

The Trend of Leading Causes of Death Among Young People in Iran Within the Last Three Decades: A Retrospective Cohort Study

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Abstract

Background: Youth is undeniably the most important force and resource of any country, thus, identifying the leading causes of death among them to develop preventable interventions is essential. This study aimed to determine the trend of mortality rate and the leading cause of death, based on the ICD-10, among young people in Iran.

Methods: The present study is a retrospective cohort and examines the trend of Iranian youth mortality, aged 15-24 years, between 1990 and 2017. The data source was the Global Burden of Disease (GBD) website. Linear Regression analysis was used to measure the slope of changes in mortality rates and causes of mortality during the period, where "time" was the independent variable and "mortality rate" and "causes of mortality" were dependent variables.

Results: the death rate of young people declined by 54% during the period, equal to an average of 1.37 units per year. The most common cause of death has been injuries (70%), and then NCDs (25%) and finally communicable diseases (5%). However, death due to injuries (except SUD) and communicable diseases (except HIV) declined significantly by 0.94 and 0.09 units per year, respectively ($P < 0.001$), while, death due to the NCDs had an increasing trend by 0.12 units per year over 28 years ($P = 0.006$).

Conclusion: Examining past trends in death rates and causes strengthens insights into the state and future trends in health and death-related indicators, which are crucial for policy-making, especially in developing countries with limited resources.

Introduction

Youth is undeniably the most important force and resource of a country, to boost its socioeconomic development (1). According to the World Health Organization (WHO), youth is defined to be in the age range of 15 to 24 years (2). Globally, there have been 1.2 billion young people aged 15–24 years in 2015, i.e. one out of every six people worldwide (3), which is projected to grow by 7 percent, to reach to nearly 1.3 billion, by 2030 (4). The age of 15 to 24 represent a period in life, filled with enthusiasm, dreams, and ambitions, when one makes the transition from the dependence of childhood to the independence of adulthood (5). It is also a period during which important events occur in life, setting the stage for adult life, such as education, marriage, and entrance into the job market (6).

Mortality rate among young people and identifying the leading causes of death in this age group is one of the fundamental priorities of any community and a part of the Millennium Development Goals (MDGs) (6–7). However, socioeconomic developments typically bring about reductions in morbidity and mortality from communicable diseases, undernutrition, and maternal causes (8). Detailed understanding of mortality trends in youth is essential to see whether progress has been made and targeting future public health efforts.

To report the cause of youth death in this study, we used the framework of the International Classification of Diseases, 10th Revision (ICD-10), developed by the WHO. The ICD-10 helps to improve comparability of the data, making it possible to link multiple data sources and create an integrated information system for countries, which is the basis of the interventions to reduce the incidence of mortalities (9). Based on the ICD-10, the causes of death have been categorised to three main groups as Injuries, Non-communicable diseases (NCDs), and Communicable diseases. According to the WHO, the NCDs will account for 70% of all deaths by 2030 (6). In 2015, 193 countries committed to reduce premature NCD deaths by one third by 2030, as part of the Sustainable Development Goals (SDG) (10). Road transport Injuries (RTI), as a subset of injuries, is one of the leading causes of death and disability in developing countries, which is going to be ranked as fifth by 2030 (11). Among young people aged 15–29, based on Blum and Nelson-Nmari there are five leading causes of death including unintentional injuries, HIV/AIDS, other communicable diseases, violence, and suicide, with substantial regional variation in the number of deaths due to each cause (12). Unintentional injuries (mostly motor vehicle accidents), homicide, and suicide are the three leading causes of youth mortality worldwide, with cardiovascular diseases (CVDs), cancer, and infectious diseases including HIV/AIDS contributing additionally to premature death among the youth (8, 13–15).

The Islamic Republic of Iran, with 83 million inhabitants (16) is currently rather a young country with a share of 14% of its population as those aged 15–24 years old (17). The number of men and women aged 15–24 years was 5,973,320 and 5,689,501, respectively in 2019 (17). By now, no studies has conducted in Iran yet with regard to the trend of prevalence and causes of death among young people longitudinally. There are only evidences from cross-sectional studies or unpublished governmental reports showing that the CVDs, cancers, and motor vehicle accidents are the major causes of death in the Iranian youth, with maximum years of life lost due to motor vehicle accidents, the CVDs and cancers, respectively (6). The NCDs in Iran, causes 79.2% (77.7% -80.7%) of all deaths and 74% (71.5–76.4%) of the burden of diseases (18). Studies show that 57% of all Years of Life Lost (YLL) is in the age group of 15 to 29 years old (19). The YLL due to RTI in Iran is higher than the world and the Eastern Mediterranean Region (20). The global RTI/death rate is 3 people per 10,000 vehicles, but in Iran it is 33 people per 10,000 vehicles (21).

The aim of this study is to make analysis on the trend of mortality among young people aged 15–24 years in the last three decades by causes of death based on the ICD-10 frame. For prevention and program planning purposes, it is helpful to understand the most common causes of death during the last decades and how each cause has been fluctuated during this period. The result of these analyses would help in projections for future and will provide a valuable source for resource allocation, program planning, and provision of services to prevent mortality of young people. By investing in improving the health of young people, direct and indirect costs of death or disability could be prevented and better health of future generations of the country would be guaranteed.

