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Review Article

Epidemiology of Traumatic Brain Injury in Iran: A Systematic Review and Meta-Analysis

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Abstract

Background: Traumatic brain injury (TBI) is one of leading cause of death and disability in Iran that has serious consequences on people's health. Understanding of epidemiology of TBI can be helpful for policy making in health care management. Therefore, this study aimed to examine the epidemiology of TBI in Iran.

Methods: PubMed, Web of Science, Scopus, Google scholar, and internal databases including, SID, Magiran, and IranMedex were searched to identify the relevant published studies up to Feb 2022. Moreover, the references list of key studies was scanned to find more records. The Joanna Briggs Institute (JBI) tool was used to assess the quality of included studies. The Excel and Comprehensive Meta-Analysis software were to analyze the data.

Results: Overall, 23,446 patients from 15 studies were included in the study. The overall mean age of the patients was 31.36 ± 0.13 yr (95%CI: 31.10 to 31.61). The majority of the patients were male (74.37%), with a male to female ratio of 3:1. The incidence rate of TBI was 15.3 to 144 per 100,000 population. The mortality rate of TBI was estimated to be 10.4% (95%CI: 5% to 19%). The most common causes of injury were road traffic accidents (RTAs) (60%; 95%CI: 49% to 70%), and falling (20%; 95%CI: 16% to 26%), respectively. The most frequent type of head injury was subdural hematoma.

Conclusion: Our findings highlight that appropriate control and prevention strategies should be focused on male, road traffic accidents, and the group under 40 yr.

Keywords: Brain injuries; Epidemiology; Prevalence; Incidence; Risk factors

Introduction

Traumatic brain injury (TBI) is a major cause of death and long-term disability in developed and developing countries across the world (1, 2) and responsible for one-half of all trauma deaths (3). TBI is defined as the disruption in brain function, or other evidence of brain pathology, caused by an external physical force (4). According to the Glasgow Coma Scale (GCS), TBI is classified based on severity into three categories: mild, moderate, and severe (5). The most common causes of TBI are falls, motor vehicle collisions, assaults (6, 7). Age ≥75 yr, male sex (8), injury severity, comorbidity, length of hospital stay, and rate of in-hospital mortality have been suggested as risk factors related to TBI (9).

TBI is one of the main causes of mortality and morbidity due to trauma in Iran (10). The consequences of TBI in Iran is significant in terms of economic burden (11). The yearly incidence of TBI is estimated at 50 million cases worldwide (12). In Europe, the overall incidence of TBI is 262 per 100,000 population (13). In addition, in the United States, TBI incidence rate is between 180 and 250 per 100,000 population per year (14). The prevalence of TBI in low- and middle-income countries varies from 1% in China to 15% in Mexico and Venezuela (15). The incidence of TBI in Iran was reported at around 295/100,000(16).

TBI is associated with a number of diseases such as Alzheimer's disease (17), Parkinson's disease (18), dementia (19), mild cognitive impairment, depression, mixed affective disorders (20), bipolar disorder (21), and sleep disturbances (22). Epidemiological characteristics of TBIs such as cause and type of TBI vary from one country to another. Therefore, understanding epidemiology of TBI can be helpful for policy-making in the health care system (23). Since there is no currently systematic review and meta-analysis on the epidemiology of TBI in Iran, this study aimed to investigate the patients' characteristics suffered from TBI, causes and patterns of TBIs, and mortality rate due to TBIs in Iran.

Materials and Methods

We used the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guideline (24) when writing our report.

Search strategy

A search systematic was performed in PubMed, Web of Science, Scopus, SID, Magiran, IranMedex, and Google scholar to identify the eligible published studies up to 31 Dec 2021. In addition, the references list of the key studies was reviewed to identify additional relevant resources. Studies were limited to English and Persian. Key search terms were traumatic brain injury, TBI, epidemiology, risk factor, mortality, prevalence, incidence, etiology, and Iran.

