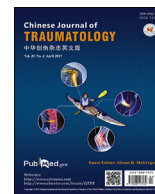




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## Original article

## Assessment of mechanism, type and severity of injury in multiple trauma patients: A cross sectional study of a trauma center in Iran

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## ABSTRACT

**Purpose:** To accurately assess the mechanism, type and severity of injury in Iranian multiple trauma patients of a trauma center.**Methods:** Patients with multiple traumas referring to the emergency department of Hasheminejad University Hospital in Mashhad, Iran, entered this cross sectional study from March 2013 to December 2013. All the patients with injury severity score (ISS) > 9 were included in this study. Data analysis was performed by SPSS software (Version 11.5) and *P* values less than 0.05 were considered as significant differences.**Results:** Among the 6306 hospitalized trauma patients during this period, 148 had ISS>9. The male female ratio was 80%. The mean age of the patients was (33.5 ± 19.3) years. And 71% of the patients were younger than 44 years old. There were 19 (13%) deaths from which 68.5% were older than 44 years old. The mean transfer time from the injury scene to hospital was (55 ± 26) minutes. The most frequent mechanisms of injury were motorcycle crashes and falling from height, which together included 66.2% of all the injuries. A total of 84% of hospital deaths occurred after the first 24 h of hospitalization. Head and neck were the most common body injured areas with a prevalence of 111 cases (75%).**Conclusion:** Motorcycle crashes have high frequency in Iran. Since most victims are young males, injury prevention strategies should be considered to reduce the burden of injuries.

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## Introduction

Injuries are one of the most important public health issues worldwide and have a considerable contribution to the disease burden, especially in young adults.<sup>1</sup> Global deaths from injuries increased by 10.7%, from 4.3 million deaths in 1990 to 4.8 million in 2013, but age-standardized rates declined over the same period by 21%. Injuries caused by interpersonal violence and road traffic crashes (RTC) constitute a significant proportion of preventable mortality cases in many countries. There are more than one million

deaths from RTC worldwide every year, which consist of 17% of all deaths in the age group of 10–40 years. The number of road traffic injuries (RTI) is estimated at more than 50 million people each year. Although the incidence of RTC is expected to decline about 30% in developed countries over the next 20 years, the frequency of deaths from RTC is predicted to rise in the least developed and developing countries.<sup>2</sup> The injuries spectrum has changed in recent decades worldwide. Years lived with disability (YLDs) from total injuries in 2013 are estimated to be about 37 million with a significant 37% rise in age-standardized YLDs since 1990.<sup>3</sup>

In addition, the proportion of disability-adjusted life years due to YLDs increased globally from 21.1% in 1990 to 31.2% in 2013.<sup>4</sup> RTI including pedestrian injuries and cyclist, motorcyclist and motor vehicle road injuries had a 6.9% rise in YLDs from 1990 to 2013. From all the reasons of fatal injuries, 69% are unintentional. Fatality from falls, which is one of the most common causes of

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unintentional injuries, has significantly increased from about 340,000 in 1990 to 556,000 in 2013.<sup>3</sup> Unintentional injuries also had a significant 17.9% rise in YLDs from 1990 with an incidence of about 22 million YLDs in 2013. Falls for example, had 23% increase in YLDs from 1990 to 2013.<sup>3</sup> While decreases in mortality from unintentional injuries added 0.3 years to life expectancy since 1990, intentional injuries reduced life expectancy in developing and least developed countries.<sup>3</sup>

Although statistically unchanged from 1990, the trend in disability-adjusted life years (DALYs) which is the sum of years of life lost (YLLs) and years lived with disability (YLDs) has shown a steady, although slowing, increase worldwide, while road injuries shifted from the 12th cause of death to the 10th with 34% increase.<sup>5</sup>

A survey for all ages and both sexes of Iranian people in 2003 showed that among 21,572 DALYs due to all diseases and injuries per 100,000 people, 14% were due to injuries. RTC was the leading cause of DALYs in males and the fourth cause in females with 1,071 million and 235,000 DALYs, respectively.<sup>6</sup> Based on the recent population-based study, the annual incidence rate of all injuries for Iranian is estimated at 905 per 1000 population, accounting for approximately nine injuries per ten persons.<sup>7</sup> Total and out-of-pocket health costs of non-fatal injuries in Iran in 2011 were estimated to be 6,111,138,000 US\$ and 1,480,411,000 US\$, respectively.<sup>7</sup>

Considering the growing need for a clearer expression of injuries due to multiple traumas as an important part of mortality and disability particularly among young people, this study was conducted to investigate the mechanism, type and severity of injury in multiple trauma patients at a referral university trauma center in Mashhad, Iran during a period of ten months.

