

## Factors related to pedestrians mortality following road traffic accidents in Tehran and Alborz Provinces, Iran

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### ABSTRACT

**Background and aims:** This study aimed to investigate the deaths and injuries following pedestrian traffic accidents and factors associated with death of pedestrian in Tehran and Alborz provinces.

**Methods:** In this cross-sectional study all traffic accidents related to pedestrians in Tehran and Alborz provinces reported from March 21, 2013 to March 21, 2014 by the traffic police were studied. The Database related to death of Legal Medicine Organization was used in order to determine the exact number of deaths. The standard population of World Health Organization was used in order to calculate the age-standardized incidence rate. We used Chi-square test, T-test and logistic regression to extract statistically significant associations. P-value under 0.05 was considered significant.

**Result:** The age-standardized mortality and injury rate were respectively, 6.1 and 65.1 per 100,000 populations. The pedestrian's road traffic (PRT) mortality and injury rates in men were 3 and 1.5 times more than women respectively. Statistically significant relationships were observed between the pedestrian's age, the direct cause in the accident, classification of road, month of occurrence, days of week, type of vehicle, accident location and pedestrian action with the death of pedestrians.

**Conclusion:** Given that the highest incidence rate of death was observed in the age group over 65 years old, it is necessary to pay special attention to the physiologic characteristics of this age group by predicting safety plans and also to provide more secure conditions for this high risk group in accident-prone road sections.

**Keywords:** Traffic accidents, Related factors, Mortality rate and injury rate, Pedestrians, Tehran and Alborz.

### INTRODUCTION

Road traffic injuries are the eighth leading cause of death in the world and

number one leading cause of death among those aged 15-29 years.<sup>1</sup> Annually more

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than 1.24 million deaths, 10 million disabilities and 50 million injuries occur due to traffic accidents in the world.<sup>2,3</sup>

Traffic accidents in Iran with an annual incidence rate of 26.5 per 100,000 populations, are the second leading cause of death and also the first cause considered for years of life lost. Totally, in Iran the amount of life loss as a result of traffic accidents is higher than Eastern Mediterranean region and the world and this problem is one of the most serious problems in the country.<sup>4</sup> The mortality rate in road traffic injuries in 2005 in the world was 3 persons per 10 thousand cars whereas this rate in our country was 33 people and unfortunately such casualties have been increasing in recent decades.<sup>5</sup>

PRTIs are among the most important problems in countries around the world, especially in developing countries.<sup>6</sup> Pedestrians as the most vulnerable people in traffic accidents and the biggest group of road users comprise a great part of deaths and disabilities caused by traffic accidents.<sup>7</sup> Annually in the world around 270 thousand pedestrian die and millions of people are injured which a large number of such injuries result in permanent disabilities. Globally, 22% of all deaths resulting from road traffic accidents are related to pedestrians, and in some countries this ratio reaches to two-third of all deaths from road accidents.<sup>8</sup> In developing countries, 55%-57% of accidents lead to deaths in urban areas are related to pedestrians.<sup>6</sup>

In Iran the mortality rate resulting from traffic accidents involving pedestrian is considerably high which makes the pedestrian safety as one of the major problems of health system.<sup>9</sup> Based on the report by the Legal Medicine Organization in the year 2011 about 23% of all deaths caused by traffic accidents are related with pedestrians. The proportion of pedestrians death in traffic accidents in different provinces were not equal and the highest

pedestrians death proportion occurred in Tehran and Alborz provinces were with respectively 46.5 and 40.5 and the lowest proportions were in South Khorasan province with 8.6%. In Tehran province on a daily average four people are being killed in traffic accidents of which two of them are pedestrians.<sup>10</sup>

Due to the high rate of pedestrians death in traffic accidents of Tehran and Alborz provinces and in order for effective intervention programs for the protection of pedestrians and promoting safe walking it is essential to achieve a true understanding of the epidemiology of death and injury of the pedestrians and their associated factors.

