Review Article and Meta-Analysis

The Frequency of Road Traffic Injuries and Deaths in Eastern Mediterranean Region: A Systematic Review and Meta-Analysis

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Abstract

Background and Objectives: Deaths and injuries due to road traffic accidents are important public health problems in the world and the Eastern Mediterranean Region (EMR). The current study aimed to review published articles and registry-based reports on the burden of road traffic injuries and deaths in the EMR for all road users. **Methods:** PubMed, Scopus, Web of Science, and Index Medicos for Eastern Mediterranean Region databases were searched to identify all related articles published until January 9, 2023. The search strategy included a thorough search of the keywords as follows: (burden OR disability-adjusted life years OR DALY OR incidence OR prevalence OR morbidity OR mortality OR death) AND (road traffic accident OR road traffic injury OR road traffic crash) AND (EMRO OR "Eastern Mediterranean Region" OR name of countries in EMRO). The population-based or registry-based data, and hospital-based data with underlying causes of death (codes V01–V99) were included. The death of other transportation, literature reviews, viewpoints, and commentaries was excluded. The quality of papers was assessed using the STROBE checklist. Available data for all road users based on their type were extracted and analyzed. Finally, a random-effects meta-analysis was performed, and pooled rates of road traffic injuries and deaths were estimated. Moreover, meta-regression was performed to identify the potential sources of heterogeneity. **Results:** The review of 69 studies showed that the pooled rate was 173.9/100,000 population (95% confidence interval [CI]: 165.1–182.9). The pooled fatal and crash injury rates were 31.4 deaths (95% CI: 30.3–32.7) and 218.6 injuries (95% CI: 212.5–224.6) per 100,000 population. The highest road traffic crash rates belonged to motorized four-wheeler users at 73.8/100,000 population (95% CI: 70.7–77.0), followed by motorized two–three wheelers/cyclists at 30.2/100,000 population (95% CI: 4.1–64.5). **Conclusions:** The burden of road traffic injury and death was high in EMR. Therefore, the modification of the traffic crash data logging system and active monitoring of the consequences of traffic crashes in this region are required.

Keywords: Burden, Eastern Mediterranean region, road traffic injuries and deaths

Introduction

Road traffic deaths and injuries are major public health problems in the world. According to the statistics, more than 1.35 million individuals die due to road traffic incidents annually, and a number of 20–50 million individuals have been injured.[1] The World Health Organization (WHO) reported that road traffic crashes were among the few nonbiological causes in the list of the top-ten causes of human deaths in 2016.[2] Currently, such crashes are the most important causes of death

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among children and young individuals aged 5–29 years. In addition, more than 50% of road traffic deaths occur more frequently in pedestrians, cyclists, and motorcyclists.[1]

According to the WHO, in 2018, more than 90% of road traffic crashes occurred in low-and middle-income countries, of which only 59% of the total number of vehicles in these countries were registered. Therefore, the burden of road traffic deaths was considerable in low- and middle-income countries.[1,3] In 2016, in the Eastern Mediterranean Region (EMR), the rate of road traffic deaths was 18/100,000 population, which was almost higher than in 2013 (17.9/100,000 population).[1] The increase in road traffic injuries and deaths is, to some extent, related to the economic development of countries, which has increased the number of vehicles on the roads without improving the road infrastructure itself.[3,4]

A study showed that road traffic crashes in the EMR were underreported. Moreover, information about factors affecting the occurrence of traffic crashes was underreported in many countries due to the lack of supportive structures of multi-sectoral cooperation.[5] Thus, underreporting and unavailability of road traffic databases were two major barriers to health-based planning in prehospital and emergency care contexts as well as other governmental agencies. To improve the underreporting gap in road traffic injuries and deaths, this study aimed to review the published articles and registry-based reports on the burden of road traffic injuries and deaths in the EMR attributed to all road users (i.e. pedestrians, motorized four-wheelers motorized two-three wheelers and cyclists).

Methods

Literature search

Electronic databases, including PubMed, Scopus, Web of Science, and Index Medicos for the Eastern Mediterranean Region, were searched to emerge articles published until January 9, 2023. The search strategy comprised of the MeSH terms as follows: (burden OR disability-adjusted life years OR DALY OR incidence OR prevalence OR morbidity OR mortality OR death) AND (road traffic accident OR road traffic injury OR road traffic crash) AND (EMRO OR "Eastern Mediterranean Region" OR name of countries in EMRO). Conference abstracts were searched in Scopus. All searches were performed by two independent reviewers.

Study selection

Papers possessing the following criteria were included in the present study: (a) Clearly referred to road traffic injuries or deaths, b) Included population-based or registry-based data, and c) Included hospital-based data with underlying causes of death which were coded in the International Classification of Disease and Related Health Problems, 10th revision (ICD-10), with codes V01–V99.

Papers were excluded if they: (a) Referred to death through other means of transportation, including water, air, and any other unspecified transportation means, (b) Were literature reviews, viewpoints, and commentaries, and (c) Were not clearly defined and consistently applied a case definition of a road traffic injury or fatality. No language restriction was applied.

In this study, an injury referred to nonfatal cases from a road traffic accident. Death was defined as a result of a road traffic accident in which one or more affected individuals died immediately or within 30 days after the accident. For nonfatal injuries, the case severity ranged from minor injuries with short-term disabilities to severe injuries with lifelong disabilities.

Titles and abstracts of the retrieved articles were independently evaluated by two reviewers. Abstracts that failed to provide adequate information regarding the eligibility criteria were further evaluated through a full-text search. The extracted articles were hand-checked for potentially referred eligible articles that had not been retrieved through electronic search. Reviewers independently evaluated full-text articles and determined study eligibility. Disagreements were addressed by consensus and a third reviewer's opinions in case of unresolved disagreements.

Data extraction

Two reviewers independently conducted the data extraction, and any disagreements were resolved by a third reviewer's opinions. Key data were extracted using a predefined checklist, including the data of the first author, publication year, study period, country (study setting), study design, study type (registry-based or population-based), source of data, type of data (death or injury), age range, sex, the common cause of death or injury, type of road user, and mechanism of injury [Table 1].

Quality assessment

The texts of the papers were evaluated according to the STROBE checklist.[74] The items of the STROBE checklist were ranked zero (poor), one (medium), or two (good). The poor-quality papers included papers with a total score of 30 or lower. The medium-quality group consisted of papers with a score between 31 and 35. The good-quality group included the papers with a score of 36 or higher. The study design, completeness, appropriateness of statistical and analytical methods, and state of limitations were explicitly checked for each study. Moreover, the quality of the reported sample size or study population was assessed to provide a representative estimate.

