



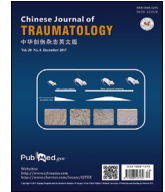
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Original Article

Comparing epidemiologic features, outcomes, and diagnostic and therapeutic procedures of traumatic patients before and during COVID-19 pandemic: Data from the National Trauma Registry of Iran

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ABSTRACT

Purpose: To prepare for future possible communicable disease epidemics/pandemics, health care providers should know how the COVID-19 pandemic influenced injured patients. This study aimed to compare epidemiologic features, outcomes, and diagnostic and therapeutic procedures of trauma patients admitted to a university-affiliated hospital before and during the pandemic.

Methods: This retrospective study was performed on data from the National Trauma Registry of Iran. All injured patients admitted to the hospital from July 25, 2016 to March 10, 2021 were included in the study. The patients were excluded if they had hospital length of stay less than 24 h. The injury outcomes, trauma mechanisms, and therapeutic and diagnostic procedures of the 2 periods: before (from July 25, 2016 to February 18, 2020) and during (from February 19, 2020 to March 10, 2021) COVID-19 pandemic were compared. All analyses were performed using STATA version 14.0 software (Stata Corporation, College Station, TX).

Results: Totally, 5014 patients were included in the registry. Of them, 773 (15.4%) were registered after the beginning of the COVID-19 pandemic on February 19, 2020, while 4241 were registered before that. Gender, education level, and cause of injury were significantly different among the patients before and after the beginning of the pandemic ($p < 0.001$). In the ≤ 15 years and ≥ 65 years age groups, injuries decreased significantly during the COVID-19 pandemic ($p < 0.001$). The frequency of intensive care unit (ICU) admission decreased from 694 (16.4%) to 88 (11.4%) ($p < 0.001$). The mean length of stay at the hospital (days) and at the ICU (days) declined as follow: 8.3 (SD = 17.2) vs. 5.5 (SD = 6.1), $p < 0.001$ and 7.5 (SD = 11.5) vs. 4.5 (SD = 6.3), $p < 0.02$. The frequency of diagnostic and therapeutic procedures before and during the pandemic was as follows, respectively: ultrasonography 905 (21.3%) vs. 417 (53.9%) ($p < 0.001$), echocardiography 313 (7.4%) vs. 107 (13.8%) ($p < 0.001$), angiography 1597 (37.7%) vs. 534 (69.1%) ($p < 0.001$), MRI 166 (3.9%) vs. 51 (6.6%) ($p < 0.001$), surgery 3407 (80.3%) vs. 654 (84.6%) ($p < 0.001$), and internal/external fixation 1215 (28.6%) vs. 336 (43.5%) ($p < 0.001$).

Conclusion: The pandemic affected the epidemiology of traumatic patients in terms of gender, age groups, educational level, and trauma mechanism. It changed the outcomes of injured patients: ICU admission, length of stay at the hospital and ICU decreased. The patients received more diagnostic and therapeutic procedures during the pandemic. To be more precise, more research is needed on the details.

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1. Introduction

Corona virus disease 2019 (COVID-19) has spread worldwide, changing the traumatic injuries incidence and epidemiologic features of trauma admissions following the extensive implementations of quarantine measures, movement restrictions, and lockdowns.¹ During the COVID-19 pandemic, people tried to stay at

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home and, just if they encountered an emergent condition, searched for medical care and referred to health centers or hospitals.² Traveling and outside activities reduced.³ Subsequently, traumatic injuries related to the workplace, sports, and road traffic decreased.⁴ However, other traumatic injuries from daily activities in the home still happened among people ranging from young to elderly.³ So, these changes in trauma mechanisms led to altering usual medical and surgical procedures in health centers and hospitals worldwide.⁵ The consequences of the extensive restrictions were not yet fully understood, although studies recommended that it alter demand on healthcare services.^{1,2}

