CHARACTERISTICS OF ROAD TRAFFIC INJURIES TO PEDESTRIANS IN NAIROBI, KENYA: IMPLICATIONS FOR URBAN SAFETY PLANNING

BY

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ABSTRACT

Every day around the world, almost 16 000 people die from all types of injuries. The category of injuries worldwide is dominated by those incurred in road crashes which account for around 25% of all deaths from injury. Pedestrians comprise 22% of all deaths that occur annually as a result of all traffic crashes worldwide. The incidences of pedestrian injuries and deaths are increasing fast on urban roads in sub-Saharan Africa. Nairobi experiences a high proportion of road traffic crashes and injuries relative to its size and population. A great proportion of those injured and killed are pedestrians. Though the levels of walking in Nairobi is high and studies have consistently shown that pedestrians are overrepresented in traffic fatalities in Nairobi, there is a general lack of published work characterizing road traffic crashes involving pedestrians and providing details on the nature of the pedestrian injuries and intervention strategies. Using a prospective study design, a cross-sectional study design and document search, this study described the characteristics of pedestrians injured in road traffic crashes that occurred in Nairobi over a period of 3 months, from 1st June to 31st August 2011 and examined policy response to pedestrian safety in Nairobi. Descriptive statistics were generated for demographic characteristics, category of road user, vehicle involved, day the crash occurred, duration of hospitalization and nature of injury. Analysis was based on frequency tabulation and group comparisons using Analysis of Variance with a p value ≤ 0.05 considered significant. A total of 176 road traffic injury patients were admitted to KNH. During the same period 107 road traffic injury cases were reported to traffic police in Nairobi. Pedestrians comprised 59.1% of all categories of injured road users admitted to KNH, 61% of total hospital bed-days, and 69.2% of the total road traffic injury cases reported to traffic police in Nairobi. The number of admitted males was significantly higher in all the age groups combined ($p=0.00496$). Young adults aged 15-44 years constituted 75% of the total road traffic injury hospital admissions, and 85.45% of the total pedestrians admitted in KNH. The mean LOS of pedestrians was not significantly different ($p=0.8339$) from that of all other road users combined. The highest proportion of pedestrian crashes occurred on Saturdays [26(25.5%)]. Cars were the leading category of motorized four-wheeler vehicles that injured pedestrians admitted to KNH (37.6%) and those reported to traffic police (44.3%). The highest number of pedestrian injuries was reported in: Thika Highway, (15.4%). Most pedestrians were hit while crossing the road (70.3%), about 85% at sites which had no traffic signs and 51% at sites which had no traffic light at the crash site. Although the Integrated National Transport and the Nairobi Metro 2030 policy documents highlight the need to improve safety of pedestrians, only 0.1% of the budget was earmarked for improvement of non-motorized transport in the city and only 0.001% of its budget for mobility and accessibility in 2008 was budgeted for road safety. Other strategies used in improvement of safety of pedestrians in Nairobi are: traffic law enforcement; road traffic engineering; pedestrian safety education, and non-governmental organizations. There is need for design and development of infrastructure that takes into account the safety of pedestrians. Urban planners and the safety system planners in the city of Nairobi should make it a high priority to cater for the safety needs of pedestrians and their physical vulnerability.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Every day around the world, almost 16 000 people die from all types of injuries (Peden *et al.*, 2004). The category of injuries worldwide is dominated by those incurred in road crashes which account for around 25% of all deaths from injury (Peden *et al.*, 2002). In 2010, pedestrians were shown to represent around 22% of all global road traffic deaths (World Health Organization, 2013a). Globally, the predominant category of road casualties up to 2020 will continue to be vulnerable road users. The proportion of pedestrians killed in relation to other road users is highest in the African Region (38%) (World Health Organization, 2013). This category tend to account for a much greater proportion of road traffic injury deaths in low- and middle-income countries than in high-income countries, with the exception of the Eastern Mediterranean and Western Pacific Regions (Peden *et al.*, 2004).

In the sub-Saharan Africa, the incidences of motor vehicle crashes involving pedestrians are increasing fast on the urban roads (Pendakur, 2005). Pedestrians, for example, are overrepresented in Addis Ababa, Ethiopia where they were shown to represent 85% of traffic casualties compared to only 40% nation-wide (Dessie and Larson, 1991). In Kampala, Uganda, pedestrians were the most frequent traffic casualties (43.5%) (Andrews *et al.*, 2000), and the leading category of road users (45.8%) presenting with serious traffic injuries as assessed using the Kampala Trauma Score (Kobusingye and Lett, 2000).

n Kenya, a great proportion (40%) of all injury producing crashes occurs in urban areas National Road Safety Council, 1992). Over 30% of the 96,927 road traffic crashes reported in Kenya during the period 1986-1994 occurred in Nairobi (Khayesi, 1999). Pedestrians have been shown to constitute the highest proportion of road traffic fatalities in Nairobi (Odero *et al.*, 2003; Gichuhi, 2007; Ogendi *et al.*, 2011).

The Kenya Government's strategy on Integrated National Transport Policy has recommended incorporation of non-motorized transport into urban road network (Republic of Kenya, 2004) but safety of pedestrians remains an important concern. Road transport safety issues are the major impediments to choosing walking as a means of transport (Mohan, 1992; Dora and Phillips, 2000). It has been recommended (Khayesi *et al.*, 2010) that the existing levels of walking in Nairobi should be much more effectively catered for. Several policy documents like the National Road Safety Action Plan, 2005-2010 (Ministry of Transport, 2005), the Integrated National Transport Policy document (Republic of Kenya, 2004), and a pilot program that implemented NMT infrastructure improvements in Nairobi during 1995 to 1999 (Pendakur, 2005) have also underlined the need to improve the safety of pedestrians, but studies (Assum, 1998; Said, 2000; Khayesi, 2003; Gichuhi, 2007; Ogendi *et al.*, 2011) consistently demonstrate that pedestrians are overrepresented in traffic injuries and fatalities in Nairobi City. Published research work, providing details on the characteristics of road traffic crashes causing injuries to pedestrians in Nairobi City, characteristics of injured pedestrians and hospital burden in terms of the hospital bed days, and the strategies that are being employed to improve the safety of pedestrians is sparse compared to the proportion of pedestrians injured or killed in traffic fatalities in Nairobi.

The purpose of this study was to examine the characteristics of road traffic injuries that occurred in Nairobi with particular emphasis on pedestrians, and examine the intervention strategies aimed at improving the safety of pedestrians in the city. Understanding and describing the characteristics of pedestrians injured road traffic crashes that occurred in Nairobi city and the strategies that are being employed to improve the safety of these categories is critical as it can inform development of context specific intervention programmes tailored to the needs of this category of road users in the city of Nairobi, and similar urban set-ups in developing nations and inform policy in safety strategies.

Previous hospital-based epidemiological studies that examined the characteristics of road traffic injuries in the city of Nairobi were undertaken in the Emergency Departments of Kenyatta National Hospital (Said, 2000; Gichuhi, 2007) and Nairobi Hospital (Said and Kahoro, 2001). Whereas both studies provided useful information, they were limited by the kind of information that could be collected since both studies were retrospective in design and abstracted information from ED records without interviewing the road trauma casualties or their caretakers. Both studies did not limit the analysis to the cases that occurred in Nairobi only and could have included road traffic injury patients referred from outside Nairobi. Moreover, one of the studies, by Said and Kahoro (2001) was limited by its setting in Nairobi hospital, a private health facility that predominantly caters for the higher social class. The findings based on this setting are unlikely to present true relative proportions of different categories of road users in Nairobi.

Nairobi city was chosen for this study for two main reasons: first, the city experiences a high proportion of road traffic crashes and injuries and deaths relative to its size and population. Of the 96,927 road traffic crashes reported in the country during the period 1986-1994, for example, over 30% occurred in Nairobi (Khayesi, 1999). Nairobi city constitutes only 0.1 percent (696

square kilometers) of the country's overall size (581,679 square kilometers) and only 8% of the proportion of the national ppulation (Kenya National Bureau of Statistics, 2010). Second, both the Kenya Government Integrated National Transport Policy (Republic of Kenya, 2004) and the Ministry of Nairobi Metropolitan Development (Ministry of Nairobi Metropolitan Development, 2008) recommend promotion of the use of non-motorized transport and public transport as preferred modes of urban transport. Promotion of use of walking as a means of transport means that the safety of those who walk must be given proper consideration because road safety fear is a disincentive to walking (Sonkin *et al.*, 2006). Kenyatta National Hospital was chosen for this study because it is the largest public hospital in the city, is centrally located, and receives trauma patients through the hospital's active Accident and Emergency Department on a 24-h basis. It also serves as a general hospital for more than 3.0 million inhabitants in Nairobi and its neighboring areas.

1. 2 Statement of the Problem

The existing levels of walking in Nairobi are high, estimated at about 50% of the modal share of urban transport (Kenya Institute for Public Policy Research and Analysis, 2006) but road transport safety of pedestrians remains a critical concern (Khayesi *et al.*, 2010). Although several policy documents (Republic of Kenya, 2004; Ministry of Transport, 2005; Ministry of Nairobi Metropolitan Development, 2008) and consultants from foreign funded implementation of a pilot program of NMT infrastructure improvements in Nairobi (Pendakur, 2005) have highlighted the need to improve the safety of pedestrians in Nairobi, and although studies consistently demonstrate the large number of pedestrians in traffic casualties in Nairobi City (Assum, 1998; Said, 2000; Khayesi, 2003; Gichuhi, 2007; Ogendi *et al.*, 2011), there is a general lack of published research work providing details on the characteristics of road traffic crashes causing

injuries to pedestrians in Nairobi City, characteristics of injured pedestrians and their hospital burden in terms of mean length of hospital stay and bed occupancy of pedestrians, the circumstances of crashes involving pedestrians, motor vehicles involved , day of week, hour of day pedestrians were injured and the strategies that are being employed to improve the safety of pedestrians.

Studies which have described characteristics road traffic injury patients admitted to hospitals in Nairobi were limited in Nairobi were retrospective (Said, 2000) and undertaken in the Emergency Departments of Kenyatta National Hospital (Gichuhi, 2007) and Nairobi Hospital (Said and Kahoro, 2001). Whereas both studies provided useful information, they were limited by the kind of information that could be collected since all the studies were retrospective in design and abstracted information from records without interviewing the road trauma casualties or their caretakers. Both studies neither limited the analysis to the cases that occurred in Nairobi only and could have included referrals from outside Nairobi nor focused on injured pedestrians. Moreover, one of the study, by Said and Kahoro (Said and Kahoro, 2001), was limited by its setting in Nairobi hospital, a private health facility that predominantly caters for the higher social class. The findings based on this setting are unlikely to present true relative proportions of different categories of road users in Nairobi.

This study uses both information obtained from consecutive road traffic injury patients that were admitted to a major hospital Nairobi, and road traffic injury cases reported to traffic police in Nairobi, to characterize road traffic injuries in Nairobi with reference to pedestrians, and also analysed the strategies that are being employed to improve the safety of pedestrians.

1.3 Significance of the Study

Understanding and describing the characteristics of pedestrians injured road traffic crashes that occurred in Nairobi city and the policy strategies that are being employed to improve the road traffic safety of these categories is important for several reasons. First, scholarly literature focusing on these categories of road users in the city of Nairobi is scarce. Previous hospital-based epidemiological studies in Nairobi did not focus on pedestrians (Said, 2000; Gichuhi, 2007); this means that there is limited data on characteristics of injured pedestrians in the city of Nairobi. Second, understanding the characteristics of traffic crashes involving pedestrians in the city of Nairobi can inform development of context specific intervention programmes tailored to the needs of these categories of road users in the city of Nairobi, and similar urban set-ups in developing nations. Third, the global effort to reduce the emerging public health consequences of inactive lifestyle means that the safety of those who use active modes of transportation, like walking, should be a priority if walking as a mode of transport is to be promoted.

1.4 Main Objectives

The main objective of this research was to examine the characteristics road traffic crashes and injuries to pedestrians in Nairobi city, Kenya and to analyze the policy strategies that are employed in improving the safety of this category of road users in the city.

1.4.1 Specific Objectives.

1. To determine the characteristics of road traffic injury cases that occurred in Nairobi and admitted to Kenyatta National Hospital, Nairobi, Kenya between 1June and 31 August 2011;

2. To determine characteristics of pedestrian injury admissions to Kenyatta National Hospital, Nairobi, Kenya;

3. To characterise road traffic crashes and injuries involving pedestrians reported to traffic police in Nairobi, Kenya;

4. To analyze the strategies that are being employed to improve the safety of pedestrians in Nairobi, Kenya.

1.5 Scope

The study was limited to obtaining the characteristics of road trauma patients admitted to Kenyatta National Hospital (KNH), Nairobi and road traffic injuries reported to traffic police in Nairobi city during the period between 1st August 2010 and 31st October 2011. The study was also limited to examining the policy documents on safety of pedestrians only.

1.6 Limitations

The research used a prospective cross sectional study designs where information regarding the circumstances of the crash were documented as reported by hospital admitted road traffic casualties but were not independently verified. Information based on self-reports should be treated with caution. Logistic and resource factors dictated that data be collected from only one major hospital in Nairobi. In the same way the circumstances of crash as reported by traffic police are based on information recorded by the police. However these limitations do not compromise the quality of the results obtained.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on the magnitude of the problem of road traffic crashes; global and regional trends; distribution of road traffic deaths by road user category; trends in road traffic injuries; demographic profile; distribution of road traffic injuries and fatalities by road user type; pedestrian injuries and safety of pedestrians. Gaps in knowledge are highlighted in sections.

2.2 Characteristics of Road traffic injuries

2.2.1 Magnitude of Road Traffic Injuries

2.2.2 Global Estimates

Approximately 1.24 million deaths occur annually as a result of road traffic crashes worldwide (World Health Organization, 2013a). This represents an average of 3,242 persons being killed each day around the world from road traffic crashes (Peden *et al.*, 2004). In addition to these deaths, globally between 20 and 50 million people are estimated to be injured or disabled each year (Murray and Lopez, 1996; Jacobs *et al.*, 2000). In 2002, road traffic injuries were the ninth leading cause of disability-adjusted life years (DALYs) lost, accounting for over 38 million DALYs lost, or 2.6% of the global burden of disease (World Health Organization, 2002). Road traffic injuries accounted for 2.1% of all global deaths, was ranked as the 11th leading cause of death and accounted for 23% of all injury deaths worldwide in 2002 (World Health Organization, 2002). Over 90% of the world's road traffic fatalities occur in low-income and middle-income countries, which have only 48% of the world's registered vehicles (World Health

Organization, 2009). Low-income and middle-income countries account for 91.8% of the DALYs lost to road traffic injuries worldwide (Peden *et al.*, 2004). Almost half of those who die in road traffic crashes are pedestrians, cyclists or users of motorized two-wheelers – collectively known as "vulnerable road users" (World Health Organization, 2009).

A review of studies in low-income and middle-income countries (Odero *et al.*, 1997) revealed that road traffic-related injury accounted for between 30% and 86% of traffic injury hospital admissions in these countries. Overall hospital mean length of stay in eleven of the 15 studies examined in the study showed that the overall mean length of stay was 20 days. The review further established that road traffic injury patients represented 48% of bed occupancy in surgical wards in some countries and were the most frequent users of operating theatres and intensive care units in the study (Odero *et al.*, 1997). Although this study which reviewed studies in low-income and middle-income countries revealed that overall hospital mean length of stay in the eleven of the 15 studies examined was 20 days, it did not specifically delineate the hospital mean length of stay of pedestrians. There is need to fill this gap in Nairobi, because a high proportion (45%) of road traffic casualties in low-income countries, compared with 18 per cent in high-income countries are pedestrians (Naci *et al.,* 2009). Most countries in the African Region fall within the low-income level and Nairobi, the capital city of Kenya (with the GNIs of US$680), falls within low-income country (World Health Organization, 2009). The review further established that road traffic injury patients represented 48% of bed occupancy in surgical wards in some countries but did not specifically show the proportion of bed occupancy by pedestrians.

2.2.3 Regional distribution of road traffic fatalities

WHO Member States are grouped into six regions: the African Region, the Region of the Americas, the South-East Asia Region, the European Region, the Eastern Mediterranean Region and the Western Pacific Region (Peden *et al.*, 2004). Countries within the six WHO regions are further divided by income level according to 2007 estimates of gross national income (GNI) per capita as compiled by the World Bank (The World Bank, 2007). On the basis of the gross national income per capita, economies are classified as low income (US$ 945 or less), middle income (US$ 946 to US$11 455) or high income (US$ 11 456 or more) (The World Bank, 2007). Most countries in the African Region fall within the low-income level (World Health Organization, 2009). The United Republic of Tanzania and Kenya with the GNIs of US$400 and US$680 respectively are categorized as low-income countries while South Africa, with a GNI of 5,760 US$, is categorized as middle-income country (World Health Organization, 2009).

The overall global road traffic fatality rate is 18 per 100 000 population (World Health Organization, 2013a). Middle-income countries have the highest annual road traffic fatality rates, at 20.1 per 100 000, while high-income countries have the lowest, at 8.7 per 100 000 (World Health Organization, 2013a) (Figure 2.1). Low-income countries have rates nearly three times higher than high-income countries (18.6 per 100 000 population for low-income countries compared to 8.7 per 100 000 for high-income countries).

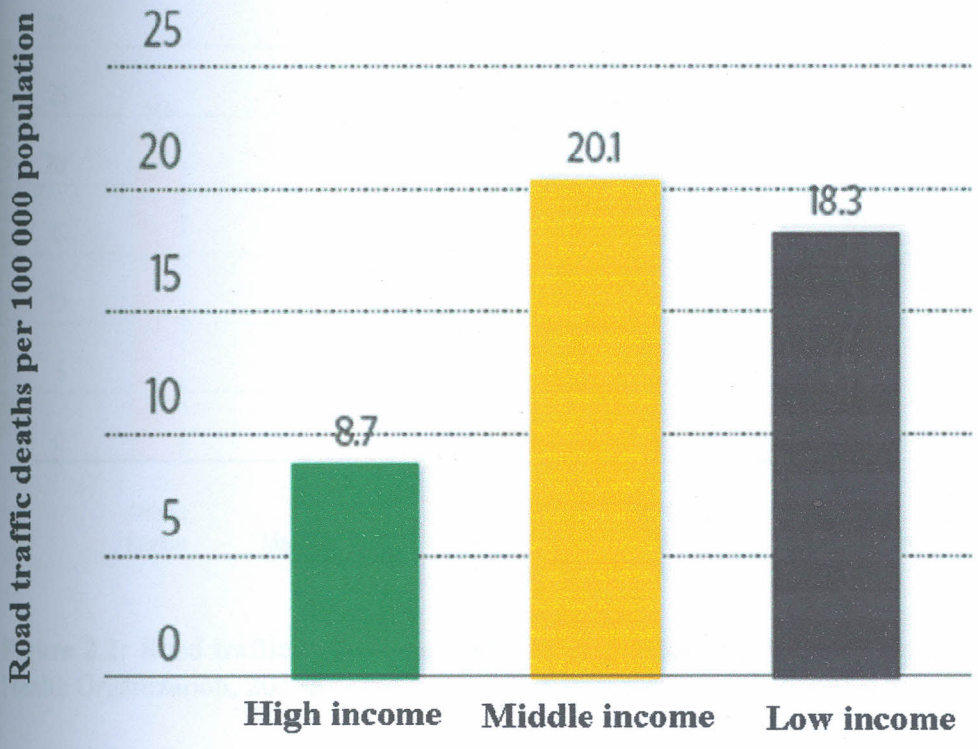

Figure 2.1 Road traffic death rates per 100 000 population, by country income status. Source: (World Health Organization, 2013a)

Figure 2.2 depicts the road traffic fatality rates by WHO regions. The African Region has the highest road traffic injury rate (24.1 per 100 000 population), followed by the Eastern Mediterranean region (21.3 per 100 000 population). The European Region has the lowest rate (10.3 per 100 000) (World Health Organization, 2013a). However, there are considerable within-region variations in road traffic death rates between income levels. The low-income countries in the European Region road traffic fatality rates are nearly three times higher than high-income countries (World Health Organization, 2013a).