Data analysis

All extracted data on road traffic accidents, including injuries and deaths, were converted to rates per 100,000 population. Studies were subdivided into population- and registry-based studies and analyzed separately for all road users and by road user category. The heterogeneity among rate estimates was checked by I^2 index as the proportion of total variance due to between-study variance. Moreover, the Q-test for heterogeneity where in a $P < 0.1$ was became taken into consideration as

Table 1: Characteristics of the studies on burden of road traffic injuries and deaths in Eastern Mediterranean Region

ID	First author, (year of publication)	Study period	Country (study setting)	Study design	Study type	Source of data
1	Soroosh *et al*., (2020)[6]	2017	Iran (Sabzevar)	Cross-sectional	Registry-based	Hospital records
2	Rezapur-Shahkolai *et al*., (2020)[7]	2016	Iran (Hamadan)	Cross-sectional	Population-based	People driving in the city
3	Khatibi *et al*., (2020)[8]	2016-2017	Iran (Torbat-e-Heidarieh)	Cross-sectional	Registry-based	Hospital records
4	Taheri Soodejani *et al*., (2020)[9]	2011-2017	Iran (Najafabad)	Cross-sectional	Registry-based	Hospital records
5	Ghodsi *et al*., (2020)[10]	2015-2016	Iran (Hamadan)	Cross-sectional	Registry-based	Forensic medicine organization, Health departments and Traffic police report
6	Soori and Khorasani-Zavareh (2019)[11]	2015	EMRO countries	Cross-sectional	Registry-based	WHO
7	Shahbazi *et al*., (2019)[12]	2006-2016	Iran (National)	Cross-sectional	Registry-based	Forensic medicine organization
8	Sepandi *et al*., (2019)[13]	2009-2013	Iran (Shiraz)	Cross-sectional	Registry-based	Hospital records
9	Roshanfekr (2019)[14]	2010	Iran (National)	Cross-sectional	Population-based	IrMIDHS
10	Rahmati *et al*., (2019)[15]	2015	Iran (Tehran)	Cross-sectional	Registry-based	Hospital records
11	Lotfi (2019)[16]	2013-2017	Iran (Fars Province)	Cross-sectional	Registry-based	Forensic medicine organization, Traffic police report, EMS and Department of roads and urban development
12	Roshanfekr *et al*., (2019)[17]	2010	Iran (National)	Cross-sectional	Population-based	IrMIDHS
13	Jamali-Dolatabad *et al*., (2019)[18]	2014-2015	Iran (Tabriz)	Case-control	Registry-based	Police report and Forensic medicine organization
14	Hashempour *et al*., (2019)[19]	2016	Iran (Tehran)	Cross-sectional	Registry-based	Hospital records
15	Zangeneh *et al*., (2018)[20]	2009-2014	Iran (Kermanshah province)	Cross-sectional	Registry-based	Forensic medicine organization
16	Shahbazi (2018)[21]	2006-2015	Iran (National)	Cross-sectional	Registry-based	Forensic medicine organization
17	Sadeghi-Bazargani *et al*., (2018)[22]	2006-2016	Iran (East Azerbayjan)	Cross-sectional	Registry-based	Forensic medicine organization
18	Parvareh *et al*., (2018)[23]	2009-2015	Iran (Kurdistan province)	Cross-sectional	Registry-based	Hospital records, Police repreportsorensic, Medicine organization and Road organization
19	Mahdian *et al*., (2018)[24]	2006-2013	Iran (Kashan)	Cross-sectional	Registry-based	Registration system for tauma
20	Lotfi *et al*., (2018)[25]	2012-2016	Iran (Yazd province)	Cross-sectional	Registry-based	Forensic medicine organization
21	Homayoun *et al*., (2018)[26]	2006-2017	Iran (Tabriz)	Cross-sectional	Registry-based	Forensic medicine organization
22	Hasani *et al*., (2018)[27]	2013-2014	Iran (Tehran and Alborz provinces)	Cross-sectional	Registry-based	Police report and Forensic medicine organization
23	Sherafati *et al*., (2017)[28]	2013-2014	Iran (Langerood)	Cross-sectional	Registry-based	Hospital records
24	Khoramdad *et al*., (2017)[29]	2009-2014	Iran (Kermanshah)	Cross-sectional	Registry-based	Forensic medicine organization
25	Izadi *et al*., (2017)[30]	2010-2011	Iran (Kermanshah)	Cross-sectional	Registry-based	National death registration and Forensics medicine organization
26	Hosseinpour *et al*., (2017)[31]	2006-2010	Iran (Isfahan province)	Cross-sectional	Registry-based	MOH database
27	Hatamabadi *et al*., (2017)[32]	2012-2013	Iran (Tehran)	Retrospective cohort	Registry-based	Hospital records
28	Fararouei *et al*., (2017)[33]	2012	Iran (Yasuj)	Case-control	Registry-based	Police report
29	Fakharian *et al*., (2017)[34]	2004-2009	Iran (Tehran)	Cross-sectional	Registry-based	Hospital records
30	Yousefzadeh-Chabok *et al*., (2016)[35]	2007-2013	Iran (Zanjan province)	Cross-sectional	Registry-based	Police report
31	Vakili *et al*., (2016)[36]	2010	Iran (Yazd province)	Cross-sectional	Registry-based	Death registration systems (such as hospitals, cemeteries, forensic medicine organization and health centers), and hospital records
32	Sargazi *et al*., (2016)[37]	2012-2013	Iran (Zabol)	Cross-sectional	Registry-based	Hospital records
33	Rakhshani *et al*., (2016)[38]	2011-2012	Iran (Fars province)	Cross-sectional	Registry-based	Forensic medicine organization
34	Rad *et al*., (2016)[39]	2009-2010	Iran (Sistan and Baluchestan province)	Cross-sectional	Registry-based	Police report

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Table 1: Contd...

