Trends in the burden and determinants of hypertensive heart disease in the Eastern Mediterranean region, 1990–2019: an analysis of the Global Burden of Disease Study 2019

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Summary

Background Hypertensive heart disease (HHD), one of the end-organ damage consequences of hypertension, is an important public health issue worldwide. Data on the HHD burden in the Eastern Mediterranean region (EMR) are scarce. We aimed to investigate the burden of HHD in the EMR, its member countries, and globally from 1990 to 2019.

Methods We used 2019 Global Burden of Disease (GBD) data to report the HHD age-standardised prevalence, disability adjusted life years (DALYs), years of life lost (YLLs), and mortality, as well as HHD risk factors attribution percent with their 95% uncertainty interval (UI). Global data are reported alongside EMR data, and its 22 respective countries. We compared the burden of HHD by socio-demographic index (SDI), sex, age groups, and countries.

Findings The age-standardised prevalence rate (per 100,000 population) of HHD was higher in the EMR (281.7; 95% UI: 204.5–383.4) in 2019, compared with the global prevalence (233.8; 95% UI: 170.5–312.9). The EMR age-standardised DALYs (per 100,000 population) for HHD in 2019 was 561.9 (361.0–704.1), compared with 268.2 (204.6–298.1) at the global level. There was an increase in HHD prevalence, reduction in mortality, and DALYs between 1990 and 2019 (4.01%, –7.6%, and –6.5%, respectively) in EMR. Among EMR countries, the highest versus lowest rates of age-standardised prevalence, mortality, and DALYs in 2019 [estimate (95% UI)] were in

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Jordan [561.62 (417.9–747.6)] versus Saudi Arabia [94.9 (69.5–129.0)]; Afghanistan [74.5 (23.7–112.3)] versus Saudi Arabia [4.3 (3.3–5.9)]; and Afghanistan [1374.1 (467.2–2020.7)] versus Qatar [87.11 (64.40–114.29)], respectively.

Interpretation HHD remains a significant problem in the EMR, with a higher burden than global levels. Serious efforts toward high-quality management and prevention are strongly recommended. Based on this study, our recommendation for the EMR is to adopt effective preventive strategies. For example, promoting healthy dietary patterns and prompt screening for undiagnosed HTN in public places, promoting regular blood pressure measurements at home, and creating community awareness about early detection of HTN.

Funding None.

Keywords: Global burden of disease; Hypertensive heart disease; Disability-adjusted life years; Years of life lost; Eastern Mediterranean region

Research in context

Evidence before this study

Existing literature on global burden of hypertensive heart disease (HHD) in Eastern Mediterranean region (EMR) countries are very limited. Multiple search terms ('Eastern Mediterranean Region' 'hypertensive heart disease', 'prevalence', 'global burden of disease', 'disability adjusted life years (ADLY)', 'years of life lost (YLL)' and 'burden of hypertensive heart disease') were used to search PubMed, Scopus, Web of Science and Science Direct for articles published in English or any other languages up to Oct 22, 2022. The worldwide burden of HHD between 1990 and 2019 has been published from the Global Burden of Disease (GBD) study 2019 reporting changes in prevalence, mortality, and DALYs of HHD. To the best of our knowledge, no comprehensive study on the burden of HHD in the EMR region has been made available to date.

Added value of this study

Our findings show an increase in the prevalence and a reduction in mortality and DALYs of HHD between 1990 and 2019 in the EMR. The age-standardised prevalence, mortality and DALYs of HHD was higher in the EMR than globally. High body mass index, diets high in sodium and alcohol use had the greatest contribution to HHD-related death in the EMR, in order of importance. We observed an inverse relationship between the Healthcare Access and Quality index and HHD mortality in EMR countries. The burden of HHD varied widely between EMR nations, notably by socio-demographic index (SDI); generally, those with a higher SDI had a better overall status than those with moderate or lower SDIs.

Implications of all the available evidence

According to the results of this study, the HHD burden in the EMR is in a worse state than it is on a worldwide scale. Given the importance of such a burden, health policymakers must take substantial steps to develop effective preventative policies, such as encouraging good food patterns (particularly salt reduction); prompt screening for undiagnosed hypertension (HTN) in public places; promote regular blood pressure measurements at home; provide cheap and easy medications like poly-pills; put cases with controlled HTN as key performance indicators for primary health care or cardiology clinics; facilitate physical activity; and create community awareness about the early detection of HTN, stress management, and self-management of HTN. In addition, considering the important role of this disease in causing major cardiovascular events (like myocardial infarction, congestive heart failure, stroke, and sudden death), it is necessary to develop the existing infrastructure to improve diagnostic facilities for early detection of this disease.

Introduction

Hypertensive heart disease (HHD), one of the end-organ damage consequences of hypertension (HTN), is a worldwide concern with significant impact on health and quality of life.[1] By definition "HHD includes left ventricular hypertrophy, systolic and diastolic dysfunction, and a broader spectrum of cardiac and vascular adaptations".[1] About one-fourth of all heart failures are caused by HHD.[2] HHD's spectrum is very heterogeneous, ranging from left ventricular hypertrophy, left atrium dilatation, atrial fibrillation, fibrosis, heart failure (HF) from reduced ejection fraction HF to preserved ejection fraction HF, vasculopathy, maybe even includes ischemic heart disease.[3] HHD by definition occurs only in people with HTN.[4] Patients with HHD are at higher risk for cardiovascular events like myocardial infarction, congestive heart failure, stroke, and sudden death compared with individuals with hypertension alone.[5]

According to the 2019 Global Burden of Disease (GBD) report, the global age-standardised prevalence of HHD increased by 137.9% from 1990 to 2019.[1]

As HHD results from chronic high blood pressure,[2] intensive control of HTN has substantial impact on improving the prognosis of HHD.[1] However, the rate of HTN control, defined as systolic blood pressure of <130 mmHg and diastolic blood pressure of <80 mmHg in hypertensive patients taking medication,[6] is low both globally and in different countries and regions. In a cross-sectional study of 142,042 adults aged 35–70 years from 17 countries categorised by income status, the total HTN control rate was 32.5%.[7] The HTN control rate in high income countries (HIC), upper middle income countries (UMIC), lower middle income countries (LMIC) and low income countries (LIC) was 19.0, 15.6, 9.9, and 12.7%, respectively.[7]

The Eastern Mediterranean region (EMR), one of the six geographical regions of the World Health Organization (WHO), consists of 22 countries (mostly categorised as UMIC and LMIC) with a population of about 583 million.[8] According to the GBD 2019 study, 1,374,977.50 deaths in the EMR were attributable to CVD, of which HHD accounted for 7.5% (102,544.92) of deaths, constituting the third most common etiology of CVD death in the region.[9] Among the six regions of the World Health Organization, the first region in terms of HTN prevalence is Africa and the second is the EMR.[10] However, the rate of HTN control in this region was low and, 40%.[11] Some reasons for low control of HTN in this region are poor insurance coverage, in availability of cheap generics of combination drugs, poor primary health care systems, and poor screenings.[12,13]

Though helpful in assisting with the prevention and management of HHD, no comprehensive study on the burden of HHD in the EMR region has been made available to date.[14] Accordingly, we aim to investigate the burden of HHD in the EMR compared to the global level and among its member countries in the region from 1990 to 2019.

Methods

We used the data of GBD 2019,[9] executed by the Institute for Health Metrics and Evaluation (IHME), to report the HHD burden in this study. GBD 2019—as the most comprehensive and up-to-date source for the assessment and estimation of diseases and injuries burden—includes data on the most important causes of morbidity and mortality burden from 1990 to 2019 at global, regional, and national levels by age and sex. All estimations reported in this study are publicly available from the IHME website (https://vizhub.healthdata.org/gbd-compare/ and http://ghdx.healthdata.org/gbd-results-tool). The study used available data from the GBD 2019 study and did not require ethical approval.

