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Abstract

Background: Road traffic accidents are a major public health problem globally, causing millions of injuries, deaths and disabilities, and a huge loss of financial resources, especially in low- and middle-income countries.

Aim: To determine the incidence of road traffic injuries and associated mortality from 1997 to 2020 in the Islamic Republic of Iran.

Methods: This retrospective study used data from the Legal Medicine Organization of the Islamic Republic of Iran to estimate the annual rates of road traffic injuries and associated mortality from 21 March 1997 to 20 March 2020. The data were analysed using STATA version 14 and the annual rates are reported per 100 000 population.

Results: During the study period, 5 760 835 road traffic injuries and 472 193 deaths were recorded in the Islamic Republic of Iran. The mortality rate increased from 22.4 per 100 000 in 1997 to 40 per 100 000 in 2005 and decreased to 18.4 per 100 000 in 2020. The injury rate increased from 111.1 per 100 000 in 1997 to 394.9 per 100 000 in 2005. It decreased in 2006 and 2007 and increased from then until 2010, finally reaching 331.8 per 100 000 in 2020. The male to female ratio for road traffic mortality was 3.9 in 1997 and 4.6 in 2020. The case fatality rate was highest (20.1%) in 1997 and decreased to 5.6% in 2020.

Conclusion: Continuous interventions are needed to reduce the burden of road traffic injuries and associated mortality in the Islamic Republic of Iran.

Keywords: road traffic accidents, road traffic injuries, road traffic deaths, Islamic Republic of Iran

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Introduction

Road traffic accidents are a public health issue in most countries (1). Annually, road traffic injuries and deaths have significant economic effects on individuals and their families, as well as countries. Road traffic injuries are one of the leading causes of death among young people aged 5–29 years. There is considerable regional variation in road traffic injuries and deaths worldwide (2). Around 93% of the global fatalities on the roads occur in low- and middle-income countries (3). In 2016, road traffic mortality in South Asia was 20 per 100 000 persons, and Afghanistan had the highest rate of 26.6 per 100 000 (4). Considerable reductions in road traffic mortality were seen in middle- and high-income countries during 1997–2017 (5). WHO has concluded that if low- and middle-income countries follow the general trend in road traffic mortality in high-income countries, initially, they will have a high number of deaths, but eventually, the mortality rate will decrease (4).

In the Islamic Republic of Iran, road traffic injuries are the second highest cause of death after cardiovascular disease, and the leading cause of years of life lost (6). Road traffic mortality rate increased from 22.1 per 100 000 persons in 1997 to 32.0 per 100 000 in 2007 (7). The Legal Medicine Organization of the Islamic Republic of Iran reported that 49.7% of injury-related deaths (n = 15 932) in 2016 were caused by road traffic accidents (8). WHO reported that the overall road traffic mortality rate in the Islamic Republic of Iran was 20.5 per 100 000 in 2018 (10 per 100 000 car users and 4.9 per 100 000 motorcyclists) (4). There are 30.4 million cars in the Islamic Republic of Iran, and in comparison with other South-West Asian countries, the situation is not favourable in terms of road traffic mortality (4). In the Eastern Mediterranean Region, the Islamic Republic of Iran has the highest rates of road traffic injuries and mortality (9,10).

The safety profile of road traffic accidents is measured by the number of people injured and the mortality rate (2). To design effective interventions and strategies to reduce road traffic injuries and mortality, it is necessary to understand the underlying trends. Several studies with different methods have analysed road traffic injuries and mortality in the Islamic Republic of Iran (11–13). Mehmandar et al (14) analysed road traffic mortality rates in each province during 2004–2013 and predicted rates for 2014 and 2015. Besharati et al (15) analysed road traffic mortality rates recorded in each province during 2005–2015 and quantified the relation between an extensive series of covariates and road safety. A systematic review in 2021 of 20 studies, with 2 682 434 road traffic injuries and 23 272 deaths indicated that there was no comprehensive and reliable representation of road traffic mortality in the Islamic Republic of Iran (16).

In this study, we used comprehensive data to determine the trends in road traffic injuries and mortality in the Islamic Republic of Iran from 1997 to 2020.

