Original Article

Gender-based Trauma Outcomes and Predictors of Postinjury In-hospital Mortalities: A Multicenter Analysis from the National Trauma Registry of Iran

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Abstract

Background and Objectives: Injuries in countries like Iran are one of the leading causes of death. This study aims to determine gender differences in trauma outcomes and predictors of in-hospital mortality after trauma. **Methods:** The data of four trauma centers were extracted from the National Trauma Registry of Iran databank between 2016 and 2020. The univariable and multiple logistic regression models analyzed gender differences in trauma outcomes and postinjury predictors of in-hospital mortalities. **Results:** Among 17,530 patients, the most common cause of injury in both genders was road traffic injury (40%). Regarding in-hospital mortality after trauma, although there was a significant gender-based difference between some centers, no overall gender difference was seen (0.9% vs. 1.0% $P = 0.26$). The odds of in-hospital mortality for patients over 65 years old was 10.45 times more than that for patients under 15 years old. Furthermore, the odds of in-hospital mortality for patients admitted to intensive care units (ICU) was 6.22 times as high as that for patients who were not admitted to ICUs. Intubation status had a significant association with in-hospital mortality after adjustment for covariates. The odds of in-hospital mortality for patients with an injury severity score (ISS) ≥16 was 2.57 times higher than that for patients with ISS 1–8. **Conclusions:** Although males had a survival privilege over females following trauma in some centers, there was no overall association between gender and in-hospital mortality. Moreover, older age, ISS, ICU admission, and intubation were predictors of in-hospital mortality for trauma.

Keywords: Gender, injury, National Trauma Registry of Iran, predictors, trauma outcomes

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Introduction

Injuries impose a substantial burden on societies since they cause premature death and long-term disabilities. Based on the World Health Organization, injuries are responsible for 9% of deaths globally.[1] Moreover, global mortality and morbidity rates due to road injuries are around 1.35 million and 20–50 million people per year, respectively.[2] Iran is among the countries where injuries, especially motor vehicle accidents, are critical leading causes of death.[3,4] The Institute for Health Metrics and Evaluation also indicated injuries as one of the ten most common reasons for death in Iran between 2009 and 2019.[5,6]

The investigation of mortality predictors and risk factors associated with injury-related outcomes, such as age, mechanism, severity, and causes of injuries, can improve the quality of care and reduce the mortality rate in trauma patients.[7] An assumption is that the severity and mechanism of injury differ between men and women. Females have lower morbidity and mortality after injuries due to their hormones.[8,9] Therefore, gender could be a risk factor which investigation of its relationship with injury outcomes seems essential. Several studies have investigated the association between gender and trauma outcomes with controversial results.[10-16] Some found no relationship between gender and mortality after trauma;[15,16] whereas others reported a significant association between them.[11]

To the best of our knowledge, insufficient studies have explicitly examined gender differences in trauma outcomes and mortality predictors in Iran.[17-20] Hence, we analyzed the data from the National Trauma Registry of Iran (NTRI) to assess the association between gender and trauma and predictors of in-hospital mortality after injuries to develop effective prevention and comprehensive management strategies in the future.

Materials and Methods

Data gathering

The Sina Trauma and Surgery Research Center established the NTRI, Tehran, Iran, in 2015.[9,21] Patients with one or more traumatic injuries with the diagnostic code of injury according to the 10th revision of the International Classification of Diseases-10, who met one of the following criteria, were included in the registry: being admitted more than 24 h to an NTRI collaborating hospital, being transferred from intensive care units (ICUs) of other hospitals to these trauma centers, and death due to injury during the first admission day in the hospitals.[21]

For the present study, the data of four trauma centers were extracted from the NTRI databank between July 24, 2016, and March 14, 2020. These centers were Sina Hospital (Tehran, Iran), Shohada Hospital (Tabriz, Iran), Shahid Rahnamoun Hospital (Yazd, Iran), and Shahid Beheshti Hospital (Kashan, Iran).

