

Epidemiological Patterns of Road Traffic Crashes During the Last Two Decades in Iran: A Review of the Literature from 1996 to 2014

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Abstract

Context: Despite considerable attention given to health statistics of road traffic crashes (RTCs), the epidemiological aspects of injuries resulting from RTCs are not fully understood in Iran and other developing countries. The aim of this review was to study the epidemiological pattern and issues arising due to RTCs in Iran.

Evidence Acquisition: The scope of this study involves data from a broad range of published literature on RTCs in Iran. Data collection for this study was conducted by searching for keywords such as traffic accidents, traffic crashes, motorcycle accidents, motorcycle crashes, motorcycle injury, motor vehicle injury, motor vehicle crashes and motor vehicle accidents, Iran and Iranian in various databases such as Embase, PubMed, Google Scholar, Scopus, Magiran, Iranian scientific information database (SID) and IranMedex.

Results: This study comprised of 95 articles. It is evident from this review that a large number of severe RTCs occur due to collision of two or more vehicles and most of the victims are males aged between 30 and 39 years. Male pedestrian, drivers and passengers are more likely to be severely injured in comparison to females. One of the most prevalent causes of death among adults involved in the RTCs are head injuries and the majority of deaths occur prior to hospitalization. Mortality rates for RTCs are higher in summer, especially during midnight among all age groups. The most common individual and environmental risk factors associated with RTCs include lack of attention, getting trapped in the car, listening to music, fatigue and sleepiness, duration and distance and negligence of seatbelt usage while driving.

Conclusions: The findings of the current study will be beneficial in prevention of RTCs and its associated complications and hence will be vital for policy makers, health service managers and stakeholders.

Keywords: Epidemiological Studies, Road Traffic Crashes, Iran, Injuries, Prevention

1. Context

Injuries are the main cause of mortality and morbidity in majority of countries around the world (1, 2). Road traffic injuries are one of the leading causes of death, hospitalization, disability, and low socioeconomic status (3-6). According to world health organization (WHO) report, higher mortality rates associated with road traffic crashes are more prevalent in South-Western Asia (7).

Various studies reported that Iran has the highest mortality rates ranging between 30 - 44 deaths per 100,000 persons (8-10). In 2005, 30,721 Iranians died annually in road traffic crashes and over one million were injured. The

death rate (44 per 100,000) is the highest of any country in the world for which reliable estimates are available (11). The total cost of RTCs was about 72,465 billion Rials (7.2 billion US Dollars), which amounts to 2.19% of Iran's Gross Domestic Production (GDP) (12). Injuries collectively caused 11.2% of disability-adjusted life years (DALYs) with many different injuries making important contributions. The largest was road injuries, which accounted for 27% of the injury total (13).

Despite the considerable attention to health statistics of RTCs, the epidemiological aspects of injuries are not clear in Iran and other developing countries due to loss

of appropriate information systems. Moreover, police and national registry data is unable to determine age and gender pattern, severity of injury, victims, time and location of event. However, epidemiological pattern of injuries and its risk factors can be determined from epidemiological studies conducted in different areas of Iran and by re-analyzing the hospital registry data. Surprisingly in Iranian medical journals only 3% of reports focus on RTCs (14). On the other hand, the environmental risk factors associated with RTCs are specific for each region and hence data obtained from other countries cannot be utilized (15). Currently there is a large gap in the knowledge which when filled in could be used as preventive measures, in making appropriate decisions and policy making. Systematic literature reviews are invaluable scientific activities. The rationale for such reviews is well-established. Health care providers, researchers, and policy makers are inundated with unmanageable amounts of information; they need systematic reviews to efficiently integrate existing information and provide data for rational decision making. Therefore, the aim of the present study was to review epidemiological pattern of RTCs and support it with evidence from published studies.

2. Evidence Acquisition

This study was conducted in 2014 using the systematic review approach adopted from the book entitled "A Systematic Review to Support Evidence-Based Medicine" (16); in addition to this Preferred Reporting Items for systematic reviews and meta-analyses (PRISMA) checklist was also completed during this review (17, 18).