According to WHO's classification, the EMR region consists of 22 countries including Afghanistan, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab republic, Tunisia, Palestine, the United Arab Emirates (UAE), and Yemen.

Case definition and input data

HHD is considered as a cause in GBD data source. Cause is defined as "a single disease or injury or an aggregation of diseases and injuries that causes death or disability" in this database.[15] GBD 2019 mapped HHD to the following codes: I-11-I11.9 (ICD-10) and 402–402.91 (ICD-9). Input data for estimation of HHD burden in GBD 2019 were extracted from vital registration, hospital and physician visit data.[9] These sources are downloadable from GBD 2019 Data Input Sources Tool website (http://ghdx.healthdata.org/gbd-2019/data-input-sources). More details on GBD 2019 data source have been presented in Supplementary-Part 1. The related ICD codes have been presented in Supplementary-Part 2.

We reported the prevalence, deaths, disability adjusted life years (DALYs), years of life lost (YLLs), attributable risks with their 95% uncertainty interval (UI) for HHD at the global level, in the EMR and in its member countries from 1990 to 2019. Details on how the estimates were produced have been presented in Supplementary-Part 3. The estimates reported were calculated for three time points of 1990, 2010, and 2019. In addition, we calculated the percentage change of these indices during each time period by dividing the difference of the values of those indices at two time points by the value of that index at the beginning of the period. We used age-standardised estimates for all measures. The metric used for all measures except attributable risks was rate. For attributable risks, we selected "Risk" from "Context" query box, "Death" from "Measure" query box, and "Percent" from "Metric" query box. It should be mentioned that for HHD as a cause in GBD database, attributable risks are estimable only for four risk factors including high systolic blood pressure (defined as blood pressure higher than 110–115 mm Hg), alcohol use (defined as any alcohol consumption"), a diet high in sodium (defined as "consumption of more than 1000 mg of sodium per day), and a high body mass index (BMI) (defined as "body mass index higher than 21.0–23.0 kg/m^2").

We categorised the EMR countries by socio-demographic index (SDI) developed by IHME.[16] The SDI, ranging from 0 (lowest development) to 1 (highest development), is a composite index of factors including income per capita, average educational attainment, and fertility rate to make it possible to compare societies in terms of social development.[17] The 2019 SDI in the EMR ranged from 0.081 in Somalia to 0.88 in UAE. We used SDI quintiles developed by GBD for categorizing countries in the EMR, where Pakistan, Afghanistan, Somalia and Yemen were in the first quintile (low SDI group, SDI < 0/454743); Palestine, Sudan, Djibouti and Morocco in the second quintile (low middle SDI group, 0/454743 < SDI < 0/607679), Iran, Syrian Arab republic,

Iraq, Tunisia and Egypt in the third quintile (middle SDI group, 0/607679 < SDI < 0/689504); Oman, Bahrain, Saudi Arabia, Jordan, Lebanon, and Libya in the fourth quintile (high middle SDI group, 0/689504 < SDI < 0/805129); and finally Kuwait, Qatar, and UAE in the fifth quintile (high SDI group, SDI ≥ 0/805129).[16] We also used the Healthcare Access and Quality index (HAQ) constructed by IHME[18] to determine the relationship between healthcare and HHD in the EMR. HAQ consists of the combination of mortality-to-incidence ratio for cancers and risk-standardisation of death rates for non-cancer causes.[19] HAQ is measured on a scale of 0 (the worst) to 100 (the best). HAQs are only available for GBD 2015 and 2016. In our analysis, the HAQs of EMR countries were determined using 2015 GBD study.[18] We used 2015 data because it was closer to the midpoint of our study period (2010).

Statistical analysis

The age standardised rates of HHD deaths and DALYs by country, sex and year were obtained from GBD 2019 by GBD results tool.[20] Age standardisation was performed via a direct method, applying the estimated age structure of the global population from 2019.[21] UIs were calculated by repeating all calculations 1000 times and taking the 2.5th and 97.5th percentiles of them. All figures were plotted by R software, version 4.2.2.[22] Statistical and calculation details have been extensively explained in previous GBD studies.[9]

Role of the funding source

We have no funding sources in this study.

Results

The age-standardised prevalence of HHD (per 100,000 population) was higher in EMR compared with global level at all studied time points (Table 1). This difference persisted by age and sex (Fig. 1 & Supplementary-Part 4, Tables S1–S3). There was an increase in the trend of HHD age-standardised prevalence from 1990 to 2019 at both global and EMR levels, and the percentages of change were 6.48% and 9.28%, respectively (Table 1).

According to age-groups, the lowest HHD prevalence was in the 25–49 age group, while the highest HHD prevalence was among those 70 years and over at the global and EMR levels for both males and females as shown in Supplementary-Part 4, Tables S2 & S3).

SDI group	Geographical area	1990			2010			2019			%Δ (1990–2010)	%Δ (2010–2019)	%Δ (1990–2019)
		Prevalence	95% UI		Prevalence	95% UI		Prevalence	95% UI				
			Upper	Lower		Upper	Lower		Upper	Lower			
	Global	219.54	299.4	158.8	228.9	304.6	167.5	233.77	312.9	170.5	4.26	2.13	6.48
	EMR	257.73	353.9	186.8	270.79	369.5	196.4	281.65	383.4	204.5	5.07	4.01	9.28
High SDI	Kuwait	512.22	682.8	373.8	509.77	691.1	369.8	514.94	690.6	376.3	−0.48	1.01	0.53
	Qatar	116.6	152	89.2	107.35	144.4	78.6	105.23	143.1	76.2	−7.93	−1.97	−9.75
	United Arab Emirates	403.09	547.1	292.2	408.02	567.3	294	424.02	577.3	305.2	1.22	3.92	5.19
High middle SDI	Oman	183.72	241.6	141.5	216.87	298.5	157.6	223.09	303.1	162.4	18.04	2.87	21.43
	Bahrain	158.36	218.3	115.7	147.48	203.8	106.7	145.26	197.9	105.2	−6.87	−1.51	−8.27
	Saudi Arabia	87.72	119.7	63.4	93.5	128.2	67.5	94.86	129	69.5	6.59	1.45	8.14
	Jordan	536.69	710.9	395.1	558.55	748.1	411	561.62	747.6	417.9	4.07	0.55	4.65
	Lebanon	410.5	556.5	300.1	418.8	568.5	306.1	428.83	568.5	306.1	2.02	2.39	4.47
	Libya	370.77	501.2	272.5	378.18	517.8	273.5	389.51	534.1	282.7	2.00	3.00	5.05
Middle SDI	Iran	420.1	566.2	303	392.71	530.4	282.8	406.32	546.3	293.7	−6.52	3.47	−3.28
	Syrian Arab Republic	106.13	145.1	76.3	110.43	150.9	79.5	112.28	156.4	81.1	4.05	1.68	5.79
	Iraq	252.47	351.6	184.7	243.03	336.1	175.7	249.77	349.7	179.6	−3.74	2.77	−1.07
	Tunisia	371.76	501.6	267.3	369.29	500.9	269.5	378.24	513.6	277.5	−0.66	2.42	1.74
	Egypt	270.73	399.7	177.2	273.45	396.6	175.9	283.14	416.5	183.8	1.00	3.54	4.58
Low middle SDI	Palestine	336.88	464.8	245.9	326.33	451.2	235.4	337.00	466.3	243.8	−18.92	0.04	0.04
	Sudan	330.63	456.9	239.6	314.83	437.4	226.4	364.63	500.0	263.6	−24.78	0.00	10.28
	Djibouti	299.9	428.8	200.9	315.72	451.5	211.6	319.34	459.3	213.6	5.28	1.15	6.48
	Morocco	353.04	483.2	255.5	349.86	478.9	251.6	355.93	487.7	258.7	−0.90	1.73	0.82
Low SDI	Pakistan	133.49	188.5	92.6	139.48	199.3	97.1	138.55	196.9	96.2	4.49	−0.67	3.79
	Afghanistan	333.31	456.3	243	344.05	468.7	251.5	357.56	491.3	261.6	3.22	3.93	7.28
	Somalia	249.59	356.8	167.4	248.7	353.9	167.9	248.69	359.6	167.5	−0.36	0.00	−0.36
	Yemen	351.69	479.7	258.8	363.56	495.1	262.7	375.92	511.6	274.8	3.38	3.40	6.89

EMR: Eastern Mediterranean region; UI: uncertainty interval; SDI: socio-demographic index.

