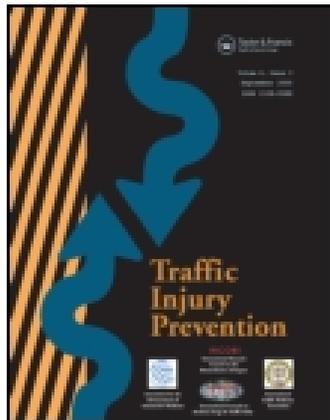


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Road Traffic Injuries in Kenya: The Health Burden and Risk Factors in Two Districts

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Background: Road traffic injuries (RTIs) contribute to a significant proportion of the burden of disease in Kenya. They also have a significant impact on the social and economic well-being of individuals, their families, and society. However, though estimates quantifying the burden of RTIs in Kenya do exist, most of these studies date back to the early 2000s—more than one decade ago.

Objective: This article aims to present the current status of road safety in Kenya. Using data from the police and vital registration systems in Kenya, we present the current epidemiology of RTIs in the nation. We also sought to assess the status of 3 well-known risk factors for RTIs—speeding and the use of helmets and reflective clothing.

Methods: Data for this study were collected in 2 steps. The first step involved the collection of secondary data from the Kenya traffic police as well as the National Vital Registration System to assess the current trends of RTIs in Kenya. Following this, observational studies were conducted in the Thika and Naivasha districts in Kenya to assess the current status of speeding among all vehicles and the use of helmets and reflective clothing among motorcyclists.

Results: The overall RTI rate in Kenya was 59.96 per 100,000 population in 2009, with vehicle passengers being the most affected. Notably, injuries to motorcyclists increased at an annual rate of approximately 29 percent (95% confidence interval [CI]: 27–32; $P < .001$). The mean age of death due to road traffic crashes was 35 years. Fatalities due to RTIs increased at an annual rate of 7 percent (95% CI: 6–8; $P < .001$) for the period 2004 to 2009. Observational studies revealed that 69.45 percent of vehicles in Thika and 34.32 percent of vehicles in Naivasha were speeding. Helmets were used by less than one third of motorcycle drivers in both study districts, with prevalence rates ranging between 3 and 4 percent among passengers.

Conclusions: This study highlights the significant burden of RTIs in Kenya. A renewed focus on addressing this burden is necessary. Focusing on increasing helmet and reflective clothing use and enforcement of speed limits has the potential to prevent a large number of road traffic crashes, injuries, and fatalities. However, it is difficult to demonstrate the magnitude of the injury problem to policymakers with minimal or inaccurate data, and this study illustrates the need for national continuous, systematic, and sustainable data collection efforts, echoing similar calls for action throughout the injury literature.

Keywords Road traffic injuries; Helmets; Reflective clothing; Speed; Kenya; Road safety

INTRODUCTION

Road traffic injuries (RTIs) are one of the leading causes of death and disability worldwide. They account for more than 1.2 million deaths—3.6 percent of the global mortality burden (World Health Organization [WHO] 2009). It is also estimated that in 2004, RTIs contributed to 2.7 percent of the total

disability-adjusted life years (DALYs) lost globally, a proportion that is expected to rise to 4.9 percent by the year 2030 and position RTIs as the third leading contributor to the global burden of disease (WHO 2008). Low- and middle-income countries (LMICs) are estimated to be responsible for as much as 90 percent of this burden, with the African region accounting for approximately 205,000 fatalities and 7,151,000 DALYs due to RTIs (WHO 2008). This translates to 969 DALYs per 100,000 population in Africa, compared to the global rate of 640 DALYs per 100,000 population due to RTIs (WHO 2008).

