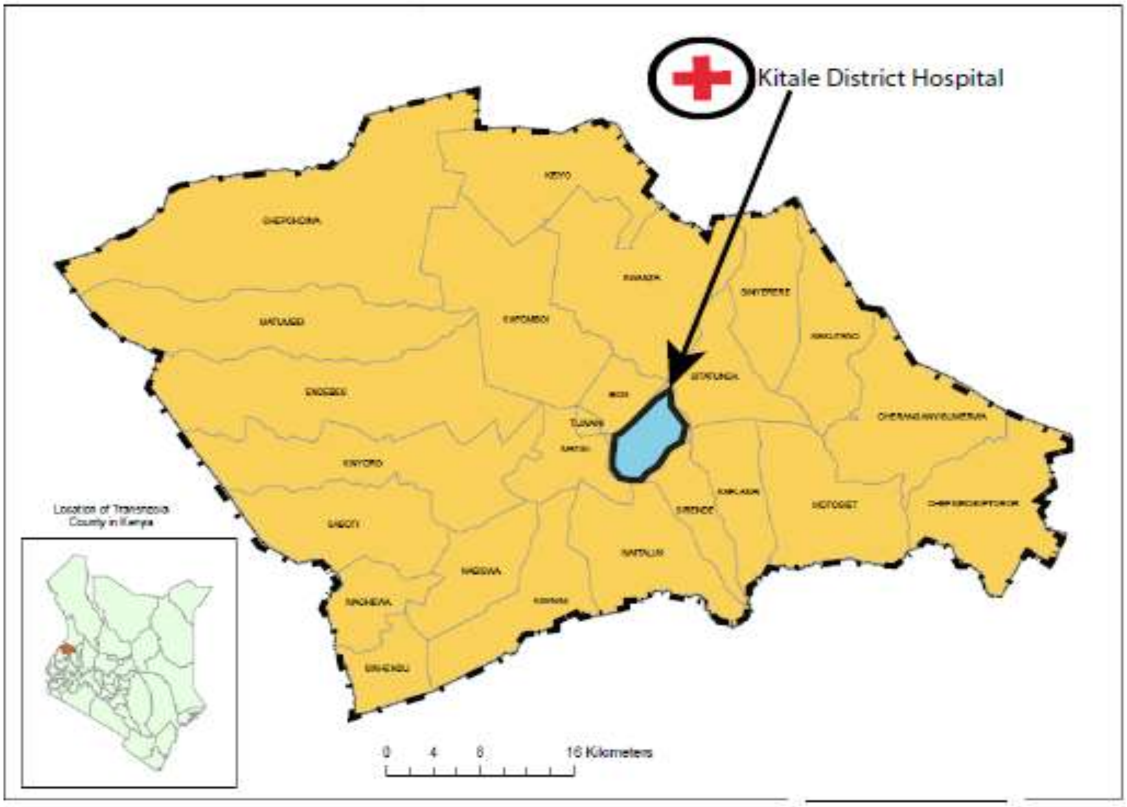
Higher speeds at the time of impact are associated with more serious motorcycle injuries (Kraus *et al*., 1975; Lin *et al*., 2003b; Shibata and Fukuda, 1994). Of the 900 motorcycle crashes studied in Los Angeles County, California during 1976–1977, 40% occurred at crash speeds of 0–20 miles per hour (mph), 30% at 21–30mph, 14% at 30–40mph, and 16% at 41mph, and the corresponding proportions for the 89 fatal crashes were 17%, 21%, 37%, and 25%, respectively (Kraus *et al*., 1975; NHTSA, 2008b). Speeding by motorcyclists in fatal crashes in the United States was about twice the rate for drivers of automobiles or light trucks (NHTSA, 2008a). Speeding is also responsible for almost two-thirds of motorcycle deaths among single-vehicle crashes (Shankar, 2001). When crash speeds exceeded 50 km/h, there was a reduction in helmet effectiveness in preventing motorcycle deaths (Shibata and Fukuda, 1994). At high speeds, parts of the body move differentially, and injuries due to deceleration may occur (Feliciano and Wall, 1991). During a high-speed crash, a helmet can also be lost if the chin strap is not securely fastened (Richter *et al*., 2001). Recently, while traffic crashes were significantly associated with an increase in mean speed, a stronger relationship between traffic crashes and a large variability in traffic speeds was also found (Aljanahi *et al*., 1999). In addition to excessive speed, inappropriate speed for traffic conditions and slow speeds were also associated with a high risk of initiating two-vehicle collisions (Lardelli-Claret *et al*., 2005). Regulating speed limits is a means of reducing traffic speed. It was estimated that persons driving on highways with a speed limit of 55 mph were 3.7-times more likely to be killed in crashes than those driving at lower speed limits for all types of vehicles (NHTSA, 1993). In the 40 states in the United States that increased speed limits on rural state highways to 65 mph in 1988, traffic deaths increased 26–36% (Baum *et al*., 1990). Following the 1995 repeal of the United States national maximum speed limit, death rates due to motor vehicle Crashes on interstate highways were 17% higher in the 24 states that raised interstate speed limits to 70 mph (Farmer *et al*., 1999). There are no specific data for examining the effect of speed limits on motorcycle deaths. On the other hand, speed camera networks were found to decrease all type of injurious crashes, including those occurring in daytime and nighttime, on roads with speed limits of 30 and 60–70 mph, and for crashes that injured motorcycle riders (by 63%) and other road users by 17–78% (Christie *et al*., 2003).

CHAPTER THREE

MATERIALS AND METHODS

3.1. Study Site

Kitale town is located at high Agricultural potential areas of Trans-Nzoia County (Appendix 1). The town is transversed by longitudes $34^{\circ}\ 38^{'}$ and $35^{\circ}\ 23^{'}$ east and latitude $0^{\circ}\ 52^{'}$ and $1^{\circ}\ 18^{'}$ north of the equator. It lies at an average altitude of 1800m above sea level and the lowest point is 1400m above sea level. Kitale County referral hospital provides Accident and Emergency services and it is Government sponsored. Most patients seek health care services from the Government hospital due to lower charges as compared to the private hospitals.



Map of Trans-Nzoia County showing location of Kitale district Hospital

Figure 3.1Map of Trans Nzoia county showing Kitale County Referral hospital

3.2. Study Design

This was a descriptive cross-sectional study of patients with commercial motorcycle crash injuries of all age groups and gender presenting at the Accident and Emergency department of Kitale County Referral Hospital.

3.3. Study population

The study population comprised victims of commercial motorcycle crashes presenting at the Accident and Emergency department of Kitale County Referral hospital, between 1st September 2013 and 30th November 2013.

3.4. Inclusion criteria

Commercial Motorcyclists and passengers were eligible for inclusion in the study if they gave informed consent and presented to the accident and emergency department within 24 hours of the Motorcycle crash injury. This was to ensure that only incident cases were included in the study and to exclude those motorcyclists whose presentation might be related to a complication of the injury rather than the initial injury. Motorcycle crash victims who came unconscious were also enrolled in this study after consent was obtained from their guardian or from themselves after gaining consciousness either in ICU or in the ward.

3.5. Exclusion criteria

Patients less than 18 years without guardians to give consent were excluded from the study. Commercial motorcycle injury patients unwilling to consent to the study were excluded.

3.6. Sample size determination

Using the Cochran's 1963 formula, the minimum sample size calculated was 384. The formula used for sample size determination was obtained as follows,

$$\frac{n = Z^2_{1-\alpha/_2} PQ}{d^2}$$

Where n = required sample size

α = level of significance (0.05)

Q = 1-p

$Z^2_{1-\alpha/2}$ = standard normal deviate within 95% confidence interval (1.96)

P = since no other study has been conducted in the area, the assumed proportion of commercial motorcycle crash injuries attending Kitale County referral Hospital (50%).

d = level of precision at 5% (standard value 0.05)

$n = (1.96^2 \times 0.5 \times 0.5) \div 0.05^2$

$n = 385$

Sample size = 385

But since the sampling frame was less than 10,000, the sample size was adjusted using the formula below.

$n = n / (1 + n/N)$

Where:

n= initial sample size

N=sampling frame

n=new sample size

$n = 385 / (1 + 385/2880)$

$= 339$

Non response rate of 10%

=10/100x339

=371 commercial motorcyclists were required for the study.

3.7. Sampling procedure

The study utilized systematic random sampling procedure. Commercial Motorcycle crash injury patients were recruited to the study as they presented at the accident and emergency department. A records desk review at the Kitale County referral hospital showed that the hospital attended on average 32 motorcycle crash victims every day. Therefore monthly target population was n = 32 x 3 x 30 → 2880.

Sampling interval = 2880/384= 7^{th}

1^{st} step was to consider the first 7 patients on the queue at the trauma clinic. Then simple random sampling was used to select 1^{st} patient. Second step was to select 2^{nd} patient in the queue at the next seventh position. The sampling procedure continued with the selection of every 7^{th} patient in the queue until the sample size was achieved. If the seventh patient failed to consent the sampling interval was still maintained.

3.8. Data collection tools and procedure

Data was collected using a standard structured questionnaire in a face to face interview (Appendix 2). Pre-test of questionnaire to remove ambiguity and clarify response categories was done two weeks before the beginning of the study. The pre-test of questionnaire was done at Eldoret Sub-county hospital with a sample size of 30 injury victims. Two trained research assistants were stationed in the accident and emergency department who interviewed patients and did data entry. Information collected included victim's demographic information, status (whether rider, passenger, pedestrian) and mechanism of collision. The pre hospital transport by relatives, police, and the rider who caused crash or nurse from other hospital was recorded. The data collected were patient's bio data, the injury sustained, mechanism of the injury, pre hospital transportation, trauma scores, body region injured, radiological findings, setting of the crash, condition of the road, collision type and use of helmet by rider and passenger. Alcohol use by the rider was based on clinical suspicion by the attending clinician. The fate of the subject whether discharged in good condition, admitted to the wards, referred or died was documented.

Other parameters that were recorded are time interval between crash and arrival at emergency department of Kitale County Referral Hospital. The body region injured, possession of driving license, use of helmet, type of road, alcohol use and weather condition at the time of motorcycle crash were also documented.

3.9. Measurement of injury severity

The Glasgow Coma Scale (GCS) was used for the assessment of a patient's level of consciousness (Appendix 5). It provides a more accurate estimation of severity for patients with serious head injuries and enables reliable predictions of outcome. The Glasgow Coma Scale is scored between 3 and 15, 3 being the worst and 15 the best. A Glasgow Coma Scale of 13 or higher correlates with a mild brain injury; 9 to 12, a moderate injury and 8 or less a severe brain injury (Sharma, 2005).

Injury severity was measured based on the Injury Severity Score (ISS) (Appendix 6) which provided an overall score for patients with multiple injuries (Rosman *et al*., 1996). Each specific injury was assigned an Abbreviated Injury Scale (AIS) score and allocated to one of six body regions (head, face, chest, abdomen, extremities and pelvis) (Sharma, 2005). Only the highest AIS score in each body region was used. The three most severely injured body regions had their AIS score each squared and added together to produce the ISS. The ISS score takes values from 0 to 75. If an injury was assigned AIS score of 6 (unsurvivable injury), the ISS score was automatically assigned to 75. Injury severity was graded as severe, moderate or mild based on the Injury Severity Score (ISS). Severe injury was defined as an ISS > 15, moderate injury as an ISS from 9-15 and mild injury an ISS ≤ 8 (Saidi, 2003).

3.9.1. Data management and analysis

Double entry was done and regular file backup was performed to avoid loss or tempering with data. Filled questionnaires were coded and entered into a computer database designed using MS-ACCESS application. Data cleaning and validation was performed using SPSS version 20. Descriptive statistics such as mean, standard deviation, range and frequency proportions was performed. Pearson's chi square was used to test for the significance of association between dependent variable and independent variables. The level of statistical significance was set at $P < 0.05$. Binary logistic regression was used to adjust for confounding.

3.9.2. Ethical consideration

All patients who met the inclusion criteria were enrolled into the study after obtaining consent (Appendix 1a and 1b). Patients who failed to give proper information and those who had no relative to consent were excluded from the study. Confidentiality of the participant's records was maintained through use of coded questionnaires. Only the principal investigator and research assistant could access the data. Patients were informed that their refusal to participate could not affect their management in anyway. Critically injured patients with inability to recall the past events were still enrolled in the study and interviewed after recovery.

The study approval was sought from KEMRI scientific steering committee (Appendix 3) and KEMRI ethics review committee (Appendix 4). Permission was also sort from the research management committee of Kitale County referral hospital (Appendix 7).

3.9.3. Dissemination of the results

The findings of this study were disseminated through a final report that was shared with the management of Kitale County Referral hospital. It was also published in the Pan African Medical Journal on 17th November 2014, ISSN 1937-8688 Volume 19:296.

CHAPTER FOUR

RESULTS

4.1. Socio demographic characteristics of commercial motorcycle crash victims at Kitale County referral hospital.

The demographic characteristics of the motorcycle crash victims interviewed during the study period are presented in Table 4.1. During the study period, 942 cases of road traffic injuries were seen at the Accident and Emergency department. Commercial Motorcycle traffic injuries accounted for 39.4% of all road traffic injuries.

