

Injuries following motorcycle crashes at a level-1 trauma center in Riyadh

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BACKGROUND: Motor vehicle crashes are the third leading cause of death in Saudi Arabia. Motorcycle riders, in particular, are considered more vulnerable than occupants, yet there are no previous studies that have examined the epidemiology of their injuries and outcomes in the country. Better understanding is needed to inform policymakers and guide future prevention programs.

OBJECTIVES: Describe patterns of injury among conscious and unconscious patients injured in motorcycle crashes.

DESIGN: Retrospective chart review.

SETTINGS: Level 1 trauma center in Riyadh.

PATIENTS AND METHODS: This retrospective study included all patients involved in motorcycle crashes who were admitted between 2001 and 2017. Medical records were reviewed, and data about injury characteristics, outcomes and healthcare utilization were ascertained.

MAIN OUTCOME MEASURES: Injury site and mortality rate.

SAMPLE SIZE AND CHARACTERISTICS: 572 patients included 488 males (85.3%) and 232 <18 years of age (40.5%), mean (SD) age 21.1 (11.6) years.

RESULTS: About 3% of patients died either before or after admission. Extremity injuries (356, 62.2%) were most common followed by head injuries (229, 40%). Fifty-six (9%) suffered amputation, mostly to a lower limb.

CONCLUSION: This study underscores the significant burden of motorcycle-related injuries on population health of Saudi Arabia. The number of amputations due to motorcycle injuries is striking. Therefore, we need to increase enforcement of safety measures during recreational use of motorcycles and to raise awareness about the dangers of motorcycle crashes to improve traffic safety and ultimately population health.

LIMITATIONS: The study was conducted at a single hospital which may affect the generalizability of the data to the Saudi population.

CONFLICT OF INTEREST: None.

Traffic crashes are a leading cause of morbidity and mortality worldwide. The World Health Organization reports that 1.2 million people die each year due to traffic injuries and up to 50 million sustain non-fatal injuries.¹ Moreover, 90% of the burden is in developing countries. In Saudi Arabia, traffic crashes are the third leading cause of death, responsible for 11.7% of total mortality.² However, data regarding motorcycle crashes is limited, which may explain the lack of awareness about this issue.

Motorcycle riders are considered more susceptible to injury and mortality because they lack basic protection relative to occupants of motor vehicles.³ Previous literature suggests that motorcyclists are 35 times more likely than occupants to die from a crash than a passenger car in a crash and eight times more likely to be injured.⁴ Therefore, injuries due to motorcycle crashes may have a significant impact on population health and healthcare facilities.

Many factors affect the outcome of a motorcycle crash—speed, demographics and the use of protective devices. A study done in Taiwan found that elderly victims have a more adverse outcome with higher severity, longer hospital stays, more intensive care unit admissions, and they suffer a different pattern of injuries compared to younger adults.⁵ In Saudi Arabia, motorcycles are primarily used for leisure activities, unlike other developing countries where motorcycles are used for transportation. Therefore, the epidemiology and outcomes may differ substantially from other nations.

The burden of motorcycle crashes has not been explored previously in Saudi Arabia due to limited information and the focus on on motor vehicle occupant-related collisions due to their higher prevalence.⁶⁻¹⁰ Exploring this issue may provide insight into the magnitude of motorcycle crashes, providing information on severity, mortality, and pattern of injuries. Therefore, we aim to describe motorcycle crash injuries and their outcome to contribute to the literature of traffic injuries in order to improve population health.

PATIENTS AND METHODS

We conducted a retrospective chart review at King Abdulaziz Medical City, a level-I trauma center. Patient information was acquired from the hospital's trauma registry, which was initiated in 2001. Patients are included in the registry if they were admitted to the ward or the Intensive Care Unit (ICU). Once a patient is identified as eligible for inclusion, a data collection sheet is completed that includes demographic, physiological and outcome variables. Afterward, the research coordinator checks the data, completes any missing values and

finally enters this information using Microsoft Access. Included patients are grouped into 12 subgroups according to their mechanism of injury, including motorcycle crashes. We included in this study any patient who sustained an injury in a motorcycle crash between 2001 and 2017. Data was retrieved primarily from the paper-based medical files except for 90 patients, in which their data was ascertained from the electronic medical record as the hospital made this shift early in 2016.

