Cohort Study

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Burden of aortic aneurysm in Iran from 1990 to 2019: an analysis based on global burden of disease study

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Background: Limited studies have been conducted on the epidemiology of aortic aneurysms in Iran. In this study, the authors aimed to comprehensively evaluate the burden and epidemiology of aortic aneurysms across various age groups, sexes, and provinces in Iran from 1990 to 2019.

Materials and methods: The authors used global burden of disease (GBD) study data in the current study. The authors retrieved data on the burden of aortic aneurysms across sexes and age groups at national and subnational levels from 1990 to 2019. The authors extracted mortality, years of life lost (YLL), years lived with disability (YLD), and disability-adjusted life year (DALY), numbers, rates, and age-standardized rates. Additionally, the authors extracted the burden of AA attributable to its risk factors, such as lead exposure, high systolic blood pressure, high dietary intake of sodium, and smoking.

Results: National ASDR (age-standardized DALY rate) was also observed to be reduced from 1990 [22.20 (17.46–26.86)] to 2019 [19.97 (17.98–21.98)]. However, the inclinations were evaluated to be slighter than the world (%change ASDR = − 19.5%). In 2019, three leading risk factors yielding death in AA patients were smoking [ASMR attributable = 0.73 (0.67–0.80)], high sodium intake [ASMR attributable = 0.11 (0.03–0.27)], and lead exposure [ASMR attributable = 0.04 (0.02–0.07)].

Conclusion: Mortality and DALYs due to AA both decreased slightly during the last three decades. Considering the role of smoking in the burden of AA in Iran, interventions targeting smoking cessation among high-risk groups, such as males, may be helpful to reduce the burden of AA in Iran in the coming years.

Keywords: aortic aneurysm, burden, epidemiology, Iran

Background

An aortic aneurysm is defined as a focal full-thickness dilation of the aorta, characterized by an increase in its diameter of more than 50%[1–3]. While aortic aneurysms typically remain asymptomatic, their rupture is marked by a notably high mortality rate[4]. A systematic review estimated that the mortality rate resulting from abdominal aortic aneurysm (AAA) is about 81%[5]. Considering the potential benefits of surgical interventions for patients with aortic aneurysms, timely diagnosis of aneurysms is of utmost importance, allowing patients to benefit from interventions and prevent ruptures[6,7]. By identifying modifiable risk factors and high-risk populations, epidemiological studies are instrumental in shaping policies and directing resources toward individuals who benefit the most from preventive programs[8].

A systematic review reported that the prevalence of AAA ranges between 1.7 and 12.7% across studies[9]. Moreover, a study revealed a greater increase in the burden attributable to aortic aneurysms in countries with a worse sociodemographic status[10]. In Iran, only limited studies have been conducted on the epidemiology of aortic aneurysms, and most are limited to single

HIGHLIGHTS

- This study presents a comprehensive evaluation of the burden of aortic aneurysms in Iran from 1990 to 2019.
- The results indicate a slight nationwide decrease in aortic aneurysm-related mortality and disability-adjusted life years (DALYs) over three decades.
- The highest mortality rates observed in the provinces of East Azarbayejan, Chahar Mahaal and Bakhtiari, and Isfahan.
- Greater burden observed in males and the older population.

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centers. A study on patients with thoracic aortic aneurysm revealed that most patients were male, and had a mean age of 59.7 years[11]. In another study, the prevalence of AAA among 240 Iranian males aged over 65 was determined to be 10%[12]. Given the limited data on the epidemiology of aortic aneurysms in Iran, we aimed to comprehensively evaluate the burden and epidemiology of aortic aneurysms across various age groups, genders, and provinces from 1990 to 2019, utilizing the Global Burden of Diseases (GBD) database.

Methods

Source and definitions

This work has been reported in line with the STROCSS criteria[13]. In this study, we used GBD study data, which was conducted by the Institute of Health Metrics and Evaluation (IHME) to determine the burden and epidemiology of 369 diseases and injuries and 87 risk factors across 204 countries and territories[14,15]. The GBD study includes information on the burden of diseases at national and subnational levels in Iran[16].

Within the GBD study, the term "aortic aneurysm" encompasses both abdominal and thoracic aneurysms, identified by the ICD-9 codes 441–441.9 and ICD-10 codes I71–I71.9[10,14]. We retrieved data on the burden of aortic aneurysms across genders and age groups at national and subnational levels from 1990 to 2019 for the GBD results tool. Iran's 31 provinces included Alborz. Ardabil, East Azerbaijan, West Azerbaijan, Bushehr, Chaharmahal and Bakhtiari, Fars, Gilan, Golestan, Hamadan, Hormozgan, Ilam, Isfahan, Kerman, Kermanshah, North Khorasan, Razavi Khorasan, South Khorasan, Khuzestan, Kohgiluyeh and Boyer-Ahmad, Kurdistan, Lorestan, Markazi, Mazandaran, Qazvin, Qom, Semnan, Sistan and Baluchestan, Tehran, Yazd, and Zanjan. We extracted mortality, years of life lost (YLL), years lived with disability (YLD), and disability-adjusted life year (DALY), which is the sum of YLD and YLL, numbers, rates, and age-standardized rates. Additionally, we extracted the burden of AA attributable to its risk factors, such as lead exposure, high systolic blood pressure, high dietary intake of sodium, and smoking.

Statistical analyses

We mainly performed descriptive analysis and visualized the extracted data. We reported the burden of AA across age groups, genders, countries, and years. We calculated the percentage changes in AA burden between 1990 and 2019. DALY rates were calculated by adding the YLD and YLL values. We employed Python version 3.8 to create all figures and choropleth maps. We utilized Folium, Numpy, Matplotlib, Statsmodels, and Pandas libraries for the analyses.

