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REVIEW ARTICLE

Epidemiology of Traumatic Spinal Cord Injuries in Iran; a Systematic Review and Meta-Analysis

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Abstract: **Introduction:** Understanding the epidemiology of traumatic spinal cord injuries (TSCIs) can be helpful for policymakers and planners to consider appropriate strategies to control and prevent these injuries. This study aimed to determine the epidemiological characteristics of TSCI in Iran in order to increase knowledge and awareness of these injuries. **Methods:** A systematic literature search was conducted up to January 2022 in the electronic databases, including PubMed, Scopus, Web of Science, Google Scholar, SID, Iranmedex, and Magiran. The quality of included studies was evaluated using the STORBE checklist. Comprehensive meta-analysis was used to analyze the data. **Results:** Nineteen studies involving 9416 cases were included in the study. Participants' pooled mean age was 35.80 ± 1.07 years (95% CI: 33.69 to 37.91), of whom 69% (95% CI: 68% to 70%; P<0.05) were male. The most frequent TSCI occurred in the age group of less than 30 years. Motor vehicle collisions (MVCs) was the most common cause of TSCI (57%; 95% CI: 25% to 63%), followed by falls (32%; 95% CI: 26% to 38%). Most participants had thoracolumbar (27%; 95% CI: 10% to 55%) and cervical injuries (23%; 95% CI: 16% to 31%), respectively. The incidence of TSCI was estimated at 10.5 per million people. The prevalence of TSCI was 3 per 10000 people. The mortality rate due to TSCI was 3.9% (95% CI: 0.02 to 0.06; P<0.05). **Conclusion:** Based on the findings of this meta-analysis, the pooled incidence and prevalence of TSCI in the Iranian population were 10.5/1000.000 people and 4.4/10.000 people, respectively. TSCIs had occurred more frequently in males following MVCs, and in the age group under 30 years. The pooled mortality rate due to TSCI was 3.9% (95% CI: 0.02 to 0.06; P<0.05).

Keywords: Spinal Cord Injuries; Epidemiology; Prevalence; Incidence; Iran

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1. Introduction

Spinal cord injuries are classified into two types, traumatic and non-traumatic (1). Traumatic spinal cord injuries (TSCI) are one of the most severe conditions in terms of morbidity and disability (2, 3). The mortality rate in people with TSCI is higher than that of normal people (4). The in-hospital mortality rate of spinal cord injuries varies from region to region (4). The most common causes of TSCI are motor vehicle collisions (MVCs), falls, violence, and sports/leisure activities (5). TSCIs predominantly occur in males younger than 30 years old (6), and most frequently at the level of the cervical spine, followed by thoracic, and lumbosacral (7). In 2016, there were 0.93 million (0.78-1.16 million) new cases of SCI, with age-based standardized incidence rates of 13 (11-16) per 100 000 people for SCI (8).

The incidence rate is different from one country to another (9). TSCI is a costly injury for patients as the average cost for the initial injury and recovery phase of SCI can be $142,366 (10). The most common symptoms in patients with TSCI include pain, weakness, fatigue, and numbness (11). The most common outcomes after TSCI are paralysis (12), depression (13), anxiety (14), osteoporosis (15), adverse events, including urinary tract infections, pneumonia, neuropathic pain, delirium, pressure ulcers (16), hydronephrosis, bladder stones, vesicoureteral reflux (17), Hypothermia (18), cardiovascular complications, and autonomic dysreflexia (19).

Given that TSCIs vary by country and region (20), and there is no meta-analysis regarding these injuries in Iran, there is an urgent need to determine the epidemiological characteristics of TSCIs in order to implement appropriate control and prevention strategies. This study aimed to investigate the epidemiological characteristics of TSCI in the Iranian population.

2. Methods

The Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines (21) were used when writing the report, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used when preparing the report (22).

2.1. Literature search strategy

Two authors, independently, carried out a systematic literature search in the most important electronic databases, including PubMed, Scopus, Web of Science, Google Scholar, SID, Iranmedex, and Magiran to identify the studies published in English or Persian languages up to January 2022 using keywords. Furthermore, the list of references of records included in the final analysis was scanned for more articles. The key search terms included traumatic spinal cord injuries, epidemiology, prevalence, incidence, risk factors, and Iran. The search strategy by database was:

PubMed

#1. Spinal Cord Injur* [Title/Abstract] OR Spinal Cord Injuries [MeSH Terms]
#2. Epidemiolog* [Title/Abstract] OR Epidemiology [MeSH Terms]
#3. Incidence [Title/Abstract] OR Incidence [MeSH Terms]
#4. Risk factor* [Title/Abstract] OR Risk factor [MeSH Terms]
#5. Prevalence [Title/Abstract] OR Prevalence [MeSH Terms]
#6. Iran [Title/Abstract]
#7. 2 OR 3 OR 4 OR 5
#8. 1 AND 7 AND 6

Web of Science

#1. TI= (Spinal cord injur*)
#2. TI= (Epidemiolog *)
#3. TI= (Incidence)
#4. TI= (Prevalence)
#5. TI= (Risk factor*)
#6. TI= (Iran)
#7. 2 OR 3 OR 4 OR 5
#8. 1 AND 7 AND 6

Scopus

#1. TITLE-ABS-KEY (Spinal cord injur*)
#2. TITLE-ABS-KEY = (Epidemiolog *)
#3. TITLE-ABS-KEY = (Incidence)
#4. TITLE-ABS-KEY = (Prevalence)
#5. TITLE-ABS-KEY = (Risk factor*)
#6. TITLE-ABS-KEY = (Iran)
#7. 2 OR 3 OR 4 OR 5
#8. 1 AND 7 AND 6

2.2. Study selection

Epidemiological studies conducted on the Iranian population with TSCI were included, and those conducted on individuals with non-traumatic spinal cord injuries, with irrelevant outcomes, case series, case reports, and the letters to the editor were excluded.

