ESC European Society of Cardiology

European Journal of Preventive Cardiology
doi:10.1093/eurjpc/zwaa147

FULL RESEARCH PAPER
Global Cardiovascular Health

Burden of heart failure and underlying causes in 195 countries and territories from 1990 to 2017

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Received 28 September 2020; revised 1 December 2020; editorial decision 1 December 2020; accepted 3 December 2020

Aims To provide the first systematic analysis of the burden and underlying causes of heart failure (HF) in 195 countries and territories from 1990 to 2017.

Methods and results We collected detailed information on prevalence, years lived with disability (YLDs), and underlying causes of HF from the Global Burden of Disease study 2017. Numbers and age-standardized rates of HF prevalence and YLDs were compared by age, sex, socio-demographic index (SDI), and location. The proportions of HF age-standardized prevalence rates due to 23 underlying causes were also presented. Globally, the age-standardized prevalence and YLD rates of HF in 2017 were 831.0 and 128.2 per 100 000 people, a decrease of -7.2% and -0.9% from 1990, respectively. Nevertheless, the absolute numbers of HF prevalent cases and YLDs have increased by 91.9% and 106.0% from 1990, respectively. There is significant geographic and socio-demographic variation in the levels and trends of HF burden from 1990 to 2017. Among all causes of HF, ischaemic heart disease accounted for the highest proportion (26.5%) of age-standardized prevalence rate of HF in 2017, followed by hypertensive heart disease (26.2%), chronic obstructive pulmonary disease (23.4%).

Conclusion HF remains a serious public health problem worldwide, with increasing age-standardized prevalence and YLD rates in countries with relatively low SDI. More geo-specific strategies aimed at preventing underlying causes and improving medical care for HF are warranted to reduce the future burden of this condition.

Keywords Global • Heart failure • Prevalence • Year lived with disability • Cause

Introduction

Heart failure (HF) is a complex, multifactorial syndrome resulting from an impaired heart function. From a clinical standpoint, HF is mainly characterized by symptoms such as dyspnoea, fatigue, and fluid retention. From an epidemiological perspective, HF imposes a relevant burden, with high prevalence and mortality rates. It has been estimated that there were over 37.7 million HF cases worldwide in 2016, and this number is expected to increase continuously during the next few decades.[1] Although advances in medical therapy and device assistance have significantly improved the outcomes of HF, implications of HF are still dramatic. For instance, in a cohort study from UK, the age-adjusted first-year rates of all-cause mortality of HF were computed at 23.0 (95% CI 22.0–24.1) per 100 person-years during 2012–2015.[2] Furthermore, besides the clinical burden, HF-related costs are particularly heavy, with an estimated yearly expenditure of US$108 billion globally.[3] Therefore, it is an onus from the public health organisms to decrease the health and economic burden generated by HF.

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In order to develop evidence-based, informed interventions to mitigate the burden imposed by HF, epidemiological differences at the regional and national levels should be taken into account. Actually, HF presents a strong heterogeneity among different countries and regions. Also, the aetiology spectrum of HF varies widely across the world. From the available scholarly literature, it is known that ischaemic heart disease has become the predominant cause of HF in East Asia due to the transition of lifestyles, while in Africa, hypertensive heart disease is the leading aetiology.[4,5] Moreover, the International Congestive Heart Failure (INTER-CHF) study has reported significantly distinct 1-year-mortality outcomes for HF globally, being highest in Africa (34%) and India (23%), intermediate in Southeast Asia (15%), and lowest in China (7%).[6] Given these differences, it is crucial that HF-related public health policies and strategies should be targeted to local conditions.

However, to the best of our knowledge, there are no systematic studies that have analysed the burden and underlying causes of HF at the global, regional, and national levels, which hampers the development and implementation of *ad hoc* prophylaxis and treatment plans of HF. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) approach is a holistic, statistically robust, and sound methodology that provides a thorough perspective on the burden of disease to clinicians and medical practitioners, as well as to other relevant stakeholders, enabling to track achievements and challenges in the healthcare field. More in details, based on a detailed knowledge of HF-related epidemiology, it would be possible to monitor the effectiveness of clinical practice patterns, and to better understand the contribution of risk factors, determinants and precipitants of HF in terms of outcomes. This could help implement locally informed guidelines, concerning the best management and treatment plan options, as well as carry out clinical trials. In the present study, relying on the GBD approach, we aimed to provide the first systematic analysis of the burden and underlying causes of HF in 195 countries and territories from 1990 to 2017.

