Studying the Epidemiology of Fatal Traffic Accidents in the Khuzestan Province

Narjes Rajaei Behbahani,[1] Mohammad Javad Mohammadi,[2,3] Seyed Saeed Hashemi Nazari,[4,*] Mohammadreza Ghadirzadeh,[5] and Soheil Hassanipour[6]

[1]Department of Epidemiology, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, IR Iran
[2]Student Research Committee, Department of Environmental Health Engineering, School of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran
[3]Abadan School of Medical Sciences, Abadan University of Medical Sciences, Abadan, IR Iran
[4]Safety Promotion and Injury Prevention Research Center, Department of Epidemiology, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, IR Iran
[5]Legal Medicine Research Center, Tehran, IR Iran
[6]School of Public Health, Shiraz University of Medical Sciences, Shiraz, IR Iran

*Corresponding author: Seyed Saeed Hashemi Nazari, Safety Promotion and Injury Prevention Research Center, Department of Epidemiology, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, IR Iran. E-mail: Saeedh_1999@yahoo.com

Received 2015 August 4; Revised 2015 December 23; Accepted 2015 December 26.

Abstract

Background: Traffic accidents with about 1.24 million deaths and 20 to 50 million cases of injury or disability per year are one of the most important public health challenges around the world. In Iran, traffic accidents, with an annual incidence of 32 cases per 100 thousand people, are considered as the second leading cause of death and the most common cause of injury.

Objectives: This study aimed to evaluate the epidemiological pattern and mortality rate caused by traffic accidents during year 2012 in the Khuzestan province and its cities.

Materials and Methods: In this cross-sectional study, all data related to fatal traffic accident referrals to legal medicine center of Khuzestan province during year 2012 were obtained and analyzed. Road traffic accidents mortality rate during this year was calculated for the province and its cities. The data were analyzed using Stata 11 statistical software.

Results: In 2012, one thousand and twenty deaths related to traffic accidents occurred in Khuzestan province. The incidence of deaths due to accidents in Khuzestan province was 22.5 and the standardized age of incidence was 24.3 per 100 thousand people. Regarding gender, 78.24% of the dead individuals were male and 21.76% were female. The most common final causes of death were head trauma (76.27% cases) and bleeding (12.55% cases). The most deceased people were drivers (42.55%), passengers (34.90%), and pedestrians (21.27%). The highest traffic accidents mortality rate in Khuzestan province was observed in Hoveizeh (55.43 per one hundred thousand), Omidiye (55.30 per one hundred thousand) and Ramhormuz (53.12 per one hundred thousand), and the lowest incidence rates belonged to Lali (5.35 per one hundred thousand) and Shadegan (9.78 per one hundred thousand).

Conclusions: This study showed that drivers, passengers and pedestrians were the most vulnerable road users. Regarding the fact that most of them were illiterate or had primary education and were self-employed or laborers, it seems essential to develop plans not only to train the road users but also to evaluate the safety of vehicles and roads and post-accident care programs, and consequently, implement special programs fully and strictly in order to reduce traffic fatalities.

Keywords: Epidemiology, Road Incidents, Khuzestan Province, Mortality Rate

1. Background

Traffic accidents are known as the leading cause of morbidity and mortality around the world and are referred to as a major public health problem in developing as well as developed countries (1). The term "road traffic accidents" can be referred to as any accident in which motor vehicles such as cars, motorcycles or bicycles are involved (2). Traffic injuries are still considered as a major public health problem around the world and in Iran. Despite the great efforts made in this regard in the recent years, no fundamental change in mortality rates has been seen so far (2, 3). Road traffic accidents are the eighth leading cause of deaths in the world and the first cause of deaths in the 15 to 29-year-old age group. About 1.24 million road traffic deaths were seen in 2010 (4). Every year, more than 10 million people become permanently disabled (5) and 50 million others are injured (6). It has been predicted that the figures will increase by 65% worldwide from 2000 to 2020 and by 85% in low-income countries (7). If the trend continues (and if no intervention is implemented), road traffic accidents will be the third leading cause of death and disabilities in 2020 (8). Traffic injuries in Iran are the second leading causes of death after cardiovascular diseases and the first causes of lost years of life and they