2.1. Eligibility Criteria

The inclusion criteria for the study included cross-sectional, case-control and cohort studies on the epidemiological pattern of traffic injuries, studies conducted in Iran and articles published in Persian and English language. The exclusion criteria for this study were conference presentations, case reports, interventional studies, economical studies, clinical studies, management studies and other no epidemiological pattern studies.

2.2. Information Sources

Required data were collected using the following search criteria: traffic accidents, traffic crashes, motorcycle accident, motorcycle crash, motorcycle injury, motor vehicle injury, motor vehicle crash and motor vehicle accident, Iran and Iranian in various databases including Embase, PubMed, Google Scholar, Scopus, Magiran, Iranian scientific information database (SID) and IranMedex. Lastly, areas of gray literature were also reviewed along with advice

from experts. Articles published earlier than the year 1996 were not included due to the possibility of transitions in epidemiological patterns.

2.3. Review Process

In the first phase of the review process, an extraction table was designed and its validity was confirmed by experts. A pilot study (using 10 articles) was conducted to further improve the extraction table. Experienced authors (SS, and A-AS) were responsible for independently extraction of the data.

In the first phase of article selection, articles with non-relevant titles were excluded. In the second phase, the abstract and the full text of articles were reviewed to include those articles matching the inclusion criteria. Reference management (Endnote X5) and Microsoft access software were used for organizing and assessing the titles and abstracts, as well as for identifying any duplicate entries.

2.4. Quality Assessment

Two reviewers (SS and A-AS) evaluated the articles according to the checklist of strengthening the reporting of observational studies in epidemiology (STROBE) (19-21). Controversial cases were referred to a third author (SBH).

3. Results

In this study, 2867 articles were reviewed but only 95 articles were related to the study objective and thus included in the study (Figure 1).

3.1. Trauma Victims

Demographic, hospital, and forensic medicine data showed that, among different types of traumatic incidents, RTCs have the highest frequency across all age and genders (8, 22-33). After fall injuries, RTCs were the second major injuries among subjects below fifteen years (28, 32, 34). According to another study, RTCs were also second major injuries after hit injuries among adolescents (35). On the other hand as outline in some studies, RTCs are likely to be the primary cause of injuries (24, 36). For instance, studies outlining fractures and injuries stated that, RTCs were the major cause of the maxillofacial fractures (37), spinal injury (38-40), abdomen and chest trauma (41), tibial fractures (42), facial injuries (43), skull fractures (44), traumatic vascular injuries (35), mid-facial fractures (45) and traumatic nasal bone fractures (46). Another study showed that burn incidents resulting from RTCs were the least in comparison to burn incidents from other accidents (46, 47).

