

# Patterns of Road Traffic Fatalities in the Six Most Populous Provinces of Iran, 2011–2015

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## Abstract

**Background:** The aim of this study was to compare the traffic safety condition as well as monthly pattern of fatalities in the six most populated provinces in Iran. **Materials and Methods:** This was a descriptive study. The data pertaining to fatalities and injuries during 2011–2015 were obtained from Iran Legal Medicine Organization. **Results:** Fatalities per 100,000 population in Kerman and Fars were significantly higher than the other four provinces, and Tehran had the lowest fatality rate per 100,000 population. To control for exposure, the number of fatalities per 100 injuries was calculated as an indicator of crash severity in the six provinces. The crashes were found to be more severe in Kerman (7.72 fatalities per 100 injuries) and Fars (5.97 fatalities per 100 injuries) compared to the other four provinces. Moreover, monthly pattern of fatalities was found to be significantly different among the six provinces. **Conclusion:** Results revealed several differences in the fatality patterns with the Kerman and Fars provinces having the most critical situation in the road safety among the six provinces. This could be due to the differences among these provinces in (1) quality and quantity of emergency and medical services, (2) road safety status, or (3) the share of vulnerable road user fatalities. Finally, our results suggest that to improve the efficiency and effectiveness of policies and countermeasure regarding traffic safety, policy-makers should consider the differences in the safety status and fatality patterns at provincial level.

**Keywords:** Fatalities per 100 injuries, monthly pattern, provincial fatality pattern, public health, road safety

## INTRODUCTION

Although many researches, each of which focuses on various groups of road users including motorcyclists,<sup>[1,2]</sup> pedestrians,<sup>[3]</sup> vehicle occupants,<sup>[4]</sup> and drivers,<sup>[5,6]</sup> have been conducted on the road safety domain, traffic crashes are still considered as a major public health problem all over the world.<sup>[7]</sup>

Road traffic crash (RTC) fatalities per 100,000 people in Iran were 22.1 in 1997 and increased to 40.5 in 2005; the highest rate among all the countries with reliable data.<sup>[8]</sup> Fortunately, road traffic fatalities have had a decreasing trend during the last decade in Iran. However, according to the Iran Legal Medicine Organization report, a total of 16,584 people died and 313,017

were injured due to RTCs in 2015 in Iran. Therefore, traffic crashes are still a leading cause of death in Iran.

Similar to other developing countries, Iran is experiencing rapid motorization as well as urbanization which could potentially increase road crashes and fatality risk.<sup>[9,10]</sup>

On the other hand, in terms of seasonal and monthly patterns, previous studies showed that seasonal and monthly variations might exist in the fatality trend of a region. In a study in

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Riyadh, capital of Saudi Arabia, seasonal variation in RTCs was evident being maximal during the summer season.<sup>[11]</sup> A study in the US found a systematic seasonal variation in the road fatality rate, with the highest rate in October and the lowest rate in March.<sup>[12]</sup> Another study showed that summer and fall months experience more crash deaths than winter and spring.<sup>[13]</sup> They attributed this variation to increased vehicular trips during summer and fall. Results of a study on the RTCs occurred in Iran between March 21, 2012, and March 21, 2013, revealed that summer and winter, respectively, have the highest and lowest rates of all RTCs.<sup>[14]</sup> They showed that the distribution of crashes by month had little variation, with the highest in August and June and the lowest in December. Variations in traffic crashes might be attributed to many factors, and the main factor is probably the different traveling patterns throughout the year. In addition, this trend might be different at the provincial level.

Mirzaei *et al.*<sup>[8]</sup> investigated the monthly trend in road traffic fatalities in Yazd, a central province of Iran, and showed that the differences in the number of deaths between seasons and months were statistically significant. They reported that road traffic deaths peak during the summer, especially in September. In addition, winter had the lowest frequency of traffic fatalities. A similar pattern was found in the studies conducted in other provinces of Iran.<sup>[15,16]</sup> They attributed this trend to an increased level of road travel by passenger vehicles in these periods. On the other hand, a study in Tehran, Iran,<sup>[17]</sup> reported the seasonal variation of traffic fatalities to be statistically insignificant.

