



Epidemiology of Road Traffic Injury Fatalities among Car Users; A Study Based on Forensic Medicine Data in East Azerbaijan of Iran

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Received: November 6, 2017

Revised: February 5, 2018

Accepted: February 6, 2018

ABSTRACT

Objective: To study the epidemiology of car user road traffic fatalities (CURTFs) during eight years, in East Azerbaijan, Iran.

Methods: A total of 3051 CURTFs registered in East Azerbaijan forensic medicine organization database, Iran, during 2006-2014, were analyzed using Stata 13 statistical software package. Descriptive statistics ($p < 0.05$) and inferential statistical methods such as Chi-squared test and multivariate logistic regression with $p < 0.1$ were applied.

Results: Of the 7818 road traffic injury (RTI) deaths, 3051 (39%) were car users of whom 71% were male (mean age of 36.7 ± 18.5 years). The majority of accident mechanisms were vehicle-vehicle crashes (63.95%), followed by rollover (26.24%). Crash causing vehicle fall increased the pre-hospital death likelihood by 2.34 times. The prominent trauma causing death was head trauma (in 62.5%). In assessing the role of type of counterpart vehicle on pre-hospital mortality, considering the other cars to be the reference group for comparison, deceased victims were 1.83 times more likely to die before hospital when the counterpart vehicle was a truck and 1.66 times more for buses.

Conclusion: Decreasing the car users' fatalities using appropriate strategies such as separating the roads for heavy and light vehicles and improving the injury related facilitation may be effective. Male drivers with low education could be prioritized for being trained.

Keywords: Car users; Injury; Mortality; Road traffic accidents; Epidemiology.

Please cite this paper as:

Sadeghi-Bazargani H, Samadirad B, Shahedifar N, Golestani M. Epidemiology of Road Traffic Injury Fatalities among Car Users; A Study Based on Forensic Medicine Data in East Azerbaijan of Iran. *Bull Emerg Trauma*. 2018;6(2):146-154. doi: 10.29252/beat-060209.

Introduction

Road traffic system becomes the most multifaceted and the riskiest system with which people have to deal daily, according to WHO report presenting based on information from 180 countries, that globally the total number of road traffic deaths were 1.25 million per year, with the supremacy of low-income countries in road traffic fatality rates [1]. To draw a startling contrast, the Nordic countries have internationally been in the forefront of injury prevention, while Iran has globally been famous for having high road traffic injury and mortality rates. According to the world health organization (WHO) Iran ranks the third regarding unsafe roads in the globe (World Health Organization. Saving millions of lives: decade of action for road safety 2011-2020). Noticeably upsurge in the number of automobiles manufactured over the last decades after Iran's 1979 revolution, accounts for the second cause of death in Iran [2, 3] and financial burden above 7.2 billion US Dollars, equals to 2.19% of the country's Gross Domestic Production [4]. As mentioned by some studies, health benefits like higher level of physical activities and lower level of air pollution for the population of a metropolitan city could be produced by interventions in car use reduction [5]. Precisely, in spite of vast researches done into road traffic related issues, they are lack of vehicle-specific epidemiological studies, particularly in North-West of Iran [6]. Consequently, collective evidence demonstrates basic necessity for figuring out the multifactorial aspects of car users mortalities. In the current paper, we provide the latest epidemiological data on the car users' fatalities, over an eight-year period between March 2006 and March 2014, in East Azerbaijan Province, Iran.

Materials and Methods

Study Population

The current cross-sectional study was conducted in East Azerbaijan, Iran, on traffic injury fatalities registered in East Azerbaijan Forensic Medicine Organization database (EAFMOD) as the study source, between 21 March 2006 and 20 March 2014. Under Iran's national legislation, all road traffic injury fatalities within 30 days after crash are legally forced to be inspected on precise reasons for death via autopsy at the Forensic Medicine centers by which all data is rendered to the lead Forensic Medicine Organization located in the capital city, Tabriz. Complete information about crash- and victim-related data is accessible at protocol of method paper [7]. Accordingly, the process run through the forensic medicine organization can be simplified in Figure 1.