The mean age of the patients was 30.8 years with a standard deviation of 12.9. The youngest age reported was 3 years and the oldest was 80 years, with a range of 77 years.

Most of the patients injured were males 259 (69.8%), while the females were 112 (30.2%), with a male to female ratio of 2.3:1. Majority of the injured patients were motorcycle riders 167 (45%), passengers injured accounted for 144 (38.8%), while pedestrians accounted for 60 (16.2%).

Three hundred and sixty five (98.4%) of the injured patients were Christians. Two hundred and ten (56.6%) of the injured patients were married, while 161 (43.4%) were single. As regard to occupational status majority of the injured victims were motorcyclists 167 (45%).

Students accounted for 65 (17.5%) of the injured victims. Majority of the crash injury victims had attained primary level of education 242 (65.2%) while 117 (31.5%) secondary level of education and 12 (3.3%) had tertiary level of education.

Table 4.1: Demographic characteristics of motorcycle crash victims at Kitale County Referral Hospital in 2013

Characteristic	Female (n=112) No. (%)	Male (n=259) No. (%)	Total (n=371) No. (%)
Age in years, Mean (S.D)	29.58(15.3)	31.38(11.8)	30.84(12.9)
Age group (years)			
<20	37(33)	86(33)	123(33.2)
21-30	31(28)	71(27)	102(26.7)
31-40	23(21)	53(21)	76(20.5)
41-50	13(12)	29(11)	42(11)
51-60	3(2)	7(3)	10(2.7)
>60	5(4)	13(5)	18(5)
Education			
Primary	73 (65.2)	169(65.3)	242(65.2)
Secondary	35 (31.3)	82(31.7)	117(31.5)
Tertiary	4(3.5)	8(3)	12(3.3)
Religion			
Christian	110(98.2)	255(98.5)	365(98.4)
Muslim	2(1.8)	4(1.5)	6(1.6)
Marital status			
Single	49(43.8)	112(43.2)	161(43.4)
Married	63(56.2)	147(56.8)	210(56.6)
Occupation			
Motorcycle rider	4(4)	163(62.9)	167(45)
Formal employment	17(15)	7(2.7)	24(6.5)
Informal employment	24(21)	16(6.2)	40(11)
Unemployed	37(33)	38(14.7)	75(20)
student	30 (27)	35(13.5)	65(17.5)

Most of the severe injuries occurred in the 21-30 age group category 24 (23.5%) while that above 60 years only suffered 1 (5.5%) of the cases. Mild injuries constituted 1 (5.5%) of the cases in the age group above 60 years. More cases of moderate injuries were seen in 31-40 years age groups 60 (78.9%) and 32 (76.2%) in the 41-50 age categories. The association between age group and motorcycle crash injuries was statistically significant $\chi^2 = 17.678$, $p<0.007$ as indicated in Table 4.2

Table 4.2: Relationship between age group and injury severity among motorcycle injury victims attended at Kitale County Referral hospital in 2013

Age-group (years)	**Severity in crash injury**			**Totals**
	Mild	Moderate	Severe	
<20	29 (23.6%)	79 (64.2%)	15 (12.2%)	123 (33.2%)
21-30	12 (11.8%)	66 (64.7%)	24(23.5%)	102 (26.7%)
31-40	5(6.6%)	60(78.9%)	11(14.5%)	76(20.5%)
41-50	3(7.1%)	32(76.2%)	7(16.7%)	42(11%)
51-60	2(20%)	6(60%)	2(20%)	10(2.7%)
>60	1(5.5%)	16(89%)	1(5.5%)	18(5%)
Totals	52(14%)	259(69.8%)	60(16.2%)	371(100%)

Table 4.3 shows the personal, motorcycle and environmental characteristics of motorcycle crash injuries. Majority 218 (59%) of the motorcycle crash injury victims average monthly income ranged 5001-10,000kshs, 55 (15%) earned monthly income less than 5,000kshs per month. Most 342 (92.2%) of the injuries occurred on motorcycles with engine capacity less than 500cc while 29 (7.8%) of the injuries occurred on motorcycles with engine capacities between 501-1000cc.

Slightly over 218 (58%) of the injured victims wore other types of helmets or none at all, 117 (32%) wore full face rigid helmets while 30 (8%) wore full face rigid helmets. Three hundred and twenty six (88%) of the motorcycle crashes occurred during the day, 32 (9%) occurred at dusk/dawn while 13 (3%) occurred at night. Most 355 (95.7%) of the collisions occurred on dry road surfaces while 16 (4.3%) occurred on wet road surfaces. At the time of motorcycle crash injury 76 (20.5%) of the victims reported that motorcycle headlights were turned off, 295 (79.5%) reported headlights were on. Other than helmets as safety gears 314 (85%) of the injured victims reported to be wearing reflective jackets while 48 (12%) used other safety gears.

Table 4.3: Personal, Motorcycle and Environmental Characteristics of Motorcycle Crash Injuries among Patients Seen at Kitale County Referral Hospital, 2013

Characteristic	Females (n=112) No. (%)	Males (n=259) No. (%)	Totals (n=371) No. (%)
Average income			
0-5000kshs	17(15)	38(15)	55(15)
5001-10,000kshs	65(58)	153(59)	218(59)
10,001-15,000kshs	13(12)	29(11)	42(11)
15001-20,000kshs	16(14)	36(14)	52(14)
>20,000kshs	1(1)	3(1)	4(1)
Motorcycle capacity			
<500cc	103(92)	239(92.3)	342(92.2)
501-1000cc	9(8)	20(7.7)	29(7.8)
Type of helmet worn			
Full face rigid	9(8)	21(8)	30(8)
Full face flexible	35(31)	82(32)	117(32)
Open face	2(2)	4(2)	6(2)
Others	66(59)	152(58)	218(58)
Light conditions at the time of crash			
Daylight	98(87)	228(88)	326(88)
Dusk /dawn	10(9)	22(9)	32(9)
Night time	4(4)	9(3)	13(3)
Road conditions at time of crash			
Wet	5(4.5)	11(4.2)	16(4.3)
Dry/dusty	107(95.5)	248(95.8)	355(95.7)
Headlights on at time of crash			
No	23(21)	53(20.5)	76(20.5)
Yes	89(79)	206(79.5)	295(79.5)
Safety gears used other than helmets			
Reflective jackets	95(85)	219(84)	314(85)
Flashing lights	2(2)	5(1.9)	7(2)
Special boots	1(1)	1(1)	2(1)
Others	14(12)	34(13.1)	48(12)

Figure 4.1 shows that majority (72.2%) of the motorcycle crash victims were involved in a motorcycle crash between Mondays to Friday. Most injuries occurred on Monday (16.4%) and Friday (16.4%) respectively. Lower rates of motorcycle injuries were recorded on Thursday (11.2%).

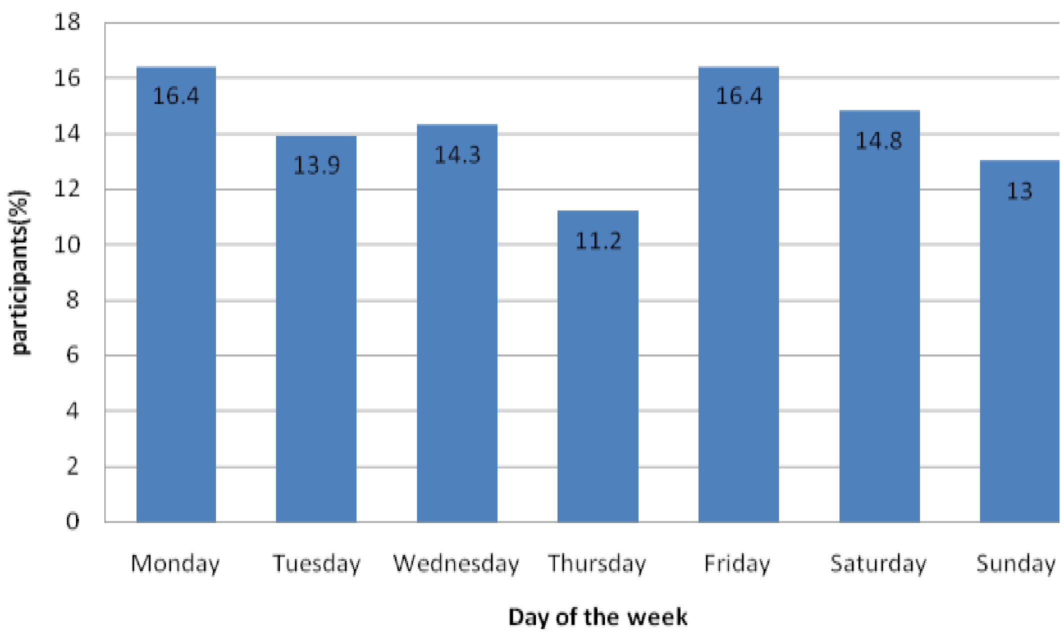


Figure 4.1: Day of the week when patients attending Kitale County Referral hospital were involved in a motorcycle crash injury, 2013

Figure 4.2 shows the time of the day when motorcycle crashes occurred. Majority (51.4%) of the motorcycle crash victims were involved in a motorcycle crash in the afternoon (12PM-5.59PM), 36.4% of the motorcycle crash injuries occurred in the morning (7.00AM-11.59AM), 10.5% of the motorcycle injuries occurred in the evening (6PM-11.59PM) while 1.7% of the motorcycle crash injuries occurred in the early morning (12AM-6.59AM).

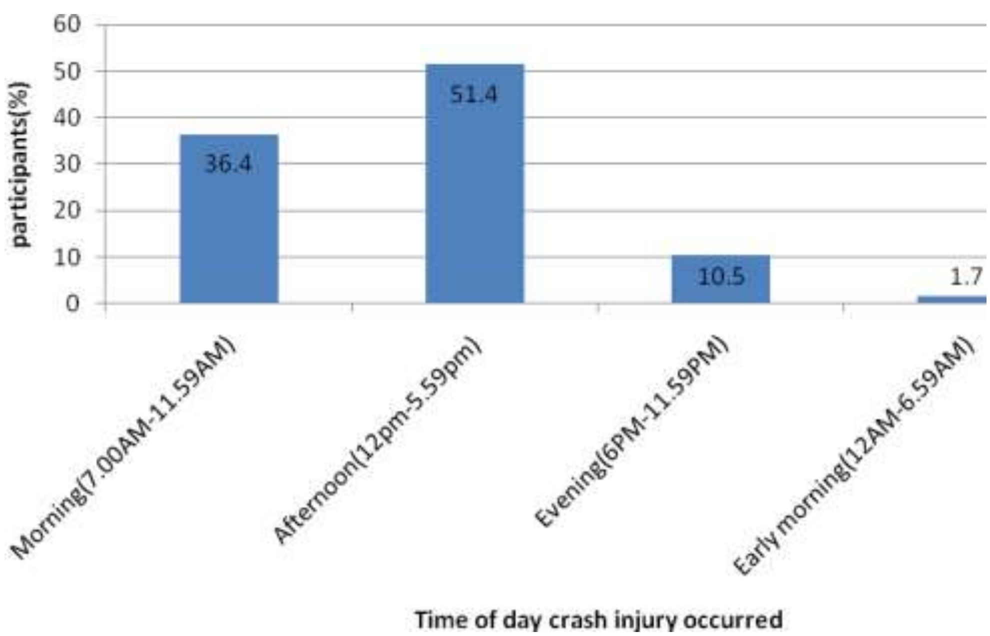


Figure 4.2: Time of the day when patients attending Kitale County referral hospital were involved in Motorcycle crash injury, 2013.

On arrival at the hospital, 240 (67%) of patients with head injury were assessed as having Glasgow coma scale of 13-15 (mild head injury). Ninety-three (26%) had Glasgow coma scale of 9-12 (moderate head injury) and 25 (7%) had Glasgow coma scale of 3-8 (severe head injuries) as illustrated in Figure 4.3.