As LMICs in Africa develop and road infrastructure is enhanced, the number of vehicles as well as vehicle speeds are

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expected to increase, resulting in increased RTIs and fatality rates in these settings (Chandran et al. 2010; Odero et al. 2003; Peden et al. 2004). Kenya, for example, has seen a sharp increase in the number of registered motor vehicles over the past 2 decades—from 1.4 motor vehicles per 100 people in 1985 to 2.7 motor vehicles per 100 people in 2007 (Assum 1998; Odero 1995; WHO 2009). Road usage has correspondingly also gone up for every type of vehicle (Assum 1998; Odero 1995). Studies by Odero and the World Bank in 1995 and 1998, respectively, found that over the 7-year period from 1983 to 1990, there was a 125 percent increase in kilometers driven by cars and light vehicles, a 123 percent increase in kilometers driven by buses and taxis, and a 91 percent increase in kilometers driven by lorries (Assum 1998; Odero 1995). Motorcycle use in Kenya has also significantly increased over the last decade. A study conducted in Nairobi showed that in just 3 years, motorcycle registration rose from 4136 in 2004 to 16,293 in 2007 (Nesoba 2010). In addition, over the last 5 years, motorcycle transport has become a common form of taxi service across the country (Nesoba 2010).

This, in addition to other factors, has led to a historically high burden of RTIs in Kenya. A 1998 study comparing mortality due to RTIs in 12 countries found that out of all 12 countries, Kenya had the highest RTI fatality rate (Assum 1998). The rate was 1.6 times higher than that for Zimbabwe, 3.6 higher than Chile, and 48.9 higher than Great Britain (Assum 1998). Other studies conducted in Kenya have found that road traffic fatalities in Kenya have increased steadily over time, from 7.8 in 1985 to 10.6 deaths per 100,000 population in 1998, indicating a 35 percent increase in the rate of RTI fatalities in Kenya (Odero et al. 2003).

In addition to the mortality and disability burden, RTIs have a significant economic impact. In Kenya, a study published by Odero and colleagues in 2003 revealed that as of 1991, RTIs were estimated to cost Kenyans as much as US\$3.8 billion annually, corresponding to 5 percent of the annual gross national product (GNP; Odero et al. 2003). This is, however, thought to be a conservative estimate because it does not include costs associated with lost productivity and other related costs due to the years of life lost (Peden et al. 2004).

Though estimates quantifying the burden of RTIs in Kenya do exist, most of these studies date back to the late 1990s and early 2000s. There is thus a need for more current estimates on the burden of RTIs in Kenya to accurately assess the scope and distribution of this burden such that interventions can be implemented to address it. Additionally, despite the high health and economic burden of RTIs in Kenya, very little attention has historically been paid to alleviating this burden. Recently, however, there has been a renewed interest in addressing road safety in Kenya, with new initiatives by organizations such as the World Bank and Bloomberg Philanthropies that are seeking to enhance safety on Kenyan roads (Peden 2010; World Bank 2011).

In this article, we present the current status of RTIs in Kenya from a public health perspective. Using data from the police and vital registration systems in Kenya, we present the current

epidemiology of RTIs in the nation. We also conducted observational studies in 2 districts in Kenya in order to assess the status of 3 well-known risk factors for RTIs—speeding, the use of helmets, and the use of reflective clothing. To our knowledge, this is the first attempt to assess the status of risk factors for RTIs in Kenya.

METHODS

Data for this study were collected in 2 steps: secondary and primary data collection. The first step involved the collection of secondary data from the Kenya Traffic Police as well as the National Vital Registration System to assess the current trends of RTIs in Kenya. Following this step, observational studies were conducted in the Thika and Naivasha districts in Kenya to assess the current status of speeding among all vehicles and the use of helmets and reflective clothing among motorcyclists.

Secondary Data

The Kenya traffic police department routinely collects data on road traffic patterns, injuries, and fatalities. Upon request, data from 2004 to 2009 were made available to the study team. These data provided information on the number of road traffic crashes, injuries, and fatalities at the national and provincial levels in Kenya, as well as the type of road users involved in road traffic crashes. Additionally, data from Kenya's death registration system were made available to the study team and provided a count of all registered traffic deaths in the country for the year 2006. Using these data and population estimates from 2004 to 2009, the rates of crashes, injuries, and fatalities were calculated. The number of events that occurred during the study period was assumed to follow a Poisson distribution. Poisson regression models were used to analyze trends of injuries and fatalities over the 6 years. Data was managed and analyzed using STATA 11 (StataCorp 2009) and MS Excel.