are among the most important problems that threaten our country's health status (9). The road traffic accidents fatality rate is 32.2 per 100 thousand people in the eastern Mediterranean region while this is 13.4 per 100 thousand people in Europe and 18.8 per 100 thousand people around the world. According to the world health organization (WHO), the rate of road traffic accidents in Iran is much higher than the rate around the world (10), so that in terms of road and traffic accidents, Iran has been known as one of the countries with the most accidents and associated deaths (11). According to the world health organization, in 2010 the number of estimated deaths caused by traffic accidents in Iran was 25224, i.e. a rate of 34.1 per 100 thousand people (12) and according to the statistics presented by the legal medicine organization, in 2012 this rate was 27.22 per 100 thousand individuals. As traffic accidents can be naturally prevented, the best way to reduce the incidence of these events is to prevent them by increasing public awareness and making efforts to reduce risk factors. Hence, if the epidemiology of traffic accidents is understood well, it can be a valuable tool for designing preventive and controlling interventions and can act as an effective tool for monitoring of interventions made to achieve the predetermined objectives.

2. Objectives

This study was designed in order to evaluate the epidemiological pattern of mortality caused by traffic accidents in Khuzestan province (located in the south-western of Iran) during year 2012. The research examined different cities of the province separately and determined some of the risk factors associated with traffic accident, so that the groups at higher risk could be identified in order to apply preventive measures and also to gain a broader perspective on this issue.

3. Materials and Methods

In this cross-sectional study, all statistical data related to traffic accidents resulting in death, involving patients who had been referred to the legal medicine center of Khuzestan province in 2012 were obtained and analyzed. The incidence of deaths caused by road traffic accidents in that year was calculated for the province and its cities. To calculate the incidence rate in that year, the population of the province and each of its cities estimated by the Census Bureau from the census held in 2010 were used. To calculate the denominator for the fraction of the incidence of accidents based on education, the information about the education groups in the whole province derived from the statistical center of Iran was used. Taking into consideration the population of the province in 2011 and the growth rate of 1.38% for the urban population and 0.68% for the rural population in the same year announced by the statistical center of Iran, the estimated population of Khuzestan

province in general and according to different months and cities was calculated for 2012 and was considered as the denominator in the calculation of the population. The incidence rates were calculated based on the populations extracted from the statistics center. Since these calculations were based on the census and no sampling was done, we practically did not have any census error. To determine the age standardized incidence rates, the standard population of the world health organization was used. To extract the required data, the data collection forms on the mortality caused by traffic accidents provided by the legal medicine organization were used. The frequency of traffic accidents was determined according to age, gender, education and type of activities of the deceased person. In addition, the frequency of the final cause of death, the deceased person's role at the time of death (driver, pedestrian or passenger), the type of accident (collision of vehicles with each other, collision of vehicles with the pedestrians, overturning of the vehicles carrying the passengers, falling of the vehicle carrying the passengers, collision of a vehicle to fixed objects along the street or road) and the accident location (urban or suburban), the lighting and the color of clothing were also examined.

To compare the frequency of fatal traffic accidents on suburban roads during different months, the estimated total number of traffics on 26 roads of Khuzestan province was used as the denominator (according to a report by the road maintenance and road transport organization, the total number of traffics on the suburban roads of Khuzestan province per month was estimated based on traffic-counting). Although this method of calculation underestimates total traffics, since the underestimations during all months are the same, the calculated rates are suitable for comparison.

The information received from the legal medicine organization was first controlled and then analyzed using the STATA 11 statistical software. To analyze the descriptive statistics, frequencies and percentages were used along with the chi-square test for analytical statistics. The incidence rates were reported per hundred thousand individuals. The P-value was considered significant at 0.05 level.

4. Results

In total, one thousand and twenty deaths related to traffic accidents had been recorded by the legal medicine organization in Khuzestan province during year 2012. The incidence of mortality due to accidents in Khuzestan province was 22.5 per 100000 individuals and the age standardized incidence rate was 24.3 per 100 thousand individuals. The incidence rates for females, males, single and married individuals were 9.88, 34.90, 30.13 and 25.50 per 100 thousand individuals, respectively. The rates of fatal accidents in individual cities of the province and based on gender are presented in Table 1.