For the present study, we verified the data extracted from the trauma registry by accessing the medical record to ensure the quality of our data over the years. Detailed information about patients was ascertained including gender, weight, height, helmet use, length of hospital and ICU stays, Glasgow coma scale (GCS) score, mechanism of injury, injury severity score (ISS), mortality, and injury site. Patient age was categorized as ≤ 17 , 18-40, 41-55, and >55 years. We subdivided patients based on status of consciousness as either 1) loss of consciousness (LOC) including those who had an alteration of their level of consciousness and 2) no LOC. This classification was used as a measure of the severity of the injury. Other severity measures include ISS and GCS. The ISS measures the severity of the injury based on the Abbreviated Injury Scale (AIS), which is computed by taking the highest score in the three body regions most affected (head and neck, face, chest, abdomen, extremities, and external). The ISS score ranges from 0 to 75.¹¹ ISS was grouped into three groups, mild (<16), moderate (16-24), and severe (≥ 25). GCS is used to assess the level of consciousness and the acuity of traumatic brain injury. GCS has three subgroups components (eye, verbal, and motor) with an overall score ranging between 3-15.¹² The site of injury was documented according to the body region into six groups (head and neck, thorax, abdomen, spine, upper limbs and lower limbs).

Statistical analysis

We used STATA 15 on Mac operating system for all data analyses. Descriptive analyses of patients' age, gender, the site of injury, mechanism of the crash, ISS, GCS, helmet use and hospital length of stay (ward or ICU) were performed. Continuous variables were described as means and standard deviation (SD) while categorical variables were tabulated with two-way tables as total numbers and percentages. Chi-square and the t tests were used for measurements of association and the unadjusted difference between variables where applicable. A two-sided *P* value of less than .05 was declared as a cut-off for statistically significant differences. Institutional review board approval was obtained from the King Abdullah International Medical Research

Center. No signed informed consent was required as patient medical records were de-identified.

RESULTS

We identified 572 motorcycle crash patients who met the inclusion criteria. Patients were relatively young with a mean (SD) age of 21.1 (11.6) years. The most affected age group was between 18 and 40 years of age (53.1%, n=304) followed by 17 years or younger (40.5%, n=232) (Figure 1). The majority of patients were males (85.3%) [n=488], and over 62% of patients sustained extremities injury. Average ISS was 8.2 and close to (3%) [n=17] of patients died before (n=5) or after hospital admission (Table 1).

Loss of consciousness

The 183 patients who had loss of consciousness (LOC) (31.9%) had lower GCS scores, longer hospital lengths of stay, ICU stays, and higher mortality rate than those with no LOC (Table 1).

Extremity injuries were significantly more prevalent among conscious than LOC patients (P<.001). However, head injuries were more common in LOC patients than in conscious patients (P<.001). Hit or being hit by another vehicle was the most common mechanism of injury among LOC patients (19.6%) followed by fall (15.3%). On the other hand, among conscious patients, fall was the most common mechanism (24.2%) followed by roll-over (10.8%), (P<.001).

Injury site

Over half of the patients had an extremity injury (62.2%), followed by head injury (40%; Figure 2). Most of those with head injuries had a cranial fracture (52.4%), followed by maxillofacial fractures which accounted for (31.8%). In addition, among thoracic injury patients, 40 patients sustained lung contusion, and 38 patients had rib fracture (48.8%,46.3% respectively). Cervical spine fracture was sustained by 24 patients (4.2%).

Limb amputation

Overall, 9.1% suffered amputation. Lower limb amputation was more common than upper limb (Table 2). The majority of those who suffered limb amputation were 17 years of age or younger (89.5%). Getting the limb stuck in the metal chains was the most common mechanism of injury (55.3%).

