

Epidemiology of Vehicle Fire Fatalities of Road Traffic Injuries in Kerman Province, Iran: A Cross-Sectional Study

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Abstract

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BACKGROUND: Vehicle fires are one of the most important causes of fatalities in road traffic injuries (RTIs), but there are no accurate statistics about vehicle fire fatalities (VFFs) due to RTIs in Iran.

AIM: This study aimed to investigate the Epidemiology of vehicle fire fatalities (VFFs) due to road traffic injuries (RTIs) in Iran.

METHODS: In this cross-sectional study, a researcher-made checklist was used to collect the required data from the files of RTI fatalities in the Kerman Legal Medicine Organization (KLMO), or coroner's office. All reported victims of vehicle fires in the ten years from 2007 to 2017 were included in the study. The data were analysed using SPSS ver. 18, with $p = 0.05$ considered as the level of significance.

RESULTS: The authors found 124 cases of vehicle fire fatalities in Kerman, with a mean age of 30.45 ± 12.41 , of which 50% were in the 25-49 years age group. Most frequently, the victims were Iranian (91.9%), married (66.1%), self-employed (51.6%), and urban dwellers (79.8%), and had died because of burns (91.9%). In 46.8% of cases, the victims were the driver, and in the remaining 53.2%, they were the passenger of the crashed vehicle. Most frequently, vehicle fires occurred on extra-urban roads (90.3%), during spring (35.5%) or summer (32.3%), due to a vehicle-to-vehicle collision (66.9%), between sedans (69.9%), and at night (63.7%). Most victims died at the scene of the incident (87.9%) and had been transferred to hospital by an ambulance (71%).

CONCLUSION: This study indicated that car fires caused the death of young and middle-aged people. The authors suggest the implementation of preventative measures promoting car safety; establishing speed management; establishing laws governing driving, manufacturing and importation of vehicles; construction of safe roads; identifying accident-prone points; installing road warning signs; establishing more roadside stations; ensuring stricter police monitoring; and improving vehicle safety standards and public awareness about the risks of speeding.

Introduction

Road traffic injuries (RTIs) are the main causes of early death, disability and a major health issue in low and middle-income countries[1]. RTIs are the cause of deaths, financial losses, and preventable health threats, even in developed countries [2]. It has been reported that most victims of RTIs are people aged <50 years old[3]. RTIs are the second leading cause of death from fatal injuries in Iran [2]. According to the World Health Organization (WHO), Iran had an

RTI mortality rate of 34.1 deaths per 100,000 in 2013 [4] and had the third-highest rate of fatal RTIs in 2015 [5].

Vehicle fire, as a notable cause of RTI-related fatality, has received increasing attention since the 1960s [6]. According to the National Fire Protection Association's (NFPA) 2010 report, in the United States, 31 vehicle fires happen every hour, and one person dies because of vehicle fire every day. Between 2003 and 2007, about 287,000 vehicle fires caused 1,525 injuries and 480 fatalities in the US. During this period, on average, 8,200 highway vehicle

fires per year occurred due to accidents and overturning [7]. Generally, highway vehicle fires in the United States were the cause for 17% of reported fires, 12% of deaths, 8% of civilian injuries and 9% of the direct property damage from reported fires [8].

Based on US Fire Administration's National Fire Incident Reporting System from 2014 to 2016, there were 171,500 highway vehicle fires in the United States with an annual death rate of 345 people, 1300 injured and \$ 1.1 billion in financial losses [9]. In 2015, vehicle fires constituted about 6.4% of all fires in Australia, 6.2% in Belarus, 4.6% in Poland, 7.8% in Romania, 13.5% in Russia, 10.3% in Slovenia, 23.5% in Sweden, 4.4% in Ukraine, 15.5% in the USA, 7.5% in Bulgaria, 5.9% in Croatia, 10.4% in the Czech Republic, 6.7% in Estonia, 9.6% in Finland, 3.4% in Hungary, 5.1% in Latvia, 4.8% in Liechtenstein, 9.1% in Lithuania, 13.3% in Moldova, 31.4% in New Zealand, and 13.1% of all fires around the world [10].

The causes of RTIs fatalities, the severity of injuries among drivers and passengers, and the factors associated with the severity of crashes and injuries in Iran have been extensively researched [11], but studies conducted in Iran have somewhat neglected the role of vehicle fires in road fatalities, and, unfortunately, there are as yet no accurate statistics on the number of Iranian fatalities due to vehicle fires. In published articles concerning RTIs in Iran, the rate of VFFs ranges from 0.9%-5% [4], [12], [13]. To our best knowledge, since the research on VFFs is scarce nothing particularly in Iran, this study aims to provide the epidemiology of VFFs in Iran. It can give a base of the problem in the country, and provide a suggestion for prevention measures .

Material and Methods

Study area and setting

In this cross-sectional study, researchers studied the RTIs files archived by the Kerman Legal Medicine Organization (KLMO) over ten years, from 2007 to 2017. KLMO is a branch of a national organisation which is responsible for identifying death causes and issuing death certificates in the province [14]. According to Iranian national laws, all road deaths after a collision must be recorded and investigated to find accurate causes of death through an autopsy process in forensic clinics [15]. Kerman is the largest Iranian Province with an area of 183,285 km², and consists of 23 counties, with a population of 3,164,718 habitats. Geographically, this province is located in the south central region of the Iranian Plateau between 26°29'-31°58' northern latitudes and 54°21'-59°34' eastern longitudes. About 700,000 vehicles are registered, and nearly 1750 km of highway (the third largest in Iran) exist in Kerman.

