Systematic Review

A

Risk Factors of Deaths Related to Road Traffic Crashes in World Health Organization Regions: A Systematic Review

Alireza Razzaghi, Hamid Soori, Amir Kavousi[1], Alireza Abadi[2,3], Ardeshir Khosravi[4], Abbas Alipour[5]

Safety Promotion and Injury Prevention Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [1]Department of Epidemiology, Safety Promotion and Injury Prevention Research Center, School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [2]Department of Community Medicine, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [3]Department of health Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [4]Department of Statistics and Informatics, Iranian Ministry of Health and Medical Education, Tehran, Iran, [5]Community Medicine Department, Medical Faculty, Mazandaran University of Medical Sciences, Sari, Iran

ORCID:

Alireza Razzaghi: http://orcid.org/0000-0003-1874-6364
Hamid Soori: http://orcid.org/0000-0002-3775-1831
Amir Kavousi: http://orcid.org/0000-0003-3922-0564
Alireza Abadi: http://orcid.org/0000-0003-2653-6623
Ardeshir Khosravi: http://orcid.org/0000-0003-2963-0674
Abbas Alipour: http://orcid.org/ 0000-0003-0781-3728

Abstract

Background: Identification of risk factors involved in road traffic deaths (RTDs) could help policymakers and road traffic managers to adopt effective strategies and approaches for the prevention and control of these incidents, while the lack of accurate data on the risk factors of RTDs causes the problem to persist. This systematic review aimed at assessing the national studies regarding the risk factors of RTDs in the regions covered by the World Health Organization (WHO). **Methods:** This review study was conducted during 2008–2018 via searching in databases of PubMed, Science Direct, Scopus, Cochrane, Thomson Reuters, Web of Science, EMBASE, ProQuest, and Trip databases. Initially, a literature review was performed to find similar systematic reviews, followed by another literature review to retrieve the published or registered protocols. At the next stage, PECOTS was developed for the search strategy, followed by the quality assessment. The eligibility criteria in this study were the national-level studies about the risk factors related to RTDs, English-language studies, and studies published during 2008–2018. **Results:** In total, 169 articles were included in this study, with the highest and lowest number of the published articles in the United States and African countries, respectively. According to the reviewed studies, human factors accounted for the most common risk factors involved in RTDs. In the southeastern regions of Asia, the main road-related risk factor for RTDs was reported to be the type of roads. Furthermore, roadside departure to the right side and long roads were denoted in the national data of the Western Pacific region on the incidence of RTDs. Differences were observed between the six regions covered by the WHO in terms of the time-related risk factors for RTDs. **Conclusions:** Several risk factors have been reported for RTDs in the countries covered by the WHO, and each risk factor is considered to have various subcategories. Therefore, it could be concluded that there are different epidemiological patterns for road traffic accidents and RTDs.

Keywords: Death, risk factors, road traffic accidents

Introduction

Road traffic accidents are considered to be a major health concern and cause of mortality across the world, especially in low-and middle-income countries. Road traffic deaths (RTDs) are reported to be the third leading cause of mortality.[1-3] The consistent and effective prevention of road traffic accidents and subsequent injuries need proper planning and comprehensive efforts.[4] Efforts to diminish the rate of road traffic accidents and RTDs could be successful with access to accurate data on the epidemiology of road traffic injuries. Such data enable countries

Access this article online

Quick Response Code:

Website: www.archtrauma.com

DOI: 10.4103/atr.atr_59_19

Address for correspondence: Prof. Hamid Soori, Safety Promotion and Injury Prevention Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
E-mail: hsoori@yahoo.com

How to cite this article: Razzaghi A, Soori H, Kavousi A, Abadi A, Khosravi A, Alipour A. Risk factors of deaths related to road traffic crashes in World Health Organization regions: A systematic review. Arch Trauma Res 2019;8:57-86.

Received: 13-07-2019, **Accepted:** 21-08-2019, **Web Publication:** 07-10-2019.

to employ proper intervention to achieve their goals of preventing road traffic accidents and minimize associated injuries.[5]

Adequate knowledge of the influential factors in road traffic accidents enables countries to progressively decrease the rate of RTDs. The success rate of the measures to prevent RTDs varies across the globe. According to statistics, the highest success rate in the reduction of RTDs has been achieved in middle-and high-income countries, while no reduction in RTDs has been reported in low-income countries.[6] The countries in Africa and southeastern Asia are reported to have the highest rate of RTDs (26.6 and 20.7 cases per 100,000, respectively). On the other hand, the lowest rate of RTDs has been reported in East Mediterranean countries and Western Pacific regions (18 and 16.9 cases per 100,000, respectively). Among the six regions covered by the World Health Organization (WHO), a descending trend in RTDs has been reported in the United States, Europe, and Western Pacific regions since 2013.[6] It is notable that there are differences in the rates of RTDs in the regions covered by the WHO. For instance, the rate of RTDs in the high-and low-income countries in the United States has been estimated at 11.8 and 18.3 cases per 100 000, respectively. In Africa, the rates of RTDs in low-and middle-income countries have been reported to be 29.3 and 23.6 cases per 100 000, respectively. In Europe, the rate of RTDs in middle-and high-income countries has been estimated 23.6 and 14.4 cases per 100 000, respectively.[6]

The experience of the nations that have succeeded in the promotion of road safety and reduction of road accident injuries and RTDs shows that road traffic accidents are avoidable and preventable. Road traffic accidents are not inadvertent and are mainly caused by disruptions in the systemic interaction between humans, vehicles, roads and environmental factors. In high-income countries, injury surveillance systems make it possible to attain high-quality data regarding RTDs, road traffic accidents, and the associated risk factors. As a result, the risk factors involved in road traffic accidents could be properly recognized and be incorporated into prevention and control programs. However, many low-and middle-income countries lack sufficient, accurate epidemiological data regarding RTDs due to the absence of valid registry systems. Therefore, it is not possible to determine the incidence rate of road traffic injuries and identify the risk factors involved in RTDs directly and accurately.[5]

Several studies have been focused on the severity of road traffic accidents. The risk factors in this regard could be classified into four main categories, including human factors, vehicle-related factors, road-related factors, and environmental factors. Identification of the risk factors involved in RTDs could help policymakers and managers adopt effective strategies for the control and prevention of road traffic injuries and the associated outcomes. Lack of data on these risk factors makes it difficult for countries to properly recognize the problems and implement effective interventions in this regard.[6] This systematic review aimed at assessing the risk factors of RTDs based on the national studies conducted in this regard.

Methods

This study was conducted during 2008–2018 via searching in databases PubMed, Science Direct, Scopus, Cochrane, Thomson Reuters, Web of Science, EMBASE, ProQuest, and Trip databases. Initially, a preliminary search was carried out to find similar systematic reviews, followed by the review of the literature to retrieve 3–5 related studies to collect the required data.

In the PubMed database, the search of articles was done with no limitations, and the search resulted in five articles. However, the review of the titles and abstracts of these articles indicated that they were irrelevant to the research subject. The literature search resulted in four articles in the Scopus database, none of which were relevant to the research subject. A review of the literature was also conducted in PubMed, Scopus, and PROSPERO databases to retrieve published or registered similar protocols. At this stage, no relevant protocols were found in PubMed.

To investigate the registered protocols, search for the relevant protocols was performed in the PROSPERO database using specific keywords, such as road accident risk factor. However, the search results showed no relevant protocols.

To search for related articles, the PECOTS search strategy was adopted based on the sample populations, exposure, comparison, outcomes, and type of relevant studies. The inclusion criteria in this study were as follows: the national-level studies about the risk factors related to RTDs, English language studies, and the studies published during 2008–2018. The search strategy was developed, and the search for the articles

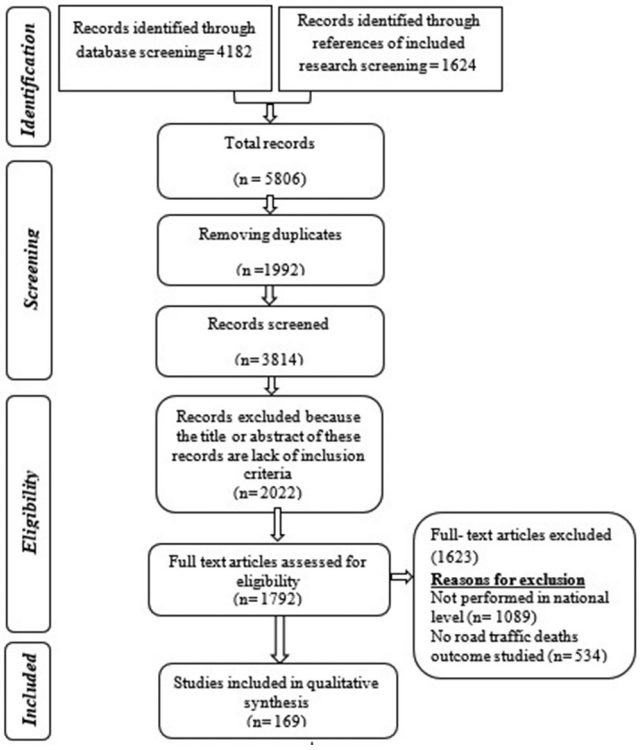

Figure 1: The flowchart of searching in systematic review

was performed in PubMed, Science Direct, Scopus, Cochrane, Thomson Reuters, Web of Science, EMBASE, ProQuest, and Trip databases. Moreover, the references of relevant articles were reviewed. The search results were investigated to find the relevant articles in two phases of screening and selection. The screening was carried out based on the titles and abstracts of the articles, and the selection of relevant articles was performed based on the full-text review of the articles. The flowchart of the literature search process is depicted in Figure 1.

Duplicate studies were determined based on the titles, abstracts, and authors of the articles. The research stages were completed by two independent researchers. In case of disagreement regarding the selection of the articles, consensus or expert opinions were applied. In addition, the reasons for the inclusion or exclusion of each article were recorded.

The quality of the retrieved studies was assessed using the STROBE checklist for cross-sectional, cohort, and case–control studies by two researchers who were experts in the research projects regarding road traffic accidents. In case of disagreement, consensus or expert opinions were applied.

The data of the selected studies were extracted by two subject experts independently. Considering the difference in the quality of the studies, the third-quartile STROBE score (≥15) was determined to synthesizing the studies with acceptable quality.

Results

In total, 169 articles were included in the present study. The distribution of the included articles in the six regions covered by the WHO was as follows: 108 articles from America, 33 articles from Europe, 10 articles from the Western Pacific region, one article from Africa, nine articles from Eastern Mediterranean, and eight articles from Southeastern Asia. Moreover, various observational studies were detected among the retrieved articles. The distribution of the reviewed articles is presented in Table 1.

Due to a large number of the studies (169 articles) to be presented in detail in a table, only the features of the selected cohort studies are shown in Table 2 considering the high evidential level of observational studies. The characteristics of all the reviewed articles are presented in the Appendix section.

According to this systematic review, most of the studies regarding RTDs were conducted in the United States, followed by Europe, the Western Pacific region, East Mediterranean, Southeastern Asia, and Africa. The investigation of the risk factors involved in RTDs was performed based on the quality assessment of the reviewed studies. Only one article in this regard has been published in Africa, which was not considered acceptable in the quality assessment. Moreover, nine articles have been published in this regard in the East Mediterranean, one of which required qualification to be further reviewed. There were 4, 17, and 50 qualified articles published in Southeastern Asia, Europe, and the United States, respectively.

According to the results of the present study, human factors were the most significant risk factor for RTDs in the reviewed studies. Some of the most important human factors have been reported to be age, male gender, education level, alcohol consumption, obesity, not using helmets by motorcyclists, driving without a driver's license, and high-speed driving. Obesity was reported to be a risk factor for RTDs in the United States and Europe. Moreover, ethnicity was considered to be a risk factor for RTDs only in the United States. In Southeastern Asia and the Western Pacific region, old age was reported to be a major risk factor for RTDs in motorcyclists. In the Middle East, the distraction of the driver was considered to be the only risk factor for RTDs.

Some of the main road-related risk factors for RTDs were reported to be urban roads, unpaved roads, off-road driving, and poor road conditions, which were extracted from the national data of the United States. In European countries, these factors included divided roads, two-way roads, and poor roadway design, which contributed to RTDs. In the southeastern regions of Asia, the main road-related risk factor for RTDs was reported to be the type of roads (local roads, highways, and freeways). Furthermore, roadside departure to the right side and long roads were denoted in the national data of the Western Pacific region on the incidence of RTDs. The only qualified study in East Mediterranean contained no data on the road-related risk factors for RTDs.

Environmental factors were considered to be among the risk factors involved in RTDs only in the United States. On the other hand, location-related factors were denoted in the United States (e.g., low-income areas), Europe (e.g., non-signalized zebra crosswalks, areas that were not built-up, geographic variations, and mid-block crosswalk location), Southeastern Asia, and Western Pacific region (e.g., interchange roads and rural areas).

Differences were observed between the six regions covered by the WHO in terms of the time-related risk factors for RTDs. Some of these factors were reported to be as follows: the United

Table 1: Number and type of studies in 6 World Health Organization regions

Region	Total articles	Ecologic studies	Cross sectional studies	Case control studies	Cohort studies
Americas	108	1	95	2	10
Europe	33	2	28	-	3
Southeast Asia Region	8	-	8	-	-
Western Pacific	10	1	9	-	-
Africa	1	-	1	-	-
Eastern Mediterranean	9	-	9	-	-

Table 2: The risk factors related to road traffic crashes deaths in cohort studies

Title	Author/year/country/region	Study design*/STROB Score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
Risk factors for death among older child and teenaged motor vehicle passengers[7]	Winston *et al*./2008/USA/ Americas/[7]	Retrospective cohort/22	AOR	Person factors (age and sex of driver, restraint use, seating position), vehicle factor, road factor, environmental factors (day of week, month, time of day), law factors (speed limit)	Person factors: Drivers younger than 18 years, restraint nonuse, high-speed roads, speed limit
A matched-cohort analysis of belted front and rear seat occupants in newer and older model vehicles shows that gains in front occupant safety have outpaced gains for rear seat occupants[8]	Bilston *et al*./2010/USA/ Americas/[8]	Matched-cohort approach/20	RR	Vehicle characteristic	Risk to front seat occupants in newer vehicles decline
The association of age, sex and helmet use with the risk of death for occupants of two-wheeled motor vehicles involved in traffic crashes in Spain[9]	Donate-López *et al*./2010/ Spain/Europe/[9]	rCoh/24	ARR	Human factor (age, sex, and helmet use for occupants of two-wheeled motor vehicles)	Age, sex, and helmet use
Population density and mortality among individuals in motor vehicle crashes[10]	Gedeborg *et al*./2010/Sweden/ Europe/[10]	Population-based cohort/-/22	Mortality rates	Human factor (population density)	Crude mortality rates were inversely related to regional population density
Traffic crash victimizations of children and teenagers by drinking drivers age 21 and older[11]	Males/2010/USA/Americas/[11]	rCoh (not mentioned in study)/18	RR	Victimizations of children and teenagers by drinking drivers age 21 and older	Drinking drivers aged 21 and older victimize 1.3 times more teenage drivers than vice versa and account for large majorities of passenger and nonoccupant alcohol-related crash victimizations of both children and teens
The effect of earlier or automatic collision notification on traffic mortality by survival analysis[12]	Wu *et al*./2013/USA/ Americas/[12]	Coh/12	Survival rates	EMS, vehicle factor: ACN	The results showed the benefits associated with earlier notifications (approximately 1.84% fatality reduction within a time frame of 6 h after a crash)
Obesity and vehicle type as risk factors for injury caused by motor vehicle collision[13]	Donnelly *et al*./2014/UK/ Europe/[13]	rCC/18	OR	Human factor (occupant BMI class; underweight, normal weight, overweight, or obese)	It is found that obesity was a risk factor for mortality caused by MVC (OR, 1.6; 95% CI, 1.2-2.0)
Driver obesity and the risk of fatal injury during traffic collisions[14]	Rice and Zhu/2014/USA/ Americas/[14]	Matched-pair cohort study/16	RRs	Human factor (obesity, sex), human behavior factor (driver seat belt use), vehicle factor (vehicle type confidence interval, collision type, confidence interval)	Estimated RRs raised for underweight drivers, RR increased with higher BMI categories

Contd...

