Texila International Journal of Public Health
Volume 7, Issue 1, Mar 2019

Incidence and Correlates of Commercial Motorcycle Accidents in Embu Town, Kenya

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Abstract

Introduction*: The recent growth of the commercial motorcycle sector in Kenya has seen a concomitant rise in road traffic accidents (RTAs). However, the correlates of RTAs involving commercial passenger motorcycles are largely unknown in Kenya and other developing countries. We sought to determine the incidence of commercial motorcycle accidents (MCAs) in Embu town, Kenya and its correlates.* ***Methods:*** *In January 2018, we recruited 202 commercial motorcycle riders and collected baseline data by means of a questionnaire in Embu town. We then followed them on weekly basis for 3 months till April 2018 to quantify the number of MCA events. Multivariable cox proportional hazards regression models were built to relate the incidence of MCAs and their correlates. Survival analysis was carried out using the Kaplan-Meier approach.* ***Results****: We quantified 48 MCA episodes translating into an incidence of 3 crashes per 1000 person-days. On multivariable analyses, riders in singlehood marital status were almost twice as likely to experience a MCA compared to those married [Adjusted HR (AHR) =1.8 (CI: 1.1, 3.4), p=0.046]. Khat (Catha edulis) users were 2-fold likely to experience a MCA relative to non-Khat (Catha edulis) users [AHR=2.1 (CI: 1.1, 4.2; p=0.021].* ***Conclusion****: Efforts to prevent MCAs need to include a program for screening and educating young riders on the dangers of khat Catha edulis use.*

Keywords: *Incidence, correlates, commercial motorcycle accident, Embu, Kenya.*

Introduction

Public transport systems in developing countries have been characterized by inadequate transport services and poor road networks among other challenges [1]. Nonetheless, commercial motorcycles have benefited the people in these regions in an affordable manner by accessing areas previously unreachable by commercial public service vehicles [2,3]. This has led to exponential growth in commercial public service motorcycles. For instance, approximately 10 years ago, estimates of >300,000 motorcycles and >200,000 bicycles were made in Kenya [4]. Besides employing >500,000 Kenyans, it is estimated that the daily revenue in the commercial public service motorcycles is >400,000 USD per day [5]. Recent statistics from the National Transportation Safety Authority (NTSA) indicate that motorcycles now account for 51% of all new motor vehicle registrations around the country – the bulk of these being commercial public service motorcycles [6]. Factors behind this growth are diverse and include access to motorcycle dedicated loans and flexible loan repayments particularly from government funds channeled to the youth [7], waiver on import duty [8], weak transport sector regulation [9] and youth unemployment [3] among others.

Whereas the commercial public service motorcycle sector has had socio-economic and welfare benefits, a growing challenge is the increase in road accidents, henceforth in paper referred to as motorcycle accidents (MCAs) [10]. Road traffic accidents (RTAs) in general are an important public health challenge in both high, low and middle-income countries [11,12]. They are the leading cause of injury, the eighth leading cause of death for young people aged

DOI: 10.21522/TIJPH.2013.07.01.Art013
ISSN: 2520-3134

15 to 29 years of age. Indeed, they account for more than 1.2 million deaths, while the number of people injured could be as high as 50 million, which amounts to 3.6% of the global mortality burden [13]. Studies show that the risk of dying as a result of a RTA is highest in the African Region (24.1 per 100 000 population), and lowest in the European Region (10.3 per 100 000) [1]. In Kenya, the rate is 34.4 per 100 000 population, which is higher than many countries around the world [6]. Besides, RTAs impact the global economy negatively [14,15].