A review of the literature reveals that although several studies have been previously conducted to examine the traffic crash fatality pattern in Iranian provinces and cities,<sup>[16,18,19]</sup> very few studies have focused on the differences that might exist among the fatality pattern of these provinces.

Descriptive analysis of road crashes and fatality patterns at national and subnational levels could be an effective tool for extracting the differences in the safety status of subnational regions and identifying those regions with the most critical safety condition. This, in turn, would help decision-makers to prioritize the safety policies to reduce traffic fatalities at the national level.

Thus, the aim of this study was to investigate the road fatality rates as well as monthly pattern of fatalities over a 5-year period across the six most populated provinces of Iran, to find similarities and dissimilarities among the safety status of these provinces.

## MATERIALS AND METHODS

This was a descriptive study that investigated road traffic deaths and injuries over a 5-year period. The study population consisted of those who died or injured due to road crashes in the six most populated provinces of Iran including Tehran, Isfahan, Fars, Khorasan Razavi, Khuzestan, and Kerman,

between March 2011 and March 2015 (which corresponds to 1390–1394 in Persian calendar).

The national- and provincial-level data pertaining to monthly fatalities and injuries of RTCs were obtained from Iran Legal Medicine Organization database. Every year, the total number of people died or injured in traffic crashes in each province of Iran is reported by the Iran Legal Medicine Organization. The dataset used in this study was complete, without any missing values. Since the data are aggregated in provincial scale, detailed information such as crash time, vehicle type, and mechanism of accident are not available in the dataset. In addition, the population information provided by the National Center of Statistics was used in the current study. It also should be noted that during 2011–2015, the population census was conducted only in 2011, and the population information for 2012–2015 was estimated and reported by the National Center of Statistics using regression models.

In international comparisons and for trend studies of traffic safety status on a national and subnational levels, the raw data of annual fatalities would not provide a real insight over the safety status of each region. It is more common to compare regions based on the fatality risk. As stated by,<sup>[20]</sup> traffic fatalities might be stated in terms of multiplication of exposure and risk.

Exposure is generally expressed in any form related to the amount of travel such as vehicle-kilometers traveled. Since the data on vehicle-kilometers are not easily obtained in macro level, some other measures such as population or number of registered vehicles have been considered as the available exposure variables.<sup>[21]</sup> In this regard, the number of fatalities per 100,000 population is a commonly used measure for evaluating the fatality risk and comparing the traffic safety among different regions (such as countries, provinces, and states).

On the other hand, the number of fatalities per 100 injuries can be considered as an appropriate proxy measure for comparing the severity of crashes among different regions. This measure has recently been used in traffic safety researches.<sup>[22]</sup>

Moreover, Chi-square d tests were employed to examine the statistical significance of the similarities and differences of monthly share of fatalities among the six provinces. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp, Released 2013.

## RESULTS

As stated in the previous section, the six provinces with the largest population were studied in the current work. Table 1 provides a general view over the population, total fatalities, and male/female ratio of fatalities across these six provinces. According to Table 1, Tehran has the largest population in Iran but received the third ranking based on traffic fatalities in 2015. Fars and Khorasan Razavi have the first and second rankings in the frequency of fatalities, respectively.

**Table 1: Population, traffic fatalities as well as male-to-female ratio of fatalities in the six provinces**

Province	Population in 2011	Fatalities in 2015			
		Total fatalities	Male	Female	Male/female ratio
Fars	4,596,658	1374	1082	292	3.7
Khorasan Razavi	5,994,402	1296	968	328	3.0
Tehran	12,183,391	1213	979	234	4.2
Isfahan	4,879,312	1104	859	245	3.5
Kerman	2,938,988	1009	761	284	2.7
Khouzestan	4,531,720	821	657	164	4.0

Further, among the six provinces, the male-to-female ratio of traffic fatalities is 4.2–1 in Tehran and 2.7–1 in Kerman, which are the highest and lowest ratios, respectively. In the following subsections, the fatality rates as well as the monthly pattern of fatalities are analyzed.

