

A Systematic Review of Road Traffic Injury Studies in Iran: Methodology and Prevention Levels

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Abstract

Background and Objectives: Road traffic injuries (RTIs) are the most frequent public health problem in Iran. The present study reviewed the methodology of the RTI articles using the Haddon matrix evidence. **Materials and Methods:** PubMed, Scopus, Web of Science, ProQuest, and Persian national databases, including SID, Magiran, and IranDoc, were searched for the articles published from March 21, 2009, to October 21, 2020. The search process was done by two independent reviewers. The quality of the articles was assessed based on the Scopus index of journals. **Results:** Nine-hundred and fourteen articles were included in this review study, which mostly focused on RTIs in Iran and precrash and postcrash prevention approaches. The methodological approach was cross-sectional in 487 (53.2%) articles and merely 5 (0.54%) articles were randomized clinical trial (RCT) papers. RCT studies focused on the human factor in the precrash phase. Research center evidence indicated that the Safety Promotion and Injury Prevention Research Centers mainly focused on human and environmental factors. However, the Trauma Research Center of Kashan and Sina Trauma and Surgery Research Center of Tehran often addressed vehicles. **Conclusion:** The RTIs studies in Iran often followed a cross-sectional methodology and used a precrash prevention approach.

Keywords: Haddon matrix, Iran, methodology research, prevention level, road traffic crash, road traffic injury, systematic review

INTRODUCTION

Road traffic injuries (RTIs) are among the main causes of death worldwide.^[1,2] The World Health Organization (WHO) reports that RTIs were the only nonbiological factors in the top 10 causes of human death in 2016. About 1.35 million people die from road traffic, and more than 50 million are injured or disabled annually.^[1] Unfortunately, the death rate due to RTIs in Iran is far higher than that reported by the WHO.^[3] It is worth noting that RTs are the fourth leading cause of death in Iran, while the WHO reports RT as the eighth major cause of death in the world.^[1] The reports indicate that about

20,000 people die of road crashes in Iran every year,^[1,2] and about 800,000 people are disabled or injured as a result of such crashes.^[4]

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Due to the high rate of RTIs in Iran and their countless consequences for people, families, society, and the health care system, researchers, research centers, policy-makers, and implementation centers have devoted considerable attention to these phenomena.^[4,5] Therefore, most studies have been conducted using different methodological approaches to identify risk factors, mechanisms, and consequences in Iran.^[6-10] In Iran, a wide range of studies have implemented different methodological approaches and outcomes at different levels of the evidence pyramid and recommended numerous scientific frameworks and trauma-related road crashes to complete the pyramid. However, it still seems that there is no clear scientific approach to this field.

The theory of systems has been used in the past decades to find a solution to crashes by modifying the components involved in the transportation system.^[11] The theory of systems is more highly successful than other theories and significantly decreases the crash rate by improving the road system, traffic control, and vehicles in developed countries.^[12,13] In this theory, special attention is allocated to road engineering and vehicle safety to reduce road traffic crashes. This theory's basic premise is that crashes result from mismatches in relationships among the components of complex systems.^[13,14] According to this theory, we cannot consider any transportation system component more important than others for successful performance.^[12]

The Haddon Matrix is an important model for reducing trauma and road crashes through the theory of systems.^[15] This approach, which has widely been used in recent decades to reduce the incidence of traffic crashes and increase road safety, was introduced by Dr. William Haddon, an American epidemiologist.^[16] The Haddon matrix provides a systemic framework for road safety using the theory of systems based on the disease model, including infrastructure, vehicles, and users, at the precrash, crash, and postcrash stages.^[15,17]

The road safety factors have been introduced based on the Haddon Matrix, host or injured person, agent or energy, a carrier, person, or an object that transmits energy or prevents energy transmission, and an environment or a situation under which trauma conditions occur (including physical, cultural, social, and economic environment). The Haddon matrix covers the roles of road safety factors in three phases, namely the precrash (all situations and factors that predispose people to crashes and injuries), the crash (any element that exacerbates the crash and injury and is related to the prephase, including the use of safety devices such as belt and helmet), and the postcrash (morbidity and crash burden). It covers complications, which occur as a result of a crash, and factors affecting the outcome of a crash, such as a recovery, disability, and death.^[15,18]