Kerman roads accommodate about 10,000,000 trips per year, but also have the highest rate of RTIs in Iran. It is reported that in 2016 alone, the RTIs in this province led to 13,624 injuries and 920 deaths [14], [16], [17], [18], [19]. Therefore, this province can be a suitable field for investigating the problem of vehicle fires and related causes, from both regional and international perspectives (Figure 1).

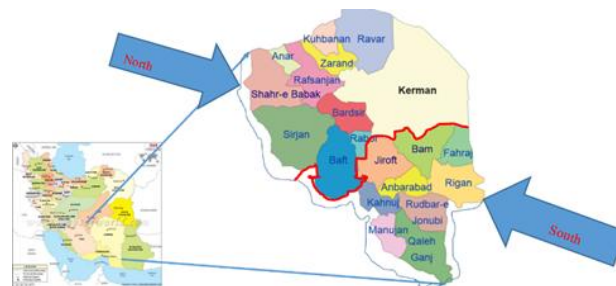


Figure 1: Kerman province map

Research population and subjects

From 11,347 RTIs that were recorded by KLMO for 10 years, 124 deaths were caused by VFFs. All of the registered deaths were included in our study.

Data collection instrument

Data collection was conducted initially by trained experts with using a researcher-made checklist and then entered to SPSS 18. In this research, to determine the validity of the checklist, content validity and the expert panel was used. Also, Cronbach's alpha was used to determine the reliability of the checklist. The reliability was 0.89. The principal investigator then extracted data from the records of KLMO. Information about the atmospheric conditions on the dates of crashes was also collected from the records available on the Iran Meteorological Organization website.

The first part of the checklist was related to socioeconomic variables including gender, age, marital status, and occupation, place of residence, education level, nationality, crash location, crash time, lighting situation, crash season, road type, and environmental conditions. The next part of the checklist consisted of pre-hospital parameter variables, including the method of transport to hospital (three categories), ultimate cause of death, place of death, and victim's status in the vehicle (driver, passenger), and vehicle-related variables, namely the type of victim's vehicle and the type of other vehicles involved in the crash.

Data analysis

The data was imported into the SPSS ver. 18. Initially, frequency, percentage, range, mean \pm

Standard Deviation on the socioeconomic status of the VFF were used. It included sex, age, marital status, educational level, occupation, residence, nationality, crash time, crash season, lighting situation, road type, crash location, crash type and place of death. Chi-squared and Fisher tests were used for assessing the associations between socioeconomic status, pre-hospital status and type of victim's vehicle (two categories: sedan and other vehicles). A P-value of less than 0.05 was considered significant.

Ethical considerations and authority permission

This study was approved by Shahid Beheshti University of Medical Sciences, Tehran, Iran, with the ethics code IR.SBMU.RETECH.REC.1396.203. All forensic records were collected with the permission of this university and KLMO.

Results

Socioeconomic status

The results showed that in the 10 years between 2007 and 2017, 124 VFFs caused by RTIs occurred in Kerman. In terms of sex, 106 victims (85.5%) were male. In terms of sex and victim's vehicle, most of the deaths among men occurred in sedans and other vehicles, and most of the deaths among women occurred in sedans. This difference was statistically significant ($P < 0.05$). In terms of victims' ages, the highest frequency, 16 (12.9%), belonged to 22-year-olds. The mean age of victims was 30.45 ± 12.41 , with a range of 2-75 years. In terms of victim's age group, the highest frequency was related to 25-49-years, and in terms of victim's age group and victim's vehicle, the difference was statistically significant ($P < 0.05$). In terms of victim's marital status, 66.1% were married. Nearly 70 % of those who had sedans were married, and over 41% of those who had other vehicles were single ($P < 0.05$). Regarding the level of education, the highest frequency of VFF was observed among people with primary school education. The difference between of victim's education level and victim's vehicle type was statically significant ($p < 0.05$). In terms of victim occupation, those who were self-employed, in sedans and other vehicles had the highest frequency ($P < 0.05$). In terms of the victim's place of residence, 99 victims (79.8%) were urban citizens. In terms of victim's residency and victim's vehicle, the numbers of urban victims were more concerning all vehicles ($P > 0.05$). In terms of nationality, 114 victims (91.9%) were Iranian, and 10 victims (8.1%) were Afghan (Table 1).

Crash time

Fifty per cent of crashes occurred between 1:00 and 6:00 a.m. and 25% occurred between 18:01 and 24:00 p.m. Most crashes occurred on Saturdays, with 26 cases (21%), and on Fridays, with 25 cases (20.2%). The number of deaths was higher in sedans on Fridays, (21 or 25.3%) and Saturdays (18 or 21.7%). The difference was statistically significant (Chi-square = 12.5; $P < 0.05$). Most VFFs occurred in March, April, May and June (Figure 2). Most VFFs occurred during spring and summer (Table 1). The year with the highest frequency of VFFs was 2012, with 27 cases (about 25%) and the years with the lowest frequency were 2011 and 2016, each with 4 cases (3.2%). According to study results, there was no significant relationship between VFFs and type of victim's vehicles ($P > 0.05$), (Figure 3).

