ORIGINAL RESEARCH

Effective Factors in Severity of Traffic Accident-Related Traumas; an Epidemiologic Study Based on the Haddon Matrix

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Abstract

Introduction: Traffic accidents are the 8th cause of mortality in different countries and are expected to rise to the 3rd rank by 2020. Based on the Haddon matrix numerous factors such as environment, host, and agent can affect the severity of traffic-related traumas. Therefore, the present study aimed to evaluate the effective factors in severity of these traumas based on Haddon matrix. **Methods:** In the present 1-month cross-sectional study, all the patients injured in traffic accidents, who were referred to the ED of Imam Khomeini and Golestan Hospitals, Ahvaz, Iran, during March 2013 were evaluated. Based on the Haddon matrix, effective factors in accident occurrence were defined in 3 groups of host, agent, and environment. Demographic data of the patients and data regarding Haddon risk factors were extracted and analyzed using SPSS version 20. **Results:** 700 injured people with the mean age of 29.66 ± 12.64 years (3-82) were evaluated (92.4% male). Trauma mechanism was car-pedestrian in 308 (44%) of the cases and car-motorcycle in 175 (25%). 610 (87.1%) cases were traffic accidents and 371 (53%) occurred in the time between 2 pm and 8 pm. Violation of speed limit was the most common violation with 570 (81.4%) cases, followed by violation of right-of-way in 57 (8.1%) patients. 59.9% of the severe and critical injuries had occurred on road accidents, while 61.3% of the injuries caused by traffic accidents were mild to moderate (p < 0.001). The most common mechanisms of trauma for critical injuries were rollover (72.5%), motorcycle-pedestrian (23.8%), and car-motorcycle (13.14%) accidents (p < 0.001). **Conclusion:** Based on the results of the present study, the most important effective factors in severity of traffic accident-related traumas were age over 50, not using safety tools, and undertaking among host-related factors; insufficient environment safety, road accidents and time between 2 pm and 8 pm among environmental factors; and finally, rollover, car-pedestrian, and motorcycle-pedestrian accidents among the agent factors.

Keywords: Wounds and injuries; accidents; accidents, traffic; risk factors

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Introduction:

Traffic accidents are one of the major causes of disability and mortality in different countries and are considered the 8th cause of mortality in the industrial countries. Based on a statement by World Health Organization (WHO) it is expected to rise to the 3rd rank by 2020 (1, 2). Traffic accidents not only cause millions of disabilities and deaths, and take a toll on the countries' finance, but are also considered a big problem in the way of improving public health (3-7). Numerous factors such as environmental, vehicle-related, host (driver, pedestrian), and their type of interaction affect the characteristics of these accidents. To accurately identify them, there are solutions such as evaluation of public health, risk factors, and Haddon matrix (8). Among the mentioned solutions, Haddon matrix is the best tool to combine the epidemiologic triangle of the host, agent and environment with 3 stages of prevention before, during and after the accident (9). Based on this tool, special strategies can be designed for road traffic injury preven-

tion. Various studies show that in traffic accidents, pedestrians and young motorcycle riders are most susceptible to injury. A cross-sectional study that evaluated traffic accident injuries over one year, showed that about 98.9% of the injured were men with the mean age of 30 years (10). A similar study revealed that factors such as age over 45 years, weather condition, type of accident and road conditions significantly correlated with severity of injury (11). In a study by Hatamabadi et al., the biggest mortality rate by far, belonged to pedestrians (12). Ahvaz city, southeast Iran, is located in an accident-prone location, and there are not enough studies regarding traffic accident characteristics in this city. Therefore, the present study aimed to evaluate the effective factors in severity of traffic accident-related traumas based on Haddon matrix.

Methods:
In the present 1-month cross-sectional study, all traffic accident trauma patients in, who were referred to the emergency department (ED) of Imam Khomeini and Golestan Hospitals, Ahvaz, Iran, during March 2013 were evaluated. The present study was approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences. Based on the Haddon matrix, effective factors in incidence of traffic accidents were defined in 3 groups of host-, agent-, and environment-related (table 1). The severity of injury was calculated using injury severity score (ISS). Traumas with a score of 1-9 were categorized as mild, 10-15 as moderate, 16-25 as severe, and over 25 as critical (13). Patients were included from equal morning and night shifts (20 patients from each shift on average). Demographic data of the patients and data regarding risk factors based on Haddon matrix were extracted and recorded by 3 trained emergency medicine residents using the police and medical files as well as asking the patient or their relatives. Patients with missing data were excluded from the study. After gathering the data, they were recorded and analyzed using SPSS version 20. Descriptive indices were described using frequency, percentage, and mean ± standard deviation, and qualitative ones were compared using chi square test. P < 0.05 was considered as significance level.

To reserve patient rights, all the researchers adhered to the principles of Helsinki Declaration and kept patient information confidential.

