

ORIGINAL RESEARCH

The Burden of Head Injuries in Iran from 1990 to 2019: Findings from The Global Burden of Disease Study 2019

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Abstract: **Introduction:** Head injuries (HI) pose a significant public health concern globally, impacting morbidity, mortality, and economic burden. This study aimed to evaluate the epidemiology and trends associated with head injuries in Iran from 1990 to 2019. **Methods:** Our study, based on data from the Global Burden of Diseases (GBD) Study 2019, undertook a comprehensive comparison of the burden of HI in Iran with the Middle East and North Africa (MENA) and global benchmarks. We assessed the incidence, prevalence, and years lived with disability (YLD) through various metrics, including absolute numbers, age-standardized rates (ASR), percentage changes, and estimated annual percentage changes (EAPC) from 1990 to 2019. **Results:** The incidence of HI in Iran decreased significantly from 1990 to 2019, with a notable reduction compared to MENA and global trends (EAPC: -1.44, 0.71, and -0.11, respectively). Prevalence showed a declining trend (EAPC: -1.00), with a slight increase in YLDs (EAPC: 0.12). Notable peaks in HI incidence coincided with natural disasters, notably the 1990 Manjil-Rudbar earthquake and the 2003 Bam earthquake. **Conclusion:** Our study reveals a decline in the overall burden of HI in Iran over the study period. To sustain this positive trend and minimize the impact of HI on public health and socioeconomic well-being, policy efforts should be directed toward ongoing prevention, early detection, and preparedness for natural disasters.

Keywords: Craniocerebral trauma; Brain injuries, traumatic; Global burden of disease; Incidence; Prevalence; Disability-adjusted life years

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1. Introduction

Head Injury (HI) represents a significant public health concern worldwide, contributing to morbidity, mortality, and economic burden across populations. Approximately over half of the population experiences HI during their life, and according to estimations, annually, 50 million people suffer from HI (1). The most common cause of HI in high-income countries and among older people is falling, while in low-income countries, it is road traffic collisions (2, 3).

HI incidence is higher in developing countries (3). The Middle East, characterized by its diverse socio-economic landscape and varying healthcare infrastructure, presents a unique context for examining the burden of HI. Iran, one of the region's largest and most populous countries with a high rate of traffic accidents and high mortality due to HI, is a special case study to explore the epidemiological patterns and challenges associated with HI (4). A study con-

ducted in Tehran, the capital of Iran, revealed that out of every 100,000 individuals, 295 experience HI during their lifetime, with a male-to-female ratio of 4.25. The annual incidence rate was also reported to be 56.3 per 100,000 individuals (5). Although understanding the distribution and impact of HI is crucial for informed policy interventions and healthcare resource allocation, studies still need to address the assessment of the HI burden at the national level. In addition, juxtaposing data from Iran with regional and global estimates could help to elucidate disparities, identify risk factors, and inform evidence-based strategies for prevention, treatment, and rehabilitation.

HI has significant impacts on the individual, their family, and society. Survivors of HI may experience long-term physical, cognitive, and emotional consequences that can affect their ability to engage in daily activities and work (6). HI results in medical costs associated with hospitalization, rehabilitation, therapeutic interventions, and medications, which can vary depending on the severity of the illness and the duration of treatment (7, 8). Additionally, HI can impose a considerable economic burden due to the individual's unemployment and the societal costs of their medical care (7).

The Institute of Health Metrics and Evaluation (IHME) pro-

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vides a comprehensive framework for analyzing the burden of diseases and injuries, offering insights into prevalence, incidence, disability-adjusted life years (DALYs), and mortality rates in the Global Burden of Disease (GBD) study. Leveraging this dataset, we endeavor to compare the burden of HI in Iran with the regional and global benchmarks (9). In this study, we conducted a comparative analysis of the burden of HI in Iran, the Middle East and North Africa (MENA), and the world, utilizing data from the GBD.

2. Methods

All the data were derived from Global Burden of Diseases (GBD) 2019 (10), executed by the IHME. GBD 2019 includes data on the most important causes of morbidity and mortality burden from 1990 to 2019 at global, regional, and national levels by age and sex.