Results

National burden of aortic aneurysm

National ASMR (age-standardized mortality rate) due to AA in Iran decreased from 1.11 [0.88–1.13] in 1990 to 1.02 [0.90–1.12] in 2019 (%C ASMR = – 8.1%) (Table 1). Moreover, ASDR (age-standardized DALY rate) was also observed to be reduced from 1990 [22.20 (17.46–26.86)] to 2019 [19.97 (17.98–21.98)] (%C ASDR = – 9.9%). However, the inclinations were evaluated to be slighter than the world (%C ASMR = – 18.0%, %change ASDR = – 19.5%) or MENA (% change ASMR = – 9.3%, %C ASDR = – 15.3%), despite a lower age-standardized rate (Fig. 1). Although the trend was decreasing during 30 years, a slight slope was detected in both ASDR and ASMR between 2000 and 2005.

Sex and age-specified burden

In general, ASMR and ASDR because of AA were significantly lower in females compared to males either in 1990 [ASMR Female = 0.66 (0.56–0.78), ASMR Male = 1.57 (1.99–1.11), ASDR Female = 12.04 (10.64–14.11), ASDR Male = 31.90 (22.67–41.04)] or 2019 [ASMR Female = 0.52 (0.47–0.57), ASMR Male = 1.51 (1.31–1.68), ASDR Female = 10.16 (9.26–11.05), ASDR Male = 29.80 (26.08–33.44)] (Fig. 2). A slight inclination was observed in both males' and females' AA mortality and DALY during these thirty years (Fig. 3). The highest mortality rate was observed in males 90–94 years, in 1990, and more than 95 years in 2019. An upward trend was seen in both mortality and DALY rates across different age groups (Fig. 4).

Provincial burden of aortic aneurysm

East Azarbayejan [ASMR = 1.63 (1.36–1.98)], Chahar Mahaal and Bakhtiari [ASMR = 1.46 (1.15–1.79)], and Isfahan [ASMR = 1.22 [1.01–1.45)] had the highest ASMR due to AA in 2019 (Fig. 5). On the other hand, Kohgiluyeh and Boyer-Ahmad [ASMR = 1.05 (0.78–1.36)], North Khorasan [ASMR = 1.14 (0.87–1.46)], and Hamadan [ASMR = 1.18 (0.90–1.47)] had the lowest. The highest increase in ASMR was observed in East Azarbayejan (%C = 18.5%), Zanjan (%C = 15.2%), and Qazvin (%C = 6.7%). Nonetheless, ASMR was highly reduced in the negative direction in Tehran (%C = – 23.9%), Qom (% C = – 18.9%), and Markazi (%C = – 18.5%) from 1990 (Table 2).

The three regions with the highest ASDR due to AA in 2019 were East Azarbayejan [ASDR = 33.27 (27.62–40.86)], Chahar Mahaal and Bakhtiari [ASDR = 29.37 (23.19–36.67)], and Isfahan [ASDR = 24.81 (20.33–30.00)]. With the lowest ASDRs, however, were Kohgiluyeh and Boyer-Ahmad [ASDR = 14.95 (11.90–18.56)], North Khorasan [ASDR = 15.95 (13.39–18.94)], and Qom [ASDR = 16.37 (13.54–19.48)]

Table 1

Comparison of the burden of abdominal aortic aneurysms in Iran, Middle East and North Africa, and the world

Location name	1990 deaths rate (age-std)	2019 deaths rate (age-std)	Percentage change (death rate) (%)	1990 DALYs rate (age-std)	2019 DALYs rate (age-std)	Percentage change (DALY rate) (%)
Global	2.7 [2.47–2.91]	2.21 [2.0–2.35]	– 17.91	50.79 [46.5–55.66]	40.94 [38.2–43.43]	– 19.39
MENA	1.49 [1.13–1.86]	1.35 [1.18–1.57]	– 8.87	33.13 [24.97–42.42]	28.02 [24.28–32.83]	– 15.42
Iran	1.11 [0.88–1.33]	1.02 [0.9–1.12]	– 8.17	22.2 [17.46–26.86]	19.97 [17.98–21.98]	– 10.08

DALY, disability-adjusted life year.