ID	First author, (year of publication)	Study period	Country (study setting)	Study design	Study type	Source of data
35	Mirzaei *et al*., (2016)[40]	2004-2010	Iran (Yazd province)	Cross-sectional	Registry-based	Death registration systems (such as forensic department, hospitals and cemeteries)
36	Masoumi *et al*., (2016)[41]	2013	Iran (Ahvaz)	Cross-sectional	Registry-based	Hospital records
37	Khorshidi *et al*., (2016)[42]	2012-2013	Iran (National)	Cross-sectional	Registry-based	Police report
38	Ebrahemzadih *et al*., (2016)[43]	2003-2013	Iran (Yazd)	Cross-sectional	Registry-based	Statistics department of health
39	Mohammadi *et al*., (2015)[44]	2010-2011	Iran (Sistan and Baluchistan province)	Cross-sectional	Registry-based	Police report
40	Yazdani-Charati *et al*., (2014)[45]	2006-2010	Iran (Mazandaran province)	Cross-sectional	Registry-based	Province governor-general office, Planning deputy and Police patrol
41	Shams Vahdati *et al*., (2014)[46]	2013	Iran (Tabriz)	Cross-sectional	Registry-based	Hospital records
42	Mohammadi (2014)[47]	2006-2009	Iran (Isfahan)	Cross-sectional	Registry-based	Police report
43	Mehmandar *et al*., (2014)[48]	2008-2009	Iran (National)	Cross-sectional	Registry-based	Police report
44	Hasanzadeh *et al*., (2014)[49]	2004-2010	Iran (Fars province)	Cross-sectional	Registry-based	Forensic medicine organization
45	Davoudi-Kiakalayeh *et al*., (2014)[50]	2009-2013	Iran (Guilan province)	Cross-sectional	Registry-based	Forensic medicine organization, Death registry system and road trauma, Research center database
46	Ardalan *et al*., (2014)[51]	2005-2010	Iran (National)	Retrospective	Registry-based	Forensic medicine organization, HCRS and Iran's statistical center
47	Paravar *et al*., (2013)[52]	2011-2012	Iran (Kashan)	Retrospective	Registry-based	EMS and Data bank of trauma research center
48	Heydari *et al*., (2013)[53]	2009-2011	Iran (Fars province)	Cross-sectional	Registry-based	Forensic medicine organization and EMS
49	Mohammadi (2013)[54]	2005-2008	Iran (Kerman)	Cross-sectional	Registry-based	Police report
50	Bahadorimonfared *et al*., (2013)[55]	2004-2011	Iran (Tehran)	Cross-sectional	Registry-based	ICT database
51	Mohammadi (2012)[56]	2005-2007	Iran (Kerman)	Cross-sectional	Registry-based	Police report
52	Derakhshanfar *et al*., (2012)[57]	2007	Iran (Not reported)	Case-control	Registry-based	EMS
53	Majdzadeh *et al*., (2011)[58]	2008	Iran (Qazvin)	Cross-sectional	Population-based	Structured questionnaire, Hospital and Police records
54	Hatamabadi *et al*., (2011)[59]	2008-2009	Iran (Tehran)	Prospective cohort	Registry-based	Police report, EMS and hospital records
55	Vafaee-Najar *et al*., (2010)[60]	2006	Iran (Mashhad)	Cross-sectional	Registry-based	Police report
56	Bigdeli *et al*., (2010)[61]	2005-2007	Iran (Urmia)	Cross-sectional	Registry-based	EMS
57	Rahimi-Movaghar *et al*., (2009)[62]	1997-2007	Iran (National)	Retrospective	Registry-based	Forensic medicine organization
58	Mohammadi (2009)[63]	2004-2007	Iran (Kerman)	Cross-sectional	Registry-based	Forensic medicine organization and Police report
59	Mohammadi (2009)[64]	2004-2007	Iran (Kerman)	Cross-sectional	Registry-based	Forensic medicine organization and Hospital records
60	Mohammadi (2009)[65]	2005-2007	Iran (Kerman province)	Cross-sectional	Registry-based	Police report
61	Jan Mohammadi *et al*., (2009)[66]	2002-2004	Iran (Mazandaran province)	Cross-sectional	Registry-based	Forensic medicine organization
62	Bhalla *et al*., (2009)[67]	2005	Iran (National)	Cross-sectional	Registry-based	MOHME
63	Soroush *et al*., (2008)[68]	2002	Iran (Shiraz)	Prospective	Registry-based	Hospital records
64	Moharamzad *et al*., (2008)[69]	2006-2007	Iran (Yazd city)	Cross-sectional	Registry-based	Forensic medicine organization
65	Kadkhodaie (2006)[70]	2001-2004	Iran (Gilan province)	Cohort	Registry-based	Hospital records
66	Roudsari *et al*., (2004)[71]	1999-2000	Iran (Tehran)	Cross-sectional	Registry-based	Hospital records
67	Montazeri (2004)[72]	1999-2001	Iran (National)	Cross-sectional	Registry-based	Forensic medicine organization
68	Bener and Bener (2007)[73]	2004-2005	Gatar (not reported)	Case-control	Registry-based	EMS
69	Mehmood *et al*., (2015)[74]	2006-2011	Pakistan (Karachi)	Case-control	Registry-based	EMS

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ID	Type of data	Age range	Sex, *n* (%)	Common cause of death or injury	Type of road user	Mechanism of injury, *n* (%)
1	Death	20-60	Male: 177 Female: 123	Lower and upper extremities injury	Four-wheelers	-
2	Injury	25-56	Male: 684 (85.5) Female: 116 (14.5)	Not report	All road users	-
3	Death	0-80	Male: 102 (77.3) Female: 30 (38.8)	Not report	All road users	-
4	Death	-	Not report	Not report	All road users	-
5	Death	5-65	Male: 362 (74.3) Female: 125 (25.6)	Not report	All road users	-
6	Death	Not report	Not report	Not report	All road users	-
7	Death	0-65	Male: 181,211 (80.1) Female: 45,303 (19.8)	Not report	All road users	-
8	Death	0-80	Male: 808 (81.7) Female: 181 (18.3)	Not report	All road users	-
9	Injury	0-60	Male: 54566 (49) Female: 56849 (51)	Not report	All road users	-
10	Death/injury	25-45	Male: 621 (62.1) Female: 379 (37.9)	Not report	All road users	Motor-pedestrian: 29 (2.9) Vehicle-pedestrian: 211 (21.1) Motorcycle rollover: 60 (6.0) Vehicle rollover: 179 (17.9) Motor-vehicle: 220 (22.0) Auto crashes: 106 (10.6)
11	Death	19-40	Male: 4865 (79.02) Female: 1292 (20.9)	Head and face trauma	All road users	Vehicle-vehicle: 50 Vehicle-overturning: 25 Vehicle-passenger: 21 Other cases: 4
12	Injury	0-60	Male: 56,849 (51) Female: 54,566 (49)	Not report	All road users	-
13	Death	Not report	Not report	Not report	Pedestrian	-
14	Death/injury	1-94	Male: 309 (77.25) Female: 91 (22.75)	Injury: Hand and foot trauma	All road users	-
15	Death	1-65	Male: 2522 (78.4) Female: 695 (21.6)	Head trauma	All road users	-
16	Death	Not report	Not report	Not report	All road users	-
17	Death	Not reported	Not reported	Head trauma and multiple fractures	All road users	Pedestrian-vehicle (elderly people): 823 (60.2) Vehicle-vehicle (other age): 4209 (52.8)
18	Injury	Not reported	Not reported	Not reported	All road users	Not reported
19	Death	0-60	Male: 767 (82.7) Female: 156 (16.9)	Not reported	All road users	Not reported

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Table 1: Contd...