During the registration process in the NTRI, trained registrars collected the data in each trauma center. First, data about the pre-hospital, emergency department (ED), and in-hospital were collected through interviews from patients or their Substitute Decision Makers (SDMs) along with extracting from patients' medical records and hospital information systems.[21] In the next step, the collected data were entered into the NRTI software by trained registrars. Finally, the entered data were subjected to quality control in which trained reviewers and independent controllers checked the data in terms of accuracy, consistency, and completeness.[9]

Statistical analysis

The mean and standard deviation was used to describe quantitative variables with the normal distribution. The data with a nonnormal distribution were presented as the median and interquartile range (IQR). In addition, numbers and percentages were used to describe categorical variables. The independent samples *t*-test was used to compare the mean age, years of school, total hospital length of stay (LOS), and ICU LOS between male and female patients. Furthermore, the Mann–Whitney *U* test was applied to compare the mean of injury severity score (ISS), Glasgow coma scale (GCS) between males and females.

The relationship of categorical variables with gender was assessed through the Chi-square test. Moreover, the univariable and multiple logistic regression models were used to estimate crude and adjusted odds ratios (ORs). A significance level of 0.05 was also considered for all analyses. Finally, the STATA software version 14.0 (Stata Corporation, College Station, TX, USA) was used for data analysis.

Ethical considerations

The Research Ethics Committee of Tehran University of Medical Sciences approved this study (Approval ID: IR.TUMS.SINAHOSPITAL.REC.1399.090). During the NTRI data collection process, verbal informed consent was obtained from the patients or their SDMs, in case the patients were not conscious or competent for providing the informed consent.

Results

A total of 17,530 patients (males = 13,391, 76.4% and females = 4139, 23.6%) were enrolled in the study. [Table 1] shows the baseline characteristics of the study population. The male patients were younger than female patients (mean age: 34.6 vs. 45.6 years, $P < 0.001$). In the age groups ≤15, 45–64, and + 65 years, the number of females was more than males, while in the age group 16–44 years, males made up a larger proportion. The median (IQR) of ISS was 4 (3.0) and 4 (5.0) in men and women, respectively [Table 1].

Overall, the most common cause of injury was road traffic injuries (RTIs) (40%), followed by fall injuries (36.4%) [Figure 1, Table S1]. Considering gender, the most common cause of injury in men was RTIs (44.3%). However,

Table 1: Baseline characteristics of trauma patients by gender from 2016 to 2020 (*n*=17,530)

	Males (*n*=13,391)	Females (*n*=4139)	*P*
Age (years), mean±SD	34.6 (20.1)	45.6 (26.9)	<0.001
Age group, *n* (%)			
≤15	2164 (16.2)	834 (20.1)	<0.001
16-44	7558 (56.2)	1096 (26.5)	
45-64	2390 (17.8)	957 (23.1)	
+65	1262 (9.4)	1251 (30.2)	
Missing	17 (0.2)	1 (0.1)	
Years of education, mean±SD	8.7 (11.5)	4.9 (9.5)	<0.001
ISS, median (IQR)	4.0 (3.0)	4.0 (5.0)	<0.001
ISS categorical, *n* (%)			
1-8	9350 (69.8)	2598 (62.8)	<0.001
9-15	2154 (16.1)	1019 (24.6)	
≥16	212 (1.6)	37 (0.9)	
Missing	1675 (12.5)	485 (11.7)	
Admission GCS score, median (IQR)	15 (0)	15 (0)	0.01

SD: Standard deviation, ISS: Injury severity score, IQR: Interquartile range, GCS: Glasgow Coma Scale

falls made up a more significant proportion of injuries in women (58.3%) [Figure 1 and Table 2].