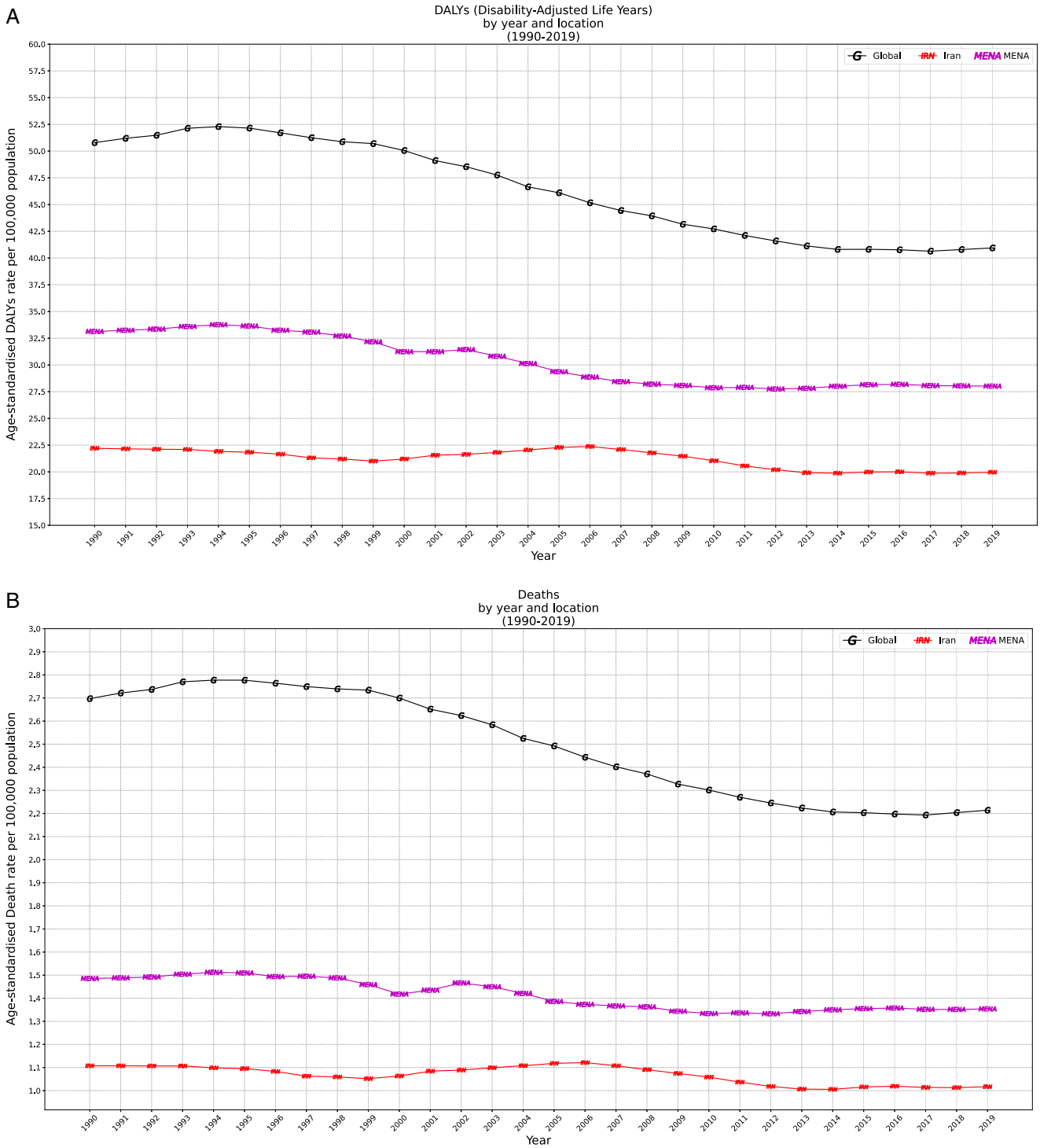

Figure 1. Comparison of age-standardized disability-adjusted life year (DALY) rate (A) and age-standardized mortality rate (B) of abdominal aortic aneurysms in Iran, Middle East and North Africa, and the world.

(Fig. 6). East Azarbayejan (%C = 21.8%), Chahar Mahaal and Bakhtiari (%C = 6.9%), and Zanjan (%C = 6.7%) saw the largest increases in ASDR. However, when compared to 1990, ASDR was significantly lower in Tehran (%C = −24.4%), Qom (%C = −23.5%), and Kermanshah (%C = −21.6%).

Mortality attributable to risk factors

In 2019, three leading risk factors yielding death in AA patients were smoking [ASMR attributable = 0.73 (0.67–0.80)], high sodium intake [ASMR attributable = 0.11 (0.03–0.27)], and lead exposure [ASMR attributable = 0.04 (0.02–0.07)].

