



Five-Year Trends of Trauma at a Level I Trauma Center in Southern Iran

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Abstract

Background and aims: Trauma is a critical public health concern with global consequences, putting significant strain on healthcare infrastructures and societal resources. This study examined the five-year trends at Emtiaz Hospital, a government-run level one trauma referral center for trauma patients, and forecasted trends to 2028.

Methods: This was a cross-sectional study of adult trauma patients who were referred to the trauma center of Emtiaz Hospital between 2018 and 2023. The required information was collected from hospital databases. The autoregressive integrated moving average (ARIMA) model from the STATS model package in Python was used for trend forecasting ($P=2$, $d=1$, $q=0$), with stationarity confirmed via the Augmented Dickey-Fuller test.

Results: The analysis included 193,306 trauma patients, with a majority of males (70.9%) and an average age of 37.4 ± 18.1 . Traffic accidents and falls increased by 12.3% ($P<0.01$) and 8.7% ($P<0.05$) from 2018 to 2023, respectively. Admissions decreased by 15.2% in 2020 ($P<0.001$), with a peak mortality rate of 5.6% ($N=1,892$). ARIMA modeling predicted stable admissions (~32,000 annually) and a 2.5% annual increase in traffic accidents. In addition, traffic accidents had a greater impact on younger age groups, while falls were more common in older patients. Eventually, gender differences revealed that traffic accidents were the leading cause of trauma among males (72.1% vs. 65.4%, $P<0.01$), with females being more likely to fall (30.2% vs. 25.6%, $P<0.05$).

Conclusion: Traffic accidents and falls are major causes of trauma, with distinct age and gender patterns. Immediate road safety measures, including improving vehicle standards and driver training, as well as long-term fall prevention programs, are crucial for Iran's growing elderly population, along with preparing for future pandemics.

Keywords: Injuries, Iran, Pattern, Trauma, Trend

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Introduction

Trauma is a critical public health concern with global consequences, putting significant strain on healthcare infrastructures and societal resources.¹ It is the leading cause of death among young people, resulting in disabilities and the loss of potential years of life.^{2, 3} Approximately between 20 million and 50 million people worldwide are injured every year, accounting for 9% of global mortality, with road traffic injuries causing 1.35 million deaths annually. The nature of these injuries is influenced by several factors, such as gender, region, and income levels. Trauma encompasses a broad range of injuries caused by a variety of injury mechanisms, including traffic accidents, falls, and assault. However, the patterns of trauma and demographic characteristics of affected populations evolve over time. In the Middle East, trauma is a major cause of disability, with Iran reporting one of the highest road traffic mortality rates (20.5 per 100,000 population).⁴ In Iran, trauma is the second leading cause of death, with Shiraz experiencing a high burden due to its role as a

referral center for urban and rural populations.⁵

Previous research has identified considerable changes in injury patterns, mortality rates, and demographic characteristics, with a special emphasis on the increasing incidence of fall-related injuries and the aging population.⁶⁻⁸ For example, Nagata et al reported a rise in fall-related injuries in Japan⁶, while Kehoe et al noted shifts in trauma demographics in the UK.⁷ Furthermore, changes in trauma mortality trends have been linked to demographic shifts, particularly the increasing representation of elderly trauma patients, who face heightened mortality risks.⁹ Notably, studies on Iranian traumatized patients have highlighted traffic accidents as the leading cause of trauma, within which human errors and inadequate safety measures are considered key contributors.^{5, 11}

As far as it is known, although retrospective investigations have been conducted, there is a lack of research on predicting trauma trends. While analyzing historical trends can help with future planning, it may not always address emerging trauma patterns immediately. As

a result, combining prospective and retrospective methods provides a more comprehensive understanding of trauma trends, allowing for more efficient and targeted responses to the changing needs of individuals and communities.

Accordingly, this study aims to examine the causes, characteristics, and temporal trends of trauma at Emtiaz Hospital, a Level I trauma center in Shiraz, Iran, from 2018 to 2023 and forecast trends to 2028, focusing on annual and monthly occurrence, mortality rates, and injury mechanisms.

Materials and Methods

Patients and Methods

This study was performed at the Shiraz Trauma Research Center, which is part of Shiraz University of Medical Sciences. This cross-sectional study investigated adult trauma patients (age ≥ 15 years) who were referred to Emtiaz Hospital, a government-run Level I trauma referral center in Shiraz, Iran, between 2018 and 2023. This hospital is located in Shiraz, the capital of Fars province in southern Iran. It serves as a tertiary healthcare facility specializing in trauma care (designated as a level I trauma center) and treats trauma cases from both urban and rural areas in the province. This study evaluated the most common injury patterns, demographic characteristics, and outcomes, with a particular focus on how these factors varied by victim gender and age. It should be noted that this study adhered to all ethical standards and guidelines, including patient confidentiality and privacy. The administrative records of Emtiaz Hospital served as the primary data source. Shiraz has a warm semiarid climate and a population of 1.7 million, the majority of whom are Muslim. The adult population of this city consists of a significant proportion (65%) of people under the age of 45, with a male-to-female ratio of 1.02.