The mean hospital LOS was longer in male patients (5.6 days vs. 4.9 days, $P = 0.02$) [Table 3]. Female patients had a higher ICU admission rate than male patients (8.6% vs. 7.0%, $P < 0.001$). However, male patients had longer ICU stays (7.8 days vs. 5.8 days, $P = 0.02$) among the patients admitted to the ICU. Females suffered more from hypotension on admission to the ED than males (4.1% vs. 2.8%, $P < 0.001$). Males, however, had a higher rate of intubation in the hospital (1.3% vs. 0.9%, $P = 0.016$) [Table 3]. No significant inter-gender differences were found in the in-hospital mortality rate (0.9% vs. 1.0%, $P = 0.26$).

Table 4 presents ICU admission and in-hospital mortality in each center. According to [Table 4], females had a higher ICU admission rate and in-hospital mortality than males in all the centers except Yazd. Female patients had a higher in-hospital mortality rate than males did in Sina Hospital (3.7% vs. 2.0%, $P = 0.01$), Kashan (1.8% vs. 1.0%, $P = 0.06$), and Tabriz (0.2% vs. 0.1%, $P = 0.40$), while males had a slightly higher rate of in-hospital mortality in Yazd, (1.7% vs. 1.6%, $P = 0.80$).

Table 5 presents the crude and adjusted ORs (95% confidence intervals [CI]) of the associations of gender and other covariates with in-hospital mortality. Multiple logistic regression showed that older age, higher ISS, ICU admission, and intubation were the most important predictors of in-hospital mortality for trauma in both genders. According to the results, after adjustment for other covariates, the odds of in-hospital mortality for patients admitted to the ICU were 6.22 times as high as the odds for patients not admitted to ICU (adjusted OR 6.22, 95% CI: (4.01–9.64), $P < 0.001$). Similarly, intubation status had a statistically significant association with in-hospital mortality after adjustment for covariates (adjusted OR 5.35, 95% CI: [2.95–9.72], $P < 0.001$).

Table 2: Cause of injury by gender from 2016 to 2020 (*n*=17,530)

	Males (*n*=13,391)	Females (*n*=4139)	*P*
Road traffic injuries	5932 (44.3)	1140 (27.5)	<0.001
Fall	3974 (29.7)	2411 (58.3)	
Nonpenetrating	1074 (8.0)	192 (4.6)	
Penetrating	1965 (14.7)	280 (6.8)	
Other causes	446 (3.3)	116 (2.8)	

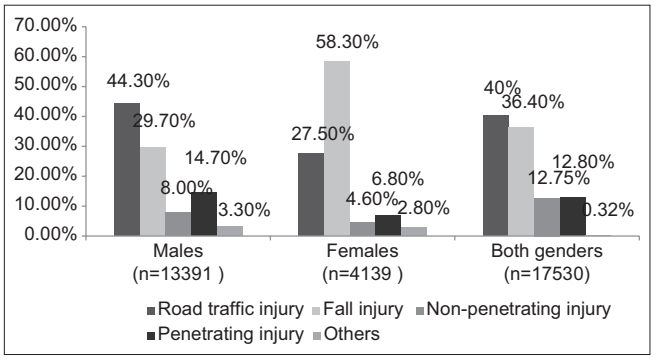

Figure 1: Cause of injury by gender (2016–2020)

Furthermore, logistic regression models did not show gender as a predictor of in-hospital mortality in the study population (Crude OR 0.84, 95% CI [0.59–1.20], $P = 0.35$) and (Adjusted OR 0.97, 95% CI: [0.60–1.47], $P = 0.88$).

Discussion

Although the present study showed no overall inter-gender difference in mortality due to trauma, the subgroup analysis found a statistically significant difference in the in-hospital death between men and women in some centers. Furthermore, we found some predictors of in-hospital

Table 3: Clinical outcomes of trauma patients by gender (2016-2020)

	Males (*n*=13,391)	Females (*n*=4139)	*P*
Total hospital LOS (days), mean±SD	5.6 (16.3)	4.9 (12.7)	0.02
ICU admission, *n* (%)	1010 (7.0)	384 (8.6)	<0.001
ICU LOS (days), mean±SD*	7.8 (10.6)	5.8 (9.6)	0.02
Hospital intubation, *n* (%)	176 (1.3)	37 (0.9)	0.016
Hypotension, *n* (%)†	374 (2.8)	168 (4.1)	<0.001
In-hospital mortality, *n* (%)	118 (0.9)	43 (1.0)	0.26

