Association Between Riders' Characteristics and Injury Patterns in The Motorcycle or Electric-Bike Accidents

Motosiklet veya Elektrikli Bisiklet Kazalarında Binicilerin Özellikleri ile Yaralanma Modelleri Arasındaki İlişki

Esin Abacı[1], Ataman Köse[2], İbrahim Ulaş Özturan[3], Çağrı Safa Buyurgan[2], Akif Yarkaç[2], Seyran Bozkurt Babuş[2], Semra Erdoğan[4]

ABSTRACT

Aim: Many risk factors have been reported to be responsible for morbidity and mortality in motorcycle and electric bike (e-bike) accidents. This study aims to determine the associations between the demographic features of motorcycle or e-bike riders and clinical outcomes.

Material and Methods: This is a retrospective case-control study conducted in an academic emergency department (ED). All adult patients admitted to the ED due to motorcycle or e-bike accidents were included.

Results: A total of 358 patients were included in the study. Of the patients, 100 (28.1%) required hospitalization where 58 (16.3%) required surgery. Injuries were related with the upper extremities (15.4%), head and neck (14.8%), and lower extremities (11.2%) in the patients. Nighttime accidents, alcohol use, and lack of protective equipment were related to multiple injuries, need for hospitalization, surgery, blood transfusion, and mortality (p<0.05 for all variables). There was no significant difference between the motorcycle and e-bike riders in demographic features, injury pattern, need for hospitalization, need for surgery, or mortality (p>0.05).

Conclusion: Nighttime accidents, alcohol or drug use, and lack of protective equipment could lead to multiple injuries, need for hospitalization, surgery, blood transfusion, and mortality. Moreover, the risk of poor outcomes is similar between the motorcycle and e-bike riders.

Keywords: Non vehicle traffic accident, motorcycle accident, e-bike accident, emergency department

ÖZ

Amaç: Motosiklet ve elektrikli bisiklet (e-bisiklet) kazalarında, morbidite ve mortaliteden sorumlu birçok risk faktörünün olduğu bildirilmiştir. Bu çalışmada amaç, motosiklet veya e-bisiklet sürücülerinin demografik özellikleri ile klinik sonuçlar arasındaki ilişkiyi belirlemektir.

Gereç ve Yöntemler: Bu çalışma, akademik bir acil serviste yürütülen retrospektif bir vaka control çalışmasıdır. Çalışmaya motosiklet veya e-bisiklet kazaları nedeniyle acil servise başvuran tüm yetişkin hastalar dahil edilmiştir.

Bulgular: Çalışmaya toplam 358 hasta alındı. Hastaların 100'ünde (%28.1) hastaneye yatış, 58'inde (%16.3) ameliyat gerekti. Hastaların yaralanmaları üst ekstremite (%15.4), baş-boyun (%14.8) ve alt ekstremite (%11.2) ile ilişkiliydi. Gece gerçekleşen kazalar, alkol kullanımı ve koruyucu ekipman eksikliği; çoklu yaralanmalar, hastane yatış ihtiyacı, ameliyat, kan transfüzyonu ve mortalite ile ilişkiliydi (tüm değişkenler için p<0.05) Motosiklet ve e-bisiklet sürücüleri arasında demografik özellikler, yaralanma paterni, hastaneye yatış, ameliyat ihtiyacı veya mortalite açısından anlamlı bir fark yoktu (p>0.05).

Sonuç: Gece kazaları, alkol veya uyuşturucu kullanımı ve koruyucu ekipman eksikliği; çoklu yaralanmalara, hastaneye yatış ihtiyacına, ameliyata, kan transfüzyonuna ve ölüme neden olabilir. Ayrıca motosiklet ve e-bisiklet kazalarında sürücülerin kötü sonuç alma riski benzerdir.

Anahtar kelimeler: Araç dışı trafik kazası, motorsiklet kazası, e-bisiklet kazası, acil servis

Introduction

According to World Health Organization (WHO), approximately 1.35 million people die annually due to motor vehicle accidents (MVA) globally. Moreover, in many of those who survived, organ loss or failure, injuries required intense treatment or long-term function loss are very common [1]. MVA is a leading reason for mortality in young adults. Vulnerable road users (VRU) including pedestrians, cyclists, and motorcyclists account for more than half of all patients with mortality after MVA [2]. The use of two-wheel vehicles has been increasing worldwide due to their being cheap and easy to use [3]. Therefore, the incidence of motorcycle accidents has been increasing gradually [4]. In 2018, WHO reported 379.356 death caused by motorcycle accidents worldwide [1]. Even in the developed countries where motorcycle accident-related morbidity and mortality (M&M) rates are lower, injury and mortality rates are 20 times higher among motorcycle riders compared to other vehicle drivers (5,6).