Alongside RTAs, MCAs related trauma has become and remains a major cause of morbidity and mortality in victims of productive age in Kenya [7]. Indeed, a study in western Kenya reported that motorcycle riders are a whopping 16 times more prone to accidents compared to pedestrians or other road users [7]. There is anecdotal and gray evidence that Embu Level 5 Hospital Orthopedic ward in Kenya receives one of the highest numbers of MCAs. For instance, in the year 2015, the Out Patient medical records indicated that the hospital had admitted 318 patients of MCAs (unpublished medical reports, Embu Level 5 Hospital, Ministry of Health, Kenya). Accurate measures of incidence of MCAs together with information on correlates of the incidence are largely unknown, not only in Kenya, but in many developing country settings. Absence of accurate data and information on MCAs are a major obstacle to the design of effective regulatory and accident prevention programmes in the country. To address these gaps in knowledge and inform transport policy in Kenya, we designed an observational prospective cohort study to determine the incidence of MCAs and associated correlates among riders of commercial public service motorcycles in Embu County in Kenya.

Materials and methods

We adopted a prospective cohort study design by following up riders of commercial public service motorcycles for a period of three months. The study was carried out in Embu Town, Embu County, located approximately 120 kilometers North East of Nairobi. The County has a road network with coverage of 914.3 km earth surface, 402 km of ground surface and 120 km of tarmac. Most of the earth surface roads in Embu are impassable during rain seasons.

Our study population comprised of commercial public service motorcycle riders from Embu Town. The sample size for the study comprised 202 riders based in the town. Convenience sampling was used to recruit eligible riders until the minimum sample size was achieved.

Data collection was achieved by means of an interviewer administered questionnaire. The variables collected included socio-demographic characteristics, Alcohol and Khat (*Catha edulis*) use, education background, age, location of riding school, eyesight problems, use of personal protective equipment and perceived status of roads. The dependent variable was the incidence density rate of MCAs. This was calculated as the total number of commercial public service motorcycle rider crashes occurring during the study period, divided by the sum person time for riders at risk.

The KNH-UoN Ethics and Research Committee reviewed the study for its scientific and ethical merit prior to study commencement. The ethical approval reference number KNH-ERC/A/4 from KNH-UoN Ethics and Research Committee was used to approach Embu town authorities to get administrative permission prior to data collection. Potential respondents were approached and after having the study explained to them, they were consented. Baseline data was subsequently collected and thereafter participants were followed longitudinally for three months. Follow-up was done through two field visits per week to collect data prospectively over the three months' period. Subjects were removed (censored) from the study as and when they got involved in an accident.

Descriptive statistics, frequencies, and proportions were used for the continuous and categorical variables respectively. Bivariate analysis was used to ascertain the association between the various possible risk factors of MCAs and the incidence density rate of their crashes in Embu Town, Embu County. Univariable and multivariable models of factors associated with commercial motorcycle accidents were built using cox proportional hazards regression. Survival analysis was performed using the Kaplan-Meier estimates.

The regression models were built as follows:

Cox proportional univariate model

$$h(t) = h0(t) \times \exp(b_1 x_1)$$

Cox proportional multivariate model

$$h(t) = h0(t) \times exp(b_1 x_1 + b_2 x_2 + \ldots + b_p x_p)$$

Where:

t represents the survival time

$h(t)$ is the hazard function determined by a set of p covariates $(x_1, x_2, \ldots, x_p)$

the coefficients$(b_1, b_2, \ldots, b_p)$ measure the impact (i.e., the effect size) of covariates.

the term $h0$ is called the baseline hazard. It corresponds to the value of the hazard if all the xi are equal to zero (the quantity $exp(0)$ equals 1).

The '*t*' in $h(t)$ reminds us that the hazard may vary over time.

In all cases, the date of baseline data collection was assumed to be the start date for the study.

Results

Socio-demographic characteristics

A total of 202 respondents were recruited into the study. Of these, 2.5% were female and the remainder (97.5%) male. A small number of the respondents were aged below 18 years (1.5%). The distribution of socio-demographic characteristics is shown in Table 1.

Motorcycle roadworthiness and road conditions

More than half (58%) of the motorcycles were less than 2 years old since purchase. Nonetheless, the respondents reported breaking the rules regarding the number of passengers they carried at a time as well as underuse of personal protective equipment, as shown in Table 2.

