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Original Article

Analysis of trends and seasonal changes in accident cases referred to the emergency medical center of Urmia city

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Abstract

***Background & Aims*:** The fluctuation in accident-related visits to the emergency department presents a significant challenge, as the department strives to provide quality services to this group of patients. This study aims to explore the trends and seasonal variations in accidents resulting in visits to the emergency department in Urmia city.

***Materials & Methods*:** This cross-sectional study includes data from the emergency department of Urmia city collected from the beginning of 1398 (2019) to mid-1403 (2024). All visits related to accidents during this period were considered. The collected data were analyzed using MINITAB and SPSS softwares.

***Results*:** The average number of accident-related visits to Urmia emergency department per month was 14467 ± 91557, showing an upward trend and seasonal fluctuations across 67 months. The results were statistically significant ($p < 0.05$).

***Conclusion*:** Our study indicates that the volume of accident-related visits to the emergency department increases in the spring-summer period and decreases during the fall-winter period. This trend has been rising steadily over the years, with no disruption, even during the COVID-19 pandemic.

***Keywords*:** Accidents, Emergency medical services, Seasonal changes, Time series, Trend

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Introduction

The health information management system is a network of interconnected components designed to register, collect, store, retrieve, and distribute information that supports the healthcare system, activities, and facilitates planning, coordination, and decision-making (clinical and managerial). Its optimal performance is vital for the advancement of individual and public health, the evaluation of services, planning, and research across various stages (1).

Given the importance of timely information for decision-making and the formulation of appropriate

treatment plans for patients, a key question arises: How does the information management system operate in critical settings like the emergency department, which handles life-or-death situations, particularly in cases of road traffic accidents, to effectively and promptly meet the informational needs of the medical staff in these high-pressure environments (2)?

Initial research has shown that health information management in emergency departments is often suboptimal and lacks coordination, with no clear oversight on how patient information is recorded. While the significance of this information in clinical decision-making, service effectiveness assessment, strategic planning, executing administrative decisions, and advancing research cannot be overstated, it is crucial to maintain comprehensive patient files, especially in legal cases, where they act as vital evidence in court. Moreover, considering the urgent nature of patient care and the critical condition of many patients, it is essential to establish clear guidelines for the collection, registration, storage, retrieval, analysis, and dissemination of information in hospitals. This will enable both medical and administrative staff to align with the hospital's core objectives, such as providing adequate and well-equipped spaces, completing the healthcare team, ensuring medical equipment availability, and managing the flow and nature of visits to the emergency department (3-6).

The emergency and accident department plays a critical role in the evaluation and treatment of urgent patients. In the United Kingdom, for example, an average of 92.5 visits per 100 patients is registered in the emergency department of each hospital within a 4-hour window. Without structured planning, such a high volume of visits cannot be adequately serviced. This situation is globally common. The challenges posed by an aging population and the shortage of specialized human resources to address incoming patients make studying trends in emergency department visit fluctuations even more essential (7-8).

The rise in vehicle traffic has contributed to an increase in road traffic accident-related visits to emergency departments worldwide, particularly in Iran. This situation necessitates urgent action to ensure that emergency medical services are sufficient and that hospital emergency departments are fully equipped (9).

In Saudi Arabia, for instance, 37127 traffic accidents were reported in 1991, leading to 3232 fatalities and 25516 injuries, with many patients visiting emergency departments. Time series models were used to analyze trends and seasonal changes, providing valuable insights into the increasing or decreasing nature of these incidents. This analysis could help improve safety and inform the development of management plans (10). Subsequent studies in Saudi Arabia revealed that traffic accidents continue to be one of the leading causes of emergency department visits, and despite safety measures, the increasing trend remains unmanageable (11).

Since emergency specialists are the first point of medical service after patients visit emergency departments in educational and healthcare centers, understanding the rising number and volume of visits related to accident victims can significantly aid in equipping and expanding specialized personnel for this demanding role. Therefore, this study aims to examine the trend of road traffic accident-related visits to the emergency department in Urmia city. Additionally, the study will analyze the trend type and seasonal fluctuations, particularly focusing on accident-related incidents that have a substantial impact and volume. These findings will offer clearer insights for managerial decisions, facilitating appropriate policy-making for the equipping and staffing of the hospital's emergency department.