GBD classifies injuries into two dimensions: the cause of injury and the nature of injury ('n-code') that determines the bodily consequences of the injury (11). We accessed the GBD website (<https://vizhub.healthdata.org/gbd-results/>) and selected "injuries by nature" in the "GBD Estimate" section, and then chose "head injury" in the "Injury" section. Within the GBD's categorization regarding injuries by nature, head injury (Injury ID: 301) has two subdivisions: minor head injury (Injury ID: 269) and moderate/severe head injury (Injury ID: 270) (11). In the "Cause" section, we selected all causes. Table 1 displays a four-level hierarchy outlining the causes of injuries (11).

All-age data for all age groups and both sexes were retrieved from 1990 to 2019. The years lived with disability (YLD), incidence, and prevalence were extracted based on the age-standardized rate per 100,000 individuals.

We compared the burden of HI in Iran with the world and MENA region, which consists of 21 countries, including Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia, Turkey, the United Arab Emirates, and Yemen, according to GBD's location grouping.

This study was approved by the ethics committee of Sina Hospital, Tehran University of Medical Sciences (Approval ID: IR.TUMS.SINAHOSPITAL.REC.1402.068).

2.1. Statistical analysis

Incidence, prevalence, and YLD values were presented as point estimate and 95% uncertainty intervals (UI). The estimated annual percentage changes (EAPC) was assessed to evaluate the changing trends in incidence, prevalence, and YLDs of HI. For this purpose, the natural logarithm of the age-standardized rate (ASR) linearly regressed with the calendar time. Additionally, the percentage change in ASRs from 1990 to 2019 was estimated. The statistical analysis was conducted using STATA 14.

3. Results

3.1. Trends in the incidence

The incidence number of HI in Iran was 224,769 (95% UI: 194,553 to 259,552) in 2019 (Table 2). The ASR of incidence in Iran was 267 per 100,000 person-years (95% UI: 232 to 309), which was lower than the global (346; 95% UI, 298 to 401) and MENA (319; 95% UI: 271 to 382) rates in 2019. Decreasing trends in the ASR of HI incidence were observed in Iran and around the globe (EAPC = -1.44%, confidence interval (CI): -2.31 to -0.56, EAPC = -0.11, 95% CI: -0.18 to -0.03, respectively). But, EAPC of HI incidence increased in MENA region (0.71, 95% CI: 0.30 to 1.12).

The decrease in incidence of HI was more noticeable among Iranian men (-23.3%) than women (-17.3%). Between 1990 and 2019, the largest growth in incidence percentage of HI was caused by violence (34.2%), followed by falls (7.2%) and transport injuries (1.8%). The incidence of violence increased the most among men, whereas the incidence of falls increased the most among women (41.3% and 13.1%, respectively). During this period, the greatest increase in moderate/severe HI was due to violence (90.0%), and the greatest increase in mild HI occurred following natural disasters (18.3%).

3.2. Trends in the prevalence

The prevalence of HI in Iran reached 478.93×10^3 (95% UI: 445.67×10^3 to 520.70×10^3) in 2019, and increased 2.38% from 1990.

However, Iran's ASR of prevalence was 549.82/100,000 in 2019, and showed a downward trend from 1990 to 2019 (EAPC = -1.00, 95%CI: -1.08 to -0.92; Table 2). The ASR of HI prevalence in the global and MENA regions increased from 1990 to 2019 (EAPC = 0.01, 95% CI: -0.05 to 0.06, and EAPC = 0.13, 95% CI: 0.04 to 0.22, respectively).

In 2019, Iranian men had almost twice the ASR of HI prevalence compared to Iranian women (721.51/100,000 and 376.00/100,000, respectively), but the ratio of changes between 1990 and 2019 was similar for both sexes (EAPC = -0.95, 95% CI: -1.02 to -0.88, EAPC = -1.01, 95% CI: -1.11 to -0.90, respectively). Among the age groups, the greatest increase occurred in those above 80 years (328%) and the greatest decrease in those below five years (-83%).

3.3. Trends in the YLD

In 2019, the number of YLD caused by HI was 70.19×10^3 (95% UI: 52.34×10^3 to 93.18×10^3) in Iran, with a decrease of 28.14% since 1990. However, the ASR of HI YLD in Iran increased from 1990 to 2019, with an EAPC of 0.12 (95% CI: 0.04 to 0.21; Table 3). Similar to Iran, the ASR of YLD in the world increased from 1990 to 2019, but MENA had a downward trend (EAPC = 0.02, 95% CI: -0.04 to 0.08, and EAPC = -0.98, 95% CI: -1.08 to -0.89, respectively).