The following search strategy: (traumatic brain injury [Title/Abstract) OR (traumatic brain injury [MeSH Terms]) OR (TBI[Title/Abstract]) OR (brain injury [MeSH Terms]) OR (head injury [MeSH Terms]) OR (brain injury [Title/Abstract]) AND (Iran [Title/Abstract])

Study selection

Initially, duplicate articles were removed. Then, in the next step, the two authors independently reviewed the titles and abstracts of the articles. In the next step, the full text of the remaining articles was reviewed and excluded if they did not meet the inclusion criteria. Disputes between the two authors over whether or not the articles were eligible were resolved through discussion and the entry of a third author. The process of screening and identifying related articles was performed by two authors (RA and HAM) independently based on inclusion criteria. The inclusion criteria used for selecting the articles were including: 1) Population: Iranian populations with TBI, 2) Intervention: TBI, 3) Comparison: no TBI, 4) Outcome: mortality, prevalence, incidence, and risk factors. Case series, case reports, the letter to editors, and so forth were excluded.

Risk of bias assessment and certainty of evidence

The quality of included studies was evaluated using the Joanna Briggs Institute (JBI) critical appraisal checklist which contains eight questions addressing the quality and possibility of bias in a study (25). The grading of recommendations assessment, development and evaluation (GRADE) approach was used to assess the certainty in the body of evidence (26). This tool consists of five domains; risk of bias, inconsistency, indirectness, imprecision and publication bias.

Data extraction

Two authors (RA and HAM) independently extracted the epidemiological and demographic data using the identical extraction form. The extracted information was including, first author, year of publication, mean age, sex, province, sample size, study period, causes of TBI, most frequent types of head injuries, and mortality rate.

Statistical analysis

Excel and Comprehensive Meta-Analysis were used to analyze the data. The mean difference (MD) and the risk ratio (RR) with a 95% confidence interval (CI) were used for continues and dichotomous variables, respectively. High heterogeneity was considered as $I^2>50\%$ or $P<0.1$. The random-effects model was used for studies with high heterogeneity. Otherwise, we used the fixed-effect model.

Results

Study characteristics and design

The process of identifying, screening, and selecting studies based on the title, abstract, and full text of the studies by the two authors is shown in Fig. 1. Overall, 300 studies were identified and after eliminating duplicates, 184 studies were reviewed based on title and abstract, of which 165 studies were excluded according to inclusion criteria. The full text of the remaining 19 studies was reviewed, and finally, 15 studies (10, 23, 27-39) with 23446 people that met the inclusion criteria were included in the evidence synthesis. The period of publication of articles was between 2016 and 2020. The main characteristics of the studies included are shown in Table 1.

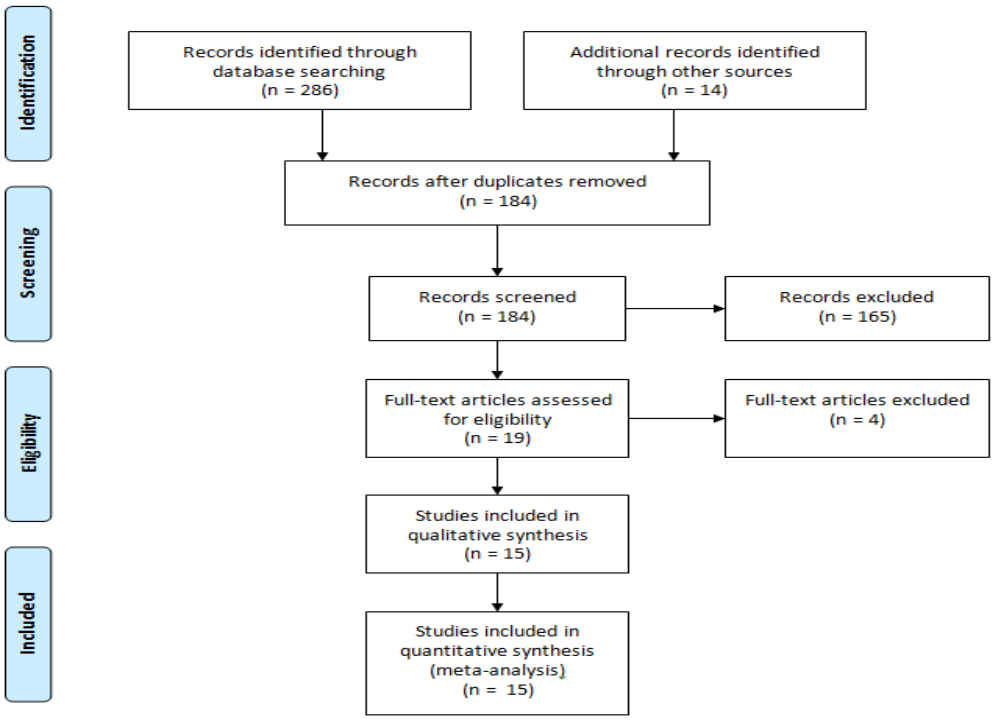

Fig. 1: PRISMA flowchart of the study selection process

Table 1: Characteristics of studies included in systematic review and meta-analysis