DISCUSSION

To the best of our knowledge, this analysis is the first to describe injuries associated with motorcycle crashes in Saudi Arabia. We found that compared with conscious

patients, those with LOC had a different mechanism of injury and worse outcome. Also, we found that extremity fracture was the most common site of injury. Furthermore, we found inadequate documentation of helmet use. The study findings highlight the importance of injury prevention to reduce the burden of trauma and reduce healthcare utilization.

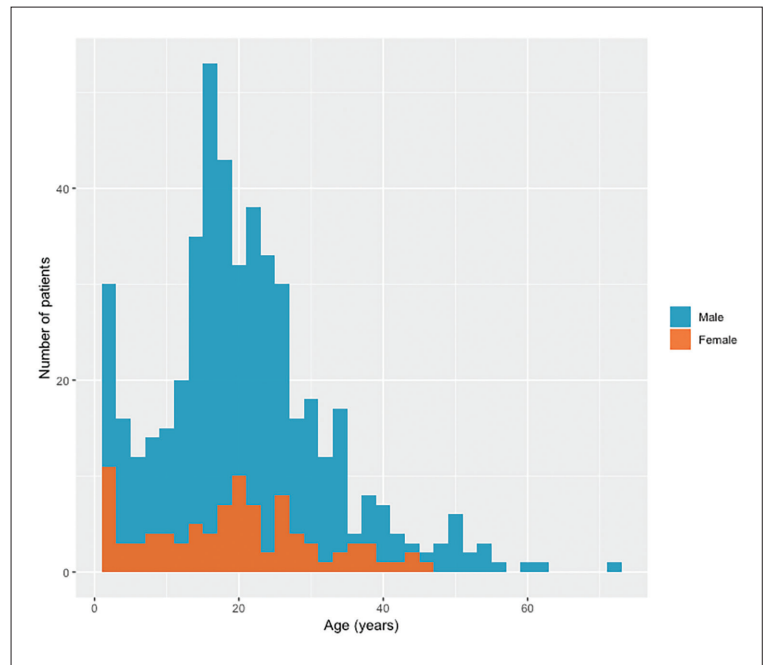


Figure 1. Age and sex distribution of motorcycle crash patients, 2001 and 2017 (bin size= 2 years).

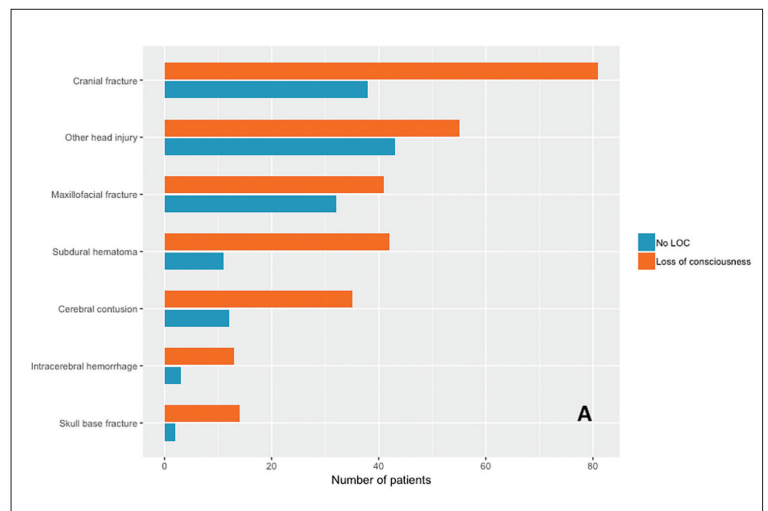


Figure 2. Sites of injury for motorcycle crash patients by loss of consciousness (LOC): A) head, B) thoracoabdominal, C) upper limbs, D) lower limbs, E) spine.