Primary Data

Helmets and reflective clothing. The observational study sought to determine helmet and reflective clothing usage rates for motorcycle drivers and passengers through systematically surveying motorcyclists at randomly selected locations in the 2 study districts, Thika and Naivasha, between July and September 2010. Observation sites were selected following a reconnaissance survey conducted in each district to identify potential sites; these included urban and rural locations and were also further subdivided into locations near junctions/intersections and near motorcycle bays (up to 50 m away). Site eligibility criteria included that the site was deemed safe for the observer; that the site was located at an elevation that of higher or equal height to a motorcycle; and that the site was in a place where the local population rather than tourists were more likely to be observed. Six intervention sites in each district were then randomly selected from the pool of eligible sites.

Study teams comprised of 2 research assistants conducted the observational study and each site was observed on one weekday

and weekend day. During an observation day, data were recorded at 5 different 90-min time intervals during the day to account for variations in traffic volume and composition at different times of the day. The study team recorded a brief description of each study location and systematically assessed the site's road traffic volume prior to beginning the study. Each motorcycle that drove through a study location was observed for helmet and reflective clothing use among drivers and passengers, and observations were recorded on an observation form. Helmet usage was documented as correct, incorrect, or oversized (unstrapped helmet); none; or unable to be determined. Reflective clothing was recorded as worn, not worn, or unable to be determined.

Speed. The speed observation study sought to determine motor vehicle speeding rates through a systematic survey of randomly selected sites in Thika and Naivasha between September and November 2010. In addition to the eligibility criteria described for the helmet and reflective clothing study above, sites for the speed study were required to be suitable for the use of a speed gun. Three intervention sites in each district were randomly selected from a pool of eligible ones using a process similar to that used for the helmet observation study described above.

Speed observations were conducted simultaneously in both districts over a 2-day period. The schedule assignment per site was done at random and traffic volume was systematically assessed. At each site, site observations were done on 2 weekdays and one weekend day; data were recorded at 5 different time intervals. Two nonuniformed police officers and one research assistant observed each site and data were collected using a speed gun provided by the Kenyan traffic police. Vehicle types were recorded as saloon cars (4-door cars, station wagons, and taxis), light trucks (pickup trucks and double-cabin trucks), large trucks (lorries and tankers), *matatus* (minibuses), and SUVs (all 4-wheel drive vehicles).

All observations were recorded during 90-min time intervals. The study team observed vehicles traveling in only one direction to avoid double counting and to ensure reliable documentation in locations with high traffic volume. If more than one vehicle simultaneously passed by the observer, the vehicle closest to the curb or roadside was observed; if time permitted, the next closest motor vehicle was observed. In settings where divided highways were present, the vehicle "furthest away" was defined as the

vehicle closest to the highway median. Data in MS Excel were managed and analyzed using SPSS (SPSS Inc. 1999) and Stata 11 (StataCorp 2009). The study was reviewed and approved by the Institutional Review Board at Johns Hopkins Bloomberg School of Public Health, as well as the Kenya Ministry of Public Health and Sanitation.

RESULTS

Road Traffic Crashes, Injuries, and Fatalities

Data from the Kenya traffic police revealed that over the 6 years, RTIs increased at an annual rate of 1 percent (IRR: 1.01; 95% confidence interval [CI]: 1.005538–1.012065; $P < .001$), with analysis by road users showing that vehicle passengers were the most affected by RTIs, accounting for almost half of all RTIs reported between 2004 and 2009. This proportion was more than twice that of RTIs among pedestrians, the second most affected group of road users (Table I). Notably, injuries to motorcyclists more than doubled from 1.23 per 100,000 in 2004 to 3.63 per 100,000 population in 2009, reflecting an annual rate of increase of approximately 29 percent (95% CI: 27–32; $P < .001$).