## Materials and methods

This study was approved by the local ethics committee of Hasheminejad Hospital, Mashhad University of Medical Sciences. Between March and December 2013, patients referring to the trauma center of Hasheminejad Hospital with the diagnosis of multiple traumas, entered this cross sectional study. After an initial evaluation in the emergency department, a complete documentation of injured organs was used for Injury Severity Score (ISS) measurement and all the patients with ISS>9 were included in the study. The information included demographic data, vital signs, Glasgow Coma Scale (GCS), time of accident, place of accident, transport methods, mechanism, type and severity of injury, associated injuries, duration of hospital stay as well as mortality and mortality after 24 h. Patients dead upon their arrival to the emergency department in addition to the patients whose data were not available or were transferred to other medical centers before the end of the investigations were excluded from this study. The data were analyzed using SPSS software (Version 11.5) and *p* values less than 0.05 were considered as statistically significant difference.

## Results

Of 6306 trauma patients referring to the trauma center of Hasheminejad Hospital during the study period, 148 had ISS>9. And 119 patients (80.4%) were male and 29 were female (19.6%) with the mean age of (33.5 ± 19.3) years (ranging from 6 months to 82 years). The frequency of injuries with severe damages was not the same during different hours of the day. And 33.8% of the injuries occurred from 12 o'clock at midnight to 12 o'clock at the mid day, while the majority of injuries (66.2%) occurred from 12 o'clock to 24 o'clock at midnight. However, the difference between the severity of injury in the morning, evening and night hours was not statistically significant (*p* = 0.381). Fig. 1 shows the frequency of injuries

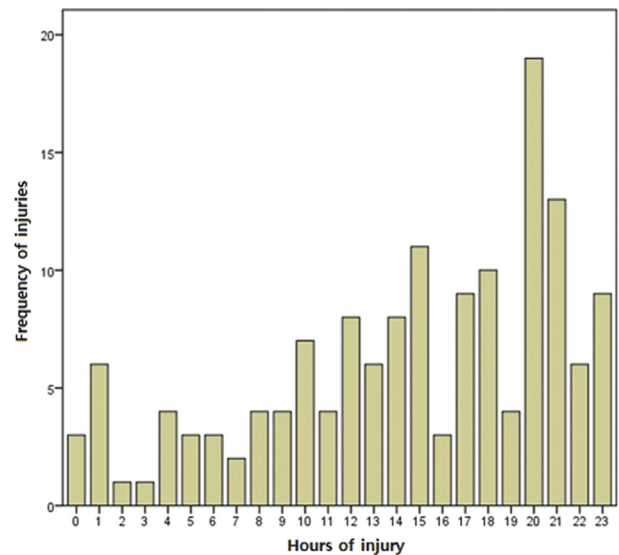


Fig. 1. Frequency of injuries during 24 h.