Table 1: **Age-standardised prevalence rate (per 100,000 population) of hypertensive heart disease based on socio-demographic index in the Eastern Mediterranean countries in 1990, 2010, and 2019.**

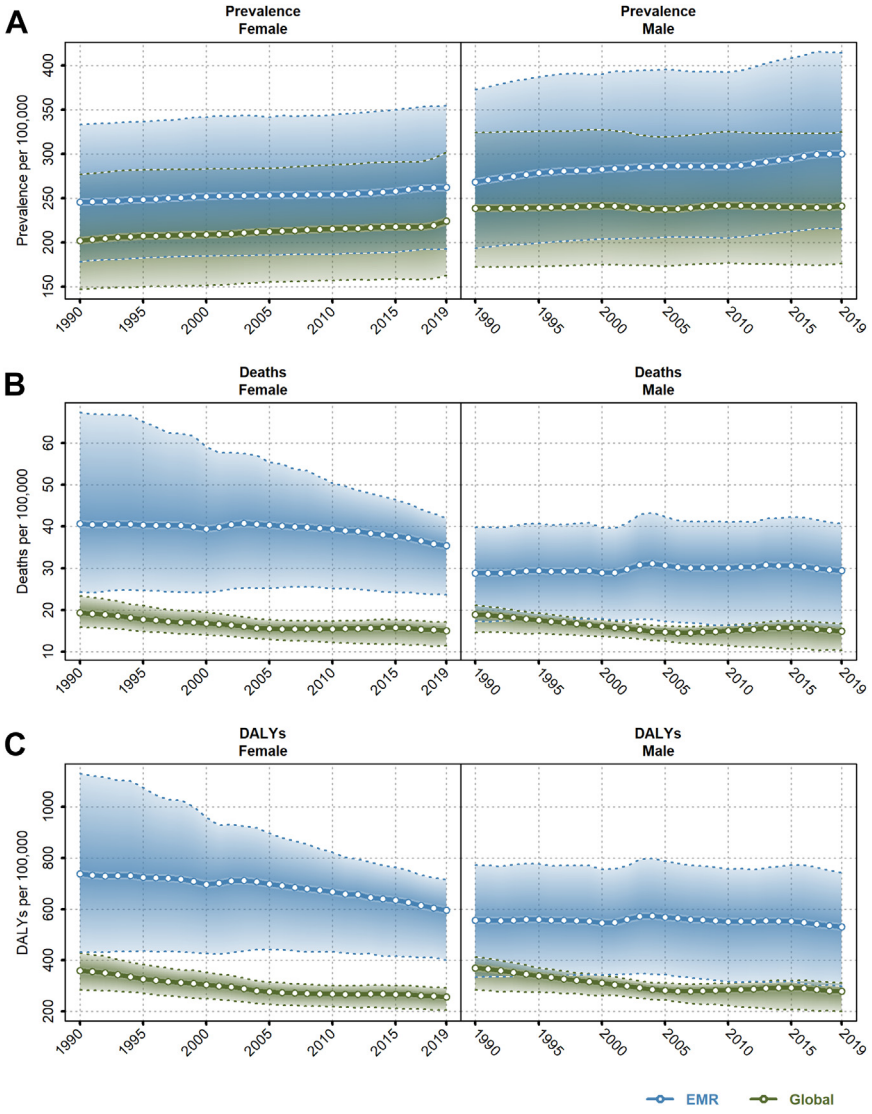

Fig. 1: **Trend of age-standardised rate (per 100,000 population) of hypertensive heart disease prevalence (A) mortality (B) and DALYs (C) from 1990 to 2019 in the Eastern Mediterranean region.** Data are Eastern Mediterranean region versus global, by sex. Shaded sections indicate 95% uncertainty intervals. DALYs: disability-adjusted life years.

The HHD age-standardised prevalence varied widely among EMR countries. In 2019, the lowest age-standardised prevalence rate of HHD was in Saudi Arabia (high middle SDI), then Qatar (high SDI), followed by Syrian Arab Republic (middle SDI). By contrast, Jordan (middle SDI), Kuwait (high SDI), and Lebanon (middle SDI) had the highest HHD age-standardised prevalence in 2019 (Table 1). The highest increase in age-standardised prevalence of HHD during 1990–2019 was in Oman (21.4%), followed by Sudan (10.28%). Inversely, Qatar and Bahrain had a considerable decrease during the same period (–9.75% and –8.27%, respectively) (Table 1).

There was a decreasing trend in the age standardised HHD mortality rate between 1990 and 2019 at both the global and EMR levels (–21.49% and –6.67%, respectively) (Table 2). However, EMR had higher age-standardised HHD mortality rates than global levels (ie, more than double at all study time points; Table 2). As shown in Fig. 1, the female age-standardised HHD mortality rate was higher than the males' at the EMR and the global levels. However, this difference was much greater in the EMR than globally. In terms of SDI, the average change in HHD mortality rate from 1990 to 2019 in high, high middle, middle, low middle, and low SDI groups was –30.4%, –20.5%, –19.1%, –8.7%,

