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Original Article

Severity and injury characteristics among matched hospitalized motorcycle drivers and their passengers

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ABSTRACT

Purpose: After car accident, motorcycle accident ranks as the second leading cause of traffic fatality in Iran. This study aimed to compare the severity and clinical presentations between drivers and passengers under the same injury circumstance.

Methods: This study was conducted in the trauma center of Shiraz, Iran in 2017. Data on demographics, triage level, blood pressure, respiratory rate, Glasgow coma scale (GCS), injured body region, injury severity score (ISS), revised trauma score (RTS), and result of accident were compared between pairs of drivers and passengers. The agreement of any type of injury between drivers and passengers evaluated by Kappa test.

Results: This study included 143 matched pairs of drivers and passengers. Most of the pairs (84.5%) did not use helmet and 77.2% of the riders do not have driving license. ISS was significantly higher in drivers than passengers. In the unmatched pairs, drivers and passengers showed no difference in sustaining injuries in the face, head & neck, chest and soft tissue, but drivers were found more likely to suffer from injuries in the abdomen, extremities, pelvis and spine than passengers. Once one part of the matched pair suffered injury in the head & neck, face, chest, abdomen, extremities and soft tissue & skin injury, the probability that the other part had an injury in the same region was 50%, 9%, 13%, 7%, 22% and 34% respectively. Kappa value for these body regions was 0.006, 0.009, −0.006, 0.068, 0.063 and 0.001, respectively, which was significant in abdomen and extremities.

Conclusion: Although drivers had higher level of injury severity and some different injury distributions, we recommend equal treatment to drivers and passengers. We also recommend related authorities to develop policies on helmet use, driving license and third-party insurance.

Introduction

Motor vehicle accidents (MVAs) represent a growing public health problem in Iran.[1] The World Health Organization reports on MVA as a forgotten epidemic in the third world countries.[2] Researchers believe that among MVAs, motorcyclists are the priority for research and intervention due to high vulnerability.[3] In numerous studies, the frequency of motorcycle accidents, as well as the increased severity of injuries and deaths from trauma in this group, has been investigated and compared with other road users.[4–6] Report showed that motorcycle drivers often are young and active members of the society, due to accident and disability, large financial costs are imposed on their families and the society.[7] High risk behaviors and unsafe riding are the major factors in the occurrence of these events.[8,9] The traumatic injuries of the brain and spinal cord are the main causes of death in traffic accidents.[10] Head injuries in motorcycle accidents are the most common cause of death, so the use of helmet can reduce these injuries.[11–14] Previous studies on the risk factors of severity and pattern of accidents in motorcycle accidents were conducted mainly on unmatched motorcycle drivers and passengers.[15–17] In Iran, with growing number of motorcycle accidents, only few motorcyclists use safety equipment, a significant number of passengers suffer serious injury or death due to lack of protective equipment.[18] In a study in Singapore on 31 pairs of motorcycle riders and passengers, no statistically significant differences were observed among the patients in terms of injury severity score (ISS) and injury distribution.[11] The small population of that study gives rise to the question that, is the appropriate sample size sufficient to achieve the result?

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A comparison of injury severity and clinical injuries in motorcycle passengers and riders would eliminate the confounding effect like pattern of accidents. Now, considering the high incidence of road-traffic accidents in Iran and the lack of adequate literature in the field, the question would arise that which one is usually more likely injured in collisions, the rider or the passenger? Also, are the clinical conditions and injured body regions similar under the same accident circumstances? Thus, the present study was conducted on more pairs of drivers and passengers aiming to answer such questions.

Shiraz is the capital of Fars province, with about 1.8 million residents according to 2015 census. Shahid Rajaie hospital is the main level 1 trauma center of Shiraz and all the MVAs victims are transferred to this center by the emergency medical center.[15] This study aimed to compare the severity and injury characteristics between matched couples of motorcycle drivers and their passengers transferred into Shahid Rajaie hospital. The results of this study can be helpful in cases where relief forces are required to prioritize the transfer of injured people from the scene to health centers and can be effective in protecting the lives of the injured. The results of this study could be a guide for traffic authorities to implement rules to reduce motorcycle road accidents.