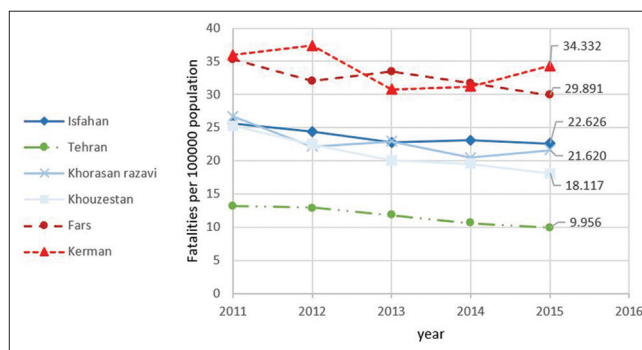
The variation of fatalities per 100,000 population for the six provinces during 2011–2015 is presented in Figure 1. According to this figure, fatalities per 100,000 population in Kerman (34.33 in 2015) and Fars (29.89 in 2015) are higher than the other four provinces. Furthermore, Tehran has the lowest number of fatalities per 100,000 population. In addition, although having a decreasing trend during the study period, the rates have increased for Kerman and Khorasan Razavi during the last year.

It should be noted that such indexes as fatalities per 100,000 population do not appropriately account for the differences in the exposure.

Assume two regions with equal populations. Region A attracts a large number of tourists and therefore has a considerably higher vehicle-kilometers compared to region B. Higher vehicle-kilometers could potentially increase the traffic crashes and fatalities. This would lead to an increase in the number of fatalities per 100,000 population for region A, compared to region B. However, this should not be considered as an indicator of the higher fatality risk in region A. In other words, one might argue that the higher fatalities per 100,000 population in Fars and Kerman are simply because of more crashes, which is a normal product of higher vehicle-kilometers driven in these provinces.

Therefore, since the data on vehicle-kilometers are not available, to control for exposure, we calculated the number of fatalities per 100 injuries as an indicator of crash severity in the six provinces. A larger number of fatalities per 100 injuries for a region would reasonably indicate higher severity of crashes in that region compared to other regions. The variation trend for the fatalities per 100 injuries in the six provinces during 2011–2015 is presented in Figure 2. This figure again confirms that Kerman (with 7.72 fatalities per 100 injuries) and Fars (with 5.97 fatalities per 100 injuries) have the most critical situation in the road safety among the six provinces.

In addition, the number of fatalities per 100 injuries has been steadily decreased in Tehran (3.28 in 2015) and is the lowest



**Figure 1:** The number of fatalities per 100,000 population for six provinces during the study period

among the six provinces. In contrast, this number has increased during the last 3 years for the Khorasan Razavi province.

### Monthly pattern of fatalities

Two Chi-squared tests were performed to assess the statistical significance of seasonal and monthly patterns of the fatality rates. Interestingly, both seasonal ( $\chi^2 = 116.2, P < 0.0001$ ) and monthly ( $\chi^2 = 82.1, P < 0.01$ ) variations of fatality rates among the six provinces were statistically significant. Figure 3 shows the monthly share of fatalities for Tehran and Isfahan. According to this figure, the monthly variation of fatalities in these two provinces is significantly similar, with both provinces having only one peak in their pattern. However, few differences are also observable. For the Isfahan province, Shahrivar (Farvardin, Ordibehesht, Khordad, Tir, Mordad, Shahrivar, Mehr, Aban, Azar, Dey, Bahman, and Isfand are names of months in Persian calendar which roughly corresponds to April, May, June, July, August, September, October, November, December, January, February, March, respectively) (11.6%), Mordad (9.5%), and Mehr (9.5%) have the highest share of annual fatalities. On the other hand, the share of these 3 months was more or less the same for Tehran province (approximately 10%). Furthermore, the lowest share of fatalities pertains to Dey, for both provinces.

Moreover, Fars and Khorasan Razavi are the other two provinces with similar monthly patterns. According to Figure 4, generally, the pattern of traffic fatalities in these provinces experienced three peaks including Shahrivar, Khordad, and Farvardin.