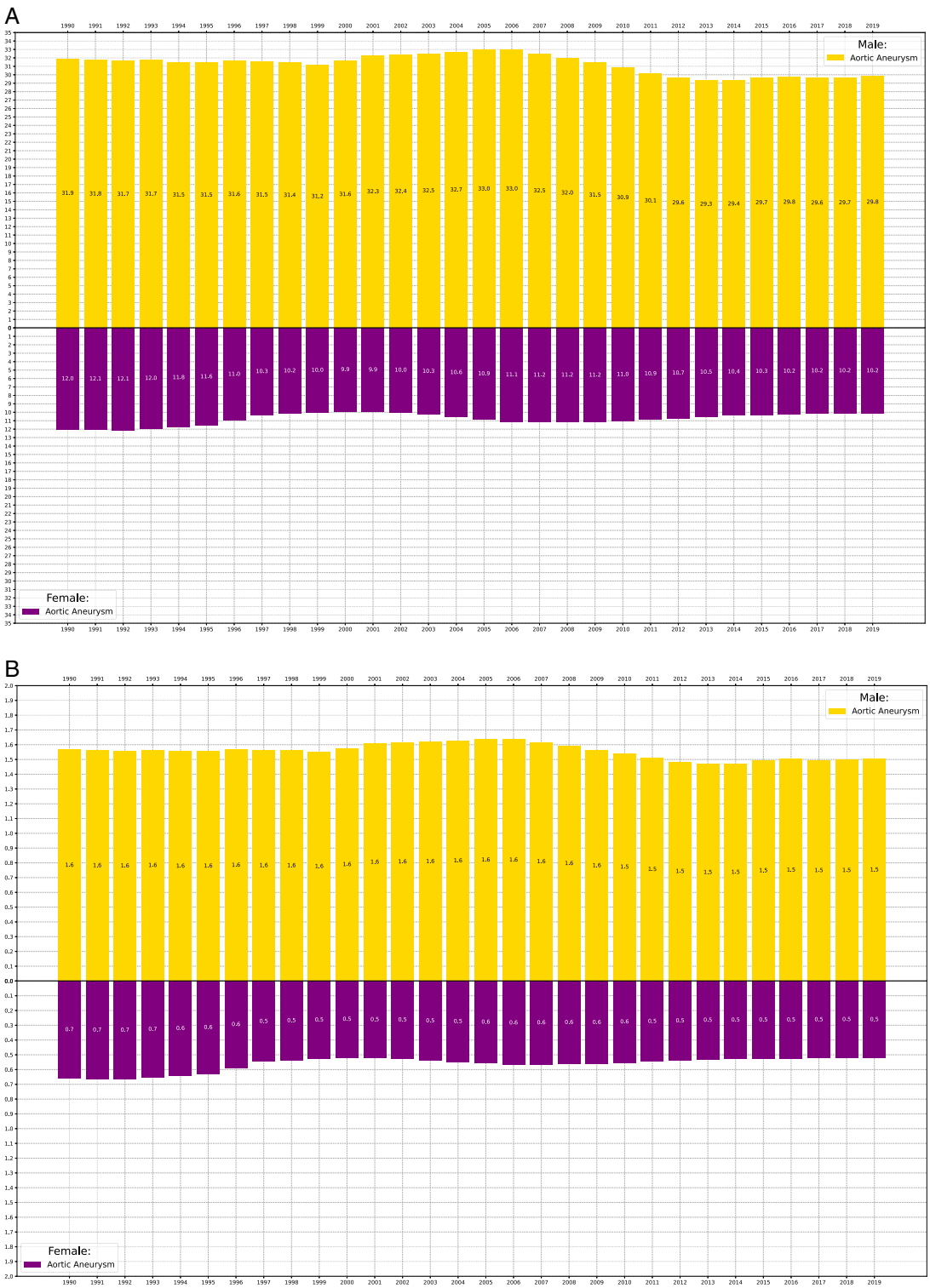

Figure 2. Age-standardized disability-adjusted life year (DALY) rate (A) and age-standardized mortality rate (B) of abdominal aortic aneurysms among males and females in Iran from 1990 to 2019.

Discussion

This study looked into the mortality and disease burden in Iran due to AA using data from the GBD 2019. Results showed a modest decrease in mortality and DALY rates over 30 years, but this decline was less pronounced compared to global trends. The study also found that AA mortality affected men more than women, aligning with global patterns[10]. A notable association was observed between age and disease burden, with increased mortality and DALY rates in older age groups, especially those

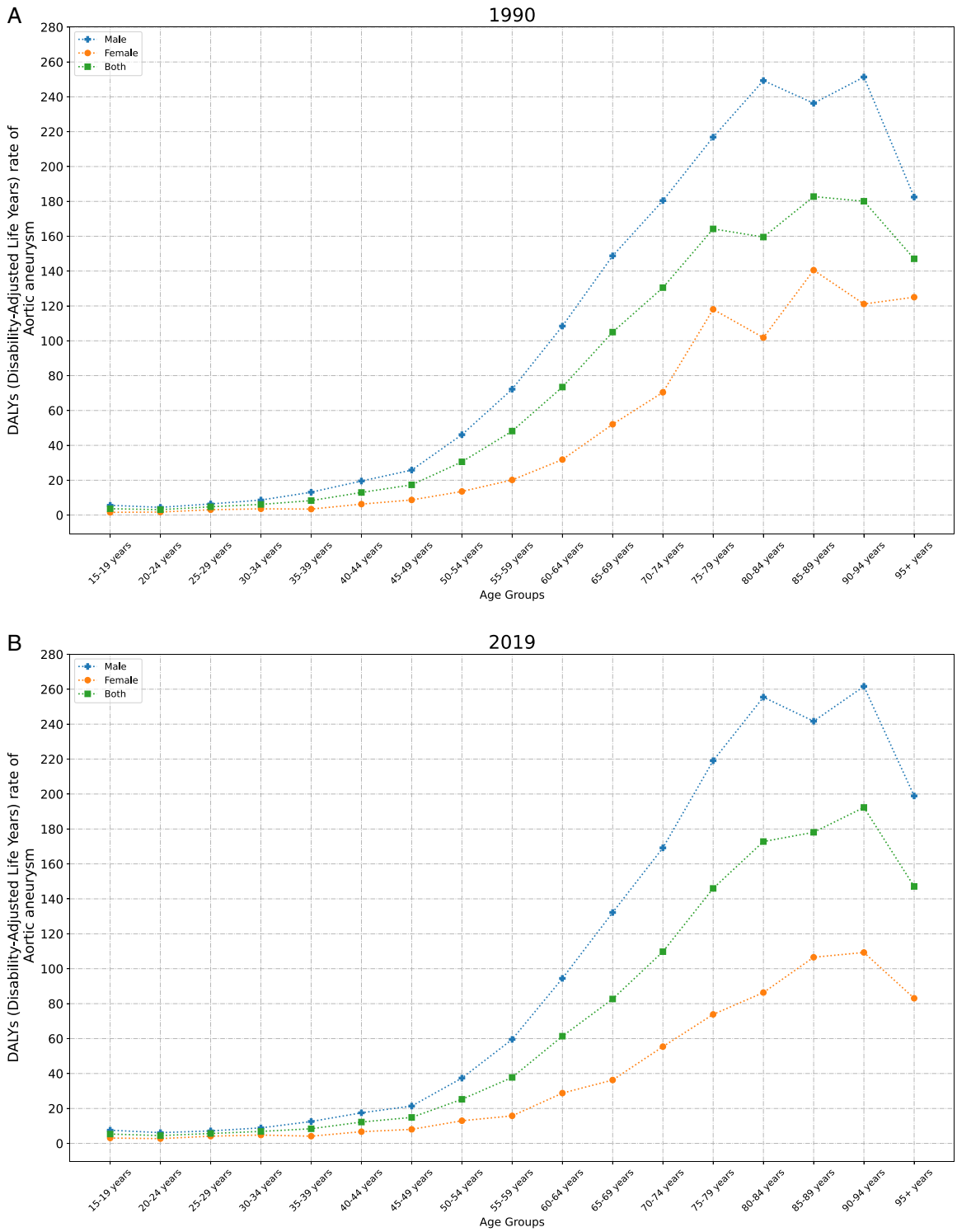

Figure 3. Age-standardized disability-adjusted life year (DALY) rate of abdominal aortic aneurysms in Iran across age groups in 1990 (A) and 2019 (B).

above 90. While there was a national decline in mortality, regional analysis indicated rising death rates in some provinces from 1990 to 2019.