Table 2: Contd...

Title	Author/year/country/region	Study design*/STROB Score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
Age, period, and cohort effects in motor vehicle mortality in the United States, 1980-2010: The role of sex, alcohol involvement, and position in vehicle[15]	Macinko *et al*./2015/USA/ Americas/[15]	Coh/16	Rate	Human factor (role of sex, alcohol involvement) and position in vehicle, age, period, and cohort effects in motor vehicle mortality	Declines in MVC deaths by position in the car vary for men and women by age and cohort over time. Cohorts born before 1970 had higher risks than those born later. New technologies and public policy efforts reduce fatalities
Helicopter transport improves survival following injury in the absence of a time-saving advantage[16]	Brown *et al*./2016/USA/ Americas/[16]	rCC/24	AOR	Medical services: HEMS compared with GEMS transport across similar prehospital transport times	HEMS had a survival benefit over GEMS for prehospital transport times between 6 and 30 min
The association between booster seat use and risk of death among motor vehicle occupants aged 4-8: A matched cohort study[17]	Rice *et al*./2009/USA/ Americas/[17]	Matched cohort study/15	RRs	Human behavior factor (booster seats and of seatbelts)	Seatbelts, used with or without booster seats, are highly effective in preventing death among motor vehicle occupants aged 4-8 years
Mortality from road traffic accidents in Switzerland: Longitudinal and spatial analyses[18]	Spoerri/2011/Switzerland/ Europe/[18]	Cohort/18	Adjusted HR	Human factor (population density)	RTA mortality increased with decreasing population density of study areas for motor vehicle occupants and motorcyclists
Association between different restraint use and rear-seated child passenger fatalities: A matched cohort study[19]	Du/2008/USA/Americas/[19]	Matched-cohort design/18	RR	Human factor (rear-seated child passengers use)	Restrained reduced the risk of death in rear-seated child passengers

*Study design: Coh: Cohort study, rCoh: Retrospective Cohort Study, CC: Case-control, CS: Cross-sectional, EMS: Emergency medical services, ACN: Automatic collision notification, CI: Confidence interval, RRs: Risk ratios, AOR: Adjusted odds ratio, HR: Hazard ratio, MCV: Motor Vehicle Crash, RTA: Road traffic accident, OR: Odds ratio, HEMS:Helicopter-based Emergency Medical Service, GEMS: Ground Emergency Medical Services, ARR: Adjusted rate ratio, BMI: Body mass index

States (hour of the day, time of the accident, early-morning accidents, non-school night driving, driving in daylight hours), Europe (darkness [especially the lack of street lighting] and summertime), Southeastern Asia (time of the accident and motorcyclists involved in accidents at nighttime), and Western Pacific region (darkness hours).

In terms of the law-related factors, the most significant influential factors in the incidence of RTDs were reported to be restraint, high gasoline prices, driver's license law, renewal of the driver's license, and alcohol consumption policies. In Europe, helmet legislation was denoted as the only law-related factor in this regard.

According to the reviewed studies, the economic influential factors in the incidence of RTDs were mainly reported in the United States, Europe, Southeastern Asia, and the Western Pacific region. Table 3 shows the distribution of the influential factors in the incidence of RTDs.

Discussion

According to the current systematic review, the epidemiological pattern of road traffic crashes (RTCs) and the associated consequences vary in the six regions covered by the WHO.

Adequate knowledge of the risk factors involved in RTDs is essential to determining the priorities and implementing effective interventions. In the six regions covered by the WHO, available data are insufficient regarding the risk factors for RTDs in the low-and middle-income countries. According to these statistics, many countries in the world may be unable to reach their sustainable development goals in reducing RTDs up until the middle of 2020. Meanwhile, the number of vehicles has increased drastically across the world, with the rate of RTDs reaching from 135 cases per 100 vehicles in 2000 to 64 cases in 2016. Furthermore, the reduced rate of RTDs by 50% within the past 15 years could be due to progress in road safety although such progress is not considered acceptable considering the growing number of motor vehicles.[6]

In low- and middle-income countries, there is a lack of systematic enforcement to collect data on RTDs. Human factors were the most significant risk factor for RTDs in the reviewed studies. From an epidemiological perspective and

Table 3: The risk factors of road traffic accidents deaths extracted in national studies in World Health Organization regions

Risk factors/region	Americas	Europe	Southeast Asia region	Western Pacific	Africa	Eastern Mediterranean
Human factors	Driver license compliance, driver drinking, system-restraint use (seatbelt), restraint nonuse, high-speed roads, speed driving, lower education, young male drivers, driver age, obesity, older age of road user, safety belt nonuse, high speed, male driver, ethnicity, adolescents, young and middle-aged road user, unrestrained, elderly road user, alcohol and drug use, nonhelmet use, new motorcycles, obesity, child occupants of motor vehicle	Older drivers, older age, male driver and seatbelt use, alcohol and drug use, lower education, unmarried men, speed driving, nonhelmet use, population density, obesity, male road users, changes in travel patterns	Male driver, older age, restrained drivers, lower education, male motorcycles drivers, older motorcycles, unlicensed motorcycles, nonhelmet use, alcohol and drug use	Speed driving, older motorcycle driver, late model motorcycles, alcohol and drug use	-	Not maintaining eyes on the road, losing control of the vehicle
Road factors	Urban roads (vs. rural), dark roads (vs. daylight), unpaved roads, off-road crashes, road surface condition	Divided road, two-way road, roadway design	Road types in city (local road, highway, freeway)	Nonlevel roadway profiles, roadside departure to the right side, road length	-	-
Crash factors	Motorist action before the crash, collisions with roadside objects, rollover crashes	-	Crash type	Speed-related crashes	-	-
Environmental factor	Presence of snow and/or rain,	-	-	-	-	-
Vehicle-related factor	Automobile (passenger) cars, vehicle damage, front seat occupants, air bags	Type of vehicle hitting the pedestrian, motorized two-wheeler	Two-wheels cars, buses	-	-	-
Time related factor	Hour of crash time of the accident, early morning crashes, nonschool night driving, driving in daylight hours	Night driving, street no lighting, summer time period	Hour of crash, motorcycle night driving	Night driving	-	-
Location-related factor	Poorer areas	Unsignalized zebra crosswalks, nonbuilt-up areas, mid-block crosswalk location, geographic variation	Location of crash, motorcycle traffic separation, nonurban single-vehicle accidents	Interchange locations, rural areas	-	-
Laws	Restrained laws, higher gasoline prices, adoption of a graduated driver licensing law, renewal driver license, alcohol policies	Helmet legislation, higher gasoline prices		-	-	-
Prehospital and hospital factor	Helicopter-based EMS and ground EMS facilities	-	-	-	-	-
Economic factor	Socioeconomic status	Socioeconomic status	Deprived areas	Lower capita	-	-

EMS: Emergency medical services

based on the assessment of the causal network of injuries, the main influential factors in RTDs could be classified as the predisposing factors, enabling factors, precipitating factors, and reinforcing factors. Some of these factors (e.g., age, gender, marital status, and education level) are regarded as the predisposing factors, which may be essential to causality relationships although they may not be sufficient. Some of the interventional enforcements regarding these factors include proper training and alcohol consumption, which are modifiable. Causality networks are also affected by enabling factors, which facilitate the development of diseases and the associated outcomes. Some of these factors are income status, climatic conditions, and access to health services, which may play a key role in causality network and are rarely sufficient. Enabling factors are often modifiable, and their modification could prevent RTCs. Precipitating factors are also considered in the investigation of the causality network of diseases and the associated outcomes. These factors contribute to disease development and the occurrence of injuries. Due to the wide range of these factors, one factor may be prioritized and regarded as the necessity factor. Some key precipitating factors include exposure to special diseases, physical shocks,

occupational stimulators, and knowledge. In road traffic accidents, each human, road-related, vehicle-related, and environmental factor could play the role of a precipitating factor. For instance, in human factors, driver distraction could be considered a precipitating factor. Among the other examples in this regard are road flows, vehicle defects, snowy/rainy weather, and road slippage, which could be regarded as precipitating factors.

Reinforcing factors lead to the persistence of increased severity of diseases, as well as disabilities, impairments, and the subsequent behavioral patterns. These factors may be repeatable or consistent and not necessarily similar to predisposing, precipitating, and enabling factors. In terms of road traffic crash, some of these factors include incidental roads, poor awareness of road users regarding road safety, high-risk driving behaviors, motor vehicle defects, and low safety. According to the results of this systematic review in the regions covered by the WHO, human factors were the most common risk factors involved in RTDs; some of these factors were old age, male gender, low education level, alcohol consumption, obesity, not using safety helmets, driving without a driver's license, and high-speed driving.

Obesity has been reported to be a risk factor for RTDs in the United States and Europe. Accordingly, the risk of RTDs is higher in obese individuals compared to overweight and underweight individuals, as well as those with normal weight. The epidemic of obesity in the United States and Europe is considered to be a major challenge, which could be considered a risk factor in the countries with the growing trend of obesity as well.

Ethnicity has been reported to be a human risk factor for RTDs only in the United States. In addition, the beliefs of fatalism are reported to be more widespread in Hispanic and African populations. Based on this belief, when they are driving, they have no control over the probability of an accident, which exposed these individuals to a high risk of death due to fatal crash.[80] In Southeastern Asia and the West Pacific region, old age of motorcyclists has been reported to be a risk factor for RTDs. On the other hand, the findings of a study conducted in France indicated that elderly drivers are at a lower risk in terms of the lost life year compared to middle-aged and young drivers.[26] With respect to this association, some studies have denoted that attention deficits in elderly drivers play a pivotal role in road traffic crash.[174]

In an article published in the East Mediterranean region, driver distraction was reported to be a major risk factor for RTDs. Driver distraction mainly involves the driver not watching the road carefully while driving, which is often associated with the significant risk of road traffic crash.[95]

However, we only found one article regarding this risk factor, and further investigation is required to obtain detailed data in EMRO countries. Driver distraction could have various causes depending on time, place, and demographic characteristics; except age and gender, the mentioned demographic factors are all modifiable. Efficient planning on modifiable factors is essential to the prevention of road traffic crash and RTDs. Unfortunately, there were few qualified studies in this regard in Africa and East Mediterranean, while these regions mostly consist of low- and middle-income countries. These countries often lack effective registry systems for road traffic crash; this leads to numerous problems in planning and decision-making regarding road traffic crash.

One of the limitations of the present study was that we only reviewed English articles. Moreover, we selected a specific publication period for the articles.[6]

Conclusions

There are similarities in the findings regarding the influential factors in the incidence of RTDs in the countries covered by the WHO. In addition, variable patterns are observed in the subcategories of each of the main factors in this regard, indicating the differences in the epidemiological patterns of road traffic accidents and RTDs. Therefore, researchers, managers, and policymakers must pay special attention to these discrepancies in the analysis of the related data, as well as planning, policymaking, and implementation of the related interventions.

Acknowledgment

We acknowledged all the people who helped us in accessing to the full text of articles.

Financial support and sponsorship

This article is derived from PhD thesis, which is funded by Shahid Beheshti University of Medical Sciences and Iran National Science Foundation.

Conflicts of interest

There are no conflicts of interest.