Figure 1 shows The ASR of YLD, prevalence, and incidence of HI in the global and MENA regions, and Iran from 1990

to 2019. Between 1990 and 2019, YLD and the prevalence of HI remained relatively stable globally and in MENA region. However, the incidence of HI in MENA fluctuated during this period. In Iran, both YLD and the prevalence of HI were affected by two peaks related to 1990 and 2003.

According to an investigation into the causes of injuries in Iran, the most common causes of HI were transport injuries, falls, violence, and natural disasters. The prevalence and YLD of HI caused by transport injuries and falls have increased from 1990 to 2019, while the trend of violence has remained relatively flat. Additionally, our analysis shows that two significant peaks in 1990 and 2003 were related to natural disasters. Figure 2 visually represents the YLD, prevalence, and incidence of HI per 100,000 Iranian people according to the most common causes.

4. Discussion

To understand the burden of HI, we analyzed its incidence, prevalence, and YLD. The age-standardized incidence of HI in all three regions in 2019 had decreased compared to 1990. Notably, Iran experienced a much more significant reduction than the Middle East and North Africa (MENA) and the global regions (-67.85% vs. -14.52% and -5.53%, respectively). This decline may be attributed to the high incidence of injuries recorded in the initial year of the period. Consequently, we estimated the EAPC using a linear regression model to measure the ASR trend over time (Table 1).

Figure 1 illustrates a sudden decrease in TBI incidence around 1990, with a subsequent increase and decrease in 2003. According to figure 2, this pattern may be attributed to natural disasters. The Manjil-Rudbar earthquake occurred on June 21, 1990, near Rudbar in Gilan Province and the northwest region of Zanjan Province in Iran. This devastating earthquake resulted in approximately 35,000 deaths and 60,000 injuries and left around 500,000 people homeless (12). Due to a lack of awareness and necessary preparations, this earthquake caused significant damage (13). HI is an unavoidable consequence of any earthquake, and this earthquake is no exception to this rule. While precise information about HI resulting from this earthquake is not available, the sudden noticeable decrease in figure 1 and natural disasters chart in figure 2 can be attributed to this earthquake.

In 2003, there was a sudden peak followed by a decrease, as shown in figure 2, which was also caused by a natural disaster. The city of Bam in southeastern Iran experienced a devastating earthquake on December 26, 2003, resulting in the tragic loss of over 40,000 lives and injuries to 30,000 individuals (14). Although there is limited information regarding the impact of Bam earthquake on brain injuries, these injuries can be attributed to the destruction of buildings, people being trapped under debris, and HI from falling objects. In a study conducted in 2009 on 274 patients with extremity injuries in Bam earthquake, 58 individuals had head and neck injuries (21%) (15). Another study in 2006, focusing on the consequences of Bam earthquake in Iran on pediatric trauma

in level 3 hospitals, reported that out of 33 patients, eight patients (24.2%) suffered head and spinal injuries (16). Based on these studies, figure 1, and the natural disasters chart in figure 2, the sudden increase in incidence, prevalence and YLD in 2003 can be attributed to Bam earthquake.

During this period, from around 1991 to 2003 and then from 2004 to 2019, we observe a declining trend with a gentle slope, which can be attributed to a relative decrease in transport injuries. These events can be attributed to better enforcement and implementation of traffic laws. Traffic laws can have a significant impact on reducing accidents and associated injuries. For example, a study conducted from 1999 to 2015, based on data from the Web-based Injury Statistics Query and Reporting System, stated that reducing the legal limit of blood alcohol content, using red light cameras, and seatbelt laws had a significant effect on reducing fatalities resulting from accidents (17). In other studies, it has been suggested that enforcing traffic laws, is the most effective method of reducing road fatalities (18). In Iran, the parliament approved the mandatory seatbelt law in 1997 and promulgated it via the government in 2000. However, widespread enforcement by the police on highways started in 2005 and in urban streets from 2011, with increased emphasis on rear-seat passengers (19). Studies conducted on this trend have shown that establishing various traffic laws, such as using seat belts and helmets, reducing speed, and pupil liaisons, have effectively reduced transport injuries from 1990 to 2019 (20-22).