ID	Type of data	Age range	Sex, *n* (%)	Common cause of death or injury	Type of road user	Mechanism of injury, *n* (%)
20	Death	20-23	Male: 1076 (74.8) Female: 361 (25.2)	Head trauma and fracture	All road users	Vehicle-vehicle: 702 Vehicle-pedestrian: 255 Vehicle-object: 50 Rollover: 430
21	Death	6-65	Not reported	Head trauma and mixed causes	Four-wheelers	Vehicle-vehicle: 139 (57.7) Rollover: 65 (26.9) Fall: 15 (6.2) Vehicle-object: 12 (4.9) Vehicle-pedestrian: 4 (1.7)
22	Death/injury	15-65	Male: 6288 (62.5) Female: 3771 (37.5)	Not reported	Pedestrian	Not reported
23	Death/injury	Not reported	Male: 1158 (76.1) Female: 362 (23.9)	Not reported	All road users	Motorcycle-vehicle: 869 (57.1) Vehicle-vehicle: 431 (28.3) Stuck as a pedestrian: 220 (14.6)
24	Death	1-99	Male: 2552 (78.4) Female: 711 (21.6)	Head trauma and multiple fractures	All road users	Not reported
25	Death/injury	0-80	Male: 4516 (70.8) Female: 1844 (29.2)	Injury: Fracture of the sternum, one or two ribs, face, mild injury	All road users	Not reported
26	Death/injury	0-80	Male: 74,743 (89.3) Female: 9201 (10.7)	Not reported	Two-three wheelers/cyclists	Not reported
27	Death/injury	1-91	Male: 1181 (80.3) Female: 290 (19.7)	Injury: Lower and upper extremities injury	All road users	Vehicle-vehicle: 1063 (72.3) Vehicle-motorcycle: 154 (10.5) Vehicle-object: 203 (13.8) Vehicle-bicycle: 12 (0.7) Unknown: 39 (2.7)
28	Injury	Not reported	Not reported	Not reported	Four-wheelers	Not reported
29	Injury	Not reported	Male: 51 (56) Female: 40 (44)	Pelvic limb and	Four-wheelers	Car collision: 27 (29.7) Rollover: 64 (70.3)
30	Death	0-71	Male: 1992 (77.5) Female: 579 (22.5)	Not reported	All road users	Not reported
31	Death/injury	0-80	Death Male: 382 (79.1) Female: 101 (20.9) Injured Male: 8187 (81.4) Female: 1868 (18.6)	Injury: Fracture of knee/lower leg and fracture facial bones	All road users	Not reported
32	Injury	4-68	Male: 673 (58.3) Female: 482 (41.7)	Long bone fractures	All road users	Vehicle-vehicle: 897 (77.6) Motorcycle-vehicle: 201 (17.5) Pedestrian-vehicle: 57 (4.9)

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ID	Type of data	Age range	Sex, *n* (%)	Common cause of death or injury	Type of road user	Mechanism of injury, *n* (%)
33	Death	0-70	Male: 1291 (77.4) Female: 377 (22.6)	Head trauma	All road users	Vehicle-vehicle: 859 (51.5) Vehicle-pedestrian: 304 (18.2) Vehicle-object: 89 (5.3) Vehicle-animal: 5 (0.3) Rollover: 367 (22) Fall: 17 (1) Fire: 1 (0.1)
34	Injury	15-45	Male: 2374 (99) Female: 24 (1)	Not reported	Four-wheelers	Motorcycle or bicycle: 262 (10.9) Single vehicle: 781 (32.6) Multiple vehicles: 96 (4.00) Animals: 64 (2.70) Pedestrians: 179 (7.50) Fixed objects: 115 (4.80) Rollover/overturn: 811 (33.8) Others (i.e., fire explosion): 90 (3.80)
35	Death	0-85	Not reported	Not reported	All road users	Not reported
36	Injury	3-82	Male: 647 (92.4) Female: 53 (7.6)	Not reported	All road users	Car-pedestrian: 308 (44) Car-motorcycle: 175 (25) Rollover: 80 (11.4) Car-car: 48 (6.9) Motorcycle-motorcycle: 47 (6.7) Motorcycle-pedestrian: 42 (6)
37	Death/injuries	Not reported	Not reported	Not reported	All road users	Not reported
38	Death	Not reported	Not reported	Not reported	Four-wheelers	Not reported
39	Death/injury	20-30	Male: 1393 (99.2) Female: 11 (0.8)	Not reported	Four-wheelers	Not reported
40	Death/injury	Not reported	Not reported	Not reported	All road users	Not reported
41	Injury	9-88	Male: 121 (67.4) Female: 60 (32.6)	Limbs, head, neck and abdominal	All road users	Overturning car: 24 (13.3) Two-car accident: 89 (49.2) Car-pedestrian: 22 (12.2) Motorcycle-car: 22 (12.2) Overturning motorcycle: 20 (11.0) Motorcycle-pedestrian: 4 (2.2)
42	Death/injury	18-45	Male: 15,934 (64.7) Female: 8674 (35.2)	Not reported	All road users	Not reported
43	Death/injury	24-55	Male: 1670 (98.9) Female: 17 (1.1)	Not reported	All road users	Not reported
44	Death	18-45	Male: 10,442 (80) Female: 2512 (20)	Head trauma and multiple fractures	All road users	Not reported
45	Death	3-85	Male: 2122 (90) Female: 430 (10)	Not reported	All road users	Not reported