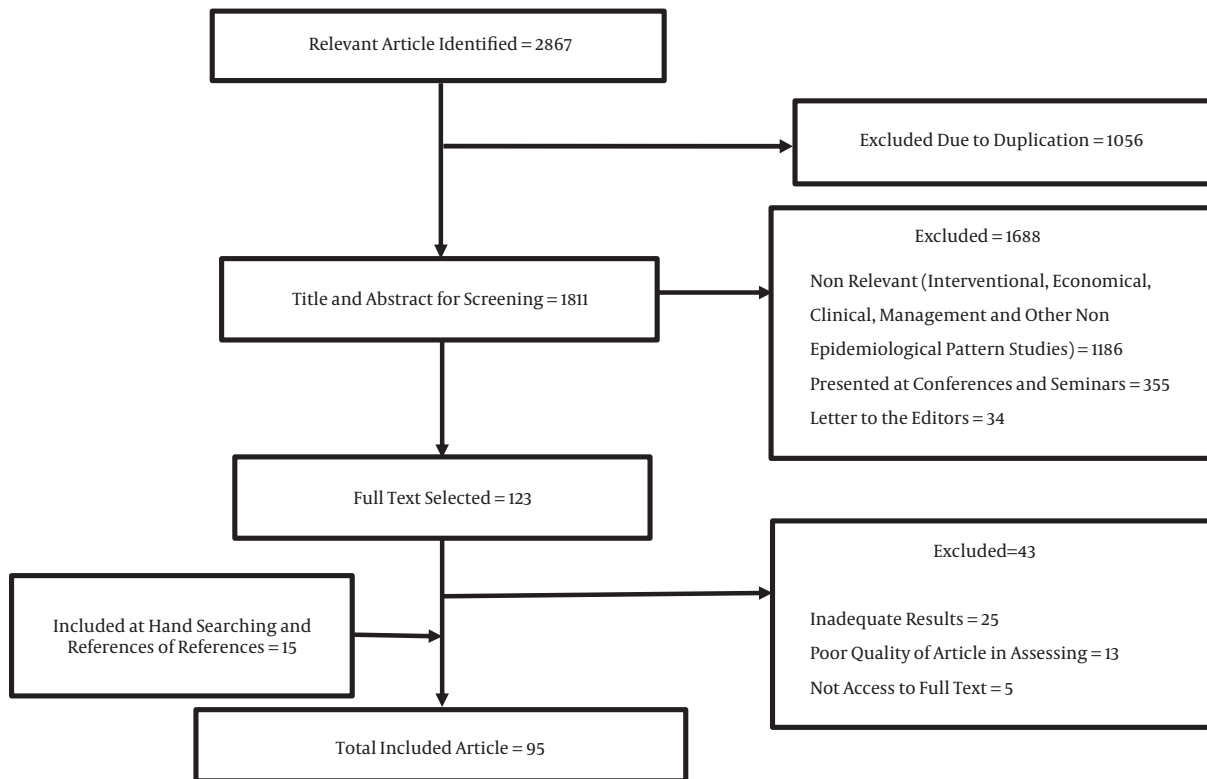


Figure 1. Bibliographical Search and Inclusion Process

3.2. Age and Gender Distribution

Studies conducted in Iran showed that most of the victims involved in accidents are aged between 30 - 39 years (48). These findings were also confirmed by a study conducted in Mashhad in 2007 (49). The mean age of traumatic victims was 23.8 years, which was determined during the referral process in hospitals of Tehran, Shiraz, Ahvaz, Tabriz, Qom, and Mashhad (50). Interestingly another study showed that most of the accidents occurred among the 25 - 34 age group (51). The Safe Community Program also found that the mean age of pedestrian victims were 28 and 30 years for interventional (Kashmar) and control counties, respectively (52). Most of the victims involved in RTCs aged between 6 - 10 years and 16 - 18 years were pedestrians and occupants, respectively (53). According to fatal road traffic accident reports, the age groups 21-30 and 51-60 years were most and least prevalent respectively (54). It has been observed that RTCs mortality cases were referred to Tehran forensic medicine and most of the victims were aged 21 - 30 and over 65 years. The mean age of victims involved in RTCs was 39 years and 48% were aged between 21 - 50 years and were economically active (55). Forensic medicine studies conducted in Kerman showed that 40%

of deaths occurred during 2004 - 2007 involving subjects aged between 15 - 30 years (56). Data from another study revealed that the road traffic mortalities were more prevalent in subjects aged 15 - 24 and very rare in 65 - 74 years (11), although the elderly hospitalization rate due to road accidents is increasing (57).

In addition to age, gender was also positively associated with the number of road traffic crashes (58). According to some studies, involvement of males in intracity accidents was four times higher in comparison to intercity accidents (51, 59). A study among the student group showed that risky driving behaviors such as using mobile phone and not using seat belt are more prevalent among males than females, thereby can increase the risk of RTCs (60). Interestingly, studies showed that seat belts are avoided by pregnant women to prevent damaging to fetus, which may increase the risk of RTCs (61).