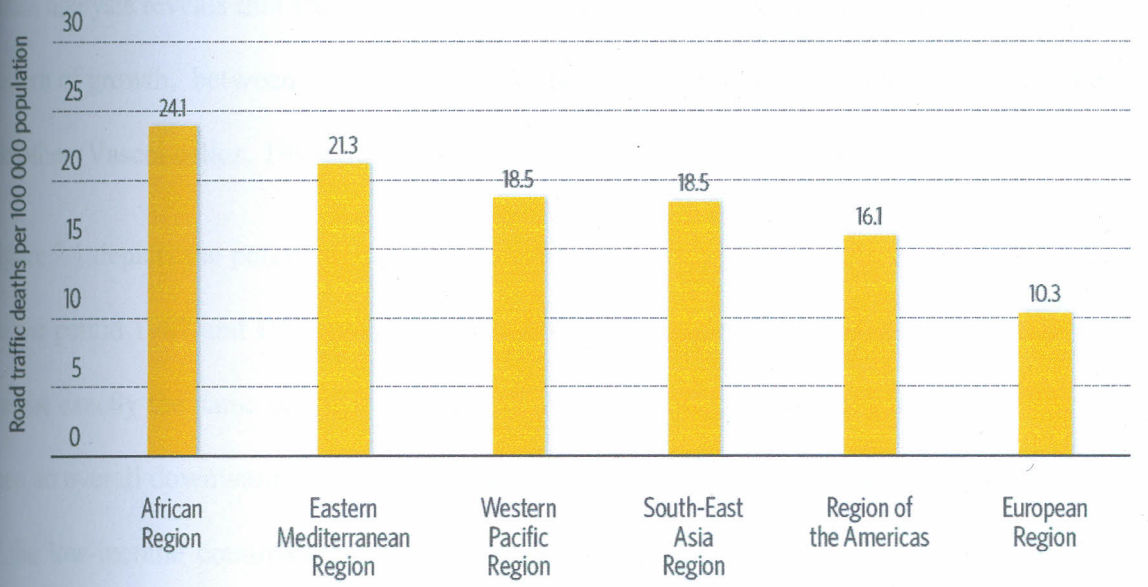

Figure 2.2: Road traffic deaths per 100 000 population, by WHO region. *Source*: World Health Organization, 2013a.

2.3 Trends in road traffic injuries

2.3.1 Global and regional trends

During the period between 1968 and 1990, the number of road traffic crash casualties in 14 high-income countries fell, on the average, by 30 per cent, while in 6 Asian and Middle Eastern countries and 12 African countries (for which reasonably accurate data were available), there were increases of about 200 and 340 per cent respectively (Wootton and Jacobs, 1995). Road traffic deaths rose by 10 per cent, from approximately 999 000 in 1990 (Murray and Lopez, 1996) to just over 1.1 million in 2002 (World Health Organization, 2002). In 2010, there were 1.24 million road deaths worldwide, similar to the number of road deaths in 2007 (World Health Organization, 2013a).

Although the number of road traffic injuries has continued to rise in the world as a whole, time series analysis reveals that road traffic fatalities and mortality rates show clear differences in the pattern of growth, between high-income countries on the one hand, and low-income countries on the other (Vasconcellos, 1999; Jacobs *et al.*, 2000; Bener *et al.*, 2003).

Figure 2.1 depicts the percentage change in road traffic fatalities in different regions of the world for the period 1987 and 1996 (Jacobs *et al.*, 2000). The regional classifications used in this study are not exactly the same as those defined by WHO, but it is clear from the figure that there has been an overall downward trend in road traffic deaths in high-income countries, whereas in many of the low-income countries and middle-income countries there has been an increase since the late 1980s (Jacobs *et al.*, 2000). Pedestrian and bicyclist fatalities have decreased more rapidly than have fatalities among vehicle occupants (Peden *et al.*, 2004). Between 1970 and 1999, for example, the proportion of pedestrian and bicyclist fatalities fell from 37% to 25% of all traffic fatalities, when averaged across 28 countries that report their data to International Road Traffic Database (IRTAD) (International Road Traffic Database, 2003). These reductions could, however, be due, at least in part, to a decrease in exposure rather than an improvement in safety (Roberts, 1993).

Although much has been documented regarding traffic fatalities,not much has been done on road traffic injuries, especially in Nairobi, Kenya,

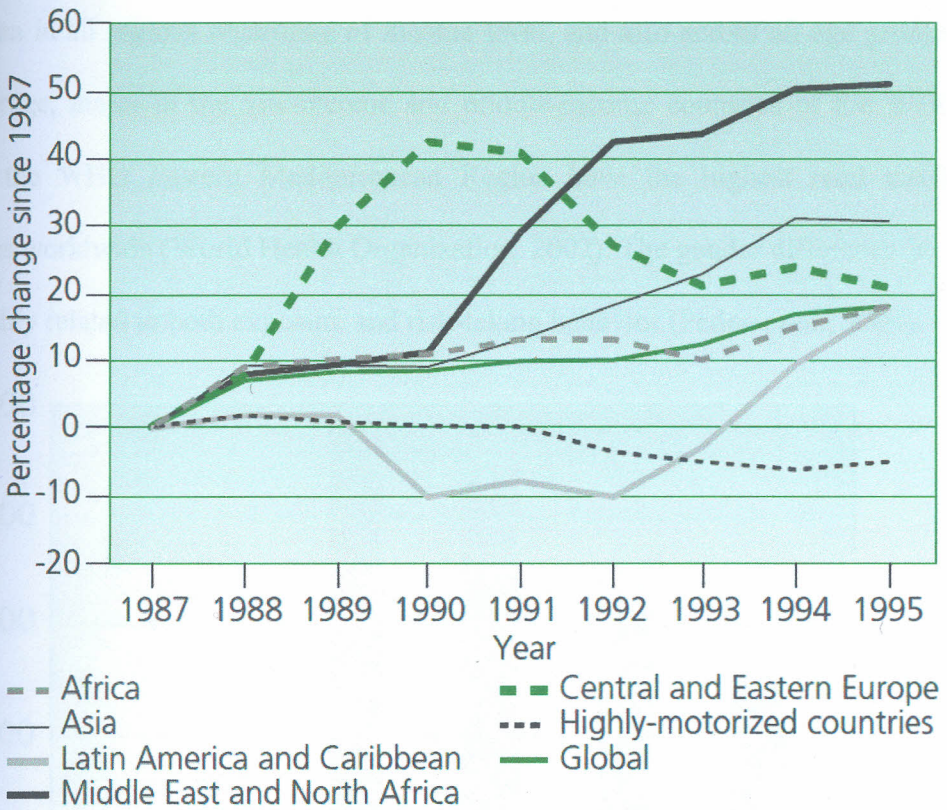

Figure 2.3: Global and regional road fatality trends, 1987-1995. Source: Jacobs *et al.*, 2000

2.4 Demographic profile

Young adults aged between 15 and 44 years account for 59% of global road traffic deaths. More than three-quarters (77%) of all road traffic deaths occur among men, with this figure highest in the Western Pacific Region (World Health Organization, 2013a). About 60% of the DALYs lost globally as a result of road traffic injury occurs among adults aged between 15 and 44 years (Peden *et al.*, 2004).

In 2002, males accounted for 73% of all road traffic deaths, with an overall death rate almost three times that for females: 27.6 per 100 000 population and 10.4 per 100 000 population,

respectively (World Health Organization, 2013a). Road traffic mortality rates are higher in men than in women in all regions regardless of income level, and also across all age groups (Figure 2.4). On average, males in the low-income and middle-income countries of the WHO Africa Region and the WHO Eastern Mediterranean Region have the highest road traffic injury mortality rates worldwide (World Health Organization, 2002). The gender difference in mortality rates is probably related to both exposure and risk-taking behavior (Peden *et al.*, 2004).

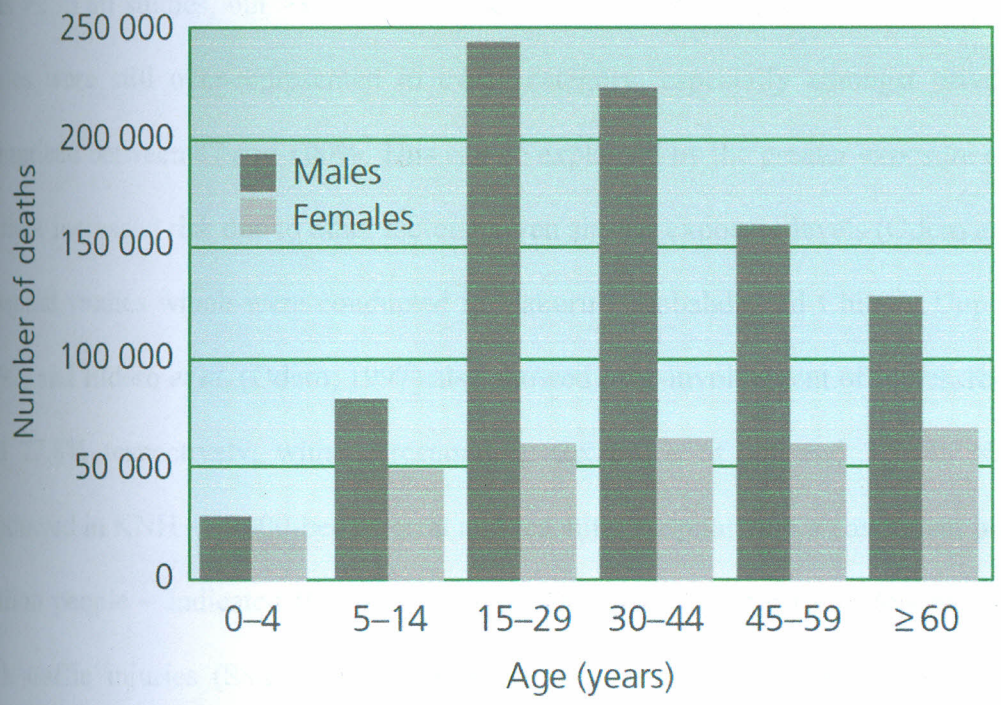

Figure 2.4: Road traffic deaths by sex and age group, world, 2002. *Source*: World Health Organization, 2002

Of all the age groups, children under 15 years of age have the lowest mortality rates (both sexes), due in large measure to the lower rate of exposure they experience (World Health Organization, 2002). These rates vary by region – the WHO African Region and the WHO Eastern Mediterranean Region both show fatality rates of above 18 per 100 000 for male children under the

age of 15 years. Globally, the road traffic fatality rate for male children aged 5 to 14 years is slightly higher than that for female children (13.2 per 100 000 for males as compared to 8.2 per 100 000 for females) (Peden *et al.*, 2004).

A comprehensive review of forty-six studies that described casualties by sex in low-income and middle-income countries revealed consistent predominance of males over females, with males comprising between 67 and 99.5% (mean 80%) (Odero *et al.*, 1997). The male to female ratio was >2 in all studies, but >3 in 83% of the studies. Even when examined by type of road-user, males were still over-represented in every category, especially amongst drivers, where they comprised between 87 and 100%. This can be explained by the greater exposure of men to traffic or their increased risk due to other factors, given similar exposure levels (Odero *et al.*, 1997).

Hospital studies which were conducted in Nakuru (Limbalala and Chirwa, Unpublished report, 1992) and Eldero *et al.* (Odero, 1997) also showed over-involvement of males, representing 92% and 77.8% respectively, with corresponding sex ratios of 3:1 and 3.5. In Nairobi, a study conducted in KNH - a 2000-bed referral and teaching hospital with a catchment population of 3.0 million people – indicated that persons aged 15-44 years comprised 76% of patients admitted with traffic injuries (Said, 2000). Although the above cited studies provided quite valuable insight and revealed overrepresentation of males, none of the studies focused on pedestrians which are the category of road user that forms the greatest proportion of road traffic injury deaths in LMICs. The sex ratio of pedestrians therefore remains a gap that needs to be addressed.

2.5 Distribution of road traffic injuries and deaths by road user type

Half of the world's road traffic deaths occur among "vulnerable road users", with 31% of deaths among car occupants and the remaining 19% among unspecified road users (World Health Organization, 2013a). The distribution of road traffic casualties by road user group vary across

the income levels and regions (Naci *et al.*, 2009). Forty-five per cent of road traffic fatalities in low-income countries are among pedestrians, compared with 29% in middle-income countries and 18 per cent in high-income countries (Naci *et al.*, 2009). Road traffic fatalities amongst motorized-four wheelers are estimated to be 63% of fatalities in high-income countries, 40 per cent in middle-income countries and 34% in low-income countries (Naci *et al.*, 2009).

The Global Burden of Disease Study estimates for the year 2002 indicated that there were 496,174 road traffic fatalities in low-income countries, 556 900 in middle-income countries and 118 750 in high–income countries (Mathers *et al.*, 2002). In most LMICs, a much higher proportion of road users are pedestrians, cyclists and users of motorized two- or three-wheeled vehicles than in high-income countries (World Health Organization, 2013a). In much of the African Region, walking is an important form of mobility for a large proportion of the population (Pendakur, 2005); in many South-East Asia and Western Pacific countries motorcycles are used frequently because they are relatively affordable to buy and run (Mohan and Tiwari, 1998). These different traffic mixes are reflected in road traffic fatality breakdowns (Mohan and Tiwari, 1998). For example, 38% of all African road traffic deaths occur among pedestrians, while 36% of road traffic deaths in the Western Pacific Region are among motorcyclists (World Health Organization, 2013a) (see Figure 2.5).

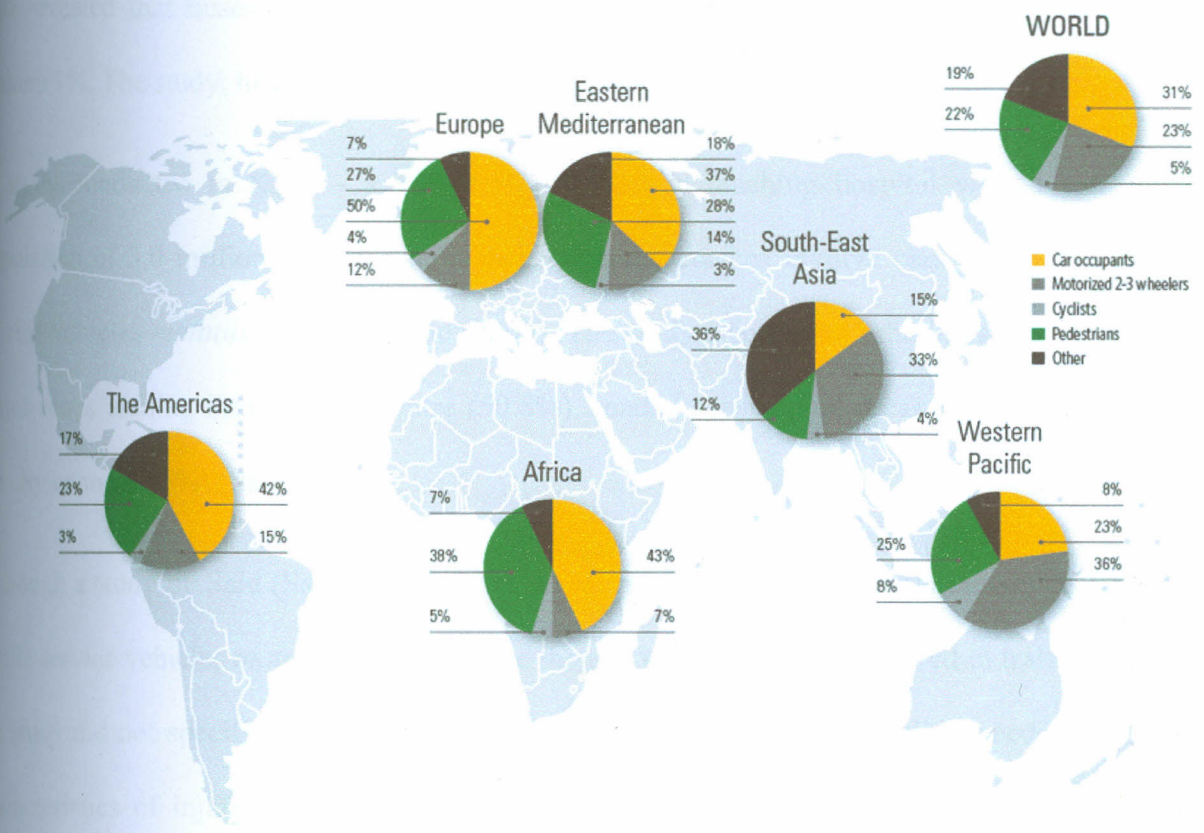

Figure 2.5 Road traffic deaths by type of road user, WHO region Source: World Health Organization, 2013a

Alarmingly high proportion of road traffic deaths in some of the countries in the African region are pedestrians (Naci *et al.*, 2009). In Ethiopia, for example, 84 per cent of road traffic fatalities occur among pedestrians, and in Cote d'Ivoire, 75 per cent of road traffic deaths occur in pedestrians (Sayer and Palmer, 1997).

2.6 Pedestrian Injuries

2.6.1 Characteristics of Crashes

A study conducted in Kenya, study revealed that cars, pick-up and vans are most frequently involved in crashes and comprise 41% of the reported crashes (Odero *et al.*, 2003). The study

so revealed that buses account for 10%, lorries 12%, *matatus* 11%, taxis 2%, trailers and tankers 1%. The study, however, did not show the vehicles involved in pedestrian crashes.

A study conducted in KNH - a 2000-bed referral and teaching hospital with a catchment population of 3.0 million people – indicated that most crashes involve cars (43%) and public service vehicles *matatus* (31.4%) (Said, 2000). The study also showed that most are injured on major roads leading into the city centre (50.8%), roads in residential areas (17.4%) and within the city centre (8.5%) (Said, 2000).

Although a study by Said (Said, 2000) indicated the proportion of crashes that involved cars and public service vehicles *matatus,* and also gave the age groups that were injured in traffic crashes, the study did not specifically show the pattern of road traffic crashes involving pedestrians and characteristics of injured pedestrians. A study by Said and Kahoro (2001) had its setting in Nairobi Hospital, a private health facility that predominantly caters for the higher social class. This limited the generalizations of its findings because of the highly specialized group that are attended to in the facility.

2.7 Strategies employed in improving the safety of pedestrians

2.7.1 An overview of effective pedestrian safety interventions

Important principles that can guide and inform practitioners and decision-makers when choosing which pedestrian safety measure(s) to implement given in World Health Organization manual are (WHO, 2013): conducting a situational assessment and utilize the results; choosing a holistic and multifaceted approach as opposed to a narrow focus; considering the distinct needs of various

/pes of pedestrians; integrating pedestrian safety as an essential feature of roadway design and and use planning; adapting proven measures to local conditions; implementing the measures over time, and; providing supportive policies and guidelines.

2.7.2 Implementing pedestrian safety interventions

This section provides further details on the pedestrian safety measures and briefly discusses the effectiveness of these measures and issues that should be considered for implementation. The safety measures are: reducing pedestrian exposure to vehicular traffic; reducing vehicle speeds; improving visibility of pedestrians; improving pedestrian and motorist safety awareness and behavior.

2.7. 2.1 Reducing pedestrian exposure to vehicular traffic

There are a number of specific engineering measures most of which involve separating pedestrians from vehicles or reducing traffic volume which can reduce pedestrian exposure to vehicular traffic (World Health Organization, 2013b). The measures that are highlighted and discussed in this section as key strategies to reduce pedestrian exposure to vehicular traffic are sidewalks/footpaths, marked crossings, overpasses and underpasses.

Sidewalks separate pedestrians from motorized vehicles as well as bicycles. They provide space for different types of pedestrians to walk, run, play, meet and talk. Studies show that sidewalks improve both pedestrian safety and increase walking. A study conducted in the United States, for example, found that pedestrian crashes were more than twice more likely to occur at locations without sidewalks than would be expected on the basis of exposure, and that residential areas without sidewalks had 23% of all pedestrian–vehicle crashes but only 3% of pedestrian–vehicle exposures (Retting *et al.*, 2003). Another study conducted in the United States found that sites

with sidewalks were 88% less likely to be pedestrian crash sites than those without sidewalks (McMahon *et al.*, 2002).