Materials & Methods

This study is a cross-sectional evaluation. Data on all accident-related visitors were collected by Urmia’s 115 emergency service from the beginning of Farvardin 1398 (March 2019) to the end of Mehr 1403 (October 2024). The physical files of all visits to the emergency department during this period were reviewed, and individuals with accident-related incidents were included in the study. Files with incomplete information, where the cause of the visit could not be identified, were

excluded. Information regarding the time and cause of the patient's visit to the emergency department was extracted from the classified files.

After data collection, the number of visits per month was recorded and entered into statistical software. Once the data was entered, the trends for each variable under study were assessed using ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function) charts. Based on this, the presence of a trend or seasonal variation was determined, and an appropriate model from the ARIMA family was selected. The initial model selection was guided by the behavior of the ACF and PACF charts. Following this, the goodness of fit was assessed, and the AIC criterion was used to select the best model. The data were analyzed using specialized statistical software, and the results were presented through descriptive statistics in the form of charts and tables. Additionally, time series models were used for inferential statistics, which were carried out using SPSS version 22 and MINITAB version 16.

Results

The present study, conducted over a span of 67 months from the beginning of Farvardin 1398 (March 2019) to the end of Mehr 1403 (October 2024), revealed that the average number of accident-related visits to the Urmia emergency department per month was 1557.9 ± 467.14 (Table 1).

Table 1. Average, minimum, and maximum number of accident-related visits to the emergency department

Type of accident	Mean	Standard deviation	Minimum	Maximum
Traffic accidents	1557.9	467.14	720	2636

Assume that the time series Y_t represents the number of accident-related visits to the emergency department in Urmia. The graph of this time series is shown in Figure 1. As observed, this time series displays both trend and seasonal components, with a non-constant variance (the spread of the changes), suggesting that it is a non-stationary time series. To identify the order of the initial models that can explain the behavior of the accident-related visit time series, the autocorrelation and partial autocorrelation plots are also presented in Figures 1 and 2.