*The mean of ICU LOS was estimated only for those admitted to the ICU, †SBP ≤89 mmHg on admission. LOS: Length of stay, SD: Standard deviation, ICU: Intensive care unit, SBP: Systolic blood pressure

Table 4: Clinical outcomes of trauma patients by gender and center (2016-2020)

	Males	Females	*P*
Sina Hospital (Tehran)			
ICU admission, *n* (%)	502 (14.5)	159 (25.8)	<0.001
In-hospital mortality, *n* (%)	70 (2.0)	23 (3.7)	0.01
Shahid Beheshti Hospital (Kashan)			
ICU admission, *n* (%)	101 (7.6)	48 (10.5)	0.06
In-hospital mortality, *n* (%)	13 (1.0)	8 (1.8)	0.20
Shahid Rahnamoun Hospital (Yazd)			
ICU admission, *n* (%)	256 (17.7)	51 (13.6)	0.07
In-hospital mortality, *n* (%)	25 (1.7)	6 (1.6)	0.80
Shohada Hospital (Tabriz)			
ICU admission, *n* (%)	151 (2.1)	125 (4.6)	<0.001
In-hospital mortality, *n* (%)	10 (0.1)	6 (0.2)	0.40

ICU: Intensive care unit

Table 5: Logistic regression analysis of in-hospital mortality on gender and other covariates in trauma patients (2016-2020), odds ratio (95% confidence interval for odds ratio)

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)
Age		
≤15	Reference	
16-44	3.91 (1.40-10.88)	1.20 (0.40-3.58)
45-64	9.05 (3.23-25.33)	3.50 (1.16-10.56)
+65	22.07 (8.05-60.5)	10.45 (3.57-30.51)
Gender	0.84 (0.59-1.20)	0.94 (0.60-1.47)
ISS		
1-8	Reference	Reference
9-15	10.22 (6.38-16.37)	2.93 (1.64-5.22)
≥16	65.49 (37.52-114.32)	2.57 (1.14-5.81)
ICU admission	12.17 (7.42-19.21)	6.22 (4.01-9.64)
RTS*	0.69 (0.66-0.72)	0.86 (0.81-0.91)
Years of school	1.04 (1.03-1.05)	1.03 (1.02-1.04)
Intubation	31.12 (25.31-38.48)	5.35 (2.95-9.72)

Bold indicates p< 0.05; *Revised Trauma Score = (0.9368 × GCS Value) + (0.7326 × SBP Value) + (0.2908 × RR Value). Abbreviations: ISS, injury severity score; ICU, intensive care unit; RTS, revised trauma score; GCS, Glasgow coma scale; SBP, systolic blood pressure; RR, respiratory rate.

mortality and the most common cause of injury following trauma; considering them will be essential to develop effective prevention and comprehensive management strategies.

Regarding the association between gender and mortality after trauma, the results of some studies were consistent with our research.[15,16,22-24] However, a significant difference was that the previous studies included patients with blunt trauma, while we assessed patients with blunt and penetrating trauma. Rappold and colleagues found no significantly inter-gender difference in the mortality of traumatic patients with shock and closed head injury.[22] In another study of 18892 patients with blunt trauma, there was no relationship between gender and mortality except for developed pneumonia.[23] Likewise, in a study on more than 36000 patients with blunt trauma, the researchers indicated no independent association between gender and mortality.[24] This study also showed gender-based morbidity outcomes, including ventilator-associated pneumonia, acute respiratory distress syndrome, and bacteremia. However, these outcomes were not evaluated in the present study.