in different hours of the day. The frequency distribution of different kinds of injuries during 24-h is shown in Fig. 2. From the total number of 6306 patients, 73% were transferred to the emergency department by ambulances of the emergency medical service (EMS), but all the trauma patients with ISS>9 were transferred to the hospital by EMS. The average time length of rescue time was (55 ± 26) minutes. The patients were divided into three age groups including <10 years, 10–44 years and >44 years. Totally 148 patients were severely injured (ISS > 9), with 15 (10.1%) distributed in the <10 years age group, 91 (61.5%) in the 10–44 years age group and 42 (28.4%) in the >44 years age group. The age group of 10–44 years consists the highest level of severely injured patients. The most common mechanisms of injury were motorcycle crashes, falls, car pedestrian injury, interpersonal violence and car crashes, respectively (Fig. 3). The mechanism of injury was different between different age groups. In the age groups of less than 10 years and more than 44 years, falls were the most common cause of severe injury, while RTC was the most prevalent in the age group of 10–44 years (Table 1). The most common mechanism of injury in males was motorcycle crashes while pedestrian injuries and falls were both in the first rank for females (Fig. 4). The frequency of pedestrian injuries was 34.5% in females while 10% in males. Injuries occurred most commonly in roads (58.5%), followed by injuries at work and houses, respectively (Fig. 5). And 84 patients (56.8%) were in the group of ISS = 10–19, 52 patients (35%) in the group of ISS = 20–29, 10 (6.8%) in ISS = 30–39 and 2 persons (1.4%) in the group of ISS = 40–49 (Table 2). Overall, 19 patients (12.8%) died of traumatic injuries. And 13 out of 19 deaths (68.4%) were in the age group of >44 years while this age group was consisted of 42 patients (28.4% of the patients). The mean age of mortality was not statistically different between the males and females (*p* = 0.909). Two women (6.2%) and one man (0.8%) died in the first 24 h after trauma. The mean ISS score of all the patients was 20.22 ± 6.89, while it was 38 ± 15.58 in the patients who died in the first 24 h and 25.6 ± 2.97 in the patients who died after the first 24 h. The patients who died during the course of hospitalization had the mean ISS score of 27.11 ± 9.2. The mean difference of ISS between those who died in the first 24 h and those who survived was statistically significant (*p* < 0.001) but it was not statistically significant between the different mechanisms of injuries (*p* = 0.431). The most common causes of death were found in motorcycle crashes, pedestrian injuries and falls, respectively (Fig. 6). There was no patient with ISS

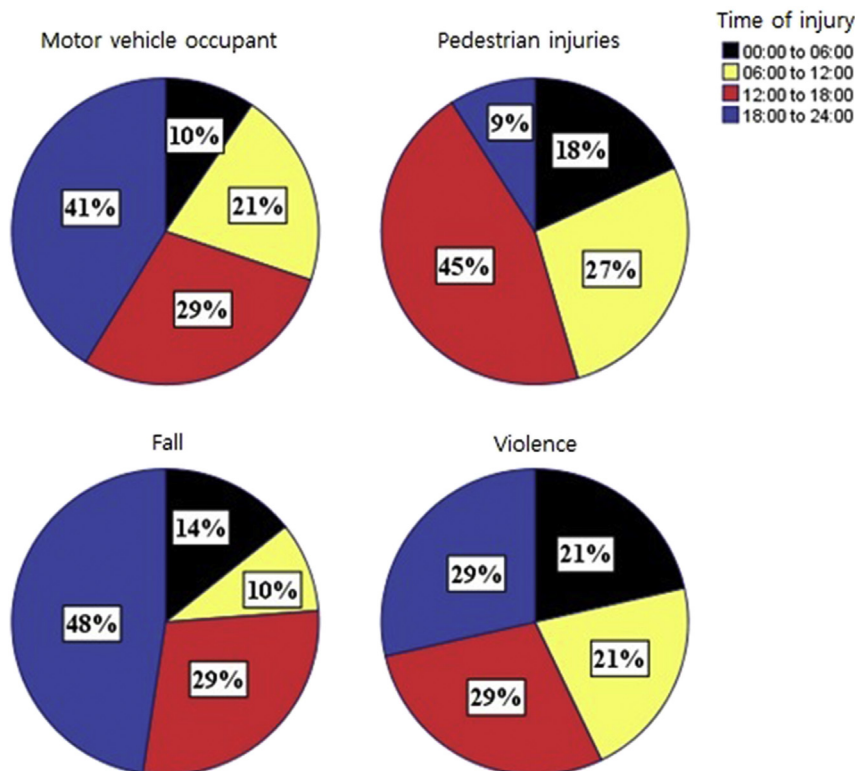


Fig. 2. Frequency distribution of different kinds of injuries during 24 h.