## METHODS

This cross-sectional study was conducted in Tehran and Alborz Provinces of Iran from March 21, 2013 to March 21, 2014.

Traffic police collects all traffic accidents data by specially designed forms called COM114 that include several variables. This data include variables related to the vehicles, passengers and occupants involved in an accident and also the road characteristics and environmental situation of the accident location. In the other hand, Legal Medicine Organization registers all fatalities caused from traffic accidents to 30 days after the accident in their data bank. In this study, we used the accidents recorded in the police database in which at least one pedestrian was involved. Considering the fact that the death event of some of the injured pedestrians may occur 30 days after the accident, we matched police and Legal Medicine Organization databases according to variables name, age, sex, date and place of the accident in order to update the final status of injured pedestrians in the police database.

The final data source was the accidents recorded in the police database with at least one pedestrian involved in Tehran and

Alborz provinces which their final outcomes were updated by Legal Medicine Organization database.

The exposures which were investigated in the models were as follows: Pedestrian age, pedestrian gender, driver gender, month of accident, Day of week (working days, Before holiday, holiday, After holiday), hour, air condition (smooth, cloudy or foggy, snowy or rainy), light status (daylight, night, dawn or dusk), road type (One-way, Two-way divided, Two-way not divided), collision type (Vehicle with pedestrian, Motorcycle with pedestrian, other), clothing color (bright, dark), residential status of the accident location (Residential area, Nonresidential area), classification of road (Highway or Freeway, Road, Local city street), accident location (inside city, outside city-suburban area), the direct cause of the accident (Failure to follow traffic rules, Exceeding the safe speed, Failure to follow traffic rules and delay in sighting, delay in sighting), Vehicle type (conventional and Pickup, Heavy and semi heavy, Motorcycles and bicycles), and Pedestrian action (crossing the road from the authorized location, crossing the road from an unauthorized direction).

The outcome in this study was death which was caused by traffic accidents and had occurred at the time of traffic accident or any time until 30 days after the accident versus injury.

All the data received from these two sources were controlled firstly and repeated items were removed, then the data the police and Legal Medicine Organization were matched in order to obtain more precise statistics of cases of death by using some common variables such as, first and last name, sex, age, date of accident, the location of accident.

To determine the mortality and injury rate since the population in 2013 were not available, the results of public census in

2011 and the annual average growth percentage of Alborz and Tehran provinces were used for estimation of the population of the year 2013. Moreover in order to determine the amount of age-standardized incidence rate which aims to eliminate the effect of the destructive variable of age and compare it to other population rates, the standard population of World Health Organization was used.

In order to describe the study findings the descriptive statistics such as absolute and relative frequency, mean and incidence rate were used.

In studying the relationship between each of the variables with dependent variable, the Chi-square test was used for qualitative variables and t-test was used for quantitative variables. Logistic regression was used to determine factors associated with death of pedestrian. At first, univariate analysis between each independent variable with the dependent variable was performed. Then, the variables with P value less than 0.2 were entered into the final model.<sup>11</sup> In the final analysis, P value less than 0.05 was considered significant. Data preparation and data connectivity was performed using Excel and Pathak software, and also data processing was done by Stata 12 statistical software.

## RESULTS

Totally, from March 21, 2013 to March 21, 2014 a number of 93,788 accidents were reported by police in Tehran and Alborz provinces that 10,742 accidents were related to pedestrians. From these 10319 cases were injured, 213 deceased and 214 had unknown status. After matching the data between two sources we found that out of 213 pedestrian deaths reported by police, 93 cases were shared between the police and the Legal Medicine and 120 cases were reported by police which were not reported by Legal Medicine. The total number of deaths

