



The Burden of Premature Mortality in Southern Iran during 2004-2019 Using Standard Expected Years of Life Lost: A Population-Based Study

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Abstract

Background: Traditionally, mortality rates are used to estimate public health problems and determine the relative significance of different causes of mortality, but they cannot necessarily determine the burden of premature death. We aimed to investigate the 16-year trend of burden of premature mortality in Southern Iran.

Methods: In this cross-sectional study, all deaths due to various causes of death in Fars Province from the electronic population-based death registration system (EDRS) were obtained. Crude and age-standardized mortality rate, Years of Life Lost (YLL) and YLL rate data were calculated and to examine the trend, joinpoint regression was used.

Results: During the study period, 281,903 deaths occurred, of which, 59.85% (n=168,735) occurred in men. Also, 42.18% of these deaths (n=118,610) occurred due to cardiovascular diseases (CVDs). The total number of YLLs due to premature death was 4,154,828 years. Of these, 2,591,564 years (62.37%) were in men. The highest number of YLL was due to CVDs, external causes of death and cancer. Trend of YLL rate due to premature mortality was decreasing: the annual percent change (APC) was -2.1% (95% CI -2.6 to -1.6, $P < 0.001$) for males, -0.9% (95% CI -1.4 to -0.4, $P = 0.002$) ($P = 0.002$) for females.

Conclusion: Although the trend of premature death has been decreasing during the years of study, but the seven major causes of premature death in 2004 to 2019 were non-communicable diseases, especially ischemic heart diseases, stroke, external cause of morbidity, and cancer. Furthermore, our findings indicate a change in the role of non-communicable diseases in premature mortality in recent years.

Keywords: Years of life lost; Premature death; Mortality rate; Join point regression; Iran

Introduction

Traditionally, mortality rates are used to estimate public health problems and determine the relative

significance of different causes of mortality, but they cannot necessarily determine the burden of



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premature death, which is an important indicator of the health status of a population (1). The classical rates of mortality are affected by diseases that are common in older age groups, so they may not fully exhibit the burden of premature mortality (2). Premature death is an important indicator and premature mortality reduction is considered as one of the goals of sustainable development by the WHO (3).

Today, another significantly used mortality indicator is YPLL (1). This index varies with other mortality indicators, such as crude death, and gives more weight to the death of young adults, and additionally examines death outcome economically and socially. However, crude mortality only reflects the number of deaths in the human population, not the burden of diseases. Therefore, international, regional and national comparisons are impossible (4). The causes of premature death are widely different across various regions. Identification of main causes of premature death and related risk factors is essential for health planning, policy development and budget prioritization in a community (5). According to the WHO estimates, non-communicable diseases (NCDs) will account for 70% of the total deaths by 2030. Cardiovascular disease (CVD), cancers, diabetes and chronic pulmonary diseases are the first cause of death around the world(6). The death reports not only reflect the main causes of death and related risk factors in the public health, the fundamental component for estimating the burden of disease in societies are also determined 7).

Iran, a middle-income country, has faced significant social, economic and demographic changes over the past four decades. It can be estimated that in this country over the next two decades, the burden of diseases and injuries would increase by 35%, which is mainly due to age or demographic and epidemiological changes (8). CVD, motor vehicle accidents and cancers are three main causes of mortality and motor vehicle accidents, CVD and cancers are three main causes of YLL in Iran (6). Fars Province is 122,608 square kilometers located in southern Iran, and is one of the most populated provinces of Iran with

a population of 4,200,000 in 2020 (according to the national population and housing census) (9). Several attempts were made for estimation of global and national mortality due to special diseases, and also there are much limited efforts to estimate all-cause deaths (All references in 10) (10). No comprehensive study on premature death has been previously conducted in Fars Province, and this study for the first time investigated the 16-year trend of burden of premature mortality in Southern Iran.

Methods

This cross-sectional population-based study was conducted to examine the YLL due to premature death from various causes of death in Fars Province between 2004 and 2019. There are two primary sources to obtain mortality information in Iran, the Electronic Death Registration System (EDRS) from the Ministry of Health and Medical Education (MOHME) and national level by national organization for civil registration (NOFCR)(11).