Road conditions

In terms of lighting conditions, more than two-thirds of VFFs occurred during the night and involved sedans, and more than half involved other vehicles ($P < 0.05$). The road with the highest frequency of VFFs was the extra-urban road (99.2%). In term of the type of extra-urban road, the highest frequency was related to freeways, highways and trunk roads, and the lowest frequency was related to other roads. More than 96% of VFFs in sedans and 78% of VFFs in other vehicles occurred in extra-urban roads ($P < 0.05$), (Table 1).

Crash location

The highest number of VFFs occurred in southern Kerman province (9 counties) with 65 cases (52.4%). In terms of crash location and victim's vehicle, nearly 60% of victims in the cities of southern Kerman province were in sedans, and nearly 61% of victims in the cities of northern Kerman province were in other vehicles ($P < 0.05$), (Table 1).

Crash type

Most crashes (66.9%) involved vehicle-to-vehicle collisions. One incident (accounting for 0.8% of all crashes) involved a vehicle falling off the road. In terms of crash type and victim's vehicle, sedans accounted for the most vehicle-to-vehicle collisions and overturned (Table 1).

Pre-hospital parameters

The most frequent place of death was the scene of the crash (about 90%) and the least frequent place was in the hospital with fifteen cases (12.1%). In terms of the place of death and the victim's vehicle, the difference was not statistically significant ($P > 0.05$).

Table 1: Socioeconomic status of the vehicle fire fatalities (VFF) in Kerman Province, Iran (2007-2016)

Variable		Victim's vehicle		Total N (%)	P value*	
		Sedan N (%)	Others* N (%)			
		83(66) Frequency (%)	41 (33.1) Frequency (%)			
Sex	Male	67 (80.7)	39 (95.1)	106 (85.5)	0.032	
	Female	16 (19.3)	2 (4.9)	18 (14.5)		
Age	< 25	33 (39.7)	21 (51.2)	54 (43.5)	0.045	
	25-49	47 (56.6)	15 (36.5)	62 (50)		
	> 50	3 (3.6)	5 (12.2)	8 (6.5)		
Marital status	Single	25 (30.1)	17 (41.4)	42 (33.8)	0.002	
	Married	58 (69.9)	24 (58.5)	82 (66.1)		
Educational level	Primary school (< 6)	22 (26.5)	17 (41.5)	39 (31.5)	0.046	
	Lower secondary school (6-8)	24 (28.9)	12 (29.3)	36 (29)		
	Upper secondary school (9-12)	31 (37.3)	5 (12.9)	36 (29)		
Occupation	University	9 (10.8)	4 (9.7)	13 (10.5)	0.001	
	Primary school and university student	9 (10.8)	2 (4.9)	11 (8.9)		
	Housewife	9 (10.8)	2 (4.9)	11 (8.9)		
	Employee and retired	6 (7.2)	2 (4.9)	8 (6.5)		
	Worker and farmer	5 (6)	6 (14.6)	11 (8.9)		
	Self-employed	49 (59.0)	15 (36.6)	64 (51.6)		
	Driver	5 (6.0)	13 (31.7)	18 (14.5)		
Residency	Military	0 (0.0)	1 (2.4)	1 (0.8)	0.409	
	Urban	68 (81.9)	31 (75.6)	99 (79.8)		
	Rural	15 (18.1)	10 (24.4)	25 (20.2)		
Nationality	Iranian	75 (90.4)	39 (95.1)	114 (91.9)	0.360	
	Afghan	8 (9.6)	2 (4.9)	10 (8.1)		
Crash time	1:00-8:00	42 (50)	20 (48.8)	62 (50)	0.888	
	8:00-12:00	8 (9.6)	4 (9.8)	12 (9.7)		
	12:01-18:00	10 (12.0)	7 (17.1)	17 (13.7)		
	18:01-24:00	23 (27.7)	10 (24.4)	33 (26.6)		
Crash Season	Spring	27 (32.5)	17 (41.5)	44 (35.5)		0.602
	Summer	29 (34.9)	11 (26.8)	40 (32.3)		
	Autumn	15 (18.1)	9 (22)	24 (19.4)		
Lighting situation	winter	12 (14.5)	4 (9.8)	16 (12.9)	0.042	
	Day	25 (30.1)	20 (48.8)	45 (36.3)		
	Night	58 (69.9)	21 (51.2)	79 (63.7)		
Road type	Freeways, highways, and trunk roads	80 (96.4)	32 (78.0)	112 (90.3)	0.001	
	Others	3 (3.6)	9 (22.0)	12 (9.7)		
Crash location	North of Kerman Province (10 counties)	34 (41)	25 (60.9)	59 (47.5)		0.035
	South of Kerman Province (9 counties)	49 (59)	16 (39.02)	65 (52.4)		
Crash type	Collision with each other	58 (69.9)	25 (61)	83 (66.9)		
	Collision with a fixed object	6 (7.2)	4 (9.8)	10 (8.1)		
	Overturn	16 (19.3)	10 (24.4)	26 (21)		
	Fall	1 (1.2)	0 (0.0)	1 (0.8)		
	Vehicle fire	2 (2.4)	2 (4.9)	4 (3.2)		

* (Bus, Trailer, Tanker, Ambulance and Truck (Pickup truck, Small truck)); ** Chi-square.