Methods

This study with a retrospective cohort design examines the trends of mortality of young adult in Iran and their causes of death during the years 1990–2017, based on the availability of data in this period. The

age group considered in this study is based on the definition of the WHO of young adult, which includes the age range of 15–24 years old (2). For data collection, we initially referred to the databases of the WHO and the Global Burden of Disease (GBD), belonging to the Institute for Health Metrics and Evaluation (IHME), which are publicly available. However, in both databases, the death rate and its causes are reported with 5-year age intervals, so that these data for the age groups of 15–19 years and 20–24 years are reported separately. Therefore, calculations were needed to obtain the mortality rate in a ten-year age range (15–24 years). To do so, first the total population aged 15–19 years and 20–24 years old was obtained for each year of study and then the mortality rate of study population (those aged 15–24 years old) was calculated. Then the population in the age range of 15–19 and 20–24 was first obtained by dividing the number of deaths in each age range by the mortality rate in the same group and then multiplied by 100 thousand. Total youth mortality rate for the age group of 15–24 years old was then calculated by dividing the total number of deaths in the two age ranges by the total population in the two groups, multiplied by 100,000. Figures number 1 to 3 were drawn accordingly, using this calculation method.

Despite, referring to both the WHO and the GBD databases as a data source, the analyses in the present study ultimately relied on the database of GBD, for two reasons; firstly, in statistical calculations, in addition to mortality rate, the number of people in the target age groups was also required, and this information was only available in the GBD database. Secondly, the data from the WHO were available only for the years 2000 to 2016, while data from the GBD database were available for a longer period; i.e. 1990 to 2017. Report of the causes of youth mortality in the GBD website is also available in the ICD-10 format, which divides the causes into 3 main categories including communicable, maternal, neonatal, and nutritional causes; NCDs; and injuries, as well as 21 sub-categories, as shown in Table 2.

In addition to descriptive analyses to show the trend of mortality rate and its causes over time in Iran, analyses were also conducted to examine whether the observed changes over time have been statistically significant. Due to the necessity of considering the time factor in all analyses, including the need to describe or express the changes in mortality rate and the causes of death per unit of time, Linear Regression analysis was used and the results are shown in Tables 2. In fact, this analysis was used to measure the slope of changes in mortality rates and causes of mortality in Iran, where "time" is the independent variable and "mortality rate" and "causes of mortality" are dependent variables. This type of analysis has been used in other similar studies (22, 23). All Regression analyses were performed in Stata software, version 14. Significance level was considered as less than 0.05. Furthermore, all calculations of descriptive statistics and preparation of the Figures were performed using Excel software.

Results

The results of the analyses showed that the death rate of young people aged 15–24 in Iran during the 28-year period declined by 54% and reached from 194 deaths per 100,000 population in 1990 to 90 deaths in 2017. The results showed a decline in mortality rates in the first year of the period (1990 to 1991) with a steep slope and then slightly downward slope until 2002, but increased sharply in 2003 from 109 deaths

to 146 deaths and finally a downward trend until 2017 (Fig. 1). Regression analysis showed the mortality rate of young people decreased significantly by an average of 1.37 units per year during the period, which was a faster decline rate among men than women (Coef. -1.58 V s. -1.18) (Table 1). However, as also shown in Fig. 1, although the mortality rate of young men was higher than young women throughout the period, the gap between men and women were gradually narrowing, so that the difference reached from 139 deaths in 1990 to 81 deaths in 2017. Among both men and women, the death rate in the age range of 20–24 years was higher than the age range of 15–19 years old. Moreover, in women aged 15–24, the mortality rate had an upward trend from 2009 to 2011, which was higher in the age group of 20–24 years old.

Table 1
Regression coefficient of changes in the trend of youth mortality rate aged 15–24 in Iran during the years 1990–2017

	Mortality Rate		Coeff.	95% CI	P
	1990	2017			
Both sex	194.4	90.5	-1.37	-2.07, -0.68	< 0.001
Male	263.2	130.2	-1.58	-2.63, -0.54	0.004
Female	124.2	49.4	-1.18	-1.65, -0.72	< 0.001

The trend of causes of death by the three main categories, by gender over a period of 28 years are shown in Fig. 2. Also, the trend of 21 sub-causes of mortality, which are, in fact, subsets of the aforementioned three main causes, was also presented in Fig. 3. In this figure, we however combined the 13 less prevalent causes together, to make the figure clearer. Additionally, the significance of the changes of the three main causes and the 21 sub-causes of mortality throughout the time period were examined by regression analyses and reported in Table 2. As shown in Fig. 2, of the three main categories, the most common cause of death among young people has been injuries, and then NCDs and finally communicable diseases. In general, of the total deaths of young people in Iran during the last three decades, about 70% were due to injuries, 25% due to NCDs and nearly 5% were attributed to communicable diseases.