2.3. Data extraction and quality assessment

The methodological quality of included studies was assessed using ROBINS-I tool (23). Two authors extracted the epidemiological and demographic data, independently, using the same extraction form. The extracted information included 1) study characteristics (first author, year, place, period, and type), demographic characteristics (sample size, mean age, and sex), and epidemiological outcomes (preva-

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Table 1: Characteristics of included studies

Study	Province	Period	N	Ratio (M:F)	Mean age	Incidence /1000000	Prevalence /10000	Leading causes	Second causes
Andalib, 2018 (24)	Guilan	2015-2018	127	3.5: 1	38.27	NR	NR	MVCs	-
Derakhshanrad, 2016 (25)	Tehran	2011-2015	1137	3.8:1	29.1	NR	2.36	MVCs	falling
Fakharian, 2004 (27)	Isfahan	1995-1999	225	3.6:1	39	NR	NR	falling	MVCs
Fakharian, 2019 (26)	Isfahan	2014-2017	986	3.3:1	39.5	NR	NR	MVCs	falling
Ghajarzadeh, 2019 (28)	Tehran	2013-2017	830	4.3:1	29	NR	NR	MVCs	falling
Haddadi, 2015 (29)	Mazandaran	2012-2014	906	1.3:1	NR	NR	NR	MVCs	falling
Jazayeri, 2015(30)	Tehran, Alborz	2015	NR	NR	NR	NR	2.96	NR	NR
Kamravan, 2014 (31)	Fars	2009-2012	261	3:1	37.2	NR	NR	MVCs	falling
Khazaeipour, 2017 (32)	Tehran	2012-2013	140	2.5:1	NR	NR	NR	MVCs	falling
Rahimi-movaghar, 2009 (35)	Tehran	2007-2008	4	1:1	31.7	NR	4.4	MVCs	falling
Ramezani, 2019 (36)	Guilan	2015-2017	170	2.3:1	40.2	NR	NR	MVCs	falling
Rasouli, 007 (33)	Southeastern Iran	1994-2005	64	18:1	27.42	NR	NR	MVCs	-
Saatian, 2020 (37)	Hamadan	2007-2017	3219	2:1	41.7	NR	NR	MVCs	falling
Sharif-Alhoseini, 2014 (38)	Tehran	2010-2011	138	5.5:1	33.2	10.5	NR	falling	MVCs
Tabesh, 2018 (34)	Isfahan	2012-2018	510	2.3:1	42.31	NR	NR	MVCs	falling
Yousefzadeh-Chabok, 2010 (41)	Guilan	2005-2006	245	2.5:1	38.2	NR	NR	MVCs	falling
Yousefzadeh-Chabok, 2015 (42)	Guilan	2015	76	8.5:1	35.2	NR	NR	MVCs	falling
Yadollahi, 2018 (39)	Fars	2017	171	4.9:1	38.2	NR	NR	MVCs	falling
Yazdani, 2021 (40)	Hormozgan	2017	207	2.5:1	40.2	NR	NR	MVCs	falling

N: number of participants, M: male, F: female, NR: not reported, MVCs: motor vehicle collisions.

Table 2: Risk of bias (ROBINS-I)

Study	Confounding	Selection	Intervention Measurement	Missing Data	Outcome Measurement	Reported Result	Overall
Andalib, 2018	Moderate	Low	Low	Low	Low	Moderate	Moderate
Derakhshanrad, 2016	Moderate	Low	Low	Low	Low	Moderate	Moderate
Fakharian, 2004	Moderate	Low	Low	Low	Low	Moderate	Moderate
Fakharian, 2019	Moderate	Low	Low	Low	Low	Moderate	Moderate
Ghajarzadeh, 2019	Moderate	Low	Low	Low	Low	Moderate	Moderate
Haddadi, 2015	Moderate	Low	Low	Low	Low	Moderate	Moderate
Jazayeri, 2015	Moderate	Low	Low	Low	Low	Moderate	Moderate
Kamravan, 2014	Moderate	Low	Low	Low	Low	Moderate	Moderate
Khazaeipour, 2017	Moderate	Low	Low	Low	Low	Moderate	Moderate
Rahimi-movaghar, 2009	Moderate	Low	Low	Low	Low	Moderate	Moderate
Ramezani, 2019	Moderate	Low	Low	Low	Low	Moderate	Moderate
Rasouli, 2007	Moderate	Low	Low	Low	Low	Moderate	Moderate
Saatian, 2020	Moderate	Low	Low	Low	Low	Moderate	Moderate
Sharif-Alhoseini, 2014	Moderate	Low	Low	Low	Low	Moderate	Moderate
Tabesh, 2018	Moderate	Low	Low	Low	Low	Moderate	Moderate
Yousefzadeh-Chabok, 2010	Moderate	Low	Low	Low	Low	Moderate	Moderate
Yousefzadeh-Chabok, 2015	Moderate	Low	Low	Low	Low	Moderate	Moderate
Yadollahi, 2018	Moderate	Low	Low	Low	Low	Moderate	Moderate
Yazdani, 2021	Moderate	Low	Low	Low	Low	Moderate	Moderate

Note: Moderate=the study is sound for a non-randomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial; Low=the study is comparable to a well-performed randomized trial with regard to this domain.

lence and incidence rate, risk factors, level of injuries, and mortality rate).

2.4. Evidence synthesis

The epidemiological and demographic findings of included studies were summarized. The Comprehensive Meta-Analysis software was used to analyze the data. The mean difference (MD) and the risk ratio (RR) with a 95% confidence

interval (CI) were used for continuous and dichotomous variables, respectively. The random-effect model was used for studies with I2>50% or P <0.1. Otherwise, the fixed-effect model was used.