According to table 2, the prevalence changes in Iran are approximately 2.38, and the EAPC is around -1. Additionally, figure 1 indicates a declining trend in prevalence. A study conducted in 2023 estimated the prevalence of HI in Iran to be approximately 26.2. This underscores the importance of preventive measures (23).

In this study, we observed an increasing trend in the number of YLDs due to traumatic brain injury in Iran from 1990 to 2019. According to the statistics, the increase in YLD worldwide and in the MENA region is larger than in Iran. Moreover, the upward trend in MENA is even more pronounced than the global trend. Additionally, the YLD rate in Iran has decreased from 1990 to 2019. The decreasing trend in this rate in MENA is less significant, and globally, there has been a slight upward trend. The ASR has decreased despite an increase in the total YLDs in 2019 compared to 1990. Based on the results, the burden of HI in Iran has generally reduced.

It is necessary to take steps toward prevention, early detection, treatment, and providing appropriate support for the individual and their family. Furthermore, considering the findings of this study, it can be inferred that natural disasters have a notable impact on the occurrence of HI and its consequences. Therefore, special attention should be paid to preparedness for facing natural disasters. Achieving these goals requires the efforts and attention of policymakers to design practical and executable plans to reduce the burden and pressure resulting from HI in the country.

5. Limitations

There were some limitations in this study. First, in the case of selecting the type of injury on the GBD website (head trauma), DALY and mortality metrics could not be chosen. However, using YLD, alongside prevalence and incidence data, valuable information was obtained and incorporated into the article. Second, the lack of regularly updated articles led to an inability to explain the trends in HI more accurately over the years. Third, HIs may have yet to be recorded appropriately.

6. Conclusion

According to the findings of this study, the overall trend of the burden of HI from 1990 to 2019 has been declining. Considering the damages resulting from HI, it is imperative to continue this declining trend.

7. Declarations

7.1. Acknowledgments

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7.2. Authors' Contribution

TM was involved in the planning and data processing and wrote the manuscript. NS was involved in implementing the research and writing the original draft. VB conducted the statistical analysis and supervised the research methodology. MS was involved in the work's planning, design, implementation, and supervision. All of the authors discussed the results and commented on the manuscript.

7.3. Conflict of interests

The authors declare that there is no conflict of interest.

7.4. Ethical Approval

This study was approved by the ethics committee of Sina Hospital, Tehran University of Medical Sciences (Approval ID: IR.TUMS.SINAHOSPITAL.REC.1402.068).

7.5. Funding

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7.6. Using artificial intelligence chatbots

The authors declare no use of artificial intelligence chatbots.

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Table 1: Cause of injury list

Hierarchy	Cause Name	Cause ID
C	Injuries	687
C.1	Transport injuries	688
C.1.1	Road injuries	689
C.1.1.1	Pedestrian road injuries	690
C.1.1.2	Cyclist road injuries	691
C.1.1.3	Motorcyclist road injuries	692
C.1.1.4	Motor vehicle road injuries	693
C.1.1.5	Other road injuries	694
C.1.2	Other transport injuries	695
C.2	Unintentional injuries	696
C.2.1	Falls	697
C.2.2	Drowning	698
C.2.3	Fire, heat, and hot substances	699
C.2.4	Poisonings	700
C.2.4.1	Poisoning by carbon monoxide	701
C.2.4.2	Poisoning by other means	703
C.2.5	Exposure to mechanical forces	704
C.2.5.1	Unintentional firearm injuries	705
C.2.5.2	Other exposure to mechanical forces	707
C.2.6	Adverse effects of medical treatment	708
C.2.7	Animal contact	709
C.2.7.1	Venomous animal contact	710
C.2.7.2	Non-venomous animal contact	711
C.2.8	Foreign body	712
C.2.8.1	Pulmonary aspiration and foreign body in airway	713
C.2.8.2	Foreign body in eyes	714
C.2.8.3	Foreign body in other body part	715
C.2.9	Environmental heat and cold exposure	842
C.2.10	Exposure to forces of nature	729
C.2.11	Other unintentional injuries	716
C.3	Self-harm and interpersonal violence	717
C.3.1	Self-harm	718
C.3.1.1	Self-harm by firearm	721
C.3.1.2	Self-harm by other specified means	723
C.3.2	Interpersonal violence	724
C.3.2.1	Physical violence by firearm	725
C.3.2.2	Physical violence by sharp object	726
C.3.2.3	Sexual violence	941
C.3.2.4	Physical violence by other means	727
C.3.3	Conflict and terrorism	945