As shown in Fig. 2, the mortality rate due to injuries has fallen from 95 in 1990 to 60 in 2017, which was picked up to 114 deaths in 2003 and then declined again. The mortality rate due to injuries was higher in young men than women, although its downward slope was higher in women; during this period, death due to injuries decreased by 73% in women and 33% in men. With regard to the second cause, the NCDs, first it had a downward direction with a gentle slope for ten years (from 1990 to 1999), then had an upward trend until 2013, and reached its highest rate at about 31 deaths in 2013 and then had a downward trend again in 2017, reaching its lowest level at about 27 deaths. Deaths by NCDs were also higher in men than women. Death due to the communicable diseases also had a slightly declining trend; it decreased from about 7 deaths per 100,000 young people in 1990 to 4 deaths in 2017 (Fig. 2). The results of the regression analysis, presented in Table 2, indicated that the mortality rate of young people

due to injuries, on average, decreased by 0.94 units per year during the period, which is a statistically significant declining trend ($P < 0.001$). Also, death due to the communicable diseases, had a declining trend by 0.09 units per year, over 28 years ($P < 0.001$). In contrast, the average mortality rate of young people due to the NCDs had a statistically significant increase by 0.12 units per year over 28 years ($P = 0.006$). (Table 2).

Table 2

Regression coefficient of changes in the trend of three main causes and 21 sub-causes of death based on the ICD-10 * among people aged 15–24 in Iran during the years 1990–2017

Main causes	Sub-causes	Coeff.	95% CI	P. Value
Communicable, maternal, neonatal, and nutritional disease	1-004- Enteric infections	-0.32	-0.038, -0.026	< 0.001
	1-020- HIV/AIDS and sexually transmitted infections (STIs)	0.008	0.007, 0.009	< 0.001
	1-005- Respiratory infections and tuberculosis (RI and TB)	-0.01	-0.017, -0.003	< 0.001
	1-087- Maternal and neonatal disorders	-0.032	-0.037, -0.027	< 0.001
	1-021- Neglected tropical diseases and) NTDs(malaria	-0.006	-0.008, -0.005	< 0.001
	1-051- Nutritional deficiencies	-0.003	-0.003, -0.004	< 0.001
	1-025- Other infectious diseases	-0.018	-0.023, -0.014	< 0.001
	Total	-0.093	-0.115, -0.071	< 0.001
Non-Communicable disease (NCDs)	1-069- Cardiovascular diseases (CVDs)	-0.033	-0.053, -0.013	< 0.001
	1-054- Diabetes and kidney diseases	0.006	0.002, 0.009	0.009
	1-078- Digestive diseases	-0.001	-0.07, 0.05	0.67
	1-055- Mental disorders	0.001	0.00, 0.001	< 0.001
	1-083- Musculoskeletal disorders (MSDs)	0.008	0.006, 0.009	< 0.001
	1-026- Neoplasms	0.065	0.039, 0.091	< 0.001
	1-058- Neurological disorders	-4.4	-0.002, 0.002	0.96
	1-077- Chronic respiratory diseases (CRDs)	0.004	0.00, 0.008	0.041
1-082- Skin and subcutaneous diseases	0.001	0.00, 0.00	< 0.001	

Main causes	Sub-causes	Coeff.	95% CI	P. Value
	1-094- Other NCDs	0.001	-0.008, 0.007	0.923
	Total	0.129	0.041, 0.216	< 0.001
Injuries	1-101- Self-harm and interpersonal violence (SH and IPV)	-0.125	-0.158, -0.092	< 0.001
	1-056- Substance use disorders (SUD)	0.081	0.06, 0.1	< 0.001
	1-096- Road Transport injuries (RTI)	-0.417	-0.546, -0.288	< 0.001
	1-103- Unintentional injuries	-0.354	-0.397, -0.312	0.003
	Total	-0.943	-1.33, -0.552	< 0.001

*ICD-10 (26)

Figure 3, which represent the trend of 21 sub-causes of mortality, indicates that death due to the RTI, under the “injuries” category, was the most common cause of death of young people. This cause, which led to about 48 deaths per 100,000 people in 1990, had a downward trend until 1998, then the trend reversed until 2004 and reached to 45 deaths, after which it decreased again and reached its lowest level, at about 32 deaths in 2017. Death in this category has decreased, on average, by 0.42 units per year during the period, which was statistically a significant change (Table 2). “Unintentional injuries” and “self-harm and interpersonal violence” (SH and IPV) have been the second and third leading causes of death among young people, respectively. Deaths due to unintentional injuries were about 23 in 1990, which witnessed fluctuations afterward and finally reached to 13 deaths by 2017. However, the trend, on average was declining by 0.35 units per year during the period, similar to the falling trends of mortality due to SH and IPV with an annual regression coefficient of 0.12. The mortality rate due to the SH and IPV overlapped from 2009 to 2015 and affected youth mortality to the same extent. Another cause of injuries is associated with “substance use disorders”, which, had an upward trend of about 2 deaths since 1990, reached to 4 deaths in 2014 and then had a downward trend until 2017 and reached to about 3 death (Fig. 3). Analysis revealed that “substance use disorders”, in contrast with other subsets of the Injury category, had a significant rising trend over time with a regression coefficient of 0.081 ($P < 0.001$).