The scope of the present review was extended from the driver in the precrash phase to the protection during the crash (on the roadside and in the vehicles) and postcrash care. This type of road safety management has been used systematically to select solutions and identify the complexity of relationships

Table 1: The search strategy in electronic databases

Name of database	Strategy of search
PubMed	((Trauma* [Title/Abstract] OR Injur*[Title/Abstract] OR Wound* [Title/Abstract]) AND (Road*[Title/Abstract] OR *way* [Title/Abstract] OR street [Title/Abstract]) AND (Traffic [Title/Abstract] OR crash* [Title/Abstract] OR collisions [Title/Abstract] OR event [Title/Abstract]) AND (Iran*[Title/Abstract] OR Iran*[Text Word] OR Iran*[Affiliation]))
Web of Sciences	TITLE: (Trauma* OR Injury* OR Wound*) AND TITLE: (Road* OR *way* OR street) AND TITLE: (Traffic OR crash* OR collisions OR event) AND TITLE: (Iran*)
ProQuest	Ab (Trauma* OR Injur* OR Wound*) AND ab (Road* OR way* OR street) AND ab (Traffic OR crash* OR collisions OR event) AND ab (Iran*)
Scopus	(TITLE-ABS-KEY (trauma* OR injur* OR wound) AND TITLE-ABS-KEY (road* OR *way* OR street) AND TITLE-ABS-KEY (traffic OR crash* OR collisions OR event) AND TITLE-ABS-KEY (iran*) OR AFFIL (iran*))

among factors that affected the loss and caused major changes in this field.^[15] Given that the literature has rarely dealt with the methodology of RTIs studies, we evaluate the methodological approaches and prevention levels in RTIs studies in Iran.

MATERIALS AND METHODS

Data sources

The present review research searched English and Persian electronic databases on PubMed, SID, Magiran, Scopus, Web of Science, ProQuest, and IranDoc using particular keywords (including trauma or injury or wound, road or way or street, traffic or crash or collisions or event, Iran) for the articles published from March 21, 2009 to October 21, 2020. We examined the summary of conferences and congresses on SID and Scopus as well as a list of articles based on the inclusion criteria. The search was done by two independent reviewers (LA and SL). The search strategy in electronic databases is presented in Table 1.

Inclusion and exclusion criteria

The inclusion criteria included articles on RTIs (V01-V99 according to the International Classification of Diseases-10th revision) conducted in Iran from 2009 to 2020, studies published in prestigious scientific journals and conferences, studies published in the Persian and English languages, and retrospective and prospective cohort, case-control, cross-sectional, quasi-experimental, randomized control trial, qualitative, and systematic review studies. Studies published in languages other than Persian and English, articles on the crash area except for RTIs (V01-V99 codes), and any trauma except about RTIs area were excluded from the present study. We evaluated articles and removed duplicates by reviewing bibliographic data through EndNote. If a study was replicated, we included the most complete or latest article. We independently evaluated the titles and abstracts of the articles in the first stage. Then, two reviewers (LA, SL) examined full

texts to remove irrelevant articles until a complete agreement was reached.

Data extraction

Two reviewers (LA and SL) with sufficient experience extracted the data independently, and disagreements were resolved through a third reviewer (MS). The quality of the articles was determined according to the journal types determined by the Scopus index.