For Fars province, after Shahrivar with 11.2%, Farvardin and Khordad with 9.6% and 9.2% have the second and third highest

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shares of annual fatalities, respectively [Figure 4]. Similar to Fars, Khorasan Razavi experience d the highest share of annual fatalities in Shahrivar (12.4%). In addition, Mehr and Khordad have the second and third highest shares of annual fatalities in this province, respectively.

Furthermore, as shown in Figure 5, the patterns of monthly share of annual fatalities in Khouzestan and Kerman are similar to each other and significantly different from the other four provinces. In the Khouzestan province, the monthly pattern shows three peaks in Farvardin (11%), Mehr (8.7%), and Bahman (9.3%). Similar to Khouzestan, Kerman has three peaks in the fatalities in Farvardin (9.8%), Mehr (9.8%), and Bahman (8.4%).

In addition, for Khouzestan, the 1<sup>st</sup> month of summer (Tir, with 7.0%) and winter (Dey, with 6.4%) has the lowest share of fatalities. For Kerman, the last months of spring (Khordad with 7.2%) and autumn (Azar with 7.1%) have the lowest share of fatalities.

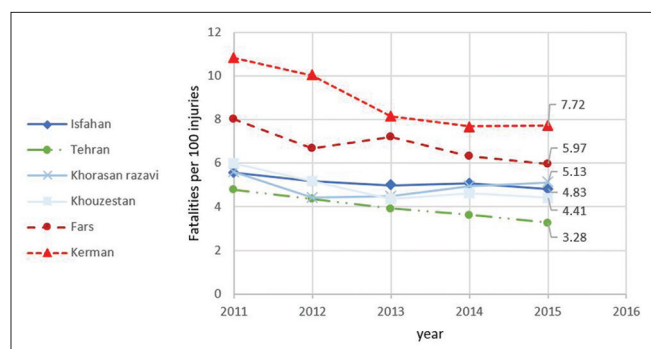
## DISCUSSION AND CONCLUSION

In the present study, males were found to be more commonly involved in fatal crashes in all the six provinces, with the highest male-to-female fatality ratio being related to Tehran (4.2:1) and Khouzestan (4:1). These ratios are somewhat similar to the findings of previous studies in Iran. For instance, results of a study on road fatalities in Yazd province showed that male/female fatality ratio was between 5.26 and 3.56 during 2004–2010.<sup>[8]</sup> In another study, accident-related deaths in Tehran during 2000–2001, male-to-female ratio was reported to be 4.1–1.<sup>[17]</sup>

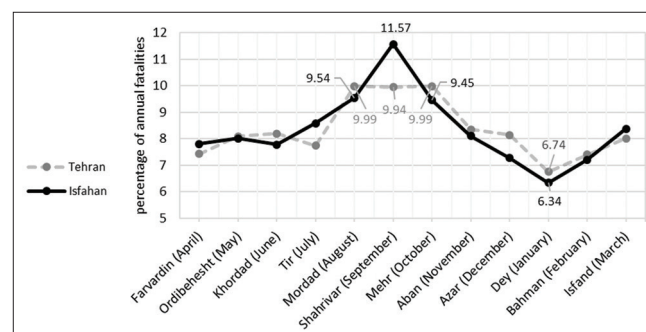
The number of fatalities per 100,000 population indicated that Fars and Kerman have the most critical safety status among the six provinces. Furthermore, the number of fatalities per 100 injuries was calculated for each province to identify those provinces with more severe crashes. Tehran had the lowest and Kerman and Fars had the highest number of fatalities per 100 injuries compared to the other provinces. A higher number of fatalities per 100 injuries in these provinces could be attributed to the following issues:

1. Lower quality or quantity of emergency and medical services in these provinces. To examine this issue, three cases in different provinces need to be investigated: (1) the number of people died at the crash scene, (2) the number of people died while transferring to hospital, and (3) the number of people died in hospital.
2. Unsafe roads in these provinces which could lead to more severe crashes
3. Higher rate of pedestrian and motorcycle crashes. Previous studies have indicated that pedestrians and motorcyclists' crashes are more severe than other types of crashes, especially in the presence of heavy vehicles and on rural roads.<sup>[1,3,23]</sup> Therefore, the difference in fatalities per 100 injuries of the six provinces may be due to the difference in pedestrian and motorcycle crash rates as well as higher presences of heavy vehicles on the roads of these provinces.