Many factors including lack in the use of protective equipment, riding under alcohol or drugs effect, high speed, and inexperience are related to motorcycle accidents [7]. However, the data on the relationship between the injury type and accident timing, motorcycle type, need for hospitalization, or surgery is limited in the literature. This study aimed to determine the association between demographic features and injury patterns in patients with motorcycle or e-bike accidents in the emergency department (ED).

Material and Methods

Design, Setting, and Population

This was a retrospective case-control study conducted in an ED of a tertiary care facility. All patients older than 18 years who were admitted to the ED with motorcycle or e-bike accidents between January 2018 and January 2019 were included in the study. Accidents related to bicycles or other vehicles, patients who left the ED against medical advice and had missed information in electronic medical records were excluded. Institutional review board approval was obtained for the study (approval date: 2019.11.20, 2019/496 decision dated and numbered).

Study protocol

Demographic features, vehicle type (motorcycle vs e-bike), the timing of the day (06:00-18:00 vs 18:00-06:00), the season of the year, the influence of alcohol, use of protective equipment (at least helmet), injury type, area of injury, presence of multiple trauma, need for hospitalization or surgery and length of hospital stay (LOS) were recorded from the hospital electronic medical records (EMR). Demographic characteristics related to patients and accidents, area of injury, or fracture were compared according to the presence of multiple trauma, need for hospitalization, use of protective equipment and type of the vehicle. Multiple trauma was defined as injuries associated with at least two systems or one system and two large bones.

Data Analysis

Shapiro Wilk test was used to assess the normality of distribution. Student-t-test or Mann-Whitney U test was used to compare the variables according to the normality of distribution. Normally distributed variables were presented as mean and standard deviation (SD) whereas median and interquartile range (IQR) were presented for non-normally distributed variables. A Chi-square test was performed to compare categorical variables. Significance was set at a p-value of .05. Descriptive statistics were given as n and percentage. Decimals were rounded for a better read.

Results

During the study period, 383 of 1702 MVA patients were admitted to the ED due to motorcycle or e-bike accidents. After excluding 25 patients due to missed information in the EMR, a total of 358 patients were included in the study. The mean age of patients was 33 ± 13 years and 93% were male. Hundred (28.1%) patients required hospitalization with a mean LOS of 6.5 ± 11. Of the patients, 58 (16,3%) required surgery. At the time of the accident, 12.9% of the patients were under the influence of alcohol, and the use of protective equipment was only 23.7%. Mortality was seen in 7 (2%) patients. Other descriptive characteristics have presented in Table 1.

Age (years), mean (SD)	33 (13)
Male sex, n (%)	332 (92,7)
Accident timing	
06:00 – 18:00, n (%)	175 (48,9)
18:00-06:00, n (%)	183 (51,1)
Season	
Fall, n (%)	88 (24,6)
Winter, n (%)	67 (18.7)
Summer, n (%)	102 (28,5)
Spring, n (%)	101 (28,2)
Vehicle type	
Motorcycle, n (%)	340 (95)
E-bike, n (%)	18 (5)
Alcohol use, n (%)	46 (12.9)
Protective equipment, n (%)	85 (23,7)
Outcome	
Hospitalization, n (%)	100(28,1)
Intensive care admits	30 (31.9)
LOS, mean (SD)	6.5 (11)
Surgery, n (%)	58 (16,3)
Blood transfusion, n (%)	15 (4.2)
Intubation	8 (2.2
Mortality n (%)	7 (2)

Table 1. Demographic features of the study participants

Soft tissue (n=177, 50%) and extremity injuries (n=96, 27%) were the most common injury types. Distribution for the areas of injury was presented in Figure 1. Fractures were detected in % 39,7 (n= 142) of the patients. Among the
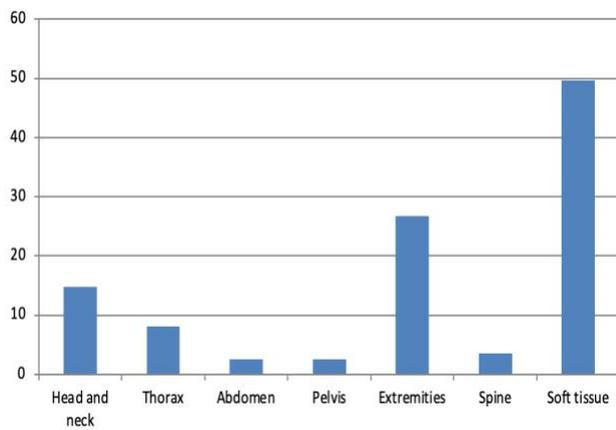
Figure 1: Distribution of the areas of injuries