References

1. Grimm M, Treibich C. Socio-Economic Determinants of Road Traffic Accident Fatalities in Low and Middle Income Countries. Vol. 504. International Institute of Social Studies of Erasmus University; 2010. p. 1-44.
2. Manan MM, Jonsson T, Várhelyi A. Development of a safety performance function for motorcycle accident fatalities on Malaysian primary roads. Saf Sci 2013;60:13-20.
3. Sarani R, Rahim S, Marjan JM, Voon WS. Predicting Malaysian road fatalities for year 2020. Transp Res Board 2012;p.12-42.
4. Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E, editors. World Report on Road Traffic Injury Prevention. World Health Organization; 2004.
5. Bhalla K, Sharaz S, Abraham J, Bartels D, Yeh P. Road Injuries in 18 Countries: Methods, Data Sources and Estimates of the National Incidence of Road Injuries. Harvard Public Health; 2011.
6. World Health Organization. Global Status Report on Road Safety. World Health Organization; 2018.
7. Winston FK, Kallan MJ, Senserrick TM, Elliott MR. Risk factors for death among older child and teenaged motor vehicle passengers. Arch Pediatr Adolesc Med 2008;162:253-60.
8. Bilston LE, Du W, Brown J. A matched-cohort analysis of belted front and rear seat occupants in newer and older model vehicles shows

that gains in front occupant safety have outpaced gains for rear seat occupants. Accid Anal Prev 2010;42:1974-7.
9. Donate-López C, Espigares-Rodríguez E, Jiménez-Moleón JJ, Luna-del-Castillo Jde D, Bueno-Cavanillas A, Lardelli-Claret P. The association of age, sex and helmet use with the risk of death for occupants of two-wheeled motor vehicles involved in traffic crashes in Spain. Accid Anal Prev 2010;42:297-306.
10. Gedeborg R, Thiblin I, Byberg L, Melhus H, Lindbäck J, Michaelsson K. Population density and mortality among individuals in motor vehicle crashes. Inj Prev 2010;16:302-8.
11. Males M. Traffic crash victimizations of children and teenagers by drinking drivers age 21 and older. J Stud Alcohol Drugs 2010;71:351-6.
12. Wu J, Subramanian R, Craig M, Starnes M, Longthorne A. The effect of earlier or automatic collision notification on traffic mortality by survival analysis. Traffic Inj Prev 2013;14 Suppl: S50-7.
13. Donnelly JP, Griffin RL, Sathiakumar N, McGwin G Jr. Obesity and vehicle type as risk factors for injury caused by motor vehicle collision. J Trauma Acute Care Surg 2014;76:1116-21.
14. Rice TM, Zhu M. Driver obesity and the risk of fatal injury during traffic collisions. Emerg Med J 2014;31:9-12.
15. Macinko J, Silver D, Bae JY. Age, period, and cohort effects in motor vehicle mortality in the United States, 1980-2010: The role of sex, alcohol involvement, and position in vehicle. J Safety Res 2015;52:47-57.
16. Brown JB, Gestring ML, Guyette FX, Rosengart MR, Stassen NA, Forsythe RM, *et al.* Helicopter transport improves survival following injury in the absence of a time-saving advantage. Surgery 2016;159:947-59.
17. Rice TM, Anderson CL, Lee AS. The association between booster seat use and risk of death among motor vehicle occupants aged 4-8: A matched cohort study. Inj Prev 2009;15:379-83.
18. Spoerri A, Egger M, von Elm E, Swiss National Cohort Study. Mortality from road traffic accidents in Switzerland: Longitudinal and spatial analyses. Accid Anal Prev 2011;43:40-8.
19. Du W, Hayen A, Bilston L, Hatfield J, Finch C, Brown J. Association between different restraint use and rear-seated child passenger fatalities: A matched cohort study. Arch Pediatr Adolesc Med 2008;162:1085-9.
20. Awadzi KD, Classen S, Hall A, Duncan RP, Garvan CW. Predictors of injury among younger and older adults in fatal motor vehicle crashes. Accid Anal Prev 2008;40:1804-10.
21. Eksler V, Lassarre S. Evolution of road risk disparities at small-scale level: Example of Belgium. J Safety Res 2008;39:417-27.
22. Eluru N, Bhat CR, Hensher DA. A mixed generalized ordered response model for examining pedestrian and bicyclist injury severity level in traffic crashes. Accid Anal Prev 2008;40:1033-54.
23. Factor R, Mahalel D, Yair G. Inter-group differences in road-traffic crash involvement. Accid Anal Prev 2008;40:2000-7.
24. Gray RC, Quddus MA, Evans A. Injury severity analysis of accidents involving young male drivers in great Britain. J Safety Res 2008;39:483-95.
25. Kvarnstrand L, Milsom I, Lekander T, Druid H, Jacobsson B. Maternal fatalities, fetal and neonatal deaths related to motor vehicle crashes during pregnancy: A national population-based study. Acta Obstet Gynecol Scand 2008;87:946-52.
26. Lafont S, Amoros E, Gadegbeku B, Chiron M, Laumon B. The impact of driver age on lost life years for other road users in France: A population based study of crash-involved road users. Accid Anal Prev 2008;40:289-94.
27. Leigh JP, Geraghty EM. High gasoline prices and mortality from motor vehicle crashes and air pollution. J Occup Environ Med 2008;50:249-54.
28. Farmer P, Howard A, Rothman L, Macpherson A. Booster seat laws and child fatalities: A case-control study. Inj Prev 2009;15:348-50.
29. Friedman LS, Hedeker D, Richter ED. Long-term effects of repealing the national maximum speed limit in the United States. Am J Public Health 2009;99:1626-31.
30. Hyatt E, Griffin R, Rue LW 3rd, McGwin G Jr. The association between price of regular-grade gasoline and injury and mortality rates among occupants involved in motorcycle – And automobile-related motor vehicle collisions. Accid Anal Prev 2009;41:1075-9.
31. Kposowa AJ, Breault KD. Motor vehicle deaths among men: Marital status, gender and social integration. Int J Mens Health 2009;8:129-42.
32. Lardelli-Claret P, Espigares-Rodríguez E, Amezcua-Prieto C, Jiménez-Moleón JJ, Luna-del-Castillo Jde D, Bueno-Cavanillas A. Association of age, sex and seat belt use with the risk of early death in drivers of passenger cars involved in traffic crashes. Int J Epidemiol 2009;38:1128-34.
33. Neeley GW, Richardson LE Jr. The effect of state regulations on truck-crash fatalities. Am J Public Health 2009;99:408-15.
34. Traynor TL. The impact of state level behavioral regulations on traffic fatality rates. J Safety Res 2009;40:421-6.
35. Wilson FA, Stimpson JP, Hilsenrath PE. Gasoline prices and their relationship to rising motorcycle fatalities, 1990-2007. Am J Public Health 2009;99:1753-8.
36. Yan X, Radwan E, Mannila KK. Analysis of truck-involved rear-end crashes using multinomial logistic regression. Adv Transp Stud 2009;17:39-52.
37. Farmer CM, Wells JK. Effect of enhanced seat belt reminders on driver fatality risk. J Safety Res 2010;41:53-7.
38. Impinen A, Mäkelä P, Karjalainen K, Rahkonen O, Lintonen T, Lillsunde P, *et al.* High mortality among people suspected of drunk-driving. An 18-year register-based follow-up. Drug Alcohol Depend 2010;110:80-4.
39. Karjalainen K, Lintonen T, Impinen A, Mäkelä P, Rahkonen O, Lillsunde P, *et al.* Mortality and causes of death among drugged drivers. J Epidemiol Community Health 2010;64:506-12.
40. Lunevicius R, Herbert HK, Hyder AA. The epidemiology of road traffic injuries in the republic of Lithuania, 1998-2007. Eur J Public Health 2010;20:702-6.
41. McCartt AT, Teoh ER, Fields M, Braitman KA, Hellinga LA. Graduated licensing laws and fatal crashes of teenage drivers: A national study. Traffic Inj Prev 2010;11:240-8.
42. Ouimet MC, Simons-Morton BG, Zador PL, Lerner ND, Freedman M, Duncan GD, *et al.* Using the U.S. National household travel survey to estimate the impact of passenger characteristics on young drivers' relative risk of fatal crash involvement. Accid Anal Prev 2010;42:689-94.
43. Sivak M, Schoettle B. Toward understanding the recent large reductions in U.S. Road fatalities. Traffic Inj Prev 2010;11:561-6.
44. Teoh ER, Campbell M. Role of motorcycle type in fatal motorcycle crashes. J Safety Res 2010;41:507-12.
45. Bambach MR, Grzebieta RH, Olivier J, McIntosh AS. Fatality risk for motorcyclists in fixed object collisions. J Transp Saf Secur 2011;3:222-35.
46. Castillo-Manzano JI, Castro-Nuño M, Pedregal DJ. Can fear of going to jail reduce the number of road fatalities? The Spanish experience. J Safety Res 2011;42:223-8.
47. Chang DC, Eastman B, Talamini MA, Osen HB, Tran Cao HS, Coimbra R. Density of surgeons is significantly associated with reduced risk of deaths from motor vehicle crashes in US counties. J Am Coll Surg 2011;212:862-6.
48. Daniello A, Gabler HC. Fatality risk in motorcycle collisions with roadside objects in the United States. Accid Anal Prev 2011;43:1167-70.
49. Fell JC, Jones K, Romano E, Voas R. An evaluation of graduated driver licensing effects on fatal crash involvements of young drivers in the United States. Traffic Inj Prev 2011;12:423-31.
50. Huang WS, Lai CH. Survival risk factors for fatal injured car and motorcycle drivers in single alcohol-related and alcohol-unrelated vehicle crashes. J Safety Res 2011;42:93-9.
51. Lemp JD, Kockelman KM, Unnikrishnan A. Analysis of large truck crash severity using heteroskedastic ordered probit models. Accid Anal Prev 2011;43:370-80.
52. Lopez-Charneco M, Conte-Miller MS, Davila-Toro F, García-Rivera EJ, Zavala DE, Torres Y, *et al.* Motor vehicle accident fatalities trends, Puerto Rico 2000-2007. J Forensic Sci 2011;56:1222-6.
53. Sarkar S, Tay R, Hunt JD. Logistic regression model of risk of fatality in vehicle-pedestrian crashes on national highways in Bangladesh. Transp Res Rec 2011;2264:128-37.
54. Chu HC. An investigation of the risk factors causing severe injuries in crashes involving gravel trucks. Traffic Inj Prev 2012;13:355-63.

55. Eluru N, Bagheri M, Miranda-Moreno LF, Fu L. A latent class modeling approach for identifying vehicle driver injury severity factors at highway-railway crossings. Accid Anal Prev 2012;47:119-27.
56. Jehle D, Gemme S, Jehle C. Influence of obesity on mortality of drivers in severe motor vehicle crashes. Am J Emerg Med 2012;30:191-5.
57. Jou RC, Yeh TH, Chen RS. Risk factors in motorcyclist fatalities in Taiwan. Traffic Inj Prev 2012;13:155-62.
58. Lyon JD, Pan R, Li J. National evaluation of the effect of graduated driver licensing laws on teenager fatality and injury crashes. J Safety Res 2012;43:29-37.
59. Nagata T, Takamori A, Berg HY, Hasselberg M. Comparing the impact of socio-demographic factors associated with traffic injury among older road users and the general population in Japan. BMC Public Health 2012;12:887.
60. Rolison JJ, Hewson PJ, Hellier E, Husband P. Risk of fatal injury in older adult drivers, passengers, and pedestrians. J Am Geriatr Soc 2012;60:1504-8.
61. Theofilatos A, Graham D, Yannis G. Factors affecting accident severity inside and outside urban areas in Greece. Traffic Inj Prev 2012;13:458-67.
62. Travis LL, Clark DE, Haskins AE, Kilch JA. Mortality in rural locations after severe injuries from motor vehicle crashes. J Safety Res 2012;43:375-80.
63. Voas RB, Torres P, Romano E, Lacey JH. Alcohol-related risk of driver fatalities: An update using 2007 data. J Stud Alcohol Drugs 2012;73:341-50.
64. Bose D, Arregui-Dalmases C, Sanchez-Molina D, Velazquez-Ameijide J, Crandall J. Increased risk of driver fatality due to unrestrained rear-seat passengers in severe frontal crashes. Accid Anal Prev 2013;53:100-4.
65. Drucker C, Gerberich SG, Manser MP, Alexander BH, Church TR, Ryan AD, *et al.* Factors associated with civilian drivers involved in crashes with emergency vehicles. Accid Anal Prev 2013;55:116-23.
66. Kaimila B, Yamashina H, Arai A, Tamashiro H. Road traffic crashes and fatalities in Japan 2000-2010 with special reference to the elderly road user. Traffic Inj Prev 2013;14:777-81.
67. Meehan WP 3rd, Lee LK, Fischer CM, Mannix RC. Bicycle helmet laws are associated with a lower fatality rate from bicycle-motor vehicle collisions. J Pediatr 2013;163:726-9.
68. Silver D, Macinko J, Bae JY, Jimenez G, Paul M. Variation in U.S. Traffic safety policy environments and motor vehicle fatalities 1980-2010. Public Health 2013;127:1117-25.
69. Stimpson JP, Wilson FA, Muelleman RL. Fatalities of pedestrians, bicycle riders, and motorists due to distracted driving motor vehicle crashes in the U.S 2005-2010. Public Health Rep 2013;128:436-42.
70. Tefft BC. Impact speed and a pedestrian's risk of severe injury or death. Accid Anal Prev 2013;50:871-8.
71. Wenzel T. The effect of recent trends in vehicle design on U.S. Societal fatality risk per vehicle mile traveled, and their projected future relationship with vehicle mass. Accid Anal Prev 2013;56:71-81.
72. Zhu M, Zhao S, Gurka KK, Kandati S, Coben JH. Appalachian versus non-Appalachian U.S. Traffic fatalities, 2008-2010. Ann Epidemiol 2013;23:377-80.
73. Fell JC. Update: Repeat DWI offenders involvement in fatal crashes in 2010. Traffic Inj Prev 2014;15:431-3.
74. French MT, Gumus G. Macroeconomic fluctuations and motorcycle fatalities in the U.S. Soc Sci Med 2014;104:187-93.
75. Jiménez-Mejías E, Onieva-García MÁ, Robles-Martín J, Martínez-Ruiz V, Luna-Del-Castillo Jde D, Lardelli-Claret P. Why has the pedestrian death rate decreased in Spain between 1993 and 2011? An application of the decomposition method. Inj Prev 2014;20:416-20.
76. Ossiander EM, Koepsell TD, McKnight B. Crash fatality and vehicle incompatibility in collisions between cars and light trucks or vans. Inj Prev 2014;20:373-9.
77. Stimpson JP, Wilson FA, Araz OM, Pagan JA. Share of mass transit miles traveled and reduced motor vehicle fatalities in major cities of the United States. J Urban Health 2014;91:1136-43.
78. Tefft BC. Driver license renewal policies and fatal crash involvement rates of older drivers, United States, 1986-2011. Inj Epidemiol 2014;1:25.
79. Teoh ER. How have changes in front air bag designs affected frontal crash death rates? An update. Traffic Inj Prev 2014;15:606-11.
80. Torres P, Romano E, Voas RB, de la Rosa M, Lacey JH. The relative risk of involvement in fatal crashes as a function of race/ethnicity and blood alcohol concentration. J Safety Res 2014;48:95-101.
81. Bakhtiyari M, Delpisheh A, Monfared AB, Kazemi-Galougahi MH, Mehmandar MR, Riahi M, *et al.* The road traffic crashes as a neglected public health concern; an observational study from Iranian population. Traffic Inj Prev 2015;16:36-41.
82. Bandi P, Silver D, Mijanovich T, Macinko J. Temporal trends in motor vehicle fatalities in the United States, 1968 to 2010 – A joinpoint regression analysis. Inj Epidemiol 2015;2:4.
83. Bouaoun L, Haddak MM, Amoros E. Road crash fatality rates in France: A comparison of road user types, taking account of travel practices. Accid Anal Prev 2015;75:217-25.
84. Cicchino JB. Why have fatality rates among older drivers declined? The relative contributions of changes in survivability and crash involvement. Accid Anal Prev 2015;83:67-73.
85. Ewing R, Hamidi S. Urban sprawl as a risk factor in motor vehicle occupant and pedestrian fatalities: Update and refinement. Transp Res Rec 2015;2513:40-7.
86. Farmer CM, Lund AK. The effects of vehicle redesign on the risk of driver death. Traffic Inj Prev 2015;16:684-90.
87. Fogarty AW, Liu C. Temporal trends in the associations between age, sex and socioeconomic status after death from motor vehicle collisions in England and Wales: 1960-2009. Emerg Med J 2015;32:203-6.
88. Harper S, Charters TJ, Strumpf EC. Trends in socioeconomic inequalities in motor vehicle accident deaths in the United States, 1995-2010. Am J Epidemiol 2015;182:606-14.
89. Lee LK, Farrell CA, Mannix R. Restraint use in motor vehicle crash fatalities in children 0 year to 9 years old. J Trauma Acute Care Surg 2015;79:S55-60.
90. Lee LK, Monuteaux MC, Burghardt LC, Fleegler EW, Nigrovic LE, Meehan WP, *et al.* Motor vehicle crash fatalities in states with primary versus secondary seat belt laws: A time-series analysis. Ann Intern Med 2015;163:184-90.
91. Martínez-Ruiz V, Jiménez-Mejías E, Amezcua-Prieto C, Olmedo-Requena R, Luna-del-Castillo Jde D, Lardelli-Claret P. Contribution of exposure, risk of crash and fatality to explain age – And sex-related differences in traffic-related cyclist mortality rates. Accid Anal Prev 2015;76:152-8.
92. Yasmin S, Eluru N, Pinjari AR. Analyzing the continuum of fatal crashes: A generalized ordered approach. Anal Methods Accid Res 2015;7:1-15.
93. Yeo J, Park S, Jang K. Effects of urban sprawl and vehicle miles traveled on traffic fatalities. Traffic Inj Prev 2015;16:397-403.
94. Andrade SS, Mello-Jorge MH. Mortality and potential years of life lost by road traffic injuries in Brazil, 2013. Rev Saude Publica 2016;50:59.
95. Bakhtiyari M, Mehmandar MR, Riahi SM, Mansournia MA, Sartipi M, Bahadorimonfared A. Epidemiologic pattern of fatal traffic injuries among Iranian drivers; 2004-2010. Iran J Public Health 2016;45:503-14.
96. Bénié Bi Vroh J, Tiembre I, Ekra DK, Ano Ama MN, Ka OM, Ncho Dagnan S, *et al.* Determinants of fatal road traffic injuries in Côte d'Ivoire from 2002 to 2011 Sante Publique 2016;28:647-53.
97. Bhatti JA, Nathens AB, Redelmeier DA. Driver's obesity and road crash risks in the United States. Traffic Inj Prev 2016;17:604-9.
98. Bin Islam M, Hernandez S. Fatality rates for crashes involving heavy vehicles on highways: A random parameter Tobit regression approach. J Transp Saf Secur 2016;8:247-65.
99. Boufous S, Olivier J. Recent trends in cyclist fatalities in Australia. Inj Prev 2016;22:284-7.
100. Brazil N, Kirk DS. Uber and metropolitan traffic fatalities in the United States. Am J Epidemiol 2016;184:192-8.
101. Brazinova A, Majdan M. Road traffic mortality in the Slovak Republic in 1996-2014. Traffic Inj Prev 2016;17:692-8.
102. Chang YS, Lee WJ, Lee JH. Are there higher pedestrian fatalities in larger cities?: A scaling analysis of 115 to 161 largest cities in the United States. Traffic Inj Prev 2016;17:720-8.
103. Denning GM, Jennissen CA. All-terrain vehicle fatalities on paved roads, unpaved roads, and off-road: Evidence for informed roadway safety warnings and legislation. Traffic Inj Prev 2016;17:406-12.

