



# Time Series Analysis of Mortalities Resulting from Car Accidents in Injured Individuals Hospitalized in Shiraz Shahid Rajaei Hospital During 2010 - 2016

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Received 2016 November 01; Revised 2017 February 11; Accepted 2017 March 08.

## Abstract

**Background:** Traffic events are among the greatest health problems which are ignored among other health issues. The treatments related to these events can involve individuals for a long period of time.

**Objectives:** This study aimed to predict the mortality resulting from car accidents in injured individuals referring to Shiraz Shahid Rajaei hospital.

**Methods:** This study was conducted on all the patients hospitalized in Shahid Rajaei hospital due to traffic events during 2010 to 2016. The best models of various instruments including auto correlation function (ACF), partial auto correlation function (PACF), and Akaike information criterion (AIC) statistics were used for identification and fitting. Moreover, normality and statistics were taken into consideration in order to determine the validation of residual diagram's pattern. Then, the best model was selected and analyzed using ITSM, SPSS 19, and Excel software.

**Results:** Mortality followed an ascending trend in this study. Among male patients, mortality trend was relatively fixed, but showed an increasing slope in some months of the year. However, this trend increased continuously in females. Considering different age groups, mortality followed a relatively fixed trend in below-30-year-old individuals, an increasing trend among the individuals between 30 and 45 years of age, and a steeper slope among above-45-year-old ones. Moreover, the prediction models indicated that the majority of the accidents had taken place during spring and summer.

**Conclusions:** The mortality resulting from car accidents followed an increasing trend. This can be attributed to the increasing number of cars in Shiraz, economic changes in Iran, and the country's movement towards development which lead to a decrease in motorcycle events and an increase in the car accidents. Moreover, the majority of accidents leading to death had taken place in May and September. This can be related to tourist attraction of this province during these months.

**Keywords:** Time Series, Mortality, Shiraz, Car Accidents, Shahid Rajaei Hospital

## 1. Background

Injuries caused by road traffic are unforeseen. At least one vehicle is involved in an accident (1). Nowadays road traffic injuries (RTIs) are a major public health challenge (2). Overall, road traffic accident is the leading cause of death, disability, and hospitalization accounting for a huge economic burden of about 1% to 5% of GDP of the countries (3). In this regard, the annual fatality rate caused by RTIs is 18 cases per 100 000 in the world with the highest level being due to middle-income countries which is 20.1 per 100 000 (4). The annual incidence of road traffic accidents in Iran is 32 per 100 000 people, being the second cause of mortality and the first cause of the loss of the years of life due to premature death and the most common cause of injury (5). The pattern of the mortality

in traffic accidents is not the same in developed countries and developing countries (6). A total of 90% of road traffic deaths occur in low-income and middle-income countries. These countries have 82% of the world's population and only have 54% of the world's registered vehicles (7, 8). Statistics have shown that 30% to 40% of the deaths and injuries in accidents are due to unauthorized speed in Iran (9). Road accidents are the most common cause of death in young people in industrialized countries; also in developing countries 65% of deaths and 90% of disabilities are due to this problem (10).

According to what was mentioned above, Iran does not have an appropriate condition regarding road accidents. In addition, the youths comprise the great section of Iran's age pyramid. Therefore, a comprehensive program should be designed so as to decrease the problems related to traf-

fic events in the future. In order to provide an appropriate program, the future should be predicted according to the past experiences. In doing so, various ways of prediction can be used, one of which being time series model (11).

## 2. Objectives

By using time series method, the present study aims to determine the trend of deaths resulting from traffic events in Shiraz and introduce an appropriate model of prediction so as to provide more efficient programs in future.

## 3. Methods

In this ecological study, the required information was extracted from the cases recorded in the hospital information system (HIS) of Shiraz Shahid Rajaee hospital. This hospital is the main and the greatest trauma center for traumatic patients in Fars province, south of Iran. All the injured patients above 13 years of age who were hospitalized in this hospital during 2010 to 2016 were enrolled in the study. On the other hand, the patients undergoing surgery (except for emergent trauma interventions) and those who were admitted for complications of previous trauma surgeries were excluded from the study.

The required data were extracted from the HIS and a checklist including demographic information (age and gender), duration of hospitalization, time of death, and damage results (improved or dead). Then, the car passengers' mortality data were divided monthly based on gender and age group (below 30, 30 to 45, and above 45 years old) and an appropriate prediction model was selected for each group.