The perceived state of the roads was also associated with the incidents of motorcycle accidents, for instance, due to blind spots, sharp bends and poor drainage as shown in Table 3. Table 4 also shows that some motorcycles had poor parts e.g. tires, brakes, and engines due to poor maintenance which can result into accidents.

Incidence density rate

In a total person-time of 15,747 days, 48 accidents occurred during the study period yielding an incidence rate of 0.003 crashes per person-day (3 crashes per 1000 person-days). This is demonstrated in Figure 1.

Factors associated with road traffic accidents

Before building the univariate models, multicollinearity among the explanatory variables was assessed by calculating bivariate correlation. A tolerance level of 0.40 or less was considered an indicator of high multicollinearity. This helped select explanatory variables that uniquely contributed relevant information. The following variables were statistically significant at the univariable level: alcohol use [Hazard Ratio (HR) =1.833 (95% confidence interval (CI): 1.0, 3.3; p=0.045], and khat (*Catha edulis*) use [HR=2.153 (95% CI: 1.2, 3.8; p=0.008].

We then carried out a backward stepwise multiple regression. For model building we first included all predictors that had a p-value of less than 0.25 in the univariable analysis. The final model was tested for model fit using the link test and the hatsq p-value was not significant (p=0.461) implying a good fit to the data.

Our analyses demonstrated a significant correlation between MCAs and crashes and marital status and the usage of khat (*Catha edulis*) among commercial motorcycle riders in Embu. Compared to those who were married, riders who were single in marital status were almost twice as likely to experience a MCA [Adjusted HR (AHR) =1.8 (95% CI: 1.1, 3.4; p=0.046]. Compared to those who did not use khat (*Catha edulis*), khat (*Catha edulis*) users were more than two times more likely to experience a RTA [AHR=2.1 (95% CI: 1.1, 4.2; p=0.021].

DOI: 10.21522/TIJPH.2013.07.01.Art013
ISSN: 2520-3134

Discussion

The incidence rate of MCAs in Embu was high with 48 accidents occurring during the 3-month follow-up study. This translated to 3 cases per 1000-person days. To the best of our knowledge, this is among the first studies to determine the incidence of MCAs, albeit for a short duration, in Kenya. This finding bridged major knowledge and data gap that exists in the sectors of transport and public health in Kenya. The incidence we report here is consistent with findings from a study in Naivasha, Kenya that studied 166 commercial motorcycle riders, 20 of whom were involved in MCA [16]. A separate study conducted in Nigeria reported that among 37,260 cases of RTA, >17,388 of them were associated with commercial motorcycle riders translating to at least two cases occurring per hour [17]. Likewise, a study conducted in Lagos, Nigeria reported 156 MCAs and reported an incidence rate of 2.8% of motorcycle accident deaths [18]. Occurrence of MCAs in developing countries continue to impact on public health services that is already burdened by both infectious and non-infectious diseases. Besides, this places an enormous burden on the country's economy in terms of cycle repairs and compensation claims.

Risk factor analysis returned two significant factors associated with the incidence in this study. These were *Catha edulis* use and being single in marital status. Furthermore, marital status was correlated with the usage of *Catha edulis* among the commercial motorcycle riders suggesting a complex relationship between the two variables and the outcome. *Catha edulis* is a type of leaf that is mostly chewed to offer euphoria and excitement as it has amphetamine-like properties. The riders pursue the alertness effect to remain active and "high" for long working hours. However, this long-period alertness is counterproductive as it subsequently increases the level of exhaustion that affects their ability to work effectively. The proximity of *Catha edulis* production around Embu region in Kenya could increase the chances of use given that the community around has embraced its wider production and use. Focusing efforts on reduction of use of *Catha edulis* at an early age may be key for reducing long-term *Catha edulis* dependence and perhaps minimize the incidence of RTAs. Efforts to reduce the use of *Catha edulis* at an early age may be directed at several fronts. For example, local community-level interventions which attempt to counter negative personal and social factors, including emotional stress, financial stress and peer pressure that are putative predictors of youths' use of substances.