In Iran, trained physicians first report deaths and then codify the causes of death according to the national protocol and the international classification of diseases (ICD). Afterwards, hospitals, local health centers, cemeteries, and forensic organizations report these data monthly to the Death Registration Committee (12). We extracted mortality data from the EDRS, in terms of age at death, time of death, gender, year and underlying cause of death, using a specific software designed for this purpose. These reports were then matched with data from NOFCR. Duplicate death reports were excluded based on similarities in father's name, time of death, and national identity code. This protocol was used for all causes of death. Since 1998, a single death certificate has been used throughout Iran, which must be legally approved and signed by a physician prior to burial. This form is in accordance with the ICD-10.

The total population of Fars Province according to annual population growth between 1996 and 2016. To calculate standardized mortality rates,

direct standardization method and using the 2013 standard populations of low- and middle-income countries (Segi) (13). The direct method of standardization involves the application of age-specific rates in a Population of interest to a standard age distribution in order to eliminate differences in observed rates that result from differences in population composition (14).

In 1990, the WHO designed a series of life tables for all countries. Since then, this organization has regularly updated them for each member state. These life tables have several applications and indicate the basis of all the WHO estimates on mortality patterns worldwide (1).

To calculate YLL The following formula was used. (15).

$$YLL = N C e^{(ra)} / (\beta+r)^2 [e^{-(\beta+r)(L+a)} [-(\beta+r)(L+a)-1 - e^{-(\beta+r)a} [-(\beta+r)a-1]]]$$

Where,

N is the number of deaths at a specific age and gender

L is the standard life expectancy of the deceased cases at the same age and gender

r is the Discounting rate, which is equal to 0.03.

β is a contract in calculating age, and is equal to 0.04.

C is a modified constant equal to 0.1658

a is the age at death and e is fixed and equal to 2.71.

The GBD applied a 3% time discount rate to years of life lost in the future to estimate the net present value of years of life lost.

β determines the importance of age-weights.

C is an adjustment constant, chosen so that the introduction of age-weights does not alter the total number of YLL (16).

Analysis of the number of YLL, using the 2015 YLL template proposed by the WHO, in EXCEL software 2016.

To calculate the trend of crude and standardized mortality rates. We used Chi-square test for trend. P-value less than 0.05 was considered sta-

tistically significant. Using SPSS software, version 25.0.

To examine the trend of YLL across several years, joinpoint regression was used, based on the log-linear model. Joinpoint regression analysis is used to describe changing trends over successive periods and to quantify the increase or decrease within each period. The resulting line segment between joinpoint is described by the Annual Percent Change (APC), based on the slope of the line segment and the Average Annual Percent Change (AAPC). This joinpoint analysis of the trend was carried out by Joinpoint Regression Program version 4.9.0.0.

The protocol describing this study was reviewed and approved by the ethics committee of Shiraz University of Medical Sciences (reference: IR.SUMS.REC.1399.772).

Results

During the study period, 281,903 deaths occurred in Fars Province, of which 59.85% (n=168,735) were in men. 42.18% (n=118,610) of these deaths were due to CVDs, 15.48% (43,651) from external causes of death and 11.00% (n=30,936) were caused by cancers and tumors.

The three main causes of death in men are CVDs (38.26%), external causes of death (19.90%), and cancers and tumors (11.14%), while CVDs (48.07%), cancers and tumors (10.78%) and external causes of death (8.89%) are respectively main causes of death in women. The highest rate of deaths in both genders was observed in the age group over 85 years and the lowest rate of deaths was reported in the age group of 5-9 years in males and 10-14 years in females.

Crude mortality rate was shown to decrease from 454.35 in 2004 to 453.43 in 2019 per 100,000 populations (p for trend = 0.919) Also, the standardized mortality rate decreased from 615.10 in 2004 to 429.54 in 2019 per 100,000 populations (P for trend <0.001) (Table 1).

Table 1: the crude and Age –standardized mortality rate (per 100,000 population) stratified by year in Fars (Iran) 2004-2019