Notably, mortality associated with AA is higher in men and older persons, suggesting that demographic factors play a significant role in determining health outcomes[17]. The review by Sprynger and colleagues indicates that the primary population afflicted by abdominal AA is elderly adults[18,19]. They recommend screening programs targeted at individuals 65 years of age or above due to the higher incidence rates in this population. This

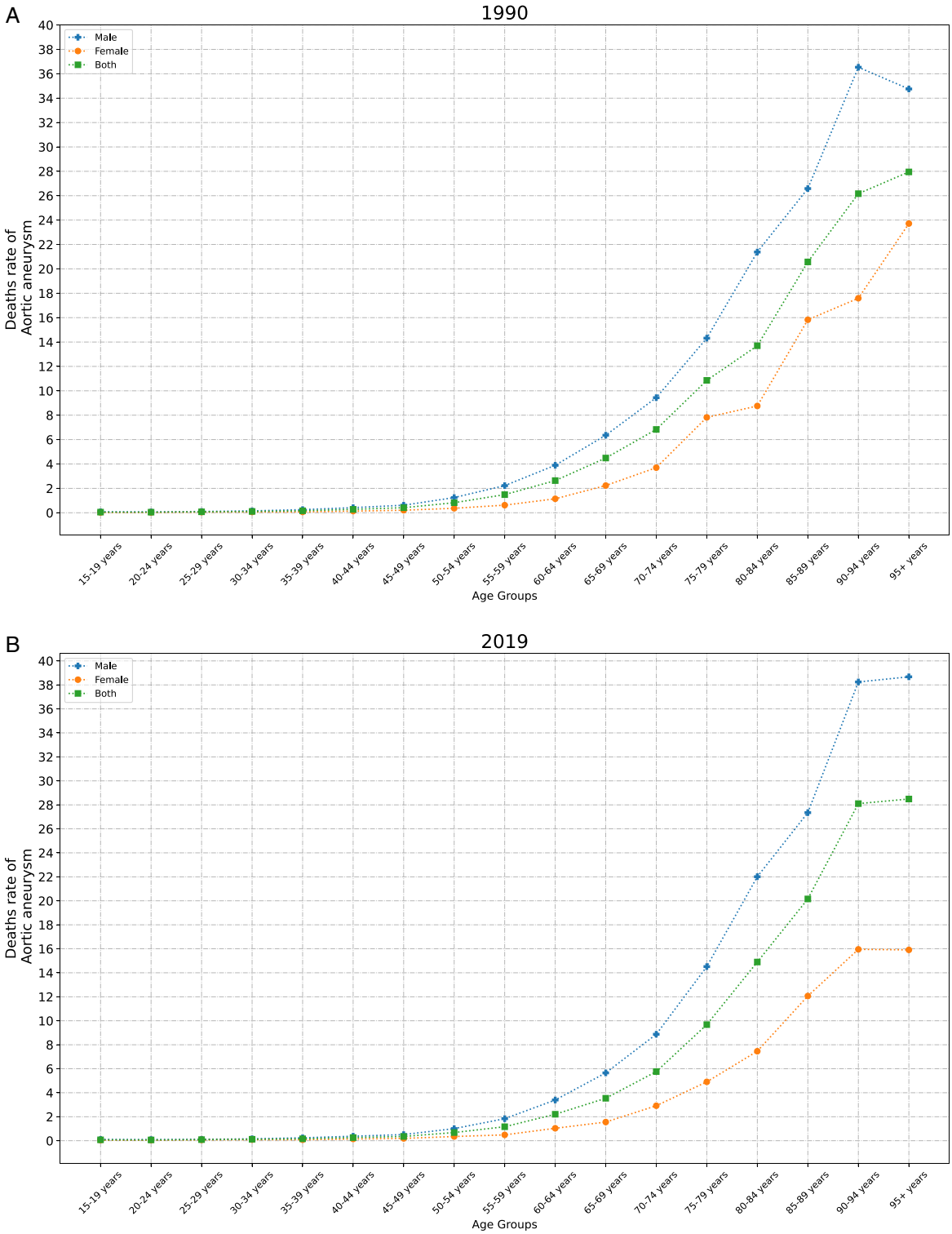

Figure 4. Age-standardized mortality rate of abdominal aortic aneurysms in Iran across age groups in 1990 (A) and 2019 (B).

sex-specific variation in the incidence of AA may be related to hormonal status[20,21]. Among the female sex hormones, estrogen seems to be particularly protective. While androgens, although normally detrimental, maintain the integrity of the aortic wall and might be useful in future treatment design. Further research, particularly including human beings, is required to properly understand the sex differences in AA's burden.