In Iran, the COVID-19 pandemic had extensive effects on people's lives.⁶ The outbreak happened in February 2020 and continued until the present time in Iran.⁷ During the pandemic, Iranian suffered from 5 peaks of COVID-19.⁸ Also, lockdown regulation, travel restrictions, closing schools, and other actions to control the COVID-19 pandemic were performed.⁹

To the best of our information, limited studies described the epidemiologic feature of traumatic injury in Iran. Nabian et al.⁶ described the epidemiological pattern of pediatric trauma in the COVID-19 outbreak, and another investigation⁷ described the pattern of limb injuries during the COVID-19 pandemic in the orthopedic emergency department in Iran. The latter study did not compare the injury patterns during and before the pandemic.⁷ However, it is vital to know how the pandemic affected traumatic patients.¹⁰

Using the National Trauma Registry of Iran (NTRI), we analyzed data of trauma patients admitted at the Sina Hospital before and during the pandemic. The study aimed to evaluate how the COVID-19 pandemic impacted traumatic injuries.

2. Methods

The current retrospective study was performed on collected data of the NTRI. The NTRI was established at Sina Hospital, affiliated with Tehran University of Medical Sciences, Tehran, Iran, in 2016.¹¹ The study population was all injured patients admitted at the hospital from July 25, 2016 to March 10, 2021. The patients were included in the study if they had one or more of the following criteria: hospital length of stay (HLOS) more than 24 h, death due to trauma, or sent from intensive care units (ICUs) of other hospitals. We divided the study interval into 2 parts by the beginning of the COVID-19 pandemic in Iran on February 19, 2020. It was the first day when a COVID-19 case was reported in Iran. We compared injury outcomes, trauma mechanisms, and therapeutic and diagnostic procedures before (from July 25, 2016 to February 18, 2020) and during (from February 19, 2020 to March 10, 2021) COVID-19 pandemic.

2.1. Data collection

Two trained nurses gathered data from injured patients applying the trauma admission list. Considering the NTRI dataset, 98 variables, including baseline characteristics, trauma data, pre-hospital and hospital care data, procedures, international classification of diseases-10 codes, determining disease, injury severity, and trauma outcomes, were reviewed. After evaluating patients' medical records, the data were transferred to the NTRI web-based portal. In the next phase, validity, completeness, and consistency of information were controlled by quality reviewers. If there were an incomplete form, it would be marked and sent back to the responsible nurse to reconsider the observation.¹¹

2.2. Variables

We considered 5 variables containing age, gender, marital status, education level, and nationality, and compared them before

and after the beginning of the pandemic. Trauma mechanisms, including road traffic injury, fall, blunt trauma, cut/stab wound, and the others, were compared. Blunt trauma refers to injuries resulting from an impact with a dull, firm surface or object. "Others" included injuries related to drowning, poisoning, animal bite, explode, burn and heat injuries, and unknown causes. Death, ICU admission and ICU length of stay (ICULOS) were used as trauma outcomes. Finally, therapeutic and diagnostic interventions for traumatic patients such as radiology, sonography, echocardiography, angiography, MRI, surgery, and fixation were evaluated. The fixations include all types of fractures, such as facial fractures and long bone fractures. Surgical interventions in trauma patients include all types of surgical procedures such as chest tube placement and laceration repairs.

Categorical and continuous variables were described as percent and mean (SD), respectively. The Chi-square test was used to compare categorical variables before and during the COVID-19 pandemic. Also, the *t*-test was used to compare continuous variables with normal distribution between the 2 periods. The significance level was set at $p < 0.05$. All analyses were performed using STATA version 14.0 software (Stata Corporation, College Station, TX).