Table 1. The Incidence of Fatal Accidents in the Cities of Khuzestan During Year 2012 Based on Gender

Town	The Qverall Mortality Rate (per 100 Thousand People)	Ranking City for Mortality Rate	The Mortality Rate According to Gender (per 100 Thousand)	
			Male	**Female**
Abadan	19.16	14	28.77	9.56
Ahvaz	17.5	17	27.5	7.36
Andica	15.75	18	23.26	7.99
Andimeshk	35.91	7	59.37	11.1
Izeh	39.3	5	46.48	32.2
Omidiye	55.3	2	94.5	15.58
Behbahan	27.3	9	35.32	19.08
Bavi	12.34	21	13.25	11.4
Baghmalek	38.16	6	65.3	11.15
Khorramshahr	31.4	8	29.68	13.28
Dezful	19.13	15	13.35	3.91
Dasht-e-Azadegan	14.02	20	17.98	10.04
Ramhormuz	53.02	3	84.75	21.03
Ramshir	44.95	4	76.9	12.38
Shadegan	9.78	22	18.2	1.31
Shush	23.67	12	36.3	10.92
Shushtar	25.6	11	40.01	10.65
Gotvand	26.2	10	45.02	6.32
Lali	5.35	23	5.25	5.45
Mahshahr	14.03	19	22.82	5.08
Masjed Soleiman	18.54	16	24.66	12.4
Haftgel	22.23	13	44.71	
Hoveizeh	55.43	1	97.61	11.86

Table 2. The Incidence of Fatal Accidents in the Khuzestan Province During Year 2012 According to Age Groups

Age Group, y	The Overall Mortality Rate (Per 100 Thousand People)
0 - 4	9.53
5 - 9	12.54
10.14	7.48
15 - 19	23.20
20 - 24	27.91
25 - 29	23.15
30 - 34	20.20
35 - 39	24.03
40 - 44	24.96
45 - 49	32.05
50 - 54	24.63
55 - 59	31.93
60 - 64	41.04
65 - 69	52.33
70 - 74	50.36
75 - 79	74.50
≥ 80	44.91

The mean age of the deceased individuals was 34.58 ± 19.83 and generally, the minimum and maximum ages were less than one year and 89 years, respectively. According to the age groups, the highest rate of accidents had occurred in the 20 to 24-year-old age group (0.15%) and 25 to 29 year-olds (11.96%). The incidence of fatal accidents based on age groups is presented in Table 2.

Regarding gender, 78.24% of the dead cases were male and 21.76% were female. On the other hand, the age-standardized incidence according to gender in males and females was 34.90 and 9.88 per 100 individuals, respectively. In terms of marital status, 43.50% were single, 56.20% were married and the marital status of the rest was unknown. As far as education was concerned, the highest percentage of the deceased (24.70%) was illiterate. After that, those with a high school diploma (23.81%), guidance school degree (23.02%) and an elementary school degree (20.04%) had lower frequencies while the deceased people with a bachelor's and higher degrees had the minimum frequency (8.23%). The incidence of deaths caused by accidents with regards to the education is presented in Table 3.

In terms of residence, the highest percentage of the deceased (67.09%) lived in urban areas while 32.02% were living in rural areas. Furthermore, the age-standardized incidences were 25.05 and 21.22 per 100 thousand people in rural and urban areas, respectively. Furthermore, 60% of the accidents had happened during daytime and 31.58% had occurred at night. Most deaths had occurred in October (2.74%) while the least number of mortality (1.21%) had been reported in December. The incidence of deaths in traffic accidents in different months of the year can be seen in Table 4.

The highest rates of fatal accidents (76.86%) had occurred on the main roads while minor rural roads were ranked next (9.99% and 5.44%, respectively). Regarding the location, 29.71% of the fatal accidents had occurred on roads within the cities and 66.27% of the cases had occurred on roads outside of cities. In this regard, there was no significant difference between male and female drivers (P = 0.8). Most of the accidents had been caused by vehicles colliding with each other (46.96%), the overturn of vehicles carrying passengers (24.61%) and pedestrians' collisions with vehicles (21.27%). In terms of the status of the deceased at the time of the accident, most deceased people were drivers (42.55%), and the passengers and pedestrians were ranked second and third (34.90 and 21.27%, respectively). In terms of the type of vehicles used, the highest percentages of the deceased people were seen among car passengers (46.33%) and motorcyclists (33.50%). On the other hand, pedestrians had mostly been hit by cars (56.34%) and motorcycles (34.73%).