Study Protocol

All the car users (including the driver and passengers

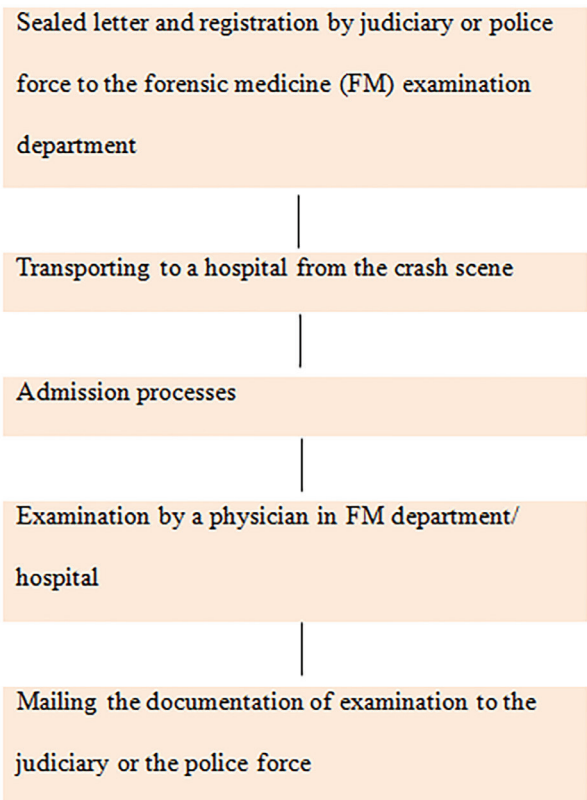


Fig. 1. Flowchart of processes related to road traffic fatalities in the forensic medicine organization, East Azerbaijan, Iran.

of a car), died in a road traffic collision between their cars and other motor vehicles (light vehicles like cars and heavy vehicles like cargo motor vehicles), pedestrians, animals, and objects, registered in East Azerbaijan forensic medicine database were included in this study. Moreover, car user deaths may also be occurred due to rollover and falling of cars as well as vehicle fire. The car is referred to a wheeled motor vehicle used for transportation of maximum six people [7].

Statistical Analysis

Data analysis was carried out using Stata 13 statistical software package (Stata Corp, Texas). Descriptive statistics such as mean, standard deviation (SD), odds ratios (OR) and 95% confidence intervals (95% CI) were calculated. Inferential statistical methods such as Chi-squared test and multivariate logistic regression were also applied to assess potential associations between categorical scaled variables and the predictors of pre-hospital fatality, respectively.

A p -value below 0.05 was considered as the statistical significance level through bivariate analysis and $p < 0.1$ for selecting the variables to introduce into the multivariate regression model. The study protocol was approved by the joint research committee of forensic medicine and road traffic injury research center, as well as the regional committee of ethics in Tabriz University of Medical Sciences.

Results

A total of 7818 traffic fatalities were registered in EAFMOD through the Persian calendar years of 1385-1392 equivalent to the time period between March 2006 and March 2014. A decreasing trend of fatal traffic accidents was observed over the study period (Figure 2). Pedestrians, car users and motorcycle users comprised about 84% of traffic fatalities. The residual percentage (16%) is related to users of pickups, trucks, bus, minibus, bicycle, ambulance, agriculture vehicles, others and unknown when crash (Figure 3).