SDI group	Geographical area	1990		2010		2019		%Δ (1990–2010)	%Δ (2010–2019)	%Δ (1990–2019)
		Rate	(95% UI)	Rate	(95% UI)	Rate	(95% UI)			
	Global	19.31	(15.88, 21.62)	15.44	(12.14, 16.89)	15.16	(11.20, 16.75)	−20.04	−1.81	−21.49
	EMR	34.61	(21.13, 44.56)	34.55	(21.09, 42.25)	32.30	(19.96, 39.72)	−0.17	−6.51	−6.67
High SDI	Kuwait	31.87	(24.75, 36.65)	20.62	(17.83, 27.92)	20.13	(16.03, 26.22)	−35.30	−2.38	−36.84
	Qatar	10.79	(7.74, 16.52)	6.27	(5.09, 7.78)	5.75	(4.20, 7.74)	−41.89	−8.29	−46.71
	United Arab Emirate	47.17	(17.52, 85.21)	58.58	(22.76, 102.65)	43.55	(15.4, 85.53)	24.19	−25.66	−7.67
High middle SDI	Oman	29.22	(21.27, 41.40)	30.00	(21.92, 34.28)	23.58	(18.21, 28.62)	2.67	−21.40	−19.30
	Bahrain	11.81	(9.64, 17.58)	8.27	(6.76, 13.46)	7.24	(5.67, 10.56)	−29.97	−12.45	−38.70
	Saudi Arabia	5.71	(4.06, 9.56)	5.22	(4.46, 6.83)	4.34	(3.34, 5.87)	−8.58	−16.86	−23.99
	Jordan	58.32	(45.26, 74.79)	44.70	(28.40, 50.73)	39.86	(24.70, 47.94)	−23.35	−10.83	−31.65
	Lebanon	33.81	(16.19, 50.83)	29.84	(12.20, 39.62)	27.14	(10.86, 36.61)	−11.74	−9.05	−19.73
	Libya	23.33	(11.77, 33.09)	22.33	(9.26, 30.16)	25.76	(10.66, 38.09)	−4.29	15.36	10.42
Middle SDI	Iran	37.24	(30.22, 47.49)	34.36	(27.46, 36.67)	30.18	(25.1, 32.83)	−7.73	−12.17	−18.96
	Syrian Arab Republic	12.63	(9.17, 17.71)	9.19	(7.65, 10.83)	9.25	(7.03, 11.98)	−27.24	0.65	−26.76
	Iraq	23.17	(16.30, 30.60)	21.14	(16.17, 25.46)	18.65	(14.40, 22.19)	−8.76	−11.78	−19.51
	Tunisia	32.63	(16.46, 42.29)	29.56	(12.50, 39.90)	26.60	(10.76, 37.51)	−9.41	−10.01	−18.48
	Egypt	53.8	(24.78, 80.52)	50.51	(18.99, 79.57)	47.34	(17.55, 80.24)	−6.12	−6.28	−12.01
Low middle SDI	Palestine	33.77	(25.24, 41.85)	31.94	(24.79, 35.57)	37.33	(24.69, 43.91)	−30.3	−7.86	10.54
	Sudan	53.0	(22.79, 75.98)	47.35	(18.86, 71.52)	47.62	(18.41, 70.56)	−10.66	0.57	−10.15
	Djibouti	52.13	(32.21, 74.84)	40.32	(23.07, 60.99)	36.89	(21.24, 54.46)	−22.65	−8.51	−29.23
	Morocco	42.91	(20.68, 64.35)	38.81	(16.19, 57.55)	40.35	(16.47, 55.28)	−9.55	3.97	−5.97
Low SDI	Pakistan	20.95	(13.09, 30.46)	23.17	(14.76, 30.61)	21.02	(14.37, 27.68)	10.60	−9.28	0.33
	Afghanistan	74.49	(23.7, 112.34)	76.74	(23.41, 114.42)	74.49	(23.7, 112.34)	3.02	−2.93	0.00
	Somalia	67.48	(41.87, 96.1)	55.47	(33.83, 85.2)	54.01	(33.12, 82.49)	−17.80	−2.63	−19.96
	Yemen	59.4	(25.01, 85.02)	56.42	(22.76, 89.34)	56.99	(22.18, 93.57)	−5.02	1.01	−4.06

EMR: Eastern Mediterranean region; UI: uncertainty interval; SDI: socio-demographic index.

***Table 2*: Age-standardised rate (per 100,000 population) of death attributed to hypertensive heart disease based on socio-demographic index in the Eastern Mediterranean countries, in 1990, 2010, and 2019.**

and −5.9%, respectively. Among EMR countries, the age-standardised mortality rate of HHD in 2019 ranged from 4.3 (95% UI: (3.3, 5.9) per 100,000 population) in Saudi Arabia to 74.5 (95% UI: (23.7, 112.34) per 100,000 population) in Afghanistan. Except for three countries (Palestine, Libya, and Pakistan), we witnessed a declining trend in HHD age-standardised mortality rate from 1990 to 2019, with the highest and lowest decline percentage in Qatar (−46.7%) and Yemen (−4.1%), respectively (Table 2). Percentage increase in HHD age-standardised mortality rate from 1990 to 2019 in Palestine, Libya, and Pakistan was 10.5%, 10.4%, 0.3%, respectively. In Afghanistan, HHD age-standardised mortality rate remained unchanged during the study period.

Age-standardised DALYs and YLLs of HHD were approximately doubled in EMR compared to global levels at all study time points. However, there was a decline in both DALYs and YLLs globally and in the EMR from 1990 to 2019 (Table 3 & Appendix-Part 4, Table A4). According to Fig. 1, females in the EMR had higher age-standardised DALYs than males. As for SDI groups, we observed the highest reduction in DALYs and YLLs from 1990 to 2019 in high SDI countries with a regular decrease trend from high to low SDI groups (Table 4 and Supplementary-Part 4, Fig. S2 and Table S4). There was notable variation in DALYs and YLLs among EMR countries. The highest rate of age-standardised DALYs in 2019 was observed in Afghanistan, followed by Yemen and Somalia. On the other hand, Qatar, Saudi Arabia, and Bahrain had the lowest rate of age-standardised DALYs in 2019 (Table 3).

According to IHME, the main risk factor for HHD is HTN as evidenced by high systolic blood pressure. Attributable risk for this factor in relation to HHD death is 100% in each condition. Compared to alcohol use and a diet high in sodium, high BMI had the greatest contribution to HHD death in the EMR and globally (Table 4). Alcohol use and diet high in sodium had lower attributable risk in the EMR than globally. Inversely, high BMI attributable risk was higher in the EMR compared to global levels (Table 4). In EMR, there was an increasing trend for high BMI attributable risk from 1990 to 2019. However, increasing trends in attributable risk for alcohol use and a diet high in sodium observed between 1990 and 2010 but the trends decreased between 2010 and 2019. Among EMR countries, the lowest versus highest attributable risks for alcohol use, a diet high in sodium, and a high BMI was in Sudan versus UAE, Bahrain versus Somalia, and

SDI group	Geographical area	1990			2010			2019			%Δ (1990–2010)	%Δ (2010–2019)	%Δ (1990–2019)
		Rate (per 100,000)	(95% UI)		Rate (per 100,000)	(95% UI)		Rate (per 100,000)	(95% UI)				
			Upper	Lower		Upper	Lower		Upper	Lower			
	Global	364.55	406.70	297.73	276.72	303.26	225.29	268.19	298.07	204.57	−24.1	−3.1	−26.4
	EMR	643.83	817.99	388.85	607.97	751.14	392.69	561.86	704.05	361.03	−5.6	−7.6	−12.7
High SDI	Kuwait	615.59	701.86	483.86	382.18	526.58	340.17	371.52	490.80	302.91	−37.9	−2.8	−39.6
	Qatar	178.02	248.12	129.77	102.73	126.46	85.29	87.11	114.29	64.40	−42.3	−15.2	−51.1
	United Arab Emirate	865.13	1576.14	347.22	1017.7	1788.9	413.29	802.29	1587.53	297.63	17.6	−21.2	−7.3
High middle SDI	Oman	519.74	719.32	375.75	541.00	613.11	381.79	385.48	461.08	296.43	4.1	−28.7	−25.8
	Bahrain	219.01	289.49	181.54	136.78	196.58	116.23	121.27	160.47	96.70	−37.5	−11.3	−44.6
	Saudi Arabia	122.86	188.56	89.82	115.38	134.97	99.21	95.68	120.81	73.26	−6.1	−17.1	−22.1
	Jordan	1008.37	1254.33	800.36	739.84	838.45	491.08	664.81	797.98	440.78	−26.6	−10.1	−34.1
	Lebanon	600.75	895.92	302.31	499.63	647.24	222.81	462.83	615.98	205.46	−16.8	−7.4	−23.0
	Libya	440.80	613.71	236.96	404.69	535.14	191.74	470.77	681.05	222.80	−8.2	16.3	6.8
Middle SDI	Iran	645.81	785.70	531.19	570.60	605.81	486.93	498.63	540.58	436.88	−11.6	−12.6	−22.8
	Syrian Arab Republic	221.06	297.03	159.48	149.14	176.94	125.50	152.79	200.31	117.93	−32.5	2.4	−30.9
	Iraq	412.05	532.34	302.62	365.25	444.20	287.74	314.70	376.43	251.47	−11.4	−13.8	−23.6
	Tunisia	556.84	711.30	298.91	490.06	658.44	229.01	443.50	622.25	205.22	−12.0	−9.5	−20.4
	Egypt	953.02	1434.94	460.23	885.69	1402.35	356.14	827.60	1419.80	337.69	−7.1	−6.6	−13.2
Low middle SDI	Palestine	561.21	706.14	418.13	522.17	577.5	434.74	587.37	686.47	410.37	−7.0	12.5	4.7
	Sudan	1017.42	1393.82	452.22	859.35	1267.69	363.62	845.63	1262.77	353.78	−15.5	−1.6	−16.9
	Djibouti	977.36	1417.02	598.71	724.71	1087.62	422.95	650.37	977.28	384.68	−25.9	−10.3	−33.5
	Morocco	775.38	1072.59	387.79	686.42	981.66	316.79	682.95	920.55	305.88	−11.5	−0.5	−11.9
Low SDI	Pakistan	375.72	515.25	229.82	412.05	541.41	247.32	370.71	481.88	246.90	9.7	−10.0	−1.3
	Afghanistan	1525.39	2324.24	462.12	1510.0	2227.2	455.80	1374.12	2020.70	467.17	−1.0	−9.0	−9.9
	Somalia	1386.33	1956.10	804.59	1064.0	1581.12	646.01	1012.32	1508.15	619.26	−23.2	−4.9	−27.0
	Yemen	1123.51	1597.73	477.67	1016.3	1572.41	428.57	1024.08	1623.17	426.76	−9.5	0.8	−8.8