Table 2: Frequency and percentage of vehicle fire fatalities (VFFs) in terms of pre-hospital conditions in Kerman Province, Iran (2007-2016).

Variable		Victim's vehicle N (%)			P value**
		Sedan	Others*	Total	
		83 (66) Frequency (%)	41 (33.1) Frequency (%)	124 (100) Frequency (%)	
Place of death	At the scene of the incident	75 (90.4)	34 (82.9)	109 (87.9)	0.232
	Hospital	8 (9.6)	7 (14.6)	15 (12.1)	
	Ambulance	56 (67.5)	32 (78.0)	88 (71)	
Transmission method	Police car	14 (16.9)	0 (0.0)	14 (11.3)	0.019
	Passing cars	13 (15.7)	9 (22.0)	21 (17.7)	
	Head and face	27 (32.5)	7 (17.1)	34 (27.4)	
The location of the body damage	Chest and abdomen	0 (0.0)	2 (4.9)	2 (1.6)	0.001
	Hands and arms	1 (1.2)	8 (19.5)	9 (7.3)	
	Multiple trauma	55 (66.3)	24 (58.5)	79 (63.7)	
The final cause of death	Bleeding	0 (0.0)	1 (2.4)	1 (0.8)	0.555
	Multiple trauma	1 (1.2)	0 (0.0)	1 (0.8)	
	Burn	82 (98.8)	40 (97.6)	122 (98.4)	
The type of vehicle involved with the victim's vehicle	Sedan	39 (47.0)	14 (34.1)	53 (42.7)	0.447
	Truck	25 (30.1)	13 (31.7)	38 (30.6)	
	Others	15 (18.1)	12 (29.3)	27 (21.8)	
Victim's status in the vehicle	No collision	4 (4.80)	2 (4.9)	6 (4.8)	0.026
	Passenger	50 (60.2)	16 (39.0)	66 (53.2)	
	Driver	33 (39.8)	25 (61.0)	58 (46.8)	

* (Bus, Trailer, Tanker, Ambulance and Truck (Pickup truck, Small truck)); ** Chi-square.

It was also found that VFFs accounted for 10.92 rate/1000 of all deaths caused by RTIs, with an annual mean of 10 deaths in Kerman Province (Table 3). The data showed that 24.55% of all deaths due to burn injuries in this area were related to vehicle fires.

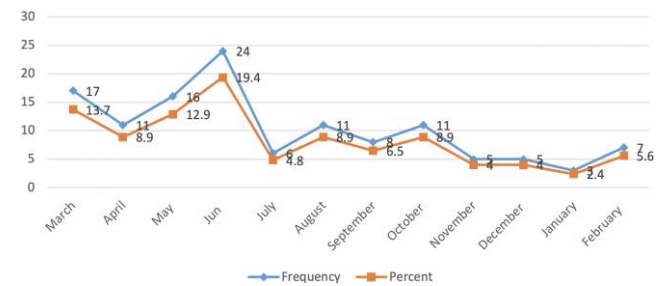


Figure 2: Number and percentage of vehicle fire fatalities (VFFs) by month in Kerman Province, Iran (2007-2016)

Environmental conditions

In terms of air temperature at the place of the crash (county), the temperatures with the highest frequency were 31°C with 23 cases (18.5%) and 36°C with 12 cases (9.7%).

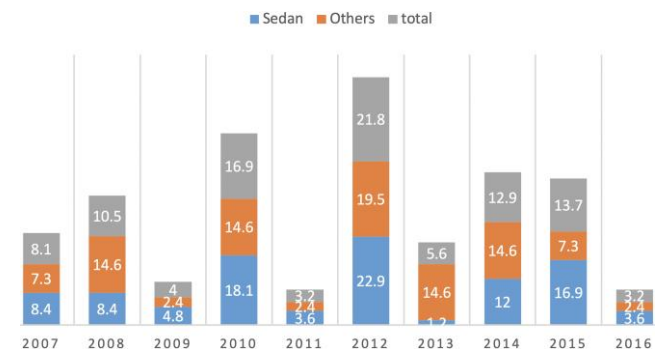


Figure 3: percentage of vehicle fire fatalities (VFFs) by year and victim's vehicle in Kerman Province, Iran (2007-2016). The difference was not statistically significant (P > 0.05)

The highest number of deaths in sedans and other vehicles occurred at the crash scene. Regarding the method of transport to the hospital, the majority of victims were transported by ambulance. In terms of transfer type and the victim's vehicle, the difference was statistically significant (P < 0.05). In terms of injury type, the most frequent class was multiple trauma, and the least frequent class was chest and abdomen injury. The most frequent type of injury based on Sedan and other vehicles were related to head, face and multiple trauma (P < 0.05). The most frequent final cause of death burned. More than 80 victims were related to sedans (Table 2). More than half a per cent (50%) of the victims were passengers and more than two-thirds were drivers. Most of the passengers (60.2%) were in sedans, and most of the drivers (61%) were in other vehicles (buses, trailers, tankers, or ambulances) (P < 0.05), (Table 2).