As far as physical injuries are concerned, the injuries to heads and faces (88.70%), chests and abdomens (44.01%), and hands and arms (41.45%), as the only or one of the limbs damaged in the deceased people, were the most frequent damage recorded. The injuries to the limbs are presented separately in Table 5.

Among the most common causes of final deaths, head trauma in 76.27% of cases and bleeding in 12.55% cases were reported as indicated in Table 6. In terms of activity, the highest percentages of the deceased people were self-employed (29.3%) and housewives (14.81%). Regarding the place of death, most of the deaths were reported to have happened where the accidents had occurred (48.73%) and in hospitals (44.71%). In terms of the ways the injured people had been carried, most of the deaths had occurred as the injured people were carried by ambulances (84.37%). Regarding the time of suburban roads traffic during different times of the day, the highest rate belonged to 6, 20, 5, 19 and 4 o'clock (21.25, 19.81, 17.96, 14.55 and 14.49 traffics per million, respectively) and the lowest rate belonged to 3, 24, 21, 23 and 2 o'clock (6.06, 8.03, 8.84, 9.83. 9.90 traffics per million, respectively). The highest mortality rates on suburban roads according to traffic in different months of the year belonged to October and April (21.54 and 18.53 per million traffics, respectively) and the lowest one belonged to January and February (6.53 and 9.73 per million traffics, respectively). In seasons of the year, the highest rate of deaths on suburban roads based on the traffic was during spring (1.61 per million) and the lowest was during winter (1.06 per million).

Table 3. The Incidence of Fatal Accidents in Khuzestan Province During 2012 With Regards to the Level of Education[a]

Education Level	The Mortality Rate, per 100 Thousand People
Illiterate	39.50 (24.70)
Elementary school	22.10 (20.04)
Guidance school	30.76 (23.02)
High school and diploma	23.11 (23.81)
Higher education	15.64 (8.23)

[a]Values are expressed as No. (%).

Table 4. The Incidence Rate of Traffic Accidents on the Basis of Death-Led Traffics in Khuzestan Province During 2012 According to Different Months of the Year

Month	Frequency	The Number of Traffic per Month	The Mortality Rate per One Million Traffic per Month
January	31	4746043	6.53
January	68	5013518	13.56
March	57	4950001	11.52
April	81	4949559	16.36
May	87	4695744	18.53
June	58	4417106	13.13
July	50	4297054	11.64
August	51	3793480	13.44
September	52	4384190	11.86
October	87	4038348	21.54
November	51	4727506	10.79
December	37	3802370	9.73
Total	710	53814919	13.21

Table 5. Frequency Distribution of Registered Injured Organ(s) In Khuzestan Province During 2011

Injured Organ	Frequency, %
Head and face	903 (88.70)
Neck	139 (13.65)
Hands and arms	422 (41.45)
Chest and abdomen	448 (44.01)
Posterior trunk (back and spine)	87 (8.55)
Pelvis	84 (8.25)
Feet	406 (39.88)

Table 6. Distribution of Deaths Caused by Traffic Accidents During 2012 in Khuzestan Province on the Basis of the Cause of Death

Cause of Death	Frequency, %
Head trauma	778 (76.27)
Bleeding	128 (12.55)
Multiple fractures	66 (6.47)
Burning	9 (0.88)
Other	23 (2.25)