DALYs: disability adjusted life years; EMR: Eastern Mediterranean region; UI: uncertainty interval; SDI: socio-demographic index.

***Table 3*: Age-standardised DALYs rate (per 100,000 population) attributed to hypertensive heart disease based on socio-demographic index, Eastern Mediterranean countries, in 1990, 2010, and 2019.**

Somalia versus Saudi Arabia, respectively (Fig. 2 and Table 4).

HAQ in the EMR countries in 2015 ranged between 24.7 and 71.7 in Afghanistan and Kuwait, respectively.[18] We drew a scatter plot to determine the relationship between HAQ and age-standardised HHD mortality rate (per 100,000) from 1990 to 2015 (Fig. 3). As shown, there was an inverse relationship between HAQ and HHD mortality. HAQ had increased in all EMR countries during 1990–2015 except in Afghanistan (Supplementary-Part 4, Table S5).

Discussion

This is the first study on the epidemiology and trends of HHD burden including prevalence, mortality, DALYs and attributable risks in the EMR over three decades (1990–2019). We observed considerably higher HHD burden in the EMR as compared to global levels throughout the period between 1990 and 2019. According to WHO's reports, high prevalence of smoking, rising obesity and change in dietary patterns from traditional foods to high-calorie processed foods in this region has led to the EMR surpassing other regions in the rise of non-communicable diseases.[23]

The age-standardised prevalence rate of HHD was higher in the EMR as compared to the global level based on age and sex throughout the period between 1990 and 2019. This can be explained by the higher prevalence of HTN in the EMR.[10] Furthermore, HTN control status can also contribute to HHD prevalence disparities.[14] As mentioned previously, HTN control rate in EMR has been low.[24] Some reasons for the low HTN control rate in this region include unhealthy lifestyle (i.e., sodium-rich diets); increased prevalence of obesity, diabetes and metabolic syndrome; lack of physical activity; low compliance with antihypertensive drug and lifestyle modification by patients; poor adherence to guidelines by healthcare providers due to lack of financial resources, shortage of space, facilities and staff; and insufficient motivation to implement recommended HTN care programs.[25–27]

Among the EMR countries, Jordan had the highest prevalence of HHD. Khader et al.[28] hinted to the lack of well-organized programs for prevention and intervention on HTN and the high rate of obesity, physical inactivity, and intake of salt and fat in this country.

We observed an increasing trend in HHD prevalence from 1990 to 2019 at both the EMR and global levels.