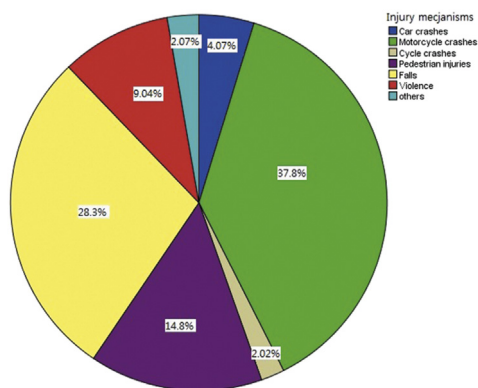


Fig. 3. Distribution of injuries according to mechanism.

greater than 47 among the survivors who arrived at the hospital. Two out of three deaths during the first 24 h were found in the group of ISS = 40–49. And 14 out of 16 deaths after the first 24 h were found in the ISS = 20–29 group. Fig. 7 shows the frequencies of death rates according to the ISS categorization. Multiple Logistic Regression Analysis showed that variables of age, ISS, GCS and

systolic pressure had a significant effect as a risk factor in predicting the death possibility in injured patients admitted to emergency department. Table 3 shows the coefficient effect, P values and standard errors of these variables.

### Discussion

In this study, traumatic information in regional level is discussed in a developing country, in which the conditions of traumatic patients may be different from those of developed countries. A large number of incidents resulting in injuries and deaths were enrolled in the study that may include detailed accidental information from which the preventive measurements may be developed. The overall pattern of our results is consistent with other studies in Iran and other developing countries. Injury victims are mostly young and motorcycle crashes and falls constitute a major proportion of severe injuries. In the current study, the youth group (younger than 44 years old) had the highest number and the highest proportion of patients with multiple traumas. Since Iran has a high proportion of young population and youth are more likely to use motorcycles, these conditions may cause a significant difference in the prevalence of multiple trauma patients in different age groups. And 80.4% of multiple trauma patients in this study were men. The

Table 1  
Frequency distribution for mechanism of injury in multiple trauma cases according to age groups.

Age group	Injury mechanisms						
	Car crash	Motorcycle crash	Cycle crash	Pedestrian injury	Fall	Violence	Others
<10	0 (0)	2 (3.6)	0 (0)	2 (9.1)	11 (26.2)	0 (0)	0 (0)
10–44	4 (57.1)	50 (89.2)	0 (0)	6 (27.3)	16 (38.1)	14 (100)	1 (25.0)
>44	3 (42.9)	4 (7.2)	3 (100)	14 (63.6)	15 (35.7)	0 (0)	3 (75.0)
Total	7 (100)	56 (100)	3 (100)	22 (100)	42 (100)	14 (100)	4 (100)

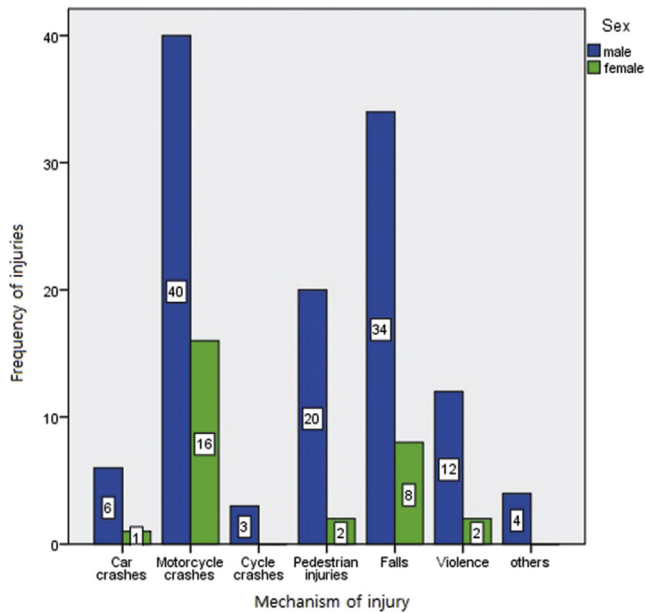
**Table 2**  
ISS distribution based on the mechanism of injury in multiple trauma patients (n = 148).