In the category of NCDs, ‘CVDs’ and ‘neoplasm’ have been main causes of death (Fig. 3). Youth mortality rate due to the CVDs was slightly higher than neoplasm from 1990 to 2004. After that, both causes had an equal impact on youth mortality from 2006 to 2017, which reached about 8 deaths in 2017. Regression analysis showed that CVDs had a significant downward trend of 0.033 units per year. However, death from neoplasm had an upward trend with an annual regression coefficient of 0.065. Of

other causes of death under the NCDs category, according to Table 2, “Mental disorders”, “Musculoskeletal disorders”, “Chronic respiratory diseases” and “Skin and subcutaneous diseases” all had a statistically significant rising trend during the last three decades.

Under the category of communicable diseases, according to Fig. 3, the mortality rate due to “respiratory infections and tuberculosis”, was about 2.5 deaths in 1990, having a downward trend with a gentle slope, finally, decreased to about 2 deaths by 2017. On average, deaths due to this cause decreased by 0.01 units per year during the period. Overall, of the 7 subcategory causes of death under the main cause of communicable diseases, which were responsible for lower mortality rate among young people, compared to the other main causes, 6 causes showed a significant falling trend, while the deaths due to “HIV/AIDS and sexually transmitted infections” witnessed a significant rising trend (Table 2).

Discussion & Conclusion

This study tried to look back on the trend of mortality of young people during the last decades and also how the main causes of deaths, which classified based on the ICD-10 format, have been changed during the same period. Although the mortality rate reduced by 54% during the period, a surprising upward rate was observed in 2003 (Fig. 1). It is believed that the cause of this sudden increase in mortality in 2003 might be attributed to the massive earthquake of Bam city on December 26, 2003, which killed about 25,514 people, including many young people (24).

According to the findings, the mortality rate was higher among young men compared to women. In other studies, young men of all ages in the world has also higher death rates than women except in Africa and Southeast Asia, which is mostly attributed to maternity-related factors (8). The results of a study by Murray and Lopez in eight regions of the world showed that 53% of deaths occurred in men and the highest frequency was related to Ischemic Heart disease (25). The results of a study by Boroumand-nia et al. (2019), which examined the mortality rate in Iranian men, showed that ischemic heart disease, RTI and ischemic stroke were the most common causes of death among Iranian adult men in 2016 (26). Figure 4, compares the mortality rate of young people aged 15–24 in Iran, the EMRO, the region where Iran is located, and the world, in which, Iran's data are aggregated within the EMRO data and the EMRO data are aggregated within the world data. According to this Figure, the mortality rate of women in all three regions is lower than that of men. Furthermore, the mortality rate of Iranian women is lower than women in the whole world and in the EMRO, while the mortality rate of women in the EMRO is higher than the other two places. Also, the mortality rate of men in the EMRO has surpassed the mortality rate of men in the world since 2002 and had the highest mortality rate. However, in 2003 alone, the mortality rate of Iranian men due to the above-mentioned cause was higher than that of other two regions.

Findings showed that the most common cause of mortality among Iranian youth has been “injuries” during the study period and the “RTI” was the most prevalent sub-cause (Fig. 2). Injuries and specially RTI are also one of the leading causes of death and disability among young people in the world, killing more than 4.4 million people in 2017 and putting a major strain on global health (27). According to statistics,

almost 90% of injuries occur in low and middle-income countries (LMICs) (28) and Iran have the highest rate compared to other LMICs (29, 30). The results of other studies in Iran showed that the highest number of deaths due to RTI is among men and in the age group of 15–24 years and 34–35 years (42% of the total mortality) (31, 32). A high percentage of deaths in this age group could be due to more involvement in road transport, greater tendency for high-risk activities, and less tendency to follow traffic rules (33, 34). RTI in Iran are estimated to cause a loss of 2271 years of life each year, as well as financial loss of \$ 6 billion (35, 36).

According to the results of the present study, after RTI, “unintentional injuries” have been in the second rank of death cause and the SH and IPV have been responsible of most deaths after the mentioned causes during the last decades (Fig. 3). An earlier study in Iran showed that the number of deaths due to attacks with firearms and sharp objects increased during the study period 1990–2015 (37). The results of a meta-analysis also showed that the trend of suicide attempt or SH is increasing in Iran (38). There is an evidence that in the EMRO, the number of deaths due to IPV has more increased in recent years compared to rest of the world due to the recent widespread conflicts in this region (39). Findings of a systematic review in the EMRO showed that although the mortality rate in people aged 0–19 years due to “RTI” and “other unintentional injuries” decreased during the years 1990 to 2017, mortality due to “SH and IPV” increased in this age group and tripled during this period (40). The results of a study by Patton et al., which examined the global pattern of mortality in young people, also showed that SH and suicide were increased in young men and women and was the second most common cause of death in this age (8). Therefore these statistics necessitate attention to this matter among young people, who are the reproductive generation of any society. The role of parental divorce, hormonal fluctuations that disrupt their mental state and access to firearms are SH-related factors in this population (41). However, regression analyses conducted in this study indicated that all of the four sub-causes of “injuries”, had a statistically significant downward trend, except death due to substance use disorders (SUD) which had a significant upward trend during the last decades (Table 2). Thus, although the other three sub-causes of injuries, especially RTI, leads to considerably more deaths among young people, and thus requires serious preventive actions, the SUD, on the other hand, needs special attention due to its increasing rate. Recent studies in Iran indicates an increasing rate of tendency to drug abuse such as Tramadol, Ritalin, Pethidine, and Morphine, especially among young people (42). It also needs consideration that, SUDs are concurrence with other problems such as depression, mood disorders, anxiety disorders, and personality disorders that make the situation more difficult to resolve (43). Evidence shows that poverty, family problems, marital discord, inappropriate patterns of assimilation, unemployment, academic failure and psychological problems and underlying factors for the tendency towards addiction among young people (44). Restricting access to drug use, increasing awareness on high-risk age groups are recommended to combat with drug abuse (45).