SDI group	Location	Year	Hypertension		Alcohol consumption		Diet high in sodium		High body mass index	
			AR (%)	95% UI	AR (%)	95% UI	AR (%)	95% UI	AR (%)	95% UI
	Global	1990	100.00	(100, 100)	7.86	(5.19, 11.00)	18.05	(4.36, 43.77)	22.50	(10.56, 40.23)
		2010	100.00	(100, 100)	8.41	(5.55, 11.70)	14.24	(2.68, 38.31)	32.31	(16.51, 51.74)
		2019	100.00	(100, 100)	8.65	(5.67, 12.12)	14.41	(2.63, 39.07)	34.93	(18.31, 55.25)
	EMR	1990	100.00	(100, 100)	0.68	(0.35, 1.09)	4.18	(0.41, 17.56)	31.25	(17.17, 49.77)
		2010	100.00	(100, 100)	0.72	(0.39, 1.11)	4.33	(0.46, 17.54)	40.77	(23.37, 61.84)
		2019	100.00	(100, 100)	0.68	(0.37, 1.08)	4.28	(0.46, 17.54)	45.11	(25.89, 66.45)
High SDI	Kuwait	1990	100.00	(100, 100)	0.00	(−0.01, 0.01)	5.28	(0.23, 22.36)	54.56	(33.37, 75.5)
		2010	100.00	(100, 100)	0.08	(−0.06, 0.28)	5.56	(0.23, 24.36)	57.70	(33.64, 79.7)
		2019	100.00	(100, 100)	0.08	(−0.06, 0.28)	5.51	(0.23, 24.57)	60.36	(36.25, 81.8)
	Qatar	1990	100.00	(100, 100)	0.82	(0.26, 1.51)	2.38	(0.29, 11.63)	54.39	(28.70, 78.79)
		2010	100.00	(100, 100)	0.57	(0.08, 1.06)	2.48	(0.29, 12.24)	61.11	(34.30, 83.03)
		2019	100.00	(100, 100)	0.59	(0.09, 1.17)	2.57	(0.26, 11.92)	61.63	(28.47, 85.89)
	United Arab	1990	100.00	(100, 100)	4.35	(1.93, 7.44)	3.01	(0.27, 15.15)	51.30	(31.37, 73.33)
	Emirate	2010	100.00	(100, 100)	1.95	(0.73, 3.53)	2.92	(0.26, 14.56)	61.02	(36.28, 81.90)
		2019	100.00	(100, 100)	2.17	(0.72, 4.03)	3.32	(0.25, 15.83)	63.36	(38.59, 83.38)
High middle SDI	Oman	1990	100.00	(100, 100)	3.20	(1.73, 5.32)	2.26	(0.29, 10.21)	29.86	(15.43, 49.27)
		2010	100.00	(100, 100)	0.65	(0.18, 1.18)	2.61	(0.28, 12.20)	53.53	(33.91, 74.42)
		2019	100.00	(100, 100)	0.34	(−0.02, 0.77)	2.44	(0.28, 12.03)	54.92	(30.53, 77.82)
	Bahrain	1990	100.00	(100, 100)	3.16	(1.95, 4.91)	2.46	(0.30, 11.72)	52.70	(31.38, 75.11)
		2010	100.00	(100, 100)	1.04	(0.48, 1.72)	2.22	(0.31, 10.51)	55.44	(28.77, 79.71)
		2019	100.00	(100, 100)	1.08	(0.44, 1.87)	2.31	(0.30, 11.41)	57.43	(30.31, 81.37)
	Saudi Arabia	1990	100.00	(100, 100)	0.67	(0.03, 1.48)	2.49	(0.29, 11.72)	48.07	(30.34, 67.63)
		2010	100.00	(100, 100)	0.34	(−0.07, 0.86)	2.65	(0.30, 11.67)	62.46	(42.36, 81.56)
		2019	100.00	(100, 100)	0.36	(−0.07, 0.91)	2.71	(0.30, 12.44)	65.49	(43.68, 84.26)
	Jordan	1990	100.00	(100, 100)	0.47	(0.10, 0.97)	2.44	(0.30, 12.05)	49.50	(28.65, 72.46)
		2010	100.00	(100, 100)	0.97	(0.41, 1.64)	2.64	(0.27, 12.78)	55.60	(31.39, 78.77)
		2019	100.00	(100, 100)	0.74	(0.21, 1.36)	2.63	(0.29, 12.46)	58.84	(33.08, 81.68)
	Lebanon	1990	100.00	(100, 100)	3.20	(1.73, 5.32)	2.56	(0.28, 11.99)	42.34	(22.82, 64.71)
		2010	100.00	(100, 100)	2.23	(1.21, 3.54)	2.60	(0.29, 12.15)	48.39	(25.51, 73.07)
		2019	100.00	(100, 100)	2.02	(1.04, 3.31)	2.66	(0.29, 12.77)	52.64	(28.77, 76.50)
	Libya	1990	100.00	(100, 100)	0.10	(0.04, 0.18)	2.76	(0.27, 13.71)	47.13	(27.49, 68.97)
		2010	100.00	(100, 100)	0.50	(0.00, 1.06)	2.77	(0.28, 13.35)	55.57	(32.74, 77.22)
		2019	100.00	(100, 100)	0.52	(0.14, 0.93)	2.85	(0.30, 13.77)	56.31	(33.51, 78.08)
Middle SDI	Iran	1990	100.00	(100, 100)	0.20	(0.07, 0.37)	2.69	(0.43, 12.51)	33.08	(17.66, 54.67)
		2010	100.00	(100, 100)	0.81	(0.47, 1.32)	2.71	(0.44, 12.71)	44.04	(23.72, 68.13)
		2019	100.00	(100, 100)	0.87	(0.49, 1.43)	2.71	(0.43, 12.3)	48.31	(25.05, 72.26)
	Syrian Arab Republic	1990	100.00	(100, 100)	1.34	(0.69, 2.45)	2.58	(0.29, 12.27)	40.32	(21.18, 62.95)
		2010	100.00	(100, 100)	1.17	(0.67, 1.99)	2.59	(0.28, 12.77)	47.15	(23.73, 72.16)
		2019	100.00	(100, 100)	0.84	(0.41, 1.50)	2.62	(0.28, 12.76)	49.09	(24.94, 73.35)
	Iraq	1990	100.00	(100, 100)	1.59	(0.79, 2.66)	2.68	(0.29, 12.59)	50.43	(26.98, 76.96)
		2010	100.00	(100, 100)	0.57	(0.13, 1.05)	2.70	(0.28, 13.30)	51.23	(26.44, 77.70)
		2019	100.00	(100, 100)	0.61	(0.14, 1.16)	2.69	(0.29, 13.45)	54.18	(27.47, 79.02)
	Tunisia	1990	100.00	(100, 100)	0.92	(0.35, 1.59)	2.50	(0.29, 12.26)	37.53	(20.47, 59.76)
		2010	100.00	(100, 100)	1.54	(0.80, 2.40)	2.48	(0.28, 12.21)	45.86	(23.69, 69.84)
		2019	100.00	(100, 100)	1.84	(0.96, 2.89)	2.55	(0.28, 12.34)	49.15	(25.31, 73.24)
	Egypt	1990	100.00	(100, 100)	0.39	(0.05, 0.88)	2.57	(0.27, 12.76)	43.15	(24.57, 65.07)
		2010	100.00	(100, 100)	0.37	(0.03, 0.82)	2.71	(0.27, 13.03)	51.03	(29.64, 73.16)
		2019	100.00	(100, 100)	0.46	(0.05, 1.01)	2.78	(0.28, 13.83)	54.64	(31.26, 76.25)
Low Middle SDI	Palestine	1990	100.00	(100, 100)	1.15	(0.53, 1.98)	2.45	(0.27, 11.87)	29.61	(14.34, 50.64)
		2010	100.00	(100, 100)	1.91	(1.13, 3.21)	2.43	(0.27, 11.57)	34.27	(17.91, 55.95)
		2019	100.00	(100, 100)	1.75	(1.01, 2.96)	2.40	(0.27, 11.32)	40.35	(20.81, 66.56)
	Sudan	1990	100.00	(100, 100)	1.17	(0.40, 2.24)	2.88	(0.29, 13.80)	25.53	(12.45, 43.12)
		2010	100.00	(100, 100)	1.20	(0.51, 2.06)	2.99	(0.30, 14.85)	38.38	(21.73, 59.69)
		2019	100.00	(100, 100)	0.01	(−0.06, 0.10)	3.04	(0.29, 14.74)	44.65	(25.33, 66.37)

(Table 4 continues on next page)

SDI group	Location	Year	Hypertension		Alcohol consumption		Diet high in sodium		High body mass index	
			AR (%)	95% UI	AR (%)	95% UI	AR (%)	95% UI	AR (%)	95% UI
(Continued from previous page)										
	Djibouti	1990	100.00	(100, 100)	1.99	(−0.11, 4.10)	19.59	(0.98, 55.71)	10.40	(2.41, 24.49)
		2010	100.00	(100, 100)	0.61	(−0.76, 2.16)	16.27	(0.37, 51.52)	20.64	(8.55, 37.76)
		2019	100.00	(100, 100)	0.42	(−0.85, 1.80)	15.60	(0.33, 49.71)	25.99	(12.59, 44.74)
	Morocco	1990	100.00	(100, 100)	0.97	(0.41, 1.68)	2.84	(0.30, 14.20)	34.28	(18.13, 54.16)
		2010	100.00	(100, 100)	0.66	(0.26, 1.22)	2.75	(0.31, 13.11)	43.91	(24.74, 66.55)
		2019	100.00	(100, 100)	0.52	(0.15, 1.04)	2.78	(0.28, 13.21)	47.21	(26.19, 70.63)
Low middle SDI	Pakistan	1990	100.00	(100, 100)	0.71	(0.32, 1.18)	7.41	(0.22, 28.95)	15.06	(4.23, 33.43)
		2010	100.00	(100, 100)	0.93	(0.45, 1.56)	10.66	(0.43, 35.93)	27.49	(13.01, 47.47)
		2019	100.00	(100, 100)	1.03	(0.51, 1.68)	10.72	(0.46, 36.20)	31.19	(15.77, 50.91)
	Afghanistan	1990	100.00	(100, 100)	0.00	(−0.01, 0.00)	2.76	(0.27, 13.10)	27.22	(12.79, 44.95)
		2010	100.00	(100, 100)	0.11	(−0.02, 0.27)	2.69	(0.29, 12.60)	32.15	(17.45, 50.66)
		2019	100.00	(100, 100)	0.10	(−0.03, 0.26)	2.64	(0.28, 12.43)	41.78	(25.00, 61.67)
	Somalia	1990	100.00	(100, 100)	NA	NA	19.65	(1.03, 54.26)	9.86	(2.21, 23.74)
		2010	100.00	(100, 100)	NA	NA	16.24	(0.36, 49.78)	10.14	(2.44, 24.08)
		2019	100.00	(100, 100)	NA	NA	15.69	(0.36, 48.89)	10.25	(2.47, 24.41)
	Yemen	1990	100.00	(100, 100)	1.76	(0.97, 3.08)	2.56	(0.31, 12.72)	17.73	(6.85, 33.61)
		2010	100.00	(100, 100)	0.71	(0.36, 1.16)	2.58	(0.29, 12.33)	25.98	(12.71, 44.04)
		2019	100.00	(100, 100)	0.70	(0.33, 1.20)	2.60	(0.31, 12.31)	28.49	(14.36, 47.51)

EMR: Eastern Mediterranean region; UI: uncertainty interval; SDI: socio-demographic index; AR: attributable risk, NA: data are not available.