In a study in Urmia, 96% of victims involved in RTCs were males and 56% of them were 15 - 24 years (62). According to a study conducted in Tehran individuals from 16-18 years of age group experienced more accidents compared to other age groups and the gender ratio was 9.9 (53). The age range of deceased people in motorcycle accidents

in Mazandaran province over the period of 2002-2004 was between 15 to 25 years. A total of 89 deaths occurred during that period, among those 83 were males and the rest were females and most of the female victims were passengers of motorcycles (63).

3.3. Most Commonly Involved Organ

According to various studies, head injuries are most prevalent and one of the major causes of death in adults due to RTCs (8, 11, 23, 48, 54, 56, 64-67). A study found that dominant causes of death is bleeding, head trauma and multiple fractures which were more prevalent causes among car drivers, motorcycle drivers or passengers, and pedestrians, respectively (68). The studies in Tehran, Mashhad and Khorram Abad showed that motorcycle accidents commonly result in lower limb injuries as compared to injuries to other parts of the body (53, 69, 70). However, most of the deaths caused by motorcycle accidents were due to head injuries, as a result of lack of helmet (62, 65, 71, 72). A study in Isfahan showed that lack of helmet usage was responsible for head and face injuries among most of the victims (73).

Helmet usage reduces the risk of death by 40% and the risk of severe injury up to 70%. A study conducted in Tehran found that only 33% of motorcyclists used helmets and 16% of them were not wearing but only carrying the helmets (74). Another study found that 97% of the population owned a helmet but the overall rate of helmet usage was only 13% (75). Another study in Tehran showed that only 6% of motorcyclists wore helmet at the time of accidents and the passengers had no helmet (29). Another study in Shiraz showed that the use of helmet was dependent on the socioeconomic status, education level and occupation of an individual (76). Analysis of this study was compatible with the study conducted in Yazd which found that the majority of individuals were not abiding by the traffic laws were unemployed (77). Additionally, socioeconomic inequalities were observed among those who did not use seatbelts in cars and helmets on motorcycles (78).

Most Iranian motorcyclists were illegally driving on the road with no license. A study in Kerman City showed that 72.6% of cases (injured motorcyclists) and 80% of controls (noninjured motorcyclists) had no license (79). In Kashan, a significant relationship was found between a higher incidence of traffic injuries caused by motorcycles and the lack of use of helmets, the lack of riding license and lack of motorcycle accident background (80).

3.4. Severity of Injury

According to a hospital based study, injury severity score (ISS) was significantly higher among males than female pedestrian (8.6 ± 6.9 vs. 7.4 ± 6.1), drivers (7.8 ± 6.4

vs. 4.4 ± 3.7), and passengers (8.2 ± 6.5 vs. 6.3 ± 4.2). Interestingly, The ISS was higher among rear seat female passengers (7.7 ± 7.5 vs. 6.9 ± 6.7); however, it was not statistically significant (29). Another study showed that the percentage of subjects with the middle ISS was higher than subjects with the server ISS score (52% vs. 48%) (51). A study assessing 58013 traumatic patients indicated that subjects with ISS score < 7 , $7 < ISS < 12$, and $ISS > 12$ were 92%, 6%, and 2%, respectively (33). Trauma registry data from 1999 to 2004 showed that the mean of ISS was higher in RTCs in comparison to other injuries (39). The ISS score was < 7 among 78% children (32) and was about 8 in 80% of children (24). Another study revealed that the mean ISS in occupants is higher than in pedestrians (7.6 vs. 6.6) (53). A study from the central of Iran showed that about 77%, 7%, and 16% of RTCs victims referred to hospitals had glasgow coma scale (GCS) less than 8, between 9-12, and 13-15, respectively (65).

3.5. Socioeconomic Status

Very few studies have focused on the socioeconomic status and its association with RTCs. A national study conducted in Iran and a study in the Fars Province found that the majority of deaths are a result of RTCs involving illiterate victims and the least number of university graduates (81). A study conducted on Iranian families showed that the demand for child care safety seats (CSS) is low in both high and low income countries (82). One study found that a lower economic level was associated with high incidence and mortality of RTCs (83).