104. El-Menyar A, Consunji R, Asim M, Abdelrahman H, Zarour A, Parchani A, *et al.* Underutilization of occupant restraint systems in motor vehicle injury crashes: A quantitative analysis from Qatar. Traffic Inj Prev 2016;17:284-91.
105. Gopaul CD, Singh-Gopaul A, Sutherland JM, Rostant L, Ebi KL, Chadee DD. The epidemiology of fatal road traffic collisions in Trinidad and Tobago, West Indies (2000-2011). Glob Health Action 2016;9:32518.
106. Huang Y, Liu C, Pressley JC. Child restraint use and driver screening in fatal crashes involving drugs and alcohol. Pediatrics 2016;138. pii: e20160319.
107. Tavakoli Kashani A, Rabieyan R, Besharati MM. Modeling the effect of operator and passenger characteristics on the fatality risk of motorcycle crashes. J Inj Violence Res 2016;8:35-42.
108. Matsui Y, Oikawa S, Sorimachi K, Imanishi A, Fujimura T. Association of impact velocity with risks of serious injuries and fatalities to pedestrians in commercial truck-pedestrian accidents. Stapp Car Crash J 2016;60:165-82.
109. Onieva-García MÁ, Martínez-Ruiz V, Lardelli-Claret P, Jiménez-Moleón JJ, Amezcua-Prieto C, de Dios Luna-Del-Castillo J, *et al.* Gender and age differences in components of traffic-related pedestrian death rates: Exposure, risk of crash and fatality rate. Inj Epidemiol 2016;3:14.
110. Pulido J, Barrio G, Hoyos J, Jiménez-Mejías E, Martín-Rodríguez M del M, Houwing S, *et al.* The role of exposure on differences in driver death rates by gender and age: Results of a quasi-induced method on crash data in Spain. Accid Anal Prev 2016;94:162-7.
111. Saha S, Schramm P, Nolan A, Hess J. Adverse weather conditions and fatal motor vehicle crashes in the United States, 1994-2012. Environ Health 2016;15:104.
112. Shults RA, Williams AF. Graduated driver licensing night driving restrictions and drivers aged 16 or 17 years involved in fatal night crashes – United States, 2009-2014. MMWR Morb Mortal Wkly Rep 2016;65:725-30.
113. Truong LT, Kieu LM, Vu TA. Spatiotemporal and random parameter panel data models of traffic crash fatalities in Vietnam. Accid Anal Prev 2016;94:153-61.
114. Vanlaar W, Mainegra Hing M, Brown S, McAteer H, Crain J, McFaull S. Fatal and serious injuries related to vulnerable road users in Canada. J Safety Res 2016;58:67-77.
115. Zhu M, Zhao S, Long DL, Curry AE. Association of graduated driver licensing with driver, non-driver, and total fatalities among adolescents. Am J Prev Med 2016;51:63-70.
116. Besharati MM, Tavakoli Kashani A. Which set of factors contribute to increase the likelihood of pedestrian fatality in road crashes? Int J Inj Contr Saf Promot 2018;25:247-56.
117. Dong C, Nambisan SS, Clarke DB, Sun J. Exploring the effects of state highway safety laws and sociocultural characteristics on fatal crashes. Traffic Inj Prev 2017;18:299-305.
118. Farmer CM. Relationship of traffic fatality rates to maximum state speed limits. Traffic Inj Prev 2017;18:375-80.
119. Hadland SE, Xuan Z, Sarda V, Blanchette J, Swahn MH, Heeren TC, *et al.* Alcohol policies and alcohol-related motor vehicle crash fatalities among young people in the US. Pediatrics 2017;139. pii: e20163037.
120. Hamidun R, Roslan A, Sarani R. Exploring factors for pedestrian fatalities at junctions in Malaysia. Pertanika J Soc Sci Hum 2017;25:1833-40.
121. Joseph B, Hadeed S, Haider AA, Ditillo M, Joseph A, Pandit V, *et al.* Obesity and trauma mortality: Sizing up the risks in motor vehicle crashes. Obes Res Clin Pract 2017;11:72-8.
122. Kashani AT, Besharati MM. Fatality rate of pedestrians and fatal crash involvement rate of drivers in pedestrian crashes: A case study of Iran. Int J Inj Contr Saf Promot 2017;24:222-31.
123. Li G, Chihuri S, Brady JE. Role of alcohol and marijuana use in the initiation of fatal two-vehicle crashes. Ann Epidemiol 2017;27:342-70.
124. Lombardi DA, Horrey WJ, Courtney TK. Age-related differences in fatal intersection crashes in the United States. Accid Anal Prev 2017;99:20-9.
125. McDonald NC. Trends in automobile travel, motor vehicle fatalities, and physical activity: 2003-2015. Am J Prev Med 2017;52:598-605.
126. Noland RB, Zhou Y. Has the great recession and its aftermath reduced traffic fatalities? Accid Anal Prev 2017;98:130-8.
127. Plevin RE, Kaufman R, Fraade-Blanar L, Bulger EM. Evaluating the potential benefits of advanced automatic crash notification. Prehosp Disaster Med 2017;32:156-64.
128. Robertson L. Climate change, weather and road deaths. Inj Prev 2018;24:232-5.
129. Schepers P, Stipdonk H, Methorst R, Olivier J. Bicycle fatalities: Trends in crashes with and without motor vehicles in the Netherlands. Transp Res Part F Traffic Psychol Behav 2017;46:491-9.
130. Wang Y, Liang L, Evans L. Fatal crashes involving large numbers of vehicles and weather. J Safety Res 2017;63:1-7.
131. Wolf LL, Chowdhury R, Tweed J, Vinson L, Losina E, Haider AH, *et al.* Factors associated with pediatric mortality from motor vehicle crashes in the United States: A state-based analysis. J Pediatr 2017;187:295-302.e3.
132. Goel R. Modelling of road traffic fatalities in India. Accid Anal Prev 2018;112:105-15.
133. Jeppsson H, Östling M, Lubbe N. Real life safety benefits of increasing brake deceleration in car-to-pedestrian accidents: Simulation of vacuum emergency braking. Accid Anal Prev 2018;111:311-20.
134. Lee JM. Mandatory helmet legislation as a policy tool for reducing motorcycle fatalities: Pinpointing the efficacy of universal helmet laws. Accid Anal Prev 2018;111:173-83.
135. Martin JL, Wu D. Pedestrian fatality and impact speed squared: Cloglog modeling from French national data. Traffic Inj Prev 2018;19:94-101.
136. Prato CG, Kaplan S, Patrier A, Rasmussen TK. Considering built environment and spatial correlation in modeling pedestrian injury severity. Traffic Inj Prev 2018;19:88-93.
137. Ramstedt M. Alcohol and fatal accidents in the United States – A time series analysis for 1950-2002. Accid Anal Prev 2008;40:1273-81.
138. Houston DJ, Richardson LE. Motorcyclist fatality rates and mandatory helmet-use laws. Accid Anal Prev 2008;40:200-8.
139. Rosén E, Sander U. Pedestrian fatality risk as a function of car impact speed. Accid Anal Prev 2009;41:536-42.
140. Arranz JM, Gil AI. Traffic accidents, deaths and alcohol consumption. Appl Econ 2009;41:2583-95.
141. Romano E, Kelley-Baker T, Voas RB. Female involvement in fatal crashes: Increasingly riskier or increasingly exposed? Accid Anal Prev 2008;40:1781-8.
142. Malyshkina NV, Mannering FL. Analysis of the effect of speed limit increases on accident-injury severities. Transp Res Rec 2008;1:122-7.
143. Cheung I, McCartt AT. Declines in fatal crashes of older drivers: Changes in crash risk and survivability. Accid Anal Prev 2011;43:666-74.
144. Nakahara S, Ichikawa M. Effects of high-profile collisions on drink-driving penalties and alcohol-related crashes in Japan. Inj Prev 2011;17:182-8.
145. Goldstein GP, Clark DE, Travis LL, Haskins AE. Explaining regional disparities in traffic mortality by decomposing conditional probabilities. Inj Prev 2011;17:84-90.
146. Kweon YJ, Lee J. Potential risk of using general estimates system: Bicycle safety. Accid Anal Prev 2010;42:1712-7.
147. Chandran A, Sousa TR, Guo Y, Bishai D, Pechansky F; Vida No Transito Evaluation Team. Road traffic deaths in Brazil: Rising trends in pedestrian and motorcycle occupant deaths. Traffic Inj Prev 2012;13 Suppl 1:11-6.
148. Males MA. Poverty as a determinant of young drivers' fatal crash risks. J Safety Res 2009;40:443-8.
149. Brady JE, Li G. Prevalence of alcohol and other drugs in fatally injured drivers. Addiction 2013;108:104-14.
150. Mannix R, Fleegler E, Meehan WP 3rd, Schutzman SA, Hennelly K, Nigrovic L, *et al.* Booster seat laws and fatalities in children 4 to 7 years of age. Pediatrics 2012;130:996-1002.
151. Viano DC, Parenteau CS. Fatalities of children 0-7 years old in the second row. Traffic Inj Prev 2008;9:231-7.
152. Wilson FA, Stimpson JP. Trends in fatalities from distracted driving in the United States, 1999 to 2008. Am J Public Health 2010;100:2213-9.
153. Consunji RJ, Peralta RR, Al-Thani H, Latifi R. The implications of the relative risk for road mortality on road safety programmes in Qatar. Inj Prev 2015;21:e105-8.