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ID	Type of data	Age range	Sex, *n* (%)	Common cause of death or injury	Type of road user	Mechanism of injury, *n* (%)
46	Death	Not reported	Not reported	Not reported	All road users	Not reported
47	Injury	2-94	Male: 1323 (82.7) Female: 277 (17.3)	Injury: Head and neck trauma, upper and lower extremities	All road users	Car-car: 187 (11.7) Car rollover 191 (11.9) Motorcycle-car 577 (36.1) Motorcycle-motorcycle: 221 (13.8) Motorcycle-rollover: 150 (9.4) Pedestrian-car: 118 (7.4) Pedestrian-motorcycle: 135 (8.4) Bike: 21 (1.3)
48	Death	15-65	Male: 2841 (78.3) Female: 801 (21.7)	Head trauma, multiple fracture and bleeding	All road users	Not reported
49	Death	18-45	Injury Male: 3329 (82.7) Female: 597 (15.3) Death Male: 1222 (78) Female: 342 (22)	Head trauma and bleeding	All road users	Not reported
50	Death	Not reported	Not reported	Not reported	All road users	Not reported
51	Death/injury	19-44	Male: 2067 (82.9) Female: 425 (17.1)	Not reported	All road users	Not reported
52	Injury	15-55	Not reported	Not reported	Four-wheelers	Not reported
53	Injury	15-45	Male: 114 (78.6) Female: 31 (21.4)	Not reported	Four-wheelers	Vehicle-vehicles: 103 (71) Fixed objects: 26 (17.9) Turnover or skidding: 16 (11.1)
54	Death/injury	Not reported	Male: 278 (64.1) Female: 99 (22.8) Unreported: 57 (13.1)	Injury: Head trauma and upper limb injuries	All road users	Not reported
55	Death/injury	25-35	Not reported	Not reported	Two-three wheelers/cyclists	Not reported
56	Death/injury	Not reported	Not reported	Not reported	All road users	Not reported
57	Death/injury	Not reported	Not reported	Not reported	All road users	Not reported
58	Death/injury	19-58	Not reported	Not reported	Four-wheelers	Not reported
59	Death	15-55	Male: 462 (81.6) Female: 105 (18.5)	Skull fracture and brain contusion	All road users	Not reported
60	Death/injury	19-46	Death Male: 1088 (85.1) Female: 191 (14.9) Injury Male: 5207 (86.7) Female: 797 (13.3)	Not reported	All road users	Not reported

Contd...

Table 1: Contd...

ID	Type of data	Age range	Sex, *n* (%)	Common cause of death or injury	Type of road user	Mechanism of injury, *n* (%)
61	Death	1-75	Male: 83 (93.3) Female: 6 (6.7)	Head trauma	Two-three wheelers/cyclists	Motorcycle-car: 59.1 Motorcycle-heavy lorry: 11.4 Collision with other objects: 29.5
62	Death	1-85	Not reported	Not reported	All road users	Not reported
63	Injury	18-60	Not reported	Not reported	All road users	Not reported
64	Death	1-89	Male: 202 (80.5) Female: 49 (19.5)	Skull base fracture, CNS cause such as epidural hematoma	All road users	Not reported
65	Injury	2-76	Not reported	Maxillofacial trauma	All road users	Not reported
66	Death/injury	0-71	Male: 3082 (81.1) Female: 720 (18.9)	Not reported	All road users	Not reported
67	Death	10-61	Male: 11,938 (79) Female: 3107 (21)	Head trauma, bleeding	All road users	Not reported
68	Injury	25-45	Case Male: 162 (74.7) Female: 55 (25.3) Control Male: 155 (71.4) Female: 62 (28.6)	Not reported	Four-wheelers	Not reported
69	Death/injury	15-65	Male: 142,289 (87.3) Female: 20,633 (12.6) Unknown: 100 (0.1)	Not reported	All road users	Not reported

IrMIDHS: Iran's multiple indicator demographic and health survey, EMS: Emergency medical services, MOH: Ministry of Health, HCRS: High commission of road safety, ICT: Information and communication technology, MOHME: Iranian Ministry of Health and Medical Education, CNS: Central nervous system, EMRO: Eastern Mediterranean Region Office, WHO: World Health Organization

statistically significant. The eager test was used to assess the publication bias. Since there was heterogeneity among studies, a random effects (DerSimonian and Laird) meta-analysis was conducted on an extracted road traffic accident, injury, and death rates using Metan command by Stata version 13.1 (StataCorp. LP, College Station, the United States of America). A forest plot was used to display the results of each study along with the pooled estimates and their 95% confidence intervals.

After observing substantial heterogeneity across the studies, meta-regression was run to identify the potential sources of heterogeneity, and the variables of publication year, sample size, study type (population- and registry-based), and type of road user were included independently in the model. Subgroup analysis was performed according to the type of road user.

Results

About 2783 articles were retrieved by database searching. After reviewing articles, 69 articles were investigated for qualitative evaluation and meta-analysis using inclusion criteria [Figure 1]. Some extracted features are presented in Table 1.

The results of the quality assessment revealed that 15 (22%) studies were of good quality, 44 (63.7%) were of medium quality, and 10 (14.3%) were of poor quality.

According to the eager test, there was no evidence of publication bias for injury rates (β =0.17, 95% CI:-1.3–1.7, $P = 0.41$) and death rates (β =0.74, 95% CI:-0.24–1.7, $P = 0.13$).

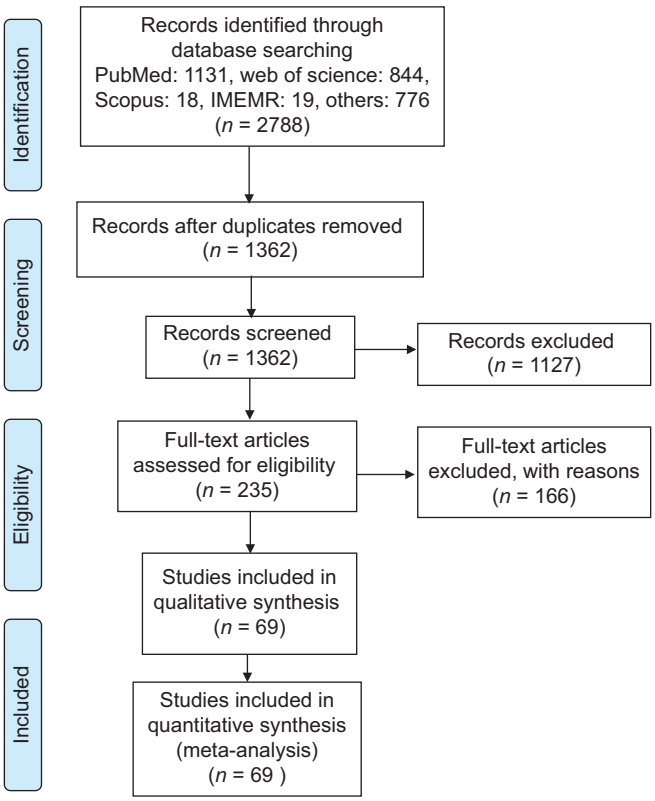

Figure 1: Flow diagram of the search strategy for meta-analysis on the burden of road traffic injuries and deaths in Eastern Mediterranean Region

Of all 69 articles, 67 articles were from Iran and two articles were from Pakistan and Qatar. More than two-thirds of studies (58 articles) have been conducted since 2010 and their time duration varied from 1 to 12 years.