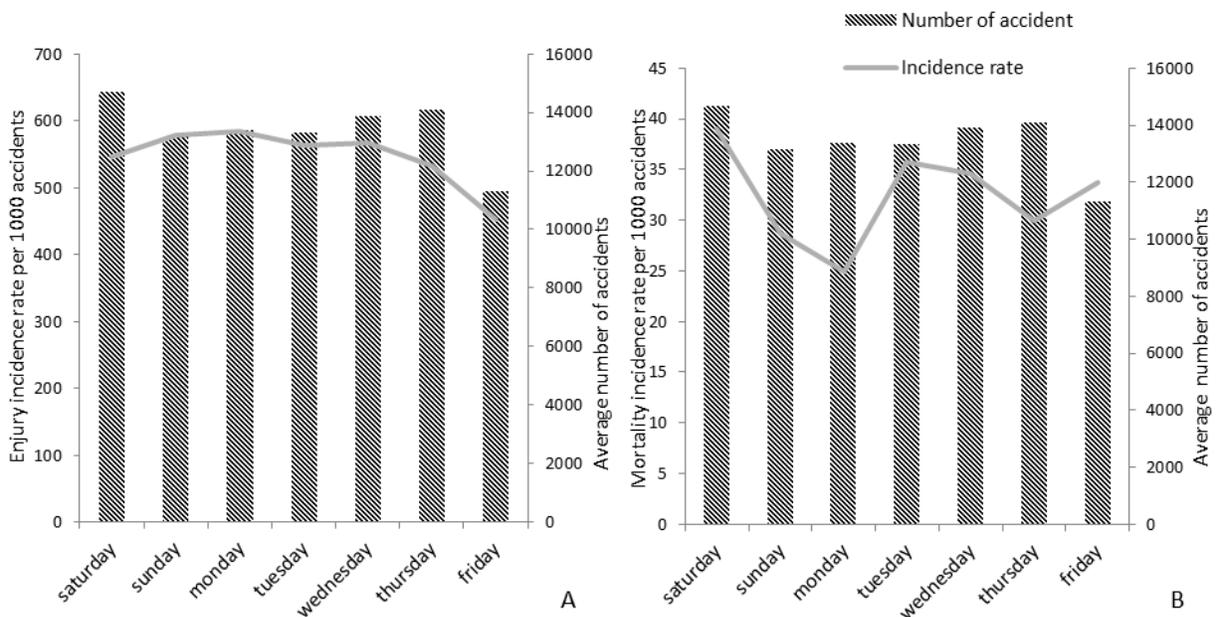
reported by Legal Medicine in both Tehran and Alborz was 774 cases of which 93 were shared between the two sources, the status of 247 and 4 of these cases were reported in police data base as injured and unknown respectively. The status of these cases in the police data base was changed to death and finally in data provided by police we had 464 deaths. For reporting crude traffic accident mortality rate we used all the reported dead cases by police and legal medicine in each province after removing the common cases but for analyzing the factors associated with death of pedestrians we used just the police database with 464 death outcome.

The mean age of the dead and injured pedestrians were respectively  $(47.15 \pm 0.82)$  years old and  $(35.4 \pm 0.22)$  years old. The age standardized mortality and injury rate were respectively 6.1 and 65.1 per 100,000 populations.