Methods

Overview

General methods used for the GBD 2017 have been described previously.[7–10] Briefly, GBD 2017, conducted by Institute of Health Metrics and Evaluation (IHME), is the most comprehensive and systematic effort, to date, to estimate the burden of diseases, injuries, and risk factors at global, regional, and national levels. There were 359 diseases and injuries, 282 causes of death, and 84 risk factors analysed in GBD 2017. Data for seven super-regions, 21 regions, and 195 countries and territories from 1990 to 2017 were available in GBD 2017. Because GBD 2017 uses de-identified, aggregated data, a waiver of informed consent was reviewed and approved by the University of Washington Institutional Review Board. For the present study, all the estimates extracted and reported were publicly available on the website of IHME and can be found at https://gbd2017.healthdata.org/gbd-search/ (21 December 2020).

Case definition and data sources

HF was diagnosed clinically using structured criteria such as the Framingham or European Society of Cardiology criteria.[11,12] Previous iterations of GBD modelled symptomatic episodes of HF only. Beginning in GBD 2016, American College of Cardiology (ACC)/American Heart Association (AHA) Stage C and above was used to capture both persons who are currently symptomatic and those who have been diagnosed with HF but are currently asymptomatic.[13] In this study, literature data, inpatient hospital data, and claims data were extracted for estimating the burden of HF. A total of 1234 site-years of data were finally included in the overall prevalence estimation process. More details about original data sources used for the estimations of HF can be found on the GBD 2017 Data Input Sources Tool website (http://ghdx.healthdata.org/gbd-2017/data-input-sources, 21 December 2020).

Prevalence and underlying cause estimation

The overall prevalence of HF was estimated using DisMod-MR 2.1, a Bayesian meta-regression tool developed for GBD analyses. For inpatient hospital data, we corrected for readmission, primary to any diagnosis, and inpatient to outpatient utilization ratios using adjustment factors derived from individual-level claims data. We included covariates in DisMod-MR 2.1 to adjust US claims data and ICPC-coded data from Norway. The underlying causes (ICD codes mapped to these causes were shown in Supplementary material online, *Table S1*) of HF were selected based on a review of the literature and expert opinion. To estimate the proportion of HF cases attributable to each cause, the proportion of HF cases attributable to each of the high-level parent cause groupings was firstly assessed. Then, we estimated the proportion of HF cases attributable to the detailed causes within each of these groupings. Finally, we applied a correction factor to adjust these proportions. Notably, the prevalence of HF attributable to Chagas, degenerative mitral valve disease, and calcific aortic valve disease were estimated separately as part of their respective modelling strategy. Thus, the prevalence of HF due to all other causes was adjusted by subtracting the prevalence of HF due to these causes from the overall HF estimates. More information about the estimation process has been published elsewhere.[9]

Years lived with disability

To calculate years lived with disability (YLDs) for HF, HF was firstly divided according to severity into four levels: controlled, medically managed; mild; moderate; and severe HF.[9] Each severity level of HF was then assigned a disability weight, which represents the magnitude of health loss associated with the severity level.[9] Disability weight is measured on a scale from 0 (full health) to 1 (death). The descriptions and disability weights for different severity levels of HF can be seen in Supplementary material online, *Table S2*. Finally, YLDs of HF were calculated as the product of prevalence at each severity level and the corresponding disability weight.[9]

Socio-demographic index

We used the socio-demographic index (SDI) to determine the relationship of development status of a region or country with the burden of HF. The SDI ranges from 0 (less developed) to 1 (most developed) and is composed of the average educational attainment in the population aged 15 years or older, total fertility rate under 25 years, and lag-distributed income per capita.[7–10] For better comparison, we divided the 195 countries and territories into five groups according to SDI quintiles: low SDI, low-middle SDI, middle SDI, high-middle SDI, and high SDI quintile.[9]

Uncertainty analysis

We applied the same technique for propagating uncertainty as used elsewhere in previous GBD studies.[7–10] At each step of the calculation process, 1000 draws were stored and used for every other step in the process. Final estimates were calculated using the mean estimate across 1000 draws, and the 95% uncertainty intervals (UIs) were determined as

the 25th and 975th ranked values across all 1000 draws. For all estimates, a 95% UI excluding zero indicated statistically significant.