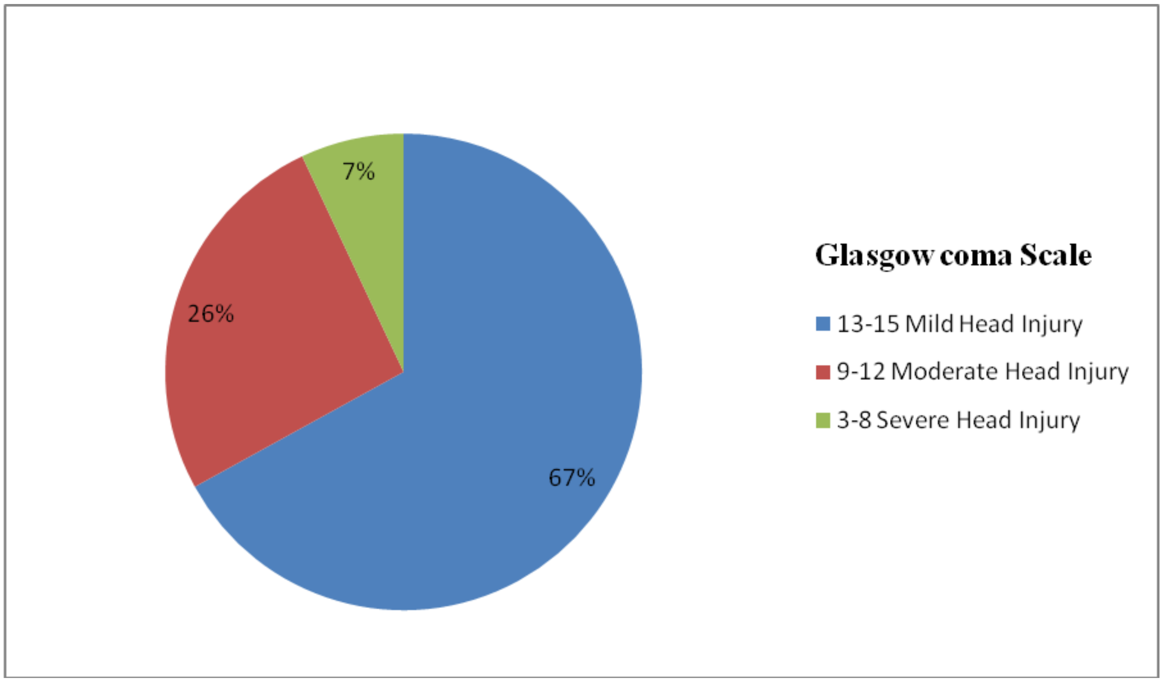


Figure 4.3: Glasgow Coma Scale on arrival at the Hospital by head injury victims of motorcycle crash at Kitale County Referral Hospital in 2013

Among the riders 27 (16.1%) suffered severe injuries as compared to passengers 23 (16%) and pedestrians 10 (16.7%). One hundred and sixteen (69.5%) of riders suffered moderate injuries as compared to passengers 100 (69.4%) and pedestrians 42 (70%). Pedestrians suffered minor injuries 8 (13.3%), riders 24 (14.4%) and passengers 21 (14.6%) as indicated in Table 4.4. There was a significant relationship between the category of road user and severity of the crash injury (χ^2 = 129.936, p<0.001).

Table 4.4: Relationship between Category of Road user and injury Severity among victims of motorcycle injuries attended at Kitale County Referral hospital in 2013

Characteristic	Rider (n=167) No (%)	Passenger (n=144) No (%)	Pedestrian (n=60) No (%)	Totals (n=371) No (%)
Injury severity				
Minor	24(14.4)	21(14.6)	8(13.3)	53(14.3)
Moderate	116(69.5)	100(69.4)	42(70)	258(69.5)
Severe	27(16.1)	23(16)	10(16.7)	60(16.2)

Majority of the riders who did not wear helmets at the time of crash suffered head injuries 89 (85.6%). Riders who wore helmets at the time of crash had no head injury 62 (98%) and this was statistically significant χ^2 =111.352, p<0.001 as illustrated in Table 4.5.

Table 4.5: Relationship between Helmet use and Head injury among Riders attended to at Kitale County Referral Hospital in 2013

Helmet use	Head injury	No head injury	Totals
Yes	1 (1.6%)	62 (98%)	63 (37.7%)
No	89 (85.6%)	15 (14%)	104 (62.3%)
Totals	90 (53.9%)	77 (46.1%)	167 (100%)

The majority of patients sustained minor to moderate injuries 238 (64%). Severe injuries occurred in 25 (6.8%) of the patients, 3 (0.8%) sustained critical injuries and mortality was recorded in 21 (5.7%) of the patients as illustrated in Figure 4.4.

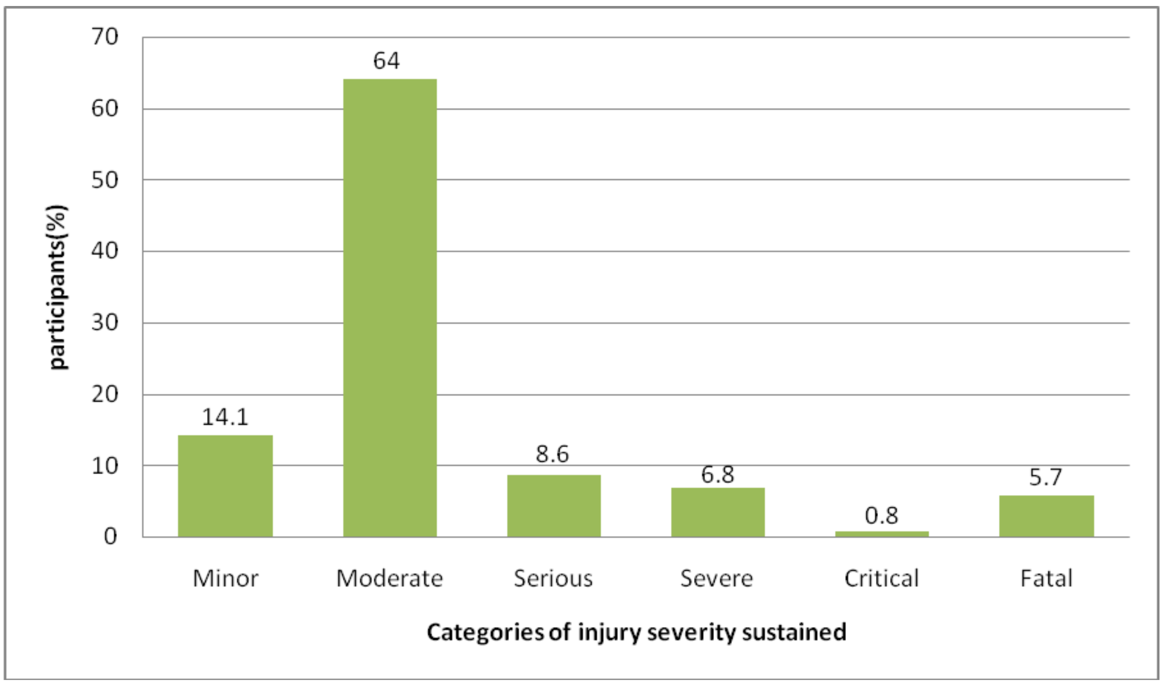


Figure 4.4: Abbreviated injury score among victims of motorcycle injuries attending Kitale county Referral Hospital in 2013.

Head and neck were the most common body region injured affecting 240 (42%) of the patients. The most common injuries sustained were open wounds to the head- neck such as lacerations, bruises, abrasions and superficial wounds. Lower extremity injuries affected 147 (25.7%) of the patients. Most common fractures of the lower extremities affected the femur, tibia fibula and ankle. Majority of the riders, passengers and pedestrians also sustained open and superficial wounds of the lower extremity. Upper extremity injuries affected 88 (15.3%) of the patients while 45 (7.9%) of the patients had multiple injuries affecting more than one body region. Chest trauma was recorded in 14 (2.5%) of the patients, including rib fractures, hemothorax and lung contusion. Eighteen (3.2%) of the patients had pelvic injuries. Spinal injuries were noted in 10 (1.8%) of patients affecting cervical, thoracolumbar and lumbosacral region. Abdominal injuries was noted in 9 (1.6%) of the patients and was mostly blunt injuries as illustrated in Figure 4.5.

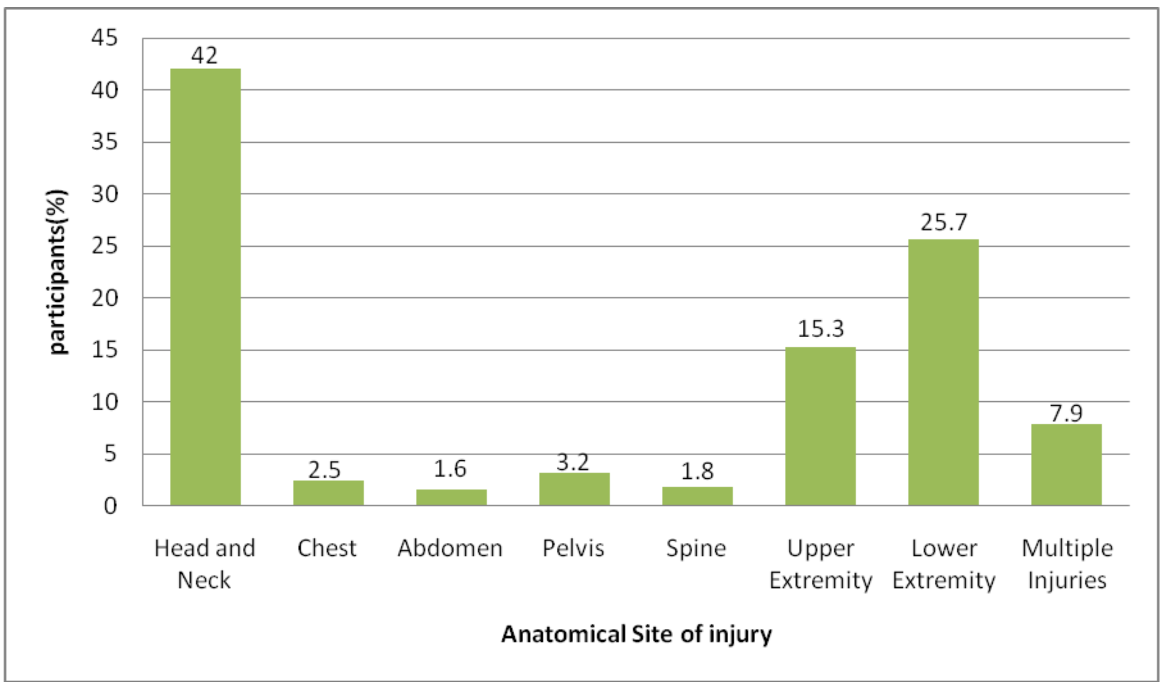


Figure 4.5: Anatomical Site of Injury among victims of Motorcycle injuries attended to at Kitale County Referral Hospital in 2013.

Majority of the patients 348 (93%) reported highway as the place of motorcycle injury crash. Fourteen (4%) of the respondents reported urban street as place of injury, 7 (2%) sustained injuries while riding on rural roads and 2 (1%) reported other areas as place of motorcycle crash injury as indicated in Figure 4.6.

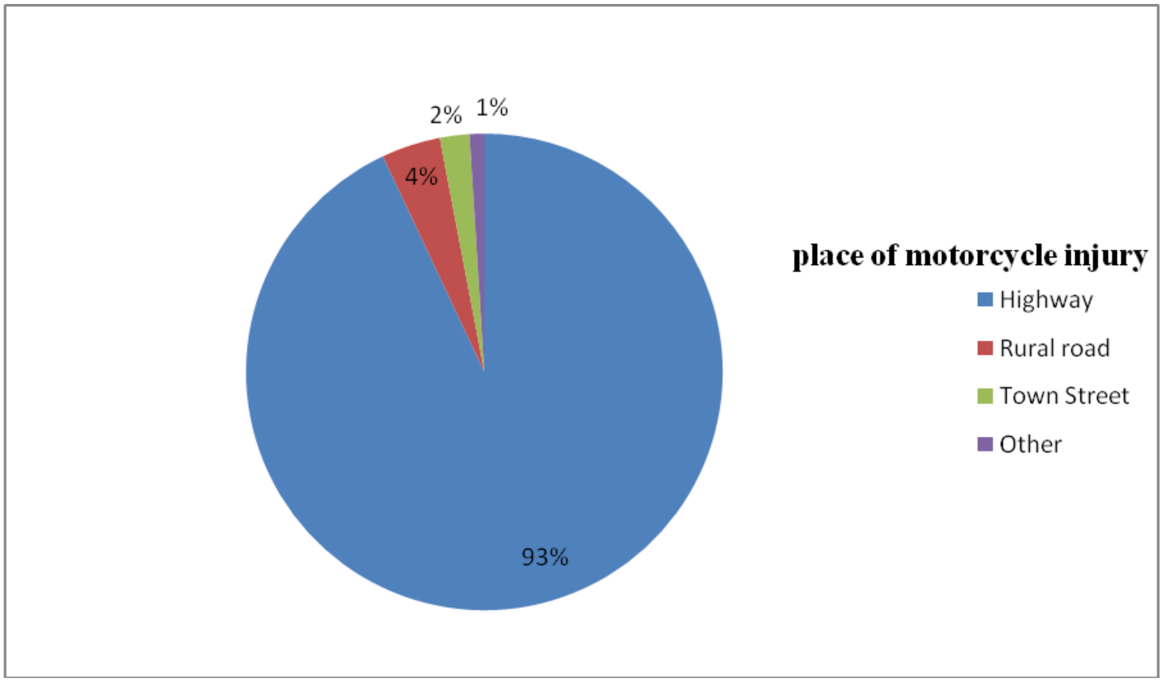


Figure 4.6: Place of Motorcycle Crash Injury Occurrence among Victims of Motorcycle crash injuries at Kitale County Referral hospital in 2013

Most patients 295 (79.5%) were travelling using commercial motorcycle at the time of injury crash. Forty seven (12.7%) were knocked by motorcycles while walking along the roads, 10 (2.7%) of the patients sustained injuries while competing in a sports event and 9 (2.4%) while cycling as illustrated in Figure 4.7.