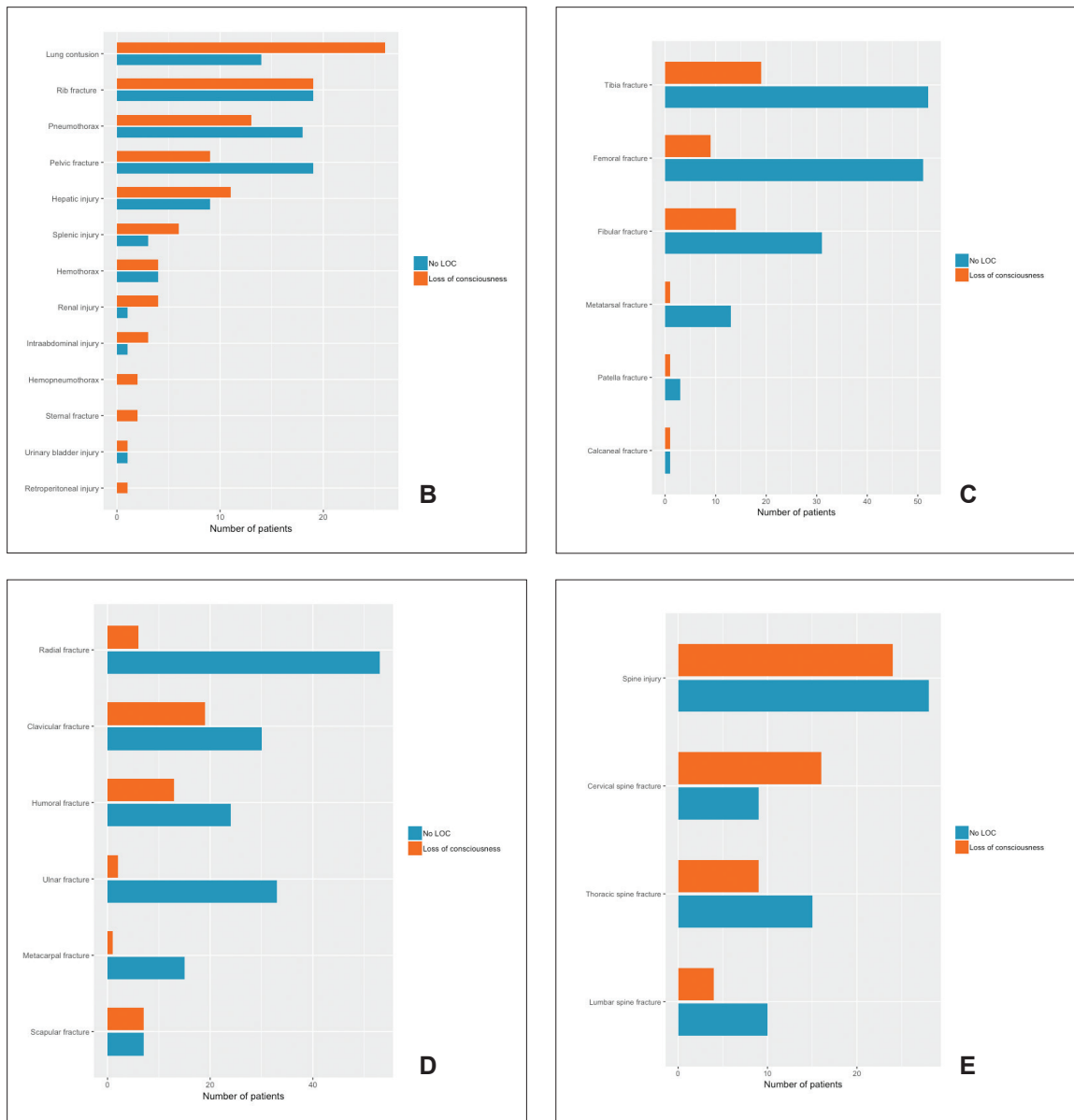


Figure 2 (cont.). Sites of injury for motorcycle crash patients by loss of consciousness (LOC): A) head, B) thoracoabdominal, C) upper limbs, D) lower limbs, E) spine.

