

Occurrence and Pattern of Maxillofacial Injuries Caused by Motorcycle Crashes Presenting at Two Major Referral Hospitals in Nairobi, Kenya

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Abstract

Motorcycle crashes in Kenya have increased over the last decade and the most common injuries include the cranio-maxillofacial regions which needs documentation. This article determines the occurrence and pattern of maxillofacial injuries in motorcycle crashes. This was a descriptive, cross-sectional prospective study conducted at two referral hospitals in Nairobi, Kenya. Data were obtained through interview and physical examination of patients. Ninety-one patients were examined, among whom 76 (83.5%) were males and 15 (16.5%) females (male–female ratio, 5:1). The age range and modal age were between 3 and 62 years and 21 and 30 years, respectively (mean age = 29 years). The midface was the most common fractured site (38%). Motorcycle-related injuries were most common in males aged 21 to 40 years. Collisions and falls were the most common cause of crashes. The midface was the most common region of facial injury and the injuries were associated with the lack of helmet use.

Keywords

- ▶ maxillofacial injuries
- ▶ motorcycle crashes
- ▶ Kenya

The third global status report on road safety showed that the low- and middle-income countries were the hardest hit, with double the fatality rates than that of high-income countries, that is, 90% of global road traffic deaths. Vulnerable road users—pedestrians, cyclists, and motorcyclists—made up half of these fatalities. More than 1.2 million people die each year on the world's roads, making road traffic injuries (RTIs) a leading cause of death globally.^{1–3} The highest rates are still in the African region (24.1 per 100,000 population), while the European region has a rate far below the global average (9.3 per 100,000 population, relative to the global average rate of 17.4).¹

Maxillofacial trauma represents one of the greatest challenges to public health service worldwide, because of their high incidence and significant financial cost involved in their

management. These injuries are often associated with varying degrees of functional and aesthetic damage.⁴ The prevalence and etiology of maxillofacial trauma have been performed globally with the aim of characterizing patterns, evaluate preventive measures, and health policies for research in this area.^{5,6} The epidemiological features varies tremendously and seems to be related to local prevailing factors of the country under study. In East Africa, studies assessing the prevalence, etiological factors, and pattern of maxillofacial injuries resulting from motorcycle accidents have been done in Tanzania and Uganda but none in Kenya.⁷ This study was done to document the occurrence and pattern of maxillofacial trauma related to motorcycles in two major referral hospitals in Kenya.

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Materials and Method

Study Design, Population, and Area

Clearance to conduct this study was obtained from the Kenyatta National Hospital (KNH)/University of Nairobi Ethics and Research Committee reference number P No. 384/06/2014. A descriptive prospective cross-sectional study design was used to document the occurrence and pattern of maxillofacial injuries caused by motorcycle crashes at two referral hospitals (KNH and Mama Lucy Kibaki Hospital [MLKH]) in Kenya in 2014. The inclusion criteria for patient recruitment were maxillofacial injury due to a motorcycle-associated accident and willingness to participate. Exclusion criteria were those with injuries due to other causes other than the motorcycle or were reluctant to participate or who were unconscious and unaccompanied by a guardian. Patients were recruited and examined to obtain their sociodemographic data, site of maxillofacial injury, causes, and time and day of the incident. Additional information was recorded with regards to motorcycle riding (for riders), patients' status, whether rider, pillion passenger, or pedestrian, and use of protective gear at the time of accident. Riders were interviewed on their training, years of experience, and alcohol/drug consumption. All data were recorded in a questionnaire. A general clinical and radiographical examination was done to assess maxillofacial injuries. The maxillofacial injuries were classified into soft tissue injury (STI), hard tissue injury (HTI), and other concomitant body

injuries. The data were coded and computerized for analysis using the SPSS version 17 (IBM Corp.). It was presented as means and standard deviation (SD), and Fisher's exact test, Pearson's chi-square, and odds ratio were used to evaluate the relationship between all the variables and *p*-value of < 0.05 was considered significant with a 95% confidence interval.