154. Chang K, Wu CC, Ying YH. The effectiveness of alcohol control policies on alcohol-related traffic fatalities in the United States. Accid Anal Prev 2012;45:406-15.
155. Morrisey MA, Grabowski DC. Gas prices, beer taxes and GDL programmes: Effects on auto fatalities among young adults in the US. Appl Econ 2011;43:3645-54.
156. Desai A, Bekelis K, Zhao W, Ball PA. Increased population density of neurosurgeons associated with decreased risk of death from motor vehicle accidents in the United States. J Neurosurg 2012;117:599-603.
157. Cotti C, Tefft N. Decomposing the relationship between macroeconomic conditions and fatal car crashes during the great recession: Alcohol-and non-alcohol-related accidents. B E J Econom Anal Policy 2011;11:35-50.
158. Masten SV, Foss RD, Marshall SW. Graduated driver licensing and fatal crashes involving 16- to 19-year-old drivers. JAMA 2011;306:1098-103.
159. Hanna CL, Laflamme L, Bingham CR. Fatal crash involvement of unlicensed young drivers: County level differences according to material deprivation and urbanicity in the United States. Accid Anal Prev 2012;45:291-5.
160. Bakhtiyari M, Mehmandar MR, Mirbagheri B, Hariri GR, Delpisheh A, Soori H. An epidemiological survey on road traffic crashes in Iran: Application of the two logistic regression models. Int J Inj Contr Saf Promot 2014;21:103-9.
161. Park K, Hwang SS, Lee JS, Kim Y, Kwon S. Individual and areal risk factors for road traffic injury deaths: Nationwide study in South Korea. Asia Pac J Public Health 2010;22:320-31.
162. Denning GM, Harland KK, Ellis DG, Jennissen CA. More fatal all-terrain vehicle crashes occur on the roadway than off: Increased risk-taking characterises roadway fatalities. Inj Prev 2013;19:250-6.
163. Cummins JS, Koval KJ, Cantu RV, Spratt KF. Do seat belts and air bags reduce mortality and injury severity after car accidents? Am J Orthop (Belle Mead NJ) 2011;40:E26-9.
164. Romano E, Voas RB. Drug and alcohol involvement in four types of fatal crashes. J Stud Alcohol Drugs 2011;72:567-76.
165. Bogstrand ST, Larsson M, Holtan A, Staff T, Vindenes V, Gjerde H. Associations between driving under the influence of alcohol or drugs, speeding and seatbelt use among fatally injured car drivers in Norway. Accid Anal Prev 2015;78:14-9.
166. Carpenter D, Pressley JC. Graduated driver license nighttime compliance in US teen drivers involved in fatal motor vehicle crashes. Accid Anal Prev 2013;56:110-7.
167. Oh C, Kang YS, Youn Y, Konosu A. Development of probabilistic pedestrian fatality model for characterizing pedestrian-vehicle collisions. Int J Automot Technol 2008;9:191-6.
168. Zhu M, Zhao S, Coben JH, Smith GS. Why more male pedestrians die in vehicle-pedestrian collisions than female pedestrians: A decompositional analysis. Inj Prev 2013;19:227-31.
169. Keall MD, Newstead S. Analysis of factors that increase motorcycle rider risk compared to car driver risk. Accid Anal Prev 2012;49:23-9.
170. Zhu M, Cummings P, Zhao S, Coben JH, Smith GS. The association of graduated driver licensing with miles driven and fatal crash rates per miles driven among adolescents. Inj Prev 2015;21:e23-7.
171. Olszewski P, Szagała P, Wolański M, Zielińska A. Pedestrian fatality risk in accidents at unsignalized zebra crosswalks in Poland. Accid Anal Prev 2015;84:83-91.
172. Prato CG, Gitelman V, Bekhor S. Mapping patterns of pedestrian fatal accidents in Israel. Accid Anal Prev 2012;44:56-62.
173. Kusano KD, Gabler HC. Comprehensive target populations for current active safety systems using national crash databases. Traffic Inj Prev 2014;15:753-61.
174. Daigneault G, Joly P, Frigon JY. Executive functions in the evaluation of accident risk of older drivers. J Clin Exp Neuropsychol 2002;24:221-38.

Appendix Table 1: The characteristics of entered studies about road traffic crashes deaths

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
1	Predictors of injury among younger and older adults in fatal motor vehicle crashes[20]	Awadzi *et al*./2008/ USA/Americas/[20]	CS/multinomial logistic regression/23	OR	Person variables, vehicle variables, environment variables	Person factors: Age, gender, driver license compliance, driver drinking, system-restraint use (seatbelt). Vehicle factors: Compared to drivers in SUVs, drivers in automobile (passenger) cars had a higher risk of fatality. Collision with a fixed object, rollover crashes. Environment factor: Hour of day, road surface condition, and driving in daylight hours
2	Evolution of road risk disparities at small-scale level: Example of Belgium[21]	Eksler and Lassarre/2008/ BELGIUM/Europe/ [21]	CS (not mentioned in article)/spatiotemporal Bayesian models/14	Rate	Spatial and time trend factors	Spatial effect
3	A mixed generalized ordered response model for examining pedestrian and bicyclist injury severity level in traffic crashes[22]	Eluru *et al*./2008/ USA/Americas/[22]	CS (not mentioned in article)/MGORL model/12	Mean	Person factors (age, sex, alcohol consumption), vehicle factors, road factors, environmental factors, crash characteristics	Person factors: (the elderly are more injury-prone) The speed limit on the roadway (higher speed limits lead to higher injury severity levels). Crash characteristics: Location of crashes (those at signalized intersections are less severe than those elsewhere). Environmental factors: Time-of-day (darker periods)
4	Inter-group differences in road-traffic crash involvement[23]	Factor *et al*./2008/ Israeli/Europe/[23]	CS/logistic regression/15	OR	Person factors: Age, Marital status, years of schooling, household social class, place of work, religion, continent of origin, traveled distance. Economic factor: Asset index	Person factors: Sex, age, race, education, socioeconomic status
5	Injury severity analysis of accidents involving young male drivers in Great Britain[24]	Gray *et al*./2008/ UK/Europe/[24]	CS (not mentioned in article)/Ordered probit models/10	Rate	Road factors, environmental factors	Environmental factors: Darkness, fine no high winds, end of the week, road factors: on the main road, when a vehicle has skidded, passing the site of previous accident
6	Maternal fatalities, fetal and neonatal deaths related to motor vehicle crashes during pregnancy: A national population-based study[25]	Kvarnstrand *et al*./2008/Swedish/ Europe/[25]	CS (not mentioned in article)/-/13	OR	Person factors: pregnant women, fetuses, and neonates	Person factors: MVCs during pregnancy were a significant cause of maternal fatalities, fetal and neonatal deaths
7	The impact of driver age on lost life years for other road users in France: A population based study of crash-involved road users[26]	Lafont *et al*./2008/ France/Europe/[26]	Population-based CS study/-/19	Lost life years	Person factors: Age of drivers	Person factors: Older drivers are responsible for the lowest rate of lost life years

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
8	High gasoline prices and mortality from motor vehicle crashes and air pollution[27]	Leigh and Geraghty/2008/ USA/Americas/[27]	CS (not mentioned in article)/Monte Carlo simulation/11	Percent	Laws factors: Gas prices	Laws factors: 50% increases in price lead to 95% of the reduction in combined deaths
9	Risk factors for death among older child and teenaged motor vehicle passengers[7]	Winston *et al*./2008/ USA/Americas/[7]	Retrospective cohort/--/22	AOR	Person factors (age and sex of driver, restraint use, seating position), vehicle factor, road factor, environmental factors (day of week, month, time of day), laws factors (speed limit)	Person factors: drivers younger than 18 years, restraint nonuse, high-speed roads, speed limit
10	Booster seat laws and child fatalities: A case-control study[28]	Farmer *et al*./2009/ USA/Americas/[28]	Case-control/general linear model/21	OR	Law-related factors (booster seat laws), crash characteristics	Laws factors (restrained)
11	Long-term effects of repealing the national maximum speed limit in the United States[29]	Friedman *et al*./2009/USA/ Americas/[29]	CS (not mentioned in paper)/-/12	Percent	Law-related factors	Law-related factors
12	The association between price of regular-grade gasoline and injury and mortality rates among occupants involved in motorcycle-and automobile-related motor vehicle collisions[30]	Hyatt *et al*./2009/ USA/Americas/[30]	CS (not mentioned in paper)/time-series analysis/18	ARR	Law-related factors: Gasoline prices	Law-related factors: Higher gasoline prices were associated with increased motorcycle-related deaths
13	Motor vehicle deaths among men: marital status, gender and social integration[31]	Kposowa and Breault/2009/USA/ Americas/[31]	CS (not mentioned in paper)/-/22	HR	Person factors	Person factors: Education
14	Association of age, sex and seat belt use with the risk of early death in drivers of passenger cars involved in traffic crashes[32]	Lardelli-Claret *et al*./2009/Spain/ Europe/[32]	CS (not mentioned in paper)/poisson multiple regression models/16	RR	Person factors: Age, sex, and seatbelt use	Person factors: Age, sex, and seatbelt use with risk of death
15	The effect of state regulations on truck-crash fatalities[33]	Neeley and Richardson/2009/ USA/Americas/[33]	CS/time-series regression model/8	Rate of fatality	Person factors: Speedy driving	Person factors: Significant association between speedy driving and fatalities
16	The impact of state level behavioral regulations on traffic fatality rates[34]	Traynor/2009/USA/ Americas/[34]	CS (not mentioned in paper)/time fixed effect model/10	Fatality rates	Person factors, law-related factors: DUI laws	Law-related factors: Licensing and DUI policies significantly reduce traffic fatality rates, while stricter seatbelt enforcement policies have a statistically insignificant negative impact on fatality rates

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
17	Gasoline prices and their relationship to rising motorcycle fatalities, 1990-2007[35]	Wilson *et al*./2009/ USA/Americas/[35]	CS (not mentioned in paper)/an ARIMA regression/11	Fatality rate	Economic factor: Fuel prices	Fuel costs
18	Analysis of truck-involved rear-end crashes using multinomial logistic regression[36]	Yan *et al*./2009/ USA/Americas/[36]	CS (not mentioned in paper)/multi nominal logistic regression/10	OR	Environmental factors, driver characteristics, road characteristics	Lighting condition, divided/ undivided highway, day of week, alcohol use, driver age, and gender are also significantly associated with fatal truck rear-end collision
19	Effect of enhanced seat belt reminders on driver fatality risk[37]	Farmer and Wells/2010/USA/ Americas/[37]	CS (not mentioned in paper)/-/10	Fatality rates	Vehicle characteristics: Seatbelt reminders on driver fatality risk	Combining all manufacturers, enhanced belt reminders reduced fatality risk
20	High mortality among people suspected of drunk-driving. An 18-year register-based follow-up[38]	Impinen *et al*./2010/ Finland/Europe/[38]	CS (not mentioned in paper)/Cox-regression model/18	Mortality rate	Driver characteristics (DUI), person factors	Being male and of higher age increased the risk of death. The lowest blood alcohol levels more harmful. Drivers with a lower level of education, married men were safer than others
21	Mortality and causes of death among drugged drivers[39]	Karjalainen *et al*./2010/Finland/ Europe/[39]	CS (not mentioned in paper)/Cox regression models/15	HR	Driver behavior: DUID	DUID had almost ten times as high risk of death compared to general Finnish population
22	The epidemiology of road traffic injuries in the Republic of Lithuania, 1998-2007[40]	Lunevicius *et al*./2010/ Lithuania/Europe/[40]	CS (not mentioned in paper)/-/5	Incidence mortality rates	Driver behavior: alcohol	Alcohol remains a prominent risk factor of traffic death
23	Traffic crash victimizations of children and teenagers by drinking drivers age 21 and older[11]	Males/2010/US/ Americas/[11]	CS (not mentioned in paper)/-/-	-	Victimizations of children and teenagers by drinking drivers age 21 and older	Drinking drivers age 21 and older victimize 1.3 times more teenage drivers than vice versa and account for large majorities of passenger and no occupant alcohol-related crash victimizations of both children and teens
24	Graduated licensing laws and fatal crashes of teenage drivers: a national study[41]	Anne *et al*./2010/ USA/Americas/[41]	CS (not mentioned in paper)/Poisson regression/15	Mortality rates	Laws factors: Graduated driver licensing laws	Compared with licensing laws rated poor, laws rated good were associated with 30 percent lower fatal crash rates among 15-17-year-olds
25	Using the U. S. National Household Travel Survey to estimate the impact of passenger characteristics on young drivers' relative risk of fatal crash involvement[42]	Ouimet *et al*./2010/ USA/Americas/[42]	CS (not mentioned in paper)/-/18	RR	Person factors	The highest risk was found for young male drivers

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
26	Toward understanding the recent large reductions in U. S. road fatalities[43]	Sivak and Schoettle/2010/ USA/Americas/[43]	Cross sectional study (not mentioned in the article)/-/13	Rate	Driver- related factors, environmental factors, car-related factors	Fatal accidents on rural interstates Local roads/streets increased fatality, front-to-side fatal collisions declined more than all fatal collisions Roads with a speed limit of 50 mph or higher showed reductions The involvement of heavy trucks was reduced more than the involvement of all vehicles Among driver-related factors, inattentive driving (talking, eating, and using cell phones) showed a large increase
27	Role of motorcycle type in fatal motorcycle crashes[44]	Teoh and Campbel/2011/ USA/Americas/[44]	CS (not mentioned in article)/Poisson regression/13	RR	Vehicle-related factors	Driver death rates for super sport motorcycles were more than those for cruiser/standard motorcycles
28	Fatality risk for motorcyclists in fixed object collisions[45]	Bambach *et al*./2011/ Australia/Western Pacific/[45]	CS (not mentioned in article)/logistic regression/18	OR	Environmental factors, driver-related factors	Increased travel speed, older motorcyclists, speed-related crashes, late model motorcycles, darkness, interchange locations, nonlevel roadway profiles, and roadside departure to the right side are all associated with an increase in the likelihood of fatality
29	Can fear of going to jail reduce the number of road fatalities? The Spanish experience[46]	Castillo-Manzano *et al*./2011/Spanish/ Europe[46]	CS (not mentioned in article)/-/9	Rate	Economic factors, consumption of gasoline	This reform has reduced Spanish road fatalities
30	Density of surgeons is significantly associated with reduced risk of deaths from motor vehicle crashes in US Counties[47]	Chang *et al*./2011/ USA/Americas/[47]	CS (not mentioned in article)/multiple linear regression/11	Rate	Medical services: Surgeon availability	Higher density of surgeons is associated with significant reduction in deaths from motor vehicle crashes
31	Fatality risk in motorcycle collisions with roadside objects in the United States[48]	Daniello and Gabler/2011/USA/ Americas/[48]	CS (not mentioned in article)/-/16	RR	Environmental factors: Roadside objects	Collisions with roadside objects
32	An evaluation of graduated driver licensing effects on fatal crash involvements of young drivers in the United States[49]	Fell *et al*./2011/ USA/Americas/[49]	CS (not mentioned in article)/-/18	Crash rates	Laws factors: Graduated driver licensing laws	The adoption of a graduated driver licensing law of average strength was associated with a significant decrease in fatal crash
33	Survival risk factors for fatal injured car and motorcycle drivers in single alcohol-related and alcohol-unrelated vehicle crashes[50]	Huang and Lai/2011/Taiwan/ Southeast Asia/[50]	CS study (not mentioned in article)/cox regression models/21	Death ratios	Environmental factors, person factors	The factors that influence the risk of death overtime in a motor-vehicle accident involving alcohol depended on different elements (variables: sex, age, restrained, crash type, hour, road types in city (local road, highway, freeway), location (motorcycle traffic separation)