Vehicle involved conditions

Regarding the type of vehicle collision with the victim's vehicle, the highest frequency was a sedan with sedan and other vehicles. Nearly 5% of car fires did not involve any collision. Trucks were responsible for nearly 31% of collisions with sedans and other cars (P > 0.05), (Table 2).

In terms of mean temperature, the highest frequency, i.e. 38 cases (30.6%), was observed for the mean temperature of 30.70°C. In terms of wind speed, most crashes, i.e. 80 cases (64.5%), had occurred in the wind speeds of 10.8-14.4 km/h, with the mean speed being 17.65 ± 11.68 . In terms of wind direction, the direction with the highest frequency was southwest with 25 cases (20.2%). From the horizontal visibility perspective, the visibility with the highest frequency was 10,000 meters, with 94 cases (75.8%), and the lowest frequency was 2,000 meters, with 2 cases (1.6%), with the mean visibility being $9,178.83 \pm 1,779.82$.

Table 3: The number and rate of vehicle fire fatalities (VFFs) compared to RTI deaths in Kerman Province, Iran by year (2007-2016)

Year	Number of deaths from RTIs in Kerman province	Number of vehicle fire deaths in Kerman province	(Rate/1000)
2007	1180	11	(9.32)
2008	1191	12	(10.07)
2009	1819	5	(2.74)
2010	1251	21	(16.78)
2011	1056	4	(3.78)
2012	1100	27	(24.54)
2013	904	7	(7.74)
2014	917	16	(17.44)
2015	1009	17	(16.84)
2016	920	4	(4.34)
Total	11347	124	(10.92)

Discussion

Our investigation of RTIs occurring in Kerman province over 10 years from 2007 to 2017 found one 124 VFFs. This number equals 10.9/1000 killed of the total 11,347 RTIs deaths, an annual mean of 10 vehicle fire deaths and a quarter (24.55%) of the total 505 burns in Kerman Province, which is higher than the average in Iran and many countries in the world [8], [11], [21], [22]. More than ninety-six per cent of the deaths in men and women under 50 occurred in sedans. These findings showed that the lives of young and middle-aged people who are useful economically and culturally have been destroyed in sedans. This may be due to the speed of this type of car and its greater vulnerability. This finding needs special attention to determine its real cause and its prevention. This finding is consistent with past statistical reports about the road accident fatalities in Iran and the world [3], [23], [24]. Most victims of VFFs were married. Therefore accident's consequences affect their families, and this problem doesn't appear in the first phase of accidents [25].

Regarding the level of education, the highest rate of VFFs was observed among people less than a university education, which is consistent with the results of studies on road accident fatalities in Iran [25], [26], [27], [28], [29], [30]. This finding showed that despite the increasing number of post-

revolutionary university education in Iran, still, most RTI victims are non-academic and less careful. This finding highlights the urgent need for effective, targeted education programs, before the issuance of driver's licenses, to reduce the rate of road accidents among these groups [27].

A major portion of victims was found to be urban dwellers, and the number of sedan fatalities among urban residents was higher than that of other vehicles, which suggests that these citizens travel more than rural citizens. This could be due to the greater tendency of urban citizens to vacation outside their home cities to escape urban traffic and pollution. Also, one-fourth of rural VFFs occurred in other vehicles. Therefore, a system must be established so that villagers do not have to travel to sell their crops and livestock products. This finding is consistent with the findings of other studies in Iran [24], [27], [31].

The self-employed, especially male self-employed, in sedans, and homemakers had the highest frequency of VFFs. This can be due to having a more flexible schedule and more free time. They have to travel more because of their occupation, so they were more exposed to crash due to fatigue and drowsiness. These findings are also consistent with other studies conducted in Iran [14], [22], [27], [31], [32].

In our study, the higher frequency of VFFs occurred among men whose job was driving, and the lowest frequency occurred among military personnel, which is understandable because most Iranian drivers are men. Because of proper training and observance of the law, military personnel had the lowest frequency of car crashes, a new point that should be addressed in educating people [4], [11], [27]. However, a study found that the highest fatality rate occurred among students [33]. This may be due to a gap between their knowledge about the risk, as other study also rely to fill this gap in order to promote the phenomena of interest.

In terms of nationality, nearly 92% of VFFs were Iranian, and about 10% were Afghan. Vehicles in high-speed chases carrying illegal immigrants in Iran and other countries have been shown to have an important effect on traffic fatalities [34], [35], [36].

The highest number of VFFs was related to night driving, especially between 1:00-6:00 a.m. and 18:01-24:00 p.m. This can be attributed to the peak traffic hours, less strict monitoring, limited police presence and less visibility as a result of limited lighting during these hours. Drivers are also more tired and sleepy in these hours [37]. Studies have suggested that good road lighting can reduce nighttime crashes [38], [39].

Most VFFs occurred in March, April, May and June and the highest frequency of VFFs occurred in spring and summer, especially on weekends, and the lowest occurred in winter. This is probably because

Iranians travel more in the summer and spring (Nowruz, weekends, school and university holidays). The police and coroner's reports, as well as other studies, showed that global road traffic control systems should pay particular attention to the management of family vacation trips [1], [27], [28], [37], [40]. One study showed that the rate of vehicle fires increased during school holidays, weekends, summer and autumn and decreased in winter [41].