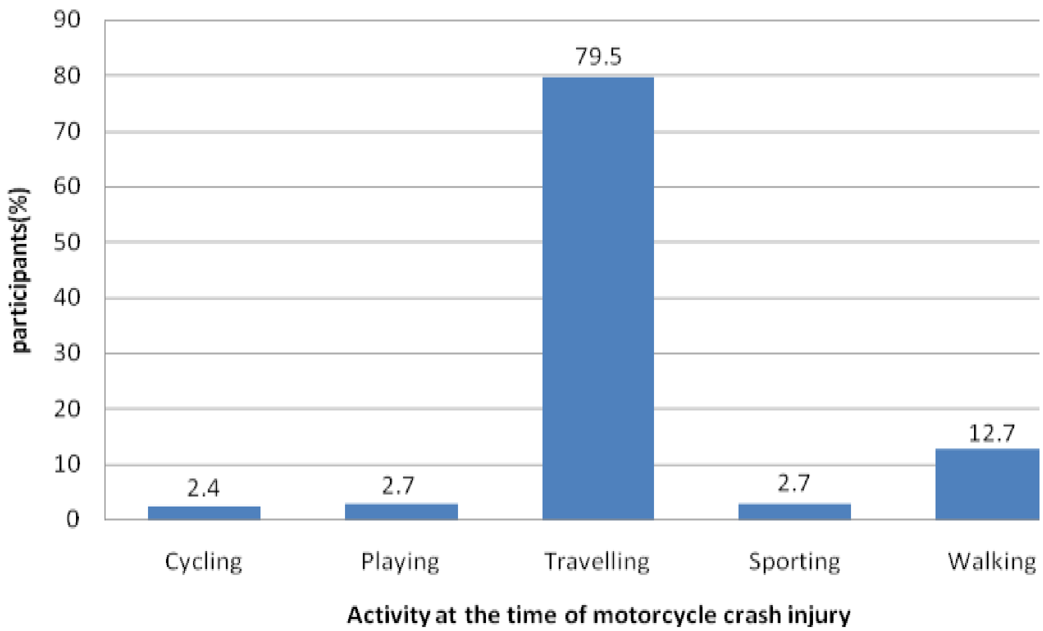


Figure 4.7: Activity at the time of motorcycle crash injury among victims of motorcycle injuries attended at Kitale County Referral hospital in 2013

Figure 4.8 shows motorcycle versus vehicle was the most reported mechanism of the motorcycle crash injuries 175 (47%). Motorcycle versus motorcycle constituted 84 (23%) patients. Motorcycle versus pedestrian collision was 71 (19%). Motorcycle versus bicycle collision was reported by 31 (8.4%) of the injured patients.

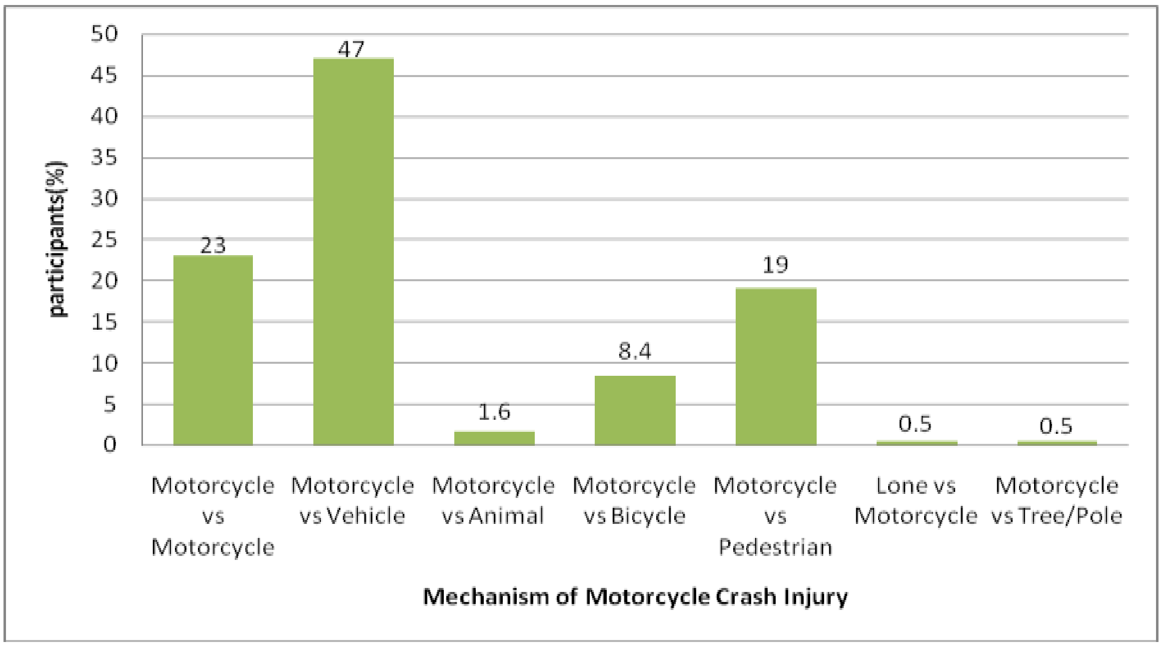


Figure 4.8: Mechanism of Motorcycle Crash Injury among victims attended to at Kitale County Referral Hospital in 2013

Among the categories of road users injured, 167 (45%) comprised of motorcycle riders, 144 (39%) comprised of passengers and 60 (16%) comprised of pedestrians as indicated in Figure 4.9.

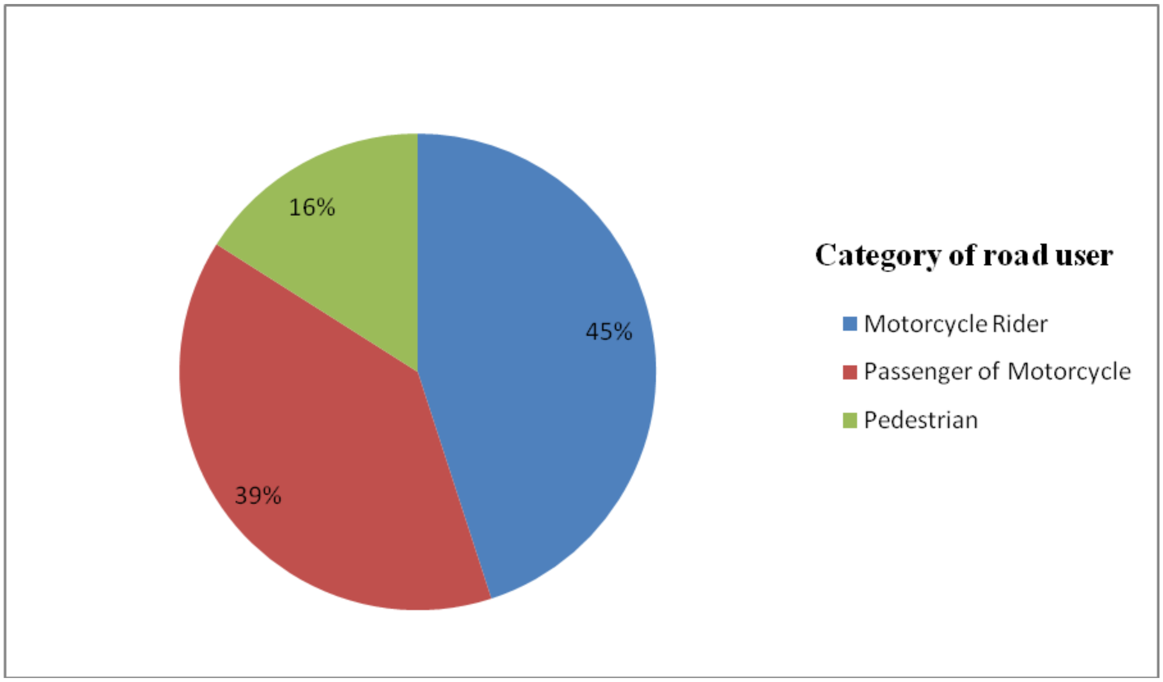


Figure 4.9: Category of road users injured at Kitale County Referral Hospital in 2013

Among the passengers injured, 60 (42.6%) boarded commercial motorcycle because it was quick and faster, 49 (34.7%) were using it because of convenience and 25 (17.7%) used motorcycles for commuting to places of work as illustrated in Figure 4.10.

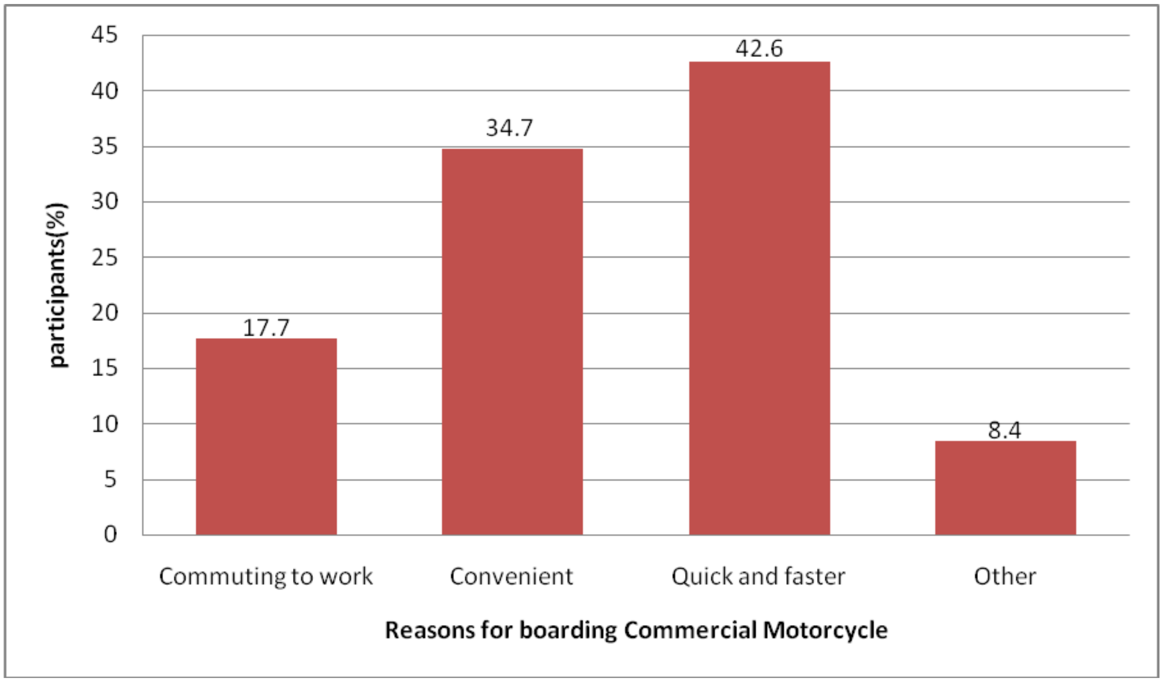


Figure 4.10: Reasons for boarding Motorcycle among injury victims at Kitale County Referral Hospital in 2013.

Figure 4.11 shows that motorcycle riders 146 (88%) had riding experience less than 5 years, 18 (11%) had less than 10 years experience riding motorcycles and 3 (1%) had riding experience of more than 10 years.

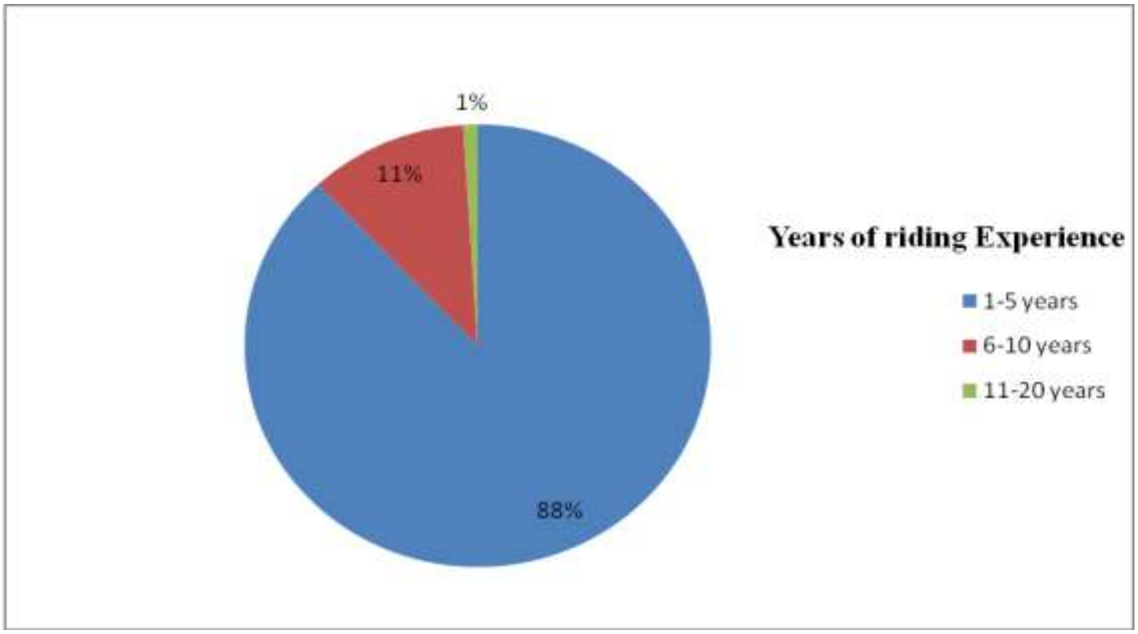


Figure 4.11: Years of riding experience among injured riders at Kitale county referral hospital in 2013

Majority of motorcycle riders 75 (44%) do ride motorcycle on daily basis, 81 (49%) of riders do ride for between 4-6 days in a week and 11 (7%) ride less than 3 days in a week as illustrated in Figure 4.12.