Overall, a number of 63 cross-sectional, three case-control, and three prospective cohort studies were included in the present study. The study type was population-based in three articles and registry-based in the rest. The most common data sources in the reviewed articles were hospital and emergency sources (29 articles), police sources (18 articles), and forensic data sources (25 articles). In the reviewed studies, lower and upper extremities injuries (7 articles, 14.9%), and head-and-face injuries (4 articles, 8.5%) have been reported as the most common types of road traffic injuries [Figures 2 and 3].

The vehicles in the reviewed studies included four-wheeled vehicles (14 articles), motorcycles and bicycles (6 articles), pedestrians (5 articles), and a combination of all (50 articles). The mechanism of occurring road traffic crashes was reported in 16 articles. In these articles, vehicle collision (11 articles), motorcycle collision with vehicle (7 articles), vehicle collision with pedestrian (3 articles), vehicle collision with fixed objects (3 articles), and overturning (7 articles) were reported as the most common types of crash mechanisms [Table 1].

Reported rates

According to the registry-based studies, the highest and lowest reported road traffic injury rates were 1810.1 and 0.21/100,000 population in 2016 and 2017, respectively.[7,8] The lowest road traffic death rate reported in 2019 was 0.06/100,000 population,[15] and the highest rate was 251.9/100,000 population in 2013.[54] The estimated pooled rates for the Eastern Mediterranean region are presented in Table 2. For all crashes, the pooled rate was 173.9/100,000 population.[7,17] The pooled road traffic death and injury rates were estimated as 31.4 deaths and 218.6 injuries/100,000 population, respectively. The pooled rates showed that the highest road traffic death and injury rates belonged to four-wheeled vehicles. Among two–three-wheeled vehicles and cyclists, the pooled road traffic injury and death rates were 30.2, 39.8, and 3.4/100,000 population, respectively. The pooled road traffic injury and death rates among pedestrians were

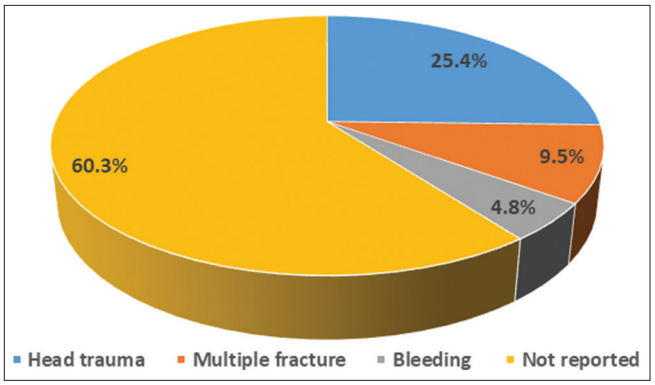

Figure 2: The most common reported causes of road traffic deaths in the Eastern Mediterranean Region in the articles published during 2004–2023

Table 2: Pooled total road traffic injury and death estimates by road user type, Eastern Mediterranean Region, 2004-2023

Road user type	Total road traffic crash rate (CI 95%)*	I^2 index (%)	*P*-value for heterogeneity	Injury rate**	I^2 index (%)	*P*-value for heterogeneity	Death rate***	I^2 index (%)	*P*-value for heterogeneity
All road users									
Pooled rate	173.9 (165.1-182.9)	100	<0.001	218.6 (212.5-224.6)	100	<0.001	31.4 (30.3-32.7)	100	<0.001
Number of data points	49			24			42		
Motorized four-wheelers									
Pooled rate	73.8 (70.7-77.0)	100	<0.001	76.6 (70.1-82.2)	100	<0.001	33.2 (24.9-41.7)	99.9	<0.001
Number of data points	14			11			6		
Motorized two-three wheelers/cyclists									
Pooled rate	30.2 (4.1-64.5)	100	<0.001	39.8 (27.4-52.2)	99.9	<0.001	3.4 (0.3-7.2)	99.6	0.07
Number of data points	6			3			4		
Pedestrians									
Pooled rate	24.4 (17.5-31.2)	100	0.08	46.4 (5.2-87.4)	99.9	0.03	3.9 (0.2-8.2)	99.8	0.06
Number of data points	5			3			3		

*Defined as the number of all road traffic injuries (fatal and nonfatal) per 100,000 population, **Defined as the number of nonfatal road traffic injuries per 100,000 population, ***Defined as the number of fatal road traffic injuries per 100,000 population. CI: Confidence interval

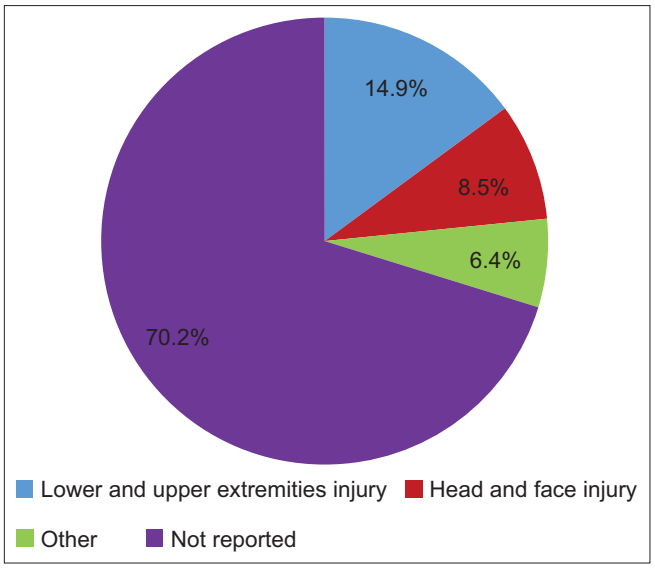

Figure 3: The most common reported site of road traffic injuries in the Eastern Mediterranean Region in articles published during 2004–2023

24.4, 46.4 and 3.9/100,000 population, respectively [Table 2]. From 2004 to 2023, road traffic death rates decreased from 33.5 to 24.1/100,000 population [Figure 4]. In contrast, injury rates decreased from 225.2 to 88.9/100,000 population since 2004-2015, but this rate increased to 128.6/100,000 population since 2016-2023 [Figure 5].

Meta-regression analysis showed a significant association between the sample size of studies and the injury rate ($\beta = -5.59$, $P = .03$). However, there was no significant association between injury rate and the publication year ($\beta = -7.8$, $P = 0.47$), type of road user ($\beta = -65.9$, $P = 0.18$), and study type ($\beta = 155.1$, $P = 0.31$). Moreover, there was no significant association between death rate and the publication year ($\beta = -1.1$, $P = 0.44$, type of road user ($\beta = -11.9$, $P = 0.06$), and sample size ($\beta = 0.34$, $P = 0.24$).