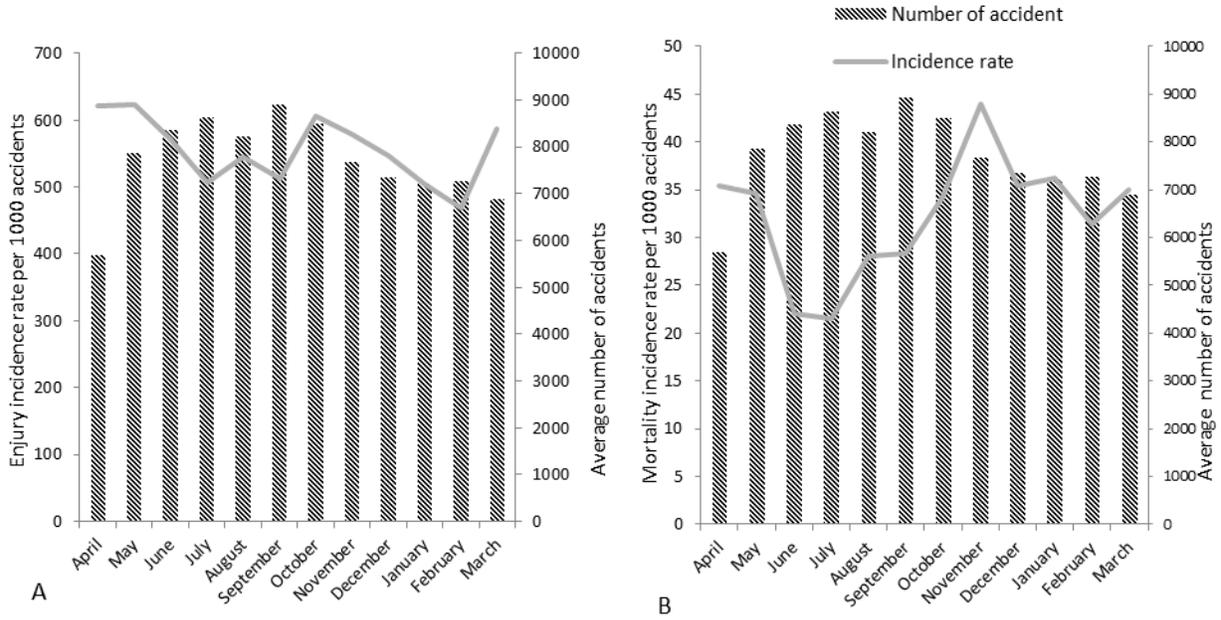
More than 78% of deaths and 62% of the injuries occurred in men. The mortality rate in men was over 2.5 times more than women (9.23 in men and 2.55 in women per 100,000 populations) and injury rate was over 1.5 times more than that of women (84 in men and 50 in women per 100,000 populations).

The frequency of death and injury in the age group of 15-64 years were respectively 60.6 and 74%, in age group of less than 15 years were respectively 10.3 and 15.7% and in age group of more than 65 years were respectively 29.1 and 10.4%. The highest mortality and injury rate (27.2 and 112 per 100,000 populations, respectively) were observed in the age group of over 65 years.

The highest mortality and injury rate of pedestrian according to days of week were observed in Saturday and Monday respectively (Figure 1).



**Figure 1:** Traffic accident injury (A) and mortality (B) rate per 1000 accidents and the average number of accidents according to the days of week in Tehran and Alborz provinces in 2013  
In each diagram the incidence rate is depicted the left Y axis and the number of accidents on the right Y axis.