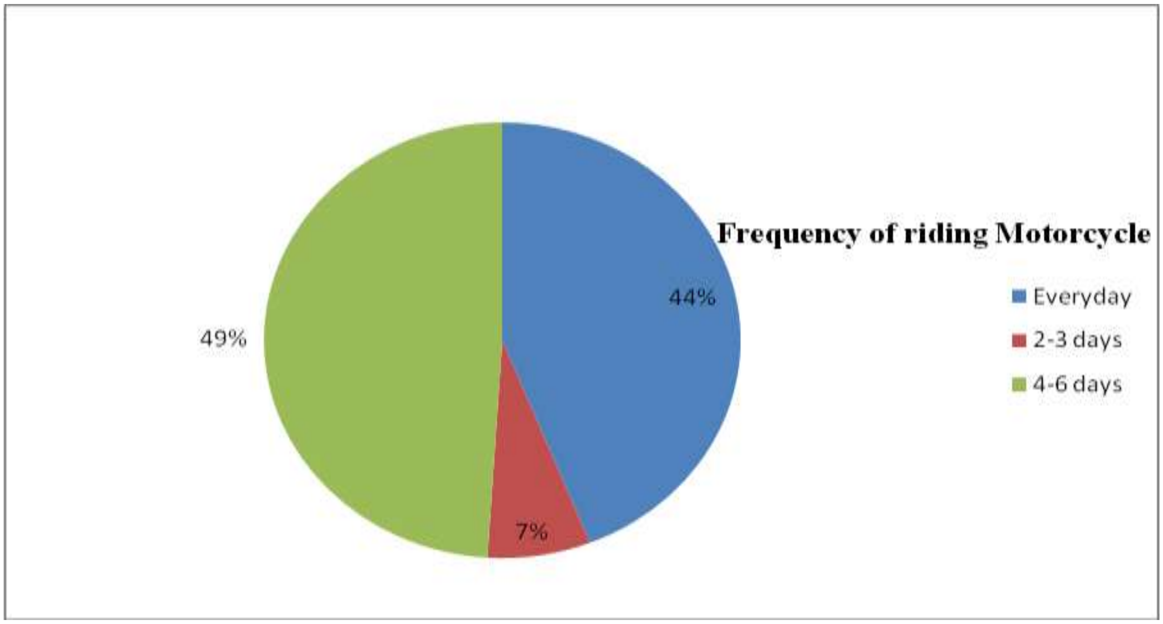


Figure 4.12: Frequency of riding motorcycle among riders seen at Kitale County referral hospital in 2013

Table 4.6 shows that motorcycle riders, 32 (19.2%) had licences to ride motorcycles and 135 (80.8%) did not possess riding licences at all. In regard to helmet use, 63 (37.7%) of riders with license wore helmets at the time of crash. One hundred and four (62.3%) of riders without licenses to ride motorcycles did not wear helmets at the time of crash and this was statistically significant (χ^2=5.72, p<0.001.)

Table 4.6: Association between helmet use and riders' possession of license

Possession of license	**Non helmeted**	**Helmeted**	**Totals**
With license	14 (43.7%)	18 (56.3%)	32 (19.2%)
Without license	90 (66.7%)	45 (33.3%)	135 (80.8%)
Totals	104 (62.3%)	63 (37.7%)	167 (100%)

Among riders and passengers not wearing helmets, 141 (70.9%) said they were not available while 55 (26%) said they were not willing to use. One hundred and nineteen (38%) of respondents reported to sometimes wear helmets while riding or using a motorcycle, 109 (35%) reported to always wearing helmets while 1% seldom use helmets as illustrated in Figure 4.13.

Figure 4.13: Frequency of Helmet use among Riders and Passengers injured at Kitale County Referral Hospital in 2013.

Over three quarters 333 (90.2%) of the patients injured reported that the weather condition was clear sky at the time of the crash. Twenty three (6.2%) of the motorcycle injury patients reported that the weather was cloudy at the time of crash. Eleven (3%) of the injured victims reported light rains at the time of motorcycle injury crash while 1 (0.3%) 0f the injured patient reported heavy rain at the time of motorcycle injury crash as illustrated in figure 4.14.

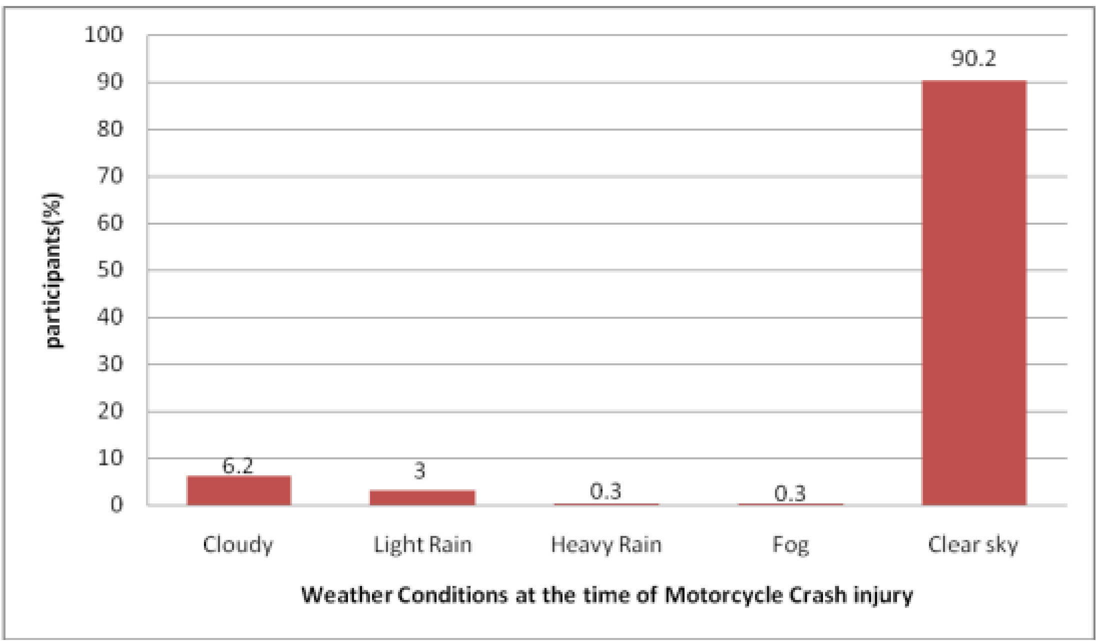


Figure 4.14: Weather conditions at the time of Motorcycle Crash Injury among injury victims attended at Kitale County Referral Hospital in 2013.

Among the patients that sustained motorcycle crash injuries 8 (2.2%) were given first aid care before arrival at the hospital, while 363 (97.8%) of the injured patients did not get appropriate first aid care. The majority of the injured patients arrived at the hospital between 1 and 6 hours 280 (75.5%) and 3 (0.8%) of the injured patients arrived after 24 hours. The majority of the injured patients were brought in by public/good Samaritans 332 (89.44%), police brought in 37 (9.97%) and only 2 (0.54%) were brought in by an ambulance as illustrated in Table 4.7

Table 4.7: First Aid care, Pre hospital transportation and Hospital arrival time among victims of motorcycle crash injury at Kitale County Referral hospital 2013.

Characteristic	Rider (n=167) No (%)	Passenger (n=144) No (%)	Pedestrian (n=60) No (%)	Totals (n=371) No (%)
First Aid care				
First Aid given	4(2.4)	3(2.1)	1(1.7)	8(2.2)
First Aid not given	163(97.6)	141(97.9)	59(98.3)	363(97.8)
Pre hospital transportation				
Police	17(10.2)	14(9.7)	6(10)	37(10)
Bystanders	149(89.2)	129(89.6)	54(90)	332(89)
Ambulance	1(0.6)	1(0.7)	0(0)	2(1)
Time interval between injury and arrival at the A and E				
Less than 1 hour	5(3)	3(2.1)	2(3.3)	10(2.7)
1 hour to 6 hours	126(75)	109(75.7)	45(75)	280(75.9)
7 hours to 12 hours	33(19.8)	28(19.4)	12(20)	73(19.7)
13 hours to 24 hours	2(1.2)	2(1.4)	1(1.7)	5(1.3)
Greater than 24 hours	1(1)	2(1.4)	0(0)	3(0.8)

Table 4.8 shows the outpatient and inpatient management of motorcycle crash injury victims at Kitale county referral hospital. The average length of hospital stay ranged from 1 day to 157 days (mean 13.7 days). Pedestrians injured had the lowest length of hospital stay of 5.14 days as compared to riders 14.63 days and passengers 14.5 days.

The waiting time ranged from 10 minutes to 31 minutes. The majority of victims 274 (74%) were attended to within 11- 20 minutes of arrival to the accident and emergency department. Majority of the crash victims received inpatient treatment 317 (86%) while 54 (14%) were treated as outpatients. For those that received outpatient treatment, minor surgery was indicated in 38 (10%) of the victims. Most of the riders 17 (10%), passengers 15 (10%) and pedestrians 6 (10%) injured received minor surgery.

For inpatient treatment major surgery was indicated for 186 (50%) of the injured victims while radiological services was indicated for 77 (21%) of the victims. Most common surgical procedures performed was wound debridement 118 (32%) of the cases, 35 (9%) of the cases were done craniotomy. Closed reduction was performed on 56 (15%) of the victims while 92 (25%) were done external fixation. Laparatomy was indicated in 6 (2%) of the injured victims while 10 (3%) of the cases with chest injuries were managed with under water seal drainage. Majority of the injured patients were not covered by the National Hospital Insurance Fund. Only 25 (7%) of the cases were covered by the National scheme. Three hundred and thirty (90%) of the injured patients had no form of insurance and therefore paid for their own hospital bills.

Table 4.8: Outpatient and inpatient management of Motorcycle crash injury victims at Kitale County referral hospital in 2013

Characteristic	Rider (n=167) No (%)	Passenger (n=144) No (%)	Pedestrian (n=60) No (%)	Totals (n=371)
Average length of stay, Mean (S.D; Range)	14.63(12.596;89)	14.5(16.167;157)	5.14(6.816;31)	13.07(14.056;157)
Patient waiting time				
0-10 minutes	24(14)	21(15)	9(15)	54(14)
11-20 minutes	123(74)	106(73)	44(73)	274(74)
21-30 minutes	19(11)	16(11)	7(12)	41(11)
>31 minutes	1(1)	1(1)	0(0)	2(1)
Type of treatment received				
Outpatient	24(14)	21(15)	9(15)	54(14)
Inpatient	143(86)	123(85)	51(85)	317(86)
Outpatient treatment received				
Observations(<24hrs)	2(1)	2(1)	1(2)	5(1)
Prescriptions drugs	2(1)	2(1)	0(0)	4(1)
Physician services	1(1)	1(1)	1(1)	3(1)
Minor surgery	17(10)	15(10)	6(10)	38(10)
Radiology services	2(1)	2(1)	0(0)	4(1)
Inpatient treatment received				
Observations(>24hrs)	10(6)	9(6)	4(7)	23(6)
Major surgery	84(50)	72(50)	30(50)	186(50)
Radiological services	35(21)	30(21)	12(20)	77(21)
Physician services	14(8)	12(8)	5(8)	31(8)
Inpatient surgical procedures done				
Craniotomy	16(10)	14(10)	5(8)	35(9)
Wound debridement	53(32)	46(32)	19(32)	118(32)
Closed reduction	25(15)	22(15)	9(15)	56(15)
ORIF/external fix	41(25)	36(25)	15(25)	92(25)
Laparatomy	3(2)	2(1)	1(1)	6(2)
UWSD	5(3)	4(3)	1(1)	10(3)
Mode of payment				
NHIF	11(7)	10(7)	4(7)	25(7)
Self payment	151(90)	130(90)	55(92)	336(90)
Other	5(3)	4(3)	1(1)	10(3)

Figure 4.15 shows the patient disposition and discharge status among victims of motorcycle injuries at Kitale County Referral hospital. Among the victims injured 313 (84%) were discharged home after full recovery. Few patients 17 (4.6%) required rehabilitation care after they were discharged home. Long term care was indicated in 12 (3.2%) of the injured patients after being discharged home. Nineteen patients succumbed to their injuries giving a mortality rate of 5.1%.