Results:
700 traffic accident trauma patients, with the mean age of 29.66 ± 12.64 years (range: 3 - 82) were admitted to the afore-mentioned EDs during 1 month (92.4% male). Trauma mechanism was pedestrian-car in 308 (44%) of the cases and car-motorcycle in 175 (25%). 610 (87.1%) cases were urban accidents and 371 (53%) occurred in the time between 2 pm and 8 pm. Violation of speed limit was the most common violation with 570 (81.4%) cases, followed by violation of right-of-way in 57 (8.1%) patients. All the drivers used seat belts (100%), while only 84.23% of the motorcycle riders used helmets. Table 2 shows the distribution of traffic accident injuries based on age; sex; type, time, and location of accident; severity of injury; and type of safety tools and moving violation. 59.9% of the severe and critical injuries had occurred in road accidents, while 61.3% of traffic ones were mild to moderate (p < 0.001). 14 (70%) of the accidents that had occurred in locations without proper safety, had led to severe to critical injuries. While in safe locations, 405 (59.5%) cases had mild to moderate injuries (p = 0.013). Undertaking, crossing over a center divider, violation of right-of-way, and violating speed limit were the cause of 65.51%, 27.27%, 22.8%, and 19.28% of the critical injuries, respectively (p < 0.001). The most common mechanisms of trauma for critical injuries were rollover (72.5%), motorcycle-pedestrian (23.8%), and car-motorcycle (13.14%) accidents (p < 0.001). Table 3 summarizes the effects of environment-, host-, and agent-related factors based on collision severity.

Discussion:
Results of the present study showed that the severity of injuries cause by traffic accidents is in correlation with factors such as age, accident location, type of accident, time of accident, and type of moving violation. In addition, mean injury severity in this study was estimated to be moderate to severe. Most of the injured were young men under 40 years old, which was similar to a study by Kumar et al. and some other studies (10, 11). In other

Table 1: Effective risk factors in occurrence of accident based on the Haddon matrix	
Category	**Risk factors**
Host	Age, using safety tools (helmet in motorcycle riders, seat belt in drivers) and moving violation (violation of speed limit, undertaking, crossing over a center divider, violation of right-of-way)
Agent	Accident type (pedestrian car , pedestrian motorcycle, 2 motorcycles, 2 cars, falling down)
Environment	Safety of the accident location (pedestrian line or footbridge, traffic light, guard rail, proper road construction, proper lighting), weather conditions at the location (time of accident), place of accident (traffic or road)

Table 2: Baseline characteristics of patients

Characteristics	n (%)
Age group (years)	
< 16	37 (5.3)
17-30	387 (55.3)
30-40	154 (22)
40-50	66 (9.4)
50-65	39 (5.6)
≥ 65	17 (2.4)
Sex	
Male	647 (92.4)
Female	53 (7.6)
Type of accident	
Car-pedestrian	308 (44)
Car-motorcycle	175 (25)
Rollover	80 (11.4)
Car-car	48 (6.9)
Motorcycle-motorcycle	47 (6.7)
Motorcycle-pedestrian	42 (6)
Location	
Traffic accident	610 (87.1)
Road accident	90 (12.9)
Time of accident (hour)	
8 am – 2 pm	245 (35)
2 pm – 8 pm	371 (53)
8 pm – 8 am	84 (12)
Injury score*	
1 - 9 (mild)	197 (28.1)
10 - 15 (moderate)	214 (30.6)
16 - 25 (severe)	137 (19.6)
> 25 (critical)	152 (21.7)
Using safety tools	
Seat belt	128 (100)
Helmet	187 (84.23)
Moving violation	
Speed limit violation	570 (81.4)
Violation of right-of-way	57 (8.1)
Crossing over a center divider	44 (6.3)
Undertaking	29 (4.1)

* Based on injury severity score (ISS).

countries, even western ones, men are far more susceptible to injury caused by accidents. In this study, most patients were injured in car-pedestrian accidents, which is in line with another study that reported vehicles hitting pedestrians as the most common cause of injury (14). Yet, some studies have introduced motorcycle accidents as the most common cause of trauma (15, 16). Although car-motorcycle accidents had a high frequency in this study, car-pedestrian accidents were the most common. This emphasizes the importance of educating pedestrians, either in schools or through the media, to decrease