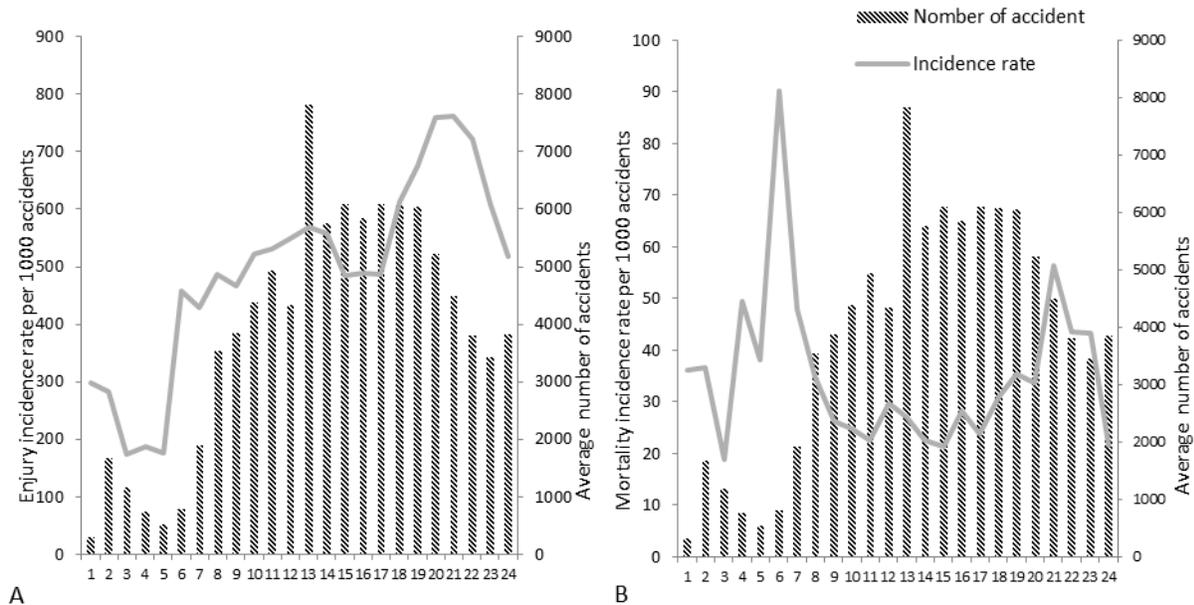


**Figure 2:** Traffic accident injury (A) and mortality (B) rate per 1000 accidents and the average number of accidents according to the month in Tehran and Alborz provinces in 2013

In each diagram the incidence rate is depicted the left Y axis and the number of accidents on the right Y axis.

The highest mortality and injury rate according to the month were observed in November and May, respectively (Figure 2).

The highest mortality and injury rates according to the hour were observed at 6:00 a.m. and 9:00 p.m., respectively (Figure 3).



**Figure 3:** Traffic accident injury (A) and mortality (B) rate per 1000 accidents and the average number of accidents according to the hour in Tehran and Alborz provinces in 2013

In each diagram the incidence rate is depicted the left Y axis and the number of accidents on the right Y axis.

Table 1 shows the absolute and relative frequency of death and injury according to some variables related to the condition and

location of the accident and also relationship between each of these variables with the dependent variable (the death of a pedestrian).

**Table 1:** The absolute and relative frequency of death and injury according to some variables related to the accident condition of the subjects under study

Item		Death	Injury	Total	P
		Number (%)	Number (%)	Number (%)	
Air condition	Smooth	430(4.4)	9336(95.6)	9766(100)	0.041
	Cloudy or foggy	13(8.4)	141(91.6)	154(100)	
	Snowy or rainy	10(5.7)	165(94.3)	175(100)	
Light status	Daylight	486(7)	6504(93)	6990(100)	<0.001
	Night	301(9.9)	2751(90.1)	3052(100)	
	Dawn or dusk	65(14.2)	393(85.8)	458(100)	
Road type	One-way	93(4)	2216(96)	2309(100)	<0.001
	Two-way divided	298(5.6)	4988(94.4)	5286(100)	
	Two-way not divided	62(2.5)	2437(97.5)	2499(100)	
Collision type	Vehicle with pedestrian	388(5)	7434(95)	7822(100)	<0.001
	Motorcycle with pedestrian	44(2.3)	1904(97.7)	1948(100)	
	Other	27(5.5)	460(94.5)	487(100)	
Clothing colour	Bright	307(14.3)	1846(85.7)	2153(100)	0.56
	Dark	291(7.6)	3549(92.4)	3840(100)	
Residential status of the accident location	Residential	336(3.9)	8233(96.1)	8569(100)	<0.001
	Non residential	119(7.5)	1472(92.5)	1591(100)	
	Highway or Freeway	149(11.1)	1189(88.9)	1338(100)	
Classification of road	Road	89(8)	1017(92)	1106(100)	<0.001
	Local city street	220(2.8)	7560(97.2)	7780(100)	
	Inside city	384(4)	9320(96)	9704(100)	
Accident location	Outside city-suburban area	70(16.2)	361(83.8)	431(100)	<0.001

To determine the factors associated with pedestrian death, a logistic regression model was used that the results of which are presented in Table 2. According to the information in Table 2, it is observed that the factors such as pedestrian age, pedestrian

gender, light status, air condition, the direct cause of the accident, way type, classification of road, month of accident, day of week, vehicle type, accident location and pedestrian action had a significant statistical relationship with the pedestrian death (Table 2).