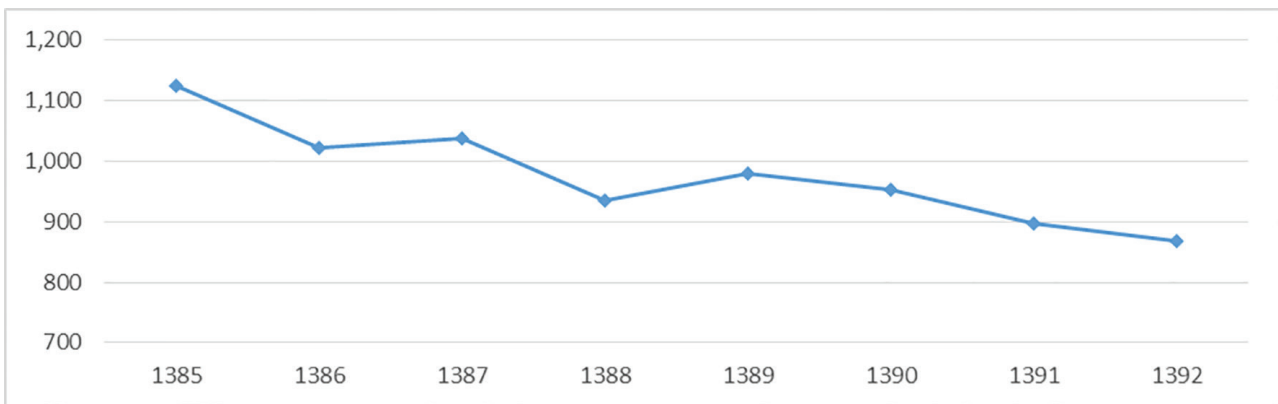
Demographic Information

A total of 3051 (39%) were car users when involved

in a fatal traffic accident. This figure reached to 52% excluding the pedestrians. Males comprised about 71% (95% CI: 0.7-0.73) of the victims. Mean age of car user victims was 36.7 years (1-95 years old, SD: 18.5). Nearly 5.5% were preschool aged children (95% CI: 4.7-6.4%), 8.7% were elderly (95% CI: 7.8-9.8) and the remainder belonged to other age groups. A majority of victims had primary and high school educations (Figure 4, left). The victims' age distribution is categorized as preschool age (0-6), school age (7-18), adults (19-64), and elderly (65 years old and above) (Figure 4, right).

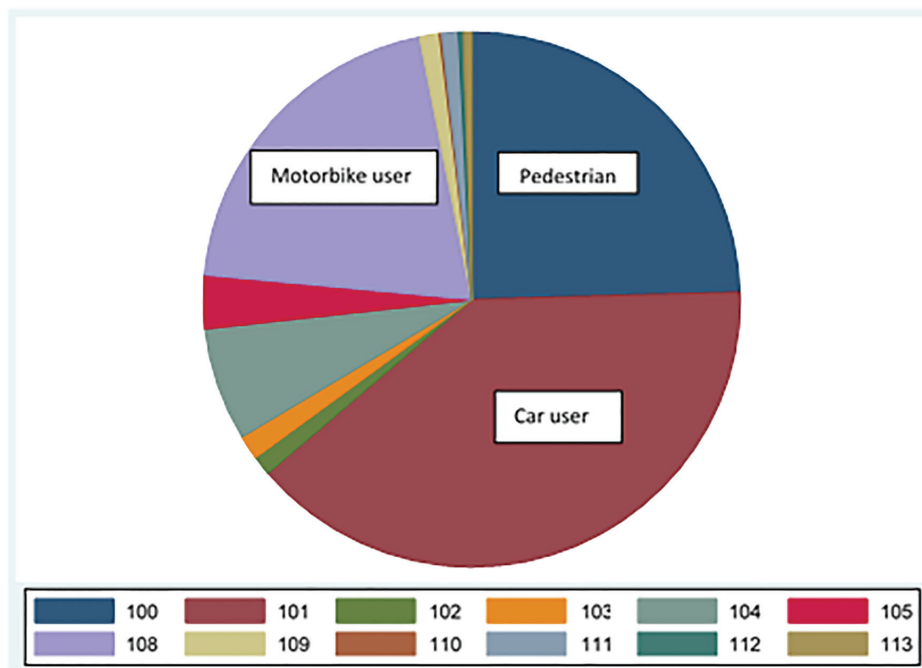
Crash Patterns

The highest number of crashes (63%) was occurred between vehicles. The next most frequent type of



X-axis shows Iranian calendar years. Grossly, 621 could be added to convert into Christian years.

Fig. 2. Trend of mortalities due to traffic injuries in East Azerbaijan Province of Iran (March 2006-March 2014)



100: Pedestrian; 101: Car; 102: Minibus; 103: Bus; 104: Pickup; 105: Truck; 108: Motorcycle; 109: Bicycle; 110: Ambulance; 111: Agriculture vehicle; 112: Other vehicles; 113: Unknown

Fig. 3. Distribution of the traffic injury victims according to the type of vehicle used for transport