Our study found that 9.1% of patients injured in motorcycle crashes sustained an amputation to a limb, mostly lower limb amputations. These injuries occurred because the limb was stuck in the metal chain of the motorcycle. Limb amputation can cause significant physical disability in these young patients that can last a lifetime or lead to a long period of rehabilitation. Adding to the physical burden of disability, the psychological effect of these injuries such as depression and anxiety on the patients and their families is significant. Moreover, these patients require more medical

care and more extended hospitalization, and are thus a significant burden to the health system. Finally, many of these patients who have any disabilities would result in a significant burden on healthcare settings for several years and ultimately reduce population health. There is a need for a population-based public health effort to reduce the burden of these preventable injuries.

Injury severity was more common among patients who lost consciousness, and LOC was associated with an extended period of hospitalization and ICU stay. In addition to a high prevalence of extremity injuries, LOC

Table 1. Demographic and clinical data of patients injured in motorcycle crashes.

	Loss of consciousness n=183 (%)	No Loss of consciousness n=389 (%)	Overall n=572 (%)	P value
Male	162 (88.5)	326 (83.8)	488 (85.3)	.108
Age				
0-17	56 (30.7)	176 (45.1)	231(40.5)	
18-40	116 (63.7)	188 (48.2)	304 (53.1)	<.004
41-55	8 (4.4)	24 (6.1)	32 (5.6)	
>55	2 (1.1)	2 (0.5)	4 (0.7)	
Helmet				
Yes	1 (0.6)	3 (0.8)	4 (0.7)	
No	10 (5.5)	9 (2.3)	19 (3.3)	.248
Missing data	172 (93)	378 (97.1)	549 (96)	
Site of injury				
Head	90 (49.2)	139 (35.7)	229 (40)	<.001
Thorax	36 (19.7)	46 (11.8)	82 (14.3)	<.001
Abdomen	21 (11.5)	37 (9.5)	58 (10.1)	.024
Extremity	63 (34.4)	293 (75.3)	356 (62.2)	<.001
Spine	24 (13.1)	27 (6.9)	51 (8.9)	.123
Injury severity score				
<16	131 (71.6)	281 (72.2)	412 (72)	
16-24	24 (13.1)	10 (2.6)	34 (5.9)	<.001
>25	28 (15.3)	5 (1.3)	33 (5.9)	
Glascow Coma Scale score	10.4 (4.5)	14.9 (0.46)	13.5 (3.3)	<.001
Hospital stay (days)	23.6 (41.3)	8. (10.48)	13.2 (25.9)	<.001
ICU stay (days)	6.4 (10.95)	0.3 (1.8)	2.2 (6.6)	<.001
Mortality	16 (8.7)	1 (0.3)	17 (2.9)	<.001
Mechanism of injury				
Hit by/being hit by another vehicle	36 (19.7)	32 (8.2)	68 (11.9)	
Fall	28 (15.3)	94 (24.2)	122 (21.3)	
Rollover	25 (13.7)	42 (10.8)	67 (11.7)	
Hit hard object	8 (4.4)	12 (3.1)	20 (3.5)	<.001
Stuck in the metallic chains	1 (0.55)	32 (8.2)	33 (5.8)	
Other	6 (3.3)	5 (1.3)	11 (1.9)	
Missing data	78 (42.6)	147 (37.8)	225 (39.3)	

Data are number (percentage) or mean (standard deviation).

Table 2 Limb amputations following motorcycle collisions.

	Upper limb (n=8)	Lower limb (n=48)
Male	7 (87.5)	36 (75)
Age		
0-17	2 (25)	43 (89.5)
18-40	4 (50)	4 (8.3)
41-55	2 (25)	1 (2.0)
>55	0	0
Injury severity score		
<16	5 (62.5)	43 (89.6)
16-24	1 (12.5)	3 (6.3)
>25	1 (12.5)	2 (4.2)
Mechanism of injury		
Hit by another vehicle	0	1 (2)
Fall	0	1 (2)
Stuck in the metallic chains	3 (37.5)	28 (58.3)
Other	0	2 (4.2)
Missing data	5 (62.5)	16 (33.3)

Data are number (percentage).

was associated with a significantly higher incidence of head injury, the primary cause of death in these collisions. Being hit by another vehicle including other motorcycles, cars, and trucks is the most common mechanism of injury. Further studies in collaboration with the traffic police are warranted to better understand the underlying causes of motorcycle crash injuries.