Data from the Kenya traffic police revealed that between 2004 and 2009, fatalities due to RTIs also increased at an annual rate of 7 percent (95% CI: 6–8; $P < .001$) in the 6 years covered by these data (Table I). Fatalities increased among all user groups except pedalcyclists over the 5-year period, with the greatest increase in RTI fatality rates occurring among motorcyclists (51% annually; 95% CI: 43–60; $P < .001$) and pillion passengers (13% annually; 95% CI: 8–19; $P < .001$). The majority of RTI fatalities were among pedestrians; 1755 pedestrian fatalities or approximately 4.4 deaths per 100,000 population were recorded in 2009, accounting for 44 percent of all road traffic fatalities reported to the police in 2009. Passengers accounted for the second highest RTI fatality rate, with 2.6 deaths per 100,000 population in Kenya in 2009 (Table I).

Analysis of the police data at the provincial level showed that though Nairobi saw the highest rate of RTIs and fatalities in the nation, there was a sharp increase in injury and fatality rates in the Rift Valley province over the period of 2007 to 2009, where the RTI rate increased by 26.52 percent from 35.43 to 44.82 injuries per 100,000 population (Table II). There was a corresponding but greater increase in RTI fatality rates, whereby

Table I National road traffic injury rates (per 100,000 population) by road user type in Kenya (2004–2009)

Year	Road user type											
	Drivers		Motorcyclists		Pedalcyclists		Passengers		Pillion passengers		Pedestrians	
	Injury	Fatality	Injury	Fatality	Injury	Fatality	Injury	Fatality	Injury	Fatality	Injury	Fatality
2004	4.65	0.70	1.23	0.15	5.21	0.88	26.83	1.75	2.83	0.24	12.59	2.77
2005	4.83	0.70	1.14	0.12	5.91	1.70	27.21	1.64	3.44	0.27	13.99	3.47
2006	5.00	0.79	1.04	0.09	5.44	0.84	28.59	1.98	2.94	0.27	12.87	3.41
2007	5.21	0.72	1.18	0.09	4.12	0.73	32.44	2.26	2.83	0.30	14.26	3.63
2008	4.61	0.84	1.81	0.29	4.33	0.91	29.15	1.74	1.77	0.17	13.46	4.20
2009	5.04	1.09	3.63	0.66	4.51	0.81	28.17	2.60	3.60	0.56	12.00	4.41

Source: Kenya Traffic Police Department (2009).

Table II Annual rates (per 100,000) of road traffic injuries and fatalities in Kenya by province (2007–2009)

Provinces	Population	2007		2008		2009	
		Injury	Fatality	Injury	Fatality	Injury	Fatality
Nairobi	3,138,369.00	146.19	18.61	134.72	19.40	121.02	18.51
Central	4,383,743.00	86.71	12.80	69.51	9.42	53.70	8.67
Coast	3,325,307.00	93.68	9.53	75.18	7.67	83.93	10.34
Eastern	5,668,123.00	56.81	6.46	56.70	7.83	45.75	7.69
North Eastern	2,310,757.00	3.76	0.65	3.72	0.78	2.08	0.65
Nyanza	5,442,711.00	51.59	6.21	45.00	5.86	46.26	3.58
Rift Valley	10,006,805.00	35.43	5.37	37.48	4.62	44.82	8.08
Western	4,334,282.00	35.44	4.78	36.02	5.51	35.21	5.17
National	38,610,097.00	60.11	2.37	55.12	8.15	56.96	10.13

Source: Kenya Traffic Police Department (2009) and Kenya National Bureau of Statistics (2009).

rates increased by 50.65 percent over the same 3-year period, from 5.37 in 2007 to 8.08 deaths per 100,000 population in 2009 (Table II). Kenya's 2006 road traffic death registration system shows that the mean age of death due to road traffic crashes was 35 years, with the highest proportion of RTI fatalities occurring among individuals aged between 25 and 34 years (26.53%); 75 percent of the victims were male (Figure 1).