3. Results

Five thousand fourteen traumatic patients were included in the registry from July 25, 2016, to March 10, 2021. Of them, 4241 were registered before the COVID-19 pandemic and 773 (15.4%) were registered after the beginning of the COVID-19 pandemic. Before the pandemic, 641 (15.1%) female injured patients were recorded compared to 80 (10.3%), which occurred during the pandemic. Accordingly, gender distributions of traumatic patients showed statistically significant differences before and after the beginning of the pandemic ($p < 0.001$). Fig. 1 showed the variation of the total number of patients and the gender distribution monthly during study. The monthly volume of patients decreased during the pandemic period (roughly from 95 to 65 patients per month). The most frequent education level among trauma patients was diploma before (28.6%) and after (29.1%) the pandemic's beginning. Overall, the distributions of education levels in the patients with lower education levels were significantly different before and during the COVID-19 pandemic ($p < 0.001$). For example, trauma patients with no formal education have been reduced from 13.6% in the pre-COVID-19 pandemic to 7.6% during the COVID-19 pandemic. Before the beginning of the pandemic, in the youngest (≤ 15 years) and the oldest (≥ 65 years) age groups, recorded injured patients were 181 (4.3%) and 510 (12.0%), respectively. After the pandemic, they reached 20 (2.6%) and 65 (5.4%), respectively. In the youngest and particularly in the oldest age groups, traumatic injuries were decreased significantly during the pandemic compared to pre-COVID-19 duration ($p < 0.001$) (Table 1). In terms of the cause of trauma, before and during the pandemic, 2175 (51.3%) and 372 (48.1%) road traffic injuries were recorded, respectively. No statistical difference in road traffic injuries was detected between the 2 periods. Overall, the distributions of the cause of trauma in the recorded patients meant statistically significant differences before and during the pandemic ($p < 0.001$). For example, falls reduced from 23.3% in pre-COVID-19 to 19% during pandemic (Table 2). The frequency of ICU admission was 694 (16.4%) before and decreased to 88 (11.4%) after the beginning of the pandemic ($p < 0.001$). The mean HLOS (days) declined from 8.3 (SD = 17.2) to 5.5 (SD = 6.1) ($p < 0.001$). Subsequently, before the pandemic, the mean ICULOS was 7.5 (SD = 11.5) days, which reduced to 4.5 (SD = 6.3) days during the pandemic ($p < 0.001$). Death was higher during the COVID-19 pandemic, but there was no statistically significant

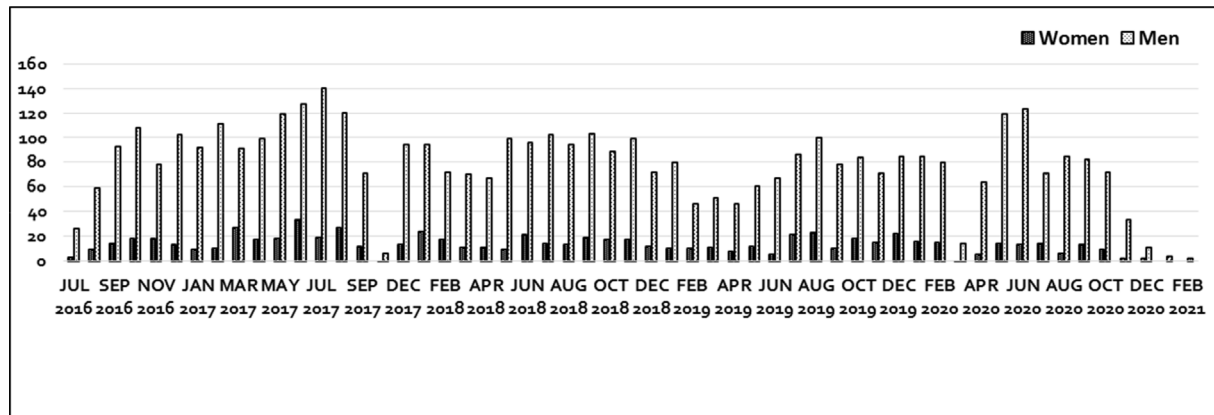


Fig. 1. The variation of the total number of patients and the gender distribution monthly during study.

Table 1

Baseline characteristics of trauma patients before and during the COVID-19 pandemic ($n = 5014$).