The study data were analyzed using time series model. By considering monthly time intervals, 72 months from January 2010 to March 2016 were accounted for the time series model and the prediction was made from March 2016 to March 2017. First of all, the data were entered into the Excel software. Then, the veracity of information was checked and the incomplete ones were corrected by referring to the patients' medical records. Subsequently, time series analysis was used to analyze the data. Data analysis was conducted using the ITSM software at the significance level of 0.05.

## 4. Results

During 2010 to 2016, a total of 51 942 traffic events were recorded in Shiraz Shahid Rajaee hospital the majority of which were related to car passengers ( $n = 30\ 520$ , 58.8%). The mean age of the car passengers was  $33.51 \pm 15.19$  years;

$32.57 \pm 14.93$  years in males and  $35.62 \pm 15.55$  years in females. Besides, males were more involved in traffic events compared to females ( $n = 21\ 068$ , 69% vs.  $9\ 452$ , 31%). Additionally, the mortality rate in the males above 45 years old was higher than that in females and this difference was statistically significant ( $P < 0.001$ ).

The prediction of deaths resulting from car accidents has been presented in Figure 1. Accordingly, the mortalities caused by car accidents followed an increasing trend. The auto regressive integrated moving average (ARIMA) model with  $AR = 4$ ,  $MA = 1$ , and Akaike information criterion statistics (AIC) = 125 was used for the prediction of mortalities caused by car accidents (1, 1, 4).

The prediction of deaths resulting from car accidents in males and females has been presented in Figure 2. Accordingly, mortality followed an ascending trend in both males and females. In order to predict the mortality resulting from car accidents, the ARIMA model was used which showed  $AR = 1$ ,  $MA = 11$ , and  $AIC = 236$  for males (1, 1, 11), and  $AR = 6$ ,  $MA = 1$ , and  $AIC = 284$  for females (1, 1, 6).

As Figure 2 depicts, the mortality rate was higher in males compared to females in the most months of the year. However, with the increase in the number of women, this rate will probably be equal in males and females in the near future.

The prediction of deaths resulting from car accidents based on age groups (below 30, 30 to 45, and above 45 years) has been presented in Figure 3. Accordingly, mortality had a relatively fixed trend in the individuals below 30 years of age, an increasing trend in the individuals between 30 and 45 years old, and a steeper slope in those above 45 years of age. In order to predict the age groups, the ARIMA model was used, which showed  $AR = 2$ ,  $MA = 1$ , and  $AIC = 278$  for below-30-year-old individuals (1, 1, 2),  $AR = 10$ ,  $MA = 0$ , and  $AIC = 380$  for those between 30 and 45 years old (0, 1, 10), and  $AR = 5$ ,  $MA = 2$ , and  $AIC = 260$  for those above 45 years of age (2, 1, 5).

Various models' coefficients for fitting and predicting by the use of ARIMA model have been presented in Table 1. Generally, in the prediction models, if the values of AIC get closer to zero, they indicate better fitness for prediction. In the current study, after several fittings, the lowest values were taken into consideration.

## 5. Discussion

This study was conducted on the data of car accident deaths in the injured individuals referring to Shiraz Shahid Rajaee hospital (the main trauma center in Shiraz) for six years with a monthly pattern from January 2010 to March 2016. The study aimed to predict the trend of mortality