Study Population

As the primary referral center for trauma cases in Fars province, and with the emergency medical services' protocol in Shiraz directing the majority of trauma patients to our facility, patients who visit us are considered to be a representative sample of the overall injured population of Shiraz. An enumeration (census) method was used to collect information from all trauma patients admitted to emergency departments or other hospital units during the study period. The study included trauma patients older than 15 years involved in incidents, such as traffic accidents (involving cars, motorcycles, and pedestrians), falls, assault, penetrating traumas, and other causes of injury ($n=193,306$). The exclusion criteria included patients admitted for planned surgeries unrelated to emergency trauma care, those with complications from previous trauma surgeries (e.g., infections, orthopedic, or coronavirus disease [COVID]), under supervision and follow-up cases, and patients with missing information ($n=31,197$). From January 2018 to December 2023, a total of 193,306 cases met the study criteria and were validated

and statistically analyzed (Figure 1). An emergency medicine specialist and a general surgery resident entered the data into a computer database, which was then cross-verified and validated.

Measurements and Data Collection

After a patient is screened upon admission, vital information (e.g., age, gender, admission date and time, and cause of injury) is digitally recorded by admission unit staff 24 hours a day, seven days a week. After discharge, physical records are transferred to the medical records department, where experienced personnel routinely collect information on the accident's external causes, injury diagnosis, and final hospitalization results. This information is encoded using the International Classification of Diseases (tenth revision) system and stored in an electronic repository. Demographic data and injury diagnoses were combined from two local hospital databases. Injury causes were classified into five categories: traffic accidents (car, motorcycle, pedestrian, and other traffic-related incidents), falls, assaults, penetrating traumas (sharp objects and gunshot/stab wounds), and others (electric injuries, explosions, sports injuries, suicides, and burns). Mortality was calculated as deaths per 100 admissions, excluding those declared dead on arrival.

Statistical Analysis

Continuous variables were examined using descriptive statistics (e.g., average and standard deviation), while categorical variables were assessed using relative frequencies. The data were analyzed utilizing

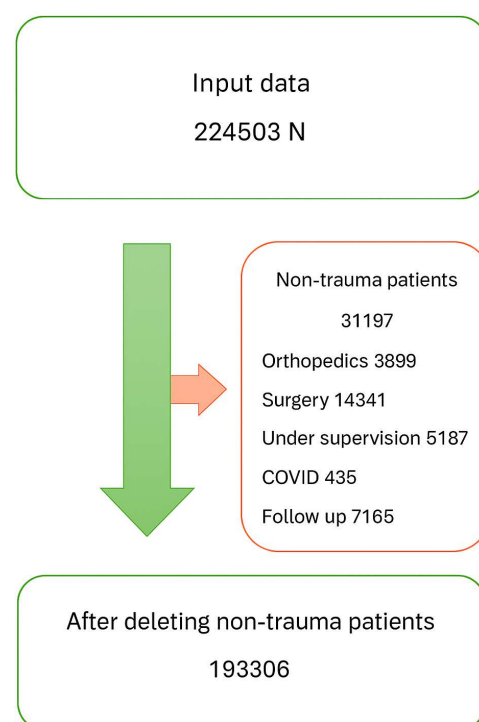


Figure 1. The Flow Chart of the Included Patients

SPSS, version 26 (SPSS Inc., USA). Furthermore, an autoregressive integrated moving average (ARIMA) model was employed to forecast trauma trends from 2018 to 2028. The computations were executed using the Python programming language (version 3.11) and the statsmodels library (version 14.0). An ARIMA model, a time series forecasting method combining autoregressive, differencing, and moving average components, was used to forecast trauma trends from 2023 to 2028 based on 2018–2023 data. Moreover, stationarity was assessed using the Augmented Dickey-Fuller test ($P < 0.05$). The ARIMA model ($P = 2, d = 1, q = 0$) was selected based on the lowest Akaike information criterion value, with autocorrelation function and partial autocorrelation function plots guiding parameter selection. The dataset was split into training (80%, 2018–2021) and validation (20%, 2022–2023) sets to optimize the model. Additionally, model reliability was evaluated using mean absolute error (MAE), root mean squared error (RMSE), and R-squared metrics. Further, annual percentage change (APC) and average APC (AAPC) were calculated using the Joinpoint Regression Program to quantify trends in admissions and injury mechanisms. Significance of changes was assessed using t-tests or chi-square tests.