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
34	Analysis of large truck crash severity using heteroskedastic ordered probit models[51]	Lemp *et al*./2011/ USA/Americas/[51]	CS (not mentioned in paper)/heteroskedastic ordered probit models/14	Ratio	Environmental factors, driver factors, vehicle factors	Nonbright lighting conditions, the snowy or icy, fog road The numbers of involved passenger vehicle and truck occupants increase the likelihood of a fatal outcome The number of truck trailers increase the fatality
35	Motor vehicle accident fatalities trends, Puerto Rico 2000-2007[52]	Lopez -Charneco/2011/ Puerto Rico/ Americas/[52]	CS (not mentioned in article)/join point regression analysis/8	Mortality rate	Person factors, environmental factors	Young adults (20-24 years) had a higher risk of MVAF
36	Logistic regression model of risk of fatality in vehicle-pedestrian crashes on national highways in Bangladesh[53]	Sarkar *et al*./2011/ Bangladesh/ Southeast Asia/[53]	CS (not mentioned in article)/logistic regression model/13	OR	Person factors, road users, environmental factors	Elderly pedestrians and young pedestrians increased the likelihood of a fatality Pedestrians who crossed the road Pedestrian collisions with trucks, buses, baby taxis or tempos (auto rickshaws), and tractors Crashes occurring at locations with no traffic control, stop control, and pedestrian crossings had a higher risk of a fatality Collisions during the rainy season
37	An investigation of the risk factors causing severe injuries in crashes involving gravel trucks[54]	Chu/2012/Taiwan/ Southeast Asia/[54]	CS (not mentioned in article)/binary logit model/8	Rate	Driver factors, road factors	Lack of driver awareness, geometric improvements to roads or intersections, runs in a day
38	A latent class modeling approach for identifying vehicle driver injury severity factors at highway-railway crossings[55]	Eluru *et al*./2012/ USA/Americas/[55]	CS (not mentioned in article)/Latent segmentation-based ordered response model/17	Rate	Accident characteristics: Highway-railway crossing attributes Driver demographics including gender, age, vehicle occupancy, vehicle type Environmental factors (weather, lighting conditions, time of day, etc.) Crossing characteristics (Annual traffic on the highway, railway traffic, etc.) Crossing safety equipment (presence of gates, traffic signals, watchmen, etc.)	The key influencing factors include driver age, time of the accident, presence of snow and/or rain, vehicle role in the crash, and motorist action before the crash
39	Influence of obesity on mortality of drivers in severe motor vehicle crashes[56]	Jehle *et al*./2012/ USA/Americas/[56]	CS (not mentioned in article)/multiple logistic regression model/20	OR	Person factors: Obesity of drivers	Increased risk of death for moderately obese, morbidly obese

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
40	Risk factors in motorcyclist fatalities in Taiwan[57]	Jou *et al*./2012/ Taiwan/Southeast Asia/[57]	CS (not mentioned in article)/logistic regression model/15	OR	Person factors, driver behavior, road conditions	Male, older, unlicensed, not wearing a helmet, riding after drinking, and driving heavy (i.e., above 550 cc) motorcycles. Motorcyclists involved in nighttime, nonurban single-vehicle accidents have a higher risk of death
41	National evaluation of the effect of graduated driver licensing laws on teenager fatality and injury crashes[58]	Lyon *et al*./2012/ USA/Americas/[58]	CS (not mentioned in article)/negative binomial generalized linear model/14	Rate	Driver factors: GDL; environmental factors	Age, nighttime
42	Comparing the impact of socio-demographic Factors associated with traffic injury among older road users and the general population in Japan[59]	Nagata *et al*./2012/ Japan/Western Pacific/[59]	Ecological study/ multivariate regression modeling/18	Rate	Person factors, economic factors, road factors, medical/cultural factors	Income per capita, total road length, alcohol consumption per person
43	Risk of fatal injury in older adult drivers, passengers, and pedestrians[60]	Rolison *et al*./2012/ Britain/Europe/[60]	Ecological study/log-link modeling/17	OR	Person factors	Aged 70 and older has highest fatality for pedestrians and passenger
44	Factors affecting accident severity inside and outside urban areas in Greece[61]	Theofilatos *et al*./2012/Greece/ Europe/[61]	CS (not mentioned in article)/linear regression models/13	OR	Person factors, collision factors	Young driver age, bicycles intersections, collision with fixed objects, urban areas
45	Mortality in rural locations after severe injuries from motor vehicle crashes[62]	Travis *et al*./2012/ USA/Americas/[62]	CS (not mentioned in article)/-/21	OR	Person factors, driver behavior, environmental factors, vehicle factors, environmental factors	Older age, safety belt nonuse, vehicle damage, high speed, and early morning crashes
46	Alcohol-related risk of driver fatalities: An update using 2007 data[63]	Voas *et al*./2012/ USA/Americas/[63]	CS (not mentioned in article)/linear regression/19	RR	Person factors	Male driver
47	Increased risk of driver fatality due to unrestrained rear-seat passengers in severe frontal crashes[64]	Bose *et al*./2013/ USA/Americas/[64]	CS (not mentioned in article)/multivariate logistic regression/13	OR	Road user behavior: Unrestrained rear-seat passengers	Unrestrained passenger
48	Factors associated with civilian drivers involved in crashes with emergency vehicles[65]	Drucker *et al*./2013/ USA/Americas/[65]	CS/Multivariate logistic regression/17	OR	Driver factors, roadway factors, environmental factors, crash factors	Urban roads (vs. rural), dark roads (vs. daylight)
49	Road traffic crashes and fatalities in Japan 2000-2010 with special reference to the elderly road user[66]	Kaimila *et al*./2013/ Japan/Western Pacific/[66]	CS (not mentioned in article)/fatal crash rates/14	Fatal crash rates	Person factors	Elderly pedestrians

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
50	Bicycle helmet laws are associated with a lower fatality rate from bicycle-motor vehicle collisions[67]	Meehan *et al*./2013/ USA/Americas/[67]	CS study/poisson multivariate regression model/12	Fatality rates	Law factors: Bicycle helmet legislation	Bicycle helmet safety laws are associated with a lower incidence of fatalities
51	Variation in U. S. traffic safety policy environments and motor vehicle fatalities 1980-2010[68]	Silver *et al*./2013/ USA/Americas[68]	Repeated CS time series design/fixed effects regression models/19	fatality rate	Road user behavior, law factors	Alcohol consumption was strongly associated with higher MVC death rates
52	Fatalities of Pedestrians, bicycle riders, and motorists due to distracted driving motor vehicle crashes in the U. S., 2005-2010[69]	Stimpson *et al*./2013/USA/ Americas/[69]	CS (not mentioned in article)/model not used/13	Fatality rate	Road user behavior	Distracted drivers are the cause of an increasing share of fatalities among pedestrians and bicycle riders
53	Impact speed and a pedestrian's risk of severe injury or death[70]	Tefft/2013/USA/ Americas/[70]	CS (not mentioned in article)/multivariable logistic regression/22	OR	Person factors	Older pedestrian
54	The effect of recent trends in vehicle design on U. S. societal fatality risk per vehicle mile traveled, and their projected future relationship with vehicle mass[71]	Wenzel/2013/USA/ Americas/[71]	CS (not mentioned in article)/ logistic regression/12	Fatality rate	Vehicle type	shifting light truck drivers into safer, car-based vehicles, such as sedans, CUVs, and minivans, would result in reductions in fatalities
55	Appalachian versus non-Appalachian U. S. traffic fatalities, 2008e2010[72]	Zhu *et al*./2013/ USA/Americas/[72]	CS (not mentioned in article)/Poisson regression/11	RR	Person factors: Appalachia and the non-Appalachian United States	The Appalachian traffic fatality rate was higher than the non-Appalachian rate
56	Update: Repeat DWI offenders involvement in fatal crashes in 2010[73]	Fell *et al*./2014/ USA/Americas/[73]	CS (not mentioned in article)/-/7	Percent	Driver Behavior: driving-while -intoxicated or DUI and crash fatality	Drivers with prior DWI convictions are overrepresented in fatal crashes
57	Macroeconomic fluctuations and motorcycle fatalities in the U. S.[74]	French and Gumus/2014/USA/ Americas/[74]	CS/Regression model/14	Fatality rate	Economic factor	The estimates suggest that an increase in real income per capita is associated with motorcycle fatality rate
58	Why has the pedestrian death rate decreased in Spain between 1993 and 2011? An application of the decomposition method[75]	Jiménez-Mejías *et al*./2014/Spain/ Europe/[75]	CS (not mentioned in article)/Poisson regression/11	Death rates	Collision factor	Collision rates were the most important determinants of the reduction in pedestrian collision death rates
59	Crash fatality and vehicle incompatibility in collisions between cars and light trucks or vans[76]	Ossiander *et al*./2014/USA/ Americas/[76]	Case control study/ logistic regression/	OR	Vehicle type: LTV on fatality crash	Occupants of vehicles colliding with any type of LTVs were at higher risk of death

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
60	A matched-cohort analysis of belted front and rear seat occupants in newer and older model vehicles shows that gains in front occupant safety have outpaced gains for rear seat occupants[8]	Bilston *et al*./2010/ USA/Americas/[8]	Matched-cohort approach/Poisson regression/20	RR	Vehicle characteristic	Risk to front seat occupants in newer vehicles decline
61	Share of mass transit miles traveled and reduced motor vehicle fatalities in major cities of the United States[77]	Stimpson *et al*./2014/USA/ Americas/[77]	Cross sectional study (not mentioned in article)/ structural equation model/11	Fatality rate	Transit type: an increasing share of mass transit use	An increasing share of mass transit miles traveled per capita was associated with reduced motor vehicle fatalities
62	Driver license renewal policies and fatal crash involvement rates of older drivers, United States, 1986-2011[78]	Tefft/2014/USA/ Americas/[78]	CS (not mentioned in article)/generalized estimating equations with a first-order autoregressive correlation structure/23	Ratios of relative risks	Laws factors: state driver license renewal laws	Mandatory in-person renewal driver license was associated with reduction in the fatal crash involvement rates
63	How changes have in front air bag designs affected frontal crash death rates? An update[79]	Teoh/2014/USA/ Americas/[79]	CS (not mentioned in article)/Poisson marginal structural models/21	Death rates	Vehicle type: Front Air Bag Designs	Air bags were associated with frontal crash death rates for both drivers and right-front passengers
64	The relative risk of involvement in fatal crashes as a function of race/ethnicity and blood alcohol concentration[80]	Torres *et al*./2014/ USA/Americas/[80]	CS (not mentioned in article)/logistic regression models/18	OR	Race/ethnicity factor, road user behavior: blood alcohol concentration	Hispanic and African-American drivers were less likely to be involved in single-vehicle
65	The road traffic crashes as a neglected public health concern; an observational study from Iranian population[81]	Bakhtiyari *et al*./2015/ Iran/Eastern Mediterranean/[81]	CS (not mentioned in article)/-/14	OR	Human factors	Alcohol consumption was the most significant human risk factor in traffic crashes within cities
66	Temporal trends in motor vehicle fatalities in the United States, 1968 to 2010-a joint point regression analysis[82]	Bandi *et al*./2015/ USA/Americas/[82]	CS (not mentioned in article)/ Join-point regression/16	Average annual Percent	Human factors	Adolescents, young, and middle-aged adults occurred to a larger degree in males than in females
67	Road crash fatality rates in France: A comparison of road user types, taking account of travel practices[83]	Bouaoun *et al*./2015/ France/Europe/[83]	CS (not mentioned in article)/poisson regression/15	Fatality rates	Modes of transport	Risks for motorized two-wheeler users are extremely high compared to other types of road user, age, sex

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
68	Why have fatality rates among older drivers declined? The relative contributions of changes in survivability and crash involvement[84]	Cicchino/2015/ USA/Americas/[84]	CS (not mentioned in article)/decomposition method/15	Rate	VMT	Changes in travel patterns and roadway design
69	Urban sprawl as a risk factor in motor vehicle occupant and pedestrian fatalities[85]	Ewing and Hamidi/2015/USA/ Americas/[85]	CS (not mentioned in article)/multilevel modeling/8	Fatality rate	Environment factor: Urban Sprawl	Sprawl was found to be associated with significantly higher traffic fatality rates
70	The effects of vehicle redesign on the risk of driver death[86]	Farmer and Lund/2015/USA/ Americas/[86]	CS (not mentioned in article)/-/14	Relative risk	Vehicle factor: Vehicle Redesign	Vehicle redesign
71	Temporal trends in the associations between age, sex and socioeconomic status after death from motor vehicle collisions in England and Wales: 1960-2009[87]	Fogarty and Liu/2015/UK/ Europe/[87]	CS/logistic regression/8	OR	Human factors	Job: Individuals in non-manual occupations were more likely to die, sex: Women had a higher risk of dying at above the annual median
72	Trends in socioeconomic inequalities in motor vehicle accident deaths in the United States, 1995-2010[88]	Harper *et al*./2015/ Canada/Americas/[88]	CS (not mentioned in article)/negative binomial regression models/19	Rate	Human factors	Education: It is found that mortality increases among the least educated
73	Restraint use in motor vehicle crash fatalities in children 0 year to 9 years old[89]	Lee *et al*./2015/ USA/Americas/[89]	CS (not mentioned in article)/-/13	Rate	Human behavior: restraint use	Restraint use among children
74	Motor vehicle crash fatalities in states with primary versus secondary seat belt laws[90]	Lee *et al*./2015/ USA/Americas/[90]	CS/multivariate regression model/14	Incidence rate ratio	laws factors: seat belt laws	Seat belt laws
75	Contribution of exposure, risk of crash and fatality to explain age and sex-related differences in traffic-related cyclist mortality rates[91]	Martínez-Ruiz *et al*./2015/Spain/ Europe/[91]	ecological study/ decomposition and quasi-induced exposure methods/20	Mortality rate ratio	Human factors	Age: death rates increased with age, sex: Males had higher death rates than females
76	Analyzing the continuum of fatal crashes: A generalized ordered approach[92]	Yasmin *et al*./2015/ USA/Americas/[92]	CS (not mentioned in article)/MGOL model/12	Rate	Driver characteristics, vehicle characteristics, roadway design, environmental factors, crash characteristics	Vehicle age, speed limit, lighting conditions and weather conditions