Key data of the articles were extracted using a predesigned checklist in IBM SPSS Statistics version 22, which included:

1. The published data of the articles, including the first author's name, publication year, study year, study type, published article quality, research center, prevention level(s) based on the Haddon model, sample number, target population, participants' age, geographical location of the crashes, and the database
2. The data related to crash consequences, including the studies of deaths, causes of death, physical disability due to traffic injuries, mental disabilities caused by traffic traumas, injuries in traffic casualties, the most reported injuries, and socio-economic factors caused by traffic injuries
3. The data related to crash determinants, such as the type of road crashes, including cars, motorcycles, trucks, public vehicles like taxis and buses, bicycles or pedestrians, or a combination of those cases, the studies of sleep disorders in drivers, driving violations, the most common type of violation committed by drivers, the crash mechanism, and the most common type of reported mechanism, drug or alcohol consumption by drivers, and the type of drug.

Quality assessment

The quality assessment of the articles was determined according to the journal types based on the Scopus index

Statistical analyses

In the articles, we reported descriptive statistics in terms of frequency and percentage for the variables. Our variables consisted of the number of samples, the quality of the published papers, type of studies, geographic location of the collision, name of research centers, type of road users, level(s) of prevention based on the Haddon Matrix, RTIs consequences (including death and causes of death and disability), location of the injury, information about factors affecting the collision (e.g., the type of road crashes, including cars, motorcycles, trucks, public vehicles, such as taxis and buses, bicycles or pedestrian, or a combination of these cases), sleep disorder in drivers, and the studies of traffic violations, the most common type of violation committed by drivers, the crash mechanism, the most common type of reported mechanism, drug or alcohol consumption by drivers, and drug types.

RESULTS

After searching electronic databases and a manual search, we obtained a total of 1772 articles. In addition, 914 articles were

selected based on the inclusion criteria, and then their information was extracted based on a predesigned checklist [Figure 1].

Place and time features

The review of studies on traffic crashes during the last 12 years indicated that the highest number of articles (112, 12.3%) were conducted in 2019, and the fewest number (50, 5.4%) was found in 2009 [Figure 2].

In 585 articles, we studied a total of 25048138 individuals and 3702471 injuries and noninjury crashes in 58 articles. It should be noted that the sample size was not reported in 101 cases. The study type was cross-sectional in 487 (53.2%) studies, and only 5 (0.54) articles had a randomized clinical trials (RCTs) method [Figure 3]. In terms of approach, 775 (64%) studies on RTIs in Iran focused on precrash levels [Table 2]. Studies in the last 12 years in the prevention phase before and after the crash often had a cross-sectional type and studied the human factor. In the crash phase, the studies often had a cross-sectional methodology and examined humans and vehicles. All RCTs on humans in the precrash phase aimed to promote students' safety behavior [Figure 4].

Table 2: The Publication information of published articles related to road traffic injuries in Iran during 2009-2020

Variables	Frequency (%)
Quality of articles indexed in electronic databases	
PubMed, Scopus ISI	170 (18.5)
Scopus ISI	60 (6.5)
ISI	16 (1.7)
PubMed, Scopus	19 (2.1)
Scopus	49 (5.3)
PubMed	40 (4.4)
Scientific Journals	403 (44.1)
Others	193 (21.1)
Approach of articles based on Haddon Matrix prevention levels	
Precrash	775 (64.3)
Crash	151 (12.5)
Postcrash	279 (23.2)
Research centers involved in RTIs in articles	
Guilan Road Truman Research Center	13 (10)
Safety Promotion and Injury Prevention Research Center of Shahid Beheshti	42 (32.3)
Road Traffic Injury research center of Tabriz	12 (9.2)
Trauma Research Center of Kashan	12 (9.2)
Sina Trauma and Surgery Research Center of Tehran	22 (16.9)
Iranian Legal Medicine Organization	7 (5.5)
Health Policy Research Center of Shiraz	4 (3.1)
Social Determinants of Health Research Center of Social Welfare	3 (2.3)
Environmental Determinants of Health Research Center of Kermanshah	3 (2.3)
Health Modeling Research Center of Kerman	3 (2.3)
Health Service Management Research Center of Kerman	3 (2.3)
Tabriz Health Service Management Research Center	3 (2.3)
Dentistry Research Center of Isfahan	3 (2.3)