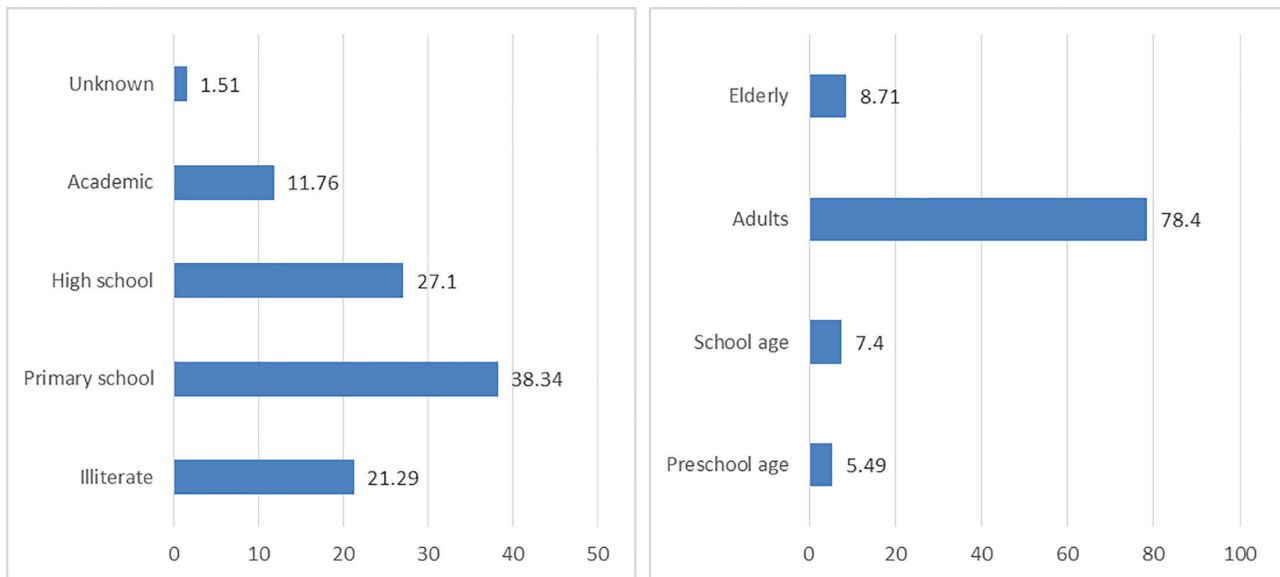


Fig. 4. Distribution of Car Users Mortalities by Educational Level (left) and Job Distribution (right) in East Azerbaijan (March 2006-March 2014).

crashes was shown to be rollover of cars, being more than a quarter of car accidents. Over the studied decade, seven percent of car user fatalities were occurred due to crash with a fixed object. The few remaining percentages covered falling, crash of vehicle-pedestrian, vehicle-animal, vehicle fire and others. Distribution of crash counterparts among car users died due to traffic injuries is given in Table 1 showing that Trucks were the leading cause of mortality, comprising about 29%. Excluding the cases when no other vehicle was engaged, truck caused 44% of deaths followed by other cars causing 33% of the fatalities. In assessing the role of the type of counterpart vehicle on pre-hospital mortality, considering the other cars to be the reference group for comparison, deceased victims were 1.83 times more likely to die before getting to hospital when the counterpart vehicle was a truck (95% CI: 1.46-2.29) followed by buses (odds ratio=1.66; 95% CI: 1.1-2.74). To assess the association between accident mechanism and pre-hospital mortality of vehicle-vehicle crashes were considered as reference group. It was observed

that “crash-caused vehicle fall” increased the pre-hospital death likelihood by 2.34 times (95% CI: 1.1-5). Victims died in crashes with other mechanisms were less likely to die before getting to hospital when compared to vehicle-vehicle crashes.

Head trauma was the leading cause of death accounting for 62.5% of the cases, followed by multiple fractures (about 14%), mixed causes (11.3%), and then bleeding (8.6%). The remaining percentage covered burning, asphyxia, others and those not defined yet. Regarding the role of the victim at the accident time, 1844 (60.5%) of victims were drivers and 1192 (39.1%) were passengers. Six victims were out of the car when the crash occurred and very few had unknown position. On the subject of urban/rural roads, urban and rural road traffic injuries were the reason for 352 (11.54%) and 2699 (88.46%) of deaths, respectively. The information on light conditions and mode of transfer provided only for the last five years of the study was analyzed. Concerning distribution of accidents according to the light conditions, the majority of crashes happened