Similarly, George *et al*. found no significant association between gender and mortality in patients with penetrating trauma.[25] However, they found a meaningful relationship between gender and mortality regarding blunt trauma, especially in patients over 50 years old, which is not consistent with our results.[25] This inconsistency could be due to the difference in the sample size. In a study investigating trauma patients with ISS ≥16 in the Netherlands, female patients aged 16–44 years old had a lower in-hospital mortality rate than the males of the same age group.[26] However, logistic regression analysis failed to demonstrate an independent association between gender and mortality; therefore, their overall results were consistent with our findings.

By contrast, some studies found inter-gender differences in the mortality rate after trauma.[8,10,18,27] For instance, a study conducted in China found a lower mortality rate after severe blunt trauma in females than males.[27] The difference between the above study findings and our results could be due to the number of participants and type of trauma. Since only 1789 cases with blunt trauma were analyzed in their study, we assessed 17530 patients with any trauma (blunt/penetrating). Moreover, Mostafa *et al*. found that young male patients experienced more complications, except pneumonia, and their mortality rate was higher than females.[28] Finally, a retrospective study indicated an association between gender and trauma outcomes after blunt and penetrating trauma.[8] In the south of Iran, an analysis of 47,295 trauma patients revealed an association between the mortality rate and gender in the elderly.[17]

Overall, the main reason behind the inconsistency between our findings and other studies indicating substantial gender-based differences in posttrauma mortalities[8,10,18,27] could be a non-significant mortality rate in both genders in the present study, hindering the detection of any differences. In addition, the lower mortality rate of the present study was because the

data were extracted from a hospital-based trauma registry rather than a population-based one.

The present study found that older age, higher ISS, ICU admission, and intubation status were predictors of in-hospital mortality following trauma. The literature review of some studies about predictors of in-hospital mortality in trauma patients has represented consistent results with ours. For example, Markogiannakis *et al*. showed that older age and higher ISS (ISS ≥18) were predictors of in-hospital mortality after vehicle-related traumas.[29] Similarly, MacLeod *et al*. found older age and ISS independent predictors of mortality in trauma patients in a trauma registry review from 1995 to 2000.[30] Another study on trauma patients ≥60 years old with ISS ≥16 represented advanced age ≥80 and intubation status on admission as the independent predictors of mortality in the elderly after trauma.[31] This finding is because patients with such conditions, including intubation, ICU admission, higher ISS, and advanced age, are critically ill and have higher mortality rates than other trauma patients.

Furthermore, our results found that the most common injury cause was RTI in both genders; however, the incidence of fall injuries among females was higher than males. This finding was in line with some previous studies in Iran about the cause of injury.[9,17-19,32-34] For example, a study conducted at Sina Hospital Tehran, Iran, represented that the most common injury causes were RTIs, followed by falls and penetrating trauma.[9] Another cross-sectional study in Shiraz, Iran, by Bolandparvaz *et al*., reported that among 47,295 individuals older than 15 years, RTIs were the most common cause of injury in males.[17] By contrast, females were primarily victims of fall and pedestrian accidents in this study.[17] Rasouli *et al*. also analyzed more than 2.9 million trauma patients admitted to the ED of university hospitals in Iran for 3 years and found that the most common cause of injury was RTI.[32]

Moreover, a literature review suggests that Iran has a high mortality rate due to RTIs.[35-37] Road conditions, such as lack of road construction standards and ignoring driving rules, are the most common causes of road-related accidents in Iran.[20,38,39] The present study also found that women, especially the elderly, were more prone to fall-related injuries than men, consistent with some previous studies.[40] These findings could raise awareness about the significance of appropriate measures to improve trauma care quality and implement preventive strategies related to RTIs and fall-related injuries.

Our study has some strengths; the most important is that predictors of in-hospital mortality in trauma patients and causes of injury in both genders were evaluated. Furthermore, we assessed gender differences in clinical outcomes following trauma, continuing previous studies.[10,15,16,22-27] Moreover, to the best of our knowledge, this is the first multicenter gender-based analysis of a large sample size of all ages and trauma types from four regions of Iran over an extended period. Finally, the data were collected by trained staff and professional reviewers, and controllers double-checked their qualities.