According to the results of the chi-square test, a statistically significant relationship was observed between the death location (death at the place where the accident occurred or death at a place other than where the accident occurred) and the location of the accident (urban or suburban) (P = 0.000). The results showed that in suburban accidents, 21.12% of the deaths had happened at the place of the accident while this ratio was only 8.78% for the accidents within the cities. Moreover, 40.12% of the people who died due to urban accidents died in hospitals while this proportion was 30.01% for suburban accidents. There was a significant relationship between the occurrence of accidents (collision of vehicles with each other, collision with a fixed object or an animal, overturning, falling and vehicles going on fire) and the type of vehicles used by the deceased (light cars, motorcycles and bicycles, trucks and vans) (P = 0.000). The occurrence of the accidents of 73.03% of the deceased people who had a car was in the form of overturning or falling of the vehicles carrying the passengers yet the occurrence of the accidents for those using heavy vehicles and motorcycles or bicycles was mainly in the form of the collision of vehicles with each other (5.22% and 47.81%, respectively). There was no significant relationship between the condition of the deceased (drivers, passengers and pedestrians) and the limbs injured (head trauma as well as abdomen and chest trauma and also the spine and pelvis trauma). However, there was a significant relationship with neck trauma (P = 0.02), upper limb trauma (P = 0.000) and lower limb trauma (P = 0.000). The injured limbs of the drivers and passengers were necks (85.62%), upper limbs (72.84 %) and lower limbs (72.75%). There was no signifi-

cant relationship between the type of vehicles used by the deceased (light cars, motorcycles and bicycles, and trucks and vans) and the following causes of death: head trauma, bleeding and fractures; however a significant relationship was seen between the type of vehicles the deceased people used and burning as the cause of death (P = 0.029). In 73.03% of the cases, burning in the accident was the cause of death of passengers of any vehicle or drivers of light cars.

5. Discussion

The incidence of deaths caused by traffic accidents has been increasing worldwide in the recent decades and nowadays, more than 1.2 million people die in the world every year as a result of traffic accidents while more than 50 million people become injured (13). More than 90% of traffic accident deaths in the world occur in low-income and middle-income countries that have only 48% of the world's registered vehicles. Road accidents are the ninth cause of mortality in the world and the world health organization has estimated this rank to increase to the third leading cause. In the past four decades, the rate of deaths from road accidents has decreased in high-income countries, while it has increased in other countries, including Iran (13, 14).

The incidence of mortality from car accidents in Khuzestan province was 22.5 per 100000 and the age standardized incidence rate was 24.3 per 100 thousand. These rates were lower than the national incidence in 2012, which were 27.22 per hundred thousand people according to the legal medicine organization. Results of this study showed that the mortality rate in 2012 was lower than the rate reported by Hashemi during 2005 - 2009 in the Khuzestan province (15). Our results showed that most incidents of death had occurred in the age group of 20 to 24-year-olds. Most cases of death in females had occurred among the age group of 15 to 19, and in males it was among the age group of 20 to 24-year-old. This is in agreement with similar results obtained by studies from Tehran, Kordestan, Isfahan, Amol, Shanghai of China, Singapore and Greece (16-22).

Investigation of the victims in terms of gender distribution showed that more than three-quarters of the cases were males. According to WHO in 2010, 79% of the deaths caused by traffic accidents in Iran occurred in males and 21% females (23). In most studies, the number of dead males was higher than that of females (14, 17, 21, 24). However, the male to female ratio was different: in our study it was 3.6 to 1, in Amol 2.5 to 1, in Kurdistan 5 to 1, in Denmark 9 to 1, in Pakistan 6 to 1, and in Sweden 6 to 1 (21). The reason could be the higher presence of males outside the home to commute to work and do social activities. In the present study, the highest rate of death occurred among people with low education as well as illiterate individuals, and those with higher education showed a lower rate of death. This was similar to the results of other studies (6, 14,