Study, year	*Study period*	*City*	*Mean age*	*N*	*M/f*	*Causes of tbi*	*Most frequent types of head injuries*	*Mortality (m/f)*
Ahadi, 2018 (34)	2009-2013	Tehran	38.8 ± 18.7	3818	3306/512	Transport accidents, fall, exposure to mechanical forces, assault	Subarachnoid haemorrhage, diffuse, epidural haemorrhage, subdural haemorrhage	16% (15.3%/ 20.9%)
Saatian, 2017 (23)	2013-2016	Hamedan	29.7 ± 21.46	9426	6258/3168	Vehicle accidents, various types of falls, assault by bodily force	Diffuse, subarachnoid hemorrhage, other intracranial injuries	4.79% (5.69%/3%)
Monsef kasmaei, 2015 (32)	2012-2013	Rasht	38.5 ± 21.7	1000	818/182	Motorbike rider, falling, same level falling, car accident, bike accident, intentional damage	Subdural, epidural bleeding	23.3% (82.6%/17.4%)
Khalili, 2017 (33)	2013-2014	Shiraz	34.8±15.5	142	127/15	Road traffic accidents, fall, others	Subdural hematoma, contusion, tight brain, epidural hematoma	40.8%
Khalili, 2016 (10)	2010-2012	Shiraz	34.6±16.6	248	216/32	Road traffic, fall, assault, others	Nr	Nr
Gilani, 2017 (29)	2008-2010	Kashan	35.4±8.6	239	208/31	Vehicle, fall and boll	Nr	Nr
Rezaei, 2015(35)	2011-2012	Rasht	37.45 ± 17.42	185	171/14	Motorcycle, acciednt, backfall, fall, pedestrain, hit the object,	Nr	Nr
Saadat, 2012 (36)	1999-2004	Multi	30.1 ± 19.11	2274	1794/480	Nr	Nr	16.9% (18.2%/ 12.2%)
Vafaee, 2013 (38)	2012-2012	Tehran	33	4644	3459/ 1077	Motor vehicle accidents, falls, assaults	Nr	0.71%
Ziaeirad, 2018 (39)	2014-2015	Isfahan	43.86 ± 18.40	267	233/ 34	Rtas, fall, others	Subdural hematoma, subarachnoid hemorrhage, cerebral edema, intracranial hematoma, epidural hematoma	Nr
Badebarin, 2021 (27)	2018	Tabriz	6.52±3.95	114	80/34	Traffic accidents, falling, pure head trauma	Epidural hematoma, brain contusion	7.17%

Farzaneh, 2017 (28)	2013-2014	Ardabil	22.6 ± 25.9	204	146/58	Traffic accidents, falls, invasion, other causes	Nr	Nr
Sharbaf-shaaer, 2021 (37)	2017	Zahedan	32.35	445	361/84	Car-accident-multiple-trauma, head-trauma, car-accident, falling, motor-accident, mi	Nr	Nr
Hosseininejad, 2019 (31)	2016-2017	Mazandaran	65.54±6.42	122	Nr	Interpersonal violence, fall, others, traffic collision	Nr	Nr
Hejini Nejad, 2015 (30)	2012	Rafsanjan	28.28+17.69	318	260/58	Motor vehicles with pedestrians, fall	Nr	Nr

Risk of bias assessment and quality of the evidence

The methodological quality of included studies was moderate, as presented in Table 2. Additionally, the quality of the evidence for each outcome is presented in Table 3.