Results

Overall, 193,306 patients were enrolled in our study between 2018 and 2023, with 137,085 (70.9%) males and 56,221 (29.1%) females. The average age was 37.4 ± 18.1 . The mechanism of injury was traffic accidents in 46.7% of patients ($n = 90,195$), followed by falls in 27.1% ($n = 52,406$), assault in 13.2% ($n = 25,488$), penetrating traumas in 4.5% ($n = 8,672$), and others in 8.6% ($n = 16,545$). Furthermore, car accidents accounted for 46.1% of all traffic incidents, followed by motorcycle accidents at 34.7% and pedestrian accidents at 19.2% (Table 1). The overall trauma admission rate demonstrated an AAPC of 3.2% (95% confidence

interval [CI]: 2.1–4.3). Traffic accidents, falls, and assaults increased by 12.3% (AAPC = 4.1%, 95% CI: 3.0–5.2, $P < 0.01$), 8.7% (AAPC = 2.8%, 95% CI: 1.5–4.1, $P < 0.05$), and 6.4% (AAPC = 2.1%, 95% CI: 1.0–3.2, $P < 0.05$), respectively, while the “others” category decreased by 5.2% (AAPC = -1.7%, 95% CI: -2.8 – -0.6, $P < 0.05$). The ARIMA model’s reliability was supported by MAE (5.2%) and RMSE (7.1%), but longer-term data could enhance accuracy. The actual value, the predicted value, and the absolute percentage error in each year and in each category are presented in Table 2.

Figure 2 depicts our centre’s admission pattern from 2018 to 2028, showing a general increase from 2018 to 2023 and a projected stable trend for 2023–2028. Admissions decreased by 15.2% in 2020 ($P < 0.001$), likely due to the COVID-19 pandemic. Figure 3 and Table 1 show annual fluctuations in the distribution of injury mechanisms. According to the data, the most common causes of injury were hospital admissions from traffic accidents, followed by falls. Furthermore, there was a significant increase in traffic accidents, falls, and assaults over the last five years. Figure 4 details traffic accident subtypes, with car accidents predominant. Figure 5 illustrates mortality rates, with a peak of 5.6% ($n = 1,892$) in 2020, followed by stabilization at ~3.8% ($P < 0.01$ for 2020

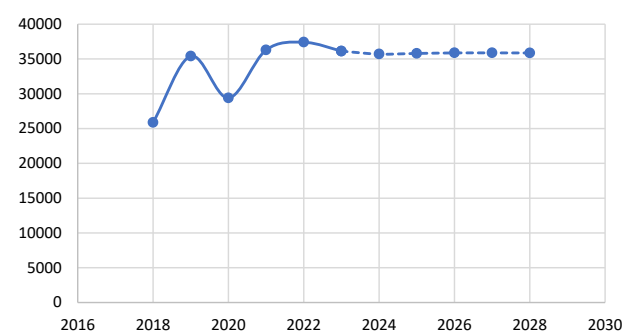


Figure 2. The Number of Annual Admission to Shahid Rajaei (Emtiaz) Hospital of Shiraz From 2018 to 2023 and the Projected Trend Between 2023 and 2028

Table 1. Demographic and Injury Event Details From 2018 to 2023

	2018 (N=24,642)	2019 (N=33,780)	2020 (N=28,298)	2021 (N=35,092)	2022 (N=36,333)	2023 (N=35,161)	Total (N=193,306)
Gender, N (%)							
Male	17,012 (69)	22,883 (67.7)	20,855 (73.7)	25,756 (73.4)	25,777 (70.9)	24,802 (70.5)	137,085 (70.9)
Female	7,630 (31)	10,897 (32.3)	7,443 (26.3)	9,336 (26.6)	10,556 (29.1)	10,359 (29.5)	56,221 (29.1)
Age, N (%)							
15-44	17,604 (71.4)	23,525 (69.6)	20,446 (72.3)	25,525 (72.7)	25,412 (69.9)	24,902 (70.8)	137,418 (71.1)
45-64	4,461 (18.1)	6,443 (19.1)	5,193 (18.4)	6,227 (17.7)	6,807 (18.7)	6,449 (18.2)	35,580 (18.4)
≥65	2,577 (10.5)	3,812 (11.3)	2,659 (9.3)	3,336 (9.6)	4,114 (11.4)	3,810 (10.8)	20,308 (10.5)
Deaths, N (%)	269 (1.1)	292 (0.9)	373 (1.3)	389 (1.1)	405 (1.1)	345 (1)	2,073 (1.5)
Cause, N (%)							
Traffic accidents	12,294 (49.9)	15,620 (46.2)	12,467 (44)	16,135 (46)	16,853 (46.4)	16,826 (47.9)	90,195 (46.7)
Penetrating Traumas	715 (2.9)	1,218 (3.6)	1,604 (5.7)	2,762 (7.9)	1,425 (3.9)	946 (2.7)	8,670 (4.5)
Falling Assault	6,579 (26.7)	9,869 (29.2)	7,444 (26.3)	8,711 (24.8)	10,220 (28.1)	9,583 (27.3)	52,406 (27.1)
Others	2,788 (11.3)	3,941 (11.7)	3,645 (12.9)	4,576 (13)	5,228 (14.4)	5,312 (15)	25,490 (13.2)
	2,266 (9.2)	3,132 (9.3)	3,138 (11.1)	2,908 (8.3)	2,607 (7.2)	2,494 (7.1)	16,545 (8.5)