patients who had bone fractures, the most common locations were upper extremities in 55 (15%), lower extremities in 40 (11%), pelvic fractures in 34 (9.5%) and dislocations in % 1,4 (n= 5). Distribution for the location of fractures was presented in Figure 2.
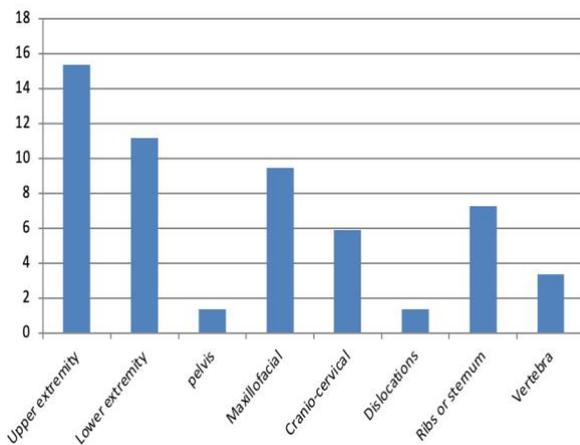

Figure 2: Distribution of the areas of fractures

Multiple trauma was seen in 93 (26%) patients. In patients with multiple trauma, nighttime accidents (p=0.006), influence of alcohol (p=0.002), use of protective equipment (p=0.003), need for hospitalization (p<0.001), need for surgery (p<0.001), need for blood transfusion (p<0.001), intubation (p<0.001), LOS (p=0.024) and mortality rate (p<0.001) were significantly higher than the patients with isolated trauma. When the relationship between the presence of multiple injuries and the areas of injury in the body is examined; head/neck (p<0.001), thorax (p<0.001), extremity (p<0.001), spinal (p<0.001), and soft tissue injury (p<0.001) rates were statistically significantly higher in the patient group with multiple injuries. It was determined that 85 of the patients used helmets and 273 didn't use helmets. In patients who didn't use helmets, night time accidents (p=0.001), influence of alcohol (p=0.002), multiple trauma (p=0.002), need for hospitalization (p=0.002), and fracture (p=0.014) rates were significantly higher than helmets users (Table 2). The presence of head/neck (p<0.001), maxillofacial injury (p=0.001) and cranial fracture (p=0.006) was found to be statistically significantly higher in patients who did not use helmets (p<0.05).

Of the study patients, only 18 (5%) had been using e-bikes. There was no statistically significant difference between the vehicle type and demographic features, injury pattern, multiple injuries, alcohol, fracture, need for hospitalization, need for surgery, blood transfusion or mortality (p>0.05 for all variables). However, in all patients with mortality (2%), vehicle type was all motorcycle and none of the patients had used protective equipment (Table 3). Injury types and fractures were more common in motorcycle accidents, but were not found to be statistically significant (p>0,05).

In hospitalized patients (26%), lack of protective equipment (p=0.021), use of alcohol (p<0.001), nighttime riding (p=0.04), multiple injuries (p<0.001), fractures (p<0.001), need for surgery (p<0.001), intubation (p<0.001), blood transfusion (p<0.001) and mortality (p=0.002) were significantly higher than the non-hospitalized patients. Although all types of injury patterns were significantly higher in the hospitalized group, the presence of pelvic fractures and dislocations were similar between hospitalized and non-hospitalized patients. (p=0.6, p=0.7, respectively).

Discussion

In our study, it was determined that motorcycle or e-bike accidents, mostly occur in the summertime, and predominantly affect males. Also, nighttime accidents, alcohol use, and lack of protective equipment have been found to be related to multiple injuries, need for hospitalization, surgery, blood transfusion, and mortality.