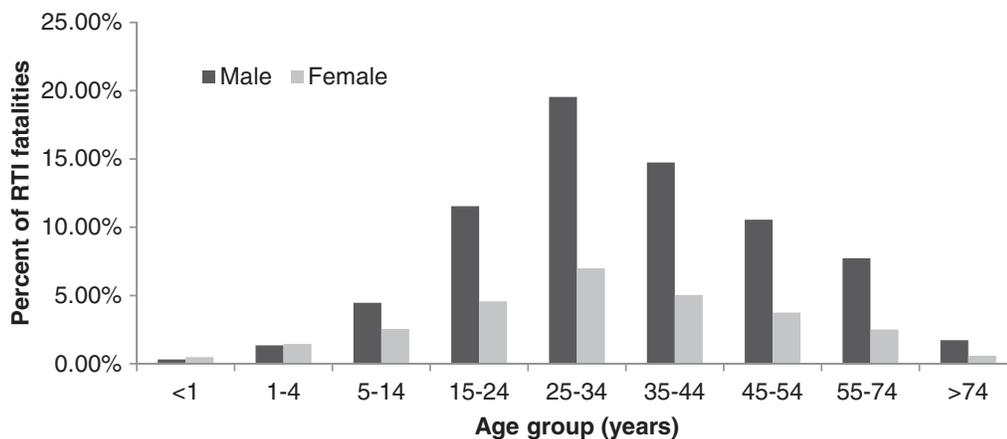
Status of Risk Factors

Three thousand seventy-five helmet observations were recorded in Thika and 3143 in Naivasha. Less than one third of drivers in Thika (30.37%) and Naivasha (21.29%) wore helmets while driving motorcycles, and there was also minimal usage of helmets by passengers in both districts (Table III). Reflective clothing usage shows a large disparity between the 2 districts: 24.85 percent of motorcycle drivers in Thika compared to 63.22 percent of drivers in Naivasha wore reflective clothing; this difference was statistically significant ($P < .05$; Table III). The use of reflective clothing by passengers in both districts was extremely low, and there were no significant variations in the use of helmets and reflective clothing by time of day or day of week. Only a fifth of motorcyclists used their headlamps in either district during the day (Table III).

Speed observational studies conducted in the Thika and Naivasha districts revealed overall speeding rates of 69.45 and 34.32 percent, respectively, in the 2 districts, and rates in Thika were almost twice as high as Naivasha (Table III). The distribution of speeding rates by vehicle types revealed that light trucks, large trucks, and *matatus* are the most common types of vehicles that speed in both of the study districts (Table III). Further analysis showed that speeding vehicles in Thika traveled at rates 1 to 79 km/h (mean = 16.75, median = 15) over the limit, whereas those in Naivasha traveled between 1 to 73 km/h (mean = 14.97, median = 12) over the limit (Figure 2).

DISCUSSION

This study highlights the significant burden of RTIs in Kenya. Our analysis shows that RTIs and fatalities mostly affect males between the economically productive ages of 15 and 45 years. These individuals are also often the heads of households, and their mortality could have potentially long-term implications on not only the financial sustainability of the family but also their social well-being. Furthermore, this analysis reveals that RTIs (and related fatalities) continue to increase in Kenya, with motorcyclists (both drivers and passengers) as well as pedestrians among the most affected.



Source: Kenya Department of Civil Registration (Kenya Department of Civil Registration, 2006)

Figure 1 Distribution of registered deaths due to road traffic injuries Kenya by age and sex (2006). Source: Kenya Department of Civil Registration (2006).

Table III Risk factor data in Thika and Naivasha districts of Kenya (2010)