Marked crossing serve the purpose of indicating the optimal or preferred location for pedestrians to cross (World Health Organization, 2013b). They are commonly installed at signalized intersections, as well as other high-volume pedestrian crossing locations such as school zones. Listed below are some of the major issues for practitioners and decision-makers to consider when installing crossings (World Health Organization, 2013b):

- Crossing markings are unlikely to increase pedestrian safety, without related enhancements such as raised crossing islands and traffic signals.
- Marked crossings are not appropriate where traffic speed is high.
- Marked crossings on roads with more than two lanes may increase the risk of pedestrian–vehicle crashes.
- Crossing locations should be convenient for pedestrians and accessible for pedestrians in wheelchairs. Pedestrian movements and desire lines (most direct/ shortest path between two locations) can be analyzed to identify optimum locations for crossings.
- Marked crossings should guide pedestrians to cross at locations where there is street lighting at night.
- Detectable warnings should be installed to advice pedestrians with visual impairments where the kerb ramp ends and the street begins. The warnings should also indicate when the traffic light will change.
- There should be adequate visibility between vehicles and pedestrians. For example, night-time pedestrian crossings should be properly illuminated in order to help drivers to see pedestrians.

Pedestrian overpasses and underpasses are bridges and tunnels that allow for uninterrupted flow that is separate from vehicular traffic (World Health Organization, 2013b). Pedestrian overpasses and underpasses are used primarily in areas with high pedestrian volumes. The effectiveness of these approaches depends largely upon the likelihood that they will be used by most of the pedestrians crossing the street. In Tokyo, where this does occur, reductions in vehicle–pedestrian crashes of up to 91% were found following the implementation of overpasses and fencing (Retting *et al.*, 2003).

2.7.2.2 Reducing vehicle speeds

Speed is a key risk factor for pedestrian traffic injury and reducing the speed of vehicles is one of the most effective ways to improve pedestrian safety (Davis, 2001). Though it is recommended that speed management measures should be used alongside measures to reduce pedestrian exposure to vehicular traffic, speed management in itself remains an effective measure to reduce pedestrian traffic risk, and a core component of the Safe System approach (World Health Organization, 2013b). There is a growing effort to implement system-wide lower speeds of 30 km/h or even less for entire geographical areas instead of focusing on individual streets (Whitelegg, 2012). Detailed guidance on the effectiveness and implementation of speed management strategies can be found in *Speed management* (Speed management, 2006), and *Speed management: A road safety manual for decision-makers and practitioners* (Global Road Safety Partnership, 2008).

2.7.2.3 Improving visibility of pedestrians

A high percentage of pedestrian collisions and deaths occur when lighting conditions are low (World Health Organization, 2013b). A number of engineering and behavioral measures that

make pedestrians more visible to motorists, especially during dusk, dawn, and at night exists (Retting *et al.*, 2003; Peden *et al.*, 2004). These measures include:

- providing crossing enhancements such as raised crossing islands and traffic signals;
- implementing lighting and/or crossing illumination measures. Increasing intensity of roadway lighting increases visibility of pedestrians at night, especially at pedestrian crossings. This intervention has been associated with significant reductions in night-time pedestrian crashes. For example, a study conducted in Australia reported a 59% reduction in pedestrian crashes following improvement in roadway lighting (Retting *et al.*, 2003);
- removing or repositioning physical objects that affect visibility, such as trees and billboards that make it difficult for drivers to see pedestrians. Alternatively, kerb extensions can be used to safely place pedestrians in a more visible location prior to crossing and to provide better sight lines to observe traffic. These have the additional advantage of reducing the crossing distance for pedestrians and narrowing the roadway, which may slow vehicle speed;
- installing signals to alert motorists that pedestrians might be crossing. Pedestrian activated signals may be appropriate at locations with sporadic pedestrian traffic;
- improving conspicuity of pedestrians. Pedestrians need to be aware that drivers may not see them in low light or dark conditions, especially when they are wearing dark clothing. Selecting light-colored clothing as well as adding reflective materials to backpacks, shoes and clothing are basic measures to increase visibility of pedestrians;
- raising awareness among pedestrians and drivers, through public service announcements and other media, about the importance of pedestrian visibility, especially at night.

2.7.2.4 Improving pedestrian and motorist safety awareness and behavior

Changing the attitudes and behavior of drivers and pedestrians is a complex, long-term undertaking that requires a variety of interventions to be implemented (World Health Organization, 2013b). In the following sections measures commonly used to raise awareness and modify behavior are discussed.

2.7.2.5 Education, outreach and training

Road safety education is an adjunct to other measures, rather than a stand-alone intervention (World Health Organization, 2013b). Safe road-user behavior and a reduction in pedestrian fatalities depend not only on knowledge and skills but also on community support, perception of vulnerability and risk, social norms and models, engineering measures and law enforcement (Peden *et al.*, 2004; Lonero *et al.*, 2006). Road safety educational programmes may include the following (World Health Organization, 2013b): raising awareness; school-based education to help children acquire knowledge and skills for pedestrian safety (Duperrex *et al.*, 2002), and; outreach programmes and mass media campaigns.

2.7.2.6 Traffic law enforcement

Comprehensive legislation is a key element of pedestrian safety, but legislation alone is not likely to facilitate behavior change in the absence of law enforcement and adequate penalties (World Health Organization, 2013b). Driver and pedestrian compliance with laws critical to pedestrian safety – such as legal vehicle speed limits, drinking and driving regulations, red-light signal compliance and pedestrian traffic control signals – are motivated in part by the perceived risk of detection, i.e. law enforcement, and in part by the perceived severity of the penalties (Lonero *et al.*, 2006). Consistent and highly visible law enforcement operations through a mix of visible patrols and fixed cameras are essential (Global Road Safety Partnership, 2008).

In European countries, the safety of people walking and cycling in urban areas is now being considered in the context of policies for encouraging people to travel on foot and by bicycle or by public transport rather than by car in order to reduce environmental damage, improve public health, and enhance quality of life in towns and cities (European Transport Safety Council, 1997).

2.8 Pedestrian Safety in the European countries

The European Union (EU) and the United States of America (USA) have officially recognized and endorsed the importance of walking and cycling as practical modes of urban transport, and have adopted the dual objectives of raising walking and cycling levels while increasing their safety (USDOT, 1994; CEMT, 2004; USDOT, 2004; European Commission, 2007). For example, most cities in the Netherlands and Germany have adopted a wide range of coordinated policies and programme to make walking safer (Pucher and Dijkstra, 2003). These cities have put in place better facilities for walking, traffic calming of residential neighborhoods, urban design sensitive to the needs of non-motorists, restrictions on motor vehicle use in cities, rigorous traffic education of both motorists and non-motorists, and strict enforcement of traffic regulations protecting pedestrians and bicyclists (Pucher and Dijkstra, 2003). They have emphasis on transportation policy aimed at improving the infrastructure used by pedestrians such as: extensive auto-free zones that cover much of the city center; wide, well-lit sidewalks on both sides of every street; pedestrian refuge islands for crossing wide streets; clearly marked zebra crosswalks, often raised and with special lighting for visibility; and pedestrian-activated crossing signals, both at intersections and midblock crosswalks (Pucher and Dijkstra, 2003).

2.9 Pedestrian safety in LMICs

In LMICs, pedestrian traffic has grown without accompanying improvements in facilities for these road users and the high number of pedestrian casualties in these countries reflects not only their inherent vulnerability but also insufficient attention to their needs in policy-making (Guitilink *et al.*, 1994; Vasconcellos, 1999; Khayesi, 2003). In Kenya, walking as a mode of transportation, has not been adequately recognized by planners neither have their needs been catered for (Republic of Kenya, 2004).

Although pedestrians constitute the highest proportion of road users injured and killed in road traffic deaths in Nairobi, there are no studies which analyze the strategies that are being employed to improve the safety of pedestrians.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

This chapter describes the methodology that was used in this research. It covers description of study area, study population, study design, ethical considerations, instruments for data collection, and analysis of data.

3.2 Study Area

3.2.1 Kenya

Kenya is a sub-Sahara African country that lies astride the equator in Eastern Africa between Somalia and Tanzania and borders the Indian Ocean. It has a land size of 582,650 square kilometers with 11,230 square kilometers of water, mainly Lake Turkana and Kenya's portion of Lake Victoria (Kenya National Bureau of Statistics, 2012). In 2009, Kenya had approximately 63,574 kilometres of roads of which 14.6 per cent were classified as butimen roads (Kenya National Bureau of Statistics, 2010). The total numbers of registered motor vehicles were 1,221,083 of which 29 per cent were cars and 20.7 per cent were motor cycles (Kenya National Bureau of Statistics, 2010). Figure 3.1 shows the location of Kenya, Nairobi city and Kenyatta National hospital. The study was conducted in Nairobi city, the capital and the largest city of Kenya.

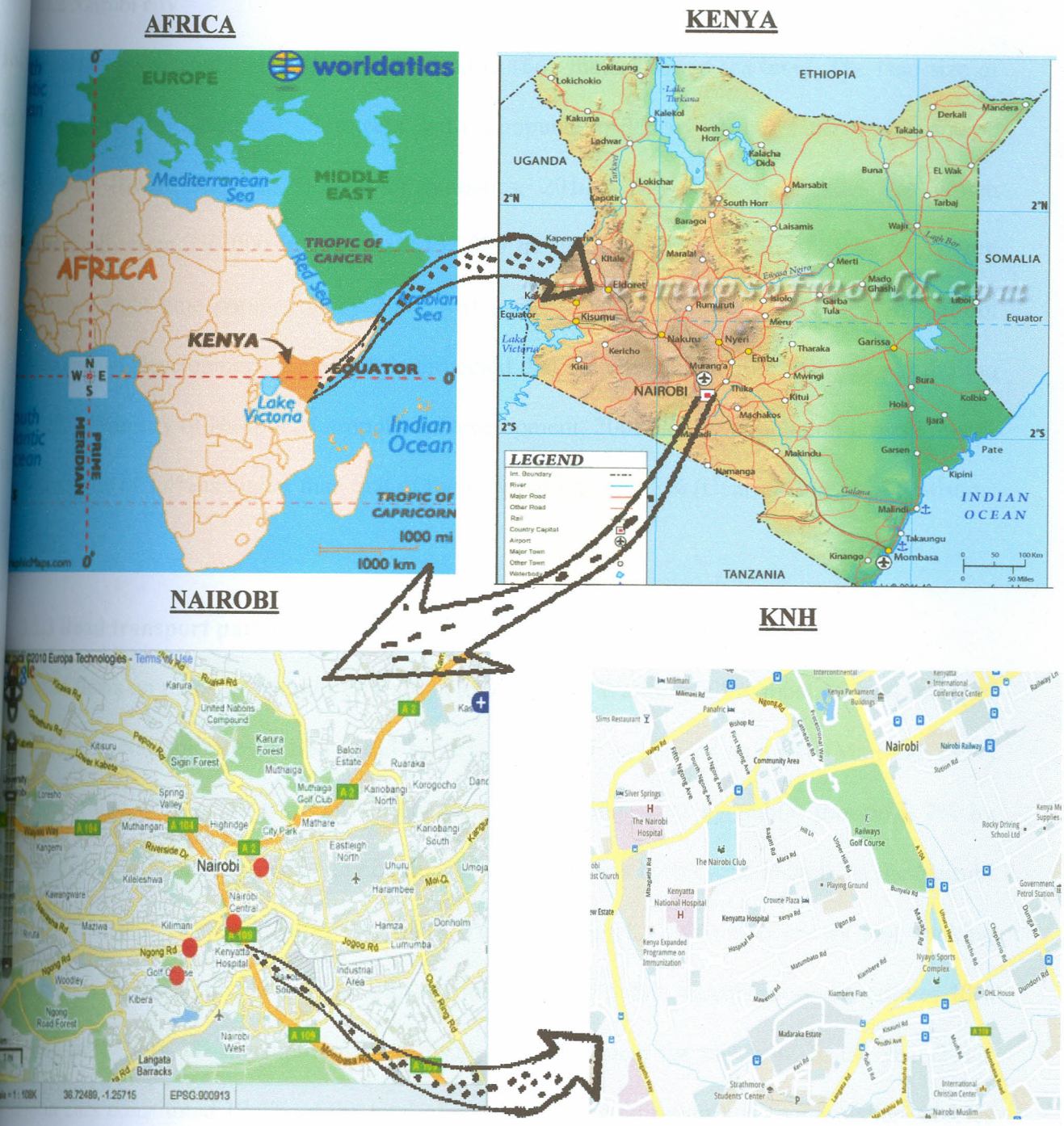

Figure 3.1: Location of Kenya, Nairobi city and Kenyatta National Hospital *Source*: googlemaps.com

3.2.2 Nairobi city

Nairobi city is located at 1°17'S, 36°49°E and is 1661 meters above sea level. The land size of Nairobi city is 695.1 square kilometers, with a population density of 4 515 person per square kilometer (Kenya National Bureau of Statistics, 2010). The city's population has grown dramatically from 350 000 in 1993 to 2,137,000 in 1999 (Central Bureau of Statistics, 1999). Nairobi's night time population by 2007 was estimated at 3.05 million (Ministry of Nairobi Metropolitan Development, 2008b). It is projected that the city's population will reach 8 million by 2030 (Ministry of Nairobi Metropolitan Development, 2008b). The population growth rate of Nairobi city of 3.4% is higher than that of the national rate of 4.8% (Central Bureau of Statistics, 1999).

3.2.3 Road transport pattern in Nairobi

Traffic flows on roads of Nairobi city are heterogeneous. Walking is the most utilized mode of transport in Nairobi city. A household survey conducted in Nairobi in 1994 (Mairura, 1994) indicated that 47% of all trips in Nairobi were by walking, 42% by public transport, 7% by private car, 3% per cent by company car and 1% per cent was by bicycle. Data from the Nairobi Urban Transport (Kenya Institute of Public Policy Research, 2006) also shows that walking constitutes the most utilized mode of transport (49%) while public transportation constitutes 40% of transport. Only 7% are reported to be using private vehicle for transport. In the year 2011, saloon cars constituted 17.4% of the total of 63, 486 registered motorized four-wheeler vehicles in Nairobi city (Kenya National Bureau of Statistics, 2012).

Public transport in Nairobi is characterized by un-coordinated operations, poor service quality, unsafe and insecure services, congested vehicles and travel ways and unaffordable services

Ministry of Nairobi Metropolitan Development, 2008). The vast majority (about 80%) of public transport trips in Nairobi are carried by *matatus* (Gonzalles *et al.*, 2009). The *matatus* are the informal paratransit industry in Kenya that provides service to millions of people a day and essentially are the backbone of transportation in Nairobi city. The *matatus* are typically 14-seater minibuses made in Japan (Gonzalles *et al.*, 2009). The *matatu* drivers tend to drive carelessly, as their income and job security is dependent upon daily profit mark set by the owners. *Matatu* drivers break traffic laws, weave in and out of traffic, cut of other vehicles, and use sidewalks to bypass traffic jams, putting pedestrians at risk (Gonzalles *et al.*, 2009). Matatus were reported to have been involved in 31% of traffic crashes cases reported to the Kenyatta National Hospital (Said, 2000).

The public transport trips which are not covered by *matatus* are served by traditional fixed route buses, a commuter rail line, and other shuttle services such as those run by schools. The mode share of formal public bus services in Nairobi has slipped from 36% of all trips in 1994 to 3.5% in 2004 (Aligula *et al.*, 2005). The wealthier residents of Nairobi tend to travel by private vehicle or taxi, and they are motivated in a large part by concerns about the safety and security of traveling by *matatu* or walking. However, the vast population, especially the slum dwellers, cannot afford to travel by any means other than walking. Nairobi's slum which were estimated at about 810,000 people in 2004 account for about one-third of the population of the city (Republic of Kenya, 2000; World Bank, 2006). The slum residents are captive walkers because they cannot afford the motorized options.

Bicycles as a mode of transport in Nairobi contribute only 1% of urban transport (Pendakur, 2005), unlike the situation in 1973 when it was reported to account for 2.6% of all trips (Nairobi

Urban Study Group, 1973). There have been some attempts by bicyclists to introduce bicycle taxis, *boda boda*, in some streets of Nairobi but their contribution to urban transport has not been very significant (Nairobi Area Traffic Commandant, personal communication 2009).

3.2.4 Motor Vehicles

The number of registered motor vehicles in Kenya increased 2.3-fold from 398,056 registered motor vehicles in 1993 to 896,573 in the year 2007 (Kenya National Bureau of Statistics, 2008). Of the 6,811,774 total motor vehicles registered in Kenya between the years 1998 and 2007, cars contributed 2,940,545 (43%). However, car ownership in Nairobi is still low. Only approximately 20 percent of Nairobi households own a car (Aligula *et al.*, 2005; Japan International Cooperation Agency, 2006). Rising income among the middle class has, however, given rise to increased consumption which is reflected in increasing car ownership in Nairobi and Kenya in general (Omwenga, 2008).

Kenyan roads have a mix of different categories of motor vehicles. These include utility vehicles, panel vans, pick-ups; lorries, trucks and heavy vans; buses and mini buses; motorcycles; trailers; other motor vehicles (Kenya National Bureau of Statistics, 2008). All these vehicles with varying sizes, body mass and speed capacity share the same roadways with pedestrians and bicyclists.

There has been an upward trend in vehicles imported into the country, especially motorcycles. Between the year 1995 and 2006, the number of motorcycles increased from 1870 to 5,212 (179%). The number of motorcycles dramatically increased from 5,212 in 2006 to 29,072 in 2007- a 458% increase in just one year. Similarly, the number of bicycles in the country increased by 89% from 127,167 in 1995 to 240,850 in 2007 (Central Bureau of Statistics, 1996; Central Bureau of Statistics, 1999; Kenya National Bureau of Statistics, 2008).

3.2.5 Road traffic injuries in Nairobi

Of the 96,927 road traffic crashes reported in Kenya during the period 1986-1994, over 30% occurred in Nairobi (Khayesi, 1999b). Pedestrians were shown to comprise 64% of road users killed in traffic crashes in the city of Nairobi, between 1986 and 1994 (Khayesi, 2003) and 71% of all road traffic deaths that were reported to traffic police in Nairobi between the year 2000 and 2008 (Ogendi *et al.*, 2011).

3.2.6 Road transport infrastructure

Nairobi has approximately 1,2145 kilometres of roads of which 8 per cent are classified as paved roads (Kenya Institute for Public Policy Research and Analysis, 2006). The road network in Nairobi is primarily composed of radial routes connecting surrounding regions to the central business district (Figure 3.2) (Gonzalles *et al.*, 2009). Infrastructure for walking is inadequate. A study which sampled 6 major roads in Nairobi, comprising a total distance of 51.4 kilometers, for example, revealed that only 3 crossing facilities were provided for and that left sidewalk was provided in a distance of 35.2 kilometers (68.5%) (United Nations Environmental Programs, 2009). The interaction between vehicles, users and the road in Nairobi creates risks for pedestrians (Gonzalles *et al.*, 2009). The drainage is absent or blocked in some roads, contributing to the quick deterioration of the roads networks during the rainy season. This renders the roads impassable and iterferes with pedestrias and motorized trasport movemets due to water loggig (Kenya Institute for Public Policy Research and Analysis, 2006). For a city of roughly 3.05 million inhabitants (Ministry of Nairobi Metropolitan Development, 2008b), Nairobi has few streets to serve traffic demand relative to cities of similar size in countries with motorized transport. The crowded state of infrastructure is further exacerbated by the encroachment of markets and commercial activities onto transport right of way. The small

number of streets for carrying cars, trucks, buses, and *matatu* traffic in Nairobi results in the interactions of factors that cause inefficiencies for vehicular traffic operations and also present a severe safety hazard for people walking in the streets (Gonzalles *et al.*, 2009).