Table 4: **Age-standardised attributable risk of factors associated with hypertensive heart disease death in the Eastern Mediterranean countries based on socio-demographic index, in 1990, 2010, and 2019.**

This can be justified partly by improvement in life expectancy, global population aging and redefining of HTN by 2017 American College of Cardiology and American Heart Association Guidelines. Among EMR countries, Oman had the highest rising in prevalence of HHD prevalence between 1990 and 2019. This can be attributed to high prevalence of HTN in this country. According to a study, 40.6% of adults in Oman were hypertensive. This is 20–30% higher than the global average and is predicted to double by 2025.[29] Considering HHD was the second most common cause of heart failure in Oman[30] and HTN as the primary cause of HHD is in a warning status in this country, there is an urgent need to early diagnosis and correct management of HTN in this country.

The prevalence of HHD in all 22 EMR countries increases with age in both men and women. Considering the worldwide increase in the elderly population, it is very important to effectively prevent and manage HHD for older patients.

It should be noted that GBD estimates on HHD prevalence was relatively lower than other studies. Miazgowski et al.[4] attributed this difference to the variations in HHD definitions. This might be explained by the fact that GBD estimated HHD prevalence as a fraction of heart failure related to HTN alone whereas in clinical practice, a combination of left ventricular hypertrophy, cardiomegaly or left ventricular diastolic dysfunction, comorbid ischemic heart disease, atrial fibrillation, or other arrhythmias were considered as HHD. In addition, the diagnosis approach (electrocardiography or echocardiography) is a strong effective factor on HHD prevalence.[4] Diagnosis of these conditions might be low in LMICs due to health system capacity or reporting capacity. Ascertainment of HHD is heavily dependent on the accuracy of medical coding. As we indicated in Supplementary-Part 2, ICD-9 has coded HHD using 402.xx series of codes, each of which is divided into malignant, benign, and unspecified essential hypertension with or without heart failure. While ICD-10 narrowed HHD to only two base codes: I11.0, HHD with heart failure and I11.9, HHD without heart failure. On the other hand, while the treatment of heart failure with reduced ejection fraction truly has improved over the last decades, the treatment of heart failure with preserved ejection fraction hasn't really.[30] So it is recommended to document HHD at least during the first ascertainment for the patient, simultaneously with both medical coding and diagnostic methods (examination, electrocardiogram, echocardiogram, etc.).[31]

HHD age-standardised DALYs and mortality rate in EMR were considerably higher than the global rate. However, both indices showed a decreasing trend from 1990 to 2019 for both the EMR and globally. This observation could be explained by the improved treatment and management of HHD in the past three decades.[14] Among EMR countries, Afghanistan, a low SDI country with the lowest HAQ in the EMR,[18] had the highest HHD age-standardised YLLs, DALYs, and mortality rate. In addition, the age standardised

***Fig. 2:* Status of age-standardised attributable risk for factors associated with hypertensive heart disease based on SDI in Eastern Mediterranean countries in 2019.** EMR: Eastern Mediterranean region; SDI: socio-demographic index.

mortality rate of HHD stayed stable between 1990 and 2019 in this country. The highest decline in YLLs, DALYs, and mortality during 1990–2019 was in Qatar, Bahrain, and Kuwait, respectively, which could be explained by resources available to reduce HHD burden as these countries are either high or high-middle SDI countries. On the other hand, the lowest decline in YLLs, mortality, and DALYs was in Pakistan, Yemen, and Pakistan, respectively (low SDI countries). This finding highlighted the need for improved public health measures in low socio-economic countries to manage HHD.[1] We observed the highest decline in HHD

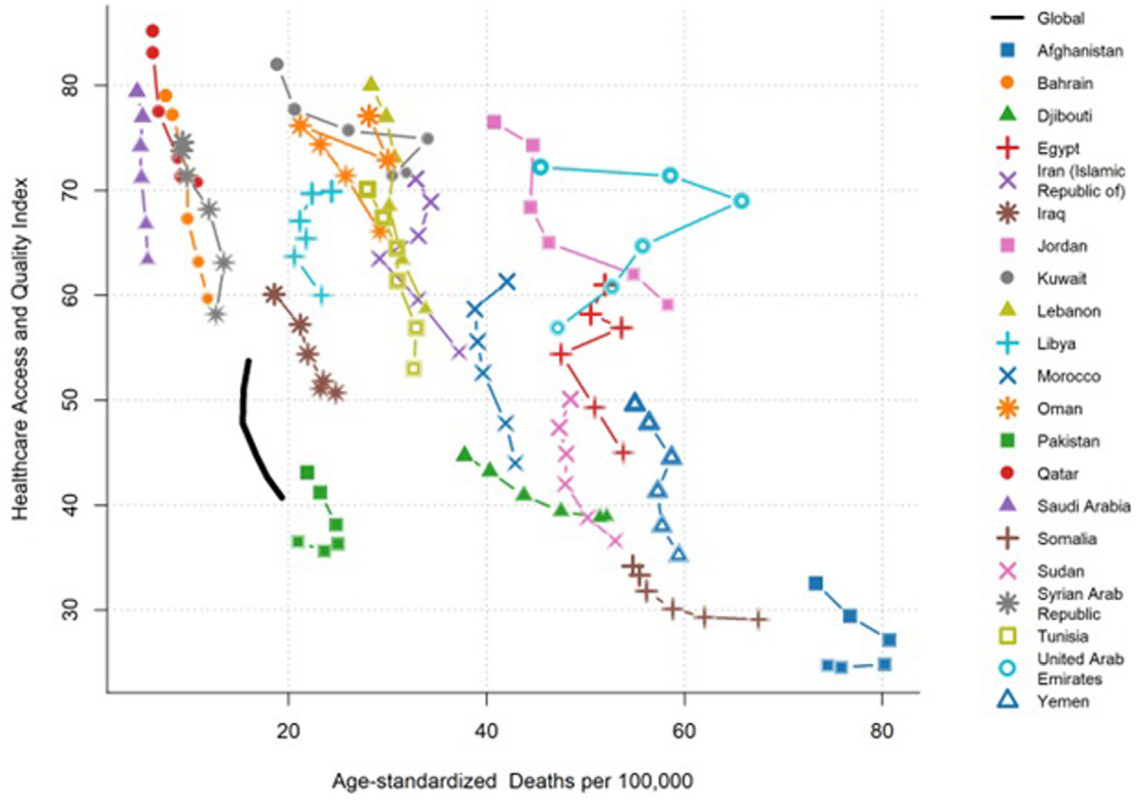

Fig. 3: **Scatter plot of age-standardised mortality rate (per 100,000 population) of hypertensive heart disease by country-specific healthcare access and quality index in the Eastern Mediterranean region, 1990–2015.** We used healthcare access and quality index presented in Lancet 2017; 390: 231–266 (https://doi.org/10.1016/S0140-6736(17)30818-8) for drawing this figure.