Methods

This prospective study was done in Shahid Rajaie (Emtiaz) hospital in Shiraz from the January 1st to June 30th in 2017 and approved by vice chancellor for research and technology of Shiraz University of Medical Sciences (SUMS). This center receives patients from about 24 motorcycle accidents each day. All matched pairs of motorcycle accidents were selected in random days of a week (one random day in a week during six months by census). The meaning of matched pair is that both the driver and passenger groups had an accident by identical motorcycle and same accident condition. The consent was obtained verbally from the patient or their relatives.

After a patient is screened in the emergency unit, an eight-digit code under the title “SERIAL CODE” is generated by the hospital admission unit. On admission, information regarding the baseline demographic characteristics such as age, gender, admission time and injury mechanism (car, motor, fall, assault, pedestrian, injury by object, others) is routinely recorded by admission unit employees. The driver or passenger, who was hospitalized, was enrolled in the study. Trained staff followed the drivers and passengers to collect the needed information. Variables such as demographics, marital status, number of passengers, weight and height for calculation of body mass index (BMI), helmet use, driving license, education, occupation, blood pressure, Glasgow coma scale (GCS), time of accident, type of accidents, season, speed of motor when the accident occurrence mode of arrival to hospital, region of injury in the body, injury severity score (ISS), revised trauma score (RTS).

ISS based on abbreviated injury scale (AIS) 2005 update 2008 scoring system and were scored by adding the squares of the three highest AIS scores in three predetermined body regions[19]; RTS were calculated by the following formula weighted by systolic blood pressure, respiratory rate and GCS.[20]

$$\mathrm{RTS} = (0.9368^{*}\ \mathrm{GCS}) + (0.7326^{*}\ \text{systolic blood pressure}) + (0.2908^{*}\ \text{respiratory rate})$$

The outcomes including severity and pattern of injury in the body were compared between each matched driver and passenger.

According to the AIS severity scale, each patient's injured body regions corresponded to the most severely ISS injured body region. In this regard, all injuries received an AIS code ranging from 1 (minor injury) to 6 (an injury that is thought to be ‘incompatible with life’), which was allocated to one of the six body regions (head, face, chest, abdomen, extremities including pelvis, and external). The patients with multiple injuries were scored by adding the squares of the three highest AIS scores in three predetermined body regions. This provided the ISS, which could range from 1 to 75.

Categorical variables were summarized by using frequency and percentage. Normality was checked using the one sample Kolmogorov-Smirnov test for continuous variables. Two independent *t*-test was used for comparing the distribution of continues variables and chi-square test was used for categorical variables in unmatched drivers and passengers. Cohen's kappa coefficient was used to calculate the agreement degree of body regions between the matched couples. The Kappa statistic is a metric that compares an observed accuracy with an expected accuracy. These criteria compare the ratio of predicted to observed changes, adjusted by the expected number of predicted outcomes that may occur observed with equal frequency. For this study, statistical analysis were done with Stat14 software and figures were prepared using R (version 3.1.2) software for windows. The entire measures have been reported with a 95% uncertainty interval (UI).

Results

A total number of 143 motorcycle accidents with matched pairs of riders and passengers were enrolled in the study. All the drivers were men and 80.5% of the matched pairs consisted of both male motor drivers and passengers. Most of the pairs (84.5%) did not use helmet and only 22.83% of motorcycle drivers have driving license. Most of the pairs (71.5%) had not any motorcycle accidents history. The median and interquartile range (IQR) of time taken for transferring to the hospital was 25 min (3–140 min) and was not significantly different in type of transfers (ambulance versus personnel device) (Table 1).

In unmatched pairs, there was no statistically significant difference in the RTS, and GCS between the drivers and passengers (Table 2). ISS was significantly higher in drivers than passengers. Fig. 1 shows significantly difference in ISS between the two groups of drivers and passengers based on the use and nonuse of helmet. As can be seen, severity of injury in both groups is significantly reduced by using helmet.

The length of stay in hospital (days) for drivers was longer than passengers and the difference was significant ($p = 0.01$). The extent of injuries to the pelvis, spine, extremities and abdomen among the drivers were higher ($p \leq 0.01$). Although the use of helmet was not common between both drivers and passengers, it was more used in drivers ($p < 0.001$). Moreover, the percentage of obesity (BMI = 30–35) was higher in drivers than passengers (Table 2) (Fig. 2).