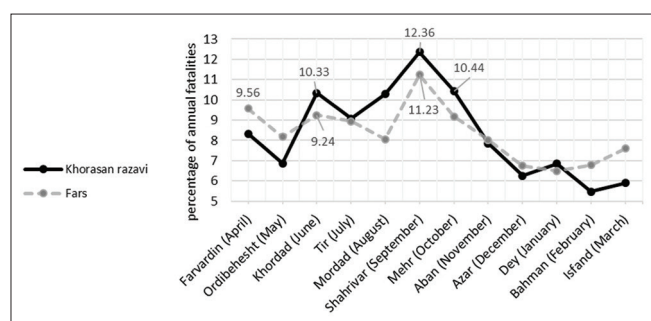
The number of fatalities per 100 injuries has not been previously analyzed across provinces of Iran. Investigating



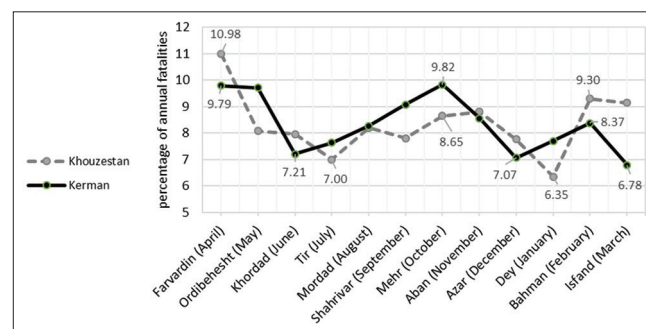
**Figure 2:** The number of fatalities per 100 injuries for six provinces during the study period



**Figure 3:** Monthly pattern of fatalities in Tehran and Isfahan provinces



**Figure 4:** Monthly pattern of fatalities in Khorasan Razavi and Fars provinces



**Figure 5:** Monthly pattern of fatalities for Khouzestan and Kerman provinces



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each of the above three issues in future studies might reveal the cause of differences in the number of fatalities per 100 injuries in these provinces.

Results of the current study also confirmed that the share of each month from the annual traffic fatalities is significantly different among the six provinces.

Results imply that for such provinces as Fars and Khorasan Razavi with historical and religious tourist attractive sites, higher share of traffic fatalities occurred in those months that pertain to the New Year's holidays and summer times. Variations in traffic crashes and fatalities might be attributed to many factors, and the main factor is probably the different traveling patterns throughout the year. This pattern is similar to the results of the study conducted by Farmer and Williams,<sup>[13]</sup> where they found that more traffic fatalities may occur during summer. This is also in line with results of previous studies in Yazd,<sup>[8]</sup> Fars,<sup>[16]</sup> and Isfahan<sup>[17]</sup> provinces which showed that traffic fatalities have the highest frequencies in summer and lowest in winter months.

In addition, Kerman and Khouzestan showed a specific pattern in the monthly share of fatalities with the highest shares occurring in the 1<sup>st</sup> month of spring and autumn. Since these provinces are located in Southern Iran with hot weather, this specific monthly pattern of fatalities could be attributed to the climatic condition of these provinces.

In summary, results of the current study revealed several differences in the patterns of traffic fatalities among the six provinces of Iran. These differences raise the need for more province-specific traffic safety policies to improve the effectiveness of these policies.

### Limitations

This is a preliminary study with descriptive analysis on limited aggregate province-level data. More in-depth analyses with further information about crash-related variables such as length of roads, safety measures, and policies adopted in each province of Iran, and postcrash response capabilities of provinces, can enrich the results. Furthermore, the data related to total roads or vehicles within provinces would provide more insight about provincial road safety. However, the authors were not able to retrieve these data.

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### Conflicts of interest

There are no conflicts of interest.

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