21, 24-27). In a study on road accident deaths in Khuzestan province during 2005 to 2009, more than half of the incidents had occurred in people with low education (15). This was probably due to their lower attention to traffic regulations while driving. Considering traffic at different times of a day, the highest mortality rates on suburban roads were at 6, 20, 5, 19 and 4 o'clock while the lowest rates were at 3, 24, 21, 23 and 2 o'clock, and this was consistent with the results of other studies (6, 14, 26-28). The reason might be the weaker light and more crowded roads during these hours of the day and the higher risk of accidents or sleepiness. Results of this study showed that most deaths had occurred during spring and this was consistent with the statistics provided in the statistical yearbook 2012 issued by the road maintenance and road transport organization of the country, but it was not consistent with the results obtained by Norzad et al. and Tavanania. In a study by Shams et al. the highest frequency was seen during the winter (29-32). The high mortality rate in the spring, especially in April and May, might be due to the heavy traffics during these seasons; 14062409 of the 53814919 traffics (26.13% of the total traffics; the total number of traffics was 1.61 per million) on 26 roads of Khuzestan province in 2012 had occurred in April and May. Most deceased people at the time of the accident were the drivers or car passengers, and this was similar to the results of a study done in Khuzestan province during 2006 to 2010 (15). Distribution of the deaths based on how the accidents had happened indicated that the most frequent cause was collisions of vehicles with each other and the least was collisions with animals, and these findings were similar to those of other studies (15, 21, 33). The highest number of deaths with regards to the type of car was as follows: sedans (passenger cars), motorcycles and pickup trucks had caused most of the incidents, and this was similar to the mortality rate during 2005 to 2009 in this province (15). Distribution of deaths according to the accident site was as follows: 66% of the cases happened on suburban roads, and similar results have been obtained by most studies (6, 14, 15, 17, 19-21, 26), yet in some studies done abroad, the inside-city victims made up 50 to 70 percent of the cases (13). Since the speed of the vehicles is one of the most important factors in the severity of injuries caused by traffic accidents (34, 35), and because the speed of vehicles on suburban roads is higher than in cities, we can consider the high speed as one of the reasons for the increase in the number of people injured on suburban roads. In this study, most of the deceased people had been transferred by ambulances (84.37%), and this was consistent with the WHO report in 2010 stating that in Iran, 50% to 74% of the victims of traffic accidents, who were severely injured were transferred to medical centers by ambulances (23).

Regarding the place of death, in the present study, most of the deaths occurred where the accidents took place and after that in hospitals. This was similar to the results of studies conducted in other parts of Iran (15, 16, 20, 24, 26, 27). Due to the high number of deaths in the area

of the incidents and before reaching the hospitals, the need for accessing road emergency care and pre-hospital treatments seems more necessary than ever. The results showed that head trauma was the main cause of death in road accidents of Khuzestan province, and it was also the most common cause in other studies (6, 20, 21, 27, 36). The most commonly injured parts of the body were the head and face. According to the world health organization, every second 1.5 people are affected by injuries in these parts of the body and every minute two people die for this reason (13). In 2012, most deaths caused by traffic accidents in Khouzestan occurred in Hoveizeh (55.43 per thousand), Omidiye (55.30 per thousand) and Ramhormuz (53.12 per thousand), and the least occurred in Lali (5.35 in one hundred thousand) and Shadegan (9.78 per thousand). A similar study conducted to investigate the death trend during 2005 to 2009 indicated that most deaths had occurred in Ramshir (51.45) and Ramhormuz (51.22) and the least had been reported in Dasht-e-Azadegan (7.69) and Indica (13.01) (15).

5.1. Limitations

The main limitations of this study were the lack of access to the total number of traffics on suburban and urban roads for calculation of rates per traffic instead of population.

5.2. Conclusions

The high incidence of accidents and mortalities caused by them shows the need for careful planning to prevent road accidents.

The young and middle-aged males were the most vulnerable groups. The important issue is that these subpopulations are considered as the productive and active population or, let's say, as the social capital of societies. Thus, improving cultural issues in terms of obeying traffic rules and using safety devices seems necessary for these age groups. Moreover, providing the victims with immediate relief and care will lead to the reduction of the mortality rate in accidents.

Acknowledgments

Footnotes

Authors' Contribution: Narjes Rajaei Behbahani participated in the statistical analysis and writing of the article. Seyed Saeed Hashemi Nazari and Mohammadreza Ghadirzadeh participated in data collection from the Iranian forensic medicine organization, and performed the final edition of the paper. Soheil Hassanipour contribut-

References

1. Garg N, Hyder AA. Exploring the relationship between development and road traffic injuries: a case study from India. *Eur J Public Health.* 2006;**16**(5):487–91. doi: 10.1093/eurpub/ckl031. [PubMed: 16641159]

2. Soori H, Eyni E, Iranrafar M. The traffic accidents in the world and Iran; Review the results from the World Health Organization. *J promote safety prev inj.* 2013;**1**(2):53–62.