	Thika N = 3075		Naivasha N = 3143			
	%	(Min, Max)	%	(Min, Max)		
A. Helmet, reflective jacket, and headlamp use						
Drivers correctly wearing helmet*	30.37	(25.27, 35.61)	21.29	(15.05, 31.58)		
Passengers wearing helmets*	4.06	(2.39, 5.23)	2.61	(0.92, 6.07)		
Drivers wearing reflective clothing*	24.85	(20.20, 28.49)	63.22	(60.3, 67.31)		
Passengers wearing reflective clothing	1.27	(0.00, 4.24)	1.27	(0.88, 2.12)		
Motorcyclists using headlamp*	23.67	(16.42, 38.38)	17.15	(8.43, 31.44)		
Vehicle type ^a	N	%	(Min, Max)	N	%	(Min, Max)
B. Speeding						
Total*	2275	69.45	(63.21, 76.26)	1252	34.32	(29.45, 40.00)
Saloon car	704	34.38	(27.48, 38.74)	470	11.70	(6.94, 14.81)
Light truck*	272	95.59	(93.98, 98.00)	77	80.52	(72.73, 87.50)
Large truck*	346	80.06	(73.91, 96.97)	182	54.95	(43.18, 64.44)
Bus*	116	71.55	(53.85, 88.00)	53	39.62	(11.11, 61.90)
Matatu*	771	88.59	(81.10, 95.45)	294	52.72	(41.33, 61.43)
SUV*	62	53.23	(7.14, 91.67)	166	18.67	(13.33, 28.00)
Other	4	50.00	(0.00, 100.00)	10	60.00	(30.00, 100.00)

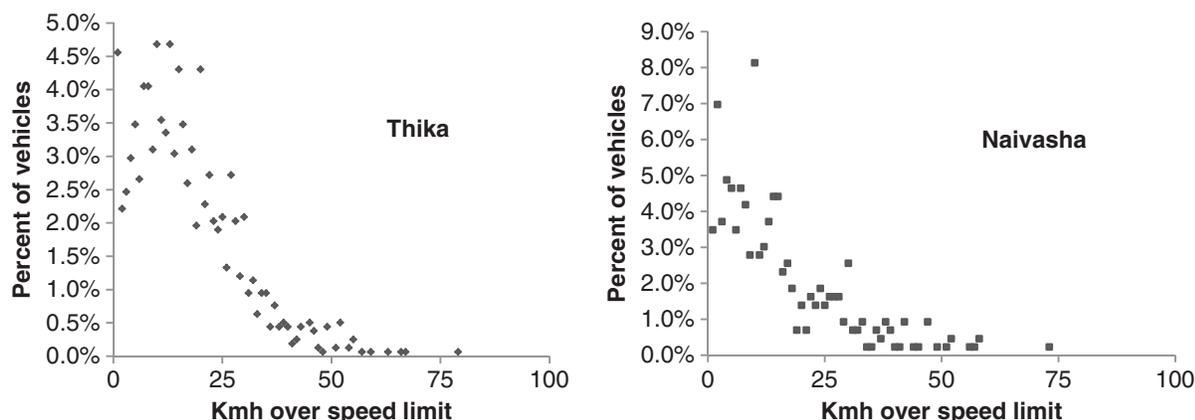
^aSpeed limits (km/h): saloon car, 110; light truck, 65; large truck, 65; bus, 80; *matatu*, 80; SUV, 110; other, 80 (National Council for Law Reporting [NCLR] 2009).

*Statistically significant difference ($P < .05$) between Thika and Naivasha districts.

A review of the literature found that there were no data from Kenya on helmet or reflective clothing usage rates among motorcyclists (drivers and passengers) or speeding rates among motorists. Therefore, this study is the first to establish helmet and reflective clothing wearing and speeding rates in the selected districts in Kenya. Helmet use was, however, disappointingly low in both districts, with only a third or fewer of the motorcycle drivers wearing helmets while operating a motorcycle. Use of helmets was even lower among passengers, with only 3 to 4 percent of passengers wearing helmets, thereby putting the majority of motorcycle riders in the 2 districts at an unnecessarily significantly increased risk of head injuries and fatalities. Studies evaluating the effectiveness of helmets have shown them to be effective in preventing head injuries and the resulting fatalities among motorcycle riders, reducing the risk of a fatality in the event of a crash by approximately 20 percent and as much as 50 percent (Liu et al. 2004).