Table 2: The result of quality assessment of included studies using Joanna Briggs Institute (JBI)

Study, Year	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Overall*
Ahadi, 2018	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Saatian, 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Included
Kasmaei, 2015	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Khalili, 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Included
Khalili, 2016	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Included
Gilani, 2017	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Rezaei, 2015	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Saadat, 2012	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Vafaee, 2013	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Ziaeirad, 2018	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Badebarin, 2021	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included

Farzaneh, 2017	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Sharbafshaaer, 2021	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Hosseininejad, 2019	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included
Hejini nejad, 2015	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Included

Question 1. Were the criteria for inclusion in the sample clearly defined?
Question 2. Were the study subjects and the setting described in detail?
Question 3. Was the exposure measured in a valid and reliable way?
Question 4. Were objective, standard criteria used for measurement of the condition?
Question 5. Were confounding factors identified?
Question 6. Were strategies to deal with confounding factors stated?
Question 7. Were the outcomes measured in a valid and reliable way?
Question 8. Was appropriate statistical analysis used?

Table 3: Assessment of Certainty of Evidence Using the GRADE Approach

Certainty assessment							***Effect***	***Certainty***
No. of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative (95% CI)	
Mortality rate								
9	Observational	Not serious	Very serious	Not serious	Not serious	None	RR= 0.10 (0.05, 0.19)	Moderate
Road traffic accident								
	Observational	Not serious	Very serious	Not serious	Not serious	None	RR = 0.60 (0.49, 0.75)	Moderate
Falls								
	Observational	Not serious	Very serious	Not serious	Not serious	None	RR = 0.20 (0.16, 0.26)	Moderate
Assaults								
	Observational	Not serious	Very serious	Not serious	Not serious	None	RR = 0.07 (0.04, 0.13)	Moderate
Other causes of TBI								
	Observational	Not serious	Very serious	Not serious	Not serious	None	RR = 0.07 (0.04, 0.11)	Moderate

Patients' demographics

The mean age of the patients was 31.36 ± 0.13 yr (CI: 31.10 to 31.61) with range 6.5 ± 0.37 to 65.57 ± 0.58 yr. Out of 23446 patients, 17437 (74.37%) were males. The most age group was people under 40 yr. The male to female ratio was around 3:1. The highest study population was 9426 and the lowest was 114. Out of 15 studies, one study was performed on children with a mean age of 6.52±3.95 yr. The lowest and highest male-to-female ratios were and in northern and southeastern Iran, respectively.

Causes of TBI

Of the 15 studies included in the meta-analysis, only two studies did not report the causes of TBI. The road traffic accidents (RTAs) (60%; 95%CI: 49% to 70%) were the major cause of TBI in Iran. (Fig. 2) Falling (20%; 95%CI: 16% to 26%) was the second major cause of TBI (Fig. 3). Other causes (8%; 95% CI: 4% to 13%) (Fig. 4), and assault (7.4%; 95% CI: 4% to 11.9%) (Fig. 5) were the third and fourth leading cause of TBI, respectively.