The significant impact of motorcycle crashes on population health reported here is consistent with reports from other countries.¹³⁻¹⁵ Fouda et al. conducted a similar study in Egypt and found that about a third of motorcycle crash patients suffer from head injuries, which is slightly lower than our findings.¹⁶ The mortality rate (2.9%) in our study was higher compared to those found in other studies (1.5%, 1.5%, 1.9%, respectively).^{5,17,18} The data on upper and lower limb fractures was similar to that reported in a study from the United Arab Emirates by Hefny et al.¹⁹ On the other hand, cranial fractures (20.5%) were more common in our study in comparison to other studies (8.7%, 14%, 8.6%, respectively).^{5,17,18} As expected, male patients constituted the majority of the cases (85.4%) which is explained by driving laws in the country that prohibited females

from driving during the study period. Women are now allowed to drive motor vehicles, including motorcycles. Therefore, future studies need to recognize that the epidemiology of motorcycle crashes may change in the upcoming years.

Helmet use documentation was almost nonexistent. Therefore, our study was unable to evaluate the impact of helmet use on outcome. It is possible that most patients did not wear a helmet because of the high incidence of head injuries, especially cranial fractures. Based on other reports, the leading cause of death among motorcycle crash patients is a traumatic brain injury.²⁰ Many studies show that wearing a helmet while driving or riding motorcycles can reduce mortality and severity of the injury.²¹⁻²³ However, compliance with helmet use laws remains low in many developing countries. An Iranian study found that over 95% of motorcyclists understand the importance of helmet use and its effect on lowering head injuries and even death, but only 13% reported wearing helmets.²⁴ A high prevalence of helmet use is needed because studies have shown that concussion is the most common type of head injury.^{20,21,25,26} Learning about helmet use among injured drivers or occupants may inform planning for prevention.

Because many motorcycle crashes are sustained during recreational use, traffic police and other relevant entities need to implement strategies to increase safety and reduce injuries. The Saudi Vision 2030, which is a national landmark plan aiming to improve population health and reduce disabilities nationwide, has emphasized traffic safety as one of its top priorities. Our results may support the Vision by informing epidemiologists, policymakers, and the public about the magnitude of the burden and the need to invest in prevention. Specifically, our findings may be used as a baseline to monitor improved surveillance of MC injuries. The Vision has initiated legislation aimed to support police enforcement and launched awareness campaigns to reduce traffic injuries.²⁷

Our study has several limitations that need to be taken into account in light of these findings. First, the study was conducted in one hospital, which may affect the generalizability of the data to the Saudi population. Also, missing data was a challenge in many areas. Exactly how the crash happened, victim position on the motorcycle, the location of the crash, type of motorcycle, and safety precautions including helmet status are examples of things that were not documented in the majority of the cases. Another limitation is that we included only hospitalized patients in this paper, and this may underestimate the burden of motorcycle crashes.

Another factor is the use of illegal substances such as alcohol or drugs. This sensitive issue is a significant challenge for future studies as well. Therefore, a national trauma registry with detailed information including those highlighted in our study is desperately needed to understand the burden and plan for prevention better. Despite limitations, this analysis is the first of its kind and can help to pave the way for future research in this field.

In summary, the high frequency of amputation, es-

pecially among young patients, is alarming. Upper and lower extremity injuries were the most common type of injury in motorcycle crashes. We recommend a national trauma surveillance system that includes detailed information about the mechanism of injury and safety precaution to facilitate prevention. Increase enforcement of safety measures during recreational use of motorcycles and public awareness about the dangers of motorcycle crashes may contribute to improving traffic safety and ultimately population health.

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