Table 2: Incidence and prevalence of head injuries in the global and MENA regions, and Iran, 1990-2019

Incidence				
Characteristics	2019		1990-2019	
	Number×10³ (95% UI)	ASR/100,000 (95% UI)	Change (%)	EAPC (95%CI)
Global				
Male	16,865.47 (14,579.19-19,425.33)	431.04 (373.36 to 496.37)	-5.34	-0.06 (-0.14 to 0.02)
Female	10,295.23 (8,797.84 to 11,992.15)	257.50 (219.21 to 301.35)	-5.01	-0.14 (-0.22 to -0.05)
Both	27,160.71 (23,357.25 to 31,415.05)	345.86 (297.81 to 401.02)	-5.53	-0.11 (-0.18 to -0.03)
MENA				
Male	1,272.48 (1,097.81 to 1,491.01)	399.22 (344.79 to 468.85)	-15.54	0.60 (0.19 to 1.00)
Female	639.01 (527.77 to 814.84)	230.22 (191.83 to 289.85)	-13.94	0.85 (0.42 to 1.28)
Both	1,911.49 (1,624.87 to 2,305.16)	318.57 (271.89 to 382.42)	-14.52	0.71 (0.30 to 1.12)
Iran				
Male	151.46 (131.23 to 175.47)	346.70 (301.83 to 399.65)	-65.86	-1.47 (-2.26 to -0.68)
Female	73.31 (62.57 to 85.61)	185.68 (159.30 to 218.03)	-71.04	-1.36 (-2.38 to -0.34)
Both	224.77 (194.55 to 259.55)	267.47 (232.34 to 308.75)	-67.85	-1.44 (-2.31 to -0.56)
Prevalence				
Global				
Male	30,040.25 (28,654.77 to 31,594.69)	749.82 (715.64 to 787.62)	0.99	0.08 (0.02 to 0.14)
Female	18,947.68 (18,130.23 to 19,795.09)	449.11 (429.79 to 469.55)	-0.74	-0.07 (-0.14 to 0.00)
Both	48,987.93 (46,840.15 to 51,316.80)	599.26 (573.04 to 627.34)	-0.01	0.01 (-0.05 to 0.06)
MENA				
Male	2,087.56 (1,912.14 to 2,347.15)	706.14 (648.03 to 354.06)	-25.71	0.08 (0.00 to 0.17)
Female	1,009.32 (926.25 to 1,142.09)	384.68 (354.06 to 433.08)	-28.95	0.17 (0.07 to 0.26)
Both	3,096.88 (2,843.66 to 3,481.27)	552.22 (507.44 to 619.24)	-27.37	0.13 (0.04 to 0.22)
Iran				
Male	319.84 (297.16 to 346.20)	721.51 (673.44 to 778.70)	1.51	-0.95 (-1.02 to -0.88)
Female	159.09 (147.33 to 174.15)	376.00 (349.90 to 408.66)	2.49	-1.01 (-1.11 to -0.90)
Both	478.93 (445.67 to 520.70)	549.82 (513.37 to 594.82)	2.38	-1.00 (-1.08 to -0.92)

MENA: Middle East and North Africa, UI: uncertainty interval; ASR: age-standardized rate, EAPC: estimated annual percentage change; CI: confidence interval.

Table 3: Years lived with disability of head injuries in the global and MENA regions, and Iran, 1990-2019