3. Results

3.1. Search results

PRISMA flow diagram of the study selection process is shown in Figure 1. In total, 265 records were identified after duplicate removal by searching the databases and resources. After screening the records by their titles and abstracts, 36 studies were screened for eligibility. Finally, nineteen studies (24-42) involving 9416 cases were included in our analysis. The main characteristics of the included studies are presented in Table 1.

3.2. Assessment of risk of bias

The results of assessing risk of bias of included studies are presented in Table 2. The methodological quality of included studies was acceptable.

3.3. Demographic characteristics

The included studies reported the mean age of TSCI patients in the range of 27.42 to 42.31 years. The pooled mean age of the participants was 35.80 ± 1.07 (CI: 33.69 to 37.91) years. A small number of studies reported the frequency of TSCI by age groups. According to the findings of the studies, the largest age group was under 30 years. The majority of participants were male (69%; 95% CI: 68% to 70%) and the male-to-female ratio was 2.4:1. The lowest and highest male-to-female ratios were 1.3:1 and 18:1 in the North and South-East of Iran, respectively.

3.4. Etiology

MVCs were the leading cause of TSCI in Iran (57.9%; CI: 25% to 63%), followed by falls (32 %; CI: 26% to 38%), assaults (7%; CI: 3% to 14%), and other causes (8% CI: 6% to 11%), respectively ((Figure 2). However, in two studies (27, 38), falls were presented as the main cause of TSCI.

3.5. Prevalence and incidence

Three studies (25, 30, 35) reported the prevalence of TSCI in the Iranian population. The meta-analysis result showed the prevalence of TSCI in the Iranian population was 4.4 per 10000 people (Figure 3). Only one study (38) examined the incidence of TSCI, according to which the incidence rate of TSCI among the Iranian population was estimated at around 10.5 per million people.

3.6. Mortality rate

Nine studies involving 6744 cases reported the mortality rate among people with TSCI. The findings of meta-analysis revealed that mortality rate due to TSCI was 3.9 % (95% CI: 0.02 to 0.06; P<0.05) (Figure 4).

3.7. Injury level

Anatomical most common sites of TSCI were thoracolumbar (27%; CI: 10% to 55%), cervical (23%; CI: 16% to 31%), thoracic (20%; CI: 9% to 40%), lumbar (20%; CI: 12% to 31%), and other multiple traumas (16%; CI: 7% to 32%), respectively (Figure 5).

3.8. Sensitivity analysis

A sensitivity analysis was performed to compare the fixed- and random-effect estimates of the effect size. The result showed no change in the effect size.

4. Discussion

According to the present study's findings, the overall mean age of TSCI in the Iranian population was 35.80 ± 1.07 years. The results of a systematic review conducted in the Middle East and North Africa showed that the mean age of the patients with TSCI was 31.32 years (43), which was similar to our finding. In addition, the most commonly affected people were in the 20-29 years age group (43). This result is also in line with our findings. A systematic review of the epidemiology of TSCI in Asian countries indicated that the mean age of injured people ranged from 26.8 to 56.6 years (44). Our study also revealed that most TSCIs (69%) occurred in males, and TSCI rate in men was almost 2.4 times greater than women. The pooled proportion of male gender in the Middle East and North Africa (43) was 77% of all cases, which was similar to our results. The evidence showed that in developing countries (45), males comprised most TSCI cases. Furthermore, a global study showed that the majority of TSCI occurred in males and mostly in individuals aged under 30 years (9).

Our study demonstrated that MVCs were the leading cause of TSCI in Iran. A similar pattern was found in the Middle East and North Africa regions (43), in which MVCs were introduced as the main cause of injuries, followed by falls. Moreover, a systematic review (45) conducted in developing countries showed that MVCs and falls were the most common mechanisms of TSCI. Similar findings were observed in Asia (44) and around the world (9), which were in line with our results. However, in Europe, the most common causes of injuries were falls and MVCs, respectively (46).

The incidence and prevalence of TSCI varied between developing and developed countries (9). Based on the present study, the prevalence of TSCI in Iran was 4.4 per 10000 people, and the incidence rate of TSCI among the Iranian popu-

lation was estimated at 10.5 per million people. The pooled annual incidence of TSCI in the Middle East and North Africa (43) was 23.24 per million people, which was higher than that of Iran.

According to the meta-analysis, the mortality rate due to TSCI among the Iranian population was 3.9%. A meta-analysis (4) conducted by Chamberlain et al. showed that TSCI-related mortality rates ranged from 2.1%, 7.0%, 7.6%, to 24.1% in the WHO regions of Western Pacific, Europe, the Americas, and Africa, respectively. The result of research conducted in Europe (46) showed that most deaths occurred in the older age groups, especially in the female population. The most common causes of death were falls (53%) and MVCs (23%) with the same proportions in both sexes. Generally, older age, injuries related to TSCI, tetraplegia, and tracheostomy have been suggested as the risk factors associated with mortality due to TSCI (47, 48). Since environmental, behavioral, and health factors can play a key role in mortality after TSCI (49), intervention strategies focusing on these factors may lead to reduction in mortality due to TSCI (50).

Based on the findings of the current study regarding injury levels, most participants had thoracolumbar cord and cervical injuries. A literature review of worldwide epidemiology (51) showed that cervical level of the spine was the most common part to get injured. It seems that appropriate prevention and control strategists for TSCI in Iran should focus on males, MVCs, and the age group under 30 years. These findings can be helpful for health researchers and policymakers to plan strategies for controlling and preventing these injuries. However, further detailed studies with large sample sizes and subgroup data are required to investigate the factors affecting TSCI in Iran.