Studies in Iran, as well as in other countries, reported a higher rate of traffic accidents on highways and extra-urban roads [13], [23]. We also found that most VFFs occur on extra-urban roads (freeways, highways, and trunk roads) and victim's sedans. This may be caused by increased traffic and the higher speed of sedans.

In this study, the highest frequency of VFFs was observed in southern Kerman Province. This area often experiences extreme temperatures during summer. The cities of Bam and Jiroft are centres of date and fruit production, car manufacturing, and tourism, especially due to Arg-e Bam, and are on the main route between the major cities of Kerman and other provinces [42]. These are the most accident-prone roads in Kerman province. Therefore, authorities in Iran and other countries should turn these kinds of roads into highways [43]. Based on our results, 64.5% (80 cases) of VFFs occurred with wind speeds of 10.8-14.4 km/h. One study indicated that wind speeds of 4-19.9 km/h had an impact on road accidents with vehicle fires [44, 45].

The study indicated most victims were transported to the hospital by ambulance. This finding is in agreement with other studies in Iran that's showed the importance of EMS [13], [27]. In terms of injury type, the most frequent class was multi-trauma. Multi-traumas were reported as the most frequent injuries among the victims of RTIs [46]. These results showed that in Iran, vehicles are unsafe and cause damage to different parts of the body. Although recently effective steps have been taken to ensure Iranian vehicle safety, they have not been enough. So, in addition to the upper airbag, which protects the head and face, vehicles must be equipped with an airbag or similar safety devices that also protect the torso and legs. Burns was the cause of 98% of fatalities. Vehicle fires caused by road accidents almost always led to the death of most passengers. Thus, the police officers and paramedics should be properly trained and equipped to handle these accidents.

Regarding the victim's status in the burning vehicle, we found that victims are frequent passengers, which is consistent with the reports of other studies [27], [31]. In the study that recorded by KLMO, drivers were most frequently victims in 2007 crashes, but in 2013, victims were most frequently passengers [15]. This finding is consistent with the results of a study conducted in Sweden [6].

In our study, the most frequent VFFs were related to the vehicle-to-vehicle collision, and the least one involved a vehicle falling off the road, which was consistent with other findings [6], [7], [12], [28]. Collision is still the main cause of accident fatality as well as VFFs, so serious prevention measures are needed to address it. The data showed that two-thirds of VFF victims were travelling in sedans. Several studies concluded that the greatest portion of traffic accident casualties involved sedans [15], [47]. Most deaths (87.8%) occurred at the scene of the accident. This is due to the severity of bodily injury and rapid death in vehicle fires. One study reported that 61.53% of victims died at the scene of accidents [13]. The year 2012 had the highest frequency of VFFs (about 25%), mostly related to sedans. This was due to a technical malfunction of the fuel system of certain domestic sedans, which were later recalled and remedied.

In conclusion, the VFFs is one of the most important causes of RTIs. There are a few types of research about VFFs thought worldwide. In Iran, our study is the first one. There are many different predisposing factors affected by VFFs. The significant ones which are extracted in our research are sex, age, marital status, education, Occupation, road type, crash location, transmission method, location of the body damage, Victim's status in the vehicle.

This study indicated that VFFs caused the death of young and middle-aged people. To prevent VFFs and promote car safety, the authors recommend equipping cars with fire extinguishers and other safety equipment, establishing speed management, enacting driving, manufacturing and vehicle importation laws, and construction of safe roads, identifying accident-prone areas, installing road warning signs at these points, improving access to fire and rescue services by establishing more roadside stations, and ensuring stricter police monitoring as well as improve sedan safety standards. Promotion of public awareness about the risks of speeding is also highly suggested.

Research limitations: The authors found information about the total number of RTIs in Kerman province. However, some details about some RTIs due to vehicle fire were missing. Also, it was difficult to access the data we needed for the study.