Once one part of the matched pairs had an injury in the head and neck, face, chest, abdomen, extremity and soft tissue & skin, the probability that the other part had an injury in the same region was 25.87%, 1.39%, 4.20%, 1.39%, 15.38% and 23.77%, respectively. Kappa value for these body regions was −0.006, 0.009, −0.006, 0.068, 0.063 and 0.001, respectively. There is no significant agreement between matched pairs, drivers and passenger, in sustaining injuries in the face, head neck, chest and soft tissue & skin. No significance in kappa was found between matched pairs, drivers and passenger, in sustaining injuries in the face, head neck, chest and soft tissue & skin; but once abdomen and extremity region of the one matched pairs was injured, the chance of damage in other matched pair was 6.8% and 6.3%, respectively, which is significant, and deduced that the chance of

Table 1
Characteristics of the study population.

Variables	*Number* (%)
Gender	
Male[a], male[b]	114 (80.85)
Male[a], female[b]	27 (19.14)
Time of accident	
7am-16pm	68 (49.27)
16pm-24pm	67 (48.55)
24pm-7am	3 (2.17)
Helmet use	
Helmet[a], unhelmet[b]	19 (13.38)
Unhelmet[a], helmet[b]	1 (0.70)
Unhelmet[a], unhelmet[b]	120 (84.50)
Helmet, helmet	2 (1.40)
BMI	
BMI[a] > BMI[b]	33 (42.30)
BMI[a] < BMI[b]	45 (57.69)
Speed of motor (km/h)	
1-60	76 (56.70)
61-90	43 (21.11)
91-150	15 (11.19)
Relationship between pairs	
Friends	68 (53.54)
Husband& wife	16 (12.59)
Others	43 (33.85)
Number of passengers	
1	75 (58.59)
2	52 (40.63)
3	1 (0.78)
Mode of arrival to hospital	
Eme rgency service	126 (91.97)
Personal device	11 (8.02)
Type of accident	
Collision with vehicle	70 (51.85)
Turn over	39 (28.89)
Deviation	12 (8.89)
Struck by object	13 (9.62)
Others	1 (0.74)
Reason of driving	
Working	25 (20.83)
To school	1 (0.83)
Travel	84 (70)
Recreation &Entertainment	10 (8.33)
Driver license	
Yes	29 (22.83)
No	98 (77.16)
Weather	
Sunny	97 (97)
Rainy	3 (3)
Number of previous accident	
0	102 (71.32)
1	26 (18.19)
2	3 (2.09)
3	9 (6.29)
4-10	3 (2.11)

[a] Drivers, [b] Passengers.
BMI: Body mass index.

Table 2
Comparison of the examined variable between drivers and passenger.

Variables	Driver	Passenger	*p* value
Age (years) (Mean ± SD)	29.1 ± 11.82	25.9 ± 11.81	0.384
ISS (Mean ± SD)	6.67 ± 9.55	4.28 ± 7.36	0.020
RTS (Mean ± SD)	7.70 ± 0.595	7.76 ± 0.64	0.423
GCS (Mean ± SD)	14.45 ± 2.08	14.34 ± 2.37	0.458
Blood pressure (Mean ± SD)	118.79 ± 11.51	121 ± 11.71	0.346
Hospital stay (Mean ± SD)	2.37 ± 1.53	1.77 ± 1.41	0.016
BMI (Mean ± SD)	24.83 ± 3.65	24.85 ± 3.75	0.510
Education			0.906
Illiterate	11 (8.03)	8 (6.78)	
High school	121 (88.32)	104 (88.14)	
Bachelor degree	6 (4.38)	6 (5.08)	
Occupation			0.35
Unemployed	20 (15.75)	23 (19.49)	
Employee	5 (3.94)	0 (0)	
Retired	3 (2.36)	0 (0)	
Worker	22 (17.32)	13 (11.02)	
Others	77 (60.63)	82 (69.49)	
Marital status			0.166
Married	61 (43.26)	43 (33.59)	
Single	80 (56.74)	85 (66.41)	
Helmet use			<0.001
Yes	21 (15.11)	3 (2.34)	
No	118 (84.89)	125 (97.66)	
Triage score			0.210
Level1	5 (3.50)	4 (2.84)	
Level2	37 (25.87)	30 (21.28)	
Level3	64 (44.76)	54 (38.30)	
Level4,5	37 (25.87)	53 (37.58)	
Head & neck			0.903
Yes	55 (38.46)	54 (37.76)	
No	88 (61.54)	89 (62.24)	
Face			0.099
Yes	15 (10.49)	8 (5.63)	
No	128 (89.51)	134 (94.36)	
Chest			0.368
Yes	24 (16.78)	27 (19.01)	
No	119 (83.22)	115 (80.99)	
Abdomen			0.001
Yes	23 (16.08)	6 (4.2)	
No	120 (83.92)	137 (95.8)	
Extremities			0.001
Upper & Lower	75 (52.45)	48 (33.57)	
No	68 (47.55)	95 (66.43)	
Externa			0.171
Yes	72 (51.06)	62 (43.36)	
No	69 (48.93)	81 (56.64)	
Spin			0.015
Yes	6 (4.2)	0 (0)	
No	137 (95.8)	143 (100)	
Pelvis			0.001
Yes	27 (19.01)	8 (5.71)	
No	115 (80.99)	132 (94.29)	
Number of total regions injuries			0.044
1 region	62 (43.36)	79 (55.24)	
2–6 regions	81 (56.64)	64 (44.76)	
Dead			0.652
Yes	3 (2.1)	2 (1.4)	
No	140 (97.9)	141 (98.6)	