**Table 2:** Risk factors of pedestrian deaths in traffic accidents in Tehran and Alborz Provinces in 2013

Item	Unit of measure	P	Odds ratio	Confidence interval 95%
Pedestrian gender	Male	<0.001	1.96	1.49-2.6
	Female	Reference	—	—
Driver gender	Male	0.46	1.19	0.74-1.93
	Female	Reference	—	—
Pedestrian age	Years	<0.001	1.027	1.02-1.03
Light status	Daylight	Reference	—	—
	Night	0.012	1.38	1.07-1.76
	Dawn or dusk	0.78	0.92	0.5-1.67
Air condition	Smooth	Reference	—	—
	Cloudy or foggy	0.033	2.05	1.06-3.99
	Snowy or rainy	0.83	0.91	0.38-2.15
Residential status of the accident location	Residential area	Reference	—	—
	Nonresidential area	0.53	0.9	0.67-1.23
	Failure to follow traffic rules	0.035	1.3	1.02-1.67
The direct cause of the accident	Exceeding the safe speed	0.017	2.35	1.17-4.43
	Failure to follow traffic rules and delay In sighting	<0.001	2.89	1.59-5.25
	Delay in sighting	Reference	—	—
	Highway or freeway	<0.001	2.5	1.88-3.37
Way type	Road	<0.001	2.13	1.42-3.18
	Local city street	Reference	—	—
	Two-way divided	0.4	1.14	0.84-1.53
Classification of road	Two-way not divided	0.005	0.56	0.38-0.84
	One-way	Reference	—	—
	April	0.43	1.3	0.67-2.52
Month of accident	May	0.2	1.48	0.81-2.69
	June	0.14	0.58	0.28-1.2
	July	Reference	—	—
	August	0.54	1.22	0.65-2.28
	September	0.17	1.48	0.81-2.68
	October	0.045	1.79	1.01-3.16
	November	0.011	2.08	1.18-3.68
	December	0.23	1.45	0.79-2.62
	January	0.039	1.85	1.03-3.22
	February	0.23	1.46	0.79-2.69
Day of week	March	0.47	1.25	0.68-2.32
	Working days	Reference	—	—
	Before holiday	0.38	1.16	0.83-1.63
	Holiday	0.035	1.43	1.02-2
Vehicle type	After holiday	0.028	1.4	1.03-1.88
	Conventional or Pickup	Reference	—	—
	Heavy of semi heavy	<0.001	2.81	1.99-4
Pedestrian action	Motorcycles and bicycles	0.01	0.62	0.43-0.89
	Crossing the road from the authorized location	Reference	—	—
	Crossing the road from an Unauthorized direction	0.001	1.7	1.25-2.31
Accident location	Inside city	Reference	—	—
	Outside city-suburban area	0.001	2.37	1.45-3.89

## DISCUSSION

In total, after matching the police and Legal Medicine Organization databases, a

number of 894 pedestrians were died from March 21, 2013 to March 21, 2014 in

Tehran and Alborz provinces and 10,068 pedestrians were injured. The results showed that the age-standardized mortality rate was 6.1 per 100,000 populations. Our results were consistent with the results of some other studies including a study conducted by the Moradi et al in 2003 in Iran and they reported the mortality rate of the pedestrians as 8.3 per 100,000 population.<sup>12</sup> The mortality rate of a pedestrian in a study done by Karimnia and Ameri in 2013 in Iran during the years 2006 to 2010 has shown a declining trend (The pedestrian mortality rate between the years 2006 to 2010 were respectively, 9.5, 7.8, 7.9, 7.7 and 7.15 per 100,000 population).<sup>13</sup>