On the other hand, Iranian population has always been the main focus of studies on health disparities and their correlation with life expectancy[16,22,23]. An equitable allocation of

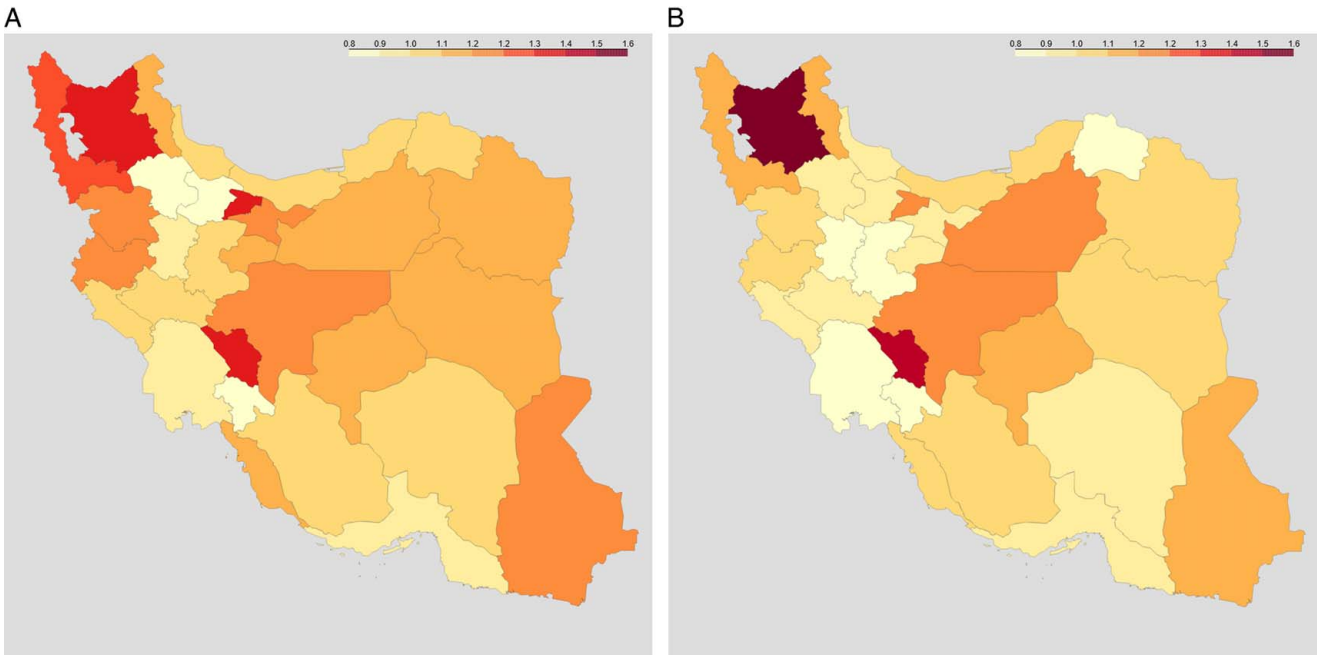

Figure 5. Age-standardized mortality rate of abdominal aortic aneurysms in Iran across provinces in 1990 (A) and 2019 (B).

healthcare across regions can have a significant impact on mortality from a variety of reasons. Early detection of AA is crucial in reducing cardiac problems and mortality in people with the condition. AA screening is a priority for many nations, particularly for the elderly. However, in many Iranian districts, this problem is still unresolved. Consequently, a delay in diagnosis may increase mortality and burden. However, compared to 1990, there has been a rise in mortality in some provinces. It is possible to draw the conclusion that either the population in these areas has aged or that access to health services has gotten worse over time[24]. Both theories raise significant issues for public health, and Iran's healthcare system should concentrate on determining the precise reason for this rise and also seeking a solution.

Smoking, being exposed to lead, and consuming a diet high in sodium have all been found to be three major risk factors for death. Yang *et al.*[25] discovered that smokers had a higher risk ratio of dying from an AA than non-smokers after evaluating more than 91 000 individuals in Japan. Additionally, they discovered that in these individuals, stopping smoking dramatically lowers mortality. Peterson *et al.*[26] confirmed above findings regarding Endovascular Repair postoperative outcome in the US. Smoking may specifically disturb collagen synthesis, modify the production of matrix metalloproteinases (MMPs), and cause oxidative stress, among other pathophysiological pathways that influence the formation and occurrence of AA[27]. Additionally, it is well established that exposure to lead damages the heart and blood vessels, raising the risk of cardiovascular disease by changing blood vessel cell activity, causing inflammatory reactions, and upsetting calcium homeostasis[28]. Lead exposure has also been connected to aortic elasticity parameter degradation, which may result in the formation of an AA[29]. Eventually, according to recent studies, older men who consume excessive amounts of sodium may be more likely to develop abdominal aortic aneurysms (AAA) and have greater aortic diameters[30]. Although the precise process by which a high salt diet influences the likelihood of an AA is unclear, it is thought to be related to the onset of hypertension, which can cause damage to the aorta wall and the aneurysm's formation[30]. It appears that understanding the risk factors as much as possible can aid in improved disease management, as the prevalence of AA has increased in certain nations.

There were variations in the burden of AA across different provinces of Iran, with East Azarbayejan, Chahar Mahaal and Bakhtiari, and Isfahan having the highest ASDR attributable to AA in 2019. There may be several reasons for this disparity. In particular, East Azarbayejan and Chahar Mahaal and Bakhtiari are two provinces with high smoking prevalence rates[31], especially among males, which, considering smoking as a risk factor for AA, may consequently contribute to a higher burden of AA among people living in these provinces. Additionally, East Azarbayejan is one of the provinces in Iran with low in-patient health service utilization compared to other provinces of Iran, which may lead to worse outcomes in patients with AA, contributing to its high burden in this province[32]. Enhancing screening and treatment utilities, and targeting modifiable risk factors of AA in these provinces, is crucial for reducing the burden of AA in these areas.