5. Limitations

This study had some limitations. First, not all studies in the meta-analysis reported the outcomes of interest, including standard deviation of mean age, male to female ratio, injury mechanisms, and injury levels. Second, most studies have been conducted in the central part of Iran, which can be considered as a problem for the generalizability of our findings. Finally, we could not perform a meta-analysis on TSCI-related mortality rates based on injury mechanisms, age groups, and sex due to lack of data.

6. Conclusion

Based on the findings of this meta-analysis, the pooled incidence and prevalence of TSCI in the Iranian population was 10.5/1000.000 people and 4.4/10.000 people, respectively. TSCIs had occurred more frequently in males following MVCs, and in the age group under 30 years. The pooled mortality rate due to TSCI was 3.9% (95% CI: 0.02 to 0.06; P<0.05).

7. Declarations

7.1. Acknowledgments

None.

7.2. Authors' contributions

- Study design: Roya Amiri, Mohsen Saheban maleki
- Designing search strategy and performing the search: Seyedeh Omolbanin Seyedrezaei, Mohsen Saheban Maleki, Farahnaz Khajehnasiri
- Data gathering: Maryam Ebrahimpour Roodposhti, Hesamedin Askari Majdabadi
- Analysis and interpreting the result: Behzad Khedri, Mohsen Poursadeqiyan, Nasir Amanat
- Drafting the manuscript: Roya Amiri, Farahnaz Khajehnasiri
- Critical review of the paper: All authors
- All authors approved the final manuscript version and are accountable for all work aspects.

7.3. Funding Source

None.

7.4. Conflict of Interest

There is no conflict of interest.

References

1. Sabapathy V, Tharion G, Kumar S. Cell therapy augments functional recovery subsequent to spinal cord injury under experimental conditions. Stem Cells Int. 2015; 1-12.
2. Davari M, Amani B, Amani B, Khanijahani A, Akbarzadeh A, Shabestan R. Pregabalin and gabapentin in neuropathic pain management after spinal cord injury: a systematic review and meta-analysis. Korean J Pain. 2020;33(1):3-12.
3. Van den Berg M, Castellote J, Mahillo-Fernandez I, de Pedro-Cuesta J. Incidence of spinal cord injury worldwide: a systematic review. Neuroepidemiology. 2010;34(3):184-92.
4. Chamberlain JD, Meier S, Mader L, Von Groote PM, Brinkhof MW. Mortality and longevity after a spinal cord injury: systematic review and meta-analysis. Neuroepidemiology. 2015;44(3):182-98.
5. Hagen EM, Rekand T, Gilhus NE, Grønning M. Traumatic spinal cord injuries–incidence, mechanisms and course. Tidsskr Nor Laegeforen. 2012;132(7):831-7.
6. Ahoniemi E, Alaranta H, Hokkinen E, Valtonen K, Kautiainen H. Incidence of traumatic spinal cord injuries in Finland over a 30-year period. Spinal cord. 2008;46(12):781-4.