The NCDs have been the second main causes of death of young people during the last three decades (Fig. 2), and of its sub-causes, death due to the CVDs and neoplasm caused the highest mortality rate among people aged 15–24 years (Fig. 3). Worldwide, deaths due to the NCDs projected to increase from 38 million in 2012 to 52 million in 2035, mostly due to the population ageing (46). Most deaths by the

CVDs are due to ischemic heart disease and stroke, one third of which occur in people under 70 years of age (47). Data have shown that the CVDs will lead to death in more than 23 million people (approximately 30.5%) worldwide by 2030 (49). Based on the analytical findings in this study, death due to the 'Neoplasm' has an increasing trend with an annual regression coefficient of 0.065 in young people during the study period (Table 2). Based on predictions, assuming that there is no change in diagnostic methods and the status of risk factors, the number of new cases of cancer in Iran will increase to 54% by 2035 (51). Therefore, increasing awareness of risk factors, signs and symptoms of cancers should be considered as a priority in cancer control planning, especially in younger female population, subject to be in higher risk of breast cancer (52). The NCDs is actually very important for considerations, as of the three main categories of death causes, only death due to the NCDs showed a significantly increasing trend during the last decades. Also, except death due to the CVDs, which was the only sub-category of the NCDs with a significant downward trend, the other sub-categories including 'Neoplasm', 'Diabetes and kidney diseases', 'Mental disorders', 'Musculoskeletal disorders', 'Chronic respiratory diseases' and 'Skin and subcutaneous diseases' all showed a growing trend, thus, needs more and special considerations (Table 2).

The third leading cause of death among young people is called as 'communicable, maternal, neonatal, and nutritional diseases', which has a lower mortality rate among young people than the other two main causes mentioned. Over the past decades, the prevalence of infectious diseases has decreased significantly. Improvements in socio-economic strategies and success in the primary health care system to control communicable diseases, infants, mothers and nutrition, as well as population aging, urbanization, industrialization and lifestyle changes have put Iran in a state of transition from communicable diseases to the NCDs (53). However, in the category of communicable diseases, "HIV/AIDS and sexually transmitted infections" was the only sub-category witnessing a significant rising trend. The result of a recent study indicated that, of all causes of maternal mortality in Iran, HIV/AIDS have been the only one, making more deaths and have had a growing trend during the last three decades (22). Therefore, special attention should be paid to this cause by health authorities in Iran.

Examining past trends in death rates and causes strengthens insights into the state and future trends in health and death-related indicators, which are crucial for policy-making, especially in developing countries with limited resources. The results of this study, due to considering data from about three decades in the country and comparing it with other countries in the same period, are of great importance, especially compared to cross-sectional or short-term studies and can be used by health policy makers in the country in predicting the causes of youth death in the future. Examining past trends in rates and causes of mortality strengthens insights into the future trends in health- and death-related indicators, which are crucial for policy-making, especially in developing countries with limited resources. The findings of this study are highly reliable due to the use of accurate and complex statistical analysis and can provide a basis for researchers to perform many other studies. However, this study also has some limitations, the most important of which is the estimated data of the GBD, which is the basis of this study. Since the data related to the causes of death are not available anywhere else and these data are not complete and accurate even at the level of Ministry of Health of countries, and are also considered highly confidential

and not available to researchers, the only solution is to use estimated international data sources such as the GBD. Considering the results regarding the trend of youth mortality causes in the last 28 years in Iran and comparing them with similar data from other regions of the world, important outcomes can be achieved, and programs and policies can be considered to reduce youth mortality in Iran by paying special attention to the causes.

Abbreviations

World Health Organization (WHO), Millennium Development Goals (MDGs), non-communicable diseases (NCD), Sustainable Development Goals (SDG), Years of Life Lost (YLL), Global Burden of Disease (GBD), Institute for Health Metrics and Evaluation (IHME), road transport injuries (RTI), Golestan Population-Based Cancer Registry (GPCR), HIV/AIDS and sexually transmitted infections (HIV/AIDS and STIs), Respiratory infections and tuberculosis (RI and TB), Neglected tropical diseases and malaria (NTDs and malaria), Self-harm and interpersonal violence (SH and IPV), Substance use disorders (SUD), Cardiovascular diseases (CVD), Musculoskeletal disorders (MSDs), Chronic respiratory diseases (CRDs).

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The data used in this study are extracted from the GBD website, belonging to the Institute for Health Metrics and Evaluation (IHME), which are publicly available for non-commercial use (<http://www.healthdata.org/about/terms-and-conditions>). The dataset used and/or analyzed in the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

M.H. and Kh.Y gathered the data from the websites and did the primary calculations in Excel software to make the data ready for main analyses. Initial and main calculations and analyses were all supervised by M.T. and comments were provided by her on how to report the findings. M.H. and Kh.Y provided the first draft of the paper in Farsi, which is translated to English by M.T.