Table 2. Trauma trends: Actual, Predicted, and APE by Injury Category and year

Category	Metric	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Traffic accidents	Actual	12,294	15,620	12,467	16,135	16,853	16,826	–	–	–	–	–
	Predicted	–	–	–	–	–	16,826	17,247	17,678	18,120	18,573	19,037
	APE (%)	–	–	–	–	0.16	–	–	–	–	–	–
Falls	Actual	6,579	9,869	7,444	8,711	10,220	9,583	–	–	–	–	–
	Predicted	–	–	–	–	–	9,583	9,583	9,583	9,583	9,583	9,583
	APE (%)	–	–	–	–	6.23	–	–	–	–	–	–
Assaults	Actual	2,788	3,941	3,645	4,576	5,228	5,312	–	–	–	–	–
	Predicted	–	–	–	–	–	5,312	5,312	5,312	5,312	5,312	5,312
	APE (%)	–	–	–	–	1.61	–	–	–	–	–	–
Penetrating traumas	Actual	715	1,218	1,604	2,762	1,425	946	–	–	–	–	–
	Predicted	–	–	–	–	–	946	946	946	946	946	946
	APE (%)	–	–	–	–	33.61	–	–	–	–	–	–
Other injuries	Actual	2,266	3,132	3,138	2,908	2,607	2,494	–	–	–	–	–
	Predicted	–	–	–	–	–	2,494	1,912	1,481	1,039	586	122
	APE (%)	–	–	–	–	4.33	–	–	–	–	–	–
Total admissions	Actual	24,642	33,780	28,298	35,092	36,333	35,161	–	–	–	–	–
	Predicted	–	–	–	–	–	35,161	35,000	35,000	35,000	35,000	35,000
	APE (%)	–	–	–	–	3.23	–	–	–	–	–	–

Note. APE: Absolute percentage error.

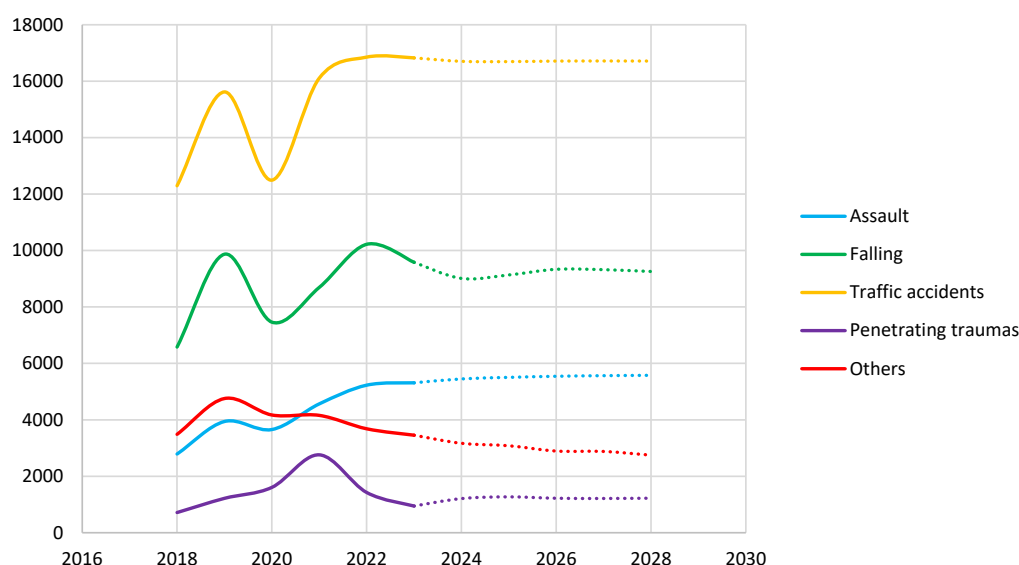


Figure 3. The Distribution of the Mechanism of Injury Among the Patients Referred to Shahid Rajaee (Emtiaz) Hospital of Shiraz From 2018 to 2023 and the Projected Trend Between 2023 and 2028