7. Chen Y, He Y, DeVivo MJ. Changing demographics and injury profile of new traumatic spinal cord injuries in the United States, 1972–2014. Arch Phys Med Rehabil. 2016;97(10):1610-9.
8. Global, regional, and national burden of traumatic brain injury and spinal cord injury, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol. 2019;18(1):56-87.
9. Singh A, Tetreault L, Kalsi-Ryan S, Nouri A, Fehlings MG. Global prevalence and incidence of traumatic spinal cord injury. Clin Epidemiol. 2014;6:309-31.
10. Mahabaleshwarkar R, Khanna R. National hospitalization burden associated with spinal cord injuries in the United States. Spinal Cord. 2014;52(2):139-44.
11. Jensen MP, Kuehn CM, Amtmann D, Cardenas DD. Symptom burden in persons with spinal cord injury. Arch Phys Med Rehabil. 2007;88(5):638-45.
12. Armour BS, Courtney-Long EA, Fox MH, Fredine H, Cahill A. Prevalence and causes of paralysis—United States, 2013. Am J Public Health. 2016;106(10):1855-7.
13. Williams R, Murray A. Prevalence of depression after spinal cord injury: a meta-analysis. Arch Phys Med Rehabil. 2015;96(1):133-40.
14. Le J, Dorstyn D. Anxiety prevalence following spinal cord injury: a meta-analysis. Spinal Cord. 2016;54(8):570-8.
15. Bauman WA, Cardozo CP. Osteoporosis in individuals with spinal cord injury. PM&R. 2015;7(2):188-201.
16. Marion TE, Rivers CS, Kurban D, Cheng CL, Fallah N, Batke J, et al. Previously identified common post-injury adverse events in traumatic spinal cord injury—validation of existing literature and relation to selected potentially modifiable comorbidities: a prospective Canadian cohort study. J Neurotrauma. 2017;34(20):2883-91.
17. Gao Y, Danforth T, Ginsberg DA. Urologic management and complications in spinal cord injury patients: a 40-to 50-year follow-up study. Urology. 2017;104:52-8.
18. Khan S, Plummer M, Martinez-Arizala A, Banovac K. Hypothermia in patients with chronic spinal cord injury. J Spinal Cord Med. 2007;30(1):27-30.
19. Hagen E, Faerestrand S, Hoff J, Rekand T, Gronning M. Cardiovascular and urological dysfunction in spinal cord injury. Acta Neurol Scand. 2011;124 (191):71-8.
20. Yang R, Guo L, Wang P, Huang L, Tang Y, Wang W, et al. Epidemiology of spinal cord injuries and risk factors for complete injuries in Guangdong, China: a retrospective study. PloS one. 2014;9(1):e84733.
21. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Jama. 2000;283(15):2008-12.
22. Moher D, Liberati A, Tetzlaff J, Altman DG, Group* P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med. 2009;151(4):264-9.
23. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. bmj. 2016;355.
24. Andalib S, Mohtasham-Amiri Z, Yousefzadeh-Chabok S, Saberi A, Emamhadi M, Kouchakinejad-Eramsadati L, et al. Traumatic spinal cord injuries due to motor vehicle accidents. Iran J Neurosurg. 2018;4(4):213-8.
25. Derakhshanrad N, Yekaninejad M, Vosoughi F, Fazel FS, Saberi H. Epidemiological study of traumatic spinal cord injuries: experience from a specialized spine center in Iran. Spinal cord. 2016;54(10):901-7.
26. Fakharian E, Sehat Z, Sehat M. Traumatic spine injury in Kashan, Iran. J Emerg Pract Trauma. 2019;5(2):65-70.
27. Fakharian E, Tabesh H, Masoud S. An epidemiologic study on spinal injuries in Kashan. J Guilan Univ Med Sci. 2004;13(49):80-5.
28. Ghajarzadeh M, Foroushani AR, Nedjat S, Sheikhrezaei A, Saberi H. Survival analysis in patients with chronic traumatic spinal cord injury. Iran J Public Health. 2019;48(12):2260.
29. Haddadi K, Yosefzadeh F. Epidemiology of Traumatic Spinal Injury in north of Iran: a prospective Study. Iran J Neurosurg. 2016;1(4):11-4.
30. Jazayeri SB, Ataeepour M, Rabiee H, Motevalian SA, Saadat S, Vaccaro AR, et al. Prevalence of spinal cord injury in Iran: a 3-source capture-recapture study. Neuroepidemiology. 2015;45(1):28-33.
31. Kamravan HR, Haghnegahdar A, Paydar S, Khalife M, Sedighi M, Ghaffarpasand F. Epidemiological and clinical features of cervical column and cord injuries; a 2-year experience from a large trauma center in Southern Iran. Bull Emerg Trauma. 2014;2(1):32-7.
32. Khazaeipour Z, Ahmadipour E, Rahimi-Movaghar V, Ahmadipour F, Vaccaro A, Babakhani B. Association of pain, social support and socioeconomic indicators in patients with spinal cord injury in Iran. Spinal cord. 2017;55(2):180-6.
33. Mohammad RR, Mohsen N, Vafa R-M. Spinal cord injuries from road traffic crashes in southeastern Iran. Chin J Traumatol. 2007;10(06):323-6.
34. Rabiei A, Tabesh H. Epidemiological study of vertebral trauma in Isfahan Province during 2012-2018. KAUMS Journal (FEYZ). 2019;23(1):102-7.
35. Rahimi-Movaghar V, Saadat S, Rasouli MR, Ganji S, Ghahramani M, Zarei M-R, et al. Prevalence of spinal cord injury in Tehran, Iran. J Spinal Cord Med. 2009;32(4):428-31.
36. Ramezani S, Mohtasham-Amiri Z, Kouchakinejad-

Eramsadati L, Yousefzadeh-Chabok S. Epidemiology of traumatic spinal fractures and spinal cord injuries in Guilan, north of Iran. Caspian J Health Res. 2019;4(1):12-5.
37. Saatian M, Kasiri N, Mohamadi Y, Sangestani S, Abdoli A, Mazloumi E. An Epidemiological Study of Traumatic Spinal Injuries in Iranian Patients from 2007 to 2017. Hormozgan Med J. 2020;25(1):24-8.
38. Sharif-Alhoseini M, Rahimi-Movaghar V. Hospital-based incidence of traumatic spinal cord injury in tehran, iran. Iran J Public Health. 2014;43(3):331.
39. Yadollahi M, Kashkooe A, Habibpour E, Jamali K. Prevalence and risk factors of spinal trauma and spinal cord injury in a trauma center in Shiraz, Iran. Iran Red Crescent Med J. 2018;20(S1):e14238.
40. Yazdani R, Hayati S, Yousefi Kafshgari M, Ghasemi A, Tabibzadeh Dezfuli SA. Epidemiology and Radiologic Findings of Patients with Traumatic Spine Injures in Iran: Methodological and Epidemiological Study. Chem Methodol. 2020;5(1):35-40.
41. Yousefzadeh CS, Safaee M, Alizadeh A, Ahmadi DM, Taghinnejadi O, Koochakinejad L. Epidemiology of traumatic spinal injury: a descriptive study. Acta Medica Iranica. 2010;48(5):308-311.
42. Yousefzadeh-Chabok S, Behzadnia H, Kouchakinejad-Eramsadati L, Hosseinpour M, Alijani B, Taghinejadi O. Incidence of spinal cord injury in traumatic patients admitted to a trauma referral center in Guilan. Iran J Neurosurg. 2015;1(1):39-42.
43. Elshahidi MH, Monir NY, Elzhery MA, Sharaqi AA, Haedaya H, Awad BI, et al. Epidemiological characteristics of traumatic spinal cord injury (TSCI) in the Middle-East and North-Africa (MENA) Region: A systematic review and meta-analysis. Bull Emerg Trauma. 2018;6(2):75-89.
44. Ning G-Z, Wu Q, Li Y-L, Feng S-Q. Epidemiology of traumatic spinal cord injury in Asia: a systematic review. J Spinal Cord Med. 2012;35(4):229-39.
45. Rahimi-Movaghar V, Sayyah MK, Akbari H, Khorramirouz R, Rasouli MR, Moradi-Lakeh M, et al. Epidemiology of traumatic spinal cord injury in developing countries: a systematic review. Neuroepidemiology. 2013;41(2):65-85.
46. Majdan M, Plancikova D, Nemcovska E, Krajcovicova L, Brazinova A, Rusnak M. Mortality due to traumatic spinal cord injuries in Europe: a cross-sectional and pooled analysis of population-wide data from 22 countries. Scand J Trauma Resusc Emerg Med. 2017;25(1):1-10.
47. Chhabra HS, Sharawat R, Vishwakarma G. In-hospital mortality in people with complete acute traumatic spinal cord injury at a tertiary care center in India—a retrospective analysis. Spinal Cord. 2022;60(3):210-5.
48. Higashi T, Eguchi H, Wakayama Y, Sumi M, Saito T. Risk factors associated with mortality after traumatic cervical spinal cord injury. OTA Int. 2018;1(1): 1-4.
49. Cao Y, Krause J, DiPiro N. Risk factors for mortality after spinal cord injury in the USA. Spinal Cord. 2013;51(5):413-8.
50. Krause JS, Cao Y, DeVivo MJ, DiPiro ND. Risk and protective factors for cause-specific mortality after spinal cord injury. Arch Phys Med Rehabil. 2016;97(10):1669-78.
51. Kang Y, Ding H, Zhou H, Wei Z, Liu L, Pan D, et al. Epidemiology of worldwide spinal cord injury: a literature review. J Neurorestoratology. 2018;6(1):1-9.
52. Ahuja CS, Wilson JR, Nori S, Kotter M, Druschel C, Curt A, et al. Traumatic spinal cord injury. Nat Rev Dis Primers. 2017;3(1):1-21.