Results

A total of 91 patients with motorcycle crash-related maxillofacial injuries were recruited in the study among whom 76 (83.5%) were from KNH and 15 (16.5%) from MLKH in Nairobi; 51 (56%) of these were inpatients. Approximately 50% of the accidents occurred in Nairobi. There were 76 (83.5%) males and 15 (16.5%) females (male-female ratio = 5:1). The age range of the patients was 3 to 62 years (mean = 29 years; SD = 12), and the majority (71%) were in the range of 21 to 40 years (► Fig. 1).

Of the 46 motorcycle riders, 39 (84.8%) had no training or valid motorcycle riding license and only 7 (15.2%) had been formally trained. Majority of the riders (80.4%) reported a riding experience of less than 2 years and 19.6% had more than 3 years. Concerning alcohol consumption, 11% were male and reported alcohol use on the day of the crash. Six participants who were riders were drunk on the day of injury and three were pedestrians. There was a statistically significant association between alcohol consumption and age

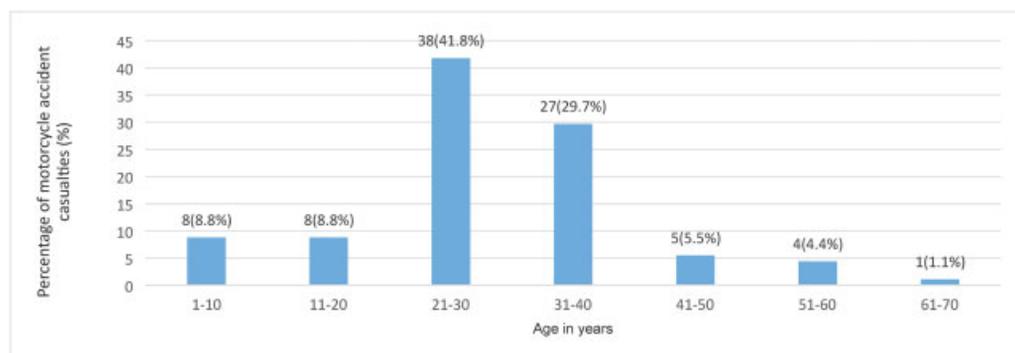


Fig. 1 Distribution of participants by age and gender.

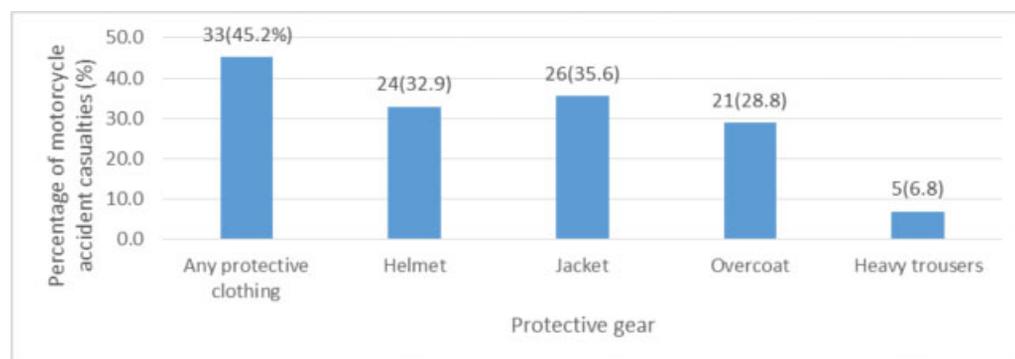


Fig. 2 Type of protective gear used among motorcyclists and pillion riders.

($p = 0.016$) for the age group of 41 to 50 years, male gender predilection ($p = 0.022$).