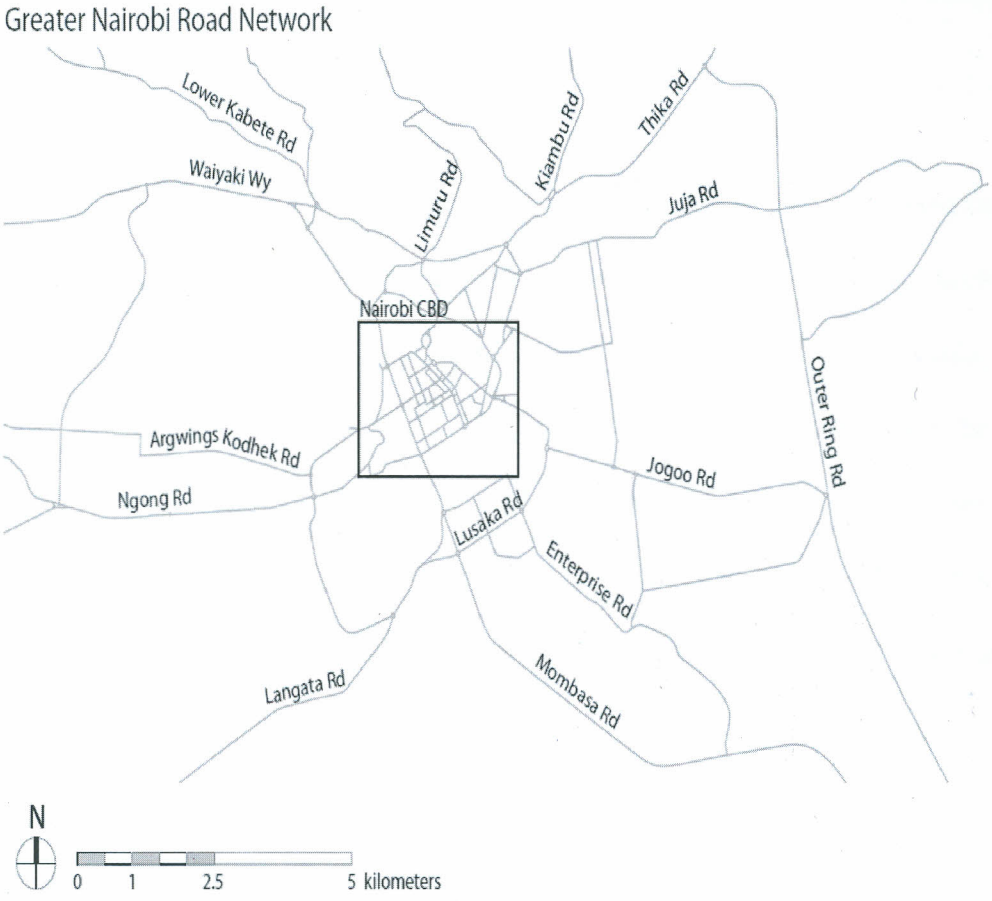

Figure 3.2 The road network in Nairobi *Source*: Gonzalles *et al.*, 2009

3.2.7 Hospitals

Approximately 55 hospitals are accredited by the National Hospital Insurance Fund to provide comprehensive in-patient health care cover in the city of Nairobi. The governments' hospitals

amongst these are: Kenyatta National Hospital, Pumwani Hospital, Mbagathi district Hospital. The bed capacities for these hospitals are 1804, 350, 250 for Kenyatta National Hospital, Pumwani Hospital, and Mbagathi district Hospital, respectively. The leading private hospitals in terms of bed capacity are Nairobi Hospital and Agha Khan Hospital Nairobi. The accredited mission hospitals are: Blessed Louis Hospital, Palalazzolo Health Center, Ngong Hills Hospital, Divine World Parish Center and Huruma Nursing and Maternity Center.

3.2.7.1 Kenyatta National Hospital

Kenyatta National Hospital was chosen for this study because it is the largest public hospital in the city, is centrally located, and receives trauma patients through the hospital's active Accident and Emergency Department on a 24-h basis. The hospital has 20 outpatient clinics, 50 wards, and 24 operating theaters with a total bed capacity of 1,804. It also serves as a general hospital for more than 3.0 million inhabitants in Nairobi and its neighboring areas. KNH is a host to several training and research institutions such as: College of Health Sciences (University of Nairobi); the Kenya Medical Training College; Kenya Medical Research Institute, and National Laboratory Services.

3.2.8 Traffic Police Department in Nairobi

The Kenya Traffic Police Department routinely collects and store data on motor vehicle crashes involving personal injury or fatality (Odero *et al.*, 2003). The data is collected by traffic officers investigating the crash using the Kenya Police Traffic Department Accident Report Form, Police 41 (Appendix 11). The traffic crash investigation officer who visits the scene of crash undertakes immediate assessment of the scene of the crash and collects information on the crash details including the details of the casualties (Chief Inspector of Police, Nairobi Area, Personal Communication, 2009). The information to be gathered in Form P41 include: day, date and time

the crash occurred; location of the crash, demographic profile of the injured, class of vehicles involved, position of the injured in the vehicle, class of persons involved, details of the pedestrians involved in the crash, sketch plan of the crash site, and additional information on the types of vehicles involved (Appendix 11).

The road traffic crash information is usually gathered from witnesses who could be by standers or anybody who can give information. Investigating officer records the statements. While at the scene of the accident 'rough sketch' of the scene is normally made by the police, and later properly updated as 'fair sketch'. The information gathered and reported in form P41 is then recorded in the Occurrence Book at the station. The originate (message) in the form of signal is dispatched to the following: local Officer Commanding Station (OCPD), Provincial Police Officer (PPO), Division Criminal Investigation Officer (DCIO), Provincial Criminal Investigation Officer (PCIO), the Police Headquarters and to the Commandant Traffic. The Police Headquarters has a computerized section that is responsible for compiling data. The Traffic Commandant maintains all the key data about all traffic accidents on behalf of the Commissioner of Police. This procedure is used to collect data on road traffic crashes, injuries and deaths that occur in Nairobi city by traffic police in all the 13 traffic Divisions in the city, namely: Gigiri, Kabete, Langata, Ngong, Buru Buru, Kayole, Kasarani, Pangani, Kilimani, Muthangare, Embakasi, Industrial Area, and Central Divisions. The police data are, mainly collected for the purposes of prosecution and insurance compensation.

3.3 Study Design

Three study designs were used in this study: a descriptive prospective study design was used to collect data on all consecutive road traffic injury cases that occurred in Nairobi City and

admitted to Kenyatta National Hospital during the period between 1st June and 31st August 2011; a cross-sectional study design was used to collect data on all consecutive road traffic injury cases that occurred in Nairobi and reported to the 13 traffic divisions in Nairobi during this study period, and ; documentary searches using internet searches and search of documents and reports of unpublished government and other organization reports were used to gather information on strategies aimed at improving safety of pedestrians in Nairobi.

3.4 Study Population

For the road traffic injury cases admitted to KNH, the study population consisted of all consecutive road traffic injury cases that occurred in Nairobi City and admitted to Kenyatta National Hospital over a period of 3 months from 1st June to 31st August 2011. For the road traffic injury cases reported to traffic police, the study population consisted of all road traffic injury cases that occurred in Nairobi City and reported to traffic police in Nairobi city over a period of 3 months from 1st June to 31st August 2011.

3.5 Inclusion criteria

For the objective on KNH road traffic injury cases, all road traffic crash injury cases that occurred in Nairobi City and admitted to Kenyatta National Hospital over a period of 3 months from 1st June 2011 to 31st August, 2011 were included in the study. For the road traffic injury cases reported to traffic police, all road traffic crash injury cases that occurred in Nairobi City and reported to traffic police in Nairobi city, during the same 3 month period from 1st June 2011 to 31st August, 2011 were included.

3.6 Exclusion Criteria

The following were excluded from the study: road traffic crash injuries that were referred to the hospital from other hospitals outside Nairobi city; patients assessed and discharged directly from the emergency department; road traffic crash deaths that were brought directly to the mortuary without passing through the wards; injury on the road without involvement of a vehicle (a person slipping or falling on the road and sustaining injury); injury involving stationary vehicle (person getting injured while washing or loading a vehicle).

3.7 Sampling Procedure

For the objective on KNH road traffic injury cases, all road traffic crash injury cases that occurred in Nairobi City and admitted to Kenyatta National Hospital over a period of 3 months from 1st June 2011 and 31st August, 2011 were included in the study. A road traffic crash injury was defined as an injury which resulted from any vehicle crash, occurring on a road or highway, and which took place between two or more objects, one of which had to be any kind of moving vehicle. For the objective on road traffic injury cases reported to traffic police, all road traffic crash injury cases that occurred in Nairobi City and reported to traffic police in Nairobi city, during the same 3 month period from 1st June 2011 and 31st August, 2011 were studied. Document searches were confined to articles deemed by the researcher to be relevant to road traffic safety; particularly those relevant to safety of non-motorized transport in Nairobi were included.

3.8 Data Collection Instruments

To collect information from road traffic crash cases reported to the police station a questionnaire was used to capture the required information (Appendix 1). For all road traffic trauma cases admitted to Kenyatta National Hospital during the study period a structured questionnaire was used to capture the variables of interest to the study (Appendix 2). Structured interview was also administered to Nairobi City Council Engineer (Appendix 3) to obtain information on road safety intervention and to Traffic Commandant, Nairobi Area (Appendix 4).

3.9 Reliability of the Instruments

A pilot study was conducted and the feedback used to refine the instruments. To enhance the reliability of the study, and to ensure that the data collected were objective, reliable, accurate and reproducible, all the 6 nursing staff, all in the rank of Kenya Registered Nurse, were selected from the wards and undertook a 2-hour training as research assistants by the investigator. The traffic police officers identified from all the 13 divisions for the data collection were the officers already working in traffic department and who were familiar with the traffic crash investigation techniques. All the 13 research assistants underwent 2-hour training on research objectives and data collection methods. The filled questionnaires were counter-checked by the investigator for accuracy and completeness.

3.10 Data Collection Procedures

3.10.1 Hospital Data

All road traffic injury admissions were identified every morning by the nursing officers working in the wards and research assistants by checking case notes and files of admissions to the wards. Informed consent was sought from the road traffic crash injury patient before conducting the

interview, or where this was not possible, because of the severity of the injury or age, from appropriate caretaker or parents. Only patients from who consent to gather information was granted, either by themselves or respective caretakers or parents, were enrolled. Those who brought the road traffic crash injury patients to the hospital, or the relatives who were taking care of the patients or the road trauma patients themselves, where possible, were also interviewed using structured questionnaires (Appendix 2). The recruited traffic injury hospital admissions were followed up daily by research assistants until the day of discharge, transfer to another hospital, or death. The information collected included: patient's demographic characteristics; date and day of admission; admission outcome and date; category of road user injured; place and time of the crash; day of the week the crash occurred; duration and outcome of admission; class of vehicle involved; conflict type for pedestrians; and the main type of injury that resulted in admission as reported in treatment files. Information on the dates of admissions and discharges and the nature of injury were obtained from the case notes in patients' files. Data collection was conducted over a period of 3 months from 1st June to 31st August 2011.

3.10.2 Traffic Police Data

Information was obtained from all road traffic injury cases that occurred in Nairobi City and reported to the 13 traffic divisions in Nairobi city over a period of 3 months from 1st June to 31st August 2011. Data were collected by traffic officers in the divisions and sent to the Nairobi Area Traffic Commandant office. The questionnaire used for collecting the information was adapted from the Form P41 (Appendix 11) which is used routinely by traffic police to gather road traffic crash data. The information collected comprised: the category of road user injured and their demographic profile, the class of vehicles involved in the crash, type of conflict, day of the week the crash occurred, and circumstances of the crash (Appendix 1).

3.10.3 Documents Review

Documentary internet searches using "Google Scholar" search engine were conducted to obtain reports and documents from the following: Ministry of Transport; Ministry of Roads; Ministry of Nairobi Metropolitan; Nairobi City Council, and; websites of organizations dealing with road safety work in Nairobi city to assess their various strategies on safety of pedestrians. Key search words were: 'pedestrians in Nairobi' "non-motorized transport Nairobi' "pedestrian safety' "pedestrian transport infrastructure' 'road traffic crashes and injuries Nairobi'. However, cognizant of scarcity of formal studies and reports in the area of safety of pedestrians in the city of Nairobi, there were no strict priori criteria on the kind of documents to search.

3.11 Statistical data analysis

Descriptive statistics were generated for demographic characteristics, category of road user, vehicle involved, day the crash occurred, duration of admission and nature of injury. Continuous variables were summarized using means and median and standard deviation. Analysis was based on frequency tabulation and group comparisons. The mean length of stay (LOS) was compared between that for pedestrians against all other categories of road users and all other road user categories combined using Analysis of Variance (ANOVA) as described by Anderson *et al.* (1994). P value less than 0.05 was considered significant. For pedestrian injuries and fatalities reported to traffic police, hour of day were categorized into eight three-hour groups, and each category compared to a reference period set at 09-12 as described by Damsere-Derry *et al.* (2010) (Damsere-Derry *et al.*, 2010) with a p value less than 0.05 considered significant.

3.12 Ethical Considerations

A letter of introduction to enable the researcher gain some background information on road traffic accidents in Nairobi to assist in the development of the research proposal was written by the Director, School of Public Health and Community Development to the Provincial Director of Medical Services, Nairobi (Appendix 5) and permission to conduct the survey granted (Appendix 6). The research proposal was reviewed and approved by the Maseno University School of Graduate Studies. Permission and ethical approval for the study were obtained from the National Council for Science and Technology (Appendix 7) and Ethics and Research Committee of Kenyatta National Hospital/University of Nairobi (Appendix 8) respectively. Written permission to collect information from Traffic Police department was issued by the Commandant Traffic Department Nairobi (Appendix 9). Permission to collect information from Nairobi City Council was sought and obtained from the Nairobi City Town Clerk (Appendix 10). Several ethical issues were taken into consideration in this study: informed consent, respect for participants, and ensuring that confidentiality is maintained.

Before interviewing the patient, or appropriate caretaker of the patient, a written consent form was issued to the respondent (Appendix 2). Consent for minors was obtained from parents or caretakers of the patients. Consent for severely injured patients was obtained from caretakers of the patients. Only consenting respondents were interviewed. Information was collected by six research assistants who were also nursing staff in the wards. Personal identifiers were not included in the analysis or presentation of the finding.

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter is divided into four sections. Section one presents results for objective one: characteristics of road traffic injury cases admitted to Kenyatta National Hospital. Section two focuses on objective two: the characteristics of pedestrian injury admissions to Kenyatta National Hospitals. Section three presents the results of objective three: the characteristics of road traffic crashes and injuries to pedestrians reported to traffic police in Nairobi. Section four, focuses on objective four: pedestrian safety interventions.

4.2. Characteristics of road traffic admissions to Kenyatta National Hospital

A total of 253 road traffic trauma cases were admitted to Kenyatta National Hospital during the 3-month study, from 1 June to 31August 2011. Of these 253, 176 (69.9%), were injured in crashes which occurred in Nairobi city (Figure 4.1). Since the study focused on road traffic injury cases that occurred in Nairobi, the analysis was confined to the 176 road traffic injuries resulting from crashes that occurred in Nairobi. Of the 176 road traffic hospital admissions, 121 (68.8%) were discharged home alive, 18 (10.2%) absconded from the hospital, 5 (2.5%) died in the hospital, giving a case-fatality rate of 2.8%. One case (0.6%) was transferred to another hospital. At the completion of the study, 31 (17.6%) were still admitted to the hospital (Figure 4.1).

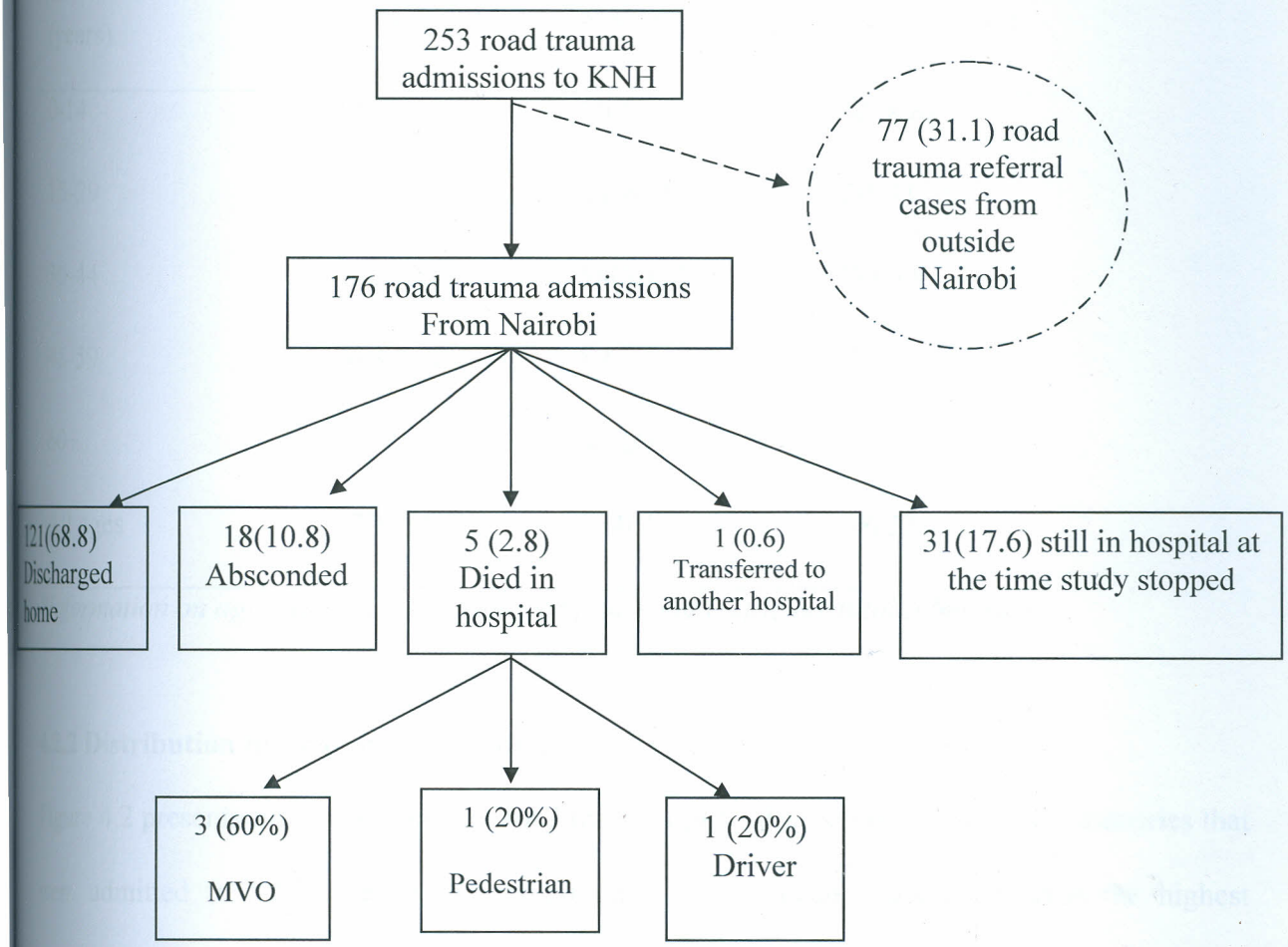

Figure 4.1 Flow Chart of road traffic injury admissions at KNH, June-August 2011

4.2.1 Distribution by age groups and sex

Males comprised 138 (78.4%) of the admissions with a male to female ratio of 3.6:1. The majority, 129 (75%), of road trauma admissions, were in the age group of 15-44 years (Table 4.1). Children in the age group of 14 years and below accounted for 8.1% of road traffic injury admissions.

Table 4.1 Hospital admitted road traffic cases by age groups and sex, KNH; n=172*

Age Group (years)	Admission		
	Total n (%)	Male n (%)	Female n (%)
0-14	14(8.1)	10(71.4)	4(28.6)
15-29	64(37.2)	44(68.8)	20(31.2)
30-44	65(37.8)	58(89.2)	7(10.8)
45-59	26(15.1)	19(73.1)	7(26.9)
60+	3(1.7)	3(100)	-
All ages	172(100)	134(77.9)	38(22.1)

**Information on ages were not available for four road traffic hospital admissions*

4.2.2 Distribution by road user categories

Figure 4.2 presents the distributions of road traffic injury admissions by road user categories that were admitted to KNH during the three-month period. Pedestrians constituted the highest proportion of road traffic injury admissions to KNH, comprising 104 (59.1%), followed by passengers, 43 (24.4%), motor cyclists 17 (9.7%), bicyclists, 9 (5.1%) and drivers 3 (1.7%).