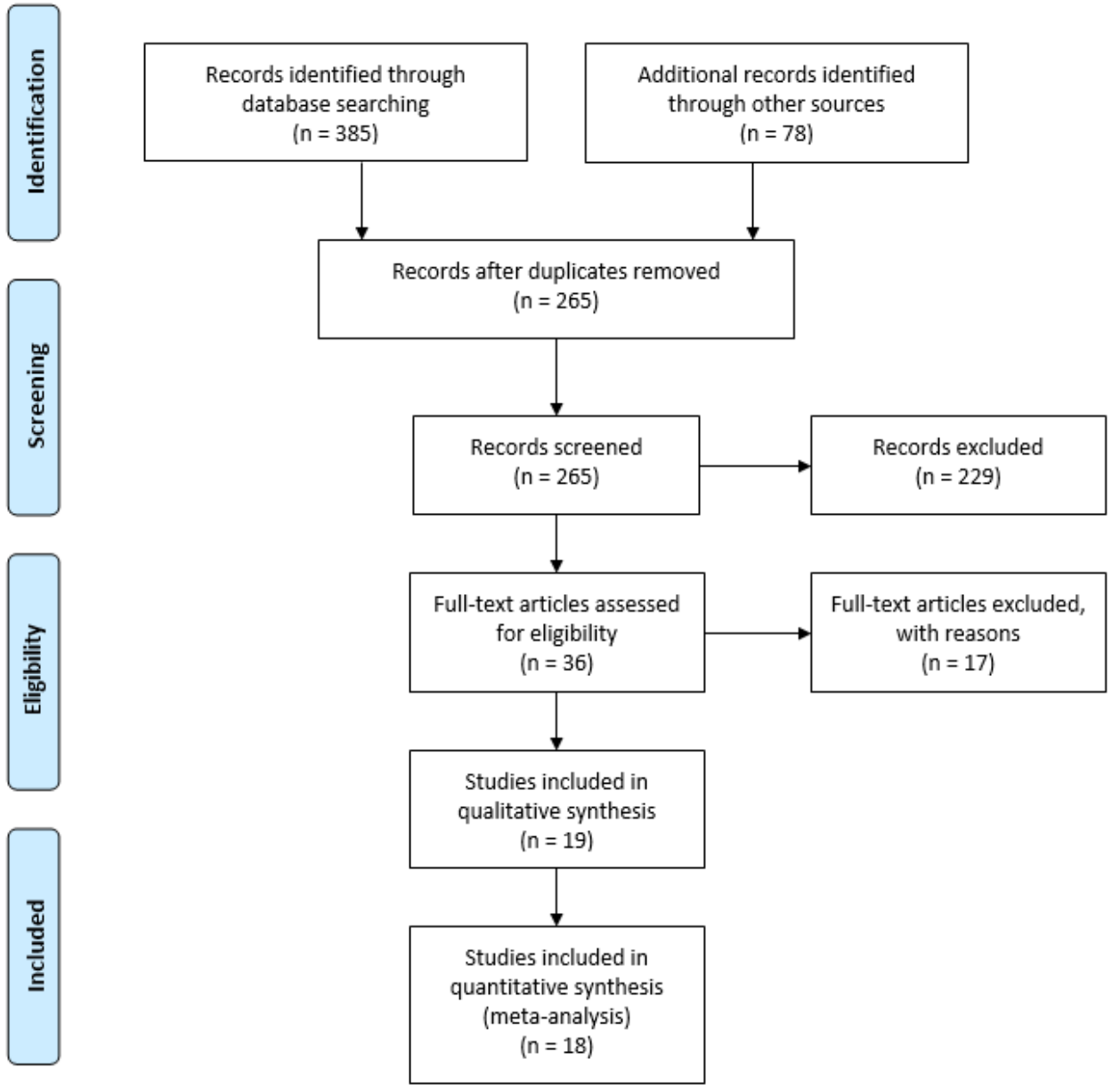

Figure 1: The PRISMA flow diagram of study selection process.