The most frequently used protective gears by the participants were a jacket (35.6%), helmet (32.9%), overcoats (28.8%), and heavy trousers (6.8%). The type of protective gear worn by 46 riders (100%) included a heavy jacket (23, 50%), helmet (19, 41.3%), light luminous overcoat (17, 37%), and heavy protective trousers (5, 10%) (► Fig. 2). There was a statistically significant association between use of helmets and occupation ($p = 0.033$). The type of protective gear worn by pillion riders ($n = 27$) was a helmet 5 (18.5%), light luminous overcoat 4 (14.8%), heavy jacket 3(11.1%), and none wore the heavy protective trousers.

The most common type of accidents among the casualties of motorcycle crashes were falls (11, 27.5%), head-on collision with vehicles (19, 20.9%), and collision with motorcycles (15, 16.5%) (► Fig. 3). There was a statistically significant association between the type of motorcycle accident and gender ($p = 0.006$), and the class of casualty, age ($p \leq 0.001$), gender ($p = 0.006$), occupation ($p \leq 0.001$), and level of education ($p = 0.002$). Those mostly injured were motorcycle riders (46, 50%), pillion riders (27, 29.6%), and pedestrians (18, 19.9%). There was no statistical significance between helmet use or nature of the accident and mandibular fractures (Fischer's exact test, $p = 0.0631$). However,

there was a statistical significance between midface fractures and helmet use (Fischer's exact test, $p = 0.008$) and the nature of the accident (Fischer's exact test, $p = 0.028$). The type of maxillofacial injuries of the participants included 88 (98%) STI and 58 (63.7%) HTI. HTI comprised of fractures of the midface (34, 38%), mandible (14, 15%), and dentoalveolar (16, 18%), whereas STI included moderate lacerations (34, 37.4%) and through-and-through perforation (30, 33%) (► Fig. 4). The common sites of STI involved the upper lip (30.8%), cheek (26.4%), malar (25.3%), eyebrow (13.9%), lower lip (10%), and the chin (6.7%). Dental injuries included avulsions (33.3%) and subluxation (65.6%). There were 15 (16.5%) with mandibular fractures of which 9 (60%) were motorcycle riders and 6 (40%) were pillion riders. The mandibular sites most involved were the body (6, 8.5%) and the parasymphiseal (6, 8.5%) region. There were no pedestrians who presented with a mandibular fracture. Midface fractures (34, 38%) distribution was as follows: orbit (33%), the zygoma (25%), maxilla (19%), nasal (10%), and nasoethmoidal bone (4%) (► Table 1). The Le Fort classification of maxillary fractures types was: Le Fort I (5.5%), Le Fort II (14.3%), and Le Fort III (0%).⁸ There were 63 (69%) who had concomitant injuries of the upper limb (46%), lower limb (41%), head (40%), abdomen (20%), and chest (20%) (► Fig. 5).

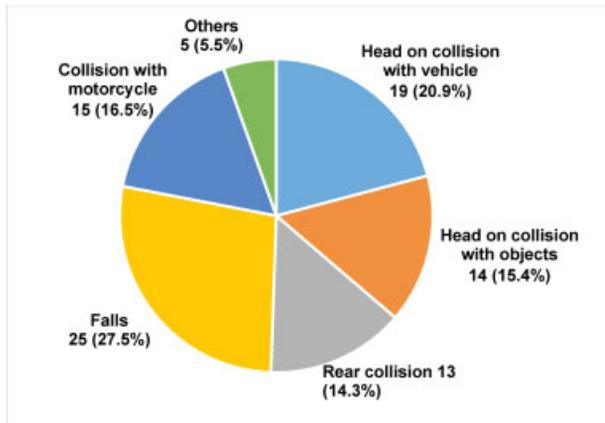


Fig. 3 Nature of accidents as reported by the participants.