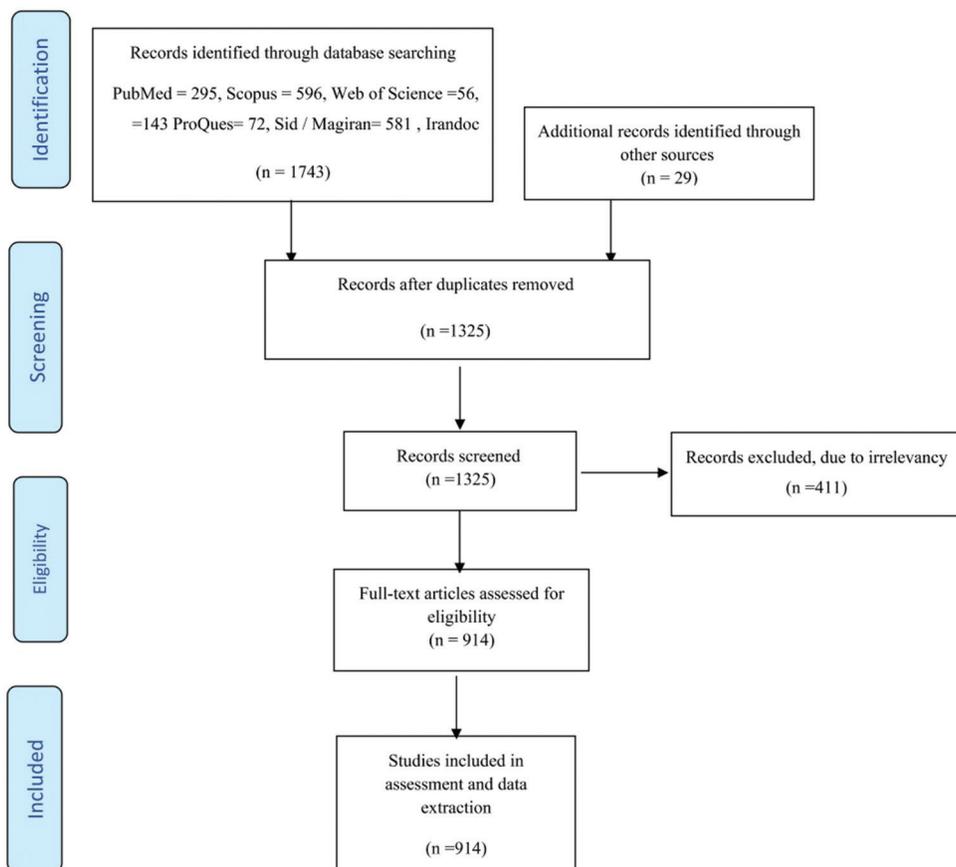


Figure 1: Flow diagram of search strategy between 2009 and 2020

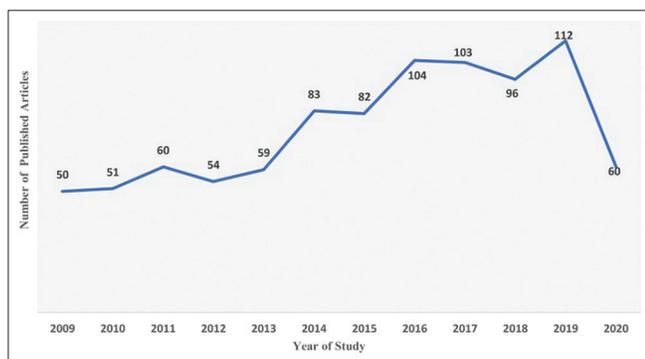


Figure 2: Frequency of articles related to road traffic crashes by year of publication (2009–2020)

Based on the Scopus index, 87 (9.5%) articles were in the first quartile (Q1), 149 (16.3%) articles in the second quartile (Q2), 25 (2.7%) articles in the third quartile (Q3), and 44 articles in the fourth quartile (Q4). Among the reviewed articles, 403 (44.1%) articles were indexed in scientific-research journals, and 170 (18.5%) articles had an electronic database, PubMed, Scopus, and ISI indexes [Table 2].