Methods

Data sources

This was a retrospective study of data obtained from Iranian official reports on population and road traffic injuries and mortality from 21 March 1997 to 20 March 2020. As required by law, all persons who die from road traffic injuries are referred to the Legal Medicine Organization, which issues permission for burial. Population data from the Statistical Center of Iran were used to estimate the road traffic injury and mortality rates for each year.

Statistical analysis

To estimate the road traffic injury and mortality rates for each year, the number of deaths in each year for men and women was divided by the total population in the middle year. These annual rates were reported per 100 000 population. Population data from the Statistical Center of Iran were used as the denominator to estimate the road traffic injury and mortality rates for each year. Linear regression was used to model the relationship between 2 variables by fitting a Poisson equation to the observed data, with 1 variable considered to be explanatory and the other dependent. Poisson regression fitted the model with the best fit between the predictors and the outcome. As a result, it may have appeared that the behaviour of the variables was not linear. We fitted a Poisson regression model to predict the mortality rate by year using maximum likelihood estimation. Statistical analysis was performed using STATA version 14.

Ethical considerations

This study was approved by the Ethics Committee of Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, with the code number 98-01-38-355.

Results

Road traffic mortality

A total of 472 193 road traffic deaths were recorded in the Islamic Republic of Iran from 1997 to 2020. In rare circumstances, the sex of the victims was not registered. Therefore, the total number of men and women is less than the total number of victims. The road traffic mortality rate ranged from 22.4 per 100 000 population in 1997 to 18.4 per 100 000 in 2020 for both sexes. This rate surged from 22.4 per 100 000 in 1997 to a peak of 40.0 per 100 000 in 2005, and decreased to 18.4 per 100 000 in 2020 (Table 1 , Figure 1). Men had a higher road traffic

mortality rate than women in all years. The male rate peaked at 61.7 per 100 000 in 2006 and decreased to 30.1 per 100 000 in 2020. The female rate peaked at 15.8 per 100 000 in 2006 and decreased to 6.5 per 100 000 in 2020. The overall pattern showed a decline in both sexes from 2006 to 2020. The male: female ratio for the road traffic mortality rate was 3.9 in 1997 and 4.6 in 2020. The case mortality rate was highest (20.1%) in 1997 but decreased to 5.6% in 2020 (Table 2). The rate showed a declining trend during the study period except for a small increase in 2017 and 2019 (Table 2 , Figure 2). Poisson regression analysis by sex showed that, with an increase of 1 year, the mortality rate among men decreased significantly, whereas the mortality rate among women did not decrease significantly (Table 3).

Road traffic injuries

The total number of road traffic injuries was 5 760 835 from 1997 to 2020 (Table 2). The road traffic injuries rate increased from 111.1 per 100 000 population in 1997 to 394.9 per 100 000 by 2005. In 2006, the rate decreased to 392.6 per 100 000 and then to 343.6 per 100 000 in 2007. The rate then increased annually until 421.4 per 100 000 in 2010. There were fluctuations in the rate between 2010 and 2020, when the rate was 331.8 per 100 000. The highest increase occurred in 2002 (40.1%), and the greatest reduction was in 2007 (–12.5%).

Discussion

This study investigated the trends in road traffic injuries and mortality in the Islamic Republic of Iran. From 1997 to 2020, 5 945 197 road traffic injuries and 456 797 deaths were recorded. The mortality rate increased from 1997 to 2005, and then decreased in 2020, with small fluctuations. With an increase in 1 year, the mortality rates overall and among men decreased significantly but the changes among women were not significant. Road traffic injuries increased from 1997 to 2005 and decreased in 2006, and with several fluctuations, they decreased in 2020. The male: female ratio for the road traffic mortality rate increased from 3.9 in 1997 to 4.6 in 2020. The ratio of mortality to injury was highest (20.1%) in 1997 but decreased to 5.6% in 2020. The relationship between changes in mortality rate and sex was significant. During 1997 to 2020 for each year increase, the mortality rate decreased by an average of 0.84 year for men.