However, this study has some limitations; For instance, the data were extracted from a hospital-based trauma registry instead of a population-based one. Hence, this registry does not include the deaths that occurred outside the hospitals. Moreover, the data of the trauma-related mortality rate of other hospitals in the studied cities were not included, which hindered the detection of any gender-specific differences in the mortality rate of trauma patients.

Conclusion

In summary, the present study revealed that the odds of intubation, the mean length of hospital stay, and the mean length of ICU stay were significantly higher in men than in women after trauma. Although males had a survival privilege over their opposite gender following trauma in some centers, there was no overall association between gender and in-hospital mortality. Moreover, older age, higher ISS, ICU admission, and intubation were the most important predictors of postinjury in-hospital mortalities.

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Conflicts of interest

There are no conflicts of interest by the authors.

References

1. World Health Organisation. Health Topics: Injuries. Available from: https://www.who.int/topics/injuries/about/en/. [Last accessed on 2020 Dec 09].
2. World Health Organization. Road Traffic Injuries: Key Facts. Available from: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries. [Last accessed on 2020 Feb 07].
3. Khaleghi-Nekou M, Moradi A, Zafarghandi M, Fayaz-Bakhsh A, Saeednejad M, Rahimi-Movaghar V, *et al.* Epidemiology of fatal injuries among patients admitted at Sina hospital, the national trauma registry of Iran, 2016-2019. Frontiers in Emergency Medicine. 2021;5(1):e9. [doi: 10.22114/ajem.v0i0.427].
4. Forouzanfar MH, Sepanlou SG, Shahraz S, Dicker D, Naghavi P, Pourmalek F, *et al.* Evaluating causes of death and morbidity in Iran, global burden of diseases, injuries, and risk factors study 2010. Arch Iran Med 2014;17:304-20.
5. Institute for Health Metrics and Evaluation. Iran (the Islamic Republic of) Related Content: What Causes the Most Deaths? Top 10 Causes of Total Number of Deaths in 2019 and Percent Change 2009–2019, All Ages Combined. Available from: http://www.healthdata.org/iran. [Last accessed on 2021 Jul 26.
6. Institute for Health Metrics and Evaluation. Iran 2017. USA 2017. Canada 2017. Health-Related SDGs: Viz Hub: The Death Rate due to Road Injuries. The Updated 2021 University of Washington. Available from: https://vizhub.healthdata.org/sdg/. [Last accessed on 2021 Jul 26].
7. Sim J, Lee J, Lee JC, Heo Y, Wang H, Jung K. Risk factors for mortality of severe trauma based on 3 years' data at a single Korean institution. Ann Surg Treat Res 2015;89:215-9.
8. Petersen S, Simms ER, Guidry C, Duchesne JC. Impact of hormonal protection in blunt and penetrating trauma: A retrospective analysis of the National Trauma Data Bank. Am Surg 2013;79:944-51.
9. Sharif-Alhoseini M, Zafarghandi M, Rahimi-Movaghar V, Heidari Z, Naghdi K, Bahrami S, *et al.* National trauma registry of Iran: A pilot phase at a major trauma center in tehran. Arch Iran Med 2019;22:286-92.