The studies using GBD data offer valuable epidemiological insights but face several limitations. Key among these is the failure to report the incidence and prevalence of AA in the 2019 data, significantly affecting data interpretation related to disease burden and mortality. The accuracy of estimates in Iran's socioeconomically disadvantaged provinces may have degrees of inaccuracy due to insufficient research, potentially skewing results. Additionally, the study overlooks the impact of major factors like diabetes, except for the three risk factors mentioned in

Table 2

Burden of abdominal aortic aneurysms across Iran's provinces

Location name	1990 deaths rate (age-std)	2019 deaths rate (age-std)	Percentage change (death rate) (%)	1990 DALYs rate (age-std)	2019 DALYs rate (age-std)	Percentage change (DALY rate) (%)
Alborz	1.37 [0.99–1.78]	1.17 [0.98–1.39]	– 15.12	27.6 [18.63–36.82]	22.8 [18.95–27.22]	– 17.38
Ardebil	1.11 [0.82–1.45]	1.13 [0.96–1.32]	2.37	21.78 [15.63–29.42]	20.83 [17.78–24.32]	– 4.38
Bushehr	1.06 [0.77–1.37]	1.0 [0.83–1.18]	– 6.16	20.66 [14.63–27.17]	18.26 [15.22–21.64]	– 11.60
Chahar Mahaal and Bakhtiari	1.37 [1.07–1.68]	1.46 [1.15–1.79]	6.66	27.48 [21.21–34.65]	29.37 [23.19–36.67]	6.88
East Azarbayejan	1.37 [1.03–1.75]	1.63 [1.36–1.98]	18.45	27.32 [19.92–35.81]	33.27 [27.62–40.86]	21.77
Fars	1.03 [0.75–1.35]	1.03 [0.83–1.26]	– 0.39	20.54 [14.51–27.68]	19.52 [15.77–24.12]	– 4.96
Gilan	0.97 [0.71–1.27]	0.94 [0.78–1.11]	– 3.27	19.58 [14.07–26.37]	17.71 [14.61–21.05]	– 9.57
Golestan	1.03 [0.79–1.28]	1.04 [0.88–1.21]	0.27	21.48 [16.14–27.29]	21.01 [17.92–24.49]	– 2.21
Hamadan	0.96 [0.7–1.27]	0.85 [0.7–1.01]	– 11.76	20.09 [14.38–27.4]	17.13 [14.22–20.47]	– 14.73
Hormozgan	0.96 [0.69–1.27]	0.88 [0.72–1.07]	– 8.13	19.09 [13.06–25.94]	16.74 [13.6–20.22]	– 12.32
Ilam	0.97 [0.67–1.31]	0.96 [0.78–1.13]	– 1.09	18.88 [12.8–25.75]	17.7 [14.51–20.9]	– 6.28
Isfahan	1.16 [0.83–1.52]	1.22 [1.01–1.45]	4.69	23.5 [16.38–31.75]	24.81 [20.33–30.0]	5.58
Kerman	1.06 [0.81–1.35]	0.89 [0.74–1.06]	– 15.36	21.35 [15.9–27.89]	16.8 [13.95–20.16]	– 21.32
Kermanshah	1.19 [0.89–1.52]	0.98 [0.8–1.19]	– 17.25	23.54 [17.39–31.09]	18.45 [15.0–22.5]	– 21.61
Khorasan-e-Razavi	1.11 [0.84–1.42]	1.0 [0.82–1.19]	– 9.68	22.34 [16.46–29.58]	18.97 [15.65–22.7]	– 15.09
Khuzestan	0.93 [0.69–1.21]	0.87 [0.73–1.03]	– 6.39	19.04 [13.82–25.51]	17.02 [14.31–20.18]	– 10.59
Kohgiluyeh and Boyer-Ahmad	0.79 [0.55–1.06]	0.78 [0.62–0.97]	– 1.43	15.62 [10.31–21.8]	14.95 [11.9–18.56]	– 4.28
Kurdistan	1.23 [0.91–1.64]	1.01 [0.82–1.21]	– 17.48	24.26 [17.65–33.35]	19.47 [15.74–23.45]	– 19.72
Lorestan	1.0 [0.74–1.3]	0.91 [0.73–1.1]	– 9.05	19.78 [14.24–26.8]	17.19 [13.83–21.06]	– 13.12
Markazi	1.05 [0.8–1.34]	0.85 [0.7–1.02]	– 18.50	21.05 [15.72–27.99]	16.93 [13.97–20.32]	– 19.55
Mazandaran	1.02 [0.7–1.36]	0.99 [0.81–1.19]	– 2.98	20.37 [13.76–27.94]	19.31 [15.85–23.17]	– 5.20
North Khorasan	0.97 [0.72–1.34]	0.82 [0.69–0.98]	– 14.81	19.91 [14.49–28.43]	15.95 [13.39–18.94]	– 19.91
Qazvin	0.84 [0.64–1.08]	0.9 [0.75–1.06]	6.73	16.62 [12.1–21.75]	17.26 [14.3–20.47]	3.84
Qom	1.08 [0.79–1.41]	0.88 [0.72–1.05]	– 18.88	21.41 [14.69–28.81]	16.37 [13.54–19.48]	– 23.55
Semnan	1.11 [0.83–1.44]	1.17 [0.95–1.41]	5.18	22.24 [16.0–29.66]	23.3 [19.13 –28.05]	4.74
Sistan and Baluchistan	1.17 [0.81–1.57]	1.1 [0.91–1.33]	– 5.76	23.94 [15.46–33.36]	24.45 [20.11–29.37]	2.12
South Khorasan	1.12 [0.82–1.52]	0.99 [0.82–1.19]	– 11.99	21.78 [15.63–30.9]	17.9 [15.0–21.67]	– 17.82
Tehran	1.19 [0.82–1.66]	0.9 [0.74–1.09]	– 23.95	23.73 [16.03–34.1]	17.93 [14.82–21.74]	– 24.44
West Azarbayejan	1.25 [0.96–1.6]	1.1 [0.92–1.32]	– 11.81	24.5 [18.5–31.84]	20.97 [17.5–24.93]	– 14.42
Yazd	1.06 [0.8–1.35]	1.13 [0.88–1.4]	5.95	21.47 [15.71–28.25]	21.91 [17.12–27.38]	2.08
Zanjan	0.79 [0.58–1.02]	0.91 [0.75–1.05]	15.20	15.54 [11.2–20.69]	16.57 [13.77–19.46]	6.65