3. Nikzad F. Iran: 2005. Road traffic injuries and its cause's damage. Ordered by Islamic republic of Iran trafficpolice.

4. World Health Organization. *Global Health Observatory (GHO) data.* Available from: http://www.who.int/gho/road_safety/mortality/number_text/en/ WHOa.

5. Pfortmueller CA, Marti M, Kunz M, Lindner G, Exadaktylos AK. Injury severity and mortality of adult zebra crosswalk and non-zebra crosswalk road crossing accidents: a cross-sectional analysis. *PloS one.* 2014;**9**(3):e90835. doi: 10.1371/journal.pone.0090835.t001.

6. Saadat S, Soori H. Epidemiology of traffic injuries and motor vehicles utilization in the capital of Iran: a population based study. *BMC Public Health.* 2011;**11**:488. doi: 10.1186/1471-2458-11-488. [PubMed: 21693056]

7. Krug EG. Injury: a leading cause of the global burden of disease; Violence and Injury Prevention. In: Department for Disability/ Injury Prevention and Rehabilitation, editor. World Health Organization: 1999.

8. Heydari ST, Hoseinzadeh A, Ghaffarpasand F, Hedjazi A, Zarenezhad M, Moafian G, et al. Epidemiological characteristics of fatal traffic accidents in Fars province, Iran: a community-based survey. *Public Health.* 2013;**127**(8):704–9. doi: 10.1016/j.puhe.2013.05.003. [PubMed: 23871394]

9. Kim JK, Ulfarsson GF, Shankar VN, Kim S. Age and pedestrian injury severity in motor-vehicle crashes: a heteroskedastic logit analysis. *Accid Anal Prev.* 2008;**40**(5):1695–702. doi: 10.1016/j.aap.2008.06.005. [PubMed: 18760098]

10. Tabibi Z, Pfeffer K, Sharif JT. The influence of demographic factors, processing speed and short-term memory on Iranian children's pedestrian skills. *Accid Anal Prev.* 2012;**47**:87–93. doi: 10.1016/j.aap.2012.01.013. [PubMed: 22326414]

11. Yunesian M, Moradi A. Knowledge, attitude and practice of drivers regarding traffic regulations in Tehran. *J School Public Health Inst Public Health Res.* 2005;**3**(3):57–66.

12. World Health Organization. *Global Health Observatory data repository.* 2015. Available from: http://apps.who.int/gho/data/node.main.A997 WHOa.

13. Peden M. Geneva: 2004. World report on road traffic injury prevention.

14. Akbari ME, Naghavi M, Soori H. Epidemiology of deaths from injuries in the Islamic Republic of Iran. *East Mediterr Health J.* 2006;**12**(3-4):382–90. [PubMed: 17037707]

15. Hashemi NSS, Kazemian M, Hosseini F. Trend of five years traffic accident mortality in Khuzestan province (2006-2010). 2011;**17**(2):123–9..

16. Abdali H, Memarzade M. Evaluation of injury severity in traumatized Patients at Al Zahra Medical///academic centter. *Journal Mil Med.* 2003;**4**(4):247–50.

17. Karbakhsh M, Rostami GN, Zargar M. Factors influencing the severity of injuries in motor vehicle crashes. *Payesh.* 2004.

18. Yan-Hong L, Rahim Y, Wei L, Gui-Xiang S, Yan Y, De Ding Z, et al. Pattern of traffic injuries in Shanghai: implications for control. *Int J I Control and Saf Promot.* 2006;**13**(4):217–25. doi:

19. Menon A, Pai VK, Rajeev A. Pattern of fatal head injuries due to vehicular accidents in Mangalore. *J Forensic Leg Med.* 2008;**15**(2):75–7. doi: 10.1016/j.jflm.2007.06.001. [PubMed: 18206822]

20. Soori H, Royanian M, Zali AR, Movahedinejad A. Road traffic injuries in Iran: the role of interventions implemented by traffic police. *Traffic Inj Prev.* 2009;**10**(4):375–8. doi: 10.1080/15389580902972579. [PubMed: 19593716]

21. Nazari N, Bijani A, Haji Hosseini F, Beheshti Z, Sharifnia SH, Hojati H. Mortality and injury severity in the accident victims referred to the hefdah shahrivar hospital of amol; 2007. *J Babol Univ Med Sci.* 2011;**13**(1):76–81.