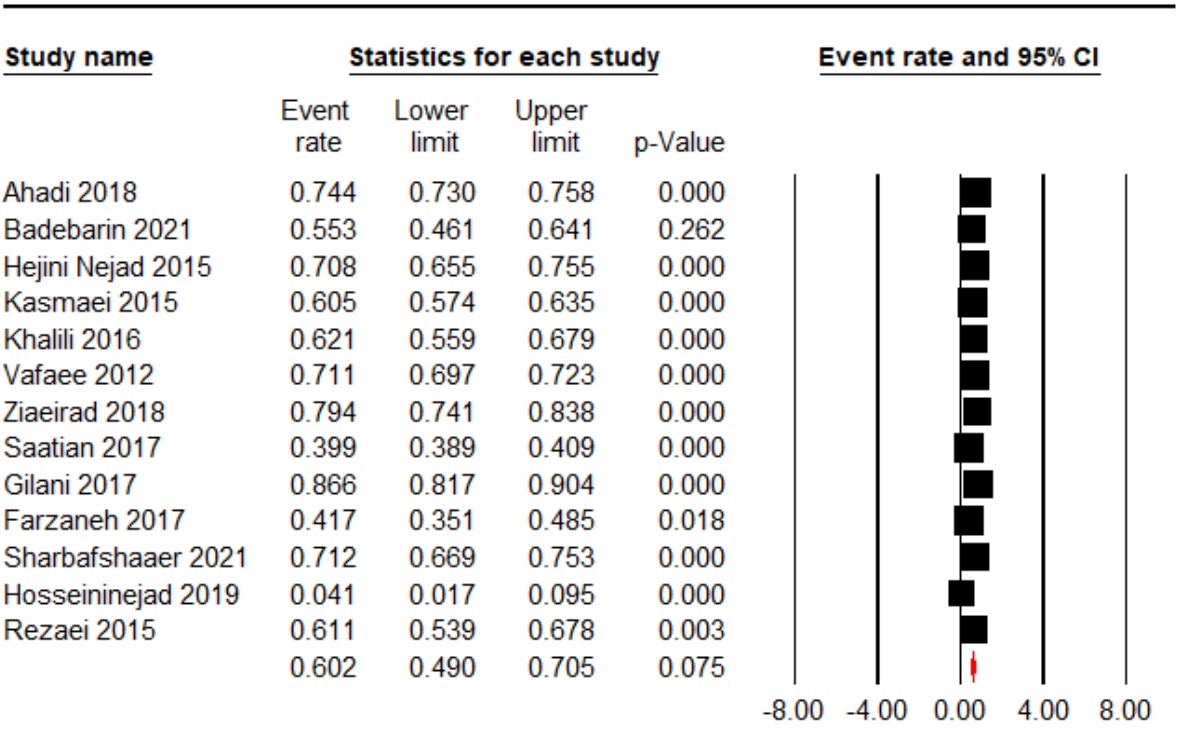

Fig. 2: Forest plot of RTAs of TBI

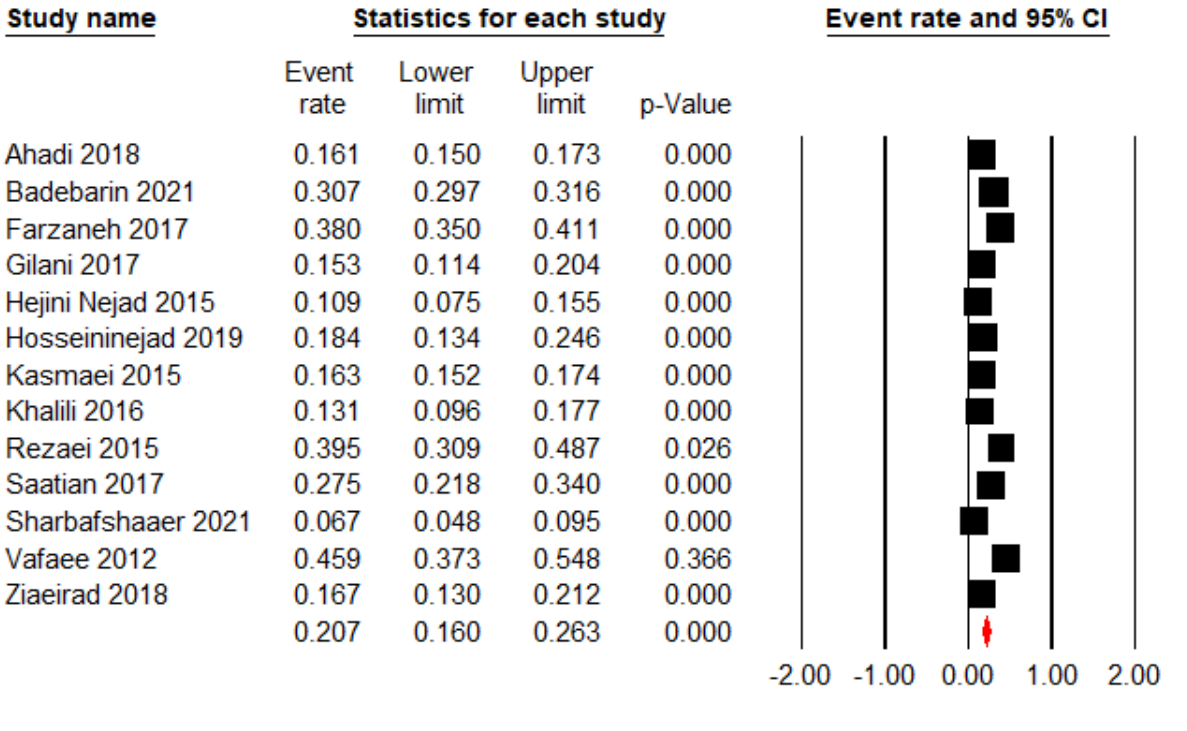

Fig. 3: Forest plot of falling of TBI

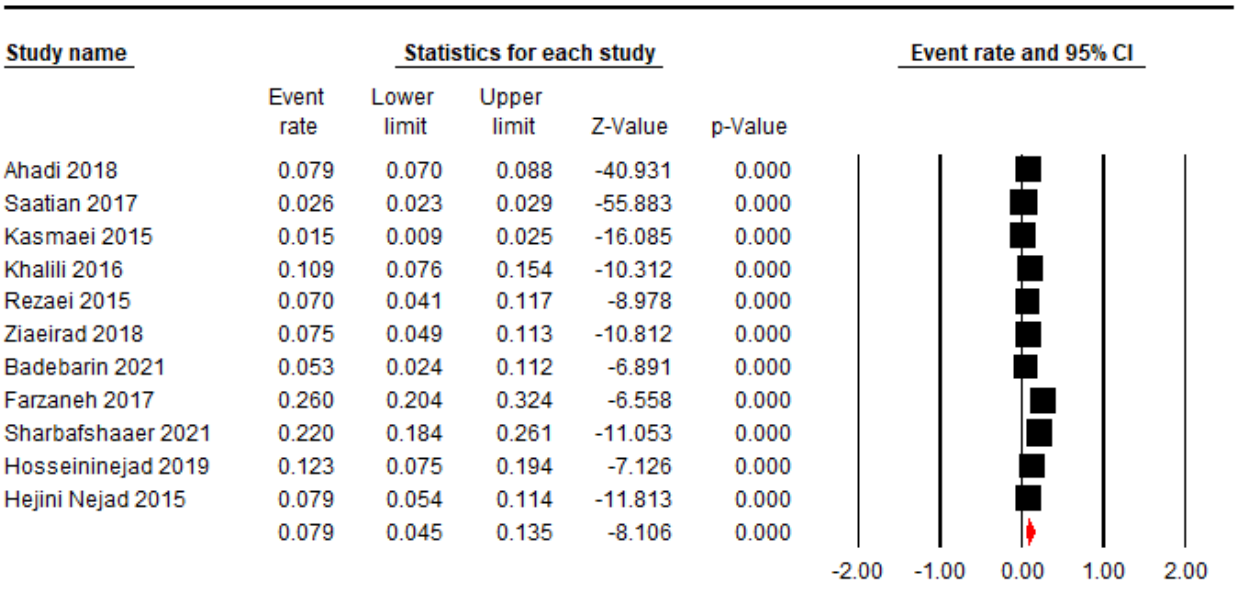

Fig. 4: Forest plot of other causes of TBI

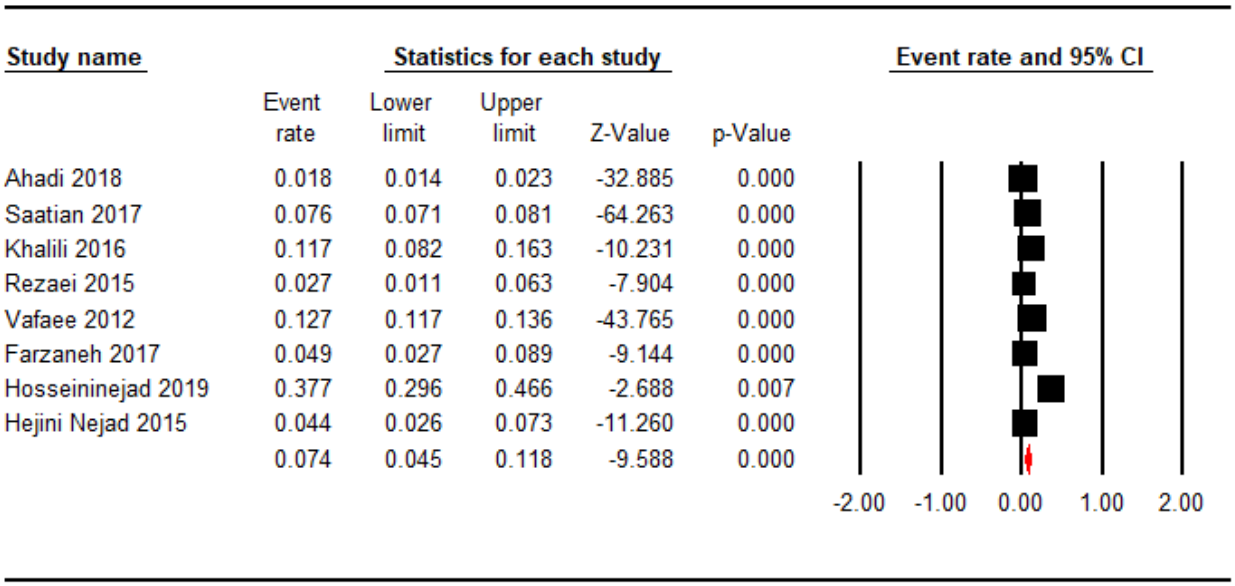

Fig. 5: Forest plot of assault of TBI

Incidence of TBI

One population-based study conducted in Tehran in 2008 showed that the annual incidence rate of TBI was 15.3 to 144/100,000 