Characteristics	2019		1990-2019	
	Number×10³ (95% UI)	ASR/100,000 (95% UI)	Change (%)	EAPC (95%CI)
Global				
Male	4,383.61 (3,102.99 to 5,946.00)	109.13 (77.17 to 148.05)	1.28	0.10 (0.03 to 0.16)
Female	2,693.29 (1,905.26 to 3,641.47)	63.96 (45.25 to 86.36)	-0.78	-0.07 (-0.13 to 0.00)
Both	7,076.90 (4,997.95 to 9,588.10)	86.52 (61.14 to 117.19)	0.14	0.02 (-0.04 to 0.08)
MENA				
Male	307.66 (225.09 to 410.62)	103.12 (75.59 to 137.47)	1.04	-0.93 (-1.01 to -0.85)
Female	145.37 (105.81 to 194.23)	54.97 (39.94 to 73.33)	1.79	-0.99 (-1.11 to -0.87)
Both	453.03 (331.63 to 604.02)	80.08 (58.58 to 106.87)	1.86	-0.98 (-1.08 to -0.89)
Iran				
Male	47.19 (35.17 to 63.01)	105.73 (78.75 to 140.67)	-26.36	0.08 (0.00 to 0.16)
Female	23.00 (17.02 to 30.36)	54.08 (39.81 to 71.26)	-30.01	0.15 (0.07 to 0.24)
Both	70.19 (52.34 to 93.18)	80.08 (59.55 to 106.40)	-28.14	0.12 (0.04 to 0.21)

MENA: Middle East and North Africa, UI: uncertainty interval; ASR: age-standardized rate, EAPC: estimated annual percentage change; CI: confidence interval.