Results

Prevalence of HF

In 2017, the global number of HF cases was 64.3 million (95% UI 57.2 to 71.6), of whom 29.5 million (95% UI 26.3 to 32.9) were males and 34.8 million (95% UI 30.9 to 39.1) were females. The global age-standardized prevalence rate per 100 000 people was 831.0 (95% UI 738.6 to 926.2) overall: 844.6 (95% UI 752.5 to 936.0) for males and 817.5 (95% UI 724.4 to 916.0) for females. Between 1990 and 2017, despite the global number of HF cases has increased by 91.9% (95% UI 87.8 to 96.5) from 33.5 million (95% UI 29.4 to 37.9) in 1990, there was a decrease of -7.2% (95% UI -9.3 to -5.1) in age-standardized prevalence rate from 895.1 (95% UI 783.9 to 1018.2) per 100 000 people in 1990; the trend pattern was similar between males and females (Supplementary material online, *Figure S1*). By age group, the prevalence rate of HF increased with increasing age in both sexes in 2017 (Supplementary material online, *Figure S2*). The number of HF cases peaked at the ages of 70–74 years in males and 75–79 years in females, and females had relatively higher number of HF cases than males in the age groups of ≥70 years (Supplementary material online, *Figure S2*).

The age-standardized prevalence rates of HF varied widely across all countries and territories in 2017 (*Figure 1* and Supplementary material online, *Table S3*). Most countries in Central Europe, and North Africa and Middle East had relatively high age-standardized prevalence rates of HF. For instance, the six countries with the highest age-standardized prevalence rates of HF in 2017 were all in Central Europe, and North Africa and Middle East [i.e. Hungary: 1196.0 (95% UI 1033.4 to 1390.7) per 100 000 people; Kuwait: 1178.0 (95% UI 1026.7 to 1343.3) per 100 000 people; Montenegro: 1169.0 (95% UI 1006.9 to 1355.0) per 100 000 people; Slovakia: 1166.4 (95% UI 1022.4 to 1317.3) per 100 000 people; Slovenia: 1154.4 (95% UI 1006.6 to 1314.0) per 100 000 people; and Czech Republic: 1133.1 (95% UI 980.5 to 1300.0) per 100 000 people]. In contrast, the lowest age-standardized prevalence rates of HF in 2017 were seen in Latvia [498.4 (95% UI 436.2 to 573.3) per 100 000 people], Myanmar [574.0 (95% UI 496.3 to 659.6) per 100 000 people], Cambodia [579.1 (95% UI 498.3 to 668.5) per 100 000 people], and Laos [594.6 (95% UI 512.7 to 684.0) per 100 000 people], which are belong to Eastern Europe and Southeast Asia.

Between 1990 and 2017, there was a decrease of -20.3% (95% UI -23.9 to -16.2) in age-standardized prevalence rate of HF in countries in the high SDI quintile, whereas the age-standardized prevalence rates have slightly increased in countries in the low SDI, low-middle SDI, and middle SDI quintiles (Supplementary material online, *Table S3*). The countries with the largest percentage decrease in the age-standardized prevalence rates of HF were almost from Western Europe [e.g. Portugal: -37.6% (95% UI -41.8 to -33.1); Denmark: -36.8% (95% UI -40.6 to -33.0); and Israel: -36.0% (95% UI -39.8 to -31.9); *Figure 1* and Supplementary material online, *Table S3*]. In contrast, Oman had the largest percentage increase [25.8% (95% UI 17.8 to 35.0)] in the age-standardized prevalence rate of HF from 1990 to 2017. Notably, nearly half of the global increase in number of HF cases occurred in China (29.9%) and India (16.6%) during 1990–2017.