<i>Year</i>	<i>No. death</i>	<i>Crude mortality rate (per 100,000)</i>	<i>Age –standardized mortality rate (95% CI)</i>	<i>YLL (Year)</i>
2004	16,531	454.35	615.10 (608.19-622.01)	266,384 (265,373-267,398)
2005	16,446	452.48	577.6 (570.70-584.51)	264,597 (263,590-265,607)
2006	17,564	479.82	595.95 (588.87-603.04)	276,914 (275,884-277,947)
2007	18,187	490.95	575.62 (568.49-582.74)	285,185 (284,139-286,234)
2008	17,306	461.79	518.62 (511.75-525.49)	267,024 (266,012-268,039)
2009	17,142	452.64	491.14 (484.38-497.91)	260,047 (259,048-261,048)
2010	17,710	462.34	483.61 (476.81-490.41)	267,102 (266,090-268,117)
2011	16,868	434.86	447.72 (441.16-454.28)	248,276 (247,300-249,255)
2012	17,371	443.13	453.96 (447.38-460.55)	263,154 (262,150-264,161)
2013	17,814	448.54	444.23 (437.65-450.81)	248,652 (247,676-249,631)
2014	17,784	442.10	437.21 (430.71-443.70)	254,594 (253,606-255,585)
2015	17,761	436.51	425.75 (419.34-432.17)	251,468 (250,486-252,453)
2016	17,223	418.00	402.51 (396.27-408.75)	237,969 (237,014-238,927)
2017	18,450	447.74	434.95 (428.49-441.41)	255,457 (254,467-256,450)
2018	18,870	455.91	438.34 (431.84-444.84)	257,158 (256,165-258,154)
2019	18,876	453.43	429.54 (423.07-436.00)	250,847 (249,866-251,831)
Total	281,903	452.16	488.47 (481.8-495.14)	4,154,828 (4,150,834-4,158,825)

The total number of YLLs during the 16-year study period was 4,154,828 years. Of these, 2,591,564 years (62.37%) belonged to men (Tables 1 and 2).

Among all age groups, the highest number of YLL in both genders was observed in the age

group under 5 years, while the lowest number of YLL belonged to the age group of 5-9 years in men and the age group of 10-14 years in women. Figure 1 shows the number of YLL in the top 5 causes of YLL by year.

Table 2: Distribution of deaths, age-specific mortality rates per 100,000 (ASMR), and YLL by gender, and age group

<i>Index</i>		<i>No. death (%)</i>		<i>ASMR</i>		<i>YLL (%)</i>		
Sex		Male	Female	Male	Female	Male	Female	
Age groups	0-4	13,218 (57.34)	9,830 (42.66)	544.39 (535.11-553.67)	418.33 (410.06-426.60)	397,645 (57.15)	298,061 (42.85)	
	5-9	1,119 (57.68)	821 (42.32)	47.57 (44.78-50.36)	36.50 (34.00-38.99)	33,138 (57.46)	24,533 (42.54)	
	10-14	1,232 (61.81)	761 (38.19)	50.45 (47.63-53.27)	32.52 (30.20-34.83)	35,641 (61.51)	22,301 (38.49)	
	15-19	4,158 (74.42)	1,429 (25.58)	142.38 (138.05-146.71)	50.89 (48.25-53.52)	117,267 (74.14)	40,888 (25.86)	
	20-24	7,001 (75.85)	2,229 (24.15)	207.69 (202.82-212.55)	67.09 (64.30-69.88)	192,301 (75.55)	62,211 (24.45)	
	25-29	7,275 (75.91)	2,308 (24.09)	209.92 (205.09-214.74)	67.70 (64.94-70.47)	193,050 (75.54)	62,483 (24.46)	
	30-34	6,516 (75.16)	2,153 (24.84)	214.40 (209.19-219.60)	71.74 (68.71-74.77)	165,692 (74.71)	56,081 (25.29)	
	35-39	5,886 (74.16)	2,050 (25.84)	237.91 (231.84-243.99)	84.07 (80.43-87.71)	142,327 (73.58)	51,099 (26.42)	
	40-44	5,805 (72.21)	2,233 (27.79)	286.30 (278.94-293.67)	112.76 (108.08-117.43)	131,793 (71.44)	52,664 (28.56)	
	45-49	6,775 (69.89)	2,918 (30.11)	384.86 (375.70-394.03)	170.11 (163.94-176.28)	142,436 (68.86)	64,409 (31.14)	
	50-54	8,228 (67.83)	3,901 (32.17)	565.41 (553.19-577.63)	275.58 (266.93-284.22)	157,714 (66.43)	79,667 (33.57)	
	55-59	8,996 (64.01)	5,058 (35.99)	790.71 (774.37-807.05)	444.24 (432.00-456.48)	153,641 (62.19)	93,372 (37.81)	
	60-64	9,425 (60.21)	6,228 (39.79)	1167.75 (1144.17-1191.32)	728.94 (710.83-747.04)	139,184 (57.71)	101,993 (42.29)	
	65-69	10,066 (56.86)	7,636 (43.14)	1817.71 (1782.20-1853.22)	1276.72 (1248.09-1305.36)	124,120 (53.68)	107,097 (46.32)	
	70-74	12,858 (56.34)	9,963 (43.66)	2901.96 (2851.80-2952.12)	2268.33 (2223.79-2312.87)	128,052 (52.72)	114,797 (47.28)	
	75-79	17,935 (56.35)	13,888 (43.65)	4850.83 (4779.84-4921.83)	4205.22 (4135.28-4275.16)	139,177 (52.57)	125,522 (47.43)	
	80-84	20,394 (54.20)	17,230 (45.80)	7934.38 (7825.48-8043.27)	7676.18 (7561.56-7790.80)	118,309 (50.45)	116,175 (49.55)	
	+85	21,848 (49.22)	22,533 (50.78)	12883.8 (12712.95-13054.64)	14225.91 (14040.16-14411.66)	80,077 (47.10)	89,912 (52.90)	
	Total	-	168,735 (59.85)	113,168 (40.15)	536.12 (533.57-538.68)	367.77 (365.62-369.91)	2,591,56 4 (62.37)	1,563,264 (37.63)