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
77	Effects of urban sprawl and vehicle miles traveled on traffic fatalities[93]	Yeo *et al*./2015/ USA/Americas/[93]	CS (not mentioned in article)/path analysis/7	VMT per capita	Environmental factors: urban sprawl	Urban sprawl is associated with higher numbers of traffic fatalities
78	Mortality and potential years of life lost by road traffic injuries in Brazil, 2013[94]	Andrade and Mello-Jorge/2015/ Brazil/Americas/[94]	CS (not mentioned in article/-/13	mortality rates	Human factors	Sex, black race/skin color, age (young adults)
79	Epidemiologic pattern of fatal traffic injuries among Iranian Drivers; 2004-2010[95]	Bakhtiari *et al*./2016/ Iran/Eastern Mediterranean/[95]	CS (not mentioned in article) /nominal logistic regression/11	OR	Human factors	Fatigue and sleepiness
80	Determinants of fatal road traffic injuries in Côte d'Ivoire from 2002 to 2011[96]	Bénié Bi Vroh *et al*./2016/Côte d'Ivoire/Africa/[96]	CS/Logistic regression/10	OR	Human factors, vehicle factors	Age (under the age of 18), speed driving, dangerous overtaking, mechanical failure, rural areas
81	Driver's obesity and road crash risks in the United States[97]	Bhatti *et al*./2016/ USA/Americas/[97]	CS (not mentioned in article) /nominal logistic regression/10	AOR	Human factors: obesity	Obese drivers had significantly higher risks for fatality
82	Fatality rates for crashes involving heavy vehicles on highways: A random parameter tobit regression approach[98]	Bin Islam and Hernandez/2016/ USA/Americas/[98]	CS (not mentioned in paper)/random parameters tobit regression model (fixed-and random-parameters tobit models)/11	Fatality rate	Human factors, Vehicle factors, Environmental factors, Road factors	Spatial characteristics, road and environmental attributes, vehicle configuration, drivers and passenger attributes
83	Recent trends in cyclist fatalities in Australia[99]	Boufous and Olivier/2016/ Australia/western Pacific/[99]	CS (not mentioned in article)/Poisson regression modeling/9	Rate	Human factors	Age
84	Uber and metropolitan traffic fatalities in the United States[100]	Brazil and Kirk/2016/USA/ Americas/[100]	CS (not mentioned in article)/negative binomial and Poisson regression models/-	Incidence rate ratio	Human factors	Drunk driving
85	Road traffic mortality in the Slovak Republic in 1996-2014[101]	Brazinova and Majdan/2016/Slovak Republic/Europe/[101]	CS (not mentioned in article)/Join point regression/	Rate	Road user type, Human factor	Motor vehicle users (other than motorcyclists) and pedestrians have the highest mortality rates among road user groups
86	Are there higher pedestrian fatalities in larger cities? : A scaling analysis of 115 to 161 largest cities in the U. S. A[102]	Chang *et al*./2016/ USA/Americas/[102]	CS (not mentioned in article)/panel data analysis of bivariate model and panel data analysis of multivariate model/14	Rate	Human factor: (population size), Economic factor: income per capita	Pedestrian fatalities increase linearly to population increase, increase in income per capita is expected to increase the number of total fatality
87	All-terrain vehicle fatalities on paved roads, unpaved roads, and off-road: Evidence for informed roadway safety warnings and legislation[103]	Denning and Jennissen/2016/ USA/Americas/[103]	CS/Multivariable logistic regression analysis/18	OR	Human factor, Road type	Unpaved roads were involved in the majority of roadway fatalities, fatality among males is higher than female

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
88	Underutilization of occupant restraint systems in motor vehicle injury crashes: A quantitative analysis from Qatar[104]	El-Menyar *et al*./2016/ Qatar/Eastern Mediterranean[104]	CS/multivariate regression analysis/14	RR	Human behavior factor: use seat belt, Human factor	Unrestrained males had increase in mortality, young males
89	The epidemiology of fatal road traffic collisions in Trinidad and Tobago, West Indies [2000-2011][105]	Gopaul *et al*./2016/ Trinidad and Tobago/Americas/ [105]	CS (not mentioned in article)/-/12	Percent	Human factor, road factor, road user factor	Sex: Men, fatalities among drivers were higher than pedestrians, most fatalities occurred at weekends
90	Child restraint use and driver screening in fatal crashes involving drugs and alcohol[106]	Huang *et al*./2016/ USA/Americas/[106]	CS (not mentioned in article)/mixed effect multivariable logistic regression/22	OR	Human behavior factor: Child-restraint use	Mortality was more among unrestrained versus restrained and was higher in front-seated than rear-seated passengers
91	Modeling the effect of operator and passenger characteristics on the fatality risk of motorcycle crashes[107]	Kashani *et al*./2016/ Iran/Eastern Mediterranean/[107]	CS (not mentioned in article)/binomial logistic regression/10	Rate	Human factor (Passenger characteristics), Environmental factor	Number of pillion passengers carried, darkness, on curves, in rural areas and on highways, then the crash would be more likely to be fatal, the head-on collisions, older operators, unlicensed operators and not using a safety helmet increase the fatality in a motorcycle crash
92	Association of impact velocity with risks of serious injuries and fatalities to pedestrians in commercial truck-pedestrian accidents[108]	Matsui *et al*./2016/ Japan/Western Pacific/[108]	CS (not mentioned in article) /linear regression/10	Rate	Vehicle factor, environmental factor	Fatality risk strongly associated with vehicle class, pedestrian fatalities at nighttime was significantly higher
93	Gender and age differences in components of traffic-related pedestrian death rates: exposure, risk of crash and fatality rate[109]	Onieva-García *et al*./2016/Spain/ Europe/[109]	CS (not mentioned in article)/decomposition model/16	Mortality rate ratio	Human factor: Age and gender	Death rates increased with age. Males had higher death rates than females
94	The role of exposure on differences in driver death rates by gender and age: Results of a quasi-induced method on crash data in Spain[110]	Pulido *et al*./2016/ Spain/Europe/[110]	CS (not mentioned in article)/constructed Poisson regression models/15	Adjusted death rate ratios	Human factor: Age and gender	Death rates increased with age. Males had higher death rates than females
95	Adverse weather conditions and fatal motor vehicle crashes in the United States, 1994-2012[111]	Saha *et al*./2016/ USA/Americas/[111]	CS (not mentioned in article)/ARCGIS/10	Rate	Environmental factor	Adverse weather-related fatalities

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
96	Graduated driver licensing night driving restrictions and drivers aged 16 or 17 years involved in fatal night crashes-United States, 2009-2014[112]	Shults and Williams/2016/ USA/Americas/[112]	Cross sectional study (not mentioned in article)/-/11	Percent	Environmental factor	More crashed during the night hours
97	Spatiotemporal and random parameter panel data models of traffic crash fatalities in Vietnam[113]	Truong *et al*./2016/ Vietnam/Europe/[113]	CS (not mentioned in article)/RENB and RPNB panel data models/9	Rates	Environmental factor	Traffic crash fatalities tend to be higher in provinces with greater numbers of level crossings, passenger distance traveled and road lengths are also positively associated with fatalities
98	Fatal and serious injuries related to vulnerable road users in Canada[114]	Vanlaar *et al*./2016/ Canada/Americas/ [114]	CS (not mentioned in article) /regression models/19	OR	Human factor,	Age: Elderly (76 years or older), alcohol, and drug use
99	Association of graduated driver licensing with driver, non-driver, and total fatalities among adolescents[115]	Zhu *et al*./2016/ USA/Americas/[115]	CS (not mentioned in article)/longitudinal analyses/16	Rate ratio	Human behavior factor: Graduated driver licensing with driver, nondriver	GDL systems were generally not associated with increased fatalities as passengers, pedestrians, or bicyclists
100	Which set of factors contribute to increase the likelihood of pedestrian fatality in road crashes?[116]	Besharati and Tavakoli Kashani/2017/ Iran/Eastern Mediterranean/[116]	CS (not mentioned in article)/multivariate modeling/12		Human behavior factor	Jaywalking, waiting beside the road on poorly illuminated locations, rural roads substantially increased the fatality risk of pedestrian
101	Exploring the effects of state highway safety laws and sociocultural characteristics on fatal crashes[117]	Dong *et al*./2017/ USA/Americas/[117]	Cross sectional study (not mentioned in article)/ zero truncated negative binomial (ZTNB) regression models/11	Rate	Law factors	Law and regulation-related factors, the use of speed cameras, no handheld cell phone ban, limited handheld cell phone ban, and no text-messaging ban
102	Relationship of traffic fatality rates to maximum state speed limits[118]	Farmer/2017/USA/ Americas/[118]	CS (not mentioned in article)/Poisson regression/12	Rate	Law factors: Speed limits	Speed limits
103	alcohol policies and alcohol-related motor vehicle crash fatalities among young people in the US[119]	Hadland *et al*./2017/ USA/Americas/[119]	CS (not mentioned in article) /logistic regression/22	OR	Law factor: Alcohol policy	Alcohol policies
104	Exploring factors for pedestrian fatalities at junctions in Malaysia[120]	Hamidun *et al*./2017/ Malaysia/Western Pacific/[120]	CS (not mentioned in article)/logistic regression model/7	OR	Human factor, environmental factor, crash type	Age, injuries sustained to their head or neck, involvement of heavy vehicles, and location of accidents
105	Obesity and trauma mortality: sizing up the risks in motor vehicle crashes[121]	Joseph *et al*./2017/ USA/Americas/[121]	CS (not mentioned in article) /Multivariate logistic regression/23	OR	Human factor: Obesity (BMI≥40)	Motorists with morbid obesity are at greater risk of MVC

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
106	Fatality rate of pedestrians and fatal crash involvement rate of drivers in pedestrian crashes: a case study of Iran[122]	Kashani and Besharati/2017/ Iran/Eastern Mediterranean/[122]	CS (not mentioned in article) /Clustering analysis/11	Rate	Human factor,	Age
107	Role of alcohol and marijuana use in the initiation of fatal two-vehicle crashes[123]	Li *et al*./2017/USA/ Americas/[123]	CS (not mentioned in article)/Multivariable conditional logistic regression models/21	AOR	Human behavior factor: Alcohol and marijuana	Alcohol and marijuana each play a significant role in fatal crash initiation
108	Age-related differences in fatal intersection crashes in the United States[124]	Lombardi *et al*./2017/USA/ Americas/[124]	CS (not mentioned in article)/multivariate Poisson regression model, Multivariate logistic regression models/23	AOR	Human factor	Age (aged 85 or older)
109	Trends in automobile travel, motor vehicle fatalities, and physical activity: 2003-2015[125]	McDonald/2017/ USA/Americas/[125]	CS (not mentioned in article)/state level fixed-effects panel models, regression model/12	Death rates	Human factor	Age (young men)
110	Has the great recession and its aftermath reduced traffic fatalities?[126]	Noland and Zhou/2017/USA/ Americas/[126]	CS/CS time-series models, negative binomial panel model, fixed effect negative binomial model/13	Rate	Human factors, vehicle factors, environmental factors, road factors, economic factors, laws factors, medical services	Economic status, inequality of income distribution, age, some laws such as; graduate licensing, cellphone laws, and motorcycle helmet laws, safety belt use, alcohol consumption, lane miles, fraction of roads and factors include a proxy for medical technology and access to EMS (based on the percent of VMT in rural areas) affect on traffic fatalities
111	Evaluating the potential benefits of advanced automatic crash notification[127]	Plevin *et al*./2017/ USA/Americas/[127]	CS study (not mentioned in article)/multiple logistic regression models/18	OR	Vehicle factors: Advanced automatic crash notification (AACN)	An AACN help decrease mortality following a motor vehicle collision (MVC) by alerting EMS providers earlier
112	Climate change, weather and road deaths[128]	Robertson/2018/ USA/Americas/[128]	CS/logistic regression/9	Rate	Environment factors (temperature), vehicle factors (miles driven per capita)	Temperatures
113	Bicycle fatalities: Trends in crashes with and without motor vehicles in The Netherlands[129]	Schepers *et al*./2017/ Netherlands/Europe/ [129]	CS (not mentioned in article) /segmented Poisson regression/11	Rate	Vehicle factors	Cyclist deaths following motor vehicle crashes decreased while cyclist deaths following crashes without motor vehicles increased
114	Fatal crashes involving large numbers of vehicles and weather[130]	Wang *et al*./2017/ USA/Americas/[130]	CS (not mentioned in article)/regression equation/11	Number of fatal crashes	Vehicle factors, environment factors	Number of vehicles, snow or fog, rain
115	Factors associated with pediatric mortality from motor vehicle crashes in the United States: A state-based analysis[131]	Wolf *et al*./2017/ USA/Americas/[131]	Ecological study/used multivariable linear regression/15	Rate	Geographic factor	Geographic variation

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
116	Modelling of road traffic fatalities in India/[132]	Goel/2018/India/ WHO Southeast Asia Region/[132]	CS/Poisson-lognormal mixture regression/21	Rate	Transit type	Two-wheels car and bus are associated with higher risk
117	Real life safety benefits of increasing brake deceleration in car-to-pedestrian accidents: Simulation of vacuum emergency braking[133]	Jeppsson *et al*./2018/ German/Europe/[133]	CS/logistic regression/13	Percent	Vehicle factors: Emergency brake (VEB) added to a pedestrian automated emergency braking (AEB) system	Adding vehicle emergency brake (VEB) to a car with pedestrian emergency brake (VEB) decreased pedestrian casualties
118	Mandatory helmet legislation as a policy tool for reducing motorcycle fatalities: Pinpointing the efficacy of universal helmet laws[134]	Lee/2018/USA/ Americas/[134]	CS/multinomial probit model/15	Rate	Law factor: Helmet legislation	Motorcycle helmet laws reduce average individual fatality
119	Pedestrian fatality and impact speed squared: Cloglog modeling from French national data[135]	Martin and Wu/2018/France/ Europe/[135]	CS (not mentioned in article)/complementary log-log or Gompertz regression/19	RR	Human factors, vehicle factors	Speed, age, type of vehicle hitting the pedestrian
120	Considering built environment and spatial correlation in modeling pedestrian injury severity[136]	Prato *et al*./2018/ Denmark/Europe/ [136]	CS (not mentioned in article)/linearized spatial logit model/9	Rate	Environment characteristics, human factors (population composition)	The intoxication of the pedestrian is related to a higher probability of suffering a severe or fatal injury
121	Alcohol and fatal accidents in the United States—a time series analysis for 1950-2002[137]	Ramstedt/2008/ USA/Americas/[137]	CS (not mentioned in article)/time series model/13	Rate	Human behavior factors: Alcohol consumption	Sex (male), age (15-34 years)
122	Motorcyclist fatality rates and mandatory helmet-use laws[138]	Houston and Richardson/2008/ USA/Americas/[138]	CS/fixed effects regression models/13	Rate	Law factor: Helmet laws	Helmet laws
123	Pedestrian fatality risk as a function of car impact speed[139]	Rosén and Sander/2009/ German/Europe/[139]	CS (not mentioned in article)/logistic regression analysis/16	Rate	Human behavior factors: Driving speed	Speed
124	Traffic accidents, deaths and alcohol consumption[140]	Arranz and Gil/2009/Spain/ Europe/[140]	CS (not mentioned in article)/logistic regression/7	Rate	Economic policies (alcohol taxes, sanctions), law factors (traffic policies)	If the tax applied to beer increases, the rate of traffic fatalities will increase
125	Female involvement in fatal crashes: Increasingly riskier or increasingly exposed?[141]	Romano *et al*./2008/ USA/Americas/[141]	CS (not mentioned in article)/-/10	Rate	Human factor	Increase in female drivers' fatalities
126	Differences in urban and rural accident characteristics and medical service utilization for traffic fatalities in less motorized societies[142]	Li/2008/Taiwan/ Western Pacific/[142]	CS (not mentioned in article)/-/17	Rate	Geographic factor: Geographic differences	A higher percentage of prehospital deaths were observed following rural