populations (16). The incidence of TBI among males was higher. Moreover, RTA was the main leading of TBI among patients suffered from TBI.

Types of head injuries

Six studies reported head injuries, with subdivisions in three studies, vertigo in one study, epi-

durals in one study, and subarachnoid having the highest incidence of head injuries. Subdural was the most common type of head injury.

Mortality rate

Out of 15 studies, 9 studies reported mortality. Four studies reported mortality by gender, in one study, mortality rate in females was higher than males. The mortality rate was 10.4% based on the results of meta-analysis (RR= 0.1; 95% CI: 0.05 to 0.18) (Fig. 6).

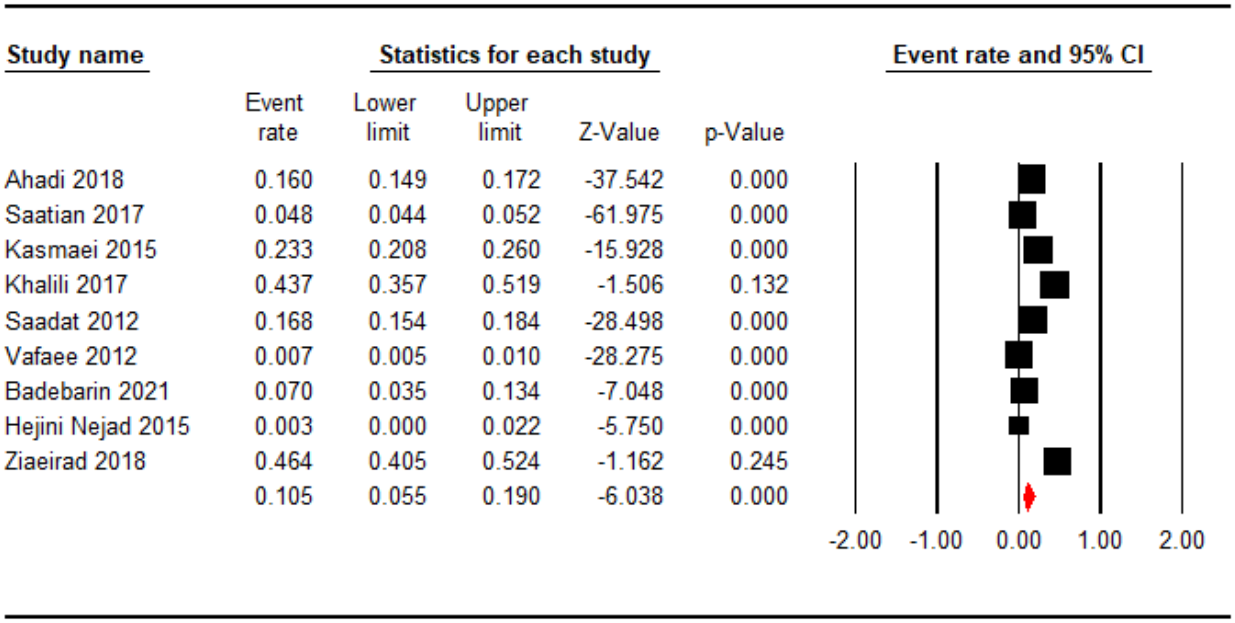

Fig. 6: Forest plot of mortality rate of TBI

Discussion

To the best of our knowledge, this is the first systematic review and meta-analysis that provides a broad outlook on the epidemiology of TBIs in Iran.