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References

1. Bazeli J, Aryankhesal A, Khorasani-Zavareh D. Epidemiology of special incidents: results from national mortality and morbidity registry and the associated factors in Iran in 2014. *Electronic physician*. 2017; 9(8):5113. <https://doi.org/10.19082/5113> PMID:28979750 PMCid:PMC5614300
2. Delshad V, Sabzalizadeh S, Moradian MJ, Safarpour H, Malekyan L, Shemshadi H, et al. Epidemiology of accidents in Tehran emergency medical service during 2012 to 2013. *Trauma Monthly*. 2018; 23(1). <https://doi.org/10.5812/traumamon.61871>
3. Al-Risi A. Characteristics of road traffic injuries and potential risk factors in Oman: University of Otago; 2014.
4. Khorrami Z, Nazari SSH, Ghadirzadeh MR. An Epidemiology study of deaths from road traffic accidents. *Safety Promotion and Injury Prevention*. 2017; 4(4):217-24.
5. Tavakoli M, Ghadipasha M, Forozesh M. Management of Road Accident Victims in Iran. *Journal of Orthopedic and Spine Trauma*. 2015; 1(1).
6. Viklund A, Bjornstig J, Larsson M, Bjornstig U. Car crash fatalities associated with fire in Sweden. *Traffic injury prevention*. 2013; 14(8):823-7. <https://doi.org/10.1080/15389588.2013.777956> PMID:24073770
7. Bunn T, Slavova S, Robertson M. Crash and burn? Vehicle, collision, and driver factors that influence motor vehicle collision fires. *Accident Analysis & Prevention*. 2012; 47:140-5. <https://doi.org/10.1016/j.aap.2011.10.008> PMID:22405242
8. Ahrens M. Trends and patterns of US fire loss. National Fire Protection Association (NFPA) report Google Scholar. 2017.
9. Topical Fire Report Series Highway Vehicle Fires (2014-2016):|FEMA, 2018.
10. Brushlinsky Nikolai, Ahrens Marty, Sokolov Sergei , Peter WI. world-fire-statistics Center of Fire Statistics: the State Fire Academy of Emercom of Russia; 2017 .
11. Kashani AT, Shariat-Mohaymany A, Ranjbari A. Analysis of factors associated with traffic injury severity on rural roads in Iran. *Journal of injury and violence research*. 2012; 4(1):36. <https://doi.org/10.5249/jivr.v4i1.67> PMID:21502788 PMCid:PMC3291279
12. Mahdieh Rad AL, Ansari-Moghaddam A, Mohammadi M, Rashedi F, Ghasemi A. The pattern of road traffic crashes in South East Iran. *Global journal of health science*. 2016; 8(9):149. <https://doi.org/10.5539/gjhs.v8n9p149> PMID:27157159 PMCid:PMC5064071
13. Taravatmanesh S, Hashemi-Nazari SS, Ghadirzadeh MR, Taravatmanesh L. Epidemiology of fatal traffic injuries in the Sistan and Baluchistan province in 2011. *Safety Promotion and Injury Prevention*. 2015; 3(3):161-8.
14. ILMO. Statistics deaths and injuries from traffic accidents in 1395(2016) Iranian legal medicine organization, 2018.
15. Vaghefi SS, Ghadipasha M, Kazemi ES, Ohadi AR, Zareenejad M. Analysis type of injury in collisions' deceased referred to legal medicine in Kerman province during 2007 versus 2013. 2016; 21(4):291-96.
16. Ghadirzadeh M, Shojaei A, Khademi A, Khodadoost M, Kandi M, Alaeddini F, et al. Status and Trend of Deaths Due to Traffic Accidents From 2001 to 2010 in Iran. *Iranian Journal of Epidemiology*. 2015; 11(2):13-22.
17. Azami-Aghdash S, Abolghasem Gorji H, Sadeghi-Bazargani H, Shabaninejad H. Epidemiology of Road Traffic Injuries in Iran: Based on the Data from Disaster Management Information System (DMIS) Of the Iranian Red Crescent. *Iran Red Crescent Med J*. 2017; 19(1). <https://doi.org/10.5812/ircmj.38743>
18. Rad M, Mirhaghi A, Shomoossi N. Self-assertiveness interfacing incivility in student nurses: Possible outcomes. *Nurse Education Today*. 2015; 35(10):e6. <https://doi.org/10.1016/j.nedt.2015.07.016> PMID:26242930
19. Balvardi M. The length of the highways of Kerman province kerman.mrud.ir 2017.
20. Kerman V. Desert Apitho. Kerman province map, 2014.
21. Haynes HJ. Fire loss in the United States during 2014: National Fire Protection Association. Fire Analysis and Research Division; 2015.
22. Moradi A, Rahmani K. Trend of traffic accidents and fatalities in iran over 20 years (1993-2013). *J Mazandaran Univ Med Sci*. 2014; 24(118):186-97.
23. Soroush D, Talebi DM, Reihani H, Vakili V, Mahmoodi GA, Tafakori A, et al. Characteristics of road traffic injuries in the second largest city of Iran. 2015.
24. Entezami N, Hashemi-Nazari SS, Soori H, Khosravi A, Ghadirzadeh MR. Epidemiology of fatal road traffic accidents in Northern provinces of Iran during 2009 to 2010. *Safety Promotion and Injury Prevention*. 2015; 3(1):1-8.
25. 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. *Bulletin of Emergency & Trauma*. 2018; 6(2):146. <https://doi.org/10.29252/beat-060209> PMID:29719846 PMCid:PMC5928272
26. Samadirad B, Khodadoost M, Sadeghi-Bazargani H, Shahedifar N, Heydari ST, Gholamzadeh S. Epidemiology of Fatal Traffic Injuries Registered in East Azerbaijan and Fars Forensic Medicine Organizations: The Research Protocol. *Journal of Clinical Research & Governance*. 2016; 5(1).
27. Davoodi F, Hashemi-Nazari SS, Ghadirzadeh MR. An Epidemiology study of road traffic accidents resulting in death: in Lorestan province in 2012. *Safety Promotion and Injury Prevention*. 2016; 3(4):257-62.
28. Ahanchi NS, Hashemi NSS, Hasani J, Shojaei A. An epidemiology study of fatal road traffic accidents in Isfahan province in 2011.
29. Hashemi Nazari SS, Ghadirzadeh M. An epidemiology study of fatal road traffic accidents in khorasan razavi province in 2011. *medical journal of mashhad university of medical sciences*. 2016; 59(4):261-8.
30. Masoud MP, Asayesh H, Hoseini MHM, Jodaki K, Bagheri MJ, Jamshidi M. Epidemiology of Road Accident Death in Qom Province, 2014 (Iran). *Qom Univ Med Sci J*. 2017; 8(11):94-100.
31. Ahadi MR, Pejmanzad P, Ardebili PB. The epidemiology of accident fatalities in Iran (8-year review). *Safety Promotion and Injury Prevention*. 2015; 2(4):329-38.
32. Khazaie S, Mohammadian Ha, Mohammadian M, Salehiniya H, Afshari M. An Epidemiologic Study Of Traffic Accidents On Iran Drivers In 2013.
33. Sanyang E, Peek-Asa C, Bass P, Young TL, Daffeh B, Fuortes LJ. Risk factors for road traffic injuries among different road users in the Gambia. *Journal of environmental and public health*. 2017; 2017. <https://doi.org/10.1155/2017/8612953> PMID:28512475 PMCid:PMC5420414
34. Perlman A, Radomislensky I, Peleg K, Group IT. Injury patterns among illegal migrants from Africa in Israel. *Journal of immigrant and minority health*. 2015; 17(4):1163-8. <https://doi.org/10.1007/s10903-014-0068-x> PMID:24972563
35. Sadeghi-Bazargani H, Ayubi E, Azami-Aghdash S, Abedi L, Zemestani A, Amanati L, et al. Epidemiological patterns of road traffic crashes during the last two decades in Iran: a review of the literature from 1996 to 2014. *Archives of trauma research*. 2016; 5(3). <https://doi.org/10.5812/atr.32985> PMID:27800461 PMCid:PMC5078874
36. Lietuvnikė M, Vasiliauskas AV, Vasilienė-Vasiliauskienė V, Sabaitytė J. Peculiarities of illegal migrant's intrusions into road freight transport units in the France-UK corridor. *Entrepreneurship and Sustainability Issues*. 2018; 5(3):634-47. [https://doi.org/10.9770/jesi.2018.5.3\(16\)](https://doi.org/10.9770/jesi.2018.5.3(16))

