Survey of accidents in suburban Tehran and the prediction of future events based on a time-series model

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Abstract:
Background: Car accidents are currently a social issue globally because they result in the deaths of many people. The aim of this study was to examine traffic accidents in suburban Tehran and forecast the number of future accidents using a time-series model.
Methods: The sample population of this cross-sectional study was all traffic accidents that caused death and physical injuries in suburban Tehran in 2010 and 2011, as registered by the Tehran Emergency Section. In the present study, Minitab 15 software was used to provide a description of traffic accidents in suburban Tehran for the specified time period as well as those that occurred during April 2012.
Results: The results indicated that the average number of traffic accidents in suburban Tehran per day in 2010 was 7.91 with a standard deviation of 7.70. This figure for 2011 was 6 daily traffic accidents with a standard deviation of 5.30. A one-way analysis of variance indicated that the average of traffic accidents in suburban Tehran was different for different months of the year (P = 0.000). The study results showed that different seasons in 2010 and 2011 had significantly different numbers of traffic accidents (P < 0.05). Through an auto-regressive moving average (ARMA), it was predicted that there would be 166 traffic accidents in April 2012 with a mean of 5.53 and maximum of 6 traffic accidents/day.
Conclusion: There has been a decreasing trend in the average number of traffic accidents per day.

Keywords: traffic accidents, death, injuries, predictions

1. Introduction
Each day, about 16,000 people around the world lose their lives due to a variety of injuries and wounds. Damages and injuries form 12% of the total burden of diseases, and they are considered to be the third most common cause of death. In the age range of 1-40, they are the most common cause of death (1). Such injuries occur mainly in traffic accidents, and, according to World Health Organization (WHO) data, deaths due to traffic accidents account for about 25% of all deaths due to injuries (1). The number of vehicles is Iran continues to increase, which, inevitably, leads to increases in the number of traffic accidents and in the resulting damages. The WHO's statistics show that Iran has one of the highest mortality rates caused by traffic accidents in the world, so such accidents are considered as the main cause of death in people under 40, and they are the second leading cause of death among the entire population (2). Overall, 2.5% of all traffic accidents in the world occur in Iran, while only 1.04% of the world's population lives in Iran (3). The purpose of this study was to study the number of traffic accidents in suburban Tehran in 2010 and 2011 and to predict the number of traffic accidents in the coming months based on a time-series forecasting model.

2. Materials and Methods
This was a cross-sectional, analytical study that was conducted in Tehran in 2011. Tehran, Iran's capital and most populous city has a population of more than eight million people (4). The statistical population that was studied included all accidents in suburban Tehran that resulted in injuries from April 2010 through March 2011and were recorded in the central EMS in Tehran. Data were collected from checklists of statistical data that were provided in a staged manner to the authors of this paper by the authorities in the EMS. After coordination with the relevant authorities in the Central Emergency Tehran over a 20-day period, the EMS authorities provided the checklists that were used by those responsible for this research.

To safeguard the confidentiality of the information concerning the people involved in the accidents and due to the related ethical considerations, all data collected in this study were gathered in coordination with and under the observation of the Tehran University of Medical Sciences and the Central Emergency authorities. After the data were analyzed, a copy of all of the statistical analyses was sent to the Central Emergency officials. After the data were entered into Minitab Statistical Software version 15, they were studied and analyzed using descriptive statistics, Tukey's multiple comparison test, the one-way ANOVA test, the t-test, the Leven test, trend analysis time series, and Autoregressive Moving Average (ARMA).

3. Results
The average of daily traffic accidents in suburban Tehran in 2010 was approximately 8 with standard deviation of 7.7. The average for 2011 was approximately 6 with a standard deviation of 5.3. On average for the two years, about 7 accidents were reported daily in suburban Tehran.

Table 1. Prediction of the number of traffic accidents in suburban Tehran in April 2012

Day	upper limit	lower limit	Mean	Day	upper limit	lower limit	Mean
1	15.89	-3.65	6	16	18.60	-7.68	5
2	16.55	-6.15	5	17	18.32	-8.05	5
3	17.12	-7.23	5	18	18.83	-7.62	6
4	18.50	-6.60	6	19	19.000	-7.54	6
5	18.87	-6.52	6	20	19.03	-7.54	6
6	18.49	-7.97	6	21	18.58	-8.04	5
7	17.72	-7.85	5	22	18.73	-7.95	5
8	18.16	-7.55	5	23	18.90	-7.89	6
9	18.73	-7.13	6	24	19.22	-7.61	6
10	19.05	-6.86	6	25	18.93	-7.96	5
11	18.37	-7.58	5	26	18.88	-8.05	5
12	18.19	-7.80	5	27	18.83	-8.20	5
13	18.39	-7.74	5	28	19.22	-7.87	6
14	19.05	-7.15	6	29	19.16	-8.00	6
15	18.86	-7.39	6	30	19.16	-8.04	6

Using the one-way ANOVA test, it was shown that the mean of accidents in suburban Tehran was different in different months of the year (P = 0.000). In 2010, most of the accidents occurred in the months of September, October, and December, while, 2011, most of the accidents occurred in April and May. The results of the study showed that the accident rates were significantly different in different seasons in 2010 and 2011 (P < 0.05). The findings of this study demonstrated that, with the exception of the spring quarter, there were fewer accidents in 2011 than in 2010.