22. Markogiannakis H, Sanidas E, Messaris E, Koutentakis D, Alpantaki K, Kafetzakis A, et al. Predictors of in-hospital mortality of trauma patients injured in vehicle accidents. *Ulus Travma Acil Cerrahi Derg.* 2008;**14**(2):125–31. [PubMed: 18523903]

23. WHO. *Supporting a Decade of Action: Global Status Report on Road Safety.* Geneva: World Health Organization; 2013. Available from: http://www.who.int/violence_injury_prevention/road_safety_status/2013/en/.

24. Hatamabadi H, Vafaee R, Hadadi M, Abdalvand A, Esnaashari H, Soori H. Epidemiologic study of road traffic injuries by road user type characteristics and road environment in Iran: a community-based approach. *Traffic Inj Prev.* 2012;**13**(1):61–4. doi: 10.1080/15389588.2011.623201. [PubMed: 22239145]

25. Hu G, Wen M, Baker TD, Baker SP. Road-traffic deaths in China, 1985-2005: threat and opportunity. *Inj Prev.* 2008;**14**(3):149–53. doi: 10.1136/ip.2007.016469. [PubMed: 18523105]

26. Khorasani-Zavareh D, Haglund BJ, Mohammadi R, Naghavi M, Laflamme L. Traffic injury deaths in West Azarbaijan province of Iran: a cross-sectional interview-based study on victims' characteristics and pre-hospital care. *Int J Inj Contr Saf Promot.* 2009;**16**(3):119–26. doi: 10.1080/17457300903023980. [PubMed: 19941209]

27. Montazeri A. Road-traffic-related mortality in Iran: a descriptive study. *Public Health.* 2004;**118**(2):110–3. doi: 10.1016/s0033-3506(03)00173-2. [PubMed: 15037040]

28. Haghparast Bidgoli H, Bogg L, Hasselberg M. Pre-hospital trauma care resources for road traffic injuries in a middle-income country–a province based study on need and access in Iran. *Injury.* 2011;**42**(9):879–84. doi: 10.1016/j.injury.2010.04.024. [PubMed: 20627291]

29. Tavanania M. Epidemiology of road traffic accidents in Qom. [in Persian]. *qom univ med sci j.* 2011;**5**(2).

30. Norzad SNH, Valizadeh B, Sadeghie S, Farzaneh E. Geographical dispersion of causes of death and risk factors in fatal road accident in Ardebil province (a GIS analysis). *Ardabil Univ Med Scie Health Serv*; 2014.

31. PDOo I. *Statistical calendar 2012.* 2013. Available from: http://www.rmto.ir/SalnameAmari/1392.

32. Shams MGN, Madanipoor M, Amiri Z, Dehdast S, Mirzaei Z. An epidemiological study of 2997 cases of traffic accidents in patients admitted to trauma center Shohada Hospital in Tehran during the 1389-87 academic. *J Sci Health Summer.* 2000;**5**(214)

33. Pikoulis E, Filias V, Pikoulis N, Daskalakis P, Avgerinos ED, Tavernarakis G, et al. Patterns of injuries and motor-vehicle traffic accidents in Athens. *Int J Inj Contr Saf Promot.* 2006;**13**(3):190–3. doi: 10.1080/17457300500294547. [PubMed: 16943163]

34. Dissanayake S, Lu JJ. Factors influential in making an injury severity difference to older drivers involved in fixed object-passenger car crashes. *Accid Anal Prev.* 2002;**34**(5):609–18. [PubMed: 12214955]

35. Owsley C, Ball K, McGwin Jr G, Sloane ME, Roenker DL, White MF, et al. Visual processing impairment and risk of motor vehicle crash among older adults. *Jama.* 1998;**279**(14):1083–8. [PubMed: 9546567]

36. Zarei MR, Rahimi-Movaghar V, Saadat S, Panahi F, Dehghanpour R, Samii A, et al. Road Traffic Crashes Mortality and Morbidity in Iran in 1997-2006. *Hakim Res J.* 2008;**11**(3):42–6.