Variables	COVID-19 pandemic, n (%)		p value
	Before ($n=4241$)	During ($n=773$)	
Gender			<0.001
Male	3600 (84.9)	693 (89.7)	
Female	641 (15.1)	80 (10.3)	
Education level			<0.001
No formal education	578 (13.6)	59 (7.6)	
Primary school	643 (15.2)	100 (12.9)	
Lower high school	863 (20.3)	187 (24.2)	
Upper high school	337 (7.9)	69 (8.9)	
Diploma	1211 (28.6)	225 (29.1)	
Higher education	414 (9.8)	91 (11.8)	
Missing	195 (4.6)	42 (5.4)	
Age (years)			0.003
≤ 15	181 (4.3)	20 (2.6)	
16–44	2631 (62.0)	509 (65.8)	
45–64	919 (21.7)	179 (23.2)	
≥ 65	510 (12.0)	65 (8.4)	
Marital status			0.13
Married	2359 (55.6)	415 (53.7)	
Single	1602 (37.8)	317 (41.0)	
Widowed or divorced	196 (4.6)	33 (4.3)	
Missing	84 (2.0)	8 (1.0)	
Nationality			0.23
Iranian	3936 (92.8)	708 (91.6)	
Afghan	305 (7.2)	65 (8.4)	

*Bold indicates a subset of categories whose column proportions differ significantly from each other at the 0.05 level.

Table 2

Trauma mechanisms before and during the COVID-19 pandemic ($n = 5014$).

Mechanisms	COVID-19 pandemic, n (%)		p value
	Before ($n = 4241$)	During ($n = 773$)	
Road traffic injury	2175 (51.3)	372 (48.1)	<0.001
Fall	989 (23.3)*	147 (19.0)	
Blunt force	793 (18.7)	195 (25.2)	
Cut/stab	181 (4.3)	46 (6.0)	
Others	103 (2.4)	13 (1.7)	

^a Bold indicates a subset of categories whose column proportions differ significantly from each other at the 0.05 level.

difference between the 2 periods (Table 3). Therapeutic and diagnostic procedures including sonography, echocardiography, angiography, surgery, and fixation were significantly higher than the pre-pandemic duration. For instance, sonography was 21.3% before the pandemic and increased to 53.9% during it. (Table 4).

4. Discussion

The current study evaluated traumatic injuries before and during the pandemic using the NTRI data. Based on the NTRI, we found that the overall epidemiologic feature of traumatic injuries changed due to the COVID-19 pandemic. Furthermore, demographic characteristics of injured patients, cause of trauma, ICU admission proportion, mean HLOS, and ICULOS changed during the pandemic compared to before this pandemic. It was consistent with the other investigations which compared trauma injuries during the COVID-19 pandemic before its beginning.^{10,12,13} The behavioral changes, lockdowns, and burdensome regulations on people's easy movement to control the pandemic could affect the occurrence and epidemiology of traumatic injuries.¹³ The rules of the lockdown were in place in Iran, containing closure of insignificant jobs and cancellation of public ceremonies. Each province could recommend regulations to react to local peaks in infections. This could consist of lockdown and restriction of traveling.⁷ These rules remained the same for the duration of the study period. Subsequently, international reports demonstrated alterations in the total number, mechanism, and severity of traumatic injuries.¹⁴

As we mentioned, gender distributions of traumatic patients implied statistically significant differences before and during the pandemic. Also, we identified that most of the patients were male before (84.9%) and during pandemic (89.7%). In Iran, this difference between males and females was because of the higher exposure of males to activities and jobs, which led to traumatic injuries.¹¹ The reduction of traumatic injuries among women during the COVID-19 pandemic was maybe because women implemented lockdown regulations better than men in Iran.⁹ Conversely, the study by Staunton et al.¹⁵, which investigated regional trauma patterns during the pandemic, reported that males included 45% of cases in Ireland. So, the gender distributions of traumatic patients were different in different countries.