According to the present study, the overall mean age of TBI in the Iranian population was 31.36 ± 0.13 yr which is similar to countries located in the Middle East and North Africa (31.32 yr) such as Turkey, Saudi Arabia, Egypt, Jordan, Kuwait, and Qatar (40). The similar result found in TBI in India, which the mean age of TBI was reported 32.15 yr (41). However, the mean age of patients with TBI in Iranian population was younger than countries such as China (42) and Japan (43). The findings of the present study also showed that TBI was more frequent in the males. The similar pattern were reported in different regions such as India (44), Europe (13, 45, 46), United States (1), Middle East and North Africa (47, 48), and global (49). Men were almost 4 times more likely to be hospitalized due to TBI than women. This could be partly due to the greater population at risk and the fact that males have more cars compared to females (50).

Our results demonstrated that RTAs and falling were the most commonly reported causes of TBI. A similar pattern was observed in other regions of the world as well (44-47). In accordance with our findings, the most common causes of TBI in developing and developed countries are motor vehicles and falling, respectively (51). However, falling and road traffic accidents were the main causes of TBI, respectively (13). Difference between these results can be attributable to age, socioeconomic factors, geographic region, and income level (52). Based on the literature,

improving road conditions, increasing driving culture, interaction between drivers and pedestrians, and intellectual transport system can be considered by planners to reduce RTAs, main leading of TBIs, in Iran (27, 53).

Our meta-analysis findings showed that the mortality rate of TBI was 10.4%. This finding is in line with a systematic review conducted on Middle East countries in which the mortality rate of TBI was reported 10% (47). A meta-analysis of TBI in Middle East and North Africa region in which the mortality rate due to TBI was 12.5%, the fairly high rates in study of Al-Hajj may be partly attributed to the military conflicts in Syria, Iraq, Afghanistan and Lebanon countries (48). When comparing our results to El-Menyar and Al-Hajj studies, a similar pattern of results was obtained in according Middle East region. Factors such as the long distance to the nearest neurosurgery center, the lack of efficient medical equipment and teams of neurosurgeons, severe head injury, delayed admission to hospital, and the unavailability of specialized hospitals can impact on increased mortality rate (54, 55). Other risk factors related-mortality rates in patients with TBI are including age, gender, severe TBI, CT findings, Glasgow coma scale, pupil examination, and the presence of thoracic trauma at admission, and geographic region (56, 57). Another explanation of higher mortality rate due to TBI in Iran is that TBIs are higher in low- and middle-income countries compared with developed countries (52, 58, 59). The inadequate access to healthcare services, Socio-cultural factors, and the high number of motorcyclists are among the causes of the difference in mortality rates (58, 60). Iran is among the leading countries in terms of the highest mortality rates of RTAs in the world (61). In Iran, head injuries are the leading cause of death in road accidents in Iran (62-64). Recently, in Iran, the risk of death in road accidents in men was 1.66 times higher than in women, and with each year of age, this risk increases by 1% (65). Gender is a risk factor in the TBI-related mortality rate. Therefore, the male gender can be considered as a risk factor for TBI. There is a relationship between age, gender, and geographic variation with increased mortality due to TBI (66). One of the best strategies that health care system should consider to reduce the mortality rate caused by TBIs is to improve the quality and speed of services in pre-hospital and emergency departments (27).

Several limitations must be noted when interpreting the results. First, the main limitation of the present study naturally was that incidence and prevalence rates did not report in included studies. Second, a small number of studies reported the mortality rate and types of injuries in patients with TBI. Finally, most studies were conducted in Tehran, the capital of Iran, which can affect the generalizability of our findings.

Conclusion

Age, male and RTAs are most important risk factors for TBIs in Iran. Furthermore, the mortality rate due to TBI in Iranian population was similar to developing countries. Appropriate preventative and control strategies for TBI in Iran should focus on males, RTAs, and the age group under 40 yr. These findings can be helpful in research, health care management, and policymaking at the national level in Iran to consider the cost-effectiveness strategies. Further research should focus on the causes and patterns of TBIs, and mortality rate by sex, age groups, and setting.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Funding Sources

None

Data availability statement information

The data that support the findings of this study are openly available in (10, 23, 27-39).

Conflict of interests

The authors have no conflicts of interest to declare.

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