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Figures

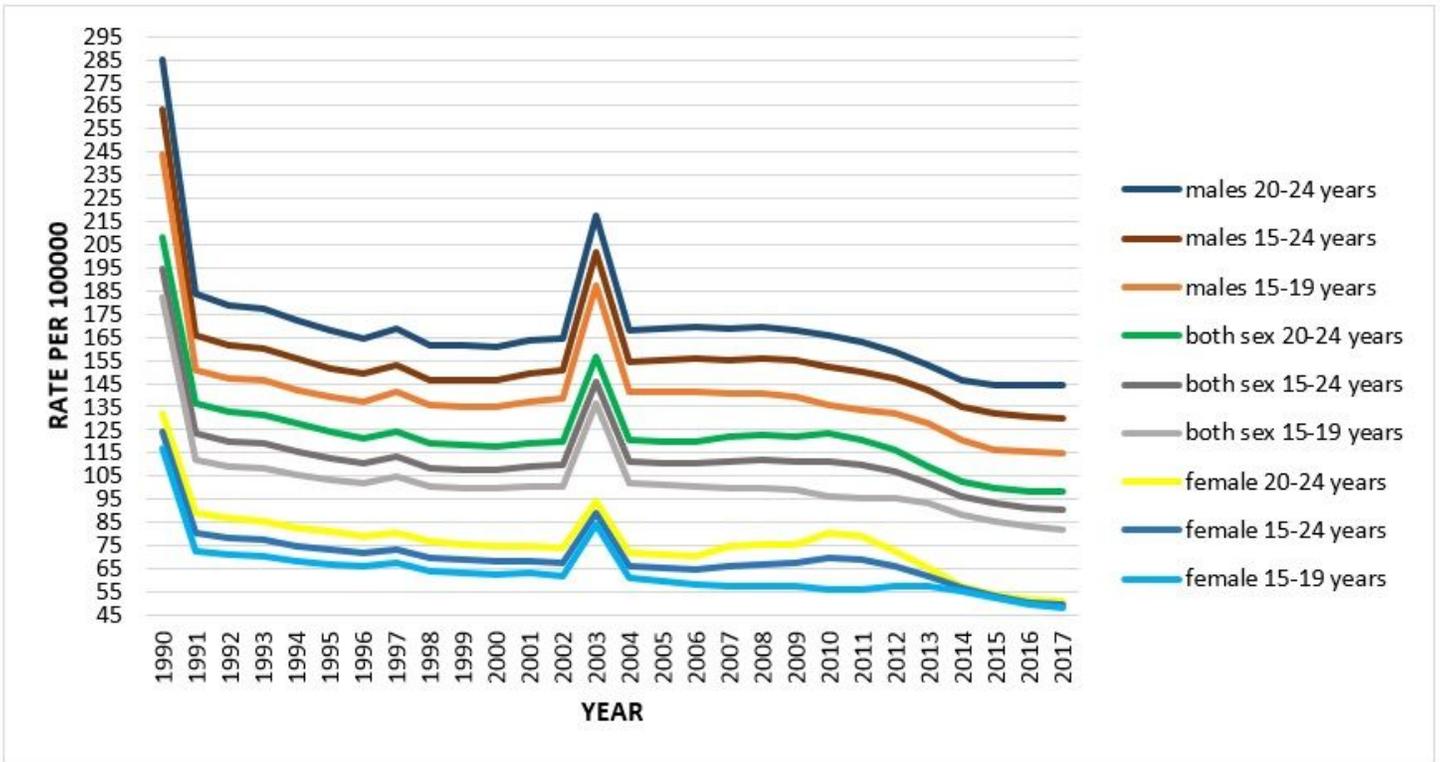


Figure 1

Youth mortality rate based on gender and age in Iran

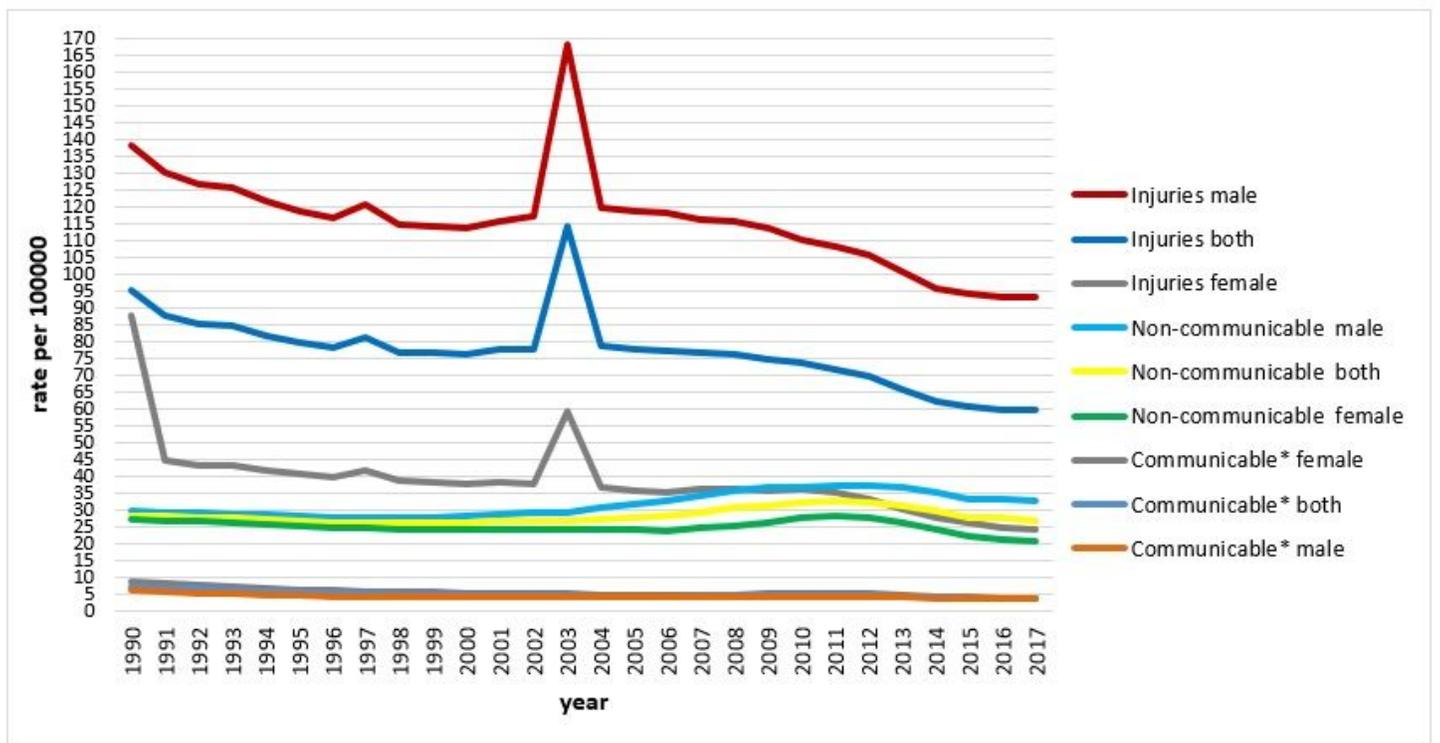


Figure 2

The trend of the three main causes of death among youth adults in Iran by gender in 1990-2017