Underlying causes of HF

Globally, among all causes of HF, ischaemic heart disease accounted for the highest proportion (26.5%) of age-standardized prevalence rate of HF in 2017, followed by hypertensive heart disease (26.2%), chronic obstructive pulmonary disease (COPD; 23.4%), other cardiomyopathy (6.5%), non-rheumatic degenerative mitral valve disease (NDMVD; 2.7%), other cardiovascular and circulatory diseases (2.4%), alcoholic cardiomyopathy (2.4%), non-rheumatic calcific aortic valve disease (NCAVD; 2.3%), rheumatic heart disease (1.8%), and myocarditis (1.7%).

The proportion of age-standardized prevalence rate of HF due to each cause varied widely by age group in 2017 (*Figure 2*). In children and adolescents aged <20 years, congenital heart anomalies, myocarditis, and other cardiomyopathy accounted for over 80% of the age-standardized prevalence rate of HF. In adults aged 25–69 years, hypertensive heart disease accounted for the most among all causes of HF. The effects of alcoholic cardiomyopathy and rheumatic heart disease on HF were mainly concentrated in adults aged 20–59 years. The effects of COPD on HF were mainly concentrated in adults aged ≥50 years. The proportions of age-standardized prevalence rate of HF due to NDMVD and NCAVD increased with increasing age, and in the elderly aged ≥95 years, the proportions reached 7.9% for NDMVD and 10.5% for NCAVD.

Figure 3 and Supplementary material online, *Table S4* show the sexual and regional variations in the proportion of age-standardized prevalence rate of HF due to each cause in 2017. By sex, in terms of the proportion of age-standardized prevalence rate of HF due to each cause, the rankings for ischaemic heart disease, COPD, and alcoholic cardiomyopathy were relatively higher in males than in females, whereas the rankings for hypertensive heart disease, NDMVD, and rheumatic heart disease were relatively higher in females than in males. Despite either ischaemic heart disease or hypertensive heart disease ranked one among most GBD regions, COPD accounted for the highest proportion of age-standardized prevalence rate of HF in South Asia (38.3%) and East Asia (34.3%). Alcoholic cardiomyopathy accounted for 16.4% (ranked 2) of age-standardized prevalence rate of HF in Eastern Europe, but only accounted for 0.5% (ranked 16) in Andean Latin America. Although the impact of Chagas disease on HF was almost zero in most GBD regions, it was a major cause of HF in Andean (ranked 4: 7.4%), Tropical (ranked 5: 6.5%), Central (ranked 5: 3.5%), and Southern (ranked 5: 9.4%) Latin America.

YLDs due to HF

In 2017, HF contributed to 9.9 million (95% UI 7.3 to 12.4) YLDs globally: 4.6 million (95% UI 3.5 to 5.7) YLDs among males and 5.3 million (95% UI 3.8 to 6.7) YLDs among females. Compared with 1990, there was an increase of 106.0% (95% UI 98.6 to 112.7) in the global number of HF YLDs. Despite this increase, the age-standardized YLD rate of HF remained stable between 129.4 (95% UI 93.8 to 165.8) in 1990 and 128.2 (95% UI 94.8 to 160.7) in 2017 (Supplementary material online, *Table S3*). The trend pattern in the absolute number and