Table 1. Distribution of crash counterparts among car users died due to traffic injuries in East Azerbaijan (March 2006-March 2014)

Crash counterpart vehicles	Percent	95% Confidence interval	
Truck	871 (28.77)	27.19	30.41
Other cars	653 (21.57)	20.14	23.07
Pickup	197 (6.51)	5.68	7.44
Bus	94 (3.11)	2.54	3.79
Minibus	56 (1.85)	1.43	2.4
Other vehicles ^a	34 (1.12)	0.8	1.57
Agricultural vehicles	19 (0.63)	0.4	0.98
Motorcycles	10 (0.33)	0.18	0.61
Ambulance	1 (0.03)	0	0.23
Unknown	48 (1.59)	1.2	2.1
No counterpart ^b	1044 (34.49)	32.82	36.2
Total	3027 (100)		

^aOther vehicles include construction vehicles, fire vehicles; ^b The car user death occurred due to accidents like roll over, falling, vehicle fire, rather than a crash with other motor vehicles.

during daytime (60.6%) and about 10% at dawn/dusk. More than eighty percent of decedents were transferred by ambulance and about ten percent of them were transferred by passerby vehicles. The least percentage was belonged to the police.

Crash Outcomes

Among those who died prior to hospitalization, head trauma was the main cause of death in 66.8% (1379 victims) of the victims versus 53.5% among those died after hospitalization (Figure 5). Head and face was the trauma site almost in 80% of fatalities. Detailed information by organs subject to trauma is given in Table 2. As shown in Table 2, of 3051 road traffic fatalities, 2426 victims (79.5%) died of injuries to their head and face that was individual cause of

death among 1709 victims. Among 717 fatalities of 3051 deaths, head and face along with another organ / organs were injured and caused deaths. The remaining number of fatalities (625 car users) were passed away because their vital organs except head and face got injured. To assess the determinants of pre-hospital mortality, a multivariate logistic regression analysis was applied. Four variables independently predicted the place of death. Those transported by passerby vehicles were 1.71 times more likely to die before getting to hospital compared to ambulance (95% CI: 1.13-2.58, $p < 0.01$). The elderly age group was less likely to die before hospital compared to other age groups (odds ratio=0.48; 95% CI: 0.33-0.69, $p < 0.001$). Those died in recent two years were less likely to die before hospital compared to those