ISS	Injury mechanisms							Total
	Car crash	Motorcycle crash	Cycle crash	Pedestrian injury	Fall	Violence	Others	
10–19	4 (2.7)	28 (18.9)	2 (1.4)	13 (8.8)	21 (14.4)	12 (8.1)	4 (2.7)	84 (56.8)
20–29	1 (0.7)	23 (15.5)	1 (0.7)	8 (5.4)	17 (11.5)	2 (1.4)	0 (0)	52 (35.0)
30–39	2 (1.4)	5 (3.4)	0 (0)	1 (0.7)	2 (1.4)	0 (0)	0 (0)	10 (6.8)
40–49	0 (0)	0 (0)	0 (0)	0 (0)	2 (1.4)	0 (0)	0 (0)	2 (1.4)

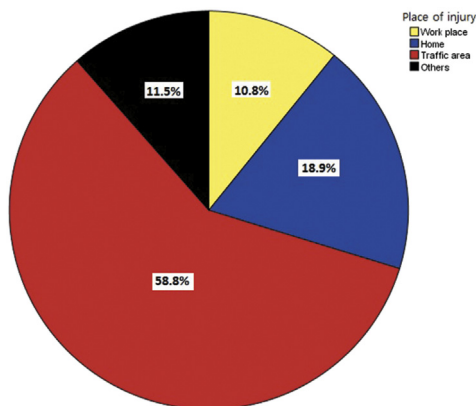
For the violence-induced trauma, one case in the ISS = 10–19 group was caused by warm weapon, and others by interpersonal violence.

discrepancy in the proportion of men and women was found in almost all the mechanisms of traumas which might be due to community customs for women or the use of motor vehicles, especially among motorcycles in the male group. Head traumas were far more than other injuries (111 cases, 75%) which indicates the lack of safety equipment use in workplaces and while driving, especially motorcyclists who do not use helmets. Given the same number, traffic injury risk with motorcycle was much more than cars. The most common mechanism of injury, like other countries, is RTCs and falls. Falls were recorded in both home and workplaces

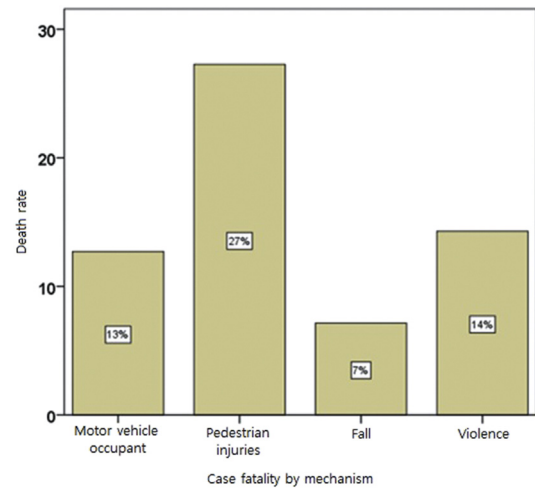
with more than two-thirds of cases occurring in the workplace. The frequency of warm weapon injuries was low which may be due to restrictive regulations. The most frequent injury was observed in the ISS group between 10 and 19. With the increasing increase in the injury severity, the frequency decreased, but the mortality rate



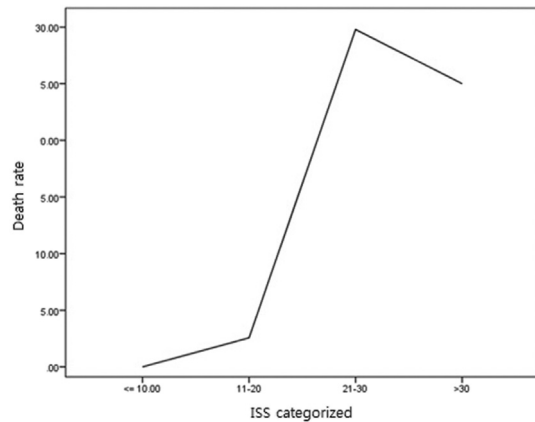
**Fig. 4.** Frequency for mechanism of injury in patients according to sex.