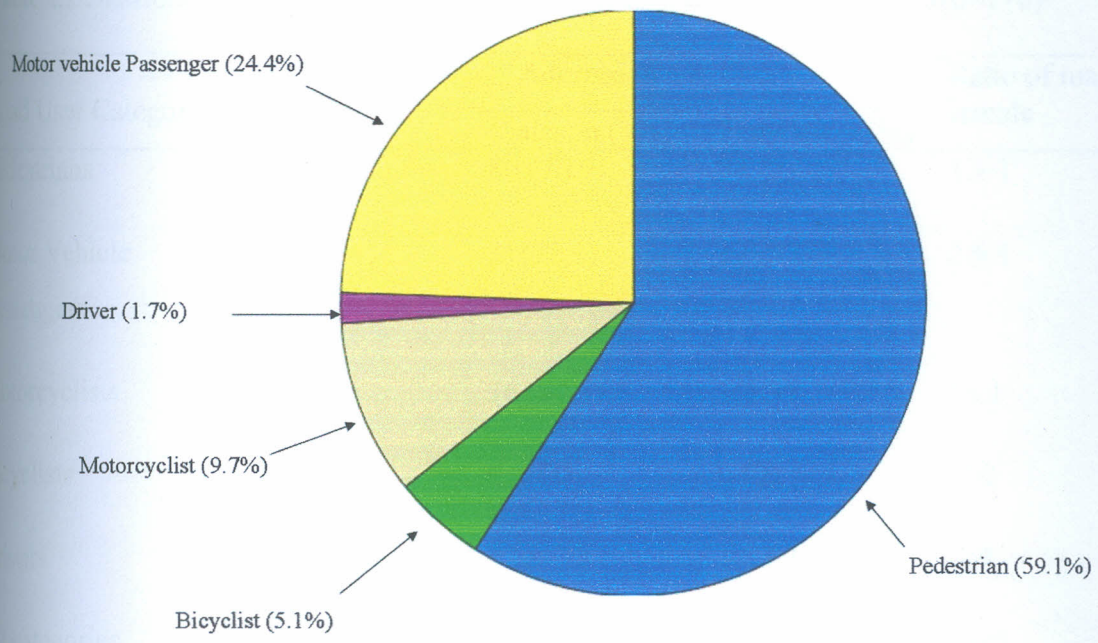

Figure 4.2 Proportion of road traffic injury hospital admissions by road user category, KNH, June-August 2011

4.2.3 Road traffic injury hospital admissions by road user categories and sex

Table 4.2 below describes the distribution of different road user categories by sex. The highest male to female (16:1) was observed amongst the motorcyclists, followed by bicyclists (9:0).

Table 4.2 Distribution of road user category by sex, KNH, July-August 2011(n=176)

Road User Category	Admission			Ratio of male to female
	Total: n (%)	Males: n (%)	Females: n (%)	
Pedestrians	104 (59.1)	80 (76.9)	24 (23.1)	3.3:1
Motor Vehicle Passengers	43 (24.4)	31(72.1)	12 (27.9)	2.6:1
Motorcyclists	17 (9.7)	16 (94.1)	1(5.9)	16:1
Bicyclists	9 (5.1)	9 (100)	0 (0)	9:0
Drivers	3 (1.7)	2 (66.7)	1(33.3)	2:1
All categories	176 (100)	138 (78.4)	38 (21.6)	3.6:1

4.2.4 Road traffic injury hospital admissions by day of the week

The highest number of road traffic injury hospital admissions 40 (23.0%), were on Saturdays, followed by Sundays, (22.4%) and Fridays, (12.1%). The lowest numbers of road traffic injury admissions (12.5%) were on Tuesdays.

4.3 Pedestrians Injury Hospital Admissions

Presented in this section are the characteristics of pedestrians admitted to KNH under the following sub-sections: distribution by age group and sex; burden of pedestrian injuries on hospital; types of injuries; pedestrian injuries and admissions by day of the week; hospital admission outcome; collision characteristics and length of hospital stay; motor vehicles involved in crash with pedestrians, and; leading roads in pedestrian crashes.

4.3.1 Distribution by age group and sex

The heaviest burden of pedestrian injuries was borne by young adults of ages 15 to 44 years. This age range contributed 69.9% of all pedestrians admitted to KNH during the study period. Male pedestrians outnumbered females in all the age groups (Table 4.3). The highest male to female ratio was observed in the age group of 30-44 (male: female ratio=8.31:1), followed by those in the age group 45-59 years (male: female ratio=4.3:1). A test of significance indicated that in all the age groups combined, the total number of males was only marginally greater ($p=0.0496$), but more significantly greater in the age groups 15-29 ($p=0.00035$) and 30-34 year olds ($p=0.0274$) (Table 4:3).

Table 4.3 Distribution of admitted pedestrians by age group and gender, KNH (n=103)*

Age Group (years)	Admission		Ratio of male to female	p-value
	Total, *n* (%)	[Male,n (%)		
0-14	13(12.6)	10(76.9)	3.3:1	0.2724
15-29	35(34.0)	21(60.0)	1.5:1	00035
30-44	37(35.9)	33(89.2)	8.35:1	0.0274
45-59	16(15.5)	13(81.2)	4.3:1	0.6552
60+	2(1.9)	2(100.0)	2:1	0.5900
All ages	103(100)	79(76.7)	3.3:1	0.0496

**Information on age was not available for one pedestrian*

4.3.2 Hospital bed days

A total of 104 pedestrians involved in road traffic crashes were admitted to KNH during the period under study, representing 59.1% of the total road traffic injury admissions (Figure 4.2). Of the total 4180 hospital bed days by road traffic injury admissions to KNH during the study period, 2573 (62 %) days were by pedestrians. This was 1.6 times higher than that for all other categories of road users combined (2573 versus 1607), 2.5 times higher than for motor vehicle passengers (2573 versus 1025) which were next in rank, and 39 times higher than the total number of bed days by drivers which spent the least total number of hospital bed days (2573 versus 66). The LOS for admitted pedestrians ranged from 2 days to 115 days with a mean of 31(SD±23.6). The mean LOS of pedestrians was not significantly different from that of all other road users

combined (p=0.8339). The mean for pedestrians of 31(SD±23.6) ranked third after that for motor vehicle passengers and drivers, with mean of 34.17(SD±26.1) and 33(SD±19.8) respectively (Tables 4.4 and 4.5).

Table 4.4 Characteristics of pedestrians and other road traffic trauma hospital admissions, KNH, July-August 2011

Characteristic/parameter	Pedestrians (n= 104)	MVO (n=43)	Motorcyclists (n=17)	Bicyclists (n=9)	Drivers (n=3)	All (n=176)	p-value	All(excluding pedestrians) (n=72)
Gender and Age								
Proportion of men	76.9	72.1	98.1	100	66.7	78.4		80.6
Mean Age (SD)*	31.5 (±13.347)*	32.7 (±12.102)**	32.9 (±10.043)	37.8 (±12.498)	34.67 (±3.055)	32.29 (±12.59)#	0.6798	33.5 (±11.372)
Median age*	30.0*	30.0**	29.0	37.0	34.0	30.0		30.0
Length of hospital stays (LHS)								
Mean LOS (SD)	31.00 (±23.609)	34.17 (±26.082)	29.54 (±20.152)	22 (±18.665)	33 (±19.799)	31.19 (±23.469)	0-8339	31.51 (±23.471)
Median LHS	26.00	29.00	29.00	17.00	33.00	26.50		26.00
Minimum days	2	1	5	6	19	1		1
Maximum days	115	90	68	59	47	115		90
Range in days	113	89	63	53	28	114		89
Bed Days	2573	1025	384	132	66	4180		1607

**(n=103); **(n=40); #(n=172)*

Table 4.5: The mean length of hospital stay and bed days by different categories of road users admitted, KNH, July-August, 2011

Category of road user	Length of Hospital Stay			
	No of cases*	Bed days, *n* (%**)	MLOHS(SD ±)	p-value
Pedestrians	83	2573(61.6)	31.00(±23.7)	0.9034
Motor-vehicle passengers	30	1025(24.5)	34.17(±26.1)	0.4331
Motorcyclists	13	384(9.2)	29.54(±20.2)	0.7901
Bicyclists	6	132(3.2)	22(±18.7)	0.3281
Drivers	2	66(1.58)	33(±19.8)	0.9132
All Categories	134	4180(100)	31.19(±23.5)	0.8339

**Information on the mean length of hospital stay, bed days for each category of road user was calculated based on the number of road trauma admissions for the category of road user which had complete information on date of admission and date of discharge. **represents the per cent of the total bed days for all road users*

4.3.3 Types of injuries

Table 4.6 presents the type of injuries that were sustained by admitted pedestrians. Information on the type of injury was available for 96 (92.3%) of admitted pedestrians. Most of the injuries [65 (67.7 %)] occurred to both the upper and lower limbs, and ten (10.4 %) to the head and neck regions. Multiple injuries were reported in nine (9.4 %) cases.

Table 4.6 Injury distribution by body region, admitted pedestrians, KNH, June-August, 2011 (n=96)

Types of injuries	Frequency	Percentage
Limb injury (upper and lower limb)	65	67.7
Head and neck	10	10.4
Multiple	9	9.4
Abdomen including lumbar spine and pelvic contents	5	5.2
Face	3	3.1
Thorax including dorsal spine	3	3.1
Unspecified	1	1.1
TOTAL	96	100

4.3.4 Pedestrian injuries and hospital admissions by day of the week

The highest number of injured pedestrians were admitted on Sundays and Saturdays, 20 (19.6%) and 18 (17.6%) respectively. Thursdays had the lowest number 10(9.8%) of admitted pedestrians (Figure 4.3). The highest number of crashes involving pedestrians occurred on Saturday, 26 (25.5%), followed by Sunday, 17 (16.7%) and Friday, 16 (15.7%). Saturdays and Sundays had 43 (42.2%) pedestrian crashes compared to 36 (50%) of all other days road traffic injury admissions.

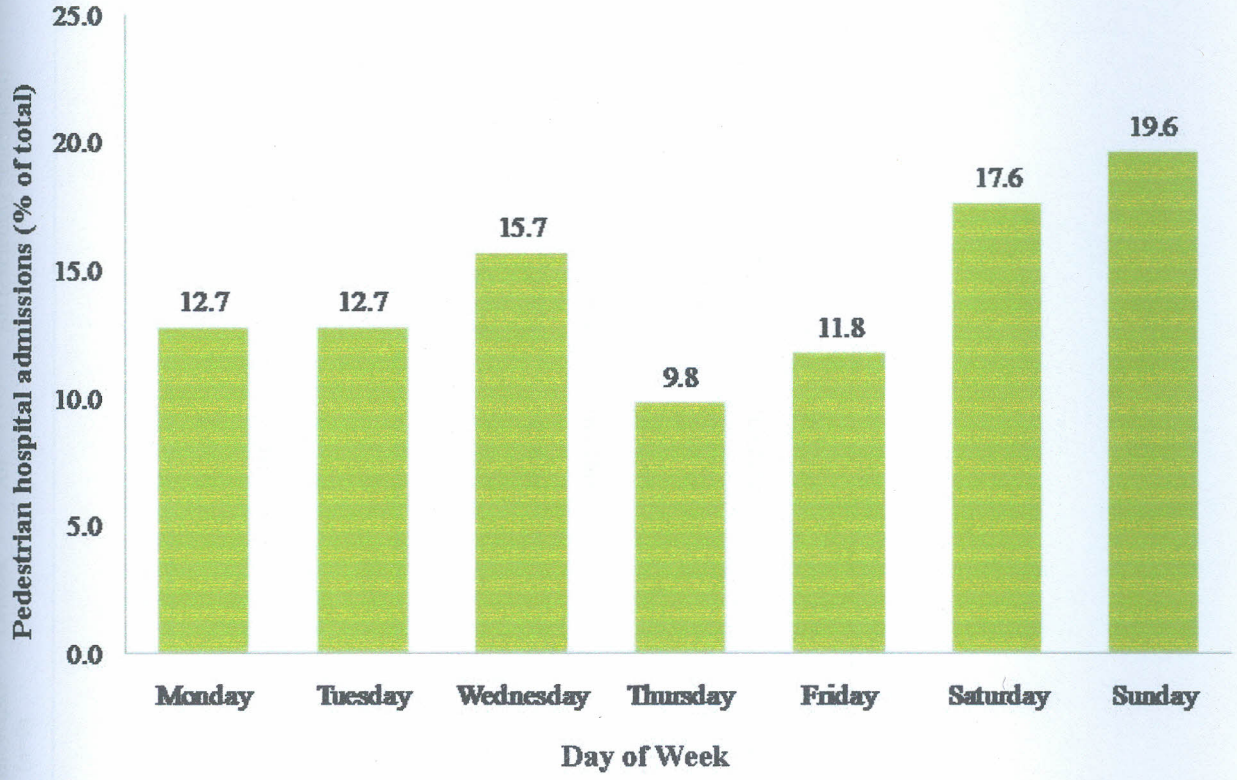

Figure 4.3 Pedestrian injury hospital admissions by day of week, KNH, 1st July to 31st August 2011

4.3.5 Hospital admission outcome

Analysis of the outcomes of admitted pedestrians indicated that of the 104 pedestrians admitted to KNH during the study period, 77(74%) were discharged home, 13 (12.5%) absconded and left the hospital against medical advice while one case (1%) was transferred to another hospital. One admitted pedestrian (1%) died at the hospital: giving in-hospital case-fatality rate of 1%. At the time the study terminated, 12 (11.5%) pedestrians were still admitted at the hospital (Table 4.7).

Table 4.7 Day of week crash occurred and hospital admission outcome, KNH, July-August 2011

Characteristic	Pedestrians (n= 104)	Passengers (n=43)	Motorcyclists (n=17)	Bicyclists (n=9)	Drivers (n=3)	All (n=176)	All (excluding pedestrians) (n=72)
Admission outcome, n (%)							
Discharged from Hospital	77(74.0)	25(58.1)	12(70.6)	6(66.7)	1 (33.3)	121(68.8)	44(61.1)
Absconded	13(12.5)	3(7.0)	2(11.8)	-	-	18(10.2)	5(6.9)
Transferred to another hospital	1(1.0)	-	-	-	-	1(0.6)	-
Still admitted two weeks after study terminated	12 (11.5)	12(27.9)	3(17.6)	3(33.3)	1 (33.3)	31(17.6)	19 (26.4)
Died in Hospital	1(1.0)	3(7.0)	-	-	1 (33.3)	5(2.8)	4(5.6)
Day of the week the crash occurred							
Monday	11(10.8)	5(11.6)	2(11.8)	2(25.0)	-	20(11.5)	9 (12.5)
Tuesday	11 (10.8)	3(7.0)	2(11.8)	-	-	16(9.2)	5 (6.9)
Wednesday	12 11.8)	5(11.6)	2(11.8)	-	-	19(10.9)	7 (9.7)
Thursday	9 (8.8)	5(11.6)	2(11.8)	2(25.0)	1 (33.3)	19(10.9)	10 (13.9)
Friday	16 (15.7)	4(9.3)	1(5.9)	-	-	21(12.1)	5 (6.9)
Saturday	26 (25.5)	7(16.3)	4(23.5)	2(25.0)	-	40(23.0)	14 (19.4)
Sunday	17 (16.7)	14(32.6)	4(23.5)	2(25.0)	2(66.7)	39(22.4)	22 (30.6)

(n=103);* *(n=40);* *#(n=172);*

4.3.6 Collision characteristics and length of hospital stay

One hundred (96.2%) of admitted pedestrians were hit by motor vehicles while four, (3.8%) admissions resulted from pedestrian-bicyclist collisions. Figure 4.4 depicts the proportions of different categories of motor-vehicles that hit pedestrians. Of the 100 pedestrians hit by motor vehicles, 94(94%) were hit by motorized-four wheelers, 5(5%) were hit by motorized-two wheelers and 1%, was hit by motorized-three wheelers.

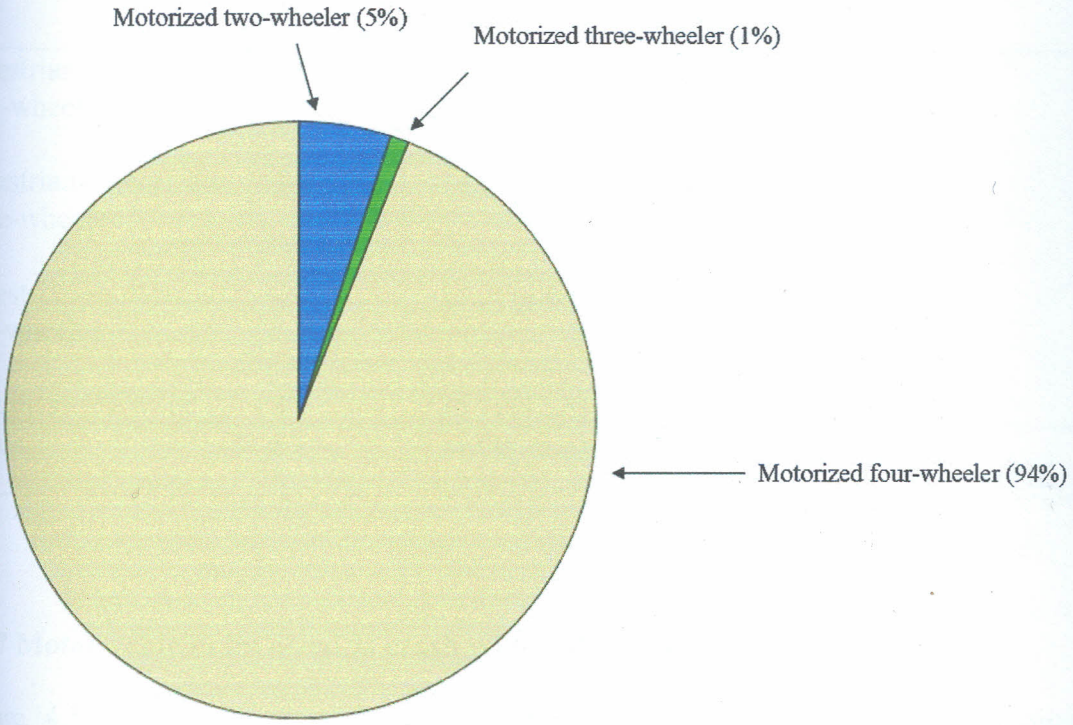

Figure 4.4 Proportion of motor vehicles involved in conflict with pedestrians

Table 4.8 presents the results on mean length of hospital stay for different pedestrian-collision types. The highest mean LOS, 35.00 (SD±12.8), was observed amongst pedestrians admitted as a result of pedestrian-bicyclist conflicts, followed by mean LOS for pedestrians admitted as a result of pedestrian-motorized four wheeler conflicts, 31.88(SD±24.4).

Table 4.8 Types of Pedestrian collisions, mean LOS and median

Conflict Characteristic	Length of stay					
	Frequency	Mean (±SD)	Median	Minimum	Maximum	Range
Pedestrian -motorized four-wheeler	74	31.88(24.4)	26.00	2	115	113
Pedestrian-motorized three-wheeler	1	29.00(0.0)	29.00	29	29	0
Pedestrian-motorized two-wheeler	4	11.25(4.6)	12.00	5	16	11
Pedestrian Bicyclist	4	35.00(12.8)	30.00	26	54	28
Total	83	31.00(23.6)	26.00	2	115	113

4.3.7 Motor vehicles involved in crash with pedestrians.

Figure 4.5 presents the proportion of motorized-four wheeler vehicles that injured pedestrians. Cars were the leading (39.4 %) category of motorized four-wheeler vehicles that hit pedestrians, followed by *matatus* (34.0 %), buses (12.8 %), and lorries (9.6 %). Public transport vehicles (*matatus* and buses) injured a total of (46.8%) of the admitted

pedestrians. Other vehicles responsible for injuries were: pick up vans [3 (3.2 %)] and lorry trailers [1 (1.1%)].