ISS: injury severity score; RTS: revised trauma score; GCS: Glasgow coma scale; BMI: body mass index.
Data are expressed as *n* (%) unless stated otherwise.

injury in the extremities and abdominal region is the same for both groups. (Table 3).

Discussion

Iran is one of the countries with highest rates of road-traffic accidents and related mortality.[1] With the increase in the usage of motorcycles in Iran, motorcycle-related accidents are becoming more and more frequent.[18] A comparison of injury severity and clinical injuries in motorcycle passengers and drivers would eliminate the confounding effect like pattern of accidents. In a study in Singapore on 31 pairs of motorcycle drivers and passengers, no statistically significant differences were observed among the patients in terms of injury severity score (ISS) and injury distribution which small population of that study can lead to their results. Thus, the present study was conducted on 143 pairs of drivers and passengers aiming to answer such questions. Our findings support the idea that equal treatment to drivers and passengers, especially considering the stronger agreement observed from extremities injuries in the first place, and injuries to external in the second. However, there was a significant chance of simultaneous kappa occurrence related to injuries to the abdomen and extremities; meaning that the risk of occurrence was higher than the chance. In this regard, the kappa value was negative in relation to thoracic

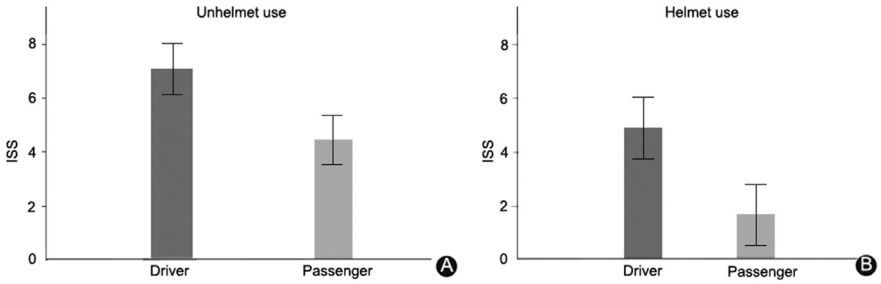

Fig. 1. ISS for drivers and passengers based on unhelmet use (A) and helmet use (B).

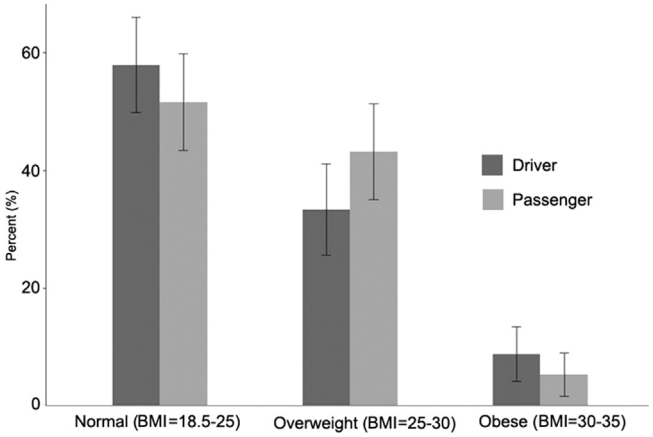

Fig. 2. The percentage of body mass index (BMI) categories among drivers and passengers.

injury; therefore, the risk was lower than the chance of occurrence in this regard.