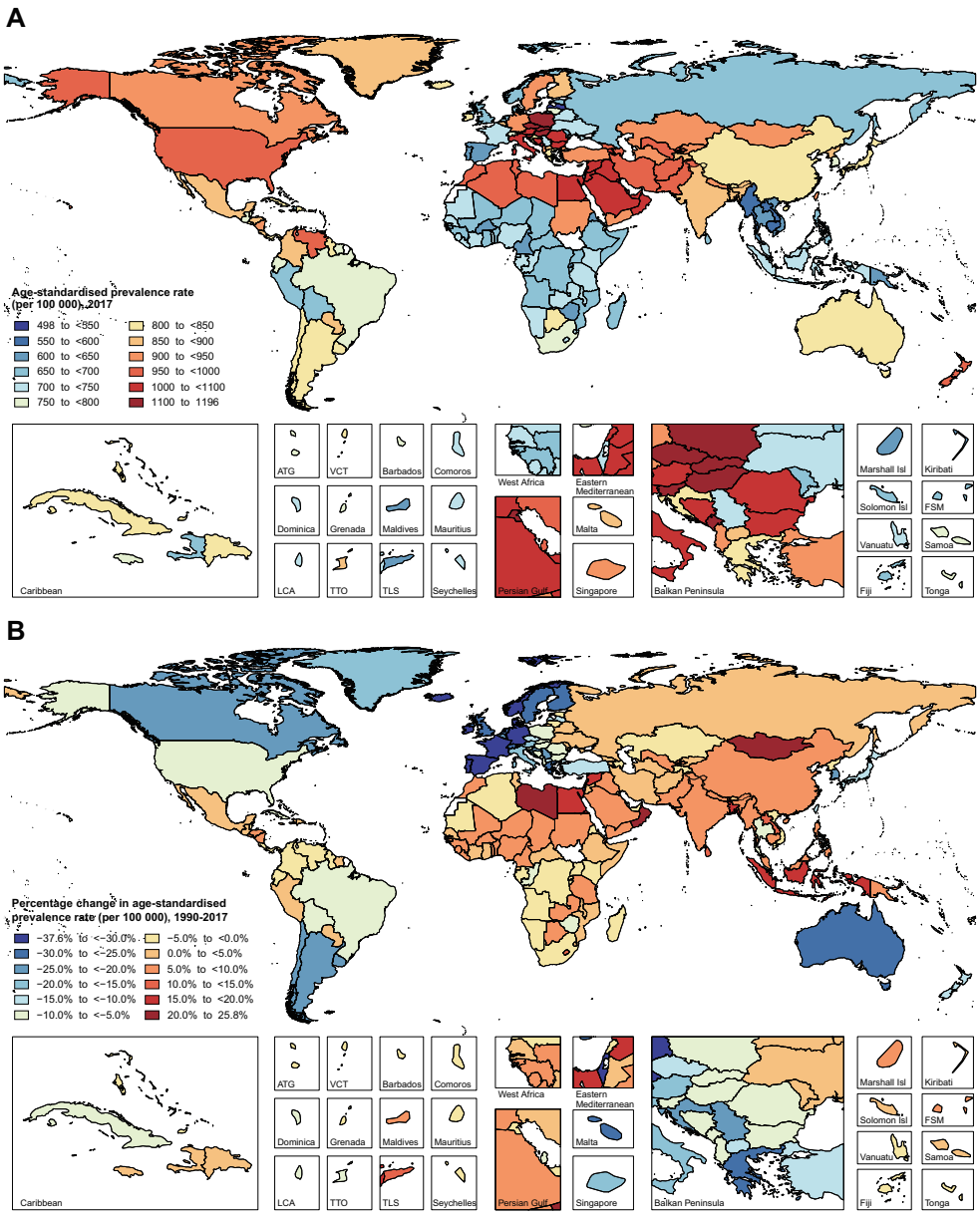

Figure 1 The global disease burden of heart failure for both sexes in 195 countries and territories. (*A*) Age-standardized prevalence rate of heart failure in 2017. (*B*) Percentage change in age-standardized prevalence rate of heart failure, 1990–2017. ATG, Antigua and Barbuda; FSM, Federated States of Micronesia; Isl, Islands; LCA, Saint Lucia; TLS, Timor-Leste; TTO, Trinidad and Tobago; VCT, Saint Vincent and the Grenadines.

age-standardized rate of HF YLDs from 1990 to 2017 was similar between males and females.

By SDI quintile, the age-standardized YLD rates of HF in countries in the high SDI quintile were highest in 1990, but became the lowest in 2017 due to a decrease of -15.8% (95% UI -19.8 to -11.2) in the rate (*Figure 4* and Supplementary material online, *Table S3*). In contrast, the greatest percentage increase [10.7% (95% UI 6.9 to 14.2)] in the age-standardized YLD rates of HF from 1990 to 2017 was seen in countries in the low SDI quintile. Similar to the variations by SDI quintile, regions with a SDI >0.59 in 