Consistent with findings from previous studies, most commercial motorcycle riders who are of the age of 25 and below are single and have unsafe road safety practices [19]. Likewise, young single commercial riders in Nigeria were found to have unsafe practices such as using mobile phones while riding, failing to use personal protective equipment like helmets despite owning them and having wrong perceptions that they were immune to accidents due to prayers [20]. In a similar study conducted in Naivasha, Kenya, a majority of the young riders aged 26-30 years had not gone past secondary school and overloading, alcohol and cigarette use was common among them [16]. Our study found that single-marital status riders were highly likely to be engaged in motorcycle RTAs due to unsafe riding. A separate study reported significant correlation between the marital status of the commercial motorcycle riders and the occurrence of RTAs in Nigeria [21]. Yet, according to different reports, commercial motorcycle riders who were young, single and had a father who used psychoactive substances were highly likely to engaged in RTA [22].

Despite appearing intuitive, other factors like alcohol use, daily income and overloading were found not to be significant after the multivariable analysis. This was presumably influenced by several factors for instance reliability in relaying accurate information from the riders. Alcohol usage and overloading passengers and luggage are punishable traffic offences and as such the riders could be hesitant in providing the correct information despite reassurances that this information was confidential.

Adherence to traffic safety rules and guidelines was also not entirely put to practice as the motorcyclists did not adhere to most of the stipulations. Specifically, the motorcyclists ferried more than a passenger at a time and sometimes combined passengers and luggage, rode at speed higher than 50km/h, received phone calls while on ride, overtook near bends, overlapped when

traffic was congested, did not wear helmets, reflective jackets, protective boots and gloves all which predisposed them to MCAs. Studies conducted elsewhere revealed that most accidents occurred during times that the riders were on a speed of 40-80km per hour, in those who did not use helmets and those who got distracted by mobile phone use while on ride [23] [24].

We found a perception of bad road status among the riders whom they associated with MCAs in Embu Town due to sharp bends, several blind spots and road construction. Other major concerns reported by the motorcyclists were that the roads had poor drainage which was detrimental during rainy seasons, potholes on the roads and loose road surface. These conditions pose a risk to the occurrence of MCAs. For instance, a study conducted in Nepal and India revealed that the highest number of accidents occurred during the month of August due to National festival which resulted in poor communication on the road and narrow roads. In this instance, the roads not only led to the occurrence of accidents but also resulted in a delay in responding to the accidents [25]. Still, a study in Nigeria reported that besides a majority of riders having knowledge on road safety, a majority of the accidents occurred along the tarred and narrow two-lane roads [26] indicating a possible role of poor road status posing a risk to users.

A mixed finding on the condition of motorcycles – ranging from good condition, to others with motorcycles with worn out tires, ineffective brakes, nonfunctional speedometer and exhaust systems was remarkable. Although there is paucity of evidence regarding association between motorcycle accidents and defective motorcycle parts, a study in India reported that skidding of motorcycles mostly occurs due to worn out tires and ineffective breaks [27].

This study benefited significantly from its study design. The prospective cohort design commences by selecting a cohort and measurement of factors or correlates or exposures before the outcome has happened [28]. In this way, a time sequence or temporality, an important factor in determining causality is established. Nonetheless, prospective cohort studies are expensive and requires many individuals to be followed up for long periods of time [28]. Indeed, our findings should be interpreted within the context of the study's limitations in mind – particularly the duration of follow-up. Normally, cohort studies require long follow-up periods particularly if the outcome is rare. However, MCAs in our settings were not rare to happen.

Conclusion

This study bridged major knowledge gaps existing in the sectors of transport and public health in Kenya. The incidence of MCAs was associated with *Catha edulis* use and being single in marital status. The implications of this are that efforts to prevent RTAs among commercial motorcycle riders should include a program for screening and educating young riders on the dangers of *Catha edulis* use. Going forward, enforcement agencies such as the National Transport and Safety Authority in Kenya should be empowered through legislation to make it a traffic offence on commercial motorcycle operators found using *Catha edulis*. Further, road safety training should be targeted at younger riders – who are more likely to be single – in a bid to reduce the incidence of MCAs specifically in Embu and Kenya in general.