Methodology features and prevention levels

The research centers included the Safety Promotion and Injury Prevention Research Center of Shahid Beheshti University of Medical Sciences (42 articles), the Sina Trauma and Surgery

Research Center of Tehran University of Medical Sciences (22 articles), the Trauma Research Center of Guilan University of Medical Sciences (13 articles), the Road Traffic Injury research Center of Tabriz University of Medical Sciences (12 articles), the Trauma Research Center of Kashan University of Medical Sciences (12 articles), the Research Center of the Iranian Legal Medicine Organization (7 articles), the Health Policy Research Center of Shiraz University of Medical Sciences (4 articles), the Social Determinants of Health Research Center of Social Welfare and Rehabilitation Sciences University, the Dentistry Research Center of Isfahan University of Medical Sciences, the Environmental Determinants of Health Research Center of Kermanshah Medical Sciences, Health Modelling Research Center of Kerman University of Medical Sciences, the Health Service Management Research Center of Kerman University of Medical Sciences, and Tabriz Health Service Management Research Center [Table 2]. Evidence collected by research centers on RTIs in Iran indicated that the Safety Promotion and Injury Prevention Research Center focused on human and environmental factors. However, the maximum focus on vehicles belonged to the Trauma Research Center of Kashan and Sina Trauma and Surgery Research Center of Tehran [Figure 5].

Features of crash determinants

The general population in 42% and drivers in 22% of the published articles constituted the largest participating

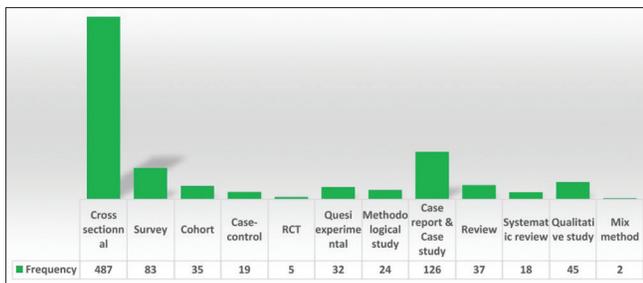


Figure 3: Frequency of articles related to road traffic crashes by type of study

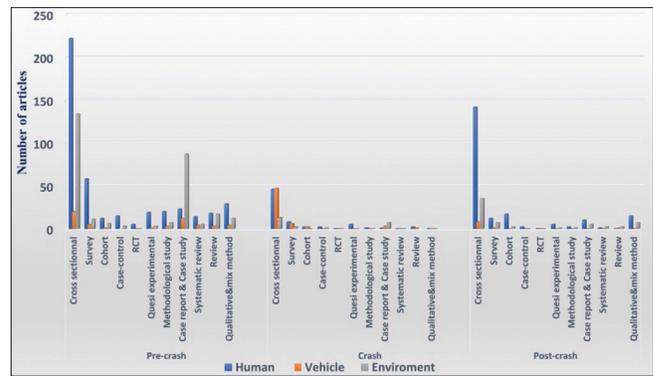


Figure 4: Frequency of articles related to road traffic crashes by type of studies in terms of Haddon Matrix factors during 2009–2020

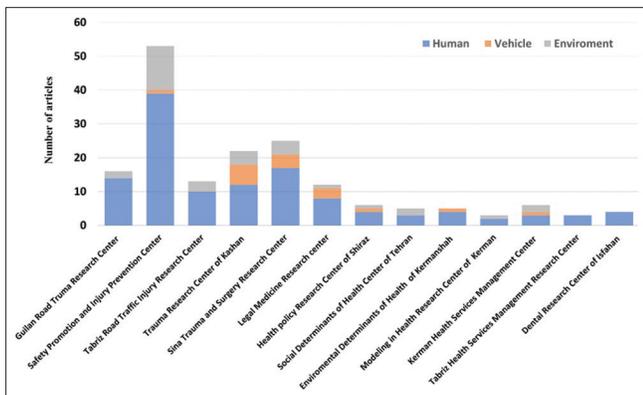


Figure 5: Frequency of articles related to road traffic crashes by research centers in terms of Haddon Matrix factors during 2009–2020