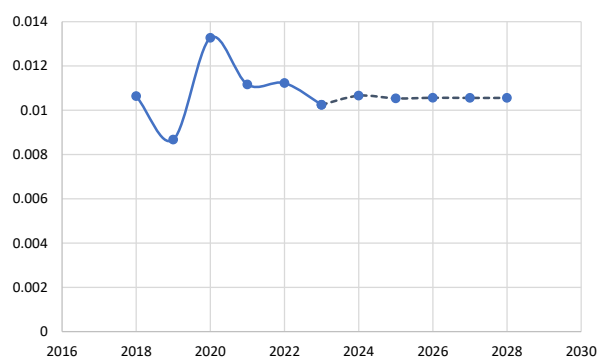


Figure 4. The Distribution of the Cause of Traffic Accidents Among the Patients Referred to Shahid Rajaee (Emtiaz) Hospital of Shiraz From 2018 to 2023 and the Projected Trend Between 2023 and 2028

vs. other years). ARIMA modeling predicted a 2.5% annual increase in traffic accidents and stable trends for falls and assaults from 2023 to 2028 (MAE=5.2%, RMSE=7.1%, R-squared=0.82).

Patients were divided into three age categories (15–44 years old, 45–64 years old, and ≥65 years old). The analysis of injury mechanisms within each age subgroup revealed that traffic accidents primarily affected younger age groups, whereas falling was the leading cause of injury among patients aged 65 years old and over. Over the last five years, there has been an increase in traffic accidents among younger age groups, as well as in falls among older patients (Figure 6).

Figure 7 shows gender differences. Males had a higher

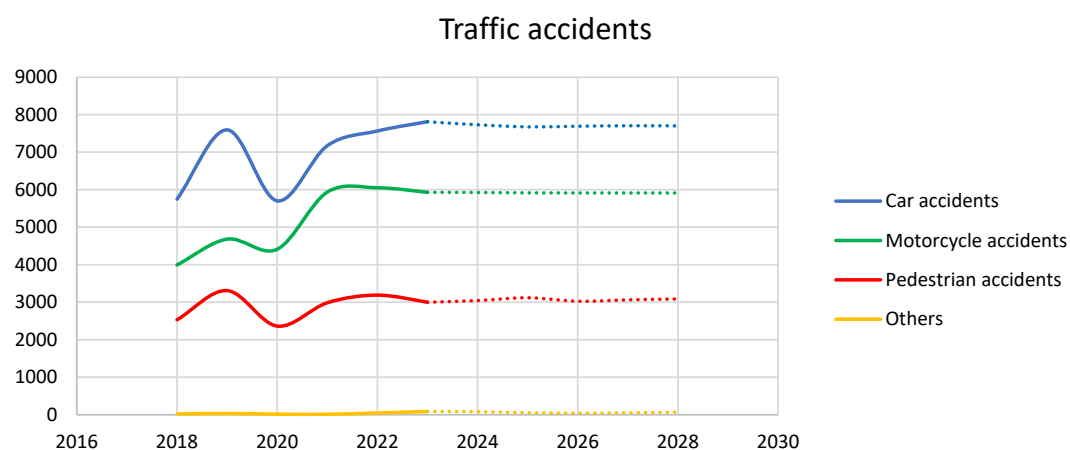


Figure 5. The Number of the Annual Mortality Rate Among the Patients Referred to Shahid Rajaee (Emtiaz) Hospital of Shiraz From 2018 to 2023 and the Projected Trend Between 2023 and 2028