Reflective clothing is aimed at improving visibility of the rider, which has been shown to be quite effective in reducing motorcycle crashes (Tran 2007). The use of reflective clothing by both motorcyclists and passengers is mandated in Kenya through a law recently enacted in 2009, which corresponds well to our study finding that a majority (63%) of motorcycle drivers in Naivasha wore reflective clothing. However, the compliance was lower in Thika (25%) and among passengers (1.3%). The low use of such clothing may be due to multiple factors such as the relative newness of the law, cost of materials, low levels of enforcement, and lack of awareness.

It is well established that speed is a major risk factor for road traffic crashes and resulting injuries and fatalities. One study examining the effect of speeding has shown that even a 1 km/h increase in vehicle speed can lead to as much as a 3 percent increased risk of a crash resulting in an injury (Finch et al. 1994). Speed is even more dangerous in the case of pedestrian

**Figure 2** Distribution of speeding vehicles by km/h over the speed limit in Thika and Naivasha districts in Kenya (2010).

involvement in a crash, with another study showing that when the speed of an impacting vehicle increases from 30 to 50 km/h, there is a resulting 8-fold increase in the probability of the pedestrian being killed due to the impact (Transport Research Centre 2006). Unfortunately, as the results from this study show, speed is a major problem on Kenyan roads. Both the Thika and Naivasha districts showed a statistically significant ($P < .05$) proportion of all types of vehicles speeding, with the exception of the category "other." A prime example of the extent of the speeding situation is the Thika district, where approximately 69 percent of the vehicles observed were found to be speeding. Additionally, a significant proportion of vehicles travel as much as 20 and 30 km/h above the speed limit. This may partly explain the significantly high rates of road traffic fatality among pedestrians in Kenya as seen from our analysis of data from the Kenya traffic police. Additionally, our results indicate that the main contributors to this proportion are *matatus*, which are one of the most common means of public transport in Kenya, thus putting the general public at an increased risk for RTIs or death.

Police data in Kenya are currently the most complete source of RTI data available in Kenya. The strengths of this source are that it provides information on the number of RTIs and fatalities at the national level and also disaggregated at the provincial level in Kenya. Police data in Kenya also provide information on the type of road users involved in road traffic crashes and fatalities. Kenya police define road traffic fatalities as those that occur immediately after a crash. It is important to note, however, that according to several studies that compared the effects of using different definitions of road traffic fatalities, the manner in which road traffic fatalities are defined has a minimal effect on the results (Bhalla et al. 2010). The data also present several limitations, because in their current form they cannot be disaggregated by demographic characteristics or beyond the provincial level. Therefore, it is not possible to determine the age distribution or sex of the victims. Though the data contain information on the severity of the injuries, consultations with the Kenya traffic police revealed that this classification is subjective and no guidelines exist to classify the severity of injuries in police records. Additionally, previous studies in other settings similar to Kenya have shown that police data often captures more severe injuries and only those that are reported to the police (Peden 2001). As such, police data are known to often underestimate the true burden of RTIs (Peden 2001).

It is evident from this study, as well as previously published studies, that the burden of road traffic crashes, injuries, and fatalities in Kenya continues to increase, and a renewed focus on addressing this burden is necessary. As seen from findings presented in this article, focusing on increasing helmet and reflective clothing use, as well as enforcement of speed limits, has the potential to prevent a large number of road traffic crashes, injuries, and fatalities. However, it is difficult to demonstrate the magnitude of the injury problem to policymakers with minimal or inaccurate data (Transport Research Centre 2006), and though a new law mandating the use of helmets was enacted in 2009, the government has not made headway into addressing

helmet standards. This study illustrates the need for national continuous, systematic, and sustainable data collection efforts. These needs echo similar calls for action put forth throughout the injury literature (Chandran et al. 2010; Hofman et al. 2005; Hsia et al. 2010; Lett and Kobusingye 2002; Mock et al. 2004; Sasser et al. 2005). Through continued data collection on the risk factors, implementation of a comprehensive hospital-based injury surveillance system, and improvement of police data systems, vital registration, and mortuary records systems, it will be possible to not only establish the true burden of RTIs in Kenya but also ascertain the effectiveness of interventions to alleviate their burden.

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