A similar increasing trend in road traffic mortality rate from 1997 to 2005 was previously reported by Rasouli et al in the Islamic Republic of Iran (17). Besharati et al (15) reported a decreasing trend in road traffic mortality in several Iranian provinces, and Mehmandar et al (14) showed a decreasing trend in road traffic mortality rate from 2004 to 2013. Several factors have

been responsible for the reduction in mortality rate; for example, the number of hospitals has been increasing since 2004 (18). Four national interventions were implemented in 2005: seat belt enforcement, helmets for motorcyclists, public traffic laws, and road safety training campaigns on social media (19). The increasing emergency admissions and number of prehospital emergency stations, as well as faster access to medical centres and hospitals have also contributed. In 2019 and 2020, the COVID-19 pandemic and the imposition of lockdown in the Islamic Republic of Iran reduced vehicle traffic, which may have significantly contributed to the reduced incidence of road traffic accidents.

Despite the declining trend in road traffic mortality in the Islamic Republic of Iran during the study period, the mortality rate was higher than in several other countries. In 2005, the road traffic mortality rate was 40 per 100 000 population, which was higher than in Türkiye (6.4 per 100 000), Iraq (21.4 per 100 000), Syrian Arab Republic (11.8 per 100 000), Saudi Arabia (26.49 per 100 000), and Egypt (13.5 per 100 000). A similar pattern for average road traffic mortality rate was observed in Eastern Mediterranean Region countries (22.2 per 100 000 in 1995, 25 per 100 000 in 2005, and 22.1 per 100 000 in 2015) (20). In Europe, road traffic mortality rate decreased from 2007 to 2018 (21), although the rate had increased steadily until 2005. The global average road traffic mortality rate decreased in 1995, 2005, and 2015, with rates of 21.5, 21.0, and 18.4 per 100 000 population, respectively (4). In 2020 in the Islamic Republic of Iran, although road traffic mortality decreased, related injuries increased. Social restrictions to prevent the transmission of COVID-19 probably helped reduce the number of road traffic accidents as well as fatal and nonfatal injuries. The incidence of road traffic accidents in Semarang, Indonesia increased by an average 15% annually between 2017 and 2019 but decreased by 18.4% in 2020 (20). The National Highway Traffic Safety Administration in the United States of America reported an increase in mortality during the pandemic, with 38 680 road traffic deaths. The mortality rate in 2020 was 1.37 per 100 million vehicle miles travelled, which was an increase over 1.11 in 2019. Potential causes included drink-driving, speeding, and failure to wear a seatbelt (22). A study in Missouri, USA showed no decrease in serious road traffic accidents or deaths during the COVID-19 pandemic (23). In Türkiye, Oguzoglu reported a significant reduction in the number of people injured (19%) and deaths (72%) due to traffic accidents during the pandemic (24).

Our results showed an increase in male to female ratio for road traffic mortality rate from 3.9 per 100 000 in 1997 to 4.6 per 100 000 in 2020. A national study in the Islamic Republic of Iran reported a ratio of 4.2 during 1997–2007 (7). In Kashan City, the ratio was 4.7 during 2006–2013 (25). Similar to our study, several others have indicated that road traffic injuries and mortality were higher among males than females in different countries (1). Pakistan reported the highest ratio at 12.0 and Kuwait at 4.5, but the ratio across the Eastern Mediterranean Region and globally was 3.84 and 3.1, respectively (10). One explanation for the sex difference in mortality rates may be that men drive more and have more risky driving behaviour. Another possibility is that women are less likely than men to drive as part of their occupation, and men use motorcycles, which are prohibited for women. Cycling and motorized 2- and 3-wheelers are

less commonly used by women, and driving these is more dangerous than driving a car. The Islamic Republic of Iran, Morocco, and Tunisia had the highest proportion of riders of motorized 2- and 3-wheelers in the Eastern Mediterranean Region (26). The reduction in the male to female ratio in recent years could be attributed to the increase in the number of women driving in the Islamic Republic of Iran.

Our study showed an increase in road traffic injuries in most years from 1997 to 2020. The excess annual percentage change peaked in 2002 (40.12%), and the greatest percentage reduction was in 2007 (–12.48%). Better registration of road traffic injuries in the Islamic Republic of Iran may have been responsible for the increase. It has previously been reported that most injuries were not being registered (27). Our results showed that for each year during the study, the mortality rate per 100 000 population decreased overall by 0.59 and among men by 0.96, but the reduction among women was not significant.