Discussion

According to the results of this study, the rate of total crashes was 173.9/100,000 people in the EMR during 2004–2023. Moreover, the rate of road traffic death and injury was 31.4 and 218.6/100,000 people, respectively. Based on a recent study, about 9.7% of road traffic deaths in the world occur in the EMR, while this region comprises only 7.4% of the total world population.[3,11] In 2016, a report by the WHO showed that the road traffic death in a region was 18/100,000 individuals,[1] which is different from the results of this study, but it is a significant amount that needs more attention of officials and policy makers. According to a report from the WHO in 2018, road traffic crashes have caused major concern for all countries in the EMR regardless of their income level, so it has the third-highest number of road traffic deaths after Africa and Southeast Asia.[76]

The report on road traffic deaths and injuries between 2004 and 2020 showed that the death rate had decreased from 33.5

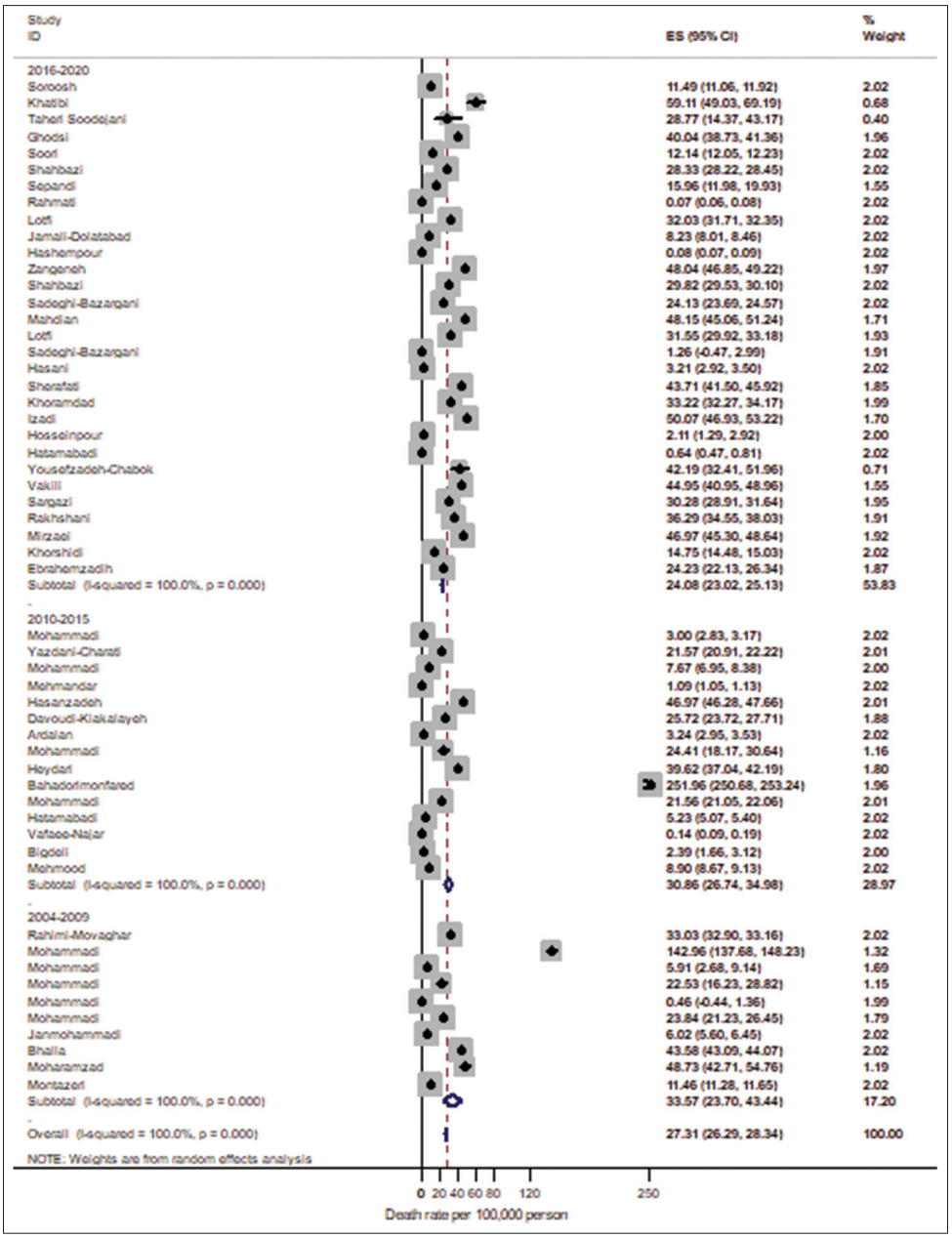

Figure 4: Forest plot of random-effects meta-analysis of the death rate of road traffic crashes in Eastern Mediterranean Region between 2004 and 2023

to 24.1/100,000 population. In contrast, from 2004 to 2015, the injury rate had decreased from 225.2 to 88.9/100,000 population, while it had increased to 128.6/100,000 population from 2016 to 2023. A previous study conducted in this region revealed that there has been a decreasing trend in road traffic deaths since 2005. However, low-income countries in the region have the highest number of road traffic deaths and injuries compared to the others, knowing that after 2015, the use of motorized vehicles in the region has an increasing trend while it has been tripled compared to the global standard.[77] It seems that an increase in the number of cars, the absence of other public transport modes (such as tram or train), quality of roads, traffic conditions, and old vehicles are all among the contributing factors in increasing injury and fatalities in low- and middle-income countries.[78,79] In these countries, there is a disproportionately higher rate of pedestrians and motorcyclists.[79] Since most of the road users in low-income countries are composed of pedestrians, cyclists and motorcyclists, targeted policy, and safety legislation must be performed.