According to the world report on road traffic injury prevention by WHO, male sex has been reported to be a risk factor for MVAs [8]. In our study, 96.7% of the patients were male. Similar to our results, several previous studies reported that males were accounted for motorcycle accidents between 68% to 94.7% [9,10,11]. The reasons for male predominance in motorcycle accidents could include the fact that the use of motorcycles is more common among males, the greater number of males in motorcycling jobs such as courier, and some other sociocultural factors. In a study from Istanbul, Turkey [12], roles of the type of motorcycle and protective equipment use were investigated in motorcycle accidents. In the study population, a rate of 4% of alcohol use and 60-77% of protective equipment used at the time of the accident were reported. Also, it was reported that the riders of heavy motorcycles with an engine limit of >125cm3 were safer than the riders of light motorcycles. In another study from Lyon, France [9], the rate of alcohol use was between 4.6% to 5.4%, and the use of protective equipment was from 83% to 89%. Also, no significant difference was reported between the moped and motorcycle accidents. In our study, the rate of alcohol use was 13% and the use of protective equipment was 24% at the time of the accidents. The diversity of sociodemographic and cultural backgrounds of the study populations could be the reason for the disparate results of the studies. However, similar to previous studies, we could not detect a difference between the vehicle types.

Multiple trauma accounts for higher morbidity and mortality in the victims of MVA [13]. Moreover, the length of the hospital stays, and healthcare expenditures significantly increase associated with multiple injuries [14,15]. Multiple trauma accounts for higher morbidity and mortality in the

		No protective equipment (n=273)		Protective equipment (n=85)		p
		Number	%	Number	%	
Sex	Female	20	7.3	6	7.1	0.934
	Male	253	92.7	79	92.9	
Accident timing	Day	120	44.0	55	64.7	**0.001**
	Night	153	56.0	30	35.3	
Season	Winter	48	17.6	19	22.4	0.781
	Autumn	67	24.5	21	24.7	
	Spring	79	28.9	22	25.9	
	Summer	79	28.9	23	27.1	
Vehicle type	Motorcycle	261	95.6	79	92.9	0.392
	E-bike	12	4.4	6	7.1	
Alcohol use		44	16.1	2	2.4	**0.002**
Multiple trauma		82	30.0	11	12.9	**0.002**
Consultation		141	52.0	29	34.1	**0.004**
Surgery		50	18.5	8	9.4	0.090
Hospitalization		85	31.4	15	17.7	**0.020**
Intubation		8	2.9	0	0.0	0.206
Blood transfusion		14	5.1	1	1.2	0.133
Mortality		7	2.6	0	0.0	0.205
Fracture		118	43.2	24	28.2	**0.014**

Table 2. The relationship between the use of protective equipment and the clinical parameters of the patients

victims of MVA [13]. Our results supported that need for hospitalization or surgery, blood transfusion and mortality rates are higher in patients with multiple trauma. It is also paramount to note that multiple trauma could be prevented by taking basic preventative measures such as using protective equipment, riding in the daytime, and not using under the influence of alcohol or drugs.

In a study that evaluated the areas of injuries in patients with multiple trauma, related to motorcycle accidents, it was reported that lower extremities, upper extremities, head and neck, and thorax were the most affected regions respectively [5]. Another study reported that head and neck, lower extremities, and upper extremities were the most frequent areas of injury, respectively. It was reported that head and neck injuries are the leading reason for mortality [16]. In another study, head and neck injuries were also found to be highest in patients with mortality [17]. In our study, 26% of the patients had multiple injuries. Among the area of injuries, upper extremities (15.4%), head and neck (14.8%), lower extremities (11.2%), and thorax (8.1%) were the most affected regions respectively in patients with multiple trauma. Interestingly, the incidence of head and neck injuries was found relatively lower although a low rate of helmet use in our study population. High rates of

extremities and thorax injuries in our study could be due to the fewer use of protective jackets and pants because of the warm climate of the study region. The incidence of vertebrae fractures and spinal cord injuries are low in our study (3.4% and 3.6% respectively). Although most of the injury mechanisms of motorcycle accidents include vertical impact collisions, rolling or deflection are also common. This type of collisions more likely to cause multiple injuries including the spinal column [18]. The reason for lower spinal injuries compared to other regions could be explained by many standard protective jackets provides back protection. However, the front part of these jackets does not ensure additional protection. Although the types of protective equipment were not evaluated in our study, we believe that considering motorcycle airbag vests or additional front protection equipment could prevent anterior region injuries.