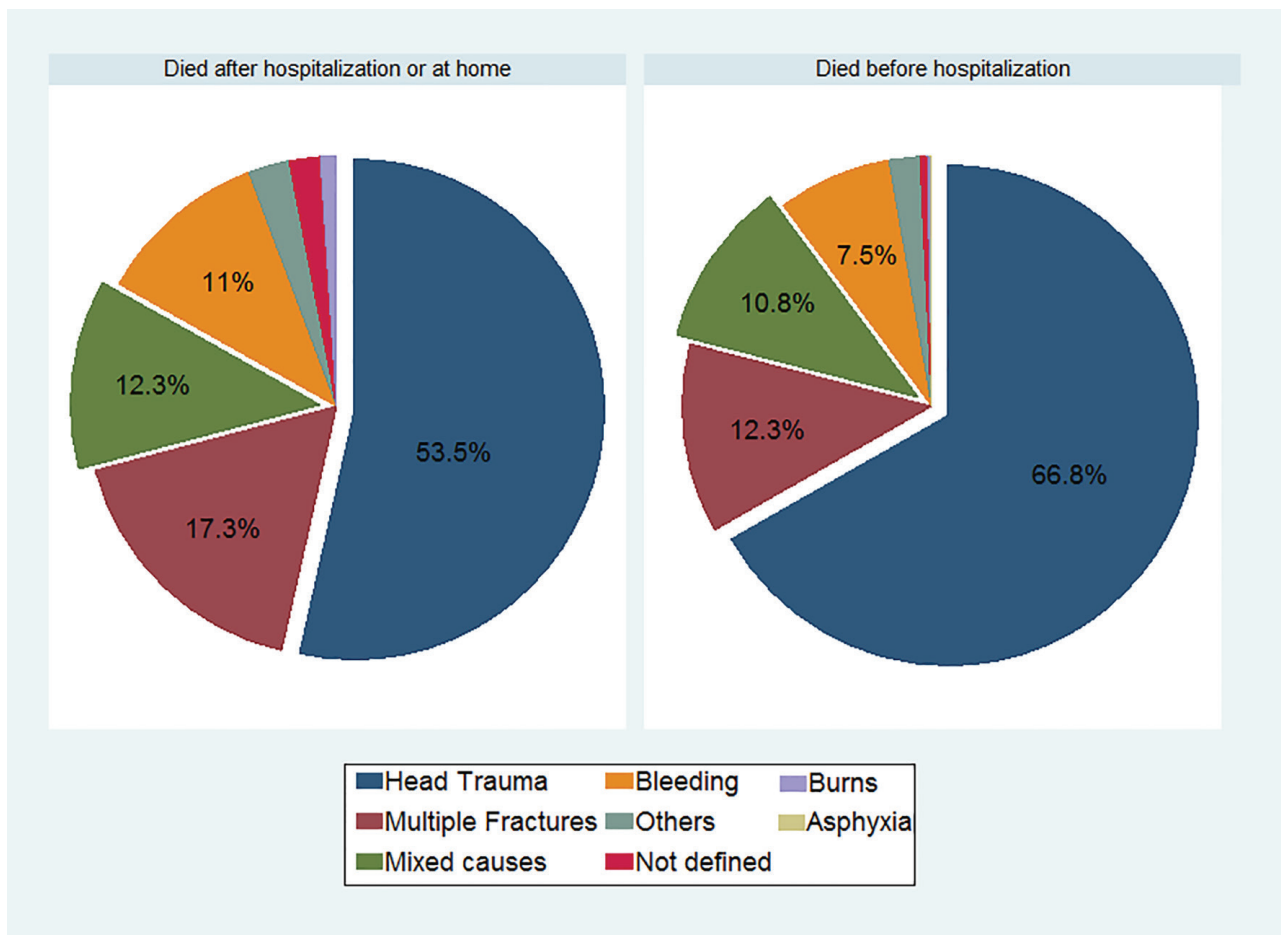


Fig. 5. Distribution of Car Users Mortalities by Cause of Death Before and After Hospitalization in East Azerbaijan (March 2006-March 2014)

Table 2. Distribution of Injured Organs among Car Users Died of Traffic Injuries in East Azerbaijan (March 2006-March 2014).

Injured organs	Single organ ^a (%)	Mixed organs ^b (%)	Total (%)	Remaining (%)
Head and face	1709 (56)	717 (23.5)	2426 (79.5)	625 (20.5)
Trunk total ^c	405 (13.3)	699 (61.7)	1058 (34.7)	1993 (65.3)
Chest and abdomen	395 (13)	641 (21)	1036 (34)	2015 (66)
Neck	40 (1.3)	170 (5.6)	210 (6.9)	2841 (93.1)
Pelvis	4 (0.1)	181 (5.9)	185 (6)	2866 (94)
Lower limbs	3 (0.1)	254 (8.8)	257 (8.4)	2794 (91.6)
Upper limbs	1 (0.03)	236 (4.4)	237 (7.7)	2814 (92.3)

^aOnly one injury caused fatality; ^bTwo or more injuries along with the related single injury caused fatality; ^cTrunk total refers to injuries related to chest and abdomen and column vertebrae.

in earlier years (Year 2012: odds ratio=0.45; 95% CI: 0.24-0.83, $p<0.01$) (Year 2013: odds ratio=0.49; 95% CI: 0.26-0.92, $p<0.02$). The trend test was not statistically significant. Those died/involved in inner city roads traffic accidents were less likely to die before getting to hospital compared to accidents occurring in outer city areas (odds ratio=0.51; 95% CI: 0.36-0.71, $p<0.000$). Ambulance was the main vehicle for transferring the injured victims in 82.5% of the cases. As well, transport mode of about 10% of decedents was passerby vehicles. The police played the smallest role in victims' transport.