*Communicable, maternal, neonatal, and nutritional diseases

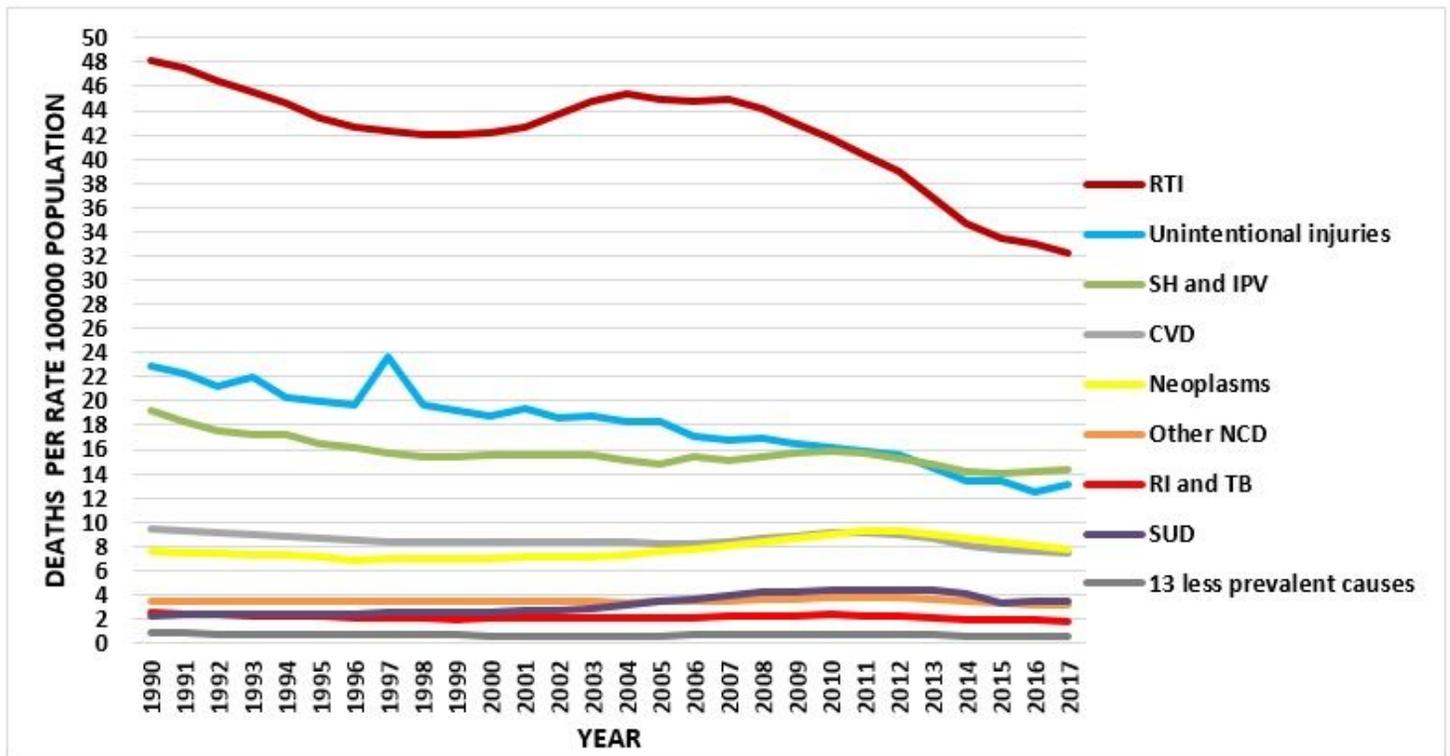


Figure 3

The trend of 21 causes of death in people aged 15-24 in Iran in 1990-2017 We grouped together 13 less prevalent causes of deaths as below and named all as OTHER: Chronic respiratory diseases, Diabetes and kidney diseases, Digestive diseases, Enteric infections, HIV/AIDS and sexually transmitted infections, Maternal and neonatal disorders, Mental disorders, Musculoskeletal