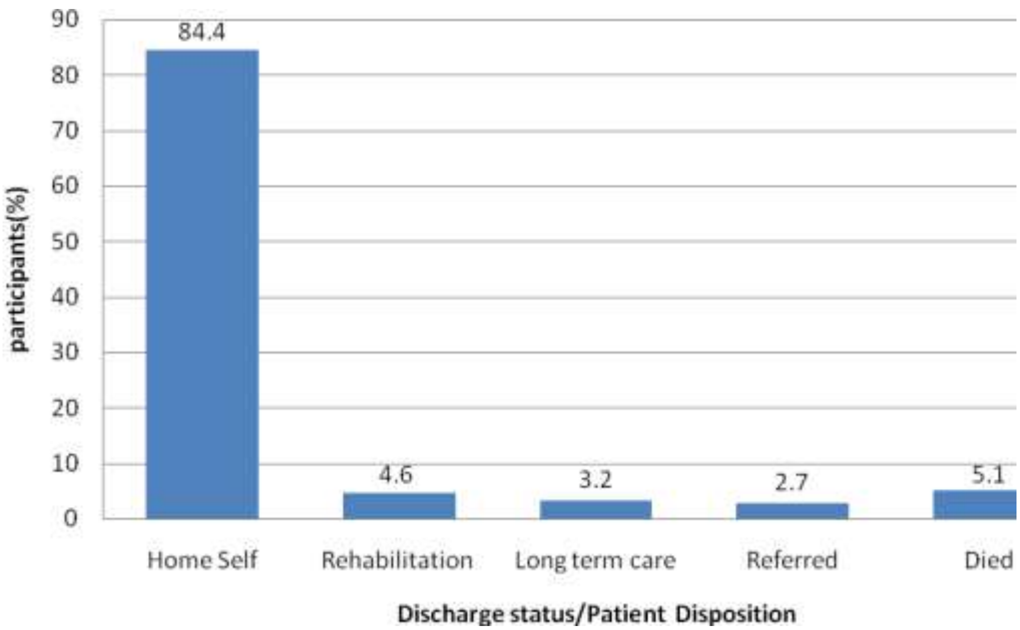


Figure 4.15: Discharge status/Patient Disposition among victims of Motorcycle Crash Injuries at Kitale County Referral Hospital in 2013

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Road transportation plays an important part in a society for the movement of not only people but also of goods. The attendant consequences of road crashes cannot be overemphasized as it leads to morbidity, mortality and increased economic cost in terms of managing injuries and hospitalization. In addition the motorcycle operators are able to navigate poor network of roads with the frequent attendant traffic congestion both in the cities and rural areas (Ameratunga *et al*., 2006). Injuries related to commercial motorcycles contribute significantly to the number of road traffic injuries seen at Kitale County Referral hospital. This has led to creation of a special wing to handle victims of commercial motorcycle crashes. This is a significant toll on limited resources including consumables and the health worker time. However, despite this burden, the public policy responses to this problem have been muted, probably because of lack of local data regarding the problem. This study provides data from a county urban setting and against which future trends may be compared.

5.2. Prevalence of commercial motorcycle crash injuries

In this study the prevalence of Motorcycle crashes at Kitale was 39.4% of all road traffic injuries reported. This is in agreement with other studies conducted in other developing countries. The reported prevalence of motorcycle injuries varies around the world, from 22.8% in China (Zhang *et al*., 2004) to as high as 62% in Vietnam (Nantulya & Reich, 2003). In Nigeria, the prevalence of motorcycle injuries varies from 12.8% -60% have been reported in different studies (Okeniyi *et al*., 2005). In Uganda the reported prevalence of Motorcycle injuries in Mulago hospital was 25% (Naddumba, 2004).

Differences in prevalence can be attributed to differences in risk factors in the study settings.

5.3. Socio demographic characteristics of commercial motorcycle crash injuries

There is a male preponderance in this study. This is in agreement with several other reports (Solagberu, Ofoegbu, Nasir, Ogundipe, Adekanye & AbdurRahman, 2006). It is observed that nearly all commercial motorcyclists are males and riders constituted the single largest risk group (64%), this agrees with other studies which identify riders as the majority of motorcycle crash victims presenting to hospitals (Odelowo, 1994). High occurrences of motorcycles crashes among this group have been attributed to a wide range of activities engaged in by this group. They are more likely to have reasons to move from one place to another. They represent the active group that partake in high risk-taking activities such as recklessness riding, over-speeding and overloading, riding under the influence of alcohol and riding without wearing any protective equipments. Males are more often exposed to traffic as riders; they travel longer distances to work and are more often involved in use of automobile as leisure activities (Akinpelu, Oladele, Amusa, Ogundipe, Adeolu & Komolafe , 2007).

Motorcycle riding in this area is almost exclusively men, most of whom do it for commercial purposes. The 39.6% of injuries involving pedestrians is one of the highest observed. It is higher than the 14–22.5% reported by other researchers (Solagberu *et al*., 2006). About half of the pedestrian victims were children. It has previously been reported that such children victims are often playing and walking by the road side (Oluwadiya *et al*., 2004). The absence of segregated road networks for pedestrians increases the risk of crashes.

Few studies have established the influence of marital status on road traffic injuries among motorcycle riders. In our study 43.6% of the injured patients were single. A bivariate analysis of a study in Nigeria found that those who never married had higher odds of getting road traffic injuries compared to their counterparts (Olumidea and Owoajea, 2014).

Injured motorcycle users in this study were more likely to be Christians (98.4%) than Muslims (1.6%). This can be attributed to the predominance of Christians around the study area. A similar observation was noted in Kampala City, Uganda which found that Christians constituted 80% of injured victims (Tumwesigye, Atuyambe & Kobusingye, 2016).

In this study the majority (45.1%) of motorcycle crash injuries were found to be riders. Similar findings were reported elsewhere where they found that 41.0% to 62.0% of motorcycle crash injury victims were riders (Zargar *et al*., 2006). This shows that the riders constitute the majority of motorcycle crash injury victims reporting to hospitals. Therefore this particular group requires a special attention when planning strategies to prevent motorcycle crashes

Businessmen, students and farmers were the most injured because of the rush through heavy traffic to get to their businesses, school and farms. Similar observation was noted by Naddumba (2004) in Kampala, Uganda. Solagrebu *et al.* (2006) also reported similar observation in Nigeria. Businessmen are often involved in buying and selling which necessitates movement from one place to another. This often involves travelling with goods purchased, and in order to maximize profits, they usually opt for the cheapest means of transport available such as motorcycles (Chalya *et al*., 2010). Students are usually involved in motorcycle crashes as they rush through heavy traffic to and from their schools. These school-age group children are usually very active and are often less supervised than pre-school age children. Coupled with the paucity of boarding school facilities for children of their age as well as of school buses, schoolchildren have to walk varying distances to and from school (Chalya *et al*., 2010). This was the case in the vast majority of children knocked down in this study. As students formed one of the largest group of motorcycle injury victims, an improved school transportation system that obviates students' need for the motorcycle may reduce the incidence of motorcycle injuries.

Crashes are also affected by the socioeconomic status of the motorcyclists. Majority of the injured patients (74%) in this study earned average monthly income less than 10,000 shillings. A similar observation was noted in Sweden where motorcycle riders of low socioeconomic status had a risk of 2.5 times more than others of having accidents (Zambon and Hasselberg, 2006). Moreover in socioeconomically low groups the drug abuse has a high percentage which increases the possibility of crashes (Zambon and Hasselberg, 2006).

5.4. Injury patterns and Severity among commercial motorcycle users

Based on the research findings, the commonest anatomical site of injury were head and neck and lower extremities. The findings are similar to a study in Tehran, which documented that the commonest musculoskeletal injury was fracture of the tibia comprising almost 50% of cases (Zargar *et al*., 2006). Similarly, Kraus *et al*., (2002) in a study of the incidence of thoracic and abdominal injuries among injured motorcyclists in California, reported that multiple intra-thoracic and intra-abdominal injuries were common. The number of rib fractures and whether they were bilateral was strongly associated with serious injuries to the thoracic and abdominal organs.

Long established patterns of injury risk suggest that the lower limbs are the body parts most likely to be injured in motorcycle crashes. The susceptibility of the extremities in particular the lower limbs could be due to a number of factors such as anatomical location and lack of protectors on the extremity. In Lagos, Nigeria, after the introduction of commercial motorcycles, the incidence of reported cases of road traffic crashes at Igbobi Orthopedic hospital increased to 300% in number of patients with fractured limbs (Idika & Sanni, 2004). Previous studies in Nigeria have shown that limb and head injuries are the commonest causes of morbidity and mortality in motorcycle injuries (Oluwadiya *et al*., 2004) and this was also eminent in the current study. Another study also reported that among moped and motorcycle riders, head injuries account for about 55–88% in Malaysia (Radin-Umar, *2002*).

Findings in the current study indicated that crash injuries were not evenly distributed by age-group and of all the crash injuries those below 25 years comprised of 33.2%. But no fatality cases were reported among this age-group. This was contrary to findings in Australia where 28% of fatalities occur among people aged between 17 and 25 years (ATSB, 2007). The pattern was also contrary to that in the United States where 27% of fatalities occur among motorcycle users aged between 16 and 24 years, which is the highest proportion of traffic fatalities for riders of all age groups (NHTSA, 2006).

In this study there was a significant relationship between the category of the road user and severity of the injury ($p<0.001$). Higher percentage of severe cases was among the motorcycle riders. However in a study of road traffic injuries in Western Maharashtra, no positive correlation existed between category of road user and severity of injury (Patil *et al*., 2008).

From a safety perspective a helmet is the most important element of a motorcycle rider. Its use has been shown to be 72% effective at reducing the incidence of head injuries (Liu *et al*., 2008). The use of a helmet in this study was recorded in 1.7% of motorcycle crash injury victims, with a significant proportion of victims sustaining head injuries. Hence helmet use has a highly significant protective factor against head injury. The increased risk of serious head injury in the absence of helmet wearing has been documented previously and this study reinforces these findings in a developing world context (Peek-Asa *et al*., 1999). While this study provides evidence of the benefits of helmet use in mitigating serious head injuries, earlier studies have reported reductions in head injury associated mortality through the use of helmets (Peden, McGee, & Sharma,, 2004).

In the present study 32% of the injured victims wore full face flexible helmets. Apart from helmets 85% of the victims had reflective clothing and head lights were on among

79.5% of motorcycles involved in crashes. This is similar to the finding in Germany (Zwipp *et al*., 2012). The use of protective devices and proper functioning of safety devices on motorcycles is not borne out of safety concerns but from need to protect self from cold or because of enforcement by regulatory agencies. Safety consciousness is lacking among the commercial motorcyclists (Peden *et al*., 2004).

The finding that most of the crashes (93%) in the present study occurred along the highway agrees with that of Naddumba (2006) in Uganda and Twagirayezu, Teteli, Bonane and Rugwizangoga, (2008) in Rwanda. Increased rate of crashes along the highway can be explained by increased traffic density. Knowing the place of injury in trauma patient is important for prevention strategies.

Many of the injured patients (42.6%) boarded motorcycles because of speed and convenience. Motorcycle riders are able to maneuver during times of traffic congestion. Similar observations by Oni Fashina, and Olagunju, (2011) in Lagos State Nigeria found that 32.9% of injured motorcycle users prefer them because of speed and need to beat traffic congestion.

This study found that the majority of the patients (74%) were attended to within 11-20 minutes of arrival at the accident and emergency department. This was much lower than that reported by Chalya *et al*., (2010) in Mwanza city, Tanzania. There study found a mean waiting time of 1-2 hours.

Most of the injured patients (50%) were treated surgically, which is in agreement with other similar studies (Solagberu *et al*., 2006). The most common type of surgical procedure performed was wound debridement (32%). The high incidence of surgical treatment in our study is attributable to the high incidence of patients with moderate to severe injuries, the majority of which required surgical intervention.

5.5. Factors associated with injuries among commercial motorcycle injury patients

Factors influencing the rate of commercial motorcycle crashes have been found to include: over speeding, wrong overtaking, bad roads, mechanical defect, and other drug intake. This assertion agreed with the previous studies of (Meuleners *et al*., 2006). The motorcycle riders do not ride with their driver's license and they do not put on their safety helmets for protection in case of accident. This could account for the severity of crash when commercial motorcyclists are involved in crashes (Mayrose, 2008). Non possession of rider's license characterized the behavior of the motorcycle riders studied. This agrees with the finding of Elliot *et al*, (2007) and Adisa, (2010).

In the present study about 80.8% of riders did not possess a driving license, higher than 46.5% which was reported in Juba, Sudan (Andrew, 2009). Also those without driving licenses were significantly likely not to wear helmets and this was statistically significant (χ^2=5.72, p<0.001) Normally the License is given to qualified individuals after attending pre riding courses and tested by the traffic police. Therefore this finding show that majority of the riders do not have enough experience required before engaging in riding of a motorcycle. Riding experience and training for riding are other human factors that are of relevance in crashes as they lay credence to fewer crashes if the rider is experienced and has a formal training (Elliot *et al*., 2007).

Among the motorcycle crash riders that participated in the study a smaller percentage were licensed to ride the motorcycle 32 (19.2%). An unlicensed or improperly licensed rider is a factor that has been associated with motorcycle fatalities. In 2007, 26% of motorcyclists involved in fatal crashes did not have a valid motorcycle license, compared to 13% of drivers of passenger vehicles who were not properly licensed (NHTSA, 2009).