Motorcyclists are often low-educated and they are ranked in the lower sects of community with regards to socio-economics status. A study in Kashan found that the incidence of motorcycle traffic injuries is quite high among young riders (under 20 years), workers and illiterates (80). These findings were confirmed by a study in Bandar Abbas stating that only 17.2% of injured motorcyclists were educated/literates (84). Most of the victims involved in motor traffic injuries were unemployed and elementary level literates (69). It is evident that personal factors such as young age, marital status (unmarried), low socioeconomic status and constant stressful life contribute to motorcycle accidents (85). Also, studies on rural areas of the countries are rare which usually address the epidemiological pattern of RTCs among individuals with low economic status (86).

3.6. Time of Injury

The majority of investigations found that mortality rates for RTCs are higher in summer among all age groups (22, 31, 53, 55, 87). On the contrary, a study conducted on 2662 registered traumatic patients in Tehran showed that

most of the RTCs occurred during winter (25). According to RTCs data, the sequence of occurrence of crashes during different seasons from highest to lowest include sunny > rainy > foggy > snowy (51). Interestingly, some studies reported that the majority of accidents occur from 8:00 to 22:00 (22, 23, 31, 56, 87). Road traffic accident mortalities were more pronounced in spring and summer seasons between 20:00 and 3:59, whereas mortalities in fall and winter were more pronounced between 12:00 and 16:00 (88). Studies conducted in Tehran and Sari show that most of the motorcycle accidents occur in spring and summer seasons (29, 71) especially around 12:00 to 18:00 and 20:00 to 24:00 hours due to traffic congestion which is maximum during those times (29, 53, 89, 90). Another study in Khorram Abad found that 41.9% of the motorcycle accidents occurred in summer (69). Several studies indicated that the highest mortalities caused by motorcycle accidents occur during summer with the highest frequency between 15:00 to 21:00 and 12:00 to 18:00 hours (23, 29, 53, 63, 91).

Additionally, a study showed that about 86.90% of RTCs occurred in clear weather with a mortality rate of 0.63%. However, mortality rate was 1.35% and 1.26% higher in stormy and foggy weather respectively in comparison to clear weather (92). In addition to this, it was reported that 82.8% of crashes occurring during winter, 60.2% during autumn and 35.8% during summer are associated with mortalities (93).

3.7. Initial Contact With Health Care Services

National data indicated that the majority of deaths occurred prior to hospitalization (54). It was found that 60% of RTC deaths occurred on the spot or during transportation to the hospital. According to a national survey in 2003, only 14% of RTC victims were transported by the ambulance and 10% rescued by trained personnel (94). Despite increasing the number of ambulances, staff and ambulance dispatch sites, the mortality rate of RTCs was not affected (95, 96). A study conducted over a three year period from 2005 to 2008 found that about 2991624 injured victims were referred to emergency departments in Iran, which was underestimated initially according to another registry data (26). A study in North - West of Iran showed that only 2% deaths occurred post emergency medical treatment (22). Interestingly, prehospital services for RTC injuries, RTC mortality and morbidity rates were not equally distributed across the provinces of Iran (97).

3.8. Individual and Environmental Risk Factors

Although there is no association between cognitive failure among drivers and RTCs, it could be used for identifying drivers susceptible to crashes during the processes

of obtaining driver's license (98). A case-control study conducted in Tabriz found that the mean of hyperactive / impulsive scores was nonsignificantly higher among injured drivers than uninjured drivers; thereby suggesting that the injured drivers are most likely to have adult attention deficit hyperactivity disorder (ADHD) (99).