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
127	Analysis of the effect of speed limit increases on accident-injury severities[142]	Malyshkina and Mannering/2008/ India/Southeast Asia Region/[142]	CS (not mentioned in article)/ordered probability model/8	Fatality, elasticity	Human behavior factors: Driving speed	Higher speed limits significantly increase the likelihood fatalities
128	Declines in fatal crashes of older drivers: Changes in crash risk and survivability[143]	Cheung and McCartt/2011/USA/ Americas/[143]	CS (not mentioned in article)/ANCOVA models/14	Rate	Human factors	Deaths of motorcyclists occur disproportionately among younger drivers
129	Effects of high-profile collisions on drink-driving penalties and alcohol-related crashes in Japan[144]	Nakahara and Ichikawa/2010/ Japan/Western Pacific/[144]	CS (not mentioned in article)/time-series regression model/14	Percent	Law factor: drink-driving law	In 2006, the trends for drivers with a blood alcohol concentration (BAC) $0.5 or<0.5 showed significant level declines
130	Explaining regional disparities in traffic mortality by decomposing conditional probabilities[145]	Goldstein *et al*./2011/USA/ Americas/[145]	CS (not mentioned in article)/multilevel or hierarchical regression model/14	Rate	Geographic factor	Traffic mortality rate increase in rural areas
131	Potential risk of using general estimates system: Bicycle safety[146]	Kweon and Lee/2010/USA/ Americas/[146]	CS (not mentioned in article)/partial proportional odds model/16	Proportional odds model	Human behavior factors: Helmet use	Helmet use
132	Road traffic deaths in Brazil: rising trends in pedestrian and motorcycle occupant deaths[147]	Chandran *et al*./2012/Brazil/ Americas/[147]	CS (not mentioned in article)/-/13	Rate	Human factors	The mortality rate for elderly pedestrians (80+years) is high
133	Poverty as a determinant of young drivers' fatal crash risks[148]	Males/2009/USA/ Americas/[148]	CS (not mentioned in article)/bivariate and multivariate regression analyses/16	Rate	Human factors (driver age, sociodemographic characteristics), vehicle factor	Drivers of all ages in poorer areas suffer substantially higher fatal crash rates
134	Prevalence of alcohol and other drugs in fatally injured drivers[149]	Brady and Li/2013/ USA/Americas/[149]	CS (not mentioned in article)/ multivariable modeling/17	Adjusted prevalence ratios	Human behavior factors: alcohol and/or other drugs (AOD)	Alcohol and/or other drugs (AOD) was significantly more prevalent among drivers who died in single-vehicle crashes
135	Booster seat laws and fatalities in children 4 to 7 years of age[150]	Mannix *et al*./2012/ USA/Americas[150]	CS (not mentioned in article)/linear regression/11	Rate	Law factors: State booster seat laws	The findings of this study shows that state booster seat laws are associated with decreased rates of fatalities
136	Fatalities of children 0-7 years old in the second row[151]	Viano and Parenteau/2008/ USA/Americas[151]	CS (not mentioned in article)/-/	Relative fatality risk	Vehicle factors	Seated behind the right-front passenger, rollovers, side impacts, and frontal crashes
137	Trends in fatalities from distracted driving in the United States, 1999 to 2008[152]	Wilson and Stimpson/2010/ USA/Americas/[152]	CS (not mentioned in article)/adjusted the multivariate regression/14	Rate	Human behavior factors: Distracted driving	Fatalities from distracted driving increased
138	The implications of the relative risk for road mortality on road safety programmes in Qatar[153]	Consunji *et al*./2015/ Qatar/Eastern Mediterranean/[153]	CS (not mentioned in article)/-/13	RR	Human factors	Age

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
139	The effectiveness of alcohol control policies on alcohol-related traffic fatalities in the United States[154]	Chang *et al*./2012/ USA/Americas/[154]	CS (not mentioned in article)/multivariate regression analyses/13	Rate	Law factors: Alcohol control policies	Beer taxes are the most effective policies in reducing alcohol-related traffic fatalities
140	Gas prices, beer taxes and GDL programmes: Effects on auto fatalities among young adults in the US[155]	Morrisey and Grabowski/2011/ USA/Americas/[155]	CS (not mentioned in article)/regression/15	Rate	Economic factor (gasoline prices, beer taxes), human factors (GDL)	Higher gasoline prices, higher beer taxes played a much larger role
141	Increased population density of neurosurgeons associated with decreased risk of death from motor vehicle accidents in the United States[156]	Desai *et al*./2012/ USA/Americas/[156]	CS (not mentioned in article/multiple regression analysis/11	Rate	Medical services: Neurosurgeon population density	Neurosurgeon population density
142	Decomposing the relationship between macroeconomic conditions and fatal car crashes during the great recession: alcohol-and non-alcohol-related accidents[157]	Cotti and Tefft/2011/ USA/Americas/[157]	CS (not mentioned in article)/regressions/11	Rate	Economic factor: Recession	Recession
143	Graduated driver licensing and fatal crashes involving 16-to 19-year-old drivers[158]	Masten *et al*./2011/ USA/Americas/[158]	CS (not mentioned in article/age-specific Poisson regression models/15	Rate ratio	Human factors: GDL	Age, stronger GDL programs were associated with higher fatal crash incidence
144	Fatal crash involvement of unlicensed young drivers: county level differences according to material deprivation and urbanicity in the United States[159]	Hanna *et al*./2012/ USA/Americas/[159]	CS/Logistic regression/14	OR	Economic factor (deprivation), geographic factor (urbanization)	Deprivation
145	An epidemiological survey on road traffic crashes in Iran: application of the two logistic regression models[160]	Bakhtiyari/2014/ IRAN/Eastern Mediterranean/[160]	CS/binary logistic regression and proportional odds regression/17	OR	Human factors	Not maintaining eyes on the road and losing control of the vehicle are the main causes of drivers' deaths
146	Individual and areal risk factors for road traffic injury deaths: nationwide study in South Korea [161]	Park/2010/Korea/ SouthEast Asia Region/[161]	CS (not mentioned in article/multilevel Poisson regression/16	RR	Human factors, geographic factor	Elderly men with a low level of education who live in deprived areas

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
147	More fatal all-terrain vehicle crashes occur on the roadway than off: increased risk-taking characterises roadway fatalities[162]	Denning/2012/USA/ Americas/[162]	CS/multivariate logistic regression/17	OR	Vehicle factor, road factor	Fatal roadway crashes were more likely than off-road crashes
148	Do seat belts and air bags reduce mortality and injury severity after car accidents[163]	Cummins/2011/ USA/Americas/[163]	CS (not mentioned in article)/multiple logistic regressions/13	AOR	Vehicle factors: Car safety devices	Seat-belt-plus-air-bag group had effect on reduction in mortality
149	Drug and alcohol involvement in four types of fatal crashes[164]	Romano/2011/USA/ Americas/[164]	Cross sectional study (not mentioned in article)/ logistic regressions modeling/15	OR	Human behavior factors: drunk and drugged driving	Drunk and drugged driving
150	Associations between driving under the influence of alcohol or drugs, speeding and seatbelt use among fatally injured car drivers in Norway[165]	Bogstrand/2015/ Norway/Europe/[165]	CS/binary logistic regression/18	OR	Human behavior factors: DUI, speeding and seat-belt use	Alcohol, drugs
151	Graduated driver license nighttime compliance in US teen drivers involved in fatal motor vehicle crashes[166]	Carpenter/2013/ USA/Americas/[166]	CS/multiple logistic regression/20		Environment characteristics: Nighttime GDL	Legislative and enforcement, nonschool night driving, seatbelt nonuse, and alcohol
152	Development of probabilistic pedestrian fatality model for characterizing pedestrian-vehicle collisions[167]	Oh/2008/Korea/ Southeast Asia Region[167]	CS (not mentioned in article)/Binary logistic regression and a PNN/8	Rate	Human factors (pedestrian age, vehicle type, and collision speed), vehicle type	Pedestrian age, collision speed, and vehicle type
153	Why more male pedestrians die in vehicle-pedestrian collisions than female pedestrians: a decompositional analysis[168]	Zhu/2012/USA/ Americas/[168]	CS (not mentioned in article)/-/13	Ratio	Human factors	Male pedestrians
154	Analysis of factors that increase motorcycle rider risk compared to car driver risk[169]	Keall/2012/USA/ Americas/[169]	CS (not mentioned in article)/logistic model/21	Odds	Human factors	The odds of fatal in new motorcycles were high
155	The association of graduated driver licensing with miles driven and fatal crash rates per miles driven among adolescents[170]	Zhu/2014/USA/ Americas/[170]	CS (not mentioned in article)/regression Model/16	Rate	Laws factors: GDL laws	Comparing persons subject to GDL policies with those not, 16-year-olds had fewer fatal crashes per person-year

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
156	Pedestrian fatality risk in accidents at unsignalized zebra crosswalks in Poland[171]	Olszewski/2015/ Poland/Europe/[171]	CS (not mentioned in article)/logistic regression/14	OR	Environment factors, road factors	Following factors increase the probability of pedestrian's death at unsignalized zebra crosswalks: darkness, especially with no street lighting, divided road, two-way road, non-built-up area, mid-block crosswalk location and summer time period
157	Mapping patterns of pedestrian fatal accidents in Israel[172]	Prato/2012/Israel/ Europe/[172]	CS (not mentioned in article)/-/5	Percent	Environment factors, road factors	Urban areas, road sections, center of the country
158	Comprehensive target populations for current active safety systems using national crash databases[173]	Kusano/2014/USA/ Americas/[173]	survey design techniques/-/9	Percent	Vehicle factor (active safety systems)	Active safety systems could potentially mitigate of fatal crashes
159	The association of age, sex and helmet use with the risk of death for occupants of two-wheeled motor vehicles involved in traffic crashes in Spain[9]	Donate-López *et al*./2010/Spain/ Europe/[9]	rCoh/-/24	ARR	Human factor (age, sex and helmet use for occupants of two-wheeled motor vehicles)	Age, sex, and helmet use
160	Population density and mortality among individuals in motor vehicle crashes[10]	Gedeborg *et al*./2010/Sweden/ Europe/[10]	Population-based cohort/-/22	Mortality rates	Human factor (population density)	Crude mortality rates were inversely related to regional population density
161	Traffic crash victimizations of children and teenagers by drinking drivers age 21 and older[11]	Males/2010/USA/ Americas/[11]	rCoh (not mentioned in study)/-/	RR	Victimizations of children and teenagers by drinking drivers age 21 and older	Drinking drivers age 21 and older victimize 1.3 times more teenage drivers than vice versa and account for large majorities of passenger and nonoccupant alcohol-related crash victimizations of both children and teens
162	The effect of earlier or automatic collision notification on traffic mortality by survival analysis[12]	Wu *et al*./2013/ USA/Americas/[12]	CC/Kaplan-Meier/12	Survival rates	EMS, vehicle factor ACN	The results showed the benefits associated with earlier notifications (approximately 1.84% fatality reduction within a time frame of 6 h after a crash)
163	Obesity and vehicle type as risk factors for injury caused by motor vehicle collision[13]	Donnelly *et al*./2014/UK/ Europe/[13]	rCC/multivariable regression model/18	OR	Human factor (occupant BMI class; underweight, normal weight, overweight, or obese)	It is found that obesity was a risk factor for mortality caused by MVC (OR, 1.6; 95% CI, 1.2-2.0)
164	Driver obesity and the risk of fatal injury during traffic collisions[14]	Rice and Zhu/2014/ USA/Americas/[14]	Matched-pair cohort study/conditional Poisson regression/16	RRs	Human factor (obesity, sex), human behavior factor (driver seat belt use), vehicle factor (vehicle type), collision type	Estimated RRs raised for underweight drivers, RR increased with higher BMI categories

Contd...

Appendix Table 1: Contd...

Number	Title	Author/Year/ Country/Region	Study design*/model which was used/STROB score	Effect size index	Categories independent variables considered	Summary findings (influenced variable on traffic crashes deaths)
165	Age, period, and cohort effects in motor vehicle mortality in the United States, 1980-2010: The role of sex, alcohol involvement, and position in vehicle[15]	Macinko *et al*./2015/ USA/Americas/[15]	CC/apply APC analysis/16	Rate	Human factor (role of sex, alcohol involvement), and position in vehicle, age, period, and cohort effects in motor vehicle mortality	Declines in MVC deaths by position in the car vary for men and women by age and cohort over time cohorts born before 1970 had higher risks than those born later. New technologies and public policy efforts reduce fatalities
166	Helicopter transport improves survival following injury in the absence of a time-saving advantage[16]	Brown *et al*./2016/ USA/Americas/[16]	Rcc/Conditional logistic regression models/24	AOR	Medical services: HEMS compared with GEMS transport across similar pre-hospital transport times	HEMS had a survival benefit over GEMS for prehospital transport times between 6 and 30 min
167	The association between booster seat use and risk of death among motor vehicle occupants aged 4-8: a matched cohort study[17]	Rice *et al*./2009/ USA/Americas/[17]	Matched cohort study/ conditional Poisson regression/15	RRs	Human behavior factor (booster seats and of seatbelts)	Seatbelts, used with or without booster seats, are highly effective in preventing death among motor vehicle occupants aged 4-8 years
168	Mortality from road traffic accidents in Switzerland: longitudinal and spatial analyses[18]	Spoerri *et al*./2011/ Switzerland/Europe/ [18]	Cohort/Weibull survival models and Bayesian methods/18	Adjusted HR	Human factor (population density)	RTA mortality increased with decreasing population density of study areas for motor vehicle occupants and motorcyclists
169	Association between different restraint use and rear-seated child passenger fatalities: A matched cohort study[19]	Du *et al*./2008/USA/ Americas/[19]	Matched cohort design/ conditional Poisson regression/18	RR	Human factor (rear-seated child passengers use)	Restrained reduced the risk of death in rear-seated child passengers

AOR: Adjusted odds ratio, HR: Hazard ratio, RRs: Risk ratios, CS: Cross-sectional, DUID: Driving under the influence of drugs, DUI: Driving under influence, ARR: Adjusted rate ratio, ARIMA: Autoregressive integrated moving average, GDL: Graduated drivers licensing, APC: Age-period-cohort, LTV: Light truck or van, VMT: Vehicle miles traveled, MGOL: Mixed generalized ordered logit, DWI: Driving While Intoxicated, HEMS: Helicopter-based Emergency Medical Services, GEMS: Ground Emergency Medical Services, RENB: Random effect negative binomial, RPNB: Random parameter negative binomial, PNN: Probabilistic neural network, EMS: Emergency medical services, ACN: Automatic collision notification, BMI: Body mass index, CI: Confidence interval, OR: Odds ratio, RRs: Risk ratios, AOR: Adjusted odds ratio, HR: Hazard ratio