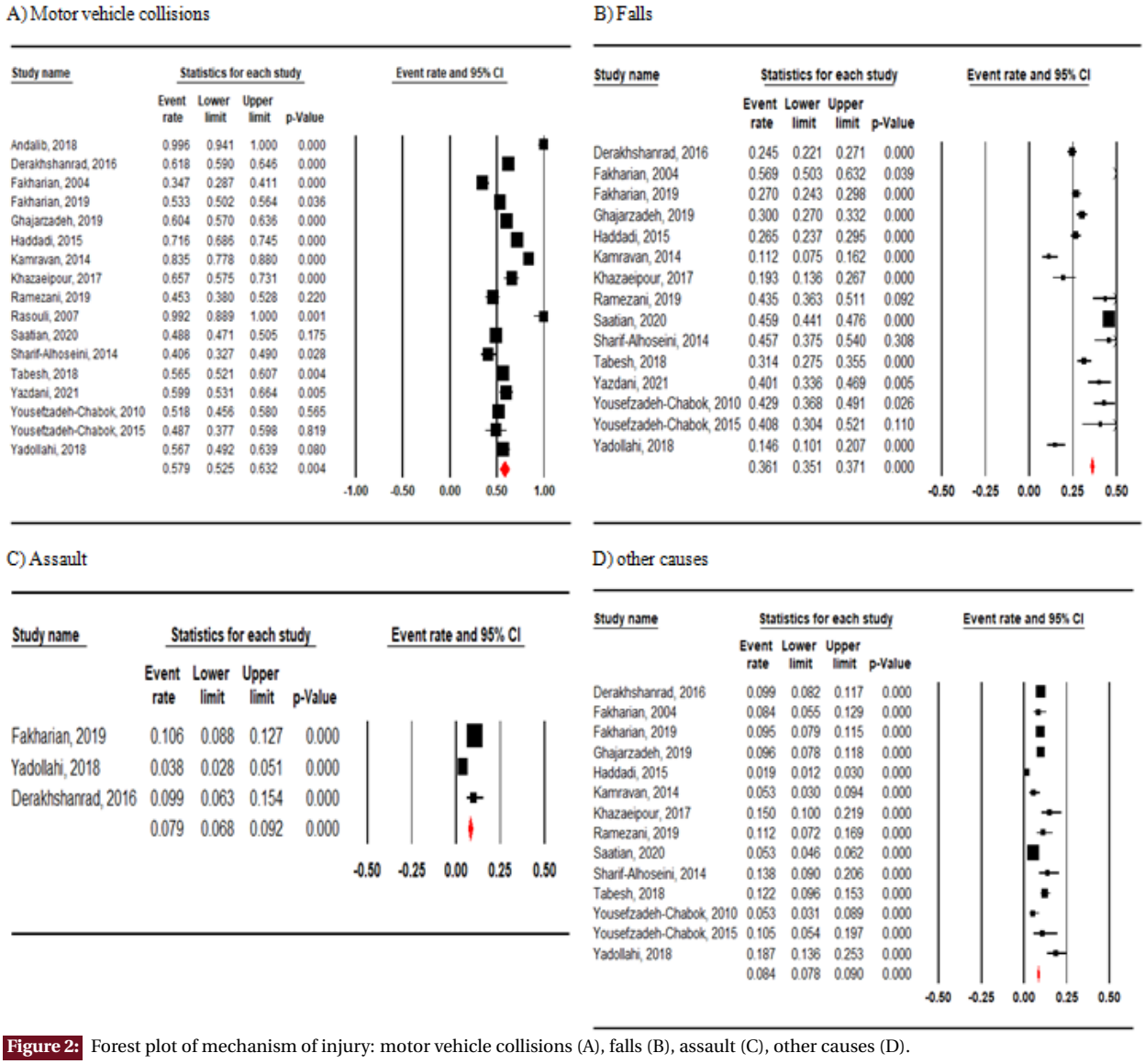

Figure 2: Forest plot of mechanism of injury: motor vehicle collisions (A), falls (B), assault (C), other causes (D).

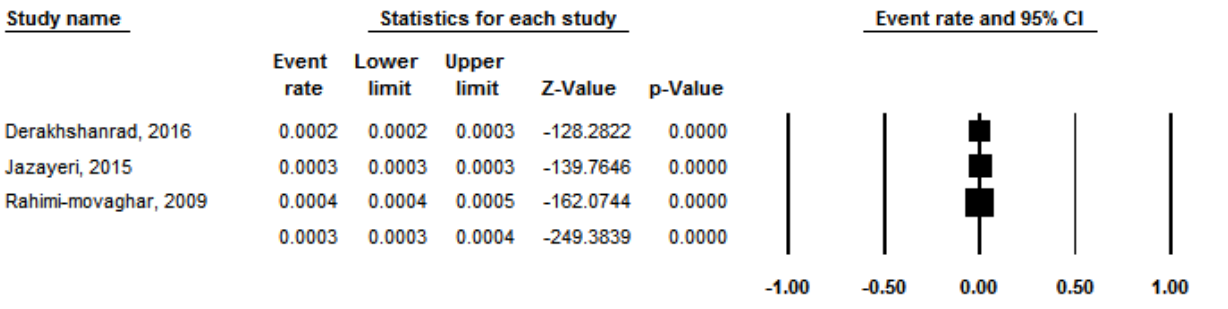

Figure 3: Forest plot of prevalence rate of traumatic spinal cord injuries.