Alcohol use, frequency of multiple injuries, frequency of fractures, consultation frequency and hospitalization rates were significantly higher in the non-helmet group. In terms of injury and fracture pattern; head-neck injury rate, maxillofacial and cranial fracture rates were statistically higher in the non-helmet group. In publications investigating motorcycle accidents in the literature, helmet use rates

Variables		Motorcycle use (n=340)		E-bike use (n=18)		p
		Number	%	Number	%	
Sex	Female	24	7.1	2	11.1	0.382
	Male	316	92.9	16	88.9	
Accident timing	Day	163	47.9	12	66.7	0.191
	Night	177	52.1	6	33.3	
Season	Winter	61	17.9	6	16.7	
	Autumn	85	25.0	3	16.7	0.149
	Spring	99	29.1	2	11.1	
	Summer	95	27.9	7	38.9	
Multiple trauma		91	26.8	2	11.1	0.175
Alcohol use		45	13.2	1	5.6	0.488
Fracture		136	40.0	6	33.3	0.752
Consultation		161	47.6	9	50.0	0.845
Surgery		54	16	4	22.3	0.324
Hospitalization		94	27.8	6	33.3	0.602
Intubation		8	2.4	0	0.0	0.689
Blood transfusion		15	4.4	0	0.0	0.510
Mortality		7	2.1	0	0.0	0.363

Table 3. Relation of clinical parameters of patients according to motorcycle and electric bicycle use

varied between 1.15% and 31.4% [19,20]. In patients who do not use helmets; the rates of hospitalization, head injury frequency, injury severity score, length of hospital stay, and hospital re-admission are found to be higher than patients who use helmets [21]. In large-scale studies on helmet use in the United States, it has been reported that 54% of drivers go to traffic without a helmet against all these risks [22]. In a study by Koçak et al. investigating the characteristics of motorcycle accident cases in our country, none of the patients included in the study used a helmet; it was also reported that they did not use additional protective equipment such as gloves, protective clothing, glasses, knee pads; and as a result, higher mortality rates were reported compared to our study [23]. Injuries related to e-bike accidents have been rising globally as the use of e-bike widespread [24]. Previous studies have shown that the injuries related to e-bike accidents could be as serious as motorcycle accidents [25]. In a study from Sweden, it was reported that the most common injured areas were head and neck, upper extremity, face, and chest in victims of e-bike accidents. Another study reported a higher rate of hospitalization and surgery in e-bike riders compared to cyclists [24]. A study from China also reported that the rate of the need for surgery was 34.9% and the need for intensive care admission was 24.7% [26]. Although the number of e-bike riders was low in this study, no significant differences were detected between the e-bike and motorcycle riders in terms of having multiple injuries, fractures, need for hospitalization, and surgery. These results suggest that e-bike accidents should be considered as high-energy trauma and be approached similarly to motorcycle accidents. Therefore, regulations for e-bike riders including driving license, the legal obligation for protective equipment, and alcohol limit should be considered.

Limitations

This study has many limitations. First, this is a single-center retrospective study. Only the patients with complete data regarding the demographic and clinical information could be included. Also, many factors that might affect the risk of accidents and injury patterns could not be evaluated because of the retrospective nature of this study, such as years of experience, types of protective equipment, speed, motorcycle training, or motorcycle engine capacity. Second, because of the lack in the chart review, the severity of injuries could not be evaluated with a standardized method such as injury severity score. Third, the number of e-bike accidents was low in our study. The higher number of e-bike accidents could provide a better comparison with motorcycle accidents. Fourth, drivers and passengers were not differentiated in our study. However, both of the rider types could be considered as vulnerable road users and injury patterns would not be significantly different. Fifth, sociocultural differences can affect the behavioral

characteristics of the riders such as riding under the influence of alcohol, use of protective equipment, or traffic culture. Because the data of this study were collected in a single center of a city, results may not be generalized to different populations. Sixth, the number of the study patients was low for an epidemiological study. A higher number of study population could increase the reliability of results.

Conclusion

The study results suggested that motorcycle and e-bike accidents were more likely to happen in males, especially in the summertime. As a result of motorcycle accidents, the most frequently injured major body parts are the extremities and head and neck region, and the most common type of injuries are soft tissue injuries. Fractures are most commonly seen in the upper extremity. Also, nighttime riding, alcohol or drug use, and lack of protective equipment were found to be related to having multiple trauma. Injuries caused by e-bike accidents and patient outcomes were not significantly different than motorcycle accidents. Mandatory use of protective equipment (helmets, goggles, body-protecting clothing) for motorcycle drivers and passengers, and frequent traffic inspections in summer and at night will contribute to the prevention of accidents. In addition, legal regulations regarding e-bike users need to be expanded. Larger studies with prospective data are needed in this regard.

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