In the spring quarter of 2011, there were more accidents than there were in this quarter in 2010. Assuming homogeneity of variance with the Leven test, the independent t-test showed that the decreased daily average number of accidents in 2011 was statistically significant. Using the ARMA model, the number of traffic accidents in suburban Tehran was predicted for April 2012, and the results are shown in Table 1 and Figure 1. Due to the results of the time-series analyses, we concluded that no component of the seasonal trend was observed in the series. But the series had a trend component, and the number of daily accidents had a decreasing trend from 2010 to 2011.
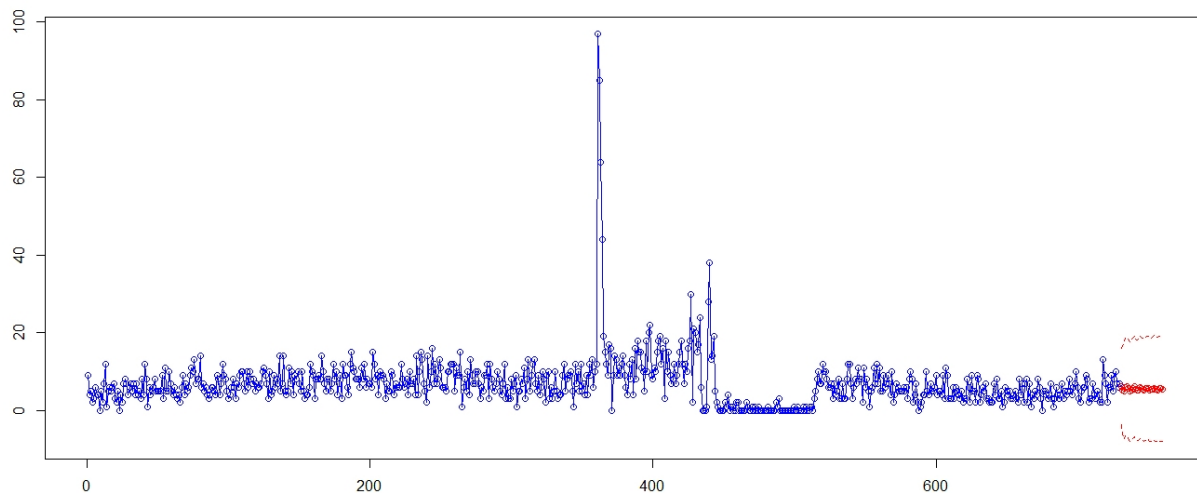

Figure 1. Prediction of the number of traffic accidents in suburban Tehran in April 2012 at the 95% significance level

4. Discussion

The aim of this study was to use statistical data related to traffic accidents in suburban Tehran in 2010 and 2011 to predict the daily rate of accidents in this area in the future. A time-series model was used to predict the daily rate of accidents in the future. Using time-series analysis, we determined the relationship between successive observations during the period of the study and estimated the number of traffic accidents at future time, i.e., April 2012. The results showed that, from April 1, 2010, through March 31, 2011, the maximum number of traffic accidents reported on a single day was 97, which was consistent with March 25, 2010, on the observed time-series graphs. In a study conducted by Afshari Azad on traffic accidents in Rasht-Anzali Port, it was found that most crashes in 2002 and 2005 occurred due to inclement weather conditions in the cold and rainy days of the year (5). It appears that the results of the different studies were not consistent. However, the accident rate reported in the present study is an alarmingly high figure, and it is recommended that the relevant authorities take necessary actions to reduce the accident rate.

The results showed that the averages of suburban traffic accidents are different in different months of the year. In a study by Farajzadeh Asl et al., it was reported that most traffic accidents occurred in June, July, and August, which accounted for more than 28% of the annual total (6). The differences in the rates of accidents in different months of the year may be due to different volumes of traffic and/or slippery roads due to inclement weather in some months. The study results showed that the traffic accident rates were significantly different in different seasons in 2010 and 2011; however, no seasonal trend was observed in the increased number of accidents. In a study in Isfahan in 1997, more accidents occurred in the summer and fall, which had 28.7% and 25.8% of the annual total, respectively (7). Differences in accident rates in different seasons of the year can be due to different volumes of traffic and/or roads being slippery due to inclement weather conditions in some seasons. The results showed that the number of

accidents is related to the day of the week and that the rate declined from 2010 to 2011. In a study by Zahed et al., which was conducted with different analytical methods from those used in this study, it was found that the number of people killed in traffic accidents in Iran has increased at the rate of 8.44% annually from 1994 to 2002. However, the rate of increase was 10% annually from 1999 through 2003 (8). It was somewhat encouraging to note that, in contrast to Zahed et al.'s study, our study showed that the accident rate in suburban Tehran decreased from 2010 to 2011.

5. Conclusions

The findings of this study showed that the months of April, June, and October and the spring quarter were the most eventful months and season of the year, respectively, relative to traffic accidents in suburban Tehran. Establishing principles and regulations to reduce truck traffic in high-risk ports in the rainy seasons can be very instrumental in reducing accidents. Also, social and cultural education aimed at reducing the rate of accidents, particularly in eventful months and seasons, is recommended.

Conflict of Interest:
There is no conflict of interest to be declared.

Authors' contributions:
All of authors contributed to this project and article equally. All authors read and approved the final manuscript.

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