DALY, disability-adjusted life year.

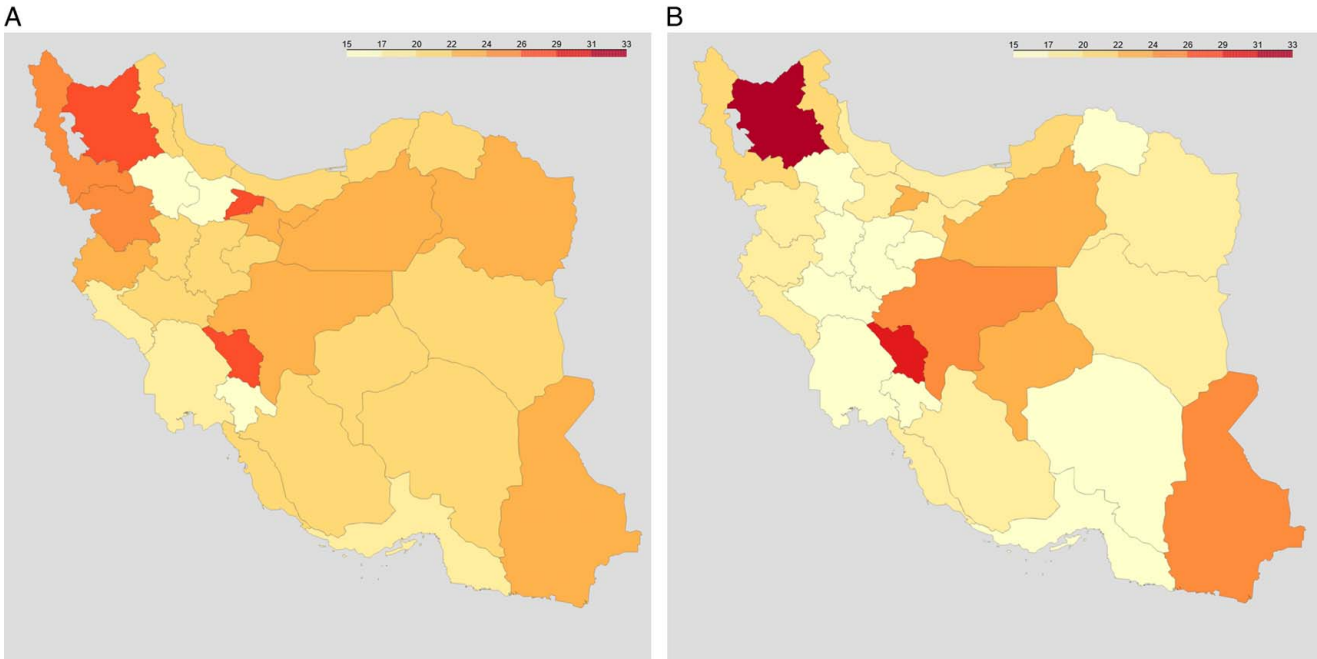

Figure 6. Age-standardized disability-adjusted life year rate of abdominal aortic aneurysms in Iran across provinces 1990 (A) and 2019 (B).

the results. Furthermore, the roles of possible factors contributing to the burden of AA, such as genetic disposition were not evaluated in the GBD study. No separate research has been conducted on the disease burden of other AA types, such as abdominal aortic aneurysm. Addressing these issues in future GBD data updates is recommended.

Conclusion

In conclusion, mortality and DALYs due to aortic aneurysm were both decreased slightly during the last three decades. However, compared to the world or MENA, the slope was less steep. Considering the role of smoking in the burden of AA in Iran, interventions targeting smoking cessation among high-risk groups, such as males, may be helpful to reduce the burden of AA in Iran in the coming years.

Ethical approval

Ethics approval and consent to participate: This study didn't involve any estimation and utilized the available GBD study data.

Consent

Informed consent was not required for this study.

Source of funding

Not applicable.

Author contribution

Conceptualization: M.M.A. Methodology: M.M.A. Data analysis: M.M.A. Drafting the manuscript: K.A., S.R., S.S. Revising the manuscript: all authors. Supervision: F.S. All authors read and approved the final version of the manuscript.

Conflicts of interest disclosure

The authors declare no conflict of interest.

Research registration unique identifying number (UIN)

As this study didn't involve human participants, we didn't register the study prior to conducting it. The details on methods for GBD estimations are described in the original article (https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30925-9/fulltext).

Guarantor

Milad Mellat Ardakani.

Data availability statement

The raw data for this study are available from the GBD website (https://vizhub.healthdata.org/gbd-results/).

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