In recent years, several interventions have been implemented in the Islamic Republic of Iran to reduce road traffic injuries, such as improved emergency medical services and transport infrastructure, increased police funding, and use of speed cameras (28, 29). However, these interventions have not sufficiently reduced road traffic injuries. The Islamic Republic of Iran is a middle-income country in the Eastern Mediterranean Region and, similar to other countries in this situation, it has insufficient resources to adequately cater for patients with road traffic injuries (9). A comprehensive, integrated trauma care system has not been developed, and there is variation in the number of reported road traffic injuries based on police reports, health centre registration data, and forensic medicine (30–32).

This study had some limitations. There was insufficient access to information on changes in the number of vehicles; distances travelled; medical services; the percentage of each type of vehicle and road users, such as bicycles, motorcycles, cars, and pedestrians; and changes in accident prevention behaviour, to determine the detailed reasons for these changes. We did not adjust for vehicle registration, ownership, vehicle type, or road user. As a result of data limitations, we did not perform longitudinal (time series) evaluation and geospatial analyses on the effect of each intervention on the incidence of mortality due to road traffic accidents Also, we did not analyse data based on age or place of residence.

Despite these limitations, this study provided novel information on the trends in road traffic injuries and mortality from 1997 to 2020 in the Islamic Republic of Iran, which can be used to inform national and international policies on road traffic accident prevention. The findings provide useful information for longitudinal and interventional studies to better investigate the increases or decreases in road traffic injuries and mortality.

Conclusion

Although there was a declining trend in the rate of road traffic mortality from 1997 to 2020 in the Islamic Republic of Iran, the rate of road traffic injuries has increased by 300%. Preventive measures have been only partially effective. These findings suggest the need for policy-related interventions to further prevent and reduce road traffic accidents and related injuries and mortality, such as better legislation, improved road safety enforcement, and safety training for drivers with attention to the behaviour and culture of the Iranian population.

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Competing interests: None declared.

Traumatismes dus aux accidents de la circulation et mortalité associée en République islamique d'Iran

Résumé

Contexte : Les accidents de la circulation constituent un problème de santé publique majeur dans le monde, qui entraîne des millions de traumatismes, de décès et d'incapacités, ainsi qu'une perte importante de ressources financières, en particulier dans les pays à revenu faible et intermédiaire.

Objectif : Déterminer l'incidence des traumatismes dus aux accidents de la circulation et la mortalité associée entre 1997 et 2020 en République islamique d'Iran.

Méthodes : La présente étude rétrospective a analysé les données de l'Organisation de médecine légale de la République islamique d'Iran pour estimer les taux annuels de traumatismes dus aux accidents de la circulation et la mortalité qui leur était associée entre le 21 mars 1997 et le 20 mars 2020. Les données ont été analysées à l'aide du logiciel STATA version 14 et les taux annuels sont rapportés pour 100 000 personnes.

Résultats : Pendant la durée de l'étude, 5 760 835 traumatismes dus aux accidents de la

circulation et 472 193 décès ont été enregistrés en République islamique d'Iran. Le taux de mortalité a augmenté, passant de 22,4 pour 100 000 personnes en 1997 à 40 pour 100 000 en 2005, puis a diminué, atteignant 18,4 pour 100 000 en 2020. Le taux de traumatismes a augmenté, passant de 111,1 pour 100 000 en 1997 à 394,9 pour 100 000 en 2005. Il a ensuite diminué en 2006 et 2007 avant d'augmenter jusqu'en 2010 pour atteindre finalement 331,8 pour 100 000 personnes en 2020. Le rapport hommes/femmes concernant la mortalité liée à ces types d'accidents était de 3,9 en 1997 et de 4,6 en 2020. Le taux de létalité le plus élevé (20,1 %) a été enregistré en 1997 et il est redescendu à 5,6 % en 2020.

Conclusion : Des interventions continues sont requises pour réduire la charge de ces traumatismes et la mortalité qui leur est associée en République islamique d'Iran.

2005 100000 40 1997 100000 22.4 100000 111.1 .2020 100000 18.4 .2005 100000 394.9 1997 100000 331.8 2010 2007 2006 3.9 .2020 1997 (20.1%) .2020 4.6 1997 .2020 5.6%

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