According to our results, there weren't any significant differences between drivers and passengers in terms of age, gender and marital status. It should be noted that all drivers, as well as more than 80% of the passengers were male. This finding is easy to explain that women almost never ride motorcycles in Iran as a consequence of cultural and legal conditions. Our results were showed that highest number of injuries of drivers were in extremities and external respectively and for passenger were in head & neck and external regions. According to the study by Goldstein et al.,[21] the high frequency of head & neck injuries in passengers can be due to the lack of helmet use, and this results showed that the use of helmets is less frequent in passengers, so they are more at risk of head & neck injuries. In this study, though totally the highest distribution of injuries were related to the head-and-neck, soft tissue & skin and extremities, lower extremities in particular; these results were similar to the findings from both matched and unmatched studies.[16,17,22] However, an observable difference in our study was the higher and more significant involvement of drivers with injuries to the abdomen, extremities, pelvis and spine, as well as their higher length of hospital stay. Generally, drivers had a higher injury severity and injury distribution compared to the passengers, despite the insignificance of other variables. In this research, although a large number of driver/passenger pairs did not have helmets on, there were a significantly more drivers wearing helmets than passengers and about 40% of accidents result in head & neck injuries. However, this finding rooted in other various factors, so further investigation is needed. In a study in Taiwan, China, a higher injury severity and incidence was associated with specific body regions in obese individuals.[23] Our study also revealed a higher level of obesity in motorcycle drivers. According to the present study, it is necessary to develop social prevention plans with regard to the low rates of helmet use (especially in passengers), driving without license, high incidence of accidents in the day time, overloaded, accident mechanisms, high prevalence of simultaneous body region involvement (especially in the head & neck), and accident history. Therefore, it is suggested that strict rules be applied to motorcyclists to prevent further damage. According to numerous studies all around the world, including Iran, the use of standard helmets by motorcycle passengers can reduce incidence of head injuries.[11,12] Moreover, due to the higher incidence of fatal accidents caused by motorcycle, we recommend that a higher level of supervision for motor vehicles.

One of the limitations of this study was that some of information is based on self-reported data. Furthermore, not a lot of patient with severe injuries transferred to the hospital which was unavoidable as samples was selected randomly. Since our study was conducted on hospitalized patients, the cases that both driver and passenger had died at the scene were excluded from the research. Moreover, according to our search, this study is the first one in Iran to make such a detailed comparison of passengers and drivers in terms of different variables before admission to the hospital, in the hospital and under similar accident conditions. For future research, we recommend a similar study on triage level 2 and 3 with a larger sample size.

Although the motorcycle drivers had higher levels of injury severity and distribution compared to the passengers, they were somewhat similar from a statistical point of view. Therefore, equal treatment to patients are required in cases where other body organs are involved. We also advise enforcement of strict laws for

Table 3
An agreement between percentages of injury in each pair.

Regions	Paired with injuries, *n* (%)	Paired with no injuries, *n* (%)	Paired with only injuries in passenger or driver, *n* (%)	Probability	Kappa	95% *CI*		*p* value
						Lower	Upper	
Head &Neck	37 (25.87)	69 (48.25)	37 (25.87)	0.50	−0.006	−0.007	0.089	0.904
Face	2 (1.39)	121 (86.62)	20 (13.99)	0.09	0.009	−0.004	0.943	0.129
Chest	6 (4.20)	98 (68.53)	39 (27.27)	0.13	−0.006	−0.007	0.602	0.644
Abdomen	2 (1.39)	115 (80.43)	26 (18.18)	0.07	0.068	0.009	0.988	0.001
Extremity	22 (15.38)	42 (29.37)	79 (55.24)	0.22	0.063	0.008	0.987	0.001
External	34 (23.77)	44 (30.77)	65 (45.45)	0.34	0.001	−0.005	0.889	0.288

helmet use, riding license, third-party insurance and maximum number of passengers.

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Ethical statement

The consent was obtained verbally from the patient or their relatives.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cjtee.2018.08.007.

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