10. Lam NN, Hung NT, Duc NM. Influence of gender difference on outcomes of adult burn patients in a developing country. Ann Burns Fire Disasters 2019;32:175-8.
11. El-Menyar A, El-Hennawy H, Al-Thani H, Asim M, Abdelrahman H, Zarour A, *et al*. Traumatic injury among females: Does gender matter? J Trauma Manag Outcomes 2014;8:8.
12. Gannon CJ, Pasquale M, Tracy JK, McCarter RJ, Napolitano LM. Male gender is associated with increased risk for post-injury pneumonia. Shock 2004;21:410-4.
13. Sperry JL, Nathens AB, Frankel HL, Vanek SL, Moore EE, Maier RV, *et al.* Characterization of the gender dimorphism after injury and hemorrhagic shock: Are hormonal differences responsible? Crit Care Med 2008;36:1838-45.
14. Dasari M, David SD, Miller E, Puyana JC, Roy N. Comparative analysis of gender differences in outcomes after trauma in India and the USA: Case for standardized coding of injury mechanisms in trauma registries. BMJ Glob Health 2017;2:e000322.
15. Bowles BJ, Roth B, Demetriades D. Sexual dimorphism in trauma? A retrospective evaluation of the outcome. Injury 2003;34:27-31.
16. Coimbra R, Hoyt DB, Potenza BM, Fortlage D, Hollingsworth-Fridlund P. Does sexual dimorphism influence outcome of traumatic brain injury patients? The answer is no! J Trauma 2003;54:689-700.
17. Bolandparvaz S, Yadollahi M, Abbasi HR, Anvar M. Injury patterns among various age and gender groups of trauma patients in southern Iran: A cross-sectional study. Medicine (Baltimore) 2017;96:e7812.
18. Yadollahi M. A study of mortality risk factors among trauma referrals to trauma center, Shiraz, Iran, 2017. Chin J Traumatol 2019;22:212-8.
19. Ansari-Moghaddam A, Martiniuk AL, Mohammadi M, Rad M, Sargazi F, Sheykhzadeh K, *et al.* The pattern of injury and poisoning in South-East Iran. BMC Int Health Hum Rights 2012;12:17.
20. Mohammadzadeh M, Paravar M, Mirzadeh AS, Mohammadzadeh J, Mahdian S. Seat belt usage in injured car occupants: Injury patterns, severity and outcome after two main car accident mechanisms in Kashan, Iran, 2012. Arch Trauma Res 2015;4:e22203.
21. Ghodsi Z, Rahimi Movaghar V, Zafarghandi M, Saadat S, Mohammadzadeh M, Fazel M, *et al*. The minimum dataset and inclusion criteria for the national trauma registry of Iran. Arch Trauma Res 2017;6:e39725.
22. Rappold JF, Coimbra R, Hoyt DB, Potenza BM, Fortlage D, Holbrook T, *et al.* Female gender does not protect blunt trauma patients from complications and mortality. J Trauma 2002;53:436-41.
23. Napolitano LM, Greco ME, Rodriguez A, Kufera JA, West RS, Scalea TM. Gender differences in adverse outcomes after blunt trauma. J Trauma 2001;50:274-80.
24. Magnotti LJ, Fischer PE, Zarzaur BL, Fabian TC, Croce MA. Impact of gender on outcomes after blunt injury: A definitive analysis of more than 36,000 trauma patients. J Am Coll Surg 2008;206:984-91.
25. George RL, McGwin G Jr., Metzger J, Chaudry IH, Rue LW 3rd. The association between gender and mortality among trauma patients as modified by age. J Trauma 2003;54:464-71.
26. Pape M, Giannakópoulos GF, Zuidema WP, de Lange-Klerk ES, Toor EJ, Edwards MJ, *et al*. Is there an association between female gender and outcome in severe trauma? A multicentre analysis in the Netherlands. Scand J Trauma Resusc Emerg Med 2019;27:16.
27. Zhu Z, Shang X, Qi P, Ma S. Sex-based differences in outcomes after severe injury: An analysis of blunt trauma patients in China. Scand J Trauma Resusc Emerg Med 2017;25:47.