pedestrian mortality, especially among children and teenagers. The results of the study carried out on 343082 accident cases in Iran in 2006 showed that, 276000 were injured in traffic accidents. 56% of the accidents were caused by the collision of 2 vehicles, 64.5% happened due to violation of the traffic rules, and 34% occurred at the time of sunrise or sunset (3). Most of the accidents in the present study had occurred in the evening (2 pm to 8 pm), which was in line with the 2006 study regarding frequency of accidents at sunrise and sunset (4). In the present study, most common moving violation was speed violation. Injury severity in traffic and road accidents was significantly different, which is in line with the results of a study by Wang et al. that evaluated 568 cases in 1 year. They expressed that age over 45 years, migrated population, weather conditions, type of accident, and road conditions significantly correlated with severe accident injuries (11). In this study, injury severity significantly correlated with type of accident, and critical injuries were mostly due to rollover, which is in line with the Wong et al. study (11). Unsafe environment of the location of accident also showed a significant correlation with trauma severity, similar to the results of Wang et al. (11). Analyses showed that type of moving violation and severity of injury significantly correlated and violation of speed resulted in more severe injuries. In addition, severity of injury varied significantly among different age groups. The most severe injuries belonged to people in the > 50 age group. This was in contrast with the results of a study done in China that reported age under 45 correlated with injury severity. Injury severity was significantly higher in midnight accidents (8 pm to 8 am). Apparently, planning to eliminate or decrease environment-, host-, and agent-related risk factors leading to severe and critical traumas in the first phase, and mild and moderate ones later, can considerably decrease financial and health-related costs of traffic accidents. Educating the society using educational programs and encouragement/punishment, improving road conditions and eliminating its accident hot zones, revising the maximum age allowed for driving, planning special traffic rules for motorcycle riders and reinforcing limitations, and controlling traffic in accident-prone times (2 pm – 8 pm) can be helpful in this regard. The short duration of the study and small sample size are among the limitations of this study. It is recommended to design more general and national studies with larger sample size to be able to identify the correlations of these factors more accurately and decrease traffic accidents and consequently injuries resulting from them.

Conclusion:

Based on the results of the present study, the most important effective factors in severity of traffic accident-related traumas were age over 50, not using safety tools, and undertaking among host-related factors; insufficient

Table 3: The effects of Haddon matrix factors on injury severity

Accident characteristics		Injury severity based on ISS* (%)				P
		Mild	**Moderate**	**Severe**	**Critical**	
Environment	**Location safety**					
	Negative	2 (10)	4 (20)	4 (20)	10 (50)	0.013
	Positive	195 (28.7)	210 (30.9)	133 (19.5)	142 (20.9)	
	Location					
	Urban road	15 (16.7)	22 (24.4)	19 (21.1)	34 (37.8)	0.001
	Inter-city road	182 (29.8)	192 (31.5)	118 (19.3)	118 (19.3)	
	Time (hour)					
	8 am – 2 pm	81 (33.1)	78 (31.8)	40 (16.3)	46 (18.8)	
	2 pm – 8 pm	100 (27)	124 (33.4)	84 (22.6)	63 (17)	0.001
	8 pm – 8 am	16 (19)	12 (14.3)	13 (15.5)	43 (51.2)	
Host	**Age (year)**					
	< 16	12 (32.4)	14 (37.8)	6 (16.2)	5 (13.5)	
	17-30	119 (30.7)	115 (29.7)	74 (19.1)	79 (20.4)	
	30-40	39 (25.3)	52 (33.8)	33 (21.4)	30 (19.5)	0.036
	40-50	14 (21.2)	23 (34.8)	7 (10.6)	22 (33.3)	
	50-65	7 (17.9)	9 (23.1)	13 (33.3)	10 (25.6)	
	≥ 65	6 (35.3)	1 (5.9)	4 (23.5)	6 (35.3)	
	Using safety tools					
	Seat belt No	0	0	0	0	
	Yes	30 (23.4)	24 (18.7)	10 (7.8)	64 (50)	0.001
	Helmet No	0	10 (28.6)	19 (54.3)	6 (17.1)	
	Yes	35 (19.5)	68 (38)	61 (34.1)	23 (12.8)	
	Moving violation					
	Speed limit	160 (28.6)	186 (33.2)	116 (21.7)	108 (19.3)	
	Undertaking	2 (6.9)	6 (20.7)	2 (6.9)	19 (65.5)	0.001
	Crossing**	18 (40.9)	11 (25)	3 (6.8)	12 (27.3)	
	Right-of-way	17 (29.8)	11 (19.3)	16 (28.1)	13 (22.8)	
Agent	**Mechanism of injury**					
	Car-pedestrian	121 (39.3)	102 (33.1)	46 (14.9)	39 (12.7)	
	Car-motorcycle	35 (20)	61 (34.8)	56 (32)	23 (13.1)	
	2 motorcycles	0	17 (36.2)	24 (51.1)	6 (12.8)	0.001
	2 cars	25 (52.1)	13 (27.1)	4 (8.3)	6 (1.2)	
	Motor-pedestrian	11 (26.2)	10 (23.8)	11 (26.2)	10 (23.8)	
	Rollover	5 (6.2)	11 (13.7)	6 (7.5)	58 (72.5)	

* ISS: injury severity score, ** crossing over a center divider.

environment safety, road accidents and time between 2 pm and 8 pm among environmental factors; and finally, rollover, car-pedestrian, and motorcycle-pedestrian accidents among the agent factors.

Conflict of interest:
We declare that the authors of this article have no competing interests.

Authors' contributions:
All authors passed four criteria for authorship contribution based on recommendations of the International Committee of Medical Journal Editors.

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