According to traffic police data, the driving penalty is quite high among the Iranian drivers and approximately 4 million penalties were recorded during 2006 - 2007 (100). The most common penalty was the negligence of seatbelt usage. Mandatory seatbelt law was passed in 2001 in Iran, but it has been neglected initially as less than 3% of drivers were fastening seatbelt at the time of crash (29). Furthermore, other risky behaviors associated with crashes include trapping in the car, listening to music, model of vehicle and type of music played at the time of accident (49). According to the road traffic data, inattention was responsible for 88% of crashes with majority occurring among subjects aged 30 - 39 years (101). Other common types of crashes include skidding from the road and collision with artifactual objects (e.g., road signs) (51). The sequence of crashes beginning with the highest to the lowest frequency includes car, pickup truck, minibuss, heavy truck and light truck (51, 102, 103). A study in 2008 found that drivers with accident history are reported to suffer with chronic fatigue, snort, BMI > 30, hypertension, and apnea (104). Incidence of road traffic accidents due to fatigue and sleepiness was significantly increased by 2.6 fold when driving on highways and freeways, compared to driving on the other types of roads (105). In addition to fatigue, RTCs are significantly associated with driving duration, smoking, lack of exercise, musculoskeletal disorders and high body mass index (106, 107).

Interestingly there was no significant association of RTC history in the past five years with apnea and insomnia index (108). Road traffic crashes occurring due to collision of other vehicles were more common than involving pedestrians. Furthermore, the study revealed that duration of daily driving and smoking were positively correlated with crashes. However, the year of manufacture of the vehicle was not associated with RTCs (109). Moreover, it was found that the proportion of drivers involved in RTCs decreased over the course of time from 15.90% in the first year of obtaining a driver's license to 3.13% after 10 years of driving experience (88).

4. Conclusions

The majority of motorcycle accident victims were youth and adolescent motorcyclists in comparison to others. Studies conducted in Iran, Brazil and New Zealand reported that men were more likely to be injured than

women as a driver and most of the women injured as passengers (29, 63, 84, 110, 111). A study in the USA found that the risk of traffic injuries in young men is two to three times higher than females (112). It was reported that mortality rate among women was higher in comparison to men due to the severity of the accident and their low physical tolerance capability (113).

The risk of accidents is higher among motorcyclists from lower castes and with low income (114). The results of a study in Sweden revealed that young motorcyclists with poor financial status have higher risk of moderate or severe injury when compared to wealthy individuals (115). Individuals with low socio-economic status deal with high levels of stress which prevents them from concentrating on driving, thereby resulting in driving at high speeds and losing control of the vehicle and resulting in accidents. Mortality rate from traffic injuries among educated individuals is lower than illiterates (116). The pattern of motorcycle incidents has been rarely investigated in Iran. Few studies conducted in Iran stated that most of the motorcycle accidents occur due to motorcycle and car collision (63, 70). These findings were consistent with a study conducted in Brazil which found that 54.4% of motorcyclist injuries were due to the accidents between motorcycle and a truck or a car (117). Most motorcycle accidents occurred in the first half of the year and during peak afternoon hours (70, 71, 89). The potential for traffic injuries during weekends and in warm seasons was high due to the fact of high empowerment in procurement of handling of motorcycle where younger men are more likely to use motorcycles instead of cars for their daily activities. Hence, a widespread usage of motorcycle and increased traffic during weekends is more likely to cause more accidents.

The weak enforcement of the law for helmet usage in most low and middle income countries results in head injuries accounting for 88% of deaths. According to the WHO's statistics in 2010 in Iran, only 30% of riders and 10% of motorcycle passengers used helmets. On the contrary, almost 99% of drivers and passengers use helmets in high-income countries such as France, Australia, Canada and Japan due to comprehensive regulations and the application of standard helmets (118). A study in Tehran showed that the use of helmets by motorcyclists and motorcycle passengers is lower and it varies with climatic changes. For examples helmet usage increases in winter and autumn in comparison to other seasons (90). Most motorcyclists in Iran use nonstandard helmets as they are cheaper, light and easy to carry, easily available in the market and are attractive (119). A study in the USA reported that using nonstandard helmets can cause more damage than no helmet. Therefore, it is recommended that standard helmets with good quality at affordable prices and consistent