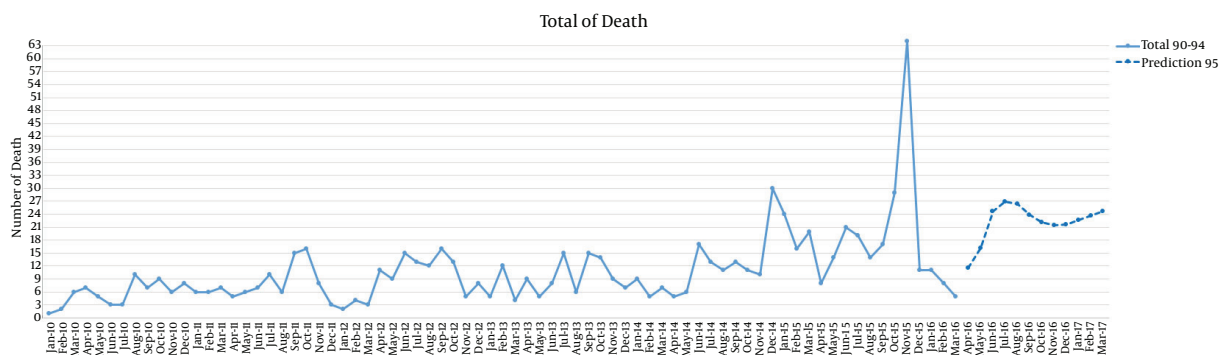


Figure 1. Total of Death

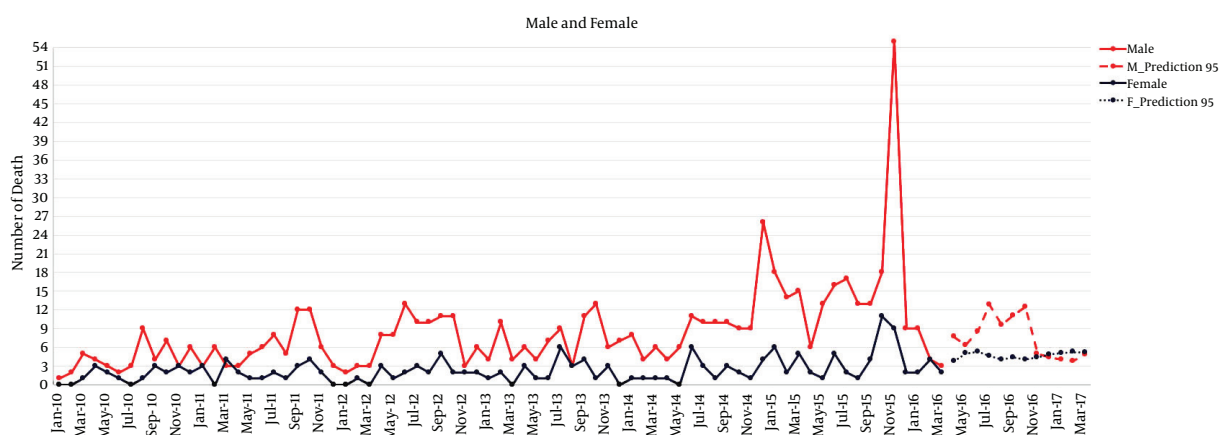


Figure 2. Male and Female

Table 1. Related Coefficients of Car Accident Fatality

	Total Mortality	Total Male Mortality	Total Female Mortality	Mortality in Below-30-Year-old Individuals	Mortality in 30-45-Year-Old Individuals	Mortality in Above 45-Year-Old Individuals
BOX COX	0.4	0.3	0.4	0.4	0.6	0.7
AR	4	1	6	2	10	5
MA	1	11	1	1	0	2
AIC	0.125901E + 03	0.227638E + 03	0.284664E + 03	0.278016E + 03	0.380297E + 03	0.260059E + 03

Abbreviations: AIC, akaike information criterion; AR, autoregressive; BOX COX, stationery used for variance; MA: moving average.

based on age and gender. The obtained results are as follows

Deaths resulting from road accidents followed an increasing trend in this study. One of the reasons for such an increase might be the countless number of vehicles in the country, especially in Fars province, in the recent years. Subsequently, with the increase in the number of cars and vehicles, more dangerous events will inevitably take place.

Another reason can be related to economic changes in Iran which are pushing the country towards development and industrialization. Therefore, deaths resulting from car accidents take place more than those caused by motorcycles. McDonald, also, reported that the most important deaths resulting from accidents were caused by motorcycles in developing countries, but by cars in the developed ones (12, 13).