37. Abbasi M, Sadeghi M, Azami AA, Esmaeili SM, Kavousi J, Aryafard A. Factors related to road traffic accidents leading to injury or death in Shahroud City. *Safety Promotion and Injury Prevention*. 2016; 4(2):83-90.
38. Jägerbrand AK, Sjöbergh J. Effects of weather conditions, light conditions, and road lighting on vehicle speed. SpringerPlus. 2016; 5(1):505. <https://doi.org/10.1186/s40064-016-2124-6> PMID:27186469 PMCID:PMC4842190
39. Nabavi Niaki MS, Fu T, Saunier N, Miranda-Moreno LF, Amador L, Bruneau J-F. Road Lighting Effects on Bicycle and Pedestrian Accident Frequency: Case Study in Montreal, Quebec, Canada. *Transportation Research Record: Journal of the Transportation Research Board*. 2016(2555):86-94. <https://doi.org/10.3141/2555-12>
40. Bahadorimonfared A, Soori H, Mehrabi Y, Delpisheh A, Esmaili A, Salehi M, et al. Trends of Fatal Road Traffic Injuries in Iran (2004-2011). *PLOS ONE*. 2013; 8(5):e65198. <https://doi.org/10.1371/journal.pone.0065198> PMID:23724132 PMCID:PMC3665536
41. Corcoran J, Higgs G, Rohde D, Chhetri P. Investigating the association between weather conditions, calendar events and socio-economic patterns with trends in fire incidence: an Australian case study. *Journal of Geographical Systems*. 2011; 13(2):193-226. <https://doi.org/10.1007/s10109-009-0102-z>
42. Moghbeli K. Most of the road casualties in the Kerman province occur at the Kerman-Bam Road, 2017/12/18.
43. Tavakkoli L, Khanjani N. The pattern of road crashes emphasizing the factors involved in their occurrence in Kerman City 2012-2015. *Safety promotion and injury prevention (Tehran)*. 2016; 4(2):101-8.
44. Leffert MG. Effects of Wind Speed and Longitudinal Direction on Fire Patterns from a Vehicle Fire in a Compact Car. SAE Technical Paper; 2017:0148-7191. <https://doi.org/10.4271/2017-01-1353>
45. Perrels A, Votsis A, Nurmi V, Pili-Sihvola K. Weather conditions, weather information and car crashes. *ISPRS International Journal of Geo-Information*. 2015; 4(4):2681-703. <https://doi.org/10.3390/ijgi4042681>
46. Hamzeh B, Najafi F, Karamimatin B, Ahmadijouybari T, Salari A, Moradinazar M. Epidemiology of traffic crash mortality in west of Iran in a 9 year period. *Chinese journal of traumatology*. 2016; 19(2):70-4. <https://doi.org/10.1016/j.citee.2015.12.007> PMID:27140212 PMCID:PMC4897842
47. Katayama Y, Kitamura T, Kiyohara K, Iwami T, Kawamura T, Hayashida S, et al. Factors associated with prehospital death among traffic accident patients in Osaka City, Japan: A population-based study. *Traffic injury prevention*. 2018; 19(1):49-53. <https://doi.org/10.1080/15389588.2017.1347645> PMID:28658590