Among the most important issues affecting the possibility of crashes as well as the severity of their following consequences in the EMR are road safety challenges, including the control and design of road infrastructure and the vehicles themselves[80] while according to the WHO, many changes have been implied in the road safety law within the countries of the region.[81] On the other hand, despite the economic growth of many countries in the region, the access and quality of prehospital, inpatient, and posthospital care for traffic accident victims are not at

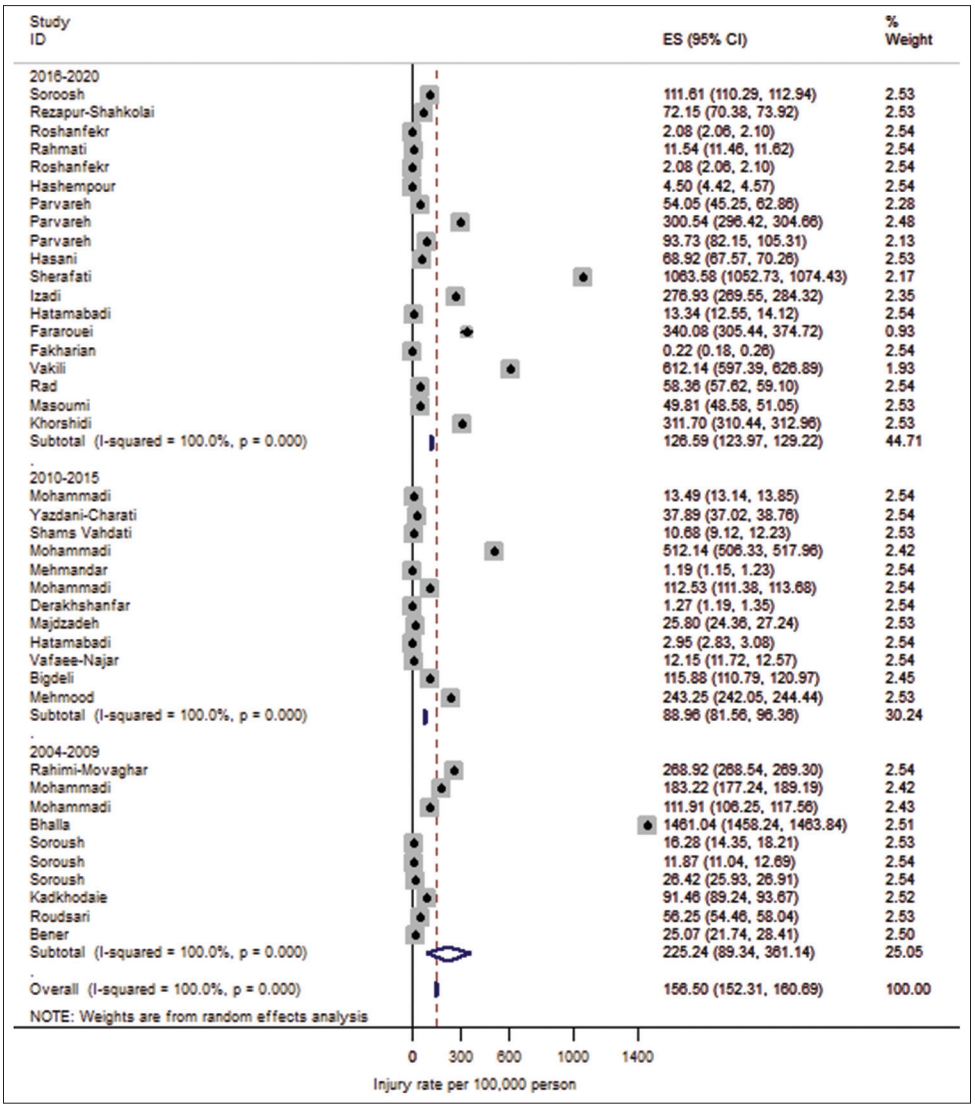

Figure 5: Forest plot of random-effects meta-analysis of the injury rate of road traffic crashes in Eastern Mediterranean Region between 2004 and 2023

the level of world standard,[82,83] knowing that easy access to quality health-care services plays an important role in reducing mortality and improving the outcome of traffic crashes.[82,83]

The results of this study showed that most traffic crashes occurred by four-wheeled vehicles and motorcycles in the EMR. In 2015, among the EMR countries, in terms of income level, the road traffic death rate caused by four-wheeled vehicles was different compared to other users, so that this rate was three times, three times and one and a half times more than others in high-, middle- and low-income countries, respectively. Since most of the obtained researches are from Iran and Iran is a middle-income country, the results of this study are consistent with the previous study conducted in the region.[77] In the countries of the region, including Iran, Morocco, and Tunisia, the most common transportation methods were using two-wheeled and three-wheeled vehicles instead of walking.[83] In these countries, the risk of crash and death in users of four-wheeled and two-wheeled vehicles increases due to the poor infrastructure, lack of special roads for high-risk users, including motorcyclists, cyclists, and pedestrians, and their absence from the view of other vehicle drivers.[11]

A major challenge for managers to react against road traffic crashes in the EMR is the lack of reliable information and data that can provide appropriate decisions to reduce the burden and injuries caused by such crashes.[5] It is also confirmed in this study as the highest (1810/100,000 people) and the lowest (0.21/100,000 people) rate of road traffic injury reported in the region was from Iran.[34,37] Moreover, the highest (251/100,000 people) and the lowest (0.06/100,000 people) rates of road traffic deaths were reported from Iran[15,55] and there were only two studies from Pakistan[74] and Qatar[76] on the burden of road traffic injury. In many countries in the region, there is neither an active data registry nor a monitoring system to track the consequences of road traffic crashes.[5] In such countries, police data are the primary source of information on traffic crashes, knowing that road traffic injuries and deaths are underreported there.[5] The reasons for this underreporting might be the incorrect classification of

death reports, the challenges in defining 30-day deaths from official sources, as well as the neglecting and underestimating of the importance of registering road traffic accident data.

The results of this study revealed that head trauma was the most common cause of death and limb injury was the most common site of injury among the victims of road traffic crash. According to studies, not wearing a safety helmet in motorcyclists and cyclists, and not wearing seat belts in drivers and occupants of four-wheeled vehicles are among the causes of head injuries.[1,3,38,81] Wearing a safety helmet reduces the risk of death by up to 40% and the risk of injury by up to 70%.[3,81] However, in the EMR, the use of it varies from 6% to 90%.[85] In these countries, instructions should be developed to make more suitable and lighter helmet. Moreover, strict rules and laws should be reformed and implemented on the mandatory use of helmets and seat belts, response systems and coordination of prehospital and hospital emergency care for the injured should be reformed, and also timely and easy access to rehabilitation services for the injured should be considered.

The current study had some limitations: (1) Most of the data were obtained from the studies in Iran and we did not have access to the data from other countries. (2) Most of the reviewed studies were based on a registry system and there is a low probability of underreporting.

Conclusion

The burden of road traffic crashes in the EMR is high and there is a high level of damage in traffic injuries. Improving systems for registering road traffic crash data and active monitoring to follow-up on the consequences of traffic crashes, improving response systems and managing prehospital and hospital emergency care for the injured, as well as improving access to rehabilitation services for the injured are among the acts that should be considered in the countries of this region.

Ethics approval

This study was approved by the Ethics Committee of Mashhad University of Medical Sciences (IR.MUMS.MEDICAL.REC.1399.703).

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Conflicts of interest

There are no conflicts of interest.

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