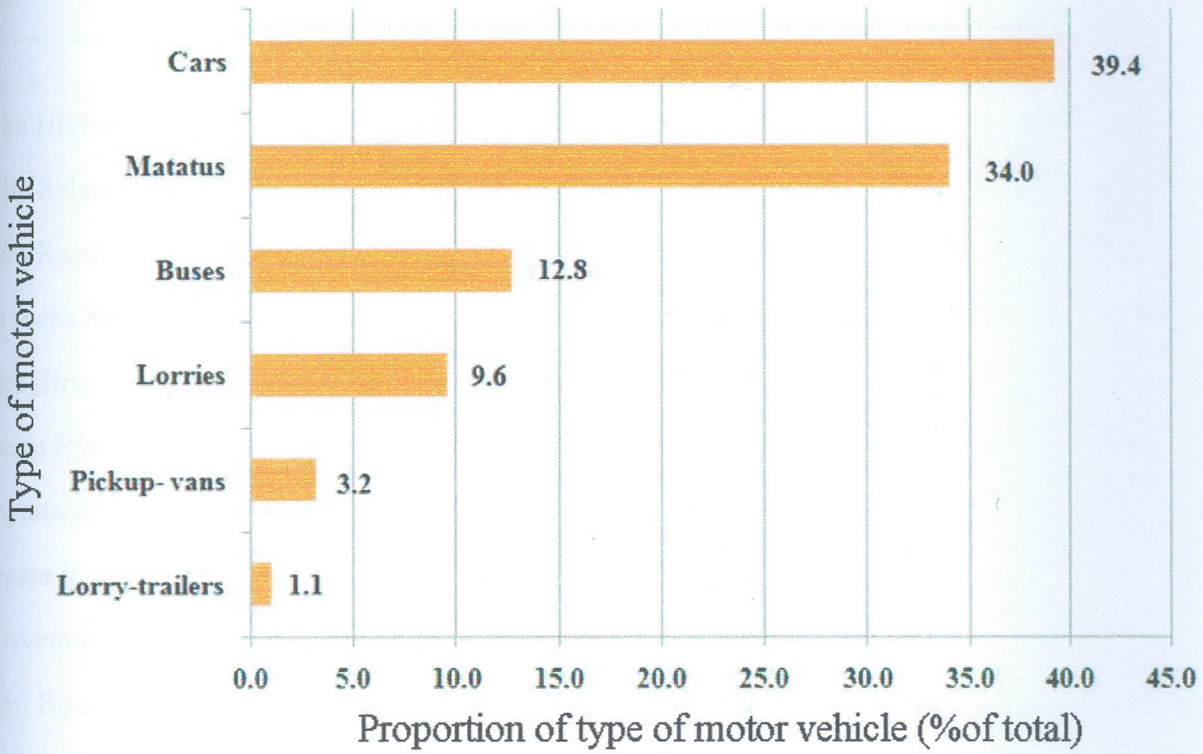

Figure 4.5 Proportion of motorized-four wheeler vehicles responsible for pedestrian injuries, KNH, July-August, 2011

4.3.8 Distribution of pedestrian crashes by road of collision

The highest number of pedestrian injuries was reported on Thika Highway, [16 (15.4%)], followed by Haille Selasie [6 (5.8%)] then Jogoo Road and Mombasa Road [5(4.8%)]

each. Outer Ring Road, Eastern Bypass, and Kenyatta Avenue reported [4 (3.8%)] each (Table 4.9).

Table 4.9 Occurrence of pedestrian crashes on roads in Nairobi

Road	Frequency	Percent
Thika Highway	16	15.4
Haille Selasie	6	5.8
Jogoo Road	5	4.8
Mombasa Road	5	4.8
Outer Ring	4	3.8
Eastern Bypass	4	3.8
Kenyatta Avenue	4	3.8
Langata Road	3	2.9
1st Avenue	2	1.9
Forest Road	2	1.9
Mbagathi Way	2	1.9
Moi Avenue	2	1.9
Ngong Road	2	1.9
Uhuru Highway	2	1.9
Waiyaki Way	2	1.9
Other roads mentioned (43)*	43	41.3
TOTAL	104	100

**Each road had a frequency of 1 totaling to 41.3%*

4.4 Characteristics of road traffic crashes and injuries reported by traffic police in Nairobi

4.4.1 Distribution of road crash casualties by road user category

A total of 107 road traffic cases were reported to traffic police during the study period, 1June to 31 August 2011. Pedestrians constituted the highest proportion 74 (69.2%), followed by passengers 18 (16.8%); drivers were 8 (7.5%), bicyclists 4 (3.7%) and motorcyclists and pillion passengers (less than 1%) (Figure 4.6).

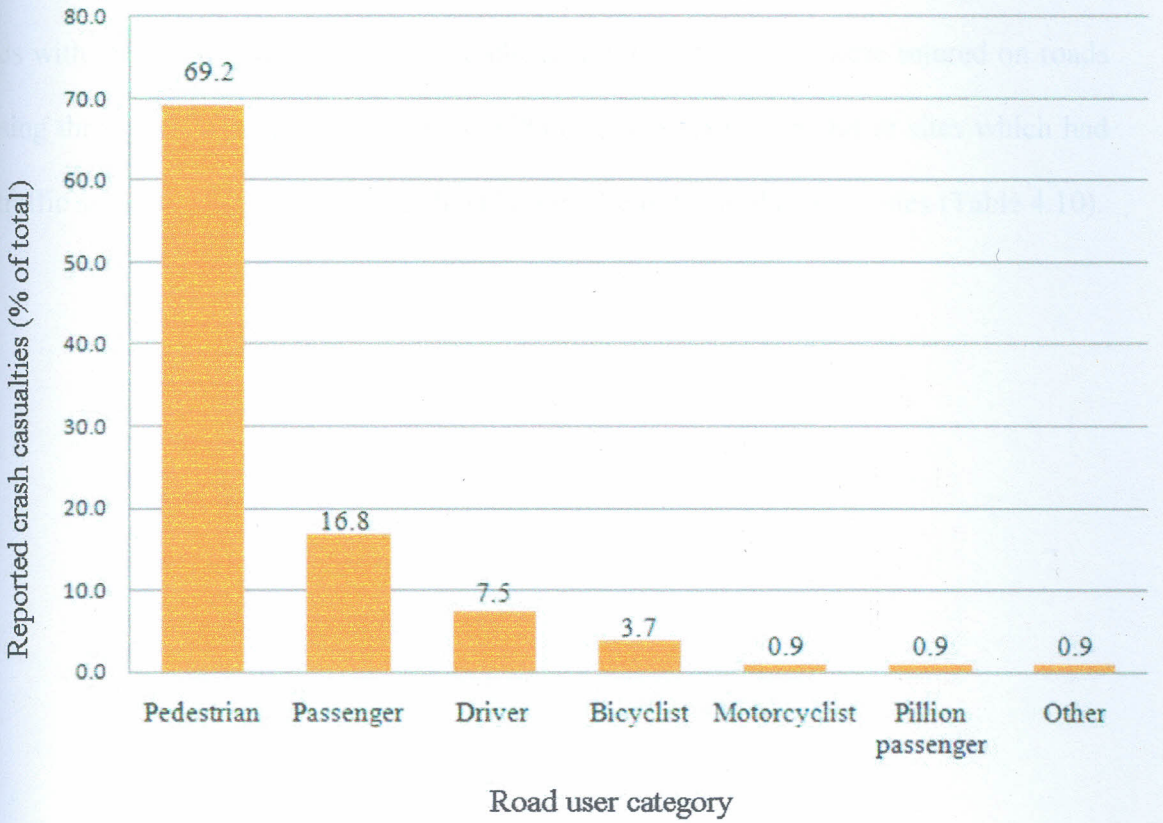

Figure 4.6 Distribution of road crash casualties by road user category, Nairobi City, June-August, 2011

4.4.2 Injury Severity

Of the 74 pedestrians reported in traffic crashes in Nairobi, 13 (17.6%) were assessed by police to be slightly injured, 35 (47.3%) to be seriously injured while 26 (35.1) were fatal, resulting in a case fatality rate of 35.1% (Table 4.10).

4.4.3 Road Conditions and Surroundings

A total of 68 (91.9%) pedestrians were injured on the tarmac roads, 5 (6.8%) on murram roads while 1 (1.4%) case was injured on earth road. Thirty four (47.9%) were injured on roads with shops on both sides of the roads, and 21(29.6%) cases were injured on roads passing through residential areas. About 85% of pedestrians were hit at sites which had no traffic signs and 51% at sites which had no traffic lights at the crash sites (Table 4.10).

Table 4.10: Characteristics of pedestrian crashes and injuries, Nairobi City, Kenya, June-August, 2013

Variable	Frequency	Percentage
Degree of injury (n = 74)		
Slight	13	17.6
Serious	35	47.3
Fatal	26	35.1
Total	74	100
Road Surface type (n =74)		
Tarmac	68	91.9
Murram	5	6.8
Earth	1	1.4
Total	74	100
Facilities opposite crash site (n=71)		
School	8	11.3
Shops	34	47.9
Informal Traders like hawkers	5	7
Drinking pub(s)	3	4.2
Residential	21	29.6
Total	71	100
Crash at junction (n=67)		
Yes	20	29.9
No	47	70.1
Total	67	100
Traffic sign at crash site (n=69)		
Yes	10	14.5
No	59	85.5
Total	69	100
Traffic light at crash site (n=55)		
Yes	4	7.3
No	51	92.7
Total	55	100

4.4.4 Day of week

Pedestrian fatalities were most common on Saturdays (26.9) and Thursdays (19.2%) but least common on Fridays and Sundays (7.7%). A two-sample proportion comparison test revealed that pedestrian fatalities reported on Saturdays were not significantly different from those on Mondays and Tuesdays ($p=0.079$) and Wednesday ($p=0.159$) and Thursdays ($p=0.255$). Pedestrian fatalities were significantly greater on Saturdays than on Sundays and Fridays ($p=0.034$) (Table 4.11).

4.4.5 Time of the day

Time of the day was categorized into eight three-hour groups, and each category was compared to a reference period (Damsere-Derry *et al.*, 2010). A total of 40 (56.3%) of pedestrian injuries, and 13 (52%) fatalities were reported to have occurred between the hours 18-06 (Table 4.11). Among the pedestrian fatalities, there were no discernible differences between most of the strata compared with 09-12 ($p\geq0.05$). A two-sample comparison test indicated that the proportion for 09-12 was significantly higher than the early hours of the day ($p=0.009$).

Table 4.11: Temporal Trend, Pedestrian Injuries and fatalities, Nairobi City, Kenya, June-August, 2013

Variable	Fatal, *n (%)*	Serious, *n (%)*	Slight, *n (%)*	Total, n (%)
Day of Week (n=74)				
Sunday	2(7.7)	6(17.1)	2(15.4)	10 (13.5)
Monday	3(11.5)	3(8.6)	3(23.1)	9 (12.1)
Tuesday	3(11.5)	3(8.6)	1(7.7)	7 (9.5)
Wednesday	4(15.4)	9(25.7)	2(15.4)	15 (20.3)
Thursday	5(19.2)	3(8.6)	1(7.7)	9 (12.1)
Friday	2(7.7)	7(20)	2(15.4)	11(14.9)
Saturday	7(26.9)	4(11.4)	2(15.4)	13(17.6)
Total	26(100)	35(100)	13(100)	74 (100)
Hour of day (n=71)				
00-03	*0(0)*	*2(6)*	*1(8)*	*3 (4.2)*
03-06	*2(8)*	*0(0)*	*1(8)*	*3 (4.2)*
06-09	2(8)	4(12)	1(8)	7 (9.8)
09-12	5(20)	2(6)	1(8)	8 (11.3)
12-15	2(8)	4(12)	2(17)	8 (11.3)
15-18	3(12)	3(9)	2(17)	8 (11.3)
18-21	*4(16)*	*12(35)*	*3(25)*	*19 (26.8)*
21-24	*7(28)*	*7(21)*	*1(8)*	*15 (21.1)*
Total	25(100)	34(100)	12(100)	71(100)

4.4.6 Motor vehicles involved in traffic crashes

Figure 4.7 presents the proportion of four-wheeler motor vehicle involved in road traffic crashes. Cars comprised 27 (44.3%) followed by *matatus* 15 (24.6%), pickup vans 8 (13.1%), lorries 6 (9.8%), unknown 5(4.9%) and buses 4 (3.3%)..

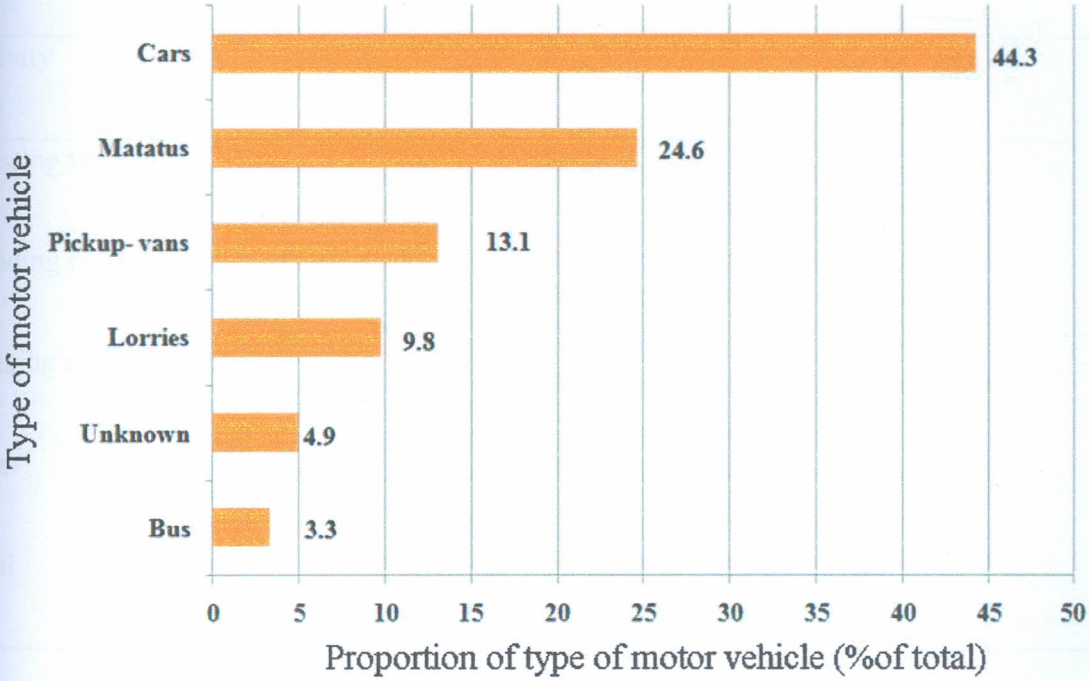

Figure 4.7 Proportion of motorized-four wheeler vehicles involved in pedestrian injuries, Nairobi City

4.4.7 Pedestrians activities and location

Information on where pedestrians were hit was available from a total of 73 pedestrians and indicated that 53 (72.6 %) pedestrians were injured while crossing the road, 8 (11 %) were standing by the road while 6 (8.2 %) were walking along the road, and another 6 (8.2 %) were hit while engaging in other activities including hawking (Table 4.12).

Table 4.12 Pedestrians activity at the time of crash, (n=73)

Activity	Frequency	Percentage
Crossing the road	53	72.6
Standing by the road	8	11.0
Walking along the road	6	8.2
Other	6	8.2
Total	73	100

4.5 Pedestrian safety in Nairobi

4.5.1 Policy Framework, Strategy and Institutions

4.5.1.1 Institutional Framework for Road Sub-sector

The responsibility for roads infrastructure was vested in the Ministry of Roads by the enactment of the Kenya Roads Act 2007. The Roads Act 2007 also established three new Road Agencies namely: the Kenya National Highways Authority (KeNHA), responsible for Class A, B and C roads; Kenya Rural Roads Authority (KeRRA), responsible for Class D, E and other roads; and, Kenya Urban Roads Authority (KURA) responsible for urban roads. Financing and provision of technical audits is the responsibility of Kenya Roads Board (KRB).

4.5.1.2 Integrated National Transport Policy and Nairobi Metro 2030

The National Transport Policy Committee was launched on 2nd of April 2003 with the sole mandate to formulate an Integrated National Transport Policy (Republic of Kenya, 2004). The Committee produced the full report in May, 2009 (Republic of Kenya, 2009a) and the Sessional Paper on Integrated Transport Policy prepared in 2010 (Republic of Kenya, 2010). The policy paper recognizes "the need to eliminate impediments to non-motorized and intermediate means of transport, enhance transport safety and security, and develop and maintain a safe and secure transport system" (Republic of Kenya, 2009a). In a New Framework for Transport Sector Management, the policy proposals recognize the importance of non-motorized transport in "addressing the needs of the poor" as well as in promoting the health of the population. To achieve this, the policy paper recommends integration of non-motorized transport in the design, development and operation of all modes of transport (Republic of Kenya, 2009a). The stated aims of these proposed measures would be to enhance role for non-motorized transport in urban and rural areas (Republic of Kenya, 2009a). In a 5-chapter report, comprising 241 pages, the safety of non-motorized transport is covered in Chapter 4, under a sub-section called Safety of NMT users (Republic of Kenya, 2009a). The Sessional paper on Integrated National Road Transport empowers the local authorities to support the development and maintenance of infrastructure for walking and bicycling like adequate sidewalks and pavements for pedestrians; separate lanes, parking bays, bridges, and other facilities for bicycles (Republic of Kenya, 2010).

The Nairobi Metro 2030 was prepared by the Ministry of Nairobi Metropolitan Development in 2008 as a blueprint for the development of the Nairobi Metropolitan Region (Ministry of Nairobi Metropolitan Development, 2008b). The Nairobi Metropolitan Region covers a total of 32,000 km^2 and is composed of 15 local authority areas including the City Council of Nairobi. Metro 2030 set target of reducing road traffic deaths by 75% by 2012 (Ministry of Nairobi Metropolitan Development, 2008b). In order to achieve the objectives for the required transport system, the Nairobi Metro 2030 identified three key implementation areas, namely: road transport infrastructure measures; traffic management strategies; traffic law enforcement (Ministry of Nairobi Metropolitan Development, 2008b).

The road transport infrastructure measures focus on construction of new roads which it proposed would save both time and costs; and, the dualling of main roads which have had perennial congestion to deal with the congestion problems in the metropolitan region (Ministry of Nairobi Metropolitan Development, 2008b). In the road transport infrastructure measures, pedestrians are mentioned as 'other measures' like "construction of overpasses that do not strengthen existing barrier to pedestrian flows". It mentions, as a 'critical concern', the need to "ensure adequate provision for metropolitan wide non-motorized transport mobility network" (Ministry of Nairobi Metropolitan Development, 2008b).

The Metropolitan Road Safety Programme planned to achieve 'significant' reductions in road traffic deaths through adoption of a 'Zero Crash' programme (Ministry of Nairobi Metropolitan Development, 2008b). Presented in Table 4.13 below is the budget for various components aimed at achieving the targets of optimizing mobility and accessibility through effective transportation. The table indicates that a higher proportion of the budget [760.2 billion Kenya Shillings (88.7%)] was allocated to Metropolitan Road Transport Infrastructure development. The budget earmarked for road safety was the lowest [(0.1 billion Kshs (0.01%)]. The Metropolitan Road Safety Programme strategies performance time frame were probably viewed as short term measures, with the time frame set was by June 2009, one year after the presentation of the Metro 2030 document; this was a shorter period than the Metropolitan Road Transport Infrastructure Programme, June 2010 (Ministry of Nairobi Metropolitan Development, 2008b).