Table 1 Distribution of facial fractures among the participants

Midface fractures		
Maxillary		18 (19%)
Nasal		9 (10%)
Nasoethmoidal		4 (4%)
Zygoma		23 (25%)
Orbital		30 (33%)
Mandible fracture		
Angle		4 (5.6%)
Body		6 (8.5%)
Condyle		2 (2.8%)
Parasymphiseal		6 (8.5%)
Symphiseal		1 (1.4%)

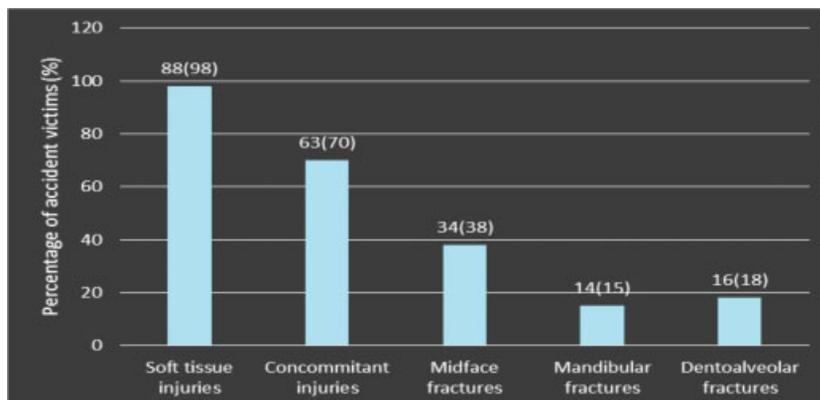


Fig. 4 Injuries sustained during motorcycle crashes.

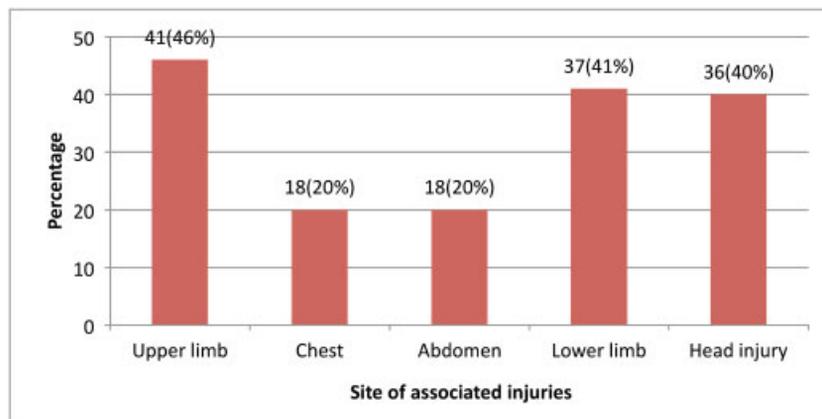


Fig. 5 Concomitant injuries with facial injuries from motor cycle crashes.

STIs were the most common affecting the upper limb (71%) and the head (64%) region.

Discussion

Data collected from 2010 and 2013, showed a 27% growth in the number of motorized two-wheelers globally, and the majority was from the low- and middle-income countries and was responsible for a large proportion of those injured in road accidents. While in high-income countries, motorcycle deaths typically comprise of approximately 12% of overall traffic deaths, in middle-income countries, this more than doubles to 26%.⁹ The motorcycle, commonly called “boda boda” in Uganda and Kenya and “okada” in Nigeria, has recently become increasingly popular in Tanzania as a means of commercial transport.^{10–12} In Kenya, between 2005 and 2011, motorcycle registration increased by 33.1% from 93,970 to 125,058 according to a 2014 government survey. In 2010, a total of 3,055 road traffic deaths were reported by the Kenya Traffic Police, of these, approximately 7% were motorcyclists—a fivefold increase in motorcycle-related deaths, the majority of these in Nairobi.¹³ A study at the Naivasha District Hospital revealed that 36% of patients of

road traffic crashes were motorcyclists, and 75% of these patients admitted to not wearing a helmet. Helmet compliance among pillion riders is as low as 3%.^{14,15} Tanzania, for example, has seen registration of motorcycles rise from 46 to 54% in the last 3 years, and motorcycles are responsible for the majority of RTIs (58.8%) and death rising from 13 to 22% of its total number of road traffic deaths.^{16,17} Studies have shown that motorcycles and all pillion riders were 8.7 times more prone to injuries than were motor vehicle occupants and the risk of dying from a motorcycle crash is 20 times higher than from a motor vehicle crash.^{12,18}