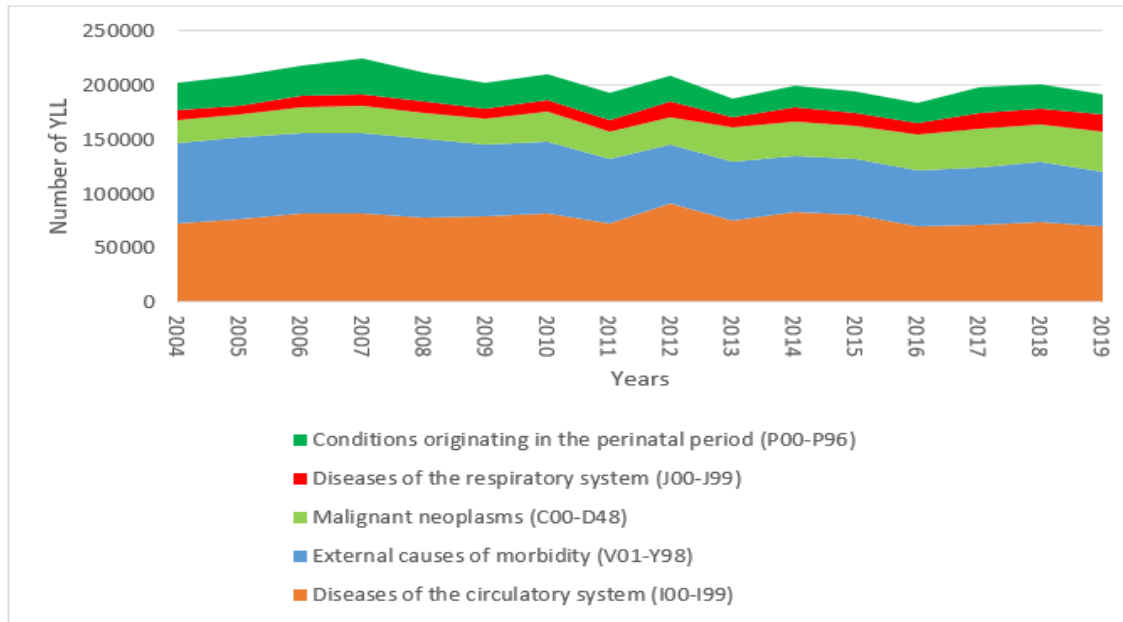


Fig. 1: The number of YLL in the top 5 causes of YLL by year (2004-2019)

Figure 2 also indicates the percentage and the number of YLL in all age groups by gender in Fars province. External causes of morbidity, circulatory system diseases and cancers are the major sources of YLL in men, whereas circulatory system diseases, external causes of morbidity and

cancers are the major sources of YLL in women. The YLL percentage of circulatory system diseases is higher in women than in men. However, the YLL percentage of external causes of morbidity is much higher in men compared to women.