mortality and DALYs to occur in high SDI countries with a decreasing trend from high to low SDI countries. Not surprisingly, to allocate a lower percentage of gross domestic product for the health sector, to divide the insufficient health budget between infectious diseases, malnutrition, children's diseases and NCDs and low rate of disease awareness in low SDI countries could explain the higher burden of HHD in these countries.[1]

Sex-based results showed that the age-standardised HHD mortality and DALY rates in females were higher than males in the EMR. This difference was much greater for the EMR than the global level. Additionally, in the majority of the EMR countries, the prevalence percentage of HHD between 1990 and 2019 was higher in females than males. Lu and Lan associated these differences to the role of sex hormones in cardiac metabolism and cardiovascular bio-function in HHD development.[1] Given HHD mostly occurs in older age, women undergoing menopause would be more vulnerable due to losing the protective effects of their hormones against high blood pressure.[32]

Although HHD, by definition occurs only in people with HTN (attributable risk = 100%), however a little people with HTN develop obvious HHD. Additional factors also contribute to HHD burden. High BMI had higher attributable risk for HHD in the EMR compared to global level in 2019. The majority of studies on obesity in EMR used BMI as the main index to measure obesity. According to published studies, obesity is increasing in an alarming status in the EMR countries.[33] Obesity prevalence in the EMR has increased from 15.1% (95% UI 13.4, 16.9) in 1980 to 20.7% (95% UI 18.8, 22.8) in 2015.[34] Additionally, high BMI was responsible for 417,115 deaths and 14,448,548 DALYs in the region.[34] Nutrition transitions, including diets high in fat (especially saturated fats), cholesterol and refined carbohydrates but low in polyunsaturated fatty acids and fibers, alongside sedentary and high stress lifestyles would most likely contribute to the high prevalence of obesity in this region.[33] Among the EMR countries, Saudi Arabia had the highest attributable risk for HHD death related to high BMI. A nation-wide study on obesity in this country in 2020 reported the national weighted prevalence of obesity as 24.7%.[35]

Another risk factor for HHD is diet high in sodium. The attributable risk for this risk factor was lower in the EMR compared to the global level. This can be partly due to sodium intake underestimation as a result of assessment challenges in this region. Dietary

assessment needs up-to-date, culture-specific salt, and/or sodium food composition tables that are rarely used in EMR. In addition, recall bias, inaccurate portion size estimations, and assessment of sodium intake by instruments with unsure validity can affect the correct measurement of sodium intake.[36]

In Djibouti and Somalia, the attributable risk was due to higher salt intake and less obesity as compared to other regions. Among EMR countries Djibouti has not yet established any policy to reduce salt and sodium consumption. In Somalia, more than one in five people are severely food insecure and in need of urgent assistance.[37] Due to the remarkable role of salt intake on the incidence of HTN, and consequently HHD incidence,[38,39] there is a serious need to pay attention to improving dietary patterns, especially reducing salt consumption in this region as per the recommendations by the WHO.[40] Indeed, the WHO called for a 30% reduction in salt consumption by 2030 via a target of 5 g per day.[41]

The contribution of alcohol consumption in HHD mortality in EMR was dramatically lower than the global level. According to Turk-Adawi et al.,[10] the EMR had the lowest consumption of alcohol globally. They attributed this difference to religious and cultural frameworks in the population of this region.[10]

Although Pakistan, Yemen, and Morocco had the highest increase in HAQ between 1990 and 2015, the HAQ had not been at a satisfactory level in these countries. This might be the reason for the lack of a noticeable decline in HHD mortality during this period. In fact, Pakistan had increasing HHD mortality in the mentioned period. Minimal access to health services due to high costs of health services and out of pocket payment of treatment[42]; remote and scattered nature of service provision; and inefficiency of health systems in the implementation of prevention and screening programs could explain the unsatisfactory HAQ level in the EMR countries as and some of the HHD burden in these countries.[43]

The burden of HHD varied widely across the countries in EMR. As mentioned in the method section, SDI extensively varies between various countries in EMR. Regarding HHD prevalence we witnessed higher proportions in countries with more desirable SDI. Conversely, these countries had lower mortality and DALY from HHD compared with low middle- and low-SDI countries. It can be explained by more access to diagnostic and therapeutic services, higher literacy, more optimal health financing and higher country capacity in high-SDI countries in EMR.[44]

Finally, it should be noted that there are other factors linked to the HHD in the EMR countries which should be considered when interpreting HHD profile. The EMR has extreme diversity in development, wealth and health that can influence its diversities in diseases rates including HHD.[45] For instance, the region has considerable heterogeneity with respect to characteristics such as historical background, geopolitical and social context, ethnicity and languages spoken, gross domestic product (GDP), sociodemographic profiles, health indicators, and health system capacities and coverage.

This is the first study on the burden of HHD in the EMR. Presenting information related to the prevalence, death rate, DALYs and YLLs of HHD from 22 countries in the EMR provides important findings about the burden of HHD in the region. Nonetheless, this study is not without limitations. Firstly, inherent in other GBD studies as well, is the heterogeneity in data collection methods, data sources and quality.[9,46] Data have been collected by each country with varying degrees of quality via various methods. Secondly, GBD does not include information about clinic-pathologic and laboratorial features of HHD that could affect the prevalence, deaths, and DALYs and attributable risk estimates of the HHD. Thirdly, the lack of data on some important indices such as awareness, treatment and control of HTN, and relative risk of HHD mortality related to uncontrolled HTN is another important limitation.

The extreme heterogeneity in development, wealth, and quality of health care in this region makes it hard to interpret overall regional average rates so aggregate rates reported in this paper should be interpreted cautiously. Lastly, with the collapsing health care systems caused by regional or civil conflicts in the region, the validity of the data in some of the countries in the EMR may be questionable.

HHD, a preventable cardiovascular disease, remains a critical problem with high prevalence and DALYs in the EMR countries. Our results would be helpful to tackle where more work needs to be done. Obesity and salt intake play a noticeable role in HHD deaths in this region. Seriou's undertaking is required to implement widespread programs to manage high blood pressure in the EMR countries, especially those with lower SDI and HAQ. Based on this study, our recommendation for the EMR is to adopt effective preventive strategies: promoting healthy dietary patterns (reducing salt intake, saturated fatty acids and high-calorie processed foods; enhancing dietary fibers and poly-unsaturated fatty acids); prompt screening for undiagnosed HTN in public places (e.g., non-cardiac clinics), promoting regular blood pressure measurements at home; providing cheap and easy medications like poly-pills; putting cases with controlled HTN as key performance indicators for primary health care or cardiology clinics; facilitating physical activity, creating community awareness about early detection of HTN, stress management, and self-management of HTN.

Contributors

All analyses presented in this manuscript were based on data extracted from Institute of Health Metrics and Evaluation (IHME) provided by the GBD core team. NS planned the original study. AM designed, analysed, and wrote first draft of the manuscript. AM and KMZ designed and made the graphs and figures. JK made substantial contribution in

conceptualization of the paper. AM, KMZ, ML, JK, KIIA, HFAR, WA, IF, CJ, BS, GAR, SMSI, AHM, and NS critically revised all versions of manuscript and improved interpretation. CJ, BS, and GAR substantially improved the how to produce the estimates. AKh, KS, NB, GS, HAF, WAM, AHM, SMSI, SSB, NH, AAl, SS, AAb, and YM reviewed and commented on the manuscript. AM revised the draft of manuscript according to comments of all co-authors and provided manuscript for submit. AM and NS accessed and verified the underlying data. All authors read and approved the final manuscript.

Data sharing statement

All GBD 2019 data are publicly available and can be downloaded via the Global Burden of Disease Results Tool (http://ghdx.healthdata.org/gbdresults-tool).

Editor note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

We declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2023.102034.

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