Discussion

Considerably high numbers of road traffic victims (39%) as car users were obtained from a total of 7818 traffic fatalities registered in EAFMOD between 2006 and 2014. In comparison, the figure is consistent with some studies [8-12], but higher than the global estimate [13], and in accordance with studies done in Isfahan [14] and [1, 15, 16]. This is likely because the main road users are car users. To make a comparison, although parallel decreasing trends in road traffic fatalities (RTFs) were observed in Turkey and Iran over the last three years, plus the similarity of their population and percentage of car users by gender, RTFs estimated by WHO were extremely different, showing higher figure in Iran, in spite of lower speed limits and law enforcement on speed control in Turkey. Therefore, the central focus is seemingly preferable to be on other factors like vehicle safety and road safety. Also the dissimilarity would be due to the type of estimation (victims died at the scene of crash in Turkey and during the 30 days after crash in Iran) [13]. In this regard, in spite of using the same method of RTF estimation (died within 30 days of crash, according to the Australian Bureau of Statistics (ABS)) and approximately equal number of car users in both Iran and Australia, our country imposed much less appropriate law enforcement regarding maximum speed limit, seat belt particularly rear seats, and child restraint, apart from vehicle safety and road safety, which led to five times the death rate in Australia. Among the middle-income countries, Iran has reached the fifth level for its top mortality rate from road traffic injuries [17].

Considering accident mechanisms, the most fatal crashes were collision with another vehicle and rollover of cars, similar to some studies [10, 11]. This finding is reasonable as cars are moving close and even nearer than standard distance to other vehicles. So crashes between vehicles are more likely to happen through improper deeds on roads, unauthorized speed and being novice or drowsy. Another main finding presents trucks as crash counterparts making the deadliest collisions, in comparison with all other counterpart vehicles. Generally, the accidents in which heavy vehicles are involved are more injurious and fatal in comparison

to those in which only passenger cars are involved [14, 18-20]. The second greatest fatality was attributed to collision with other cars, as opposed to and less than some studies published two times more amount [21].

On comparison, urban road traffic injuries accounted for fewer car user mortalities. It seems because the emergency care is quickly provided or the severity of crashes are not as fatal as those on highways. Also presence of police and prohibition of heavy vehicles on urban roads may be effective factors. Urban speed limit can be robustly enforced by means of equipment such as speed control cameras, and virtual three-dimensional or mock objects on roads where cars' crash counterparts can mostly be heavy vehicles. Trucks and then buses caused the deadliest pre-hospital car user mortalities, similar to a study [8]. As previously mentioned, heavy vehicles lead to fatal crashes and severe damages on counterpart vehicle [18].

The pre-hospital death in case of crash-caused fall into valley represented the most likelihood, compared with other crash mechanisms. In this subject, Emergency Medical Services (EMS) would play a crucial role if reaching soon and being qualified. But mainly such event happens on roads far from city and EMS stations. The average "to scene" time reached 14 minutes outside the under-study cities [22]. Factors like poor driving training and driver fatigue may be increasing likelihood of such events.

As inferred from the results, head trauma plays the leading role in killing those involved in fatal car accidents, followed by multiple fractures, mixed causes, and bleeding in descending order. Additionally, approximately three fourths of victims were registered to die of a single trauma to one of coded organs, including head and face, neck, chest and abdomen, upper limbs, vertebral column, pelvis, and lower limbs, with predominance of head and face [9-11, 14, 15, 23, 24], then chest and abdomen. It clearly demonstrates that the single injury to victims' organs was too serious to be recovered. Additionally, multiple fractures accounted for the second greatest percentage of fatalities, in accordance with a couple of studies [10, 25]. Contrary to the study of Vahdati *et al.*, [21] in East Azerbaijan, our findings showed greater percentages. Unlikely, Taghipour *et al.*, reported injuries to hip and lower limbs as the second most frequent cause of death. Notably, low and middle-income countries fail to meet even the most basic international standards on vehicle safety [13].

Based on the study, among car occupant victims, drivers lives were threatened to the highest degree, in line with a study in Isfahan [14]. The point to note is that few national vehicles were merely standardized by Euro NCAP [26, 27]. Also drivers training in driving risks and cautiously driving are definitely required to promote safety trips [28], since improving the cultural infrastructure and the universal access to safe roads can be mentioned as

measures of social justice [29]. According to the results from the last five years of the current study, similar to some studies, the greatest multitude of accidents occurred during the day [30, 31], followed by a fourth of cases at night and a tenth at twilight. In opposition, Soltani *et al.*, found the highest number of road traffic deaths at night [32]. The introduction of laws for automatic daytime headlights in high-income countries has shown substantial reductions in daytime crashes involving more than one party [33-36]. Then, it is preferable to modify driving rules in the same way as other developed countries and make daytime running lamps an option at least.