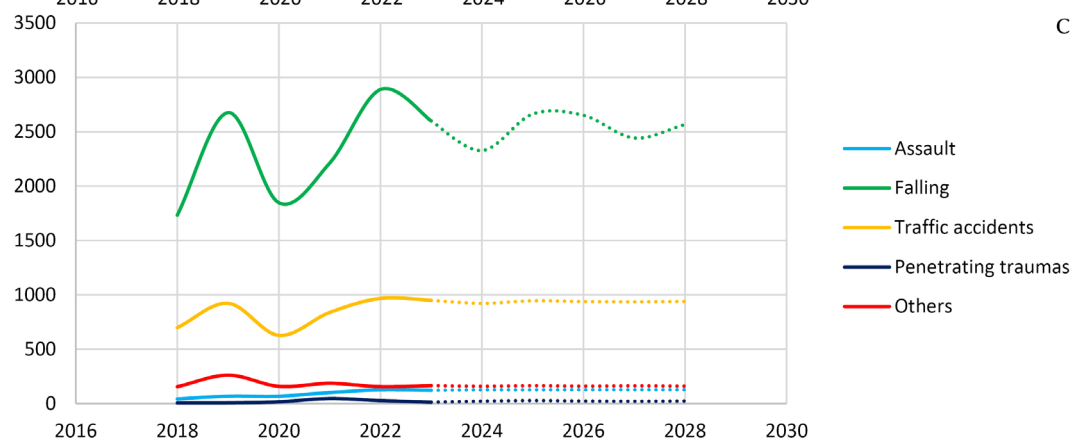
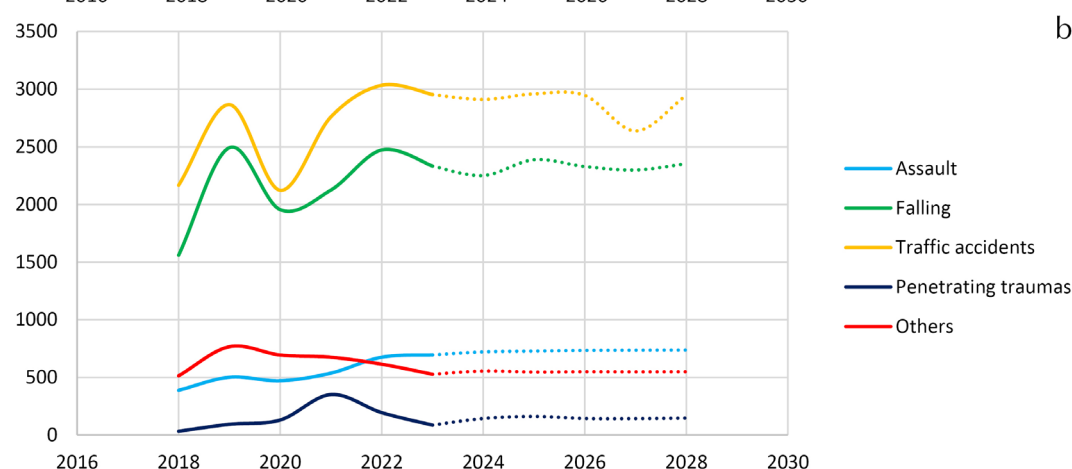
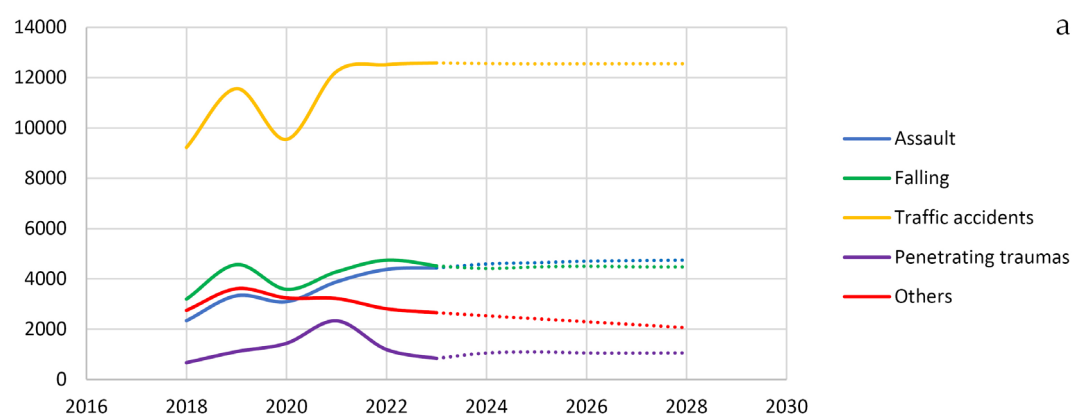


Figure 6. The Distribution of Injury Mechanism Among the Patients Referred to Shahid Rajaee (Emtiaz) Hospital of Shiraz From 2018 to 2023 and the Projected Trend Between 2023 and 2028 by Age Groups: (a) First Group (15–44 years old), (b) Second Group (45–64 years old), and (c) Third Group (≥ 65)