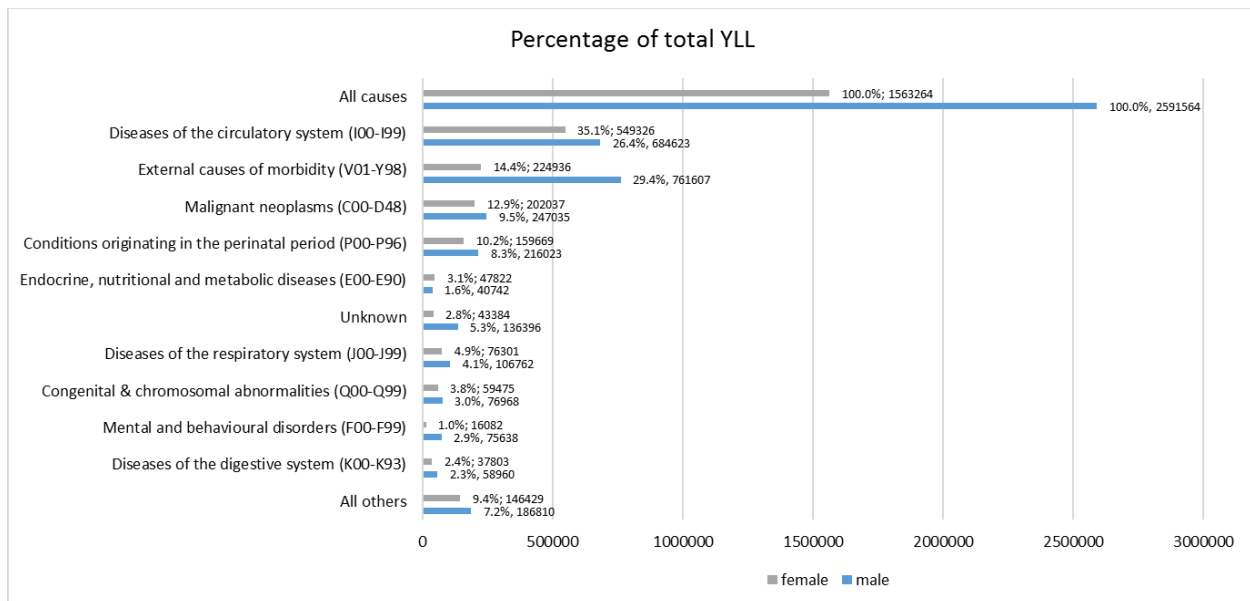


Fig. 2: Years of life lost by causes and sex, Fars Province, 2004-2019

Figure 3 shows the percentage of five main causes of YLL of total YLL. It is clear that the highest percentage of YLL per year is related to cardiovascular disease. Clearly, the percentage of YLLs due to external causes of death is declining

over the study period, while the percentage of YLLs due to cancers is increasing. In addition, the percentage of respiratory-related diseases is increasing while the percentage of postpartum diseases is shown to be decreasing.