What is known about this topic

- There has been increased number of MCAs
- RTAs has been the leading cause of mortality and morbidity
- No adequate measures to address MCAs

What this study adds

- Incidence of MCAs was strongly associated with Catha edulis use
- Being single in marital status contributed to MCAs
- Alcohol use contributed to the increased number of MCAs

DOI: 10.21522/TIJPH.2013.07.01.Art013
ISSN: 2520-3134

Acknowledgments

Our profound gratitude to the department of Environmental Health and Disease Control, JKUAT. We also extend appreciation to all the participants in this study without which it would have been difficult to achieve the results

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Table 1. Socio-demographic Characteristics of Respondents – showing the frequency distribution and proportions for the socio-demographic descriptors in the study

Characteristic	Category	No.	%
Age	Under 12	2	1.0
	(12-17)	1	0.5
	(18-24)	62	31.0
	(25-34)	100	50.0
	(35-44)	23	11.5
	(45-54)	11	5.5
	Above 55	1	0.5
Sex	Male	194	97.5
	Female	5	2.50
Marital status	Single	66	32.8
	Married	132	65.7
	Widowed	2	1.0
	Separated	1	0.5
Religion	Christian	189	95.0
	Muslim	10	5.0
Highest Education level	No formal education	4	2.0
	Primary education	53	26.5
	Secondary education	97	48.5
	Tertiary education	46	23.0
Have other form of employment	Yes	107	53.2
	No	94	46.8
Monthly income (KES)	<10000	30	14.9
	10000-15000	32	15.8
	15000-24000	59	29.2
	>24000	81	40.1
Daily income (KES)	<500	52	25.7
	500-1000	90	44.6
	1000-1500	52	25.7
	>1500	8	4.0

DOI: 10.21522/TIJPH.2013.07.01.Art013
ISSN: 2520-3134

Table 2. Adherence to traffic safety rules and guidelines – showing the adherence levels of traffic safety rules and guidelines by the motorcycle riders.

Adherence to traffic safety rules and guidelines	**Always (n, %)**	**Often (n, %)**	**Sometimes (n, %)**	**Rarely (n, %)**	**Never (n, %)**
Transport >1 passenger at a time	22 (10.9)	15 (7.4)	33 (16.3)	26 (12.9)	106 (52.5)
Simultaneous transport of passengers and luggage	55 (27.4)	34 (16.9)	49 (24.4)	33 (16.4)	30 (14.9)
Riding at >50Kilometers per hour	34 (16.9)	38 (18.9)	61 (30.3)	40 (19.9)	28 (13.9)
Receive phone calls while driving	20 (10.0)	21 (10.4)	44 (21.9)	25 (12.4)	91 (45.3)
Use daytime headlight when riding	41 (21.0)	15 (7.7)	28 (14.4)	13 (6.7)	98 (50.3)
Overtake from the left-side of the road	14 (7.0)	28 (13.9)	44 (21.9)	45 (22.4)	70 (34.8)
Overtake near a bend	6 (3.0)	9 (4.5)	12 (6.1)	24 (12.1)	147 (74.2)
Overlaps when traffic is congested	48 (23.9)	33 (16.4)	34 (16.9)	25 (12.4)	61(30.3)
Puts on a helmet	97 (49.0)	36 (18.2)	18 (9.1)	15 (7.6)	32 (16.2)
Presence of passenger helmet	12 (6.0)	5 (2.5)	8 (4.0)	33 (16.4)	143 (71.1)
Wears a reflective jacket	99 (49.0)	33 (16.3)	26 (12.9)	8 (4.0)	36 (17.8)
Wears protective boots	21 (10.4)	11 (5.5)	32 (15.9)	39 (19.4)	98 (48.8)
Wears protective gloves	18 (8.9)	12 (5.9)	20 (9.9)	33 (16.3)	119 (58.9)