Regarding education level, the distributions of education levels in the patients with higher education levels were not significantly

Table 3

Trauma outcomes before and during the COVID-19 pandemic ($n = 5014$).

Trauma outcomes	COVID-19 pandemic		p value
	Before ($n = 4241$)	During ($n = 773$)	
Death, n (%)	92 (2.2)	18 (2.3)	0.78
ICU admission, n (%)	694 (16.4)	88 (11.4)	<0.001
HLOS, mean \pm SD (days)	8.3 \pm 17.2	5.5 \pm 6.1	<0.001
ICULOS, mean \pm SD (days)	7.5 \pm 11.5	4.5 \pm 6.3	0.02

HLOS: hospital length of stay; ICULOS: intensive care unit length of stay.

Table 4

Therapeutic and diagnostic interventions for traumatic patients before and during the COVID-19 pandemic ($n = 5014$).

Interventions	COVID-19 pandemic, n (%)		p value
	Before ($n = 4241$)	During ($n = 773$)	
Sonography	905 (21.3)	417 (53.9)	<0.001
Echocardiography	313 (7.4)	107 (13.8)	<0.001
Angiography	1597 (37.7)	534 (69.1)	<0.001
MRI	166 (3.9)	51 (6.6)	0.001
Surgery	3407 (80.3)	654 (84.6)	0.003
Internal/external fixation	1215 (28.6)	336 (43.5)	<0.001

different before and during the COVID-19 pandemic. Nevertheless, trauma patients with no formal education and lower high school education level have reduced. It may be because lower educated cases had more fear of the virus and did not hospitalize.¹⁶

Most injuries were occurred in the 16–44 years age group before and during the pandemic. Subsequently, the proportion of traumatic injuries in the youngest (≤ 15 years) and the oldest (≥ 65 years) age groups decreased during the pandemic compared to before the beginning of this pandemic. It might indicate that children and elder adults engaged in high-risk behaviors for traumatic injuries less than other age groups during the pandemic because they were not responsible for economic issues and earning money in their family during the pandemic and could implement lockdown strategy well.⁹ Additionally, reducing the trauma proportion in the youngest (≤ 15 years) age group may be due to the closing of the schools following the pandemic.¹⁷ Inconsistent with our study, Khak et al.⁹ reported that most injured patients were 21–40 years old during the pandemic. Hence, particularly during the COVID-19 pandemic, the preventive interventions, and programs for the mentioned age group, as the riskiest age group, should be emphasized.¹⁰

This study found that the alterations in trauma mechanisms of patients recorded in the NTRI during the pandemic showed increased blunt injuries, cut/stab wounds, and decreased falls. However, no difference in road traffic injury was detected between the 2 periods. Falls were the leading cause of injury-related hospital admissions among elder people.¹⁸ Therefore, staying at home might decrease traumatic injuries among the oldest age group. Furthermore, no significant change in traffic injuries during the pandemic can demonstrate the importance of performing more rigid road traffic regulations to reduce their impacts. In line with our results, Chodos et al.¹⁹ found that the proportion of penetrating trauma increased significantly during COVID-19 in the United States. Likewise, they defined blunt injuries as one of the indicators of domestic violence, so it was expected to increase due to staying-at-home regulations during the pandemic.¹⁹ Additionally, Sanford et al.¹⁴ compared pediatric trauma patients during the COVID-19 to before the beginning of this pandemic in the United States. They showed that lockdown regulations led to increased penetration and burn injuries among children less than 19 years old.

This study showed that the number of ICU admissions, the mean HLOS and the mean ICULOS decreased statistically significant compared with the pre-COVID-19 period. Similarly, Pelzl et al.²⁰ found that patients had a diminished median HLOS during the pandemic than before the period in the United States. It might be because the pandemic raised patients' anxiety about being infected in potentially contagious hospitals.²¹ In addition, because of shortages of beds and equipment in hospitals during the pandemic, health care providers discharged patients earlier than before.¹⁰ Because of the large decline in operational preparedness, just emergency surgeries were performed at most facilities which maybe lead to decreasing of the mean ICULOS.²² Although the

mean HLOS declined statistically significant, no significant change in the death occurred.