Most of the patients (92.2%) sustained injuries on motorcycles with engine capacity less than 500cc. In the United Kingdom using high engine powered motorcycles is another safety factor against crashes. However the degree of the injury is not only related to engine capacity (Clarke *et al.*, 2007). High engine powered motorcycle users generally have training, give importance to safety equipments and are usually above middle age. These factors are the basic features that reduce the risk of crashes (Clarke *et al.,* 2007).

Majority (72.2%) of the motorcycle crash victims were involved in a motorcycle crash between Monday to Friday, with most of the crashes occurring on Monday (16.4%) and Friday (16.4%). Majority of the motorcycle crashes occurred in the afternoon (51.4%) and morning (36.4%). Similar observations were made by Peden *et al.,* (2004) who observed that an important factor that is associated with road traffic crashes is the day of the week. More crashes were reported on Monday and Friday because they are working days and open market days. In the afternoon more crashes were reported because of the rush by people to reach their homes.

Most of the motorcycle crashes (88%) were reported to occur during day time with peak in the afternoon, similar to what has been reported elsewhere (Twagirayezu *et al*., 2008). In Kitale town traffic is very busy early in the morning, lunch and evening time. The reason being residents are moving to and from work and at the same time students are also rushing to and from school.

Most of the crashes (90.2%) occurred during the dry weather season, the months of September to October. This finding differs from the study of Oginni *et al*., (2009) where it was reported that the crashes occurred in the early months of the January-April with a peak incidence in the month of April during the rainy season. The variation can be explained by the different seasons the study was conducted. Furthermore, 95.7% of the injured patients reported that the road condition was dry at the time of crash. The findings are in agreement with a study in the United Kingdom based on regression models to assess the influence of the environment on the occurrence of child pedestrian and cyclist casualties. The study established that road layout, traffic volumes, and other engineering and safety factors have a significant impact on accident and casualty risk (Petch & Henson, 2000).

Commercial motorcyclists were the single largest occupational risk factor for injury as fewer than 30% of victims identify this as their occupation. Lack of formal education could be a contributory factor to motorcycle crashes as 44% of riders had only basic primary education or none at all. Students were the second most common victims of commercial motorcycle crash injuries. Motorcycle is a common means of transportation to and from schools. An effective public transportation system for schools will prevent most of these injuries.

Having primary level of education has been identified to be a risk factor in motorcycle crashes. The primary level of education encountered among most of the motorcycle riders concluded in this study is in accordance with similar studies by Iribhogbe and Odai (2009) in Benin City in Nigeria which was (52.8%). Therefore, at least and as Swaddiwudhipong *et al*., (1994) concluded in their study in Thailand, Motorcycle rider education may be a promising intervention for prevention of motorcycle related injuries.

Socio-economic status may have a possible role to play in this study in the form of educational status. Majority of riders had primary levels of education qualification in comparison to passengers who had educational attainment up to the college level. In addition the association between educational status and status in a crash was statistically significant ($p<0.001$).

As the motorcycle crashes are preventable or the risks are reducible, many European countries regard motorcycle riders as vulnerable groups and training of the riders and helmet usage is inspected by law (Solagberu *et al*., 2006). In this study majority of riders 85.6% did not wear helmets at all. Majority of riders 80.8% did not possess riding license and therefore did not undergo formal training. Riders under 25 years of age in European countries must have basic training of 125 cc or below motorcycles. Here the aim is to use high engine powered motorcycles gradually after gaining experience and skill (Jeffers *et al*., 2004). Legal obligation of wearing helmet is proved to lessen fatal crashes and severe head injuries.

The pre hospital care of trauma patient has been reported to be the most important factor in determining the ultimate outcome after the injury (Chalya *et al*., 2010). 2.2% of our patients had pre-hospital care while 97.8% had none. Majority of the injured patients were brought in by relatives, bystanders and police who are not trained on how to take care of patients during transportation. This observation is common to many other developing countries. The lack of advanced pre-hospital care and ineffective ambulance system for transportation of patients to hospitals are major challenges in providing care for trauma patients in developing countries (Chalya *et al*., 2010).

The commonest cause of motorcycle crash was collision with a vehicle 175 (45.6%) followed by collisions of motorcycle versus motorcycle (23.4%). Vehicles have been reported to contribute majority of motorcycle crashes mainly due to their inability to detect or recognize them in traffic (Solagberu *et al*., 2006). Similar findings have been reported elsewhere where up to 64.0% of motorcycle collisions were due to motorcycle and motor-vehicle collision (Naddumba, 2004).

The motorcycle-vehicle and motorcycle-pedestrian collisions occur commonly because the majority of the riders often ignore safety measures, making them more vulnerable to accidents with other motorized vehicles (Oluwadiya *et al*., 2004; Solagrebu *et al*., 2006). In addition, the absence of pedestrian walkways in most of the roads in Kenya has increased the vulnerability of pedestrians to accidents. These shows that probably co-operation, awareness and concern for others and good riding and driving habits, education, are essentials among all road users. According to NHTSA, (2008a), alcohol consumption among riders has been associated with high motorcycle fatalities. Motorcycle operators have the highest incidence of alcohol use among all motor vehicle drivers (Williams, 2006), and fatal motorcycle crashes are more likely to involve alcohol use than fatal automobile crashes (Peek-Asa *et al*., 1999).

The length of hospital stay has been reported to be an important measure of morbidity among trauma patients. Prolonged hospitalization is associated with an unacceptable burden on resources for health and undermines the productive capacity of the population through time lost during hospitalization and disability. Our figures for the overall mean length of stay (13.7 days) in the present study was lower than that reported by Chalya *et al*., (2010) in Tanzania which was 22.4 days.

Majority of the injured patients (84%) were discharged home after full recovery and 3.2% required long term care. The current study had a mortality rate of 5.1%, which is lower than that reported in Rwanda by Twagirayezu *et al*., (2008). Mortality was recorded in patients with severe head injuries and multiple injuries.

5.6. Limitations of the study

Patients with minor injuries who never sought treatment were never captured. Pre hospital deaths were also not captured. In some instances, it was impossible to corroborate independently the information provided by victims. This study was done in one hospital and data was collected over a period of 3 months. The findings may fail to reflect the true picture of motorcycle crashes, injury patterns and risk factors in Kenya.

5.7 Conclusions

- Majority of those involved in motorcycle crashes are the youth in the age group of 15 to 40 years.
- Head injuries and lower extremity injuries accounted for the major proportion of injuries sustained by commercial motorcycle users.
- Non helmet use among riders and passengers was associated with increased risk of sustaining head injuries in a motorcycle crash.

5.8 Recommendations

- Enforcement of helmet use among riders and passengers.
- Use of reflective clothing by riders and passengers of motorcycles.
- Use of head lumps throughout by the motorcycle rider.
- Carrying one passenger per motorbike, riders not to carry luggage and passenger at the same time.
- All commercial motorcyclists to be registered and numbered.
- Mandatory training for all commercial motorcycle riders.
- Provision of educational and training programs aimed at improving road user behavior.
- Further studies are needed to establish the role of drugs and substance abuse among motorcycle riders and road traffic crashes.

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APPENDICES

Appendix 1a: Consent Form-1(English Version)-+

Title of the study: Crash Characteristics and Injury Patterns among Commercial Motorcycle users attending Kitale County Referral Hospital, Kenya in 2013

PART A: Introduction

Motorcycle injuries constitute a major but neglected emerging public health problem in developing countries and contribute significantly to the overall Road Traffic Injuries. Motorcycle injuries are among the leading causes of disability and deaths and the main victims are the motorcyclists, passengers and pedestrians in their young reproductive age group. The problem is increasing at a fast rate in developing countries due to rapid motorization and other factors.

You/your child are therefore invited to participate in this study whose main objective is to establish the prevalence of motorcycle injuries in Kitale Municipality. I kindly request you to read this form and ask any questions you may have before agreeing to participate in the study.

This study is being conducted by Peter Sisimwo from the college of health sciences, Jomo Kenyatta University of Agriculture and Technology.

Purpose of the study

The main objective of this study is to determine the prevalence of motorcycle crash injuries among commercial motorcyclists' patients presenting in Kitale level IV County referral Hospital. The information gathered from this study will be used to advise policy and to modify intervention programmes which will go a long way in formulating injury control programmes.

Study procedures

If you agree to take part in this study you/ your child will be asked questions surrounding the crash injury and this will be entered in a questionnaire. Further information will be sought if u will be admitted for further treatment.

Risks of participation

There are no risks anticipated to cause pain or discomfort to you/ your child while participating in this study. Research assistants will be stationed in the examination rooms to assist in providing information to you.

Research benefit

There will be no direct benefit in participating in the study and there will be no risk too. The information gathered from this study will be used to advise policy, modify intervention programmes which will go a long way in formulating injury control programmes.

Study costs

If you accept to take part in the study, there will be no payment to you and for the study procedures.

Confidentiality

The information collected from you will be strictly private and confidential and will be kept under lock and key. Your names will not be used in any report of this study, or in any reports, publications or presentations. In case the officials from college of health sciences, Jomo Kenyatta University of Agriculture and Technology will review your records for the study, they will protect your privacy.

Participation information

Participation is voluntary and there are no risks at all. It is your decision to participate or not to participate in this study. If at any time you wish to withdraw from participating in the study, you can do so, and this will not affect any future participation or relations with anyone or any institution.

Contacts and questions

The researcher conducting this study is Peter Sisimwo. You may ask any questions you have now, or if you have any questions later, you are encouraged to contact him through mobile phone number: 0722 172818, or email. psisimwo@yahoo.com

If you have any questions or concerns regarding the study and would like to talk to someone other than the researcher (s), you are encouraged to contact the following:

The Principal,

College of Health Science,

Jomo Kenyatta University of Agriculture and Technology

P.O. Box 62000- 00200, Nairobi

Telephone no: 067- 52711

OR

The Chairman

KEMRI Ethical Review Committee,

P.O. BOX. 54840 00200, Nairobi

PHONE 2722541, 2713349, 0722 205901

Email: erc-secretariat@kemri.org

Part B: Participant consent form

Please read the information sheet (PART A) or have the information read to you carefully before completing and signing this consent form. If there are any questions you have which are not clear to you regarding this study, please feel free to ask the investigator prior to signing the consent form.

Participant Statement

I, Mr, Mrs, Miss…... Hereby give consent to Peter Sisimwo to include me in the proposed study entitled "Crash Characteristics and Injury Patterns among Commercial Motorcycle users attending Kitale County Referral Hospital, Kenya". I have read the information concerning this study, and I fully understand the aim of the study and what will be required of me if I accept to take part in the study. The risks and benefits have been explained to me. Any questions I have concerning the study have been adequately answered and I am satisfied.

I understand that I can withdraw from this study anytime if I wish so without giving any reason and this will not affect my access to normal health care and management.

I understand that I will be interviewed from the implementation of this study to the end. I therefore consent voluntarily to participate in this study.

Name of Participant or respondent...

Relation to the child (subject)..

Signature .... Or

Thumb print

Date…..
....

Name of the person taking
consent………………………………………………………………………

Signature…..
Date………………………………………………..

Name of the
investigator………………………………………………………………………………
….

Signature…..Date…………………………........................
....

Appendix 1b: CONSENT-1 (SWAHILI VERSION)

IDHINI YA KUSHIRIKI

Anwani ya utafiti: Ajali na mwelekeo wa majeraha kati ya majeruhi wanaolazwa hospitalini miongoni mwa pikipiki za kibiashara katika Kitale Kenya 2013.

SEHEMU A: Utangulizi

Majeraha ya pikipiki ni miongoni mwa sababu kuu ya kujitokeza kwa tatizo la afya kwa umma lakini umesahaulika katika nchi zinazoendelea na kuchangia kwa kiasi kikubwa kwa ujumla wa majeruhi barabarani. Majeraha ya pikipiki ni miongoni mwa sababu ya kuongoza kwa ulemavu na vifo. Waathirika kuu ni wanao endesha pikipiki, wanao abiri pikipiki na wanaotembea kwa miguu katika kundi la vijana walio katika umri wao mdogo wa uzazi. Tatizo hili linaongezeka kwa kiwango cha haraka katika nchi zinazoendelea kutokana na magari kuongezeka kwa haraka na mambo mengine.

Kwa hivyo unalikwa kushiriki katika utafiti huu ambao lengo kuu ni kubaini maambukizi ya majeruhi ya pikipiki katika manispaa ya kitale. Ninakuomba usome fomu hii na kuuliza maswali yoyote unaweza kuwa nayo kabla ya kukubali kushiriki katika utafiti.

Utafiti huu unafanyika na Peter Sisimwo kutoka taasisi ya tiba na magonjwa ya kuambukiza cha chuo kikuu cha Jomo Kenyatta, kilimo na technologia.

Lengo la utafiti

Lengo kuu la utafiti huu ni kuamua kiwango cha maambukizi ya majeraha ya ajali ya pikipiki kati ya pikipiki ya kibiashara inayowasilisha katika hospitali kuu ya kitale. Taarifa zitakazokusanywa kutoka kwa utafiti huu utatumika kushauri sera na kurekebisha mipango ambayo kwa muda mrefu utandaa mipango ya kudhibiti kuumia.