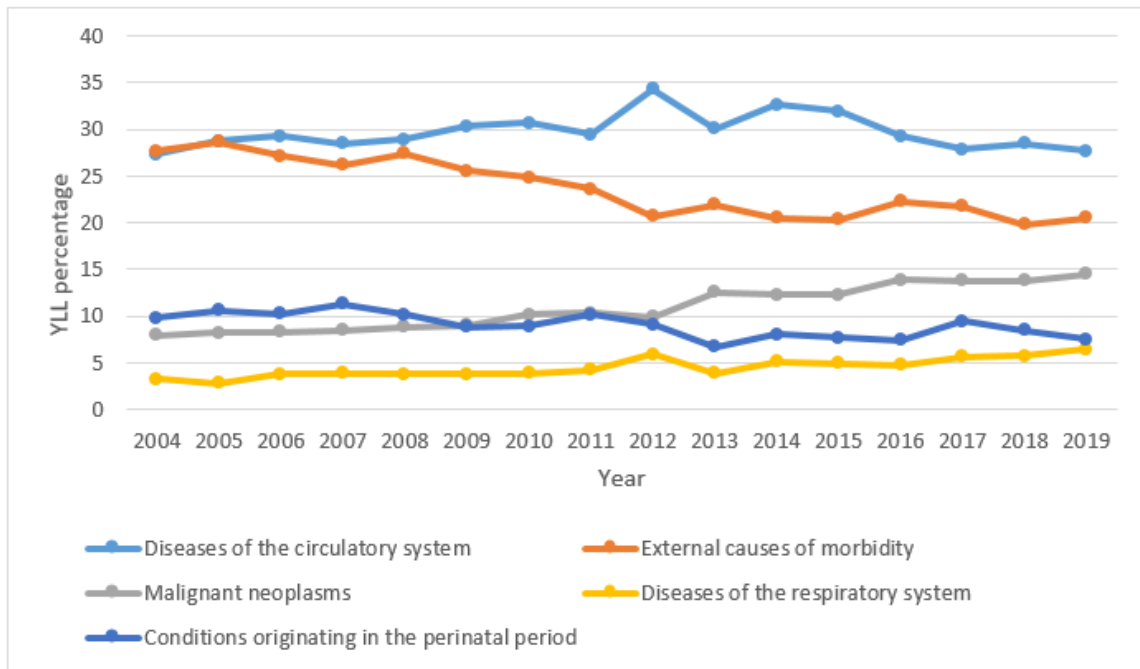


Fig. 3: Proportion of the top five sources of YLL out of total YL

According to the joinpoint regression analysis, the 16-year trend of YLL rate due to premature mortality was decreasing: the APC was -2.1% (95% CI -2.6 to -1.6, $P < 0.001$) for males, -0.9% (95% CI -1.4 to -0.4, $P = 0.002$) for females, and -1.8% (95% CI -2.2 to -1.4, $P < 0.001$) for both sexes. The model did not show any join point; hence, the AAPC is the same as APC.

Figure 4 shows the YLL in terms of NCDs, communicable diseases, external causes of morbidity, maternal diseases, birth defects, congenital anomalies and unknown factors. It can be concluded that the highest number of YLL is due to NCDs.

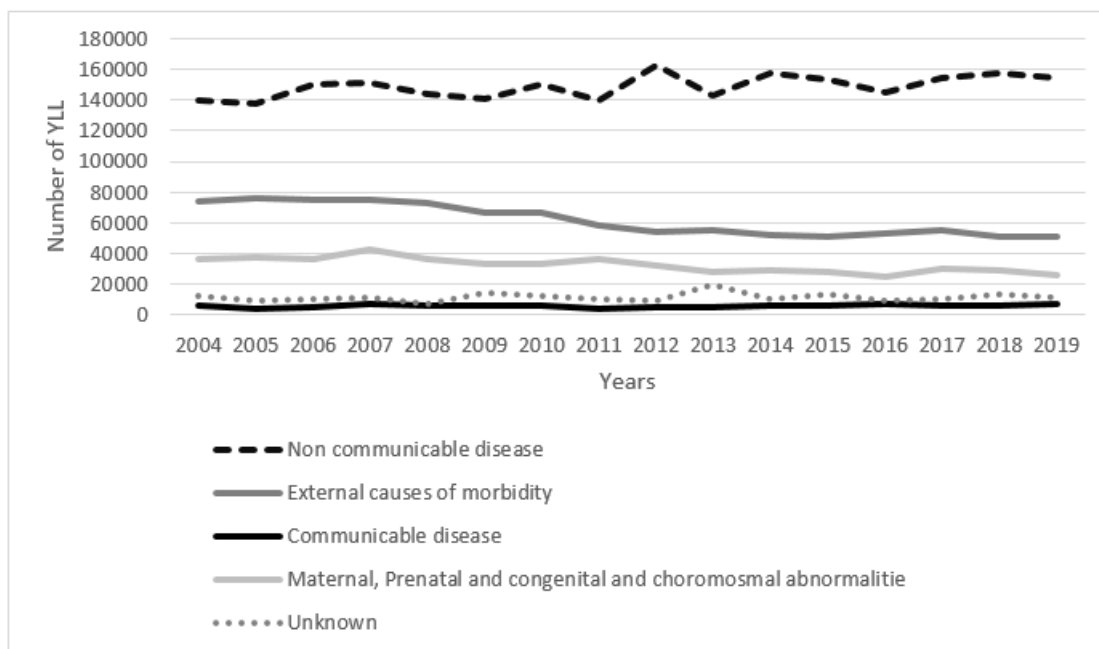


Fig. 4: The YLL in terms of NCDs, communicable diseases, external causes of morbidity, maternal diseases, birth defects, congenital anomalies and unknown factors

Discussion

The results of our study showed that circulatory system diseases, external causes of morbidity and cancers were the top three causes of premature death during the study period.

In our study, the percentage of YLL due to cancer increased during the study period, which was in line with the results of a study (17) conducted in 2020 in Iran. According to the findings of this study, the YLL due to cancer indicated an increasing trend in both men and women.