Table 4.13: Mobility and Accessibility Budget, Nairobi Metropolitan Region, 2008

Implementation areas	Performance time frame	Budget (Kshs billions)	% of total (budget)
Metropolitan road transport Infrastructure programme	June 2010	760.1	88.7
Metropolitan mass rapid transit	By 2015	80.4	9.38
Metropolitan road safety programme	By June 2009	0.1	0.01
Integrated transport infrastructure Systems	By June 2010	15	1.75
Transport logistics and supply chain management	By June 2009 and continued	0.2	0.023
Develop an integrated institutional Framework for transport management	By June 2009	1	0.11
TOTAL		856.8	100

Source: Ministry of Nairobi Metropolitan Development (2008)

Table 4.14 presents the budget for the four strategies that were proposed to be used for implementing objectives aimed at improving the road transport infrastructure for Nairobi Metropolitan Region (Ministry of Nairobi Metropolitan Development, 2008b). The greatest proportion of the proposed budget [Kshs 500 billion (65.8%)] was for new road construction, including construction of overpasses and bypasses. This was followed by the budget for improvement of existing roads network Ksh 200 billion (26.3%)]. The budget earmarked to implement a non-motorized transport strategy, providing for NMT facilities, pedestrianisation and vehicle-restriction measures and public awareness campaigns, was only Kshs 0.1 billion (0.13%) (Ministry of Nairobi Metropolitan Development, 2008)

Table 4.14: Improvement of Metropolitan Road Transport Infrastructure Budget, Nairobi Metropolitan Region, 2008.

Strategies	Indicator and Timeframe		Budget	
	Performance indicators	Completion Timeframe	(Kshs billions)	% of total
Rehabilitation of the estate road network	Kilometers completed	None	60	7.9
Improve the existing road network construction of overpasses and by-pass roads	Kilometers completed	None	200	26.3
New road construction including construction of overpasses and by-pass roads	Kilometers completed	None	500	65.8
Implement a non-motorized transport strategy, providing for NMT facilities, pedestrianisation and vehicle-restriction measures and public awareness campaigns	Non-motorized strategy in place	None	0.1	0.13
OVERALL			760.1	100

Source: Ministry of Nairobi Metropolitan Development, 2008

4.5.2 Traffic Law Enforcement

Enforcement of traffic regulations is the responsibility of Traffic Police (Laws of Kenya, 1993). In the city of Nairobi, the City Inspectorate Department augments the Kenya Police in enforcement of certain safety regulations (City Council of Nairobi, 2010). The Sessional Paper on Integrated National Transport Policy (Republic of Kenya, 2010)

empowers Local Authorities to enforce by-laws on use of non-motorized transport. The City Inspectorate Department is currently involved in enforcement by arresting and charging in courts pedestrians who use cell phones while crossing the roads and motor vehicle passengers who alight or board motor vehicles at none-designated points in the city (City Engineer, personal communication). Speed limit within the boundaries of any trading centre, township, municipality or city is set at 50 km/hr in Kenya (Laws of Kenya, 1993).

Contravening or failing to comply with these provisions constitutes an offence. A recent development aimed at traffic safety improvement in Kenya is the introduction of the use of speed radar cameras, as a strategy to enforce compliance with the speed limit rules (Laws of Kenya, 2011b). This legislation on speed cameras was introduced along with other measures such as legislation to control drunken driving (Laws of Kenya, 2011a).

However, enforcement of speed limit in Kenya is inadequate. A World Health Organization study in reviewing the country health profiles, for example, asked the respondents to rate the effectiveness of enforcement of various elements of road safety legislation on the basis of their professional opinion or perception (World Health Organization, 2009). WHO used enforcement score which represents consensus based on professional opinion of respondents, on a scale of 0 to 10, where 0 is not effective and 10 is highly effective. Using these criteria, enforcement score of speed limit in Kenya was 4 in the WHO scale (World Health Organization, 2009).

Effective enforcement of traffic regulations is perceived to be hampered by inadequate deterrent measures, flaws in punitive judgments given by the adjudication authority, poor co-ordination between traffic control and the adjudication function (Republic of Kenya, 2004); poor involvement and coordination of different stakeholders (Assum, 1998; Khayesi, 1998); and, corruption (Kebede, 2001; Republic of Kenya, 2004; Sanborn, 2007). Enforcement of the speed limit remains a major challenge, and poor coordination between traffic control and the adjudication functions hinders effective enforcement of laws and regulations (Republic of Kenya, 2004). The use of speed cameras was recently introduced as strategy to monitor and enforce compliance with posted speed limits (Laws of Kenya, 2011b).

4.5.3 Road Traffic Engineering

The drainage of the roads in Nairobi is poor or absent on some roads, contributing to the quick deterioration of the roads networks during the rainy season (Kenya Institute for Public Policy Research and Analysis, 2006). The water logging renders the roads impassable and interferes with pedestrias and motorised trasport movemets (Kenya Institute for Public Policy Research and Analysis, 2006). Infrastructure for walking is inadequate. A study which sampled six major roads in Nairobi, comprising a total distance of 51.4 km, revealed that only three crossing facilities were provided for and that left sidewalk was provided in a distance of 35.2 km (68.5 %) (United Nations Environmental Programs, 2009). The interaction between vehicles, users, and the road in Nairobi creates risks for pedestrians (Gonzalles *et al.*, 2009). There are no specific

designs for pedestrians in the City of Nairobi except for a few streets which are currently being designated for pedestrians (Nairobi City Engineer, 2011).

Some efforts are being made at reduction of traffic complexity for non-motorized users in urban traffic by designating some streets for pedestrians only (City Engineer, 2011). Mama Ngina Street, Kaunda Street, Standard Street, and Luthuli Avenue have been specifically assigned for non-motorized transport (City Engineer, 2011). It is believed that this strategy will increase the number of route options for cyclist and pedestrians and also help minimize and/or soften conflicts and confrontations between motorized traffic and cycling/pedestrian traffic (City Engineer, 2011). Specific projects targeting NMT facilities under implementation are Muthurwa CBD Project and NMT facilities along 1st Avenue Eastleigh.

The Sessional Paper on Integrated National Transport empowers local authorities and road agencies to: support the development and maintenance of infrastructure for walking like adequate sidewalks and pavements for pedestrians, footpaths, and other facilities for pedestrians; and, enhance safety on the roads by specifying technical standards for each category of non-motorized transport (Republic of Kenya, 2010). However, the design manuals which have been used in planning is deficient in many aspects regarding pedestrian safety and infrastructure and are still under review to include pedestrians needs (City Engineer, 2011). The Design Manuals for Urban areas has been in a draft form since the year 2001(City Council of Nairobi, 2010).

4.5.4 Road Safety Education

In Kenya, road safety education is incorporated in the Ministry of Education Curriculum (Republic of Kenya, 2002), and is taught in lower primary classes as a unit called *Safe Travel to and from School*. The contents are covered in standard two and are grouped under three subtopics, how to ride a bicycle safely; basic road signs; and, dangers to be avoided on the road (Republic of Kenya, 2002). Road safety education is also highlighted in *the National School Health Guidelines* (Republic of Kenya, 2009b). The *National School Health Guidelines* was a joint undertaking between the Ministry of Public Health and Sanitation and Ministry of Education (Republic of Kenya, 2009b). The nine-chapter guideline has one chapter entitled *School Infrastructure and Environmental Safety.* The section *Transport Safety* of the chapter recommends that there should be collaboration between the key stakeholders in road safety education like the Ministry of Education, the National Road Safety Council and the traffic police to instruct children on road safety key road safety aspects like zebra crossings, bumps, and traffic lights (Republic of Kenya, 2009b). An interview with traffic officer in the city indicated that there are occasional sessions of traffic safety education but because of resource constrains it is not a regular and sustained activity (Traffic Officer, Personal Communication).

4.5.5 Media, private companies, non-governmental organizations

In the city of Nairobi, the Nairobi City Council Authority is working with various media such as *Standard Newspaper*, *The People* and *The Star*, and sponsors like the *Shell Company* to support road safety education in the city (City Engineer, Personal Communication). Churches and schools are being encouraged by the City Council

Department of Education to educate their members on road safety (City Engineer, Personal Communication).

Two non-governmental Organizations that are engaged in road safety education, particularly among primary schools in the city of Nairobi, are the *Lollipop Project* (The Lollipop Project, 2011) and the *Association for Safe International Road Travel (ASIRT)* (Association for Safe International Road Travel, 2011). ASIRT is a non-profit, non-governmental organization that promotes global road safety through education, advocacy and targeted road safety projects in low and middle income countries (Association for Safe International Road Travel, 2011). ASIRT activities in Kenya include: national road safety efforts; *matatu* safety; youth involvement; child safety programs; advanced trauma training and injury prevention; post-crash care; memorial quilt program; and, international awareness events (Association for Safe International Road Travel, 2011).

Lollipop Project also works with various road safety stakeholders like the Nairobi Traffic department to promote children's safely on the roads. The major sponsors of the Lollipop project include the oil companies such as *the Shell, General Motors, Isuzu, chloride exide, UAP* (The Lollipop Project, 2011). The motto of Lollipop Project is to train children to become "road traffic compliant drivers of tomorrow" (The Lollipop Project, 2011).

CHAPTER FIVE: DISCUSSION

5.1 Introduction

This chapter discusses the main findings of the study. It is divided into seven sections: the first section discusses the findings on demographic characteristics of road traffic injury hospital admissions while the second section discusses the findings on overrepresentations of pedestrian in road traffic crashes in Nairobi. The third section discusses the findings on circumstances of crashes involving pedestrians and the fourth section discusses the finding on strategies aimed at improving safety of pedestrians. Finally, limitations of the study are discussed.

5.2. Demographic Characteristics of road traffic injury hospital admissions

The findings of the study that males were overrepresented (78.4 per cent) in road traffic injury admissions to KNH is consistent with previous studies on admitted road traffic injury cases to KNH where males were shown to comprise 84.6% of all traffic injury cases (Said, 2003). It is also consistent with a study that examined the data of the road traffic injury cases that were treated at the Casualty Department of KNH (Gichuhi, 2007) where males were shown to 74.6 per cent of all traffic injury cases seen at the Emergency Department of KNH. Overrepresentation of males among road traffic injuries in road traffic injury cases was also demonstrated in a study conducted in Nairobi Hospital, a private hospital adjacent to KNH where the proportion of males was 63.1 per cent of all road trauma cases seen at the Casualty Department of Nairobi Hospital (Said, 2000). Other hospital-based studies conducted in Nakuru (Limbalala and Chirwa, 1992),

Eldoret, (Odero, 1997), and in Kisumu (Ogendi and Ayisi, 2011) also showed overrepresentation of males with proportion of males being between 65% and 92%. This study reinforced the earlier findings that males are overrepresented in traffic injuries in Nairobi even in a study that specifically analysed only road traffic injury admissions that took place in Nairobi and admitted to Kenyatta National Hospital.

In low-income and middle-income countries, males predominate in traffic casualties. A study that reviewed 46 studies that described road traffic casualties by sex in low-income and middle-income countries revealed that males comprised between 67 and 99.5% (mean 80%) in all the studies (Odero *et al.*, 1997). According to the study, the ratio of male to female was greater than 2 in all studies, but greater than 3 in 83% of the studies. Globally in 2002, overall death rate for males was almost three times that for females: 27.6 per 100 000 population for males compared to 10.4 per 100 000 population for females (World Health Organization, 2013a).

The overrepresentation of males in traffic injuries observed in Nairobi cannot be explained by population characteristics in terms of gender differentials; the estimated populations of males and females in Nairobi in the year 2009 were 1 605 230 and 1 533 139 respectively, with a male to female ratio of about 1:1.1 (Kenya National Bureau of Statistics, 2010). The male to female ratio in road traffic injury admissions was about 3 times that of the population in Nairobi (3.6:1 for traffic injury admissions compared to 1:1). Overrepresentation of males has been demonstrated in several studies (Friis and Sellers, 1996). This is probably due to the greater exposure of men to traffic, higher risk-taking behavior amongst men, or increased risk due to other factors, given similar

exposure levels (Odero *et al.*, 1997; Peden *et al.*, 2004). The findings of this study that there has been no change in male to female ratio in road traffic casualties in Nairobi implies that underlying factors or differential exposures may not have changed.

The demonstrated distribution of road traffic injury admissions by age group, where young adults aged between 15 and 44 years is the group most affected, is in agreement with previous studies conducted in Nairobi (Gichuhi, 2007) Eldoret (Odero, 1997), Nakuru (Limbalala and Chirwa, 1992), and Kisumu (Ogendi and Ayisi, 2011). Studies indicated that this age group comprised 82 per cent, 77.8 per cent, 92 per cent and 65 per cent, respectively. The observed overrepresentation of this age group in injury admissions cannot be explained by population characteristics with regards to age structure for Nairobi: although our findings indicate that young adults aged between 15 and 44 years constituted 75% of all road traffic injury admissions to KNH, this segment of population comprise only 44.4% of the total population of Nairobi (Kenya National Bureau of Statistics, 2010). Globally, young adults aged between 15 and 44 years have also been reported to account for 59% of road traffic deaths and about 60% of the DALYs lost globally as a result of road traffic injury globally (Peden *et al.*, 2004b).

Our finding indicated that the case-fatality rate was 2.8% which was slightly lower than that reported in a rural hospital close to Nairobi, Kijabe Hospital which reported case fatality rate of 3.5% (Otieno *et al.*, 2004). The low case fatality rate observed in the two studies strengthens the suggestions that the true magnitude of road traffic crashes cannot captured through studies based on mortality rates alone (Dultz *et al.*, 2013).

5.3 Characteristics of overall road traffic injuries and pedestrian admissions to KNH

Our findings that pedestrians were the leading (59%) category of road users admitted to Kenyatta National Hospital reinforces the previous hospital-based studies conducted in KNH where pedestrians were shown to comprise 69.7% of road traffic injury cases seen at the Kenyatta National Hospital Casualty Department during a six-month period from February to July 2004 (Gichuhi, 2007) and 65% of all road traffic injury cases admitted at the same hospital in 1999 (Said, 2003).

The overrepresentation of pedestrians in traffic casualties is a characteristic feature for most cities in sub-Saharan Africa. In Ethiopia, for example, pedestrians were shown to account for 91% of road traffic casualties in Addis Ababa in 1991 (Dessie and Larson, 1991). In Zambia, over 50% of road traffic casualties in urban areas were pedestrians (Jacobs *et al.*, 2000). In Uganda, hospital based studies, and hospital-based trauma registries in two hospitals, showed that pedestrians were the most frequent traffic casualties (43.5%), and the leading category of road users (45.8%) presenting with serious traffic injuries as assessed using the Kampala Trauma Score (Kobusingye and Lett, 2000). Alarmingly high proportion of road traffic deaths in some of the countries in the African region are pedestrians (Naci *et al.*, 2009). In Ethiopia, for example, 84% of road traffic fatalities occur among pedestrians, and in Cote d'Ivoire, 75 per cent of road traffic deaths occur in pedestrians (Sayer and Palmer, 1997).

Two major reasons have been advanced to explain the high prevalence of pedestrian injuries and deaths in these countries and regions. First, Mohan and Tiwari (1998) (Mohan and Tiwari, 1998) attribute road traffic fatality breakdowns to different traffic mixes in different regions of the world. In much of the African Region, walking is an important form of mobility for a large proportion of the population (Pendakur, 2005): in the African region, 38% of all road traffic deaths are pedestrians (World Health Organization, 2013a). Second, the high number of pedestrian casualties in these countries reflects, not just their inherent vulnerability, but also insufficient attention to their needs in policy-making (Vasconcellos, 2001; Khayesi, 2003). Urban transport planning in most African cities, including the city of Nairobi, is predominantly skewed to meet the needs of motor vehicle users despite the fact that a great proportion of urban population use walking as a mode of transport (De Langen, 2005).

The disproportionately high proportion of pedestrians injured in Nairobi streets is a manifestation of neglect of these categories of road users in planning for their safety. For decades, the urban and transport planners in the city of Nairobi have remained motor-vehicle centered, disregarding the safety of pedestrians (Omwenga *et al.*, 1993; Khayesi, 1997; Republic of Kenya, 2004; Republic of Kenya, 2010). Planning for pedestrians in the city of Nairobi involve few inadequate, temporary and piecemeal steps that give false impressions that some actions are being taken towards the safety of pedestrians, without really ensuring a genuine shift in transportation policies (Khayesi *et al.*, 2010).

The case of Jogoo Corridor illustrates this aspect. In the late 1990s, the International Non-motorized Transport Consultants proposed an impressive and ambitious list of interventions for pedestrians' safety for Nairobi (Pendakur, 2005). However, only a limited number of test interventions were implemented because the proposals were considered to be disruptive to the already congested traffic flow (Pendakur, 2005). In Jogoo Road, for instance, where about 30 fatalities (pedestrians and cyclists) per year occur along this 5 kilometers urban corridor (Pendakur, 2005), the International Consultants recommendation for traffic calming on the road was turned down by the city engineering department because it was felt that this would aggravate traffic problems and increase the risk of conflicts rather than resolve them (Pendakur, 2005). The City Engineers recommended, instead, and actually went ahead and constructed two pedestrian bridges despite opposition by the NMT Consultants, who pointed at local and international evidence that pedestrian overpasses tend to be "white elephants" (Pendakur, 2005). The two bridges have remained unutilized and road traffic deaths and injuries to pedestrians remain very high along Jogoo road (Pendakur, 2005).

Male predominance in traffic fatalities have consistently been documented in all regions and across all age groups previously (Nantulya *et al.*, 2003; Odero *et al.*, 2003; Peden *et al.*, 2004; Yee *et al.*, 2006). Our study adds to the evidence for the disproportionate non-fatality injury burden of the male pedestrians. Male to female ratio ranged from 1.5:1 in the age bracket of 15 to 29 to 8.4:1 in the 30 to 34 age group.

Young adult pedestrians in the age group 15 to 44 are the group most frequently (75%) injured. Though previous studies in Nairobi (Said, 2003; Gichuhi, 2007) had given this

age group as the most affected in road traffic injuries and deaths, none had specifically delineated pedestrians age group most affected. This study adds to this by indicating that pedestrians in the age group 15 to 44 are the group most frequently (75%) injured in road traffic crashes in Nairobi. Our findings do not support the finding that pedestrian injuries are most prevalent among young children of ages 5 and 9 years, and older adults over 70 years of age as reported in high-income countries (Vestrup and Reid, 1989; Traffic Safety Facts 2001, 2002; Retting *et al.*, 2003).

5.4 Day of Week

Our study reveals that the highest proportion of both pedestrians that were admitted to KNH (25.5%) occurred on Saturdays. A previous study which reviewed of epidemiological studies of road traffic injuries in developing countries showed that an average of 52 % crashes occurred during the weekends (Odero *et al.*, 1997a). Suggested reasons for this high incidence, in excess of the normal expectancy, have been given include the effect of variations in traffic density (Odero *et al.*, 1997). Traffic volumes are generally low during weekends as most people do not go to work. Drivers tend to compensate reduced vehicular density with increase in speed of motor vehicles during weekends (Peden *et al.*, 2004). In our study, a two-sample proportion comparison test using data obtained from traffic police, however, revealed that pedestrian fatalities reported on Saturdays were not significantly different from those on Mondays and Tuesdays ($p=0.079$) and Wednesday ($p=0.159$) and Thursdays ($p=0.255$). In terms of interventions to traffic safety, that would suggest that safety efforts for pedestrians should be not only on Saturdays but even equally in other days as well.

5.5 Over involvement of cars in Pedestrian crashes

This study revealed that of all the motorized-four wheeler vehicles that hit pedestrians, cars hit a total of 39.4% of pedestrians admitted to KNH and 44.3% of injured pedestrians reported to traffic police. This is an interesting finding since cars constitute only 17.4% of the total of 63, 486 registered motorized four-wheeler vehicles in Nairobi city (Kenya National Bureau of Statistics, 2012) and only 20% of Nairobi households own a car (Aligula *et al.*, 2005; Japan International Cooperation Agency, 2006).

Our study did not determine the part of the cars that hit the pedestrians. However, quite a number other previous studies (Mohan and Tiwari, 1998; O'Neill and Mohan, 2002; Parliament of Victoria, 2003) have demonstrated that the majority of fatally-injured pedestrians are hit by the fronts of cars. Creating safer car fronts is thus a key means of improving pedestrian safety vehicle safety standards as one means of protecting those outside the vehicle. Some innovative technologies like changing the shape and stiffness of vehicle fronts, which would significantly reduce the severity of injuries sustained by pedestrians when hit by a vehicle exists (Peden *et al.*, 2004b).