The age range (3–62 years) and mean (29 years) in this study population was similar to the studies from Nigeria and Uganda where the upper limit was the 6th to 7th decade of life. In contrast, the age range and mean for Taiwan and Brazil was reported as 19 to 29 years and 30 years, respectively, whereas for Tanzania it was 4 to 87 years and 31 years, respectively.^{11,19–22} Males were much more affected than females (male–female ratio, 5:1) as earlier reported by another study in Kenya (7:1), although the ratio was less than in Tanzania (2.3:1) and Nigeria (3.5:1).^{11,19,23} The younger age male gender predilection is probably their role as sole bread winner of the family (► **Table 2**).

Table 2 Comparison of age ranges, mean, and gender among populations

Author	Country	Age range	Mean	Most common age group affected	M:F
Current study	Kenya	3–62	29	21–40 (71%)	5:01
2016 (Rhodieleen)	Phillipines	14–60	NA	NA	NA
2013 (Saidi)	Kenya	<21–>60yrs	30.8 (12.2)	21–30 (41.6%)	7.01
2012 (Lima)	Brazil	19–29	31	NA	N/A
2010 (Chalya)	Tanzania	4–87	30.7	21–30	2.3:1
2012 (Maliska)	Brazil	10–65	26.1	10–17	4:01
2011 (Hashim)	Malaysia	<9–>50	27.8	20–29	4.5:1
2006 (Oginni)	Nigeria	6–68	29(±12.5)	20–29	3.5:1
1995 (Lea)	Taiwan	19–29	31	NA	NA

Abbreviations: F, female; M, male; NA, not available.

Table 3 Comparison of the variations in fracture types among populations

Year	Country	Author	Dentoalveolar	Mandible	Orbit	Zygoma	Maxilla	Nasal	NOE	Le Fort I	Le Fort II	Le Fort III
2016	Philippines	Rhodieleen and Rene	5	19	NA	20	19	11	1	7	4	0
2014	Kenya	Current authors	16.5	16.5	33	25	19	10	4	5.5	14.3	0
2013	Rwanda	Majambo et al	59.3	19.8	NA	4.1		NA		7	1.2	1.7
2012	Brazil	Maliska et al	13.9	39	NA	26	6	7.9	1.3	6	3	0.2
2006	Nigeria	Oginni et al	25.7	63.3	1	22.7	NA	3	NA	3	3	NA

Abbreviations: NA, not available; NOE, nasoorbitoethmoid.

According to Chalya et al, most of their patients (78.6%) had primary or no formal education, mainly businessmen followed by students, public servants, children, and peasants. However, in this study the level of literacy was similar to the one done earlier, where most had primary and secondary education, followed by tertiary level of education.^{11,12} Businessmen and students were the most commonly injured probably due to rush through heavy traffic for purposes of business and school, and this is identical to the situation in Uganda and Nigeria, where motorcycles are a popular and affordable transport.^{5,7,11} On the contrary, Saidi and Mutisto found an infrequent involvement of students, the majority being businessmen and casual laborers.²³ Motorcycle operators and small-scale businessmen (61.6%) formed the dominant population followed by students (16.5%). The low level of literacy among the riders probably explains their difficulty in the interpretation of traffic laws.

There were few studies that have noted the pattern of motorcycle crashes according to the time of the day and weekdays. Both Kenya (62.6%) and Tanzania (73.9%) reported most of the motorcycle collisions occurring during the day and less at night, unlike in this study where it was highest at night from 6 p.m. to 6 a.m. and less during the daylight hours between 6 a.m. to 6 p.m. A higher number of crashes appeared to occur over the weekends (Friday–Sunday) and there were less reported during the weekdays.^{11,23}

Surprisingly, most of the motorcycle riders (84.8%) had no training or a valid motorcycle license and only 7% had received formal training, and this may probably be the reason for the high number of accidents. This is in keeping with those riders from urban and suburban cities in Nigeria who lack formal training and a license and therefore a lack of respect for traffic rules. In Malaysia, the majority of seriously injured but surviving riders were men of age less than 25 years and having a valid license of less than 3 years only.^{24,25} Motorcyclists are usually vulnerable to accidents as they drive being intoxicated with alcohol causing carelessness and lack of concentration.¹¹ Only 10% of the casualties in this study had consumed alcohol of which 6 were riders between the age of 41 and 50 years.