The most widely used modes of transport were ambulance, then, passerby vehicles, unknown, and police, in descending order, similar to Vahdati *et al.* in North-West of Iran [21] and opposed to estimates of Khorasani-Zavareh (2010) declaring cars of untrained people and passenger as the main mode of transport to hospital [37]. Passerby vehicles as closest help to victims, do not engage until arriving EMS, whether due to lack of the first aids knowledge or due to legal consequences. "Platinum Ten Minutes", the transport time of victims from the scene to a hospital, as mentioned by Calland (2005), would be achieved through qualifying the provision of EMS [38]. It is claimed that elderly fatalities (65 years and above) were more prevalent at hospital and after discharge, rather than prior to hospitalization, compared to other age groups. Apparently, some common and deadly complications such as embolism and thrombosis were faced by old victims on account of road traffic injuries, which may not endanger the life of adults injured [39]. Victims of inner-city crashes were determined to be less likely to die before hospitalization. It is supposed that EMS provide on-time services, showing EMS response time to inner-city crashes is shorter than to interurban ones [38, 40], OR possibly due to lack of appropriate care after hospitalization.

In terms of demographic characteristics, male car users were three times more involved in fatal road traffic crashes. The dominance of men indicates higher number of male car occupants as drivers/passengers [10-12, 14, 37, 41-43], possibly due to their frequent commuting by cars or their interest in excitement of speedy driving, [44, 45]. Particularly in countries like Iran though women share a smaller role in transportation [45], they comply with traffic rules and regulations, with great respect for human rights [46]. According to the study, the upmost number of traffic victims related to the age range between 19 and 65 years old (78.4%) [11, 31, 43]. The result is reasonable, since the people represent active human resources.-This figure was twice as many as a global statistic and a national one [11, 47]. Promoting e-learning system for students, teleworking for staff, and e-commerce through bringing about infrastructures may lead to reduction in commuting among them [48]. Based

on national census on the elderly population (65 years and above), it can be assumed that elderly may have the lower driving rate than other age groups. If so, according to the elderly fatality rate, it can be considered that traffic mortality risk among the elderly could be higher than the figure of other ages. Bhalla *et al.*, found highest rate of death among elderly despite their lower rate of involvement in non-fatal crashes [15].

The high amount of mortality rate was allocated to illiterate victims, and those with primary and guidance school education, indicating high quantity but less than that of some study [10, 11, 14], although low number of people in the province are illiterate [49]. Less than seven percent of victims had academic education. In East Azerbaijan, 10.3% had academic education [49]. The car user mortalities vary in terms of job distribution; the highest number of road traffic mortality is assigned to self-employed victims, followed by housekeepers. Seemingly they spend much amount of time driving, travelling, and commuting in order to their occupational affairs as well as being tired and sleepy. So they would bear the brunt of such high risk conditions.

Generally, a downward trend of fatalities, over the eight-year period, demonstrated noticeable decline with small fluctuations against a backdrop of motorization. It may be resulted from the rising petrol costs [22] and tolls on roads, which compel people to use public transportation system.

In terms of limitations, it is important to note that like any other register-based studies, we could only study few most important variables of interest archived through documents of EAFMOD, for an instance, classified principal data on different types of roads were unavailable. So, it would help extend required information. The strength of this study was that, to our knowledge, it was among the first studies in Iran that compared a variety of conditions with focus on all car users victimized over an eight-year period in East Azerbaijan Province, Iran. The most effective and long-term amendments will be prepared using multidimensional approach to travel safety, by multi-agency and injury-based plans, provision of safe-driving- and injury-related information as compulsory courses for drivers particularly illiterate and less educated ones, and school children, improving emergency services in terms of availability and qualification of services at the scene of event. Further research is also required to be conducted in this field.

In conclusion, it seems decreasing the car users' fatalities using appropriate strategies such as separating the roads for heavy and light vehicles and improving the injury related facilitation may be effective. Male drivers with low education could be prioritized for being trained.

Acknowledgment

The authors would like to express their gratitude to the psychiatry scholars and official staff of the forensic medicine organization, as well as specialties

of Information Technology (IT).

Conflicts of Interest: None declared.

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