with the climatic conditions of Iran need to be manufactured (120). Study conducted in Italy found that most adolescents are influenced by their friends in using a helmet (121). Therefore, motivating a group of teenagers to use helmet by educational programs, in order to introduce the culture of helmet usage can be implemented since adolescence. Also, in addition to reforming and reviewing the mandatory helmet usage law, Iranian authorities should create the culture of using a helmet for both the motorcyclists and their passengers via training programs. It has been proven that compared to other drivers, the trained drivers are more cautious and show less risky behaviors when driving. Therefore, conducting periodical training classes for young motorcyclists enhances their riding skills whilst reducing the risk of accidents (122). In addition to this, the educational trainings enforce the motorcyclists to drive safely with less risky behaviors. According to a study in Italy, each individual should pass various training courses and exams to be deemed competent for a riding license (121). A study in USA showed that the risk of mortality among trained motorcyclists holding a riding license is lower in comparison to the motorcyclists without a riding license (123). Riding without a license increases the accident risk by two times in comparison to motorcyclists with a license (124). The data records from Spain collected from 1993 to 2003 show that motorcyclists and moped-riders a valid license are associated with increased risk of RTCs (125). According to the WHO, the law of mandatory use of standard helmets should be passed in each country and the police officers should be trained how to recognize the standard helmets from the nonstandard ones (118).

The results of the study showed that due to weak enforcement of mandatory helmet usage, most Iranian motorcyclists do not use standard helmets. Therefore, head injury was the major cause of death in motorcycle accidents. It is important that the helmets are manufactured according to climatic conditions of the region, as most motorcyclists reported that they did not use helmets due to their inappropriate material and their heavy nature creating it difficult to carry around. Since most motorcyclists are involved in accidents are young and have little experience in riding, the age of getting a license should be raised and they should undergo extensive trainings in order to obtain a license. Moreover, it is essential to allocate separate pathways for the motorcyclists and bicyclists on roads thereby preventing or reducing accidents during peak traffic hours.

Statistics obtained from twenty countries in the Eastern Mediterranean showed that frequency of deaths due to RTCs is considerably higher in Iran, which constitutes about 14.5% of total deaths. Interestingly, a mortality rate due to RTCs in Iran is lower than Afghanistan, Egypt, Libya

and Iraq; however, Iran has the highest rate of nonfatal RTCs in the Eastern Mediterranean region (126).

One of the limitations of this study was limited access to full text articles. However, this limitation was overcome to a certain extent by collaboration with a member from foreign university. Another important limitation was the lack of quantitative extraction of the findings due to heterogeneity of reporting formats.

Findings of the current study if analyzed with different variables such as meta-analysis of different areas of RTCs including motorcycle crashes, influencing factors of RTCs, RTCs among different age groups may provide us with better understanding of the epidemiological pattern in the near future.

It was evident from the current study that the majority of RTCs victims are males aged between 30 to 39 years. Road traffic crashes are mostly associated with head injuries and are hence one of the major causes of death in adults. In addition, a high incidence of RTCs is also linked with the lower socio-economic level and therefore a higher mortality rate. Interestingly, the incidence of RTCs during summer season is higher among all age groups. The majority of accidents occur in peak hours between 8:00 to 22:00. During spring and summer seasons, mortalities were more pronounced between 20:00 and 3:59, whereas during fall and winter they were elevated between 12:00 and 16:00. The majority of deaths due to RTCs were either on the spot or during transportation to the hospital. Road traffic crashes are associated with many risky behaviors such as limited/no usage of seat belt, distraction while driving, being trapped in the car, listening to music and type of music played and model of vehicle. Future studies combined with the current findings will be beneficial for policy makers, health service managers and stakeholders for prevention of RTCs and its complications.

Footnotes

Authors' Contribution: Homayoun Sadeghi-Bazargani, Saber Azami-Aghdash, Leila Abedi, Alireza Zemestani, Louiz Amanati and Saeid Safiri have made substantial contributions to conception and design, acquisition and reading of papers; Erfan Ayubi, Leila Abedi and Saeid Safiri: have been involved in writing the manuscript; Saeid Safiri, Saber Azami-Aghdash, Mahmood Moosazadeh and Naeema Syedi have been made substantial contributions to critically review the manuscript for important intellectual content, and have given final approval of the version to be published.

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