Table 3. Condition of the roads – showing the state of the roads in currently in use in Embu county

Week	Failure function	No. of failures
1	0.0297	6
2	0.0495	4
3	0.0792	6
4	0.0941	5
5	0.099	2
6	0.1188	4
7	0.1535	7
8	0.1832	6
9	0.198	3
10	0.2079	2
11	0.2178	2
12	0.2376	4

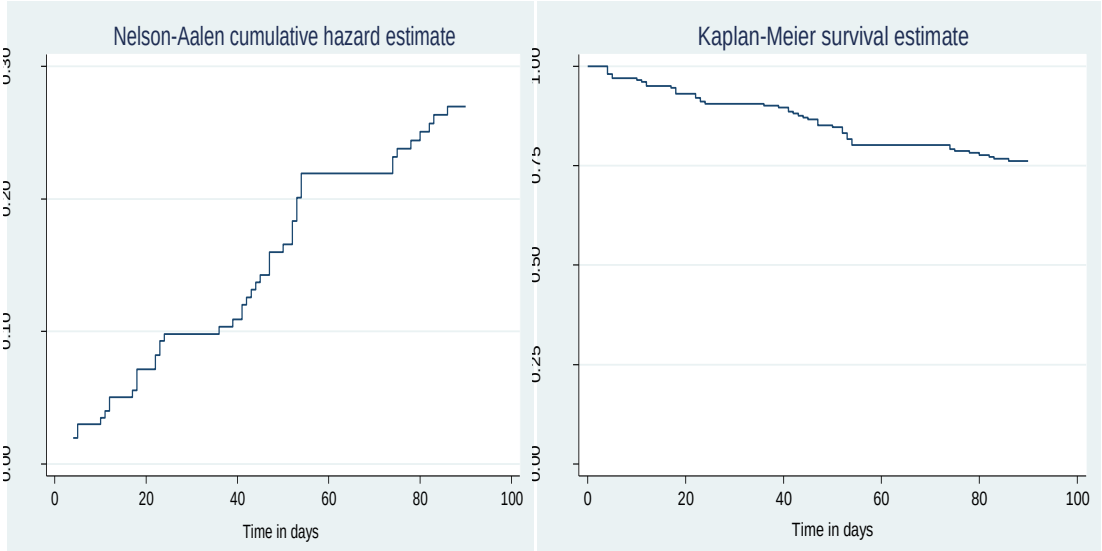

Figure 1. Cumulative Hazard and Survival Estimates – showing Nelson-Aalen Cumulative hazard estimate and Kaplan-Meier Survival Estimate

Road Conditions	**Agree (n, %)**	**Neutral (n, %)**	**Disagree (n, %)**
The road has several sharp bends	170 (84.6)	10 (5.0)	21 (10.4)
The road has several blind spots	129 (64.8)	15 (7.5)	55 (27.6)
The road is under construction	112 (56.6)	19 (9.6)	67 (33.8)
The road has poor drainage and floods during the rainy season	174 (88.3)	9 (4.6)	14 (7.1)
The road has several potholes	174 (87.0)	7 (3.5)	19 (9.5)
I frequently ride during nights	70 (35.2)	29 (14.6)	100 (50.3)
The road surface has loose parts such as loose stone and gravel	173 (86.9)	5 (2.5)	21 (10.6)

Table 4. Condition of parts – showing the state of the motorcycle parts

Condition of parts	**Poor (%)**	**Average (%)**	**Good (%)**
Tires	45 (22.4)	22 (10.9)	134 (66.7)
Brakes	7 (3.5)	12 (5.9%)	183 (90.6)
Speedometer	66 (32.7)	19 (9.4)	117 (57.9)
Exhaust system	26 (12.9)	15 (7.4)	161 (79.7)
Engine functionality	9 (4.5)	19 (9.4)	174 (86.1)