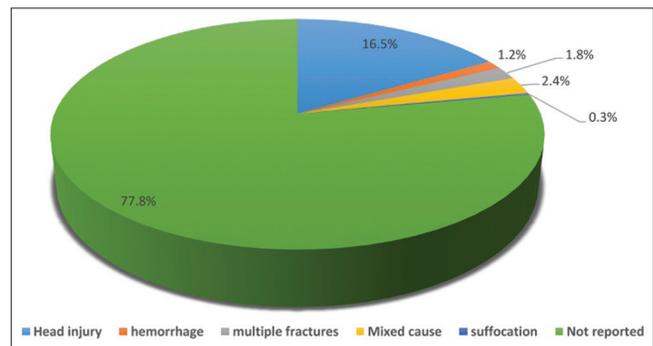


Figure 6: The most common causes of death reported in a road traffic crash in articles published during the years 2009–2020

population in traffic crash studies on Iran’s roads [Table 3].

Death and physical and mental disabilities of road traffic crash victims were studied in 36, 9, and 6% of the articles published during the last 12 years, respectively [Table 3]. Suffocation (lack of oxygen) in 16% and multiple fractures in 3% of the articles were the most common causes of death in RTIs [Figure 6].

Furthermore, the cases of injuries caused by RTIs were studied in 9% of the articles published during the last 12 years. Among these casualties, injuries with mixed causes (44%) and head and neck (38%) were the most common locations of injury [Figure 7].

Driver sleep disorders and drug and alcohol use were reviewed in 2% (18) and 2% (24) of the articles published in the last 12 years, respectively.

The drug type was not reported in 46% (11) of the cases, and the most common drugs included morphine, methamphetamine, opium, Pan, and narcotics in the remaining articles. Car drivers and motorcyclists were studied in 25 and 24% of the articles, respectively. Moreover, pedestrians and public vehicles-taxis and buses were studied in 20 and 12% of the articles over the mentioned period, respectively. Simulation software was used in 4% of the articles. Driving violations were also studied in 17% of the articles published during the last 12 years. It is worth mentioning that multiple violations

in 33% and no immune equipment in 37% of the studies were the most common types of violations reported by the drivers. The collision of two vehicles and overturning were the most common traffic crashes in 60 and 18% of the articles, respectively [Table 3].

DISCUSSION

In the present study, most articles on RTIs in Iran adopted the precrash approach. The evidence in the studies concentrated on humans in the precrash and postcrash prevention phases and the vehicles in the during-crash phase. All RCT studies had focused on the human factor in the precrash phase. The Safety Promotion and Injury Prevention Research Center mainly focused on human and environmental factors, while the Trauma Research Center and Sina Trauma and Surgery Research Center mainly targeted vehicles.

Based on the results, most articles on RTIs in Iran had focused on precrash, and a few used the postcrash and crash prevention approaches. The focus was mainly on the human factor in the pre and postcrash prevention phases. By contrast, the during-crash phase mostly involved humans and vehicles. Based on the Haddon Matrix, a systematic framework for road safety through the theory of systems, traffic crashes were the outcome of combined factors related to road, environment, vehicle, users, and their interaction.^[17]

Table 3: Descriptive statistics of factors affecting the occurrence of road traffic injuries and their consequences in articles published during 2009-2020