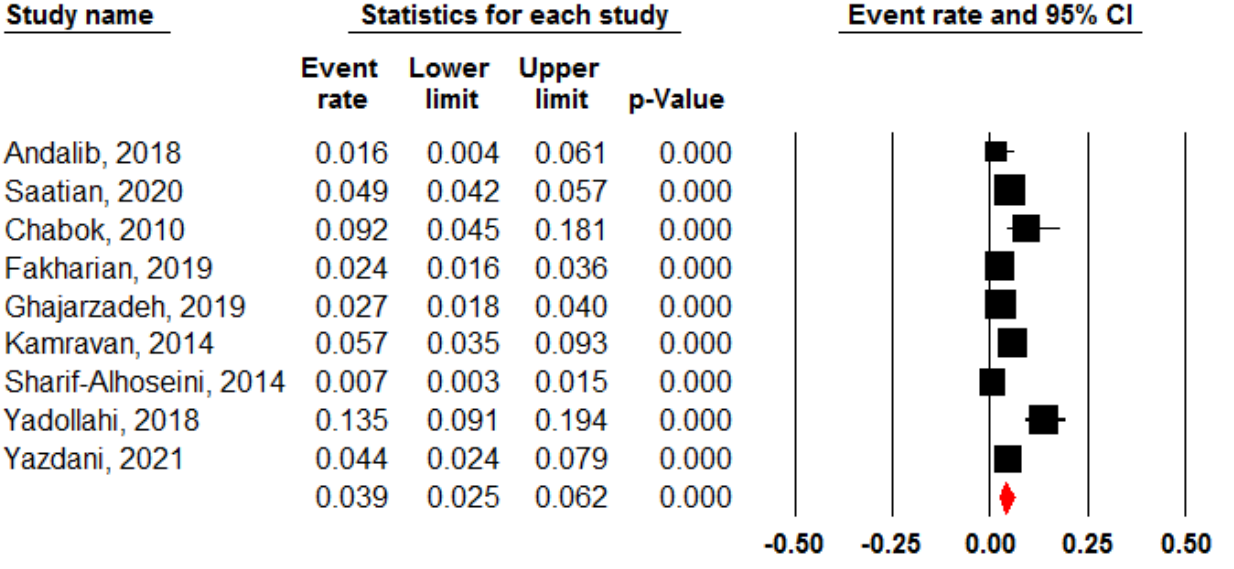

Figure 4: Forest plot of rate of mortality due to traumatic spinal cord injuries.

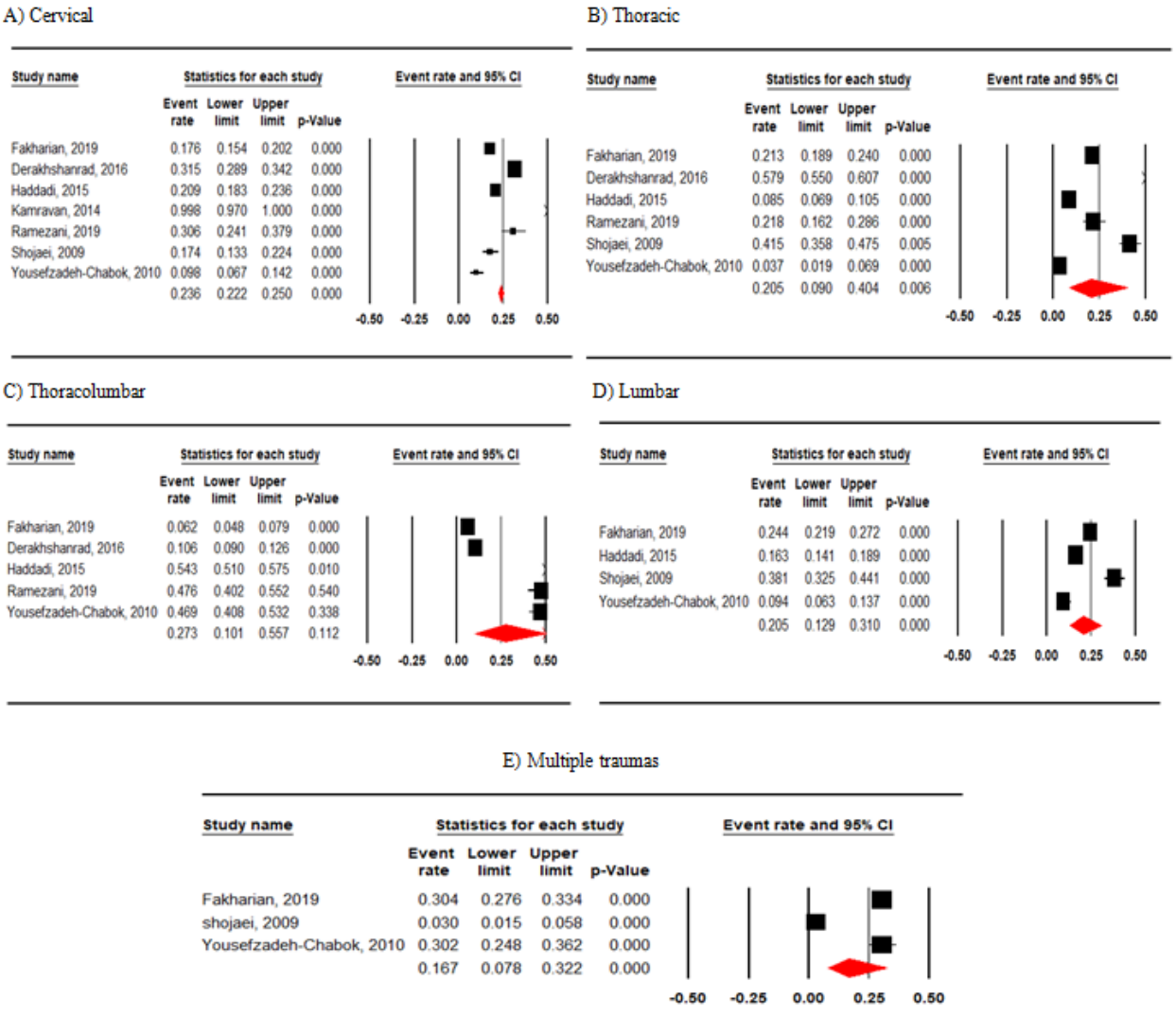

Figure 5: Forest plot of the level of the injury: cervical (A), thoracic (B), thoracolumbar (C), lumbar (D), multiple traumas (E).