28. Mostafa G, Huynh T, Sing RF, Miles WS, Norton HJ, Thomason MH. Gender-related outcomes in trauma. J Trauma 2002;53:430-4.
29. Markogiannakis H, Sanidas E, Messaris E, Koutentakis D, Alpantaki K, Kafetzakis A, *et al.* Predictors of in-hospital mortality of trauma patients injured in vehicle accidents. Ulus Travma Acil Cerrahi Derg 2008;14:125-31.
30. MacLeod J, Lynn M, McKenney MG, Jeroukhimov I, Cohn SM. Predictors of mortality in trauma patients. Am Surg 2004;70:805-10.
31. Bala M, Willner D, Klauzni D, Bdolah-Abram T, Rivkind AI, Gazala MA, *et al.* Pre-hospital and admission parameters predict in-hospital mortality among patients 60 years and older following severe trauma. Scand J Trauma Resusc Emerg Med 2013;21:91.
32. Rasouli MR, Saadat S, Haddadi M, Gooya MM, Afsari M, Rahimi-Movaghar V. Epidemiology of injuries and poisonings in emergency departments in Iran. Public Health 2011;125:727-33.
33. Modaghegh MH, Saremi E, Mohamadian M, Jafarzadeh R. Characteristics of trauma in North East Iran and the prevention strategies. Arch Iran Med 2013;16:576-9.
34. Yadollahi M, Ghiassee A, Anvar M, Ghaem H, Farahmand M. Analysis of Shahid Rajaee hospital administrative data on injuries resulting from car accidents in Shiraz, Iran: 2011-2014 data. Chin J Traumatol 2017;20:27-33.
35. Bhalla K, Sharaz S, Abraham J, Bartels D, Yeh P. Road Injuries In 18 Countries. Boston, MA, USA: Department of Global Health and Population, Harvard School of Public Health; 2011. Available from: http://pubdocs.worldbank.org/en/356861434469785833/Road-Safety-Burden-of-Injuries-in-Africa.pdf. [Last accessed on 2020 Feb 7].
36. Naghavi M, Shahraz S, Bhalla K, Jafari N, Pourmalek F, Bartels D, Puthenpurakal JA, Motlagh ME. Adverse health outcomes of road traffic injuries in Iran after rapid motorization. Arch Iran Med. 2009 May;12(3):284-94. PMID: 19400607. Available from: http://www.healthdata.org/research-article/adverse-health-outcomes-road-traffic-injuries-iran-after-rapid-motorization.
37. Bazargan-Hejazi SH, Ahmadi A, Shirazi A, Ainy E, Djalalinia SH, Fereshtehnejad SM, *et al.* The burden of road traffic injuries in iran and 15 surrounding countries: 1990–2016, Arch Iran Med 2018;21:556-65.
38. Hamzeh B, Najafi F, Karamimatin B, Ahmadijouybari T, Salari A, Moradinazar M. Epidemiology of traffic crash mortality in west of Iran in a 9 year period. Chin J Traumatol 2016;19:70-4.
39. Sayyar Roudsari B, Sharzei K, Zargar M. Sex and age distribution in transport-related injuries in Tehran. Accid Anal Prev 2004;36:391-8.
40. Johansson J, Nordström A, Nordström P. Greater fall risk in older women than in men is associated with increased gait variability during multitasking. J Am Med Dir Assoc 2016;17:535-40.

Table S1: Cause of injury by gender and centers, (2016-2020), *n* (%)

	Sina hospital		Kashan		Yazd		Tabriz	
	Male (*n*=3458)	Female (*n*=616)	Male (*n*=1327)	Female (*n*=456)	Male (*n*=1445)	Female (*n*=375)	Male (*n*=7161)	Female (*n*=2692)
Road traffic injury	1903 (55.0)	192 (31.2)	788 (59.4)	197 (43.2)	894 (61.9)	215 (57.3)	2347 (32.8)	536 (19.9)
Fall injuries	606 (17.5)	342 (55.5)	291 (21.9)	221 (48.5)	295 (20.4)	124 (33.1)	2782 (38.8)	1724 (64.0)
Nonpenetrating	157 (4.5)	16 (2.6)	166 (12.5)	22 (4.8)	63 (4.4)	11 (2.9)	688 (9.6)	143 (5.3)
Penetrating	705 (20.4)	52 (8.4)	39 (2.9)	4 (0.9)	126 (8.7)	12 (3.2)	1095 (15.3)	212 (7.9)
Others	87 (2.5)	14 (2.3)	43 (3.2)	12 (2.6)	67 (4.6)	13 (3.5)	249 (3.5)	77 (2.9)