Variables	Frequency (%)
Data sources used in articles	
Hospital data	136 (14.8)
Police data	136 (14.8)
Forensic data	79 (8)
The researcher's own data	293
Other	270
Geographic location of the crash	
Urban	296 (14.8)
Suburban and rural	15 (1)
Road	162 (17)
Not reported	92 (10.1)
Don't exist cases	56 (6)
Others	287 (31.3)
Study of socioeconomic status	
Yes	53 (5.8)
No	861 (94.2)
Target population	
General population	422 (46.2)
Drivers	208 (22.7)
Students	24 (2.6)
Children	18 (1.9)
Police and traffic experts	30 (3.2)
Not reported	61 (6.6)
Don't exist cases	123 (13.4)
Others	28 (3)
Study of death and causes of death related road traffic injuries	
Yes	333 (36.4)
No	581 (63.6)
Study of physical disability	
Yes	81 (8.9)
No	833 (91.1)
Study of psychological disability	
Yes	51 (5.6)
No	863 (94.4)
Study of type of injuries	
Yes	210 (22.9)
No	548 (59.9)
Not reported	156 (17.2)
Study of sleep disorder in drivers	
Yes	18 (2.1)
No	895 (97.9)
Drug or alcohol use by drivers	
Yes	24 (2)
No	890 (97)
Type of road users in articles	
Cars	278 (24.9)
Motorcycles	271 (24.3)
Trucks	124 (11.1)
Public transportation	135 (12.1)
Pedestrians	226 (20.2)
Cycles	81 (7.2)

Contd...

Table 3: Contd...

Variables	Frequency (%)
Use of simulation software in articles	
Yes	28 (4)
No	886 (96)
Study of traffic violations	
Yes	151 (16.6)
No	711 (77.8)
Not reported	52 (5.6)
The most common type of violation committed by drivers	
Violation of speed limit	22 (14.5)
Don't use of immune equipment	56 (27.1)
Mobile phone use while driving	4 (2.6)
Lack of attention to the front	8 (2.5)
Ignoring the rules	11 (7.2)
Multiple violations	50 (33.1)
The most common type of reported mechanism	
Vehicle-vehicle	49 (60.4)
Overturning	15 (18.5)
Vehicle-fixed object	1 (1.2)
Vehicle-pedestrian	11 (13.5)
Combination of them	5 (6.1)

However, the results of a review article indicated that most studies had examined human factors, and a handful of studies investigated vehicles and environmental safety. In addition, few studies highlighted the during-crash phase. Hence, future studies should pay more attention to these issues. In our study, the human factor was mainly taken into account, and the roles of road, environment, and vehicles in the traffic crash cycle should not be underestimated due to their effectiveness in crash occurrences.^[18] Therefore, a proper road design based on different user expectations can protect users against many dangers, reduce the injury severity for the occupants in the crashes through new and smart equipment in vehicles, and help drivers decide in different situations.^[19] It seems that postcrash studies were scarce due to the high number of crashes. Moreover, less attention has been paid to short-term and long-term disabilities.

As our review indicated, half of the studies were cross-sectional, and only five articles used an RCT methodology. Although the key focus of cross-sectional studies was on human and environmental factors, RCT studies focused only on the human factor in promoting students' safety behaviors. We suggest further observational cohorts, case – control studies, and interventional clinical trials on the human factor and methodological studies on the simulator and vehicle use, humans, and the environment. In RCTs, studies on students showed positive effects of teaching traffic and driving regulations on their conceptual knowledge, attitudes towards prophylactic potential traffic dangers, and traffic performance in terms of pedestrian, cyclist, vehicle occupant, and traffic effects and driving signs.^[20-22]

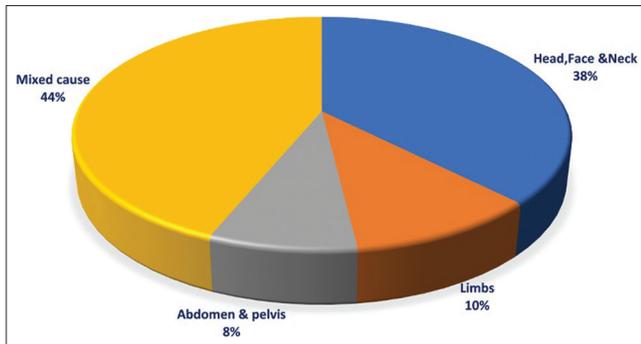


Figure 7: The most common site of injury reported in road traffic casualties in articles published during 2009–2020