**Fig. 5.** Distribution of the injuries according to the location of injury.



**Fig. 6.** Frequency of case fatality by mechanism of injury.



**Fig. 7.** Frequency of death rate according to the ISS categorization.

**Table 3**  
Logistic regression analysis of the risk factors of death (sex, pulse rate and respiratory rate failed to remain in the model).

Variables	Coefficients	Standard error	p values
Age	0.115	0.028	0.000
Systolic pressure	-0.033	0.015	0.029
GCS	-0.372	0.121	0.002
ISS	0.133	0.050	0.008



increased. A significant relationship was found between the frequency of mortality and the severity of injury in our study. About 92% of injuries had the severity score of less than 40. The highest mean of ISS was observed in the fall group, which may be justified considering the high probability of head injuries. Frequency of severe injuries increased from the early hours of the day to the noon and then to the night. The maximum rate was observed at about 8–10 PM. Young people are exposed to the highest risk of damage caused by injuries, which is found more frequently in men. Targeted educational efforts to induce the attitude of safety can be very important in reducing the burden of injuries in this important high-risk group. The application of more advanced standards on vehicles and improving traffic environment in order to improve the cultural beliefs can be offered for risk management, as well.

In this study, the most common mechanism of injury was motorcycle crashes followed by falls, car pedestrian injuries, interpersonal violence and car crashes. The most common mechanism of injury in males was motorcycle crashes while pedestrian injuries and falls were both the first in females. The ISS of most severely injured patients (91.8%) was between 10 and 29 and only two patients (1.4%) who were both dead had ISS = 40–49. The mean ISS score was 20.22 in all the patients and 38 in the patients who died in the first 24 h. These indicate that RTC injuries are still a major concern among the Iranian population. Of course, injuries to the body may be different for the patients who suffered from different injury mechanisms. While ISS cannot distinguish between the injured bodies and an Abbreviated Injury System (AIS) score may be better to be used for comprehensive understanding of the injured bodies.

Most global road traffic deaths occur in the low-income and middle-income countries and are rapidly increasing because of the growth in motorization. Road injuries are one of the top ten leading causes of YLL worldwide. Drowning and road injuries are among the seven causes with 50,000–100,000 deaths annually worldwide. Pedestrians are most often affected and are followed by car occupants and motorcyclists. Conversely, traffic deaths are decreasing in high-income countries. There is also a similar divergence between low-income and high-income countries in occupational injuries which has decreased in high-income countries whereas occupational injury deaths have increased in low-income countries.<sup>3</sup> Our results also indicate that RTC injuries are also the most common mechanism of severe injury in the Iranian population.

Interpersonal violence consisted of 8.8% of the total frequency of injuries in multiple trauma patients with ISS>9 in our study. In developing countries, there are not adequate valid data on violence-related injuries and deaths.<sup>4</sup> Salamati et al<sup>8</sup> estimated the incidence rate of self-reported interpersonal violence-related physical injury at 3.04 per 1000 population in Iran during a three-month population-based cross-sectional study with an incidence rate of 4.72 per 1000 population for males and 1.78 per 1000 population for females in Iran<sup>9</sup>. This difference is probably due to the larger sample size of Salamati's study. Violence is the cause of death in 1.5 million people in a year and it is one of the most important causes of death among 15–44 year-old persons in the world now.<sup>2</sup> Almost 95% of all deaths and lost lives are caused by violence occurring in the least developed and developing countries.<sup>10</sup> In South Africa, for instance, injuries are the second leading cause of death and lost disability-adjusted life years and almost 50% of the mortality due to trauma is because of interpersonal violence.<sup>11</sup> Injury is now the fifth leading cause of death in the republic of China and at least 800,000 deaths from injuries and 50 million non-fatal injuries occur each year. In Iran, injury is the leading cause of mortality, disability and health care costs in patients aged 1–34 years.<sup>8</sup> In our study, the 10–44 age group consists of 61.5% severely injured patients. Although fatal injuries can be

seen in all ages, more than 40% are seen in the 10–24 years age group.<sup>1,12</sup> The good news is that some countries that were low-income in 1990, including Iran, have achieved remarkable progress in controlling fatal injuries.<sup>3</sup>