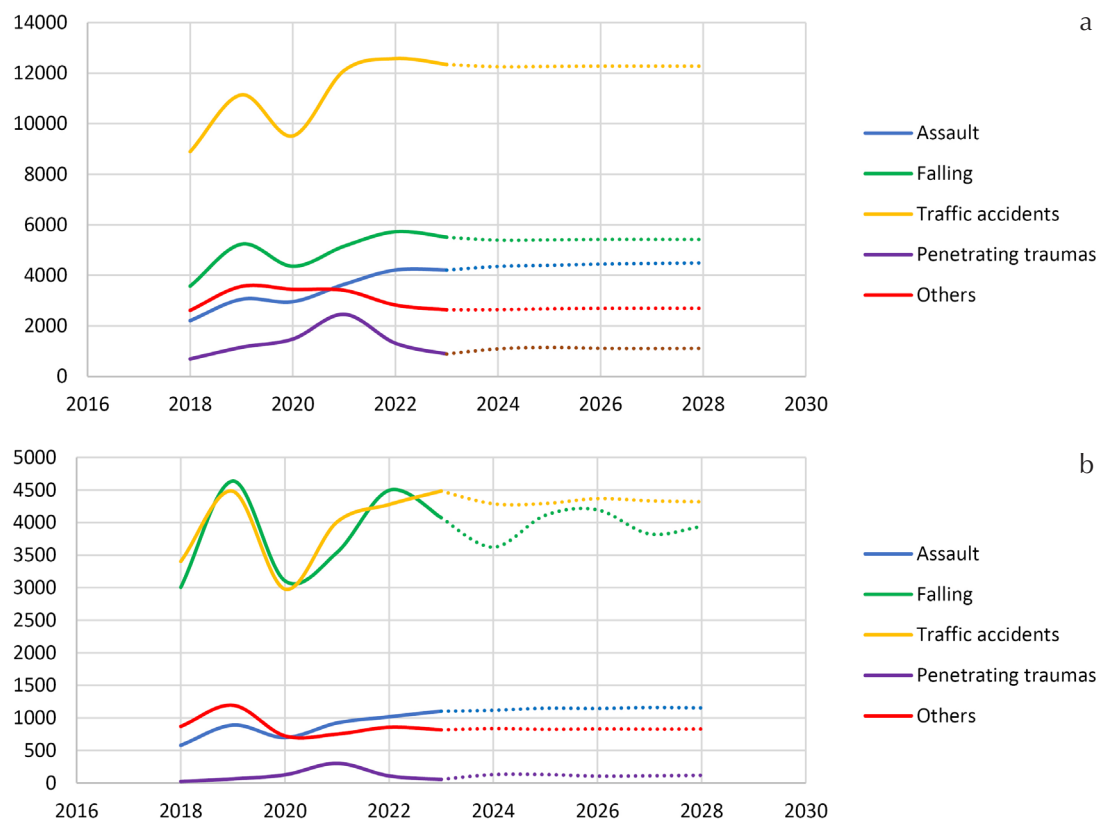


Figure 7. The Distribution of Injury Mechanism Among the Patients Referred to Shahid Rajaee (Emtiaz) Hospital of Shiraz From 2018 to 2023 and the Projected Trend Between 2023 and 2028 by Gender: (a) Males and (b) Females

incidence of traffic accidents (72.1% vs. 65.4%, $P < 0.01$), while females were more likely to fall (30.2% vs. 25.6%, $P < 0.05$).

Discussion

This study investigated the causes, characteristics, and temporal trends of trauma in a single level I trauma center in southern Iran over the previous and subsequent five years. Our findings revealed that traffic accidents, falls, and assaults were the leading causes of injury, with car accidents being the most common type. Mortality peaked in 2020 (5.6%, $n = 1,892$), likely due to the impact of the COVID-19 pandemic on healthcare access and injury patterns, with admissions dropping by 15.2% ($P < 0.001$). Traffic accidents could disproportionately affect younger age groups, whereas falls were more common among older patients.

In our research, a relatively high occurrence of trauma injuries was observed among young adult males, which is consistent with some studies.^{12, 13} Occupational risks and accidents, lifestyle choices, and risk-taking tendencies commonly observed in young males may contribute to a higher number of injuries.¹⁴ Considering that young males make up a sizable proportion of the workforce in developing economies, trauma in this demographic imposes a significant socioeconomic burden and communal disability, affecting both the nation and the affected individuals' families. This emphasizes the importance of targeted educational initiatives and

awareness campaigns aimed at encouraging safe practices and preventing injuries in this particular demographic.

From 2018 to 2023, traffic accidents were the leading cause of trauma among patients admitted to our trauma center. These findings conform to those of several other studies, identifying traffic accidents as a major contributor to traumatic injuries globally.^{5, 15, 16} In Iran, it is estimated that one person dies from road traffic accidents every 19 minutes, and a person is injured every two minutes.¹⁷ Human errors are the primary cause of road traffic accidents, followed by inadequate safety measures, unsafe vehicles, and roads.¹¹ The consistency of these findings emphasizes the critical need for comprehensive strategies to address road safety issues and prevent traffic injuries. While poor road conditions and a lack of safety measures contribute to traffic accidents in this region, the construction of new roads has resulted in some improvements in recent years. Currently, Iran has a number of regulations governing driving behaviors aimed at reducing the number of road traffic accidents and thus the burden.