In Nigeria, Oginni et al reported 50.5% of the victims were riders and 37.4% were pillion riders. This study is almost similar to Oginni et al’s study with 50% being riders, 29.7% pillion riders, and 19.8% being pedestrians.¹⁹ Although, helmets are known to reduce the risk of fatalities and head

injuries, most developing countries like Uganda (18.6%), Tanzania (22.7%), Kenya (43%), and Nigeria (0–8%) report poor use of helmets. Similarly, 32.9% of the riders were noncompliant despite law enforcement.^{5,11,19–23} Bachani et al reported only 3 to 4% of pillion riders wearing helmets in two districts (Thika and Naivasha) in Kenya placing an unnecessary significant risk of head injury and fatality; although 18.5% of the pillion riders in this study wore helmets, similar to the observation from the Philippines.^{9,26} The situation in the developed countries like Germany (100%) and Brazil (76%) is contrasting where the majority of the participants wore helmets.^{22,27} Reflective clothing is aimed at improving visibility of the rider and its use has been mandated in Kenya since 2009; however, reinforcement has been poor.²³ An earlier study done in Kenya in 2012 found 63 and 25% compliance, respectively, among the riders, and the other types of protective gear worn were a heavy reflective jacket (50%), light luminous coat (37%), and heavy protection trousers (10%).⁹

In Tanzania (52.6%), Nigeria (39.2%), and Iran (72.5%), collision between motorcycle and vehicle was the most common mechanism of injury followed by that of between motorcycle and pedestrian.^{11,19,28} However, in our study, falls (11, 27.5%) from the motorcycle was the most common followed by collision with a vehicle (19, 20.9%), and the least was collision between motorcycles (15, 16.5%). Riders were mainly affected (46, 50%) followed by pillion riders (27, 29.6%) and pedestrians (18, 19.9%) unlike the findings as earlier reported in Kenya.^{9,23}

Most studies confirm that the jaw region is the most commonly affected in facial injuries resulting from motorcycle accidents.^{29,30} A previously cited study in Brazil noted that mandibular fractures and fractures of the midface were common in motorcycle accidents. They associated it with the fact that even with helmets there is still a prominence of the mandible and dissipation of forces to the midface.²⁷ However, in this study the most common fractures were those of the midface (orbit and zygoma) followed by the mandible, which is similar to the observations made in the Philippines and United States.²⁶ Fracture of the mandible (excluding the dentoalveolar segment) was most frequent in Brazil and Nigeria.^{19,27} Rwanda and Malaysia reported dentoalveolar fractures as the most frequent. In Nigeria and in our study, it was the second most common fracture. These fractures included avulsion, and subluxation injuries, in addition to

a higher number of tooth fractures.^{17,19} In contrast, the most common fractures in the Philippines were maxillary fractures (tripod fractures and temporal bone), while mandibular fractures were not as common.²⁶ According to the Le Fort midface fracture classification, type I and II were recorded in Rwanda and Nigeria, and in our study there was no type III fracture. It was challenging to compare specific anatomical fracture sites as data from most studies were scarce^{17–19} (– **Table 3**). The cause of these differences in observations made in different countries is not clear.

Conclusion

Motorcycle-related injuries were common in males between the ages of 21 and 40 years. This study identified the midface as the most affected followed by the limb and head regions. Lack of adequate training coupled with poor law enforcement among motorcyclists is probably the reason of the crashes.

Conflicts of Interest

None.

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