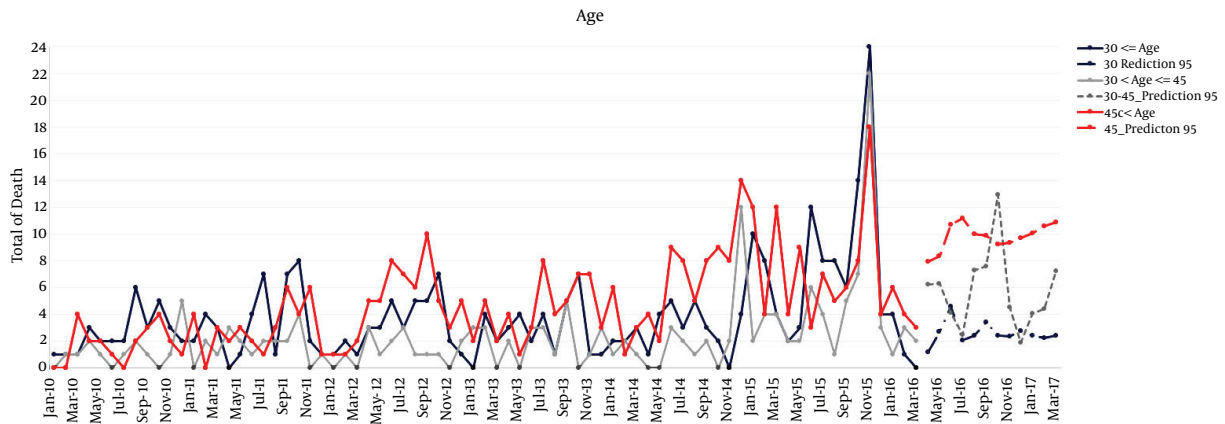


Figure 3. Age Group

The findings of the present study demonstrated that death had a fixed trend, but increased in some months of the year in males. However, this trend increased with a steeper slope in females. This finding is in agreement with the results of some other studies (14). The most important reasons for this increasing trend in females can be related to women’s jobs and activities in the society in comparison to the past years, their inclination towards driving, and having a personal car (15, 16). However, the rate of deaths resulting from car accidents was higher in males compared to females, which corresponds with the results of other studies conducted in Iran and other countries (17-19). Such differences can be attributed to men’s risky driving styles, high-risk behaviors while driving, and paying less attention to the driving signs (20). Another reason might be the greater number of male drivers in Iran as well as in some other countries. According to the statistics related to the 80s, the number of deaths in males was four times as high as that in females (21, 22). In Thailand, also, the number of deaths and injuries resulting from car accidents was four or five times higher in males in comparison to females (23-25).

One of the most important points of this study, which is consistent with the findings of the previous studies, was the increasing trend of mortality in females. This increasing trend can decrease the difference between men and women in future and the two groups would be equal with regard to the deaths resulting from road accidents.

In the current study, the trend of death was relatively fixed in below-30-year-old individuals, increasing in the individuals between 30 and 45 years old, and increasing with a steeper slope in those above 45 years of age. One of the reasons for the increasing trend in the individuals above 45 years old is the occurrence of less high-risk behaviors in

comparison to those below 30 years of age. This leads to a decrease in this group’s death in the accident scene and the increase in their death in the hospital. It can also be attributed to this group’s use of cars more than usual, low safety of their cars, and inadequate driving skills in these ages.

The prediction diagrams for males and females of various ages in our study indicated an increasing trend in mortality in spring especially May and summer especially September. This can mainly result from various tourist attractions and nice weather of this province in different seasons of the year and political, economic, or important structural situations located there. Furthermore, Fars province, especially in Shiraz, has a heavy traffic that may in turn increase problems, such as road accidents, leading to an increase in the individuals’ death. Another reason for the increase in mortality can be related to the distance traversed by cars which leads to a high traffic volume (26, 27).

5.1. Strengths and Limitations of the Study

The large sample size was the most important strong point of the present study which resulted in better model fitting and more precise prediction of the accident trends. Another strong point was determining the process and prediction of the data inside the hospital. In contrast, just emergency deaths were taken into account in the previous studies. On the other hand, the main weak point of this study was using the recorded data which had a lot of missing information. In order to eliminate these problems, complementary information was collected by returning to the patients’ records. Another weak point of the study was the lack of follow-up information about the patients after their discharge from the hospital. In general, deaths taking place 30 days after discharge from the hospital are known

as inside-hospital deaths. However, due to the lack of programs for following and monitoring the patients after discharge in this study, they were not taken into account.

## 5.2. Conclusion

Fitting various models of time series, the results indicated that ARIMA model could provide an appropriate prediction of future accidents. Besides, monthly pattern was the best time process for prediction. Due to the increasing trend of the mortality in traffic accidents, duration of hospitalization, and the number of recorded accidents, especially during summer holidays, traffic events have to be decreased in the society by enforcing driving laws among people, increasing the number of hospital personnel during holidays, increasing the number of beds in trauma hospitals, and increasing cooperation among all organizations. Furthermore, the majority of driving injuries resulting from accidents took place among the youth, creating physical and mental problems for them as well as their families. Thus, strategies have to be proposed to decrease these events in this age group. To do so, the following measures can be implemented: training drivers to obey traffic laws such as fastening seatbelt, improving the safety of personal vehicles, and enhancing drivers' driving knowledge and culture.

## Acknowledgments

The present article was extracted from a thesis written by Mahmood Hajipour and was financially supported by Shiraz University of Medical Sciences (grant 93-01-38-7858). Hereby, the authors would like to thank Ms. A. Keivanshekuh at the research improvement center of Shiraz University of Medical Sciences for improving the use of English in the manuscript.

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