Our findings revealed a distinct injury trend in 2020, marked by a decrease in total admissions to our facility, a lower proportion of traffic accidents and falls, and a higher proportion of assaults and penetrating traumas compared to previous years, as well as an increase in the annual mortality rate. These findings corroborate those of other studies conducted in the same year.^{18, 19} The emergence of the COVID-19 pandemic in 2020 most likely played a significant role, leading to noticeable shifts in daily work

and leisure patterns, as well as considerable changes in the occurrence of traumatic injuries.¹⁸ Reductions in trauma volume and admissions at our center can be attributed to changes in social distancing measures, changes in work environments, and adjustments in in-person schooling practices.²⁰⁻²³ With more injuries resulting from assaults and fewer from accidents (e.g., falls and traffic accidents), different conclusions can be drawn about injury patterns. The rise in assaults could be related to increased interpersonal conflicts caused by extended time at home, stress from the pandemic and global events, rising unemployment rates, or other social stressors. The decrease in accidents observed at our hospital could be associated with a genuine reduction in such incidents. Individuals involved in accidents such as falls may have chosen not to seek medical attention at a hospital that treats COVID-19 patients. Furthermore, the observed peak in the mortality rate in 2020 could be attributed to the COVID-19 pandemic at that time.²⁴ However, further investigation into the reasons for this event is necessary. The findings emphasize the impact of the pandemic on trauma patients and the importance of being prepared for future pandemics. Future pandemic planning should account for the possibility of increased trauma center utilization in cases involving penetrating trauma. While the onset of COVID-19 in 2020 can explain some of these findings, a more in-depth overview of the causes and patterns of injuries in this year is of necessity.

Falling is one of the most common causes of injury in the elderly.²⁵ In Iran, 12% of 8,000 individuals hospitalized due to traumas are adults aged 60 or older, with 70% of them experiencing falling.²⁶ Our findings revealed noticeable disparities in the causes of injury across age groups. Traffic accidents primarily affected younger people, while falls were the leading cause of injury among patients 65 and older. These findings are consistent with the results of other studies, identifying falling as a major cause of injury in the elderly population.²⁷⁻²⁹ Our results also demonstrated a noticeable increase in falls over the last five years, which could be attributed to the growing elderly population of Iran. The expected frequency of falls in our study may be validated with the recent increase in the country's elderly population and a projected estimate of 2050³. This demographic shift poses unique challenges for healthcare providers and policymakers, as the aging population necessitates tailored interventions to address their increased risk of falls and related injuries.

In our study, gender differences revealed that traffic accidents were the leading cause among males, whereas falls were the leading cause among females, which can be due to differences in risk-taking behaviors, physical abilities, and environmental factors.³¹ These findings conform to those of previous research, highlighting gender-specific patterns in the causes of injuries.³² Females may be more prone to falls due to several factors, including osteoporosis, increased depressive symptoms, and incontinence.^{33, 34} Accordingly, recognizing and

addressing these gender-specific patterns are critical for developing effective prevention strategies and interventions to reduce the number of injuries in both male and female populations.

Our research had several limitations. Initially, the mortality rate of trauma patients was determined solely through hospitalization data. Second, it was impossible to investigate the injury severity score because it was unavailable in the hospital's health information management center. Third, it is important to note that the specific impact of the 2020 COVID-19 pandemic has made it difficult to accurately predict the pattern of injuries over the next five years. Finally, while ARIMA models benefit from longer historical data, our 5-year dataset limited long-term forecast precision. It should be noted that partial 2024 data were unavailable; thus, future studies should incorporate them to validate forecasts. It is noteworthy that this study can serve as a preliminary model for creating annual reports on trauma patients in Shiraz using a comprehensive trauma database, with the goal of informing the medical community, the general public, and policymakers.

Conclusion

Our findings revealed that traffic accidents are the leading cause of injury, with car accidents being the most common. Although mortality rates peaked and patient admissions fell in 2020, they remained stable in subsequent years. Remarkably, traffic accidents disproportionately influenced younger age groups, whereas falls were more prevalent in older patients. It was found that males demonstrated higher rates of traffic accidents, while females were more likely to experience falls. This study sheds light on key factors influencing injury patterns and outcomes by revealing temporal trends and characteristics of trauma in our center. In the near future, focusing efforts on road safety, improving vehicle standards, and offering driver training courses are all viable strategies. Looking ahead, given the growing elderly population in Iran, focusing on fall prevention initiatives becomes critical. Eventually, prioritizing readiness for future pandemics is essential due to the distinct injury trends observed during such health crises.

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Competing Interests

The authors declare no conflict of interests.

Ethical Approval

Ethical considerations in this study included obtaining permission from the Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.REC.1402.533) and obtaining written consent from the participants to participate in the study.

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