The results also show that despite the significant improvement in cancer treatment, it is necessary to implement appropriate programs to prevent cancer and reduce the disease burden, especially in Iran.

In our study, the YLL due to external causes of morbidity showed a decreasing trend during the study period. Another study (18) conducted in 2018 in Iran and 15 surrounding countries supported the findings of our study. In our study, the rate of deaths due to traffic injuries decreased in 2016. It was lower compared to 1990 in Iran. One of the reasons for this reduction is the re-

duction of deaths and YLL among pedestrians through protection and elevation of the safety of these vulnerable individuals. In Iran, road congestion has been reduced at local level through monitoring system and road network. Another study (19) conducted in Iran supported the findings of our study. According to the findings of this study, the rate of traffic accident-related mortality has decreased from 41.5 per 100,000 population in 2006 to 20.4 per 100,000 population in 2016 in Iran. Necessary interventions, including training programs and harm reduction strategies, are essential to reduce this mortality trend.

We also concluded that the 7 main causes of YLL are NCDs, which indicates the shift in death pattern from communicable diseases to NCDs. Iran is experiencing a transition period due to population aging, changes in disease risk factors and a shift from communicable diseases to NCDs, such as CVD, hypertension, diabetes, mental and behavioral disorders, alcohol and substance abuse, and traffic injuries (20). Four major NCDs, including CVD, diabetes, cancer and chronic respiratory diseases, are related to preventable risk factors of lifestyle, such as unhealthy diet, lack of

physical activity or low physical activity, overweight and obesity, Which requires a program to deal with them (1, 21, 22).

We showed that, most of the YLL were due to respectively circulatory system diseases, external causes of morbidity and cancer. In contrast, a similar study (23) conducted in Iran showed that traffic injuries and circulatory system diseases were the first and second leading causes of premature death, respectively.

In our study, 7 main causes of premature death are due to NCDs, which was in accordance with another study conducted in Iran (2018). Based on the findings of this study, 79% of all deaths and 74 % of disease burden were due to NCDs in Iran (24).

The results of our study suggest the increasing trend of mortality rate with age. In addition, age- and sex-specific mortality rates and the number of YLL in all age groups were higher in men than in women, except those over the age of 85 years. One reason for this difference can be unhealthy lifestyle, such as smoking, which may increase risk of death among men. In addition, external factors, such as road traffic accidents, suicide, and drug abuse were more common in men (25-27).

We also found that the trend of premature death was lower in 2019 compared to 2004 in both men and women, with more significant reduction among men. Another study (3) conducted in Iran supported these results. In our study, premature death had a decreasing trend, with higher reduction rate among men in Iran. Therefore, the age-standardized all-cause premature death will decrease by 27.5% in men and 14.5% in women between 2010 and 2030 in Iran. A large portion of premature death is related to NCDs, and premature death is declining in Iran due to the decreasing trend of major NCDs, such as CVD and cancer, (3). Given that one of the sustainable development goals is to reduce by one third premature mortality from NCDs (28), it is necessary to take basic measures by health planners and policymakers to achieve this goal.

In our study, similar to another study (29) conducted in Iran, the crude and standardized mortality rates were lower in 2019 compared to 2004. Restructuring Iranian healthcare system was a successful step in expanding health care and services in most parts of the country, designed to provide access to preventive health interventions, improve water sanitation, vaccination, and control environmental hazards. Addressing these challenges requires a responsive, flexible structure and adequate manpower (25).

In our study, YLL due to Conditions originating in the perinatal period, decreased. The expansion of prenatal diagnosis and prenatal care, the increase in giving birth in health facilities and the expansion of neonatal intensive care in the country have contributed to the improved survival of newborns and children in this period (2).

The strengths of this study include a large timeframe, large sample size and use of all mortality-related causes. In addition, our study showed the main causes of YLL in the target population. One of the limitations of this study was the use of a number of deaths with unknown cause in this study and were named as "unknown causes of death", and it is necessary to clarify this problem by accurately recording the cause of death.

Conclusion

Although the trend of premature death has been decreasing during the years of study, but the 7 main causes of premature death are due to NCDs, such as ischemic heart disease, stroke, cancer and external causes of morbidity, including road traffic injuries and self-harm. For many risk factors, such as diet harms, physical inactivity, smoking, and most importantly mental health, the current health system needs to improve infrastructure and empowerment through the employment of sophisticated health professionals and long-term programs based on laws and regulations.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interest

The authors declare that there is no conflict of interests.

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