Among the 148 patients with ISS >9, 80.4% were male and 19.6% were female. The results of this study indicate that males are more exposed to severe injuries and this result is almost the same as other studies. And 69% and 82% of deaths from injuries in the world and Iran are unintentional, respectively.<sup>13,14</sup> Deaths from injuries are more common among men; for example, 68% of the deaths from injuries in 2010 were reported in men.<sup>14</sup>

And 68.4% of the mortalities in our study were in the age group of >44 years while this age group consisted of 28.4% of the patients. The data from Iran indicate that the incidence of mortality from injuries is at its highest point at the average age of 35.3 years.<sup>13</sup> The injury age-standardized YLD rates decreased substantially from 1990 to 2013. The number of deaths from unintentional injuries, however, remained essentially unchanged since 1990. The age-standardized death rates also fell for self-harm and interpersonal violence. For unintentional injury categories, with the exception of falls, the steady drop was partially driven by a downward trend in case fatality rates accompanied by a drop in incident cases.<sup>4</sup> The variables of age, ISS, GCS and systolic pressure showed significant effects in predicting the death probability in an injured patient, while the other variables including sex, pulse rate and respiratory rate failed to remain in the model. We preferred not to choose the variable of rescue time in the model, since the rescue time may be affected by the injury severity in many cases.

Each case of death or disability has a significant financial burden, totally estimated over 518 billion dollars annually worldwide.<sup>15</sup> Assessment of injuries reflected a high proportion of disability and loss of life at all ages and in both sexes.<sup>6</sup> In Iran, the data show that the financial burden of RTC was about 6 billion dollars in 2006.<sup>13</sup> A review of studies conducted in Iran shows that the injury prevalence in Iran is comparable with other parts of the world and accounts for 15.1% of all total causes of mortality.<sup>16</sup> The frequency of RTC in Iran is relatively high and recent studies have made it clear that Iran has many RTIs which were the second mortality cause after cardiovascular diseases among Iranians.<sup>16</sup> Ten years ago, in a study on fatal injuries in 10 provinces of Iran, the deaths from traffic injuries (30/100,000) in Iran are reported to be the highest in the world. In this survey, out of 66,846 deaths, 9733 (58/100,000) resulted from injuries and 14.9% of all deaths with 26.9% of years of lost life were from injuries.<sup>13</sup> The high RTC fatality rate of 39 per 100,000 population in Iran was almost the same as some other developing countries while the RTC fatalities in Iran are almost twice the highest rate among the European countries.<sup>17</sup> There are a variety of possible reasons for this situation such as the increase in the number of non-standard cars and motorcycles, low gas price, the decreasing ratio of travels *via* public transportation compared with private vehicles, and problems with safety design.<sup>16</sup> The recent decrease in death following RTC has been shown in Iran. The decrease in road traffic death might be due to a variety of interventions including seat belt legislation for drivers and front passengers, helmets for motorcycle riders, police enforcement, police cameras for monitoring speeding, improved health care facilities, public education campaigns, police's school assistance program, and identification of hazardous locations on the country's major road network.<sup>18</sup>

Focusing on educational programs, such as the role of drivers' attitude, knowledge and practice, especially among young drivers and revising traffic regulations, can be considered as solutions for prevention of RTC. Besides a urgent need for a system safety approach, Iran needs to deal with the problem of producing a large number of cars and motorcycles. Providing safe mobility for

the people of Iran needs to be a top priority for the government. There are gaps regarding financing, legislations and education of high-risk groups. Other issues of education and training standards of the front line medical team and continuing education and evaluation are yet to be addressed.

In conclusion, RTI is still a major concern among the Iranian population and the overall patterns of injury mechanisms and severity are consistent with other developing countries. The results of the present study can help health policy makers to plan more comprehensive and cost-effective strategies at national and sub-national levels for preventing and controlling the burden caused by injuries.

### Conflicts of interest

Authors report no commercial or other association that might pose a conflict of interest with respect to this research.

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