In Kenya, most of the imported cars are second-hand cars imported from Japan and United Arab Emirates (United Nations Environmental Programs, 2006). Performance requirements for cars that are safer to pedestrians have been provided by the European Enhanced Vehicle-safety Committee (EEVC) (Peden *et al.*, 2004b). Legislation in this area and adoption of these well-researched EEVC tests would save many lives in Nairobi

(European Road Safety Action Programme, 2003; United Nations Economic Commission for Europe regulation, 2003).

5.6 Circumstances of crashes involving Pedestrians

The findings from police data that a disproportionately high proportion (70.3%) of pedestrians was hit while crossing the road, 11% of pedestrians were hit while "standing by the road" and 8.2% while "walking along the road" reinforces previous study (Gichuhi, 2007) which showed that 62.5% of pedestrians attended to at the Emergency Department were hit by motor vehicles while crossing the road. It also agrees with a study conducted in urban environment in Ghana which found that 68% of the pedestrians killed were knocked down by a vehicle when they were in the middle of the roadway (Damsere-Derry *et al.*, 2010). The high proportion of pedestrians hit while crossing the road in urban environments underlines the fact that the road environments for the pedestrians are unsafe not only when crossing the road but also when they are "walking along the road" or just "standing by the road". This point to the need for safety-awareness in planning road networks (Peden *et al*, 2004).

The finding that about 92% of pedestrians were injured on the tarmac road, about 85% of pedestrians were hit at sites which had no traffic signs and 51% hit on sites which had no traffic light at the crash sites raises the issues of neglect of safety pedestrians in urban planning in our roads. This concern is further strengthened by our other finding in the study that the highest proportion of pedestrian injuries was reported in Thika Highway (15.4%), Haille Selasie (5.8%) and Jogoo Road and Mombasa Road 5(4.8%) each. Thika

Highway is a modern superhighway in Nairobi and was built at a cost of about Kshs 27 billion. The high number of pedestrian injuries in Thika Highway, a modern superhighway in Nairobi points to the fact that not enough attention is being paid to safety of pedestrians in Nairobi and further strengthens what has been observed that planning in the city of Nairobi is motor vehicle centered (Republic of Kenya, 2004). It points to lack of coherence in safety planning in Nairobi because though policy document stresses the need to incorporate walking in urban transport, this is still not observed in Thika Highway.

The high proportion of pedestrians injured in Jogoo Road also raises concern as to the seriousness of safety of pedestrians in urban transport safety planning. The issue of improving safety of pedestrians in Jogoo Road has been on since the early 1990s when the sub-Saharan Africa Transport Policy (SSATP) implemented a program of pilot NMT infrastructure improvements in Nairobi during 1995 to 1999 (Pendakur, 2005). The International Consultants recommended for traffic calming on the road but was turned down by the city engineering department because it was felt that this would aggravate traffic problems and increase the risk of conflicts rather than resolve them (Pendakur, 2005). The City Engineers instead constructed two pedestrian bridges which have remained unutilized yet road traffic deaths and injuries to pedestrians remain very high along Jogoo road (Pendakur, 2005). The high number (29.6%) of pedestrians injured in residential areas points to the need to think about traffic calming in residential areas (Pucher and Dijkstra, 2003; World Health Organization, 2013b).

Crossing a street safely involves the rapid and complex process which includes taking into account and assessing the speed of traffic, and recognizing and coping with visual occlusions such as parked cars, bushes, curves, and inclines of the roadway (Barton and Schwebel, 2007). Pedestrians face these complex considerations when crossing the road. Urban planning, however, has remained motor-vehicle focused, with insufficient attention to planning for pedestrians (Omwenga *et al.*, 1993; Khayesi, 1997; Republic of Kenya, 2004; Republic of Kenya, 2010).

The greatest proportion of traffic injuries to pedestrians were reported in Thika Road, 27 (15.3%) and Mombasa Road, 18 (10.2%). An earlier study by Said (2003) indicated that Thika road had the highest casualties followed by Waiyaki way, Jogoo road and, Mombasa road (Said, 2003). This high proportion of pedestrian injuries reported in Thika Road, a newly built road, raises concerns about the extent to which newly constructed roads are including the safety of pedestrian in the safety considerations. It calls for the urgent need for decision-makers, engineers and planners to give serious considerations to pedestrian safety as part of roadway design and land use planning (World Health Organization, 2013b). The World Bank emphasis is that 10% of the cost of building roads should go into safety strategies. The high proportion of pedestrian injuries is awake up call that some more serious safety considerations of pedestrians should be a top priority when new roads are being constructed in our urban areas. Some efforts are being made at reduction of traffic complexity for non-motorized users in urban traffic by designating some streets for pedestrians only (City Engineer, 2011).

5.7 Education as a Strategy for Pedestrian Safety Improvement

Our finding indicated that road safety education is covered in school curriculum and is also included in School Health Programme. The two non-governmental organizations that promote road safety in Nairobi mainly use education as a strategy to improve the road safety amongst school children. Education is also emphasized in the recommendation of the Integrated Transport Policy (Republic of Kenya, 2004) that road user knowledge, skills and attitudes be enhanced through a comprehensive approach, including formal education, non-formal education and informal education where media such as radio, television, posters, and pamphlets are used to ensure voluntary compliance. This is consistent with the historical approach to road safety work, where considerable emphasis has been placed on efforts to reduce road user error through traffic safety education – for example, in pedestrian and cycle education for school children, and in advanced and remedial driver training schemes (Peden et al., 2004).

Education has always featured as the mainstay of prevention in public health approach to injury prevention (Johnston, 1992). (Casbard *et al.*, 2003), for example, contends that to produce road safety conscious adults, it is imperative to develop road safety programmes that are progressive and address all stages of an individual's development. Educating pedestrians on how to cope with the traffic environment is considered an essential component of strategies to reduce pedestrian injuries and has been recommended in all types of countries (Peden *et al.*, 2004). These approaches include talks, printed materials, films, multi-media kits, table-top models, mock-ups of intersections, songs and other forms of music (Peden *et al.*, 2004).

However, there is a growing concern to re-examine the role that education plays in prevention of road traffic injuries and deaths in the light of ongoing research and experience of the systems approach to road injury prevention (Trinca, 1988; Zaza, 2001; O'Neill *et al.*, 2002). Informing and educating road users can improve knowledge about the rules of the road and about such matters as purchasing safer vehicles and equipment; bring about a climate of concern and develop sympathetic attitudes towards effective interventions (Peden *et al.*, 2004b). Such efforts can be effective in changing behavior (Duperrex *et al.*, 2002), but there is no evidence that they have been effective in reducing rates of road traffic crashes (Duperrex *et al.*, 2002; Ker, 2003).

A systematic review (Duperrex *et al.*, 2002), including 15 randomized controlled trials that measured the effectiveness of programmes of safety education for pedestrians, found that there was a lack of good evidence from low-income and middle-income countries and that the effect of education on the risk of a pedestrian incurring an injury remains uncertain.

Although reliable scientific information on the effectiveness of educational approaches to pedestrian safety in low-income and middle-income countries is lacking (Peden *et al.*, 2004b), blind faith in education and training of road users as a preferred intervention strategy persists in many quarters (O'Neill and Mohan, 2002). This belief that increasing motorist's or other road users' knowledge or skills is a panacea for road safety problems and will produce fewer crashes reflects a naïve view of human behavior (O'Neill and Mohan, 2002).

5.8 Traffic Law Enforcement.

Enforcement of traffic regulations, like speed are predominantly the responsibility of Traffic Police (Laws of Kenya, 1993). In the city of Nairobi, the City Inspectorate Department augments the Kenya Police in enforcement of certain safety regulations (City Council of Nairobi, 2010). Almost all of the demonstrable gains produced by changing road user behavior in motorized countries have resulted from traffic safety laws (Task Force on Community prevention Services and Expert Commentary, 2001).

However, laws by themselves often are not sufficient: the key factor in the effectiveness of a traffic law is motorists' perception that they run a high risk of being detected and punished for violating the law (O'Neill and Mohan, 2002). Laws work because it is possible to convince motorists that they face a considerable risk of punishment if they violate the laws (Ross, 1982).

In Kenya, effective enforcement of traffic regulations is perceived to be hampered by inadequate deterrent measures, flaws in punitive judgments given by the adjudication authority, poor co-ordination between traffic control and the adjudication function and corruption (Assum, 1998; Khayesi, 1998; Odero *et al.*, 2003; Republic of Kenya, 2004; Sanborn, 2007). Corruption is believed to be a major factor that hampers efforts at road safety in Kenya (Sanborn, 2007). The traffic police force is currently undergoing reforms (Republic of Kenya, 2009c). Some of the recommendations given in a report of the National Task Force of Police Reforms which are currently being implemented includes: improvement in the terms of service for police staff and development of clear code of

ethics that capture the values, positive traditions, principles, and ethics that define the policing work (Republic of Kenya, 2009c).

There has been no evaluation on the effectiveness of these changes in the police force or "service", and the extent, if at all, the changes will strengthen the police force to engage in effective enforcement of traffic rules particularly speeds. At the moment, WHO rates enforcement of traffic regulations at 4 in a scale where 0 is the least enforcement and 10 the highest level of enforcement (World Health Organization, 2013a).

5.9 Limitations

We do acknowledge certain limitations of this study. Our findings were based on admissions to one hospital, and missed out other patients who were treated and discharged as outpatient cases, deaths which occurred before admissions and were taken directly to the mortuary, and road traffic injury cases that were admitted into other hospitals in the city. There was also possibility of the reporting bias to police data which could have emerged from traffic police because of missed cases due to fear of liability. The third is the possibility of recall bias. Information collected in hospital relied on patients' or other bystanders memories of events such as the time of the crash and vehicle type. However, these limitations are minimal and do not invalidate the findings.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The purpose of this study was to examine the characteristics of road traffic injuries that occurred in Nairobi with particular emphasis on pedestrians, and examine the intervention strategies aimed at improving the safety of pedestrians in the city. A prospective study design was used to describe the characteristics of pedestrians injured in road traffic crashes that occurred in Nairobi and admitted to KNH over a period of 3 months, from 1st June to 31st August 2011; a cross-sectional study design was used to describe the characteristics of pedestrians injured in road traffic crashes that occurred in Nairobi and reported to traffic police during that period. Document search were used to examine policy response to pedestrian safety in Nairobi. This chapter presents the summary, conclusions and recommendations of the study.

6.2 Summary

A total of 253 road traffic trauma cases were admitted to Kenyatta National Hospital during the 3-month study, from 1st June to 31st August, 2011. Of these, 176 (69.9%), were injured in crashes which occurred in Nairobi city. For the purpose of this study, analysis was confined to 176 cases. With respect to demographic characteristics of road traffic injury patients admitted to KNH it was found that males comprised 138 (78.4%) of the admissions with a male to female ratio of 3.6:1. The highest male to female (16:1) was observed amongst the motorcyclists, followed by male to female for bicyclists (9:0).

The majority 129 (75%) of road trauma admissions were in the age group of 15-44 years. Children in the age group of 14 years and below accounted for 8.1%. Pedestrians constituted the highest proportion of road traffic injury admissions to KNH, comprising 104 (59.1%).

During the period under study, a total of 104 pedestrians involved in road traffic crashes in Nairobi were admitted to KNH, representing 59.1% of the total road traffic injury admissions. Young adults of ages 15 to 44 years comprised 69.9% of all pedestrians that were admitted to the hospital. Male pedestrians outnumbered females in all the age groups (male: female ratio=3.3:1). The highest male to female ratio was observed in the age bracket of 30-44 (male: female ratio=8.31:1). The total number of males was significantly greater in all the age groups combined (p=0.0496) and in the age groups 15-29 (p=0.00035) and 30-34 year olds (p=0.0274). The highest proportion of crashes involving pedestrians occurred on Saturdays, 26 (25.5%). Cars were the leading (39.4 %) category of motorized four-wheeler vehicles that hit pedestrians. The highest number of pedestrian injuries was reported in Thika Highway, (15.4%) followed by Haille Selasie (5.8%) and Jogoo Road and Mombasa Road (4.8%). Most of the injuries (67.7 %) occurred to both the upper and lower limbs. A total of 2573 (62 %) of hospital bed days by road traffic injury admissions to KNH days were by pedestrians. The mean LOHS for admitted pedestrians was not significantly different from that of all other road users combined (p=0.8339).

Traffic police department in Nairobi reported a total of 107 road traffic cases during the study period (1st June to 31st August 2011) with pedestrians constituting the highest proportion 74 (69.2%) of reported cases. An overwhelming proportion of pedestrians (91.9%) were injured on the tarmac road, (47.9%) in roads with shops on the opposite side of the road while (29.6%) pedestrians were injured in roads passing in residential areas. A great majority (85%) of pedestrians were hit at sites which had no traffic signs while 51% had no traffic light at the crash sites. Although pedestrian fatalities were reported to be most common on Saturday (26.9%), there were no significant differences in pedestrian fatalities between Saturday compared to most days of the week such as Mondays and Tuesdays (p=0.079), Wednesday (p=0.159) and Thursdays (p=0.255). Pedestrian fatalities were, however, significantly greater on Saturdays than on Sundays and Fridays (p=0.034). A total of 40 (56.3%) of pedestrian injuries, and 13 (52%) fatalities were reported to have occurred between the hours 18-06. Nearly a half (44.3%) of motorized four-wheeler vehicles that hit pedestrians were cars. Information on what pedestrians were doing when they were hit indicated that 53 (72.6 %) were hit while crossing the road while 8 (11 %) were standing by the road.

Intervention strategies that were identified were categorized as: policy documents strategies; enforcement of traffic regulations strategies; road engineering strategies; road safety education strategies. Both the Ministry of Transport's Integrated National Transport Policy and the subsequent Sessional Paper on Integrated Transport Policy prepared in 2010, and the Nairobi Metro 2030 which was prepared by the Ministry of Nairobi Metropolitan Development in 2008 as a blueprint for the development of the

Nairobi Metropolitan Region highlight the need to eliminate impediments to non-motorized transport and enhance transport safety. Nairobi Metro 2030 earmarked a total of 0.13% of budget for the strategies aimed at improving the road transport infrastructure for Nairobi Metropolitan Region to provide for NMT facilities, pedestrianisation, vehicle-restriction measures, and public awareness campaigns. Enforcement of traffic regulations is the responsibility of Traffic Police and the Nairobi, the City Inspectorate Department augments the Kenya Police in enforcement of certain safety regulations.

The Sessional Paper on Integrated National Transport Policy empowers Local Authorities to enforce by-laws on use of non-motorized transport. Speed limit within the boundaries of any trading center, township, municipality or city is set at 50 km/hr in Kenya. A recent development aimed at traffic safety improvement in Kenya, particularly in Nairobi is the introduction of the use of speed radar cameras, as a strategy to enforce compliance with the speed limit rules. This legislation on speed cameras was introduced along with other measures such as legislation to control drunken driving.

Road Engineering Strategies is covered in the Sessional Paper on Integrated National Transport Policy which empowers local authorities and road agencies to: support the development and maintenance of infrastructure for walking like adequate sidewalks and pavements for pedestrians, footpaths, and other facilities for pedestrians; and, enhance safety on the roads by specifying technical standards for each category of non-motorized transport. Road safety education Strategy which is incorporated in the Ministry of Education Curriculum, and is also highlighted in *the National School Health Guidelines*.

Two non-governmental Organizations, namely the *Lollipop Project* and the *Association for Safe International Road Travel (ASIRT)* are also engaged in road safety education, particularly among primary schools in the city of Nairobi.

6.3 Conclusions

Our findings indicate that road traffic injury crashes in Nairobi is a major public health problem and affects males, those in the age group of 15-44 years, pedestrians disproportionately. Pedestrians comprised a large proportion of road traffic injury admissions to KNH (59%) and 62% total hospital bed days. Cars were the leading category of motorized four-wheeler vehicles that hit pedestrians resulting in hospital admissions (39.4 %), and; also the leading category of motorized four wheeler vehicles (44.3%) that hit pedestrians reported to traffic police in Nairobi. The highest number of pedestrian injuries was reported in Thika Highway, (15.4%) followed by Haille Selasie (5.8%) and Jogoo Road and Mombasa Road (4.8%). Most of the injuries (67.7 %) occurred to both the upper and lower limbs. Most pedestrians (72.6 %) were hit while crossing the road while (11 %) were standing by the road.

An overwhelming proportion (91.9%) of injured pedestrians reported to traffic police were reported injured on the tarmac road, 47.9% in roads with shops on the opposite side of the road, 29.6% injured in roads passing through residential areas, and 85% of pedestrians hit at sites which had no traffic signs.

Both the Sessional Paper on Integrated Transport Policy prepared in 2010, and the Nairobi Metro 2030 a blueprint for the development of the Nairobi Metropolitan Region

prepared by the Ministry of Nairobi Metropolitan Development in 2008 highlight the need to eliminate impediments to non-motorized transport and enhance transport safety. Road safety education is also incorporated in the Ministry of Education Curriculum, and also highlighted in *the National School Health Guidelines.* However, only 0.13% of budget for the strategies aimed at improving the road transport infrastructure for Nairobi Metropolitan Region was earmarked to provide for NMT facilities, pedestrianisation, vehicle-restriction measures, and public awareness campaigns. The National Transport Safety Authority, the Nairobi Urban Planners, and traffic law enforcers should all work together to improve the safety of pedestrians by ensuring coordinated policies, techniques and programmes that can improve the safety of pedestrians such as traffic calming which limit the speeds of motor vehicles both by law to 30 km per hour or less and through physical barriers such as raised intersections and crosswalks and ensure people-and-not-car-oriented urban designs. Nairobi Metro 2030, the Urban Road Agency and the National Transport Authority should ensure allocation of funding to improve the safety of pedestrians that is proportionate to the proportion of the pedestrians injured in Nairobi crashes.

6. 2.1 Recommendations

In the context of the findings of this study the following recommendations have been suggested:

- Road traffic safety authorities, particularly, the National Transport Safety Authority and the Nairobi Urban Planners should pay more serious attention to

road safety in Nairobi with a particular focus on the males and those in the age group of 15-44 years. This age group comprised about 70% of all pedestrians that were admitted to KNH; the highest male to female ratio was observed in the age group of 30-44 (male: female ratio = 8.3:1).

- The National Transport Safety Authority, the Nairobi Urban Planners, the Kenya Traffic Police and the Nairobi City Council law enforcers should all work together to improve the safety of pedestrians by ensuring coordinated policies, techniques and programmes that can improve the safety of pedestrians.

- Urban transport planners in Nairobi should ensure the safety of pedestrians, particularly in tarmac roads, places which have shops, in residential areas by introducing and implementing area-wide traffic calming which gives pedestrians as much right to use streets as motor vehicles. Traffic calming should limit the speeds of motor vehicles both by law to 30 km per hour or less and through physical barriers such as raised intersections and crosswalks;

- Traffic safety enforcers should step up pedestrian traffic safety on Saturdays but also sustain the safety activities directed at protecting pedestrians throughout all the days of the week as there were no significant differences in pedestrian fatalities between Saturdays and the other four days of the week, the Mondays, Tuesdays, Wednesdays and Thursdays;

- Urban transport safety planners and law enforcers in the city of Nairobi should specially focus their attention to pedestrian crashes during the hours between 18-06 the time period when most pedestrian fatalities occur by providing wide and well-lit sidewalks on both sides of every street;
- Regarding traffic education, driver training should be include the aspect of avoiding collisions with pedestrians;
- Nairobi Metro 2030, the Urban Road Agency and the National Transport Authority should ensure allocation of funding and other logistics to improve the safety of pedestrians which reflects the proportion of the pedestrians injured in Nairobi crashes.

6.2.2 Suggestions for Further Research

Taking into account the scope, limitations and findings of this study, further research is needed that:

- Reveals reasons for the vulnerability the males and male pedestrians, particularly the males in age bracket of 30-44 years.
- Sheds light on why both upper and lower limbs are the most affected parts of the body and give possible special ways of reducing these injuries to limbs;
- Show how to improve policy on the design of cars that should be allowed in into Kenya and inform on possible car modifications and improvements that can ameliorate injuries to pedestrians.

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