Hatua ya utafiti

Ukikubali kushiriki katika utafiti huu utaulizwa maswali inayousika na kutokea kwa ajali yenyewe. Habari itakayo kusanywa itaiingizwa kwenye dodoso. Habari zaidi itakusanywa ikiwa utalazwa kwa matibabu zaidi.

Hatari ya kushiriki kwa utafiti

Hakuna hatari inayotarajiwa kusababisha maumivu au usumbufu wakati unashiriki katika utafiti huu. Wasaidizi wa utafiti watakuwepo ili kusaidia kutoa usaidizi kwako unaposhiriki.

Manufaa ya uchunguzi

Hakutakuwa na manufaa ya moja kwa moja kwa kushiriki katika utafiti na pia hakuna hatari yoyote. Taarifa zilizokusanywa kutoka kwa utafiti huu utatumika kushauri sera, kurekebisha mipango ambayo kwa muda mrefu itaanda mipango ya kudhibiti kuumia.

Gharama ya utafiti

Ukikubali kushiriki katika utafiti huu, hutapokea malipo yoyote hata kwa hatua yoyote ya utafiti huu.

Kubanwa kwa utafiti

Taarifa zitakazokusanywa kutoka kwako zitawekwa kwa siri kubwa na kuhifadhiwa kwa kufuli na ufunguo. Majina yako hayatatumiwa kwenye ripoti ya utafiti huu, ama kwenye makala yo yote au maonyesho. Ikiwa maafisa kutoka Idara ya Utafiti wa Madawa na Magonjwa ya Kuambukizana au wale kutoka Chuo Kikuu cha Kilimo na Teknolojia cha Jomo Kenyatta watatumia majibu yako, watahifadhi siri yako.

Taarifa ya kushiriki

Kushiriki katika utafiti huu ni wa hiari na hakuna madhara yo yote. Ni uamuzi wako kushiriki au kutoshiriki katika utafiti huu. Endapo unahisi kujiondoa wakati wo wote katika kushiriki kwenye utafiti huu, una uhuru kufanya hivyo na hiyo haitaathiri kushiriki kwako nyakati zijazo au uhusiano wako na mtu ye yote au idara yo yote.

Mawasiliano na maswali

Mtafiti anayetekeleza utafiti huu ni Peter Sisimwo. Unaweza kuuliza maswali yo yote uliyonayo sasa ama ikiwa utakuwa nayo baadaye, unahimizwa kuwasiliana naye kupitia nambari ya simu ya mkono: 0722 172818, au barua pepe. psisimwo@yahoo.com

Ikiwa una maswali yo yote kuhusu utafiti huu na ungependa kuongea na mtu mwengine asipokuwa mtafiti, unahimizwa uwasiliane na wafuatao:

Mkurugenzi,

Idara ya Utafiti ya Madawa na Magonjwa ya Kuambukiza

Chuo Kikuu cha Kilimo na Teknolojia cha Jomo Kenyatta,

S.L.P 62000 00200, Nairobi

Nambari ya simu: 067-52711

AU

Mwenyekiti

KEMRI Ethical Review Committee,

S.L.P. 54840 00200, Nairobi

Nambari ya simu 2722541, 2713349, 0722 205901

Barua pepe: erc-secretariat@kemri.org

Sehemu B: Fomu ya mshiriki ya idhini

Tafadhali soma taarifa kwenye sehemu A ama hakikisha kwamba umesomewa na kuelewa kabla ya kutia sahihi fomu hii. Tafadhali uwe huru kuuliza maswali yo yoye kwa mtafiti yasiyoeleweka kuhusiana na utafiti huu, kabla ya kutia shahihi kwenye fomu.

Maelezo ya mshiriki

Mimi Bw/Bi/Binti ………………………………………………….. natoa idhini kwa Peter Sisimwo anijumulishe kwa utafiti ujulikanao kama "Majeruhi yanayohusiana na pikipiki miongoni mwa pikipiki za kibiashara katika manispaa ya Kitale, Kenya." Nimesoma habari zote kuhusu utafiti huu, nimeelewa lengo la utafiti huu na yanayohitajika kwangu kama nitashiriki katika utafiti huu. Hatari na manufaa ya utafiti huu yameelezwa kinagaubaga kwangu. Maswali yote niliyokuwa nayo yamejibiwa vilivyo na nimeridhika.

Ninaelewa kwamba ninaweza kujiondoa kushiriki kwenye utafiti huu wakati wowote na sitakuwa na budi la kutoa sababu yo yote au haitanizuia kupata huduma ya kawaida ya matibabu.

Ninaelewa ya kwamba nitahojiwa kutoka mwanzo wa utekeleshwaji wa utafiti huu mpaka ukingoni mwake. Kwa hivyo, ninatoa idhini kwa hiari nishiriki katika utafiti huu.

(Jina la mhojiwa)…………………………………………………………………………………
…

Uhusiano kwa mtoto mshiriki……………………………………………………………………

Sahihi……………………………………………*Tarehe*..
....

Jina la anayetoa idhini………………………………………………………………………

Sahihi…..
Tarehe…………………………………………………

Jina la mtafiti…………………………………………………………………………………

Sahihi…... /
Tarehe……………………….....................................

Appendix 2: Questionnaire

Crash Characteristics and Injury Patterns among Commercial Motorcycle users attending Kitale County Referral Hospital, Kenya 2013.

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___________

2. 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 ___________

3. 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 (---)

4. Type / Category of road user

(1). motorcycle rider (---)

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

(3). pedestrian (---)

5. 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 (---)

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

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

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

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

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

7. How frequently do you ride a motorcycle?

(1). every day (---)

(2). Weekend only (---)

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

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

8. Are you legally entitled to ride a motorcycle?

(1). Yes (---)

(2). No (---)

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

(1). Yes (---)

(2). No (---)

10. Is your motorcycle insured to carry passengers?

(1). Yes (---)

(2). No (---)

11. If passenger reason for boarding a motorcycle

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

(2). Personal errands (---)

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

(4). Other (---)

12. What type of roadway do you commonly travel by motorcycle?

(1). City / town roads (---)

(2). Rural road (---)

(3). Other (---)

13. Pre hospital care given after the crash

(1). Yes (---)

(2). No (---)

14. Pre hospital transportation

(1). Police (---)

(2). Relative (---)

(3). Bystanders (---)

15. Helmet use

(1). Yes (---)

(2). No (---)

16. If Yes type of helmet worn

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

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

(3). Open face (---)

(4). Other (---)

17. If No reasons for not wearing helmets

(1). Not worried about crashes (---)

(2). Freedom of choice (---)

(3). Not available (---)

(4). Creates problem with my vision/ hearing (---)

(5). don’t believe helmets make me safer (---)

(6). Other (---)

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

(1). Always (--)

(2). Sometimes (---)

(3). Seldom (---)

(4). Never (---)

19. 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 (---)

20. Abbreviated Injury score (AIS)

(1). Minor (---)

(2). Moderate (---)

(3). Serious (---)

(4). Severe (---)

(5). Critical (---)

(6). Fatal (---)

21. 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 (---)

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

(1). No (---)

(2). Yes (---)

(3). High beam (---)

(4). Low beam (---)

23. Weather conditions at the time of the crash

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

(2). Light rain (---)

(3). Heavy rain (---)

(4). Fog (---)

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

24. 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 (---)

25. Road condition at the time of crash

(1). Wet (---)

(2). Dry (---)

(3). Other (---)

26. Type of treatment received

(1). Outpatient (---)

(2). Inpatient (---)

27. Patient waiting time

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

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

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

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

28. If outpatient type of treatment /service received

(1). Physician services (---)

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

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

(4). Prescription drugs (---)

(5). Radiological investigations (---)

(6). Laboratory tests (---)

29. If inpatient type of treatment /service received

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

(2). Major surgery (---)

(3). Radiological investigations (---)

(4). Physician services (---)

(5). Laboratory services (---)

30. Anatomical /Site of injury

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

(2). Chest (---)

(3). Abdomen (---)

(4). Pelvis (---)

(5). Spine (---)

(6). Upper extremity (---)

(7). Lower extremity (---)

31. Type of surgical procedures performed

(1). Craniotomy (---)

(2). Wound debridement (---)

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

(4). ORIF/EF (---)

(5). Exploratory laparotomy (---)

(6). UWSD (---)

34. Length of hospital stay

(1). (--------)

35. Discharge status /patient disposition

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

(2). Rehabilitation (---)

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

(1). Referred (---)

(2). Died (---)

36. Mode of payment

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

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

(3). Other (---)

End thank you

Appendix 3: Scientific Steering Committee Approval

KENYA MEDICAL RESEARCH INSTITUTE

P.O. Box 54840-00200, NAIROBI, Kenya
Tel (254) (020) 2722541, 2713349, 0722-205901, 0733-400003; Fax: (254) (020) 2720030
E-mail: director@kemri.org info@kemri.org Website: www.kemri.org

ESACIPAC/SSC/101412 6th February, 2013

Peter Sisimwo

Thro'
Director, CPHR
NAIROBI

REF: SSC No. 2528 (Revised) – Crash characteristics and injury patterns among commercial motorcyclists patients attending Kitale Level IV District Hospital, Kenya

I am pleased to inform you that the above mentioned proposal, in which you are the PI, was discussed by the KEMRI Scientific Steering Committee (SSC), during its **199th** meeting held on **5th February, 2013** and has since been approved for implementation by the SSC.

Kindly submit 4 copies of the revised protocol to SSC within 2 weeks from the date of this letter i.e. 20th February, 2013 for onward transmission to the ERC office.

We advise that work on this project can only start when ERC approval is received.

Sammy Njenga, PhD
SECRETARY, SSC

In Search of Better Health

Appendix 4: KEMRI Ethical Approval

KENYA MEDICAL RESEARCH INSTITUTE

P.O. Box 54840-00200, NAIROBI, Kenya
Tel (254) (020) 2722541, 2713349, 0722-205901, 0733-400003; Fax: (254) (020) 2720030
E-mail: director@kemri.org info@kemri.org Website:www.kemri.org

KEMRI/RES/7/3/1 **June 18, 2013**

TO: **PETER SISIMWO,**
PRINCIPAL INVESTIGATOR

THROUGH: **DR. YERI KOMBE,**
THE DIRECTOR, CPHR,
NAIROBI

Forwarded
21/06/2013

Dear Sir,

RE: SSC PROTOCOL 2528 (*RESUBMISSION*): CRASH CHARACTERISTICS AND INJURY PATTERNS AMONG HOSPITALIZED COMMERCIAL MOTORCYCLE PATIENTS ATTENDING KITALE LEVEL IV DISTRICT HOSPITAL, KENYA

Reference is made to your letter dated 12th June, 2013. The ERC Secretariat acknowledges receipt of the revised proposal on 13th June 2013.

This is to inform you that the Committee determines that the issues raised are adequately addressed. Consequently, the study is granted approval for implementation effective this **18th day of June 2013.** Please note that authorization to conduct this study will automatically expire on **June 17, 2014**.

If you plan to continue with data collection or analysis beyond this date, please submit an application for continuing approval to the ERC Secretariat by **May 6, 2014**.

You are required to submit any proposed changes to this study to the SSC and ERC for review and the changes should not be initiated until written approval from the ERC is received. Please note that any unanticipated problems resulting from the conduct of this study should be brought to the attention of the ERC and you should advise the ERC when the study is completed or discontinued.

Work on this project may begin.

Appendix 5: Glasgow Coma Scale

Assessed Response	Score
Best eye response	
Spontaneously	4
To verbal stimulation or to touch	3
To pain	2
No response	1
Best verbal response	
Smiles, oriented to sounds, follows objects, interacts	5
Cries but is consolable, inappropriate interactions	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 spontaneous or to painful stimuli	2
Flaccid	1

Medscape

Appendix 6: Abbreviated Injury Scale

Injury	AIS Score
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurvivable

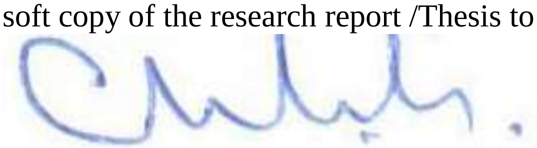
Appendix 7: Research Authorization from Kitale County Referral Hospital

Tel: 054-31551, Fax: 31551 Kitale County Referral Hospital
Email: kdhkitale@yahoo.co.uk Po Box 98-30200
Our Ref: medsup/rsc: 10/5/13-Kitale

Sisimwo Kiteywo Peter
Jomo Kenyatta University of Agriculture and Technology
School of public health
Po Box 62000-00200
Nairobi
October 8, 2013

Dear Sir,

RE: APPLICATION FOR RESEARCH AUTHORIZATION
This is in reference to your application for authority to carry our research on ‘‘Crash Characteristics and Injury Patterns among Commercial Motorcycle users attending Kitale County Referral Hospital’’
I am pleased to inform you that your request to undertake the research in the hospital has been granted
And on completion of the research you are requested to submit one hard copy and one soft copy of the research report /Thesis to this office



Hospital Research Committee
Kitale County Referral Hospital
08 OCT 2013