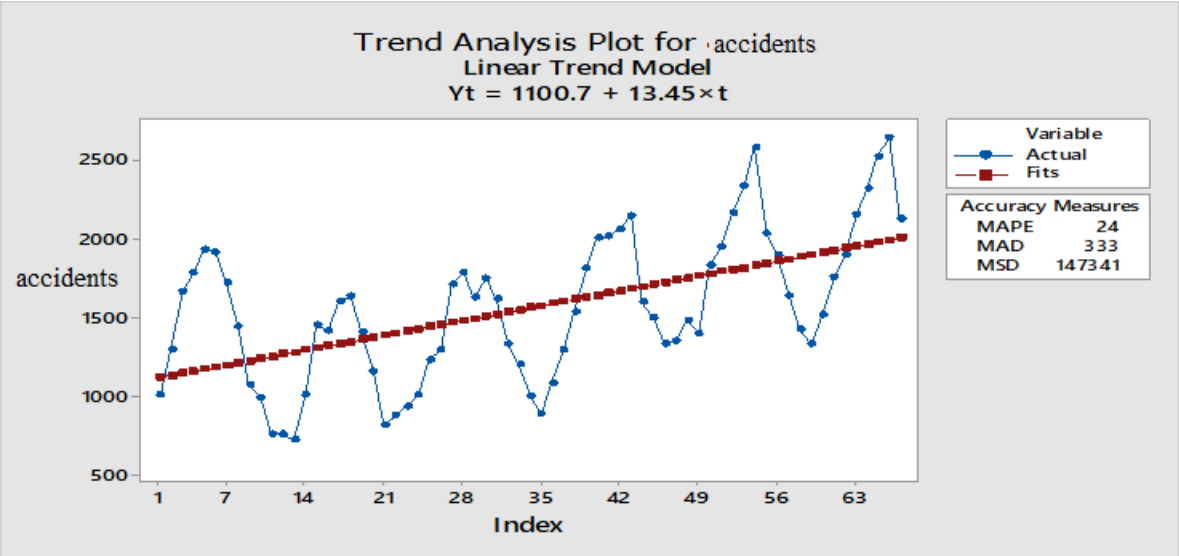

Fig. 1. Time series plot of accident-related visits to the emergency department

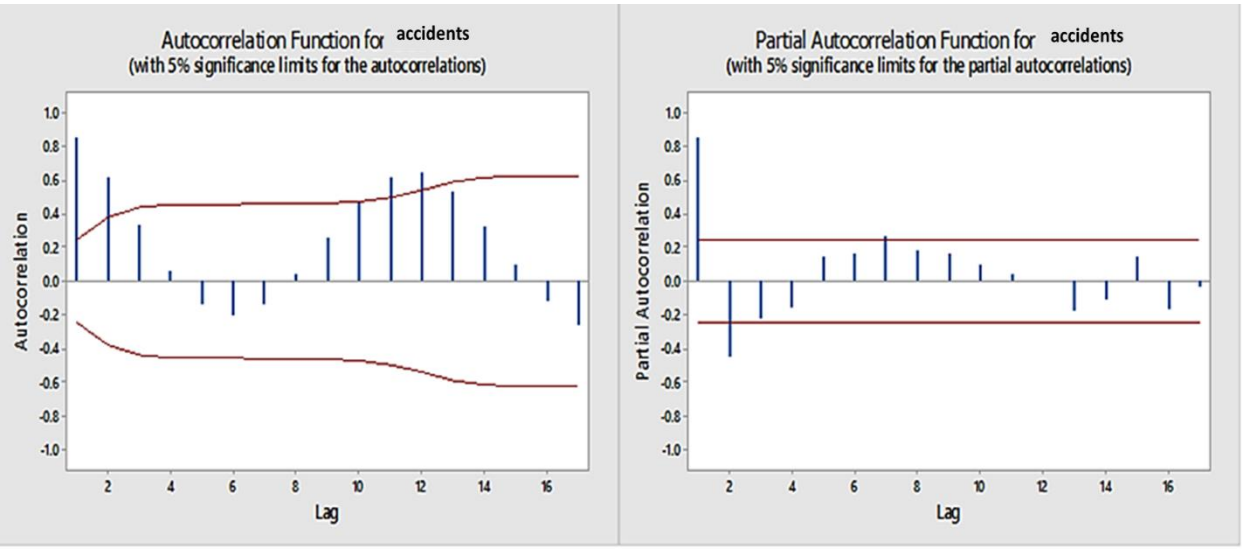

Fig. 2. Time series plot, autocorrelation, and partial autocorrelation of accident-related visits to the emergency department

Based on Figures 1 and 2, significant trends and seasonal variations were observed and further confirmed through the autocorrelation and partial autocorrelation plots. After removing the seasonal variations and trends, the SARIMA family was applied for modeling. Following the estimation of the parameters of this model and other models that could potentially explain the behavior of the accident-related visit time series, it was concluded that only the SARIMA model $(0,1,1)_1(0,1,1)_{12}$, with $m \neq 0$, adequately fit the data. The residuals of this model were tested for normality and independence, and Table 2 presents the model along with the values of MSE and SSE.

Table 2. Estimated models for accident-related incidents

Model	Intercept	Sum of squares	Mean squares
SARIMA $(0,1,1)_1(0,1,1)_{12}$ m≠0	4.26	935652	18346.1

Based on the low values, the SARIMA $(0,1,1)_1(0,1,1)_{12}$ m≠0 model was selected as the chosen model. The maximum likelihood estimation for the parameters of the SARIMA $(0,1,1)_1(0,1,1)_{12}$ m≠0 model, with the intercept μ, in accident-related incidents is shown in Table 3, indicating the significance of the model parameters.

Table 3. Maximum likelihood estimation for the parameters of the SARIMA $(0,1,1)_1(0,1,1)_{12}$ m≠0 model with intercept μ for accident-related incidents

Parameter	Estimate	Standard deviation	*T - value*	*P - value*	Lag
MU	4.26	3.89	1.1	0.278	0
MA1	0.49	0.128	3.84	< 0.001	1
SMA2	0.698	0.159	4.45	< 0.001	2

It should be noted that the Ljung-Box independence test for the SARIMA $(0,1,1)_1(0,1,1)_{12}$ model with the intercept μ in traffic accidents referred to the emergency department indicated the independence of the residuals at the 0.05 significance level.