According to the results of the present study, the Safety Promotion and Injury Prevention Research Center mainly focused on human and environmental factors, while the Trauma Research Center of Kashan and Sina Trauma and Surgery Research Center often examined vehicles. However, most trauma research centers in Iran focus on the human factor, and we recommend that future studies investigate environmental and vehicle factors. To reduce traffic crashes, interventions are warranted for all components of the environment, vehicles, and road users.

In the present study, death was the most commonly reported outcome, while a significant percentage of crashes led to disability. However, there were only a few studies in this field in Iran. The physical and mental disabilities of RTIs in the published articles indicated the need for psychological care in the emergency and orthopedic wards and screening. Hence, early detection of these disorders to prevent long-term consequences could be of great importance. Social, psychological, and financial support and rehabilitation should also be considered to improve hospitalized victims' life quality and mental health.^[23] Based on the studies, RTI psychological consequences, including acute stress disorder, depression, anxiety, stress, unusual fatigue, and stressful life events, affect life quality and mental health.^[24,25] In addition, more than half of the casualties were still suffering from depression about 6 weeks later, probably due to ignoring their mental health by health care providers.^[26]

Sleep disorders of drivers and drug and alcohol use were studied only in 2% of the articles published in the last 12 years. Due to the effects of sleep disorders on job crashes, including RTIs, timely diagnosis in driving can be a crucial factor in RTI incidences. Therefore, driving should be treated and prevented until drivers' full improvement, which can reduce crashes to a large extent. According to previous studies, alcohol and substance abuse increased RTI risks in drivers by impairing their awareness and problem-solving skills.^[27,28] In driving under the influence of drugs or alcohol, drivers do not consider the consequences of their behaviors and performance for others, which leads to increased crashes.^[29] Therefore, screening for alcohol and substance abuse is an effective way to identify drivers who are at a greater risk of RTIs.

The findings of the present study illustrated that nonuse of safe equipment and violations were common among drivers. We think that creating traffic culture and education by assistant policies, educational programs in the mass media, social networks, schools, and universities, serious and full enforcement of laws by the police, continuous update of laws, and users' satisfaction helped reduce traffic violations among drivers.

We further found that researchers of trauma and traffic crashes can choose their topics according to the needs and weaknesses of the evidence in the study. However, the Safety Promotion and Injury Prevention Research Center has produced a larger number of articles compared to others. In general, it seems that research centers in the country need to act more powerfully in producing sound evidence. Furthermore, Iranian trauma and road traffic crash research centers can determine their priorities according to the present results to complete necessary evidence for the Haddon Matrix, reduce risk factors, and increase road safety. In the present study, studies were mostly hospital-based. Apparently, further community-based studies are required. Furthermore, the results showed that a head injury was the most critical injury in trauma, necessitating further investigations due to its high complications.

Using a combination of training programs, strengthening traffic laws, securing vehicles, securing roads and streets, and installing speed cameras could effectively reduce RTIs. Further research can include interventional studies on the human factor, methodological studies, such as simulators on vehicles, humans, and the environment, and vehicle safety assessment before entering the market.

CONCLUSION

The studies on RTIs in Iran often adopted a cross-sectional methodology. The reviewed studies mainly focused on the precrash, less on the postcrash, and rarely on the crash phase. The studies on the precrash and postcrash prevention phases focused on the human factor, while those on the during-crash phase probed human and vehicle factors. Based on the Haddon Matrix, future research requires more clinical trial interventions, case-control, and cohort studies for the human factor. In addition, methodological studies, including simulators on vehicles, humans, and the environment, should be undertaken in terms of RTIs due to the above-mentioned evidence.

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Conflicts of interest

There are no conflicts of interest.

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