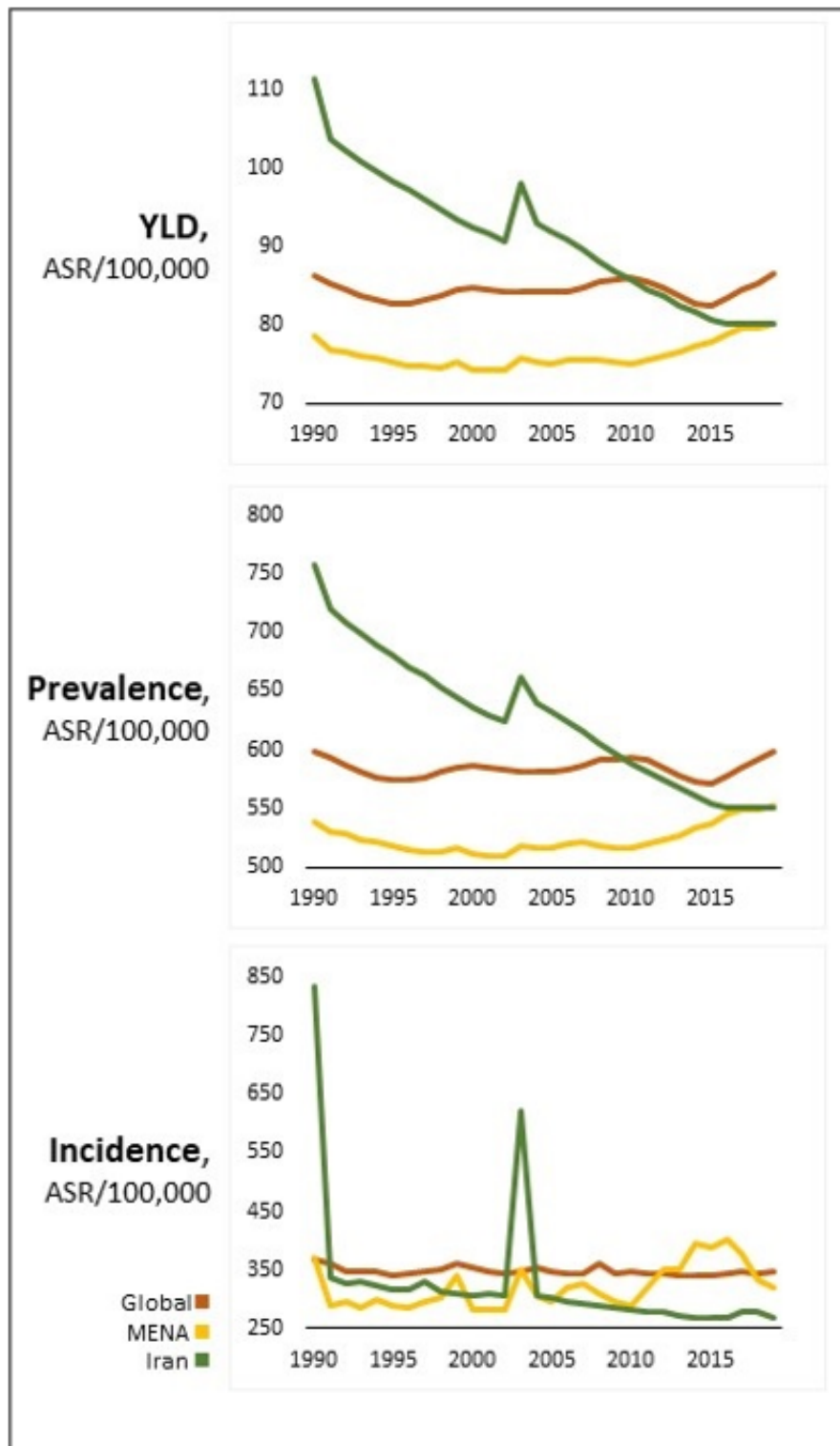


Figure 1: Years lived with disability (YLD), prevalence and incidence of head injuries (HIs) in the global and MENA regions, and Iran, 1990-201*. ASR: age-standardized rate, MENA: Middle East and North Africa.

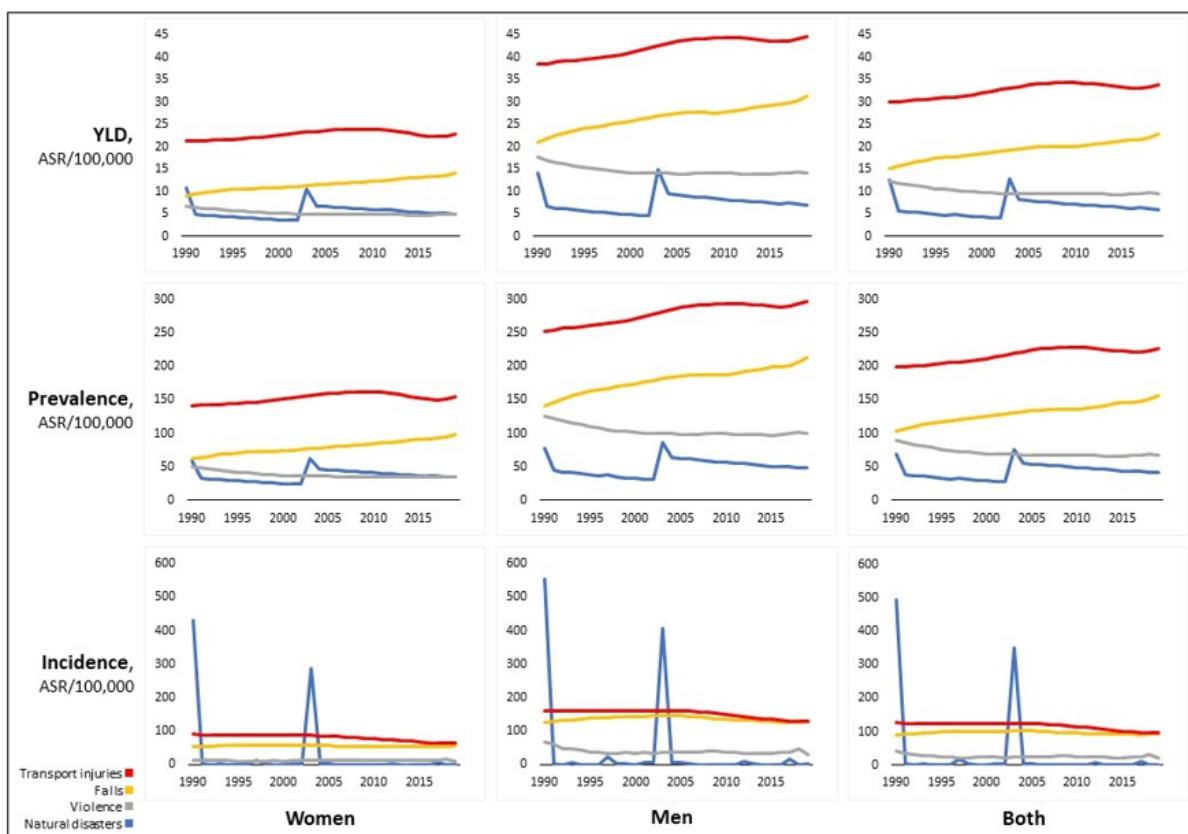


Figure 2: Years lived with disability (YLD), prevalence and incidence of head injuries (HIs) in Iran, according to cause of injury, 1990-2019. ASR: age-standardized rate.