disorders, Neglected tropical diseases and malaria, Neurological disorders, Nutritional deficiencies, Other infectious diseases, Skin and subcutaneous diseases, ** Abbreviations: CVDs (Cardiovascular diseases), SH and IPV (Self-harm and interpersonal violence), SUD (Substance use disorders), RI and TB (Respiratory infections and tuberculosis)

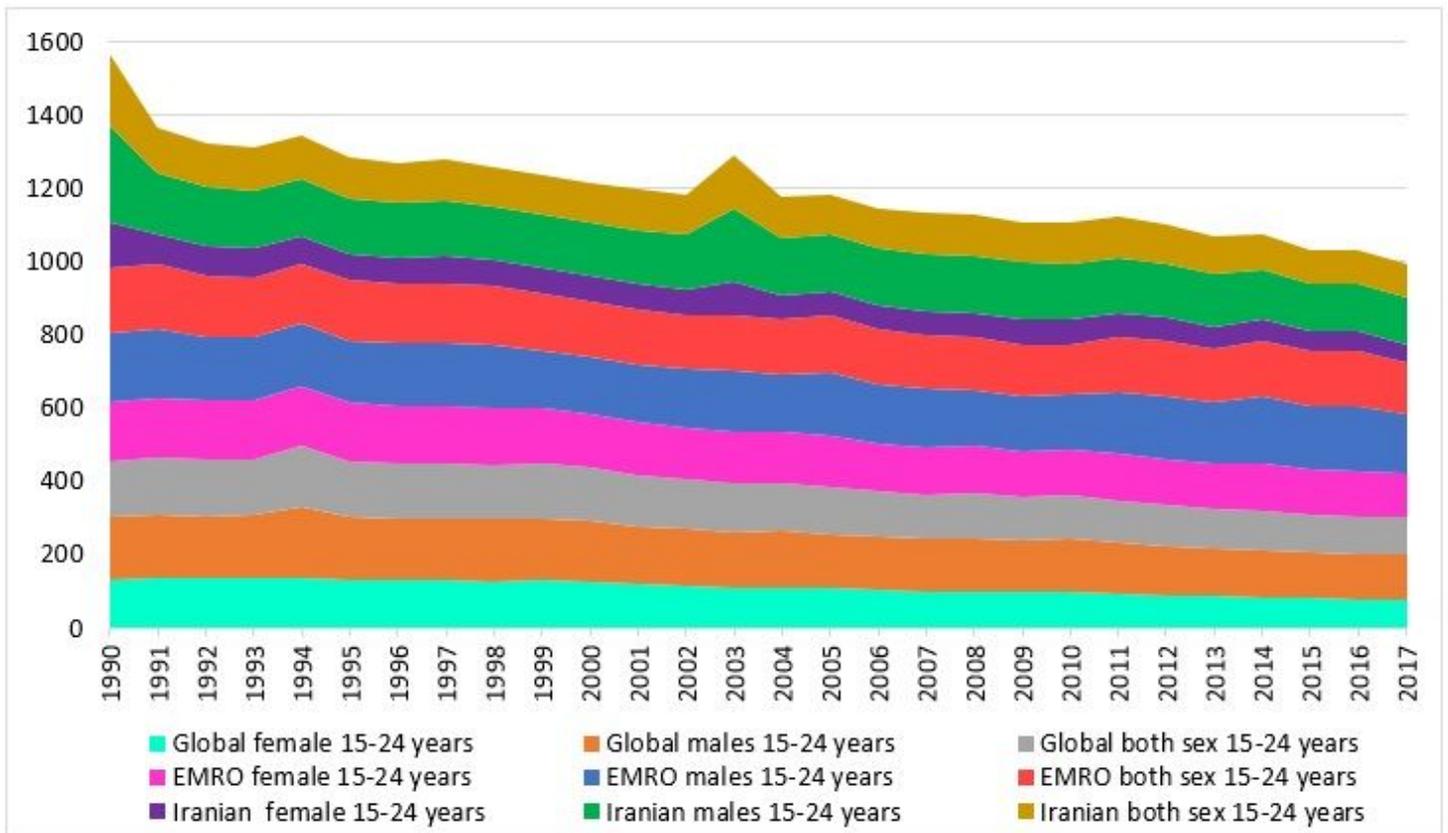


Figure 4

Comparison of mortality rates of young people in glob, EMRO and Iran by gender