The Ljung-Box independence test for the SARIMA (0,1,1)1(0,1,1)12 model with a width from the origin of μ in suicide incidents, which indicates the independence of the residuals, is shown in Table 4.

Table 4. Ljung-Box test for ARIMA (0,1,1)1(0,1,1)12 model with width at origin μ in suicide incidents

Lag	Chi-square	DF	*P - Value*
12	5.46	9	0.792
24	16.53	21	0.739
36	24.54	33	0.856
48	32.73	45	0.913

Discussion

Based on the results of the study, a significant trend and seasonal variation with a 12-month lag were observed in the number of accidents reported to the emergency department in Urmia. This indicates that the frequency of accidents follows a predictable pattern, increasing in the warmer months of spring and summer due to higher travel activity, and decreasing in the colder months of autumn and winter.

In a study conducted by AI-Ghamdi, all three time-series models showed an increasing trend in accident volumes in Saudi Arabia, with forecasts suggesting that this upward trend would continue. This aligns with the findings of our study regarding the increasing trend, but unlike our results, no seasonal variations were noted. One possible explanation for this discrepancy could be the hotter climate of Saudi Arabia compared to Urmia, where travel and vehicle usage may not be as influenced by seasonality (10). Similarly, a study by Al-Hasani and colleagues confirmed an increasing trend in accident volumes in Oman, which also aligns with our findings concerning the increasing trend but lacks seasonal variations. Again, the warmer climate of Oman compared to Urmia may account for this difference, as travel volume and vehicle use might not be as significantly impacted by seasonal changes (12).

In a study conducted by Agyemang et al. in the United States, the time-series model indicated an increasing trend in accident volumes, and forecasts suggested that the upward trend would continue. This finding aligns with the increasing trend observed in our study. However, unlike our study, no seasonal variations were noted, which could be attributed to the cultural differences between the United States and Urmia, where travel volume and vehicle use may not be as influenced by seasonality (13).

In another study by Cheruiyot Chelule et al. in Kenya, over 3,000 fatalities were reported annually. This study also used time-series models (ARIMA), which showed a significant increasing trend. However, no significant seasonal variations were observed. While the increasing trend aligns with our study, the absence of seasonal variations is inconsistent. Factors such as climate, economic conditions, and regional cultural characteristics may contribute to this discrepancy (14).

A similar study by Maitama Ahmed et al. in Nigeria utilized multiple models for forecasting, with the best-fitting model selected from the ARIMA family. A significant increasing trend was found, but no significant seasonal changes were observed. This aligns with the increasing trend in our study, but the absence of seasonal changes is inconsistent. Differences in climate, economic conditions, and regional culture may explain the lack of seasonal variations in their findings (15).

In a study by Alemtsega Getahun et al. in Ethiopia, no significant increasing or decreasing trend was found, and no significant seasonal changes were observed in the time-series models. This differs from our findings, where both the increasing trend and seasonal variations were significant. Local climate, regional culture, and

economic conditions might explain the discrepancies in both trend and seasonal variations (16).

Conclusion

Based on the findings of this study and the results of other studies, traffic accidents show an increasing trend with significant seasonal variations, occurring with a 12-month delay. The trend of accidents in Urmia city is rising, and environmental factors, particularly seasonal changes, play a crucial role in influencing the volume of traffic accidents.

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Authors' Contributions

Vahid Hosseinpour conducted methodology, sampling, and data curation. Hamidreza Khalkhali did the statistical analysis. Amir Shadloo wrote the original draft. Vahid Hosseinpour conducted the investigation.

Data Availability

All the data obtained from this study are included in the text of the article.

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

Ethical Statement

The study protocol was approved by the institutional ethics committee of Urmia University of Medical Sciences, Urmia, Iran, with the Code of Ethics IR.UMSU.REC.1403.232.

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