A statistically significant relationship was observed between the type of vehicle and pedestrian deaths. The risk of death in accidents with heavy and semi heavy vehicles was about 3 times higher compared with the risk in accidents with conventional vehicles and pickup trucks. A study conducted by Desapriya et al. in 2010 showed that the risk of death in collisions of trucks with pedestrian increased 55% compared with conventional vehicles ( $P=0.001$ ).<sup>14</sup> The higher weight of heavy vehicles compared with conventional vehicles could be a cause of increased risk of pedestrian death. In the same way a study done by Ballesteros et al in 2004 on pedestrian injuries and the types of vehicle in Maryland showed that the increase of weight and speed of the vehicle is strongly associated with increased pedestrian death and injury.<sup>15</sup>

Results of this study showed that a statistically significant relationship was observed between death and travel time (weekday). Results of a study by Wong and Sze in 2007 showed that there was no significant correlation with the severity of pedestrian injury and the days of the week. In addition the use of personal vehicles and pedestrians' traffic on holidays increases

which is associated with an increased risk of pedestrian death. On the other hand after a holiday traffic volume of vehicles and pedestrian traffic due to the reopening of schools, educational and governmental institutions will increase the risk of pedestrian death. So that in this study, the highest incidence rate of death and injury per thousand accidents have occurred on Saturday.

The highest frequency of death and injury were observed in the inner city roads. The risk of death in suburban roads was over 2 times more than that of inner city roads. In a study done by Peymani et al 56% and in a study by Karimnia and Ameri 58.8% of the deaths occurred in the inner city roads.<sup>13,16</sup> The higher Frequency of deaths in inner-city roads refers to the higher density of vehicles and pedestrians in urban areas. On the other hand high risk of death in suburban roads might be due to the high speed of vehicles and also to the relatively longer distance from medical centers.

A statistical significant relationship was observed between the situations of the pedestrian with death. The risk of pedestrian's death while crossing the road from an unauthorized direction was higher compared with crossing the road from the permissible direction. Pedestrians may prefer to cross the unauthorized direction and take the risk of accidents due to inadequate facilities or because of not using the existing facilities (bridges, pedestrian crossings). An important factor for people in decision making in using the bridges is the appropriate locating of the bridge and on pedestrians' way. A large number of people who commute daily in a way might not be willing to use the pedestrian bridge or crossing due to their lengthy distances. Therefore, locating the pedestrian bridge on pedestrians' usual pathways, will encourage them in using the bridge.<sup>17</sup> On the other hand, appropriate traffic control can encourage pedestrians in

using the provided facilities on their pathways. In addition, physical barriers such as concrete edges and planting flowers have an impact on pedestrians' decision making in crossing the street.

In this study all registered pedestrian traffic accidents in the police database were cross matched with legal medicine organization registry which provided a good estimate of mortality rate in pedestrians due to traffic accidents. This matching was the first time that has been done for this data which reported these statistics in this paper.

In this study, we were not able to estimate the number of at-risk populations (the population with outdoor activity which are at risk of traffic accidents) to provide a better estimate of mortality and morbidity rate, although this limitation exists in all studies that have reported mortality and morbidity rates. Besides some other factors are also important in outcome of accident like vehicle speed and consumption of alcohol which should be considered in the future studies.

## CONCLUSION

Considering the fact that the highest mortality rate was observed at above 65 years old population, it is necessary to pay special attention to physiological characteristics of this age group. Physical disability of this age-group people make them to have not willing to use some facilities (such as pedestrian bridges, pedestrian underpasses). Then, in the performing safety plans, this age-group people should be considered and make the facilities usable and convenient for this people. Another finding of this study was that crossing the road in an unauthorized way was associated with increased risk of pedestrian death. So we should increase the safe authorized directions to protect the pedestrians. Appropriate control of traffic, crosswalks and physical barriers and

appropriate locating of the pedestrian bridge could have positive effect at pedestrian decision to cross the street. So we should consider these issues perfectly.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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