As illustrated in the present study, the proportion of diagnostic procedures increased, such as sonography, echocardiography, angiography, and MRI. The change in imaging utilization happened at the time of the pandemic. It seems that health care providers tried to discharge patients as soon as possible and provided more outpatients services, so the proportion of diagnostic procedures such as sonography, echocardiography, angiography, and MRI increased. Likewise, considering the handling of trauma during the pandemic, generally, a higher proportion of trauma patients underwent operative treatments. It might be due to some reasons. After the beginning of the pandemic, elective surgeries were canceled.¹⁰ Additionally, it seemed that the majority of traumatic patients with mild injuries avoided being admitted into hospitals. Fear of getting COVID-19 led to hesitancy for patients and health care providers.²¹

Similarly, regarding the treatment of traumatic injuries with fractures, the proportion of the patients undergoing fixation increased during the COVID-19 pandemic compared to before the pandemic. Maybe, before the pandemic, they were some of the fixations deferred to a later time instead of being completed during the index admission. The other reason was that the increase in "blunt force" injuries during the COVID-19 pandemic led to the increase in fixations. More studies are needed to investigate the impacts of the COVID-19 pandemic on the selection of treatment choices and comparison among countries worldwide. Some trauma guidelines were developed in the context of the COVID-19 pandemic, such as the British Orthopedic Associated Standards, to make an easier decision on managing traumatic patients.²³ Furthermore, because of the COVID-19 pandemic, most medical resources were allocated to COVID-19 patients instead of the standard care.² Health systems were faced with leading challenges to deliver the appropriate level of care to patients with different diseases. In most of the Sina hospital wards during the COVID-19 pandemic, just COVID-19 patients were admitted. However, for traumatic patients, doing diagnostic and treatment procedures were not canceled, which led to performing more therapeutic and diagnostic procedures than before the beginning of this pandemic to discharge injured patients as soon as possible.

The present study was done on an abundant number of traumatic patients. Nevertheless, there was even some missing information because of pandemic conditions that might influence the findings. Furthermore, in the present study, there was no enough data about the patients' condition regarding ventilation and invasive monitoring. As a result, making better data collection can be beneficial.

The COVID-19 pandemic affected epidemiologic features, outcomes, and diagnostic and therapeutic procedures of traumatic patients during the pandemic. We found that the majority of the patients were male before and during COVID-19 pandemic and in the youngest (≤ 15 years) and the oldest (≥ 65 years) age groups, traumatic injuries were decreased during the COVID-19 pandemic. Therefore, the preventive programs for the mentioned age group and males are recommended. Additionally, the COVID-19 outbreak changed the outcomes of the injured patients based on ICU admission, HLOS, and ICULOS. The patients had more diagnostic and therapeutic procedures during the pandemic. To be more precise, more research is needed on the details.

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Ethical statement

This study was approved by the Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran (Ethical approval number: IR.TUMS.SINAHOSPITAL.REC.1399.090. We respected the autonomy of patients and protected their anonymity. Furthermore, all participants provided oral informed consents to participate in the study.

Author contributions

Maryam Baradaran-Binazir and Payman Salamati were involved in study design and prepared the manuscript; Mohammad Reza Zafarghandi and Payman Salamati conducted the project; Vafa Rahimi-Movaghar and Moein Khormali contributed to the implementation of the research; Payman Salamati, Vafa Rahimi-Movaghar, Moein Khormali and Vali Baigi critically revised the manuscript; Moein Khormali provided and processed data; Vali Baigi conducted all statistical analyses; and all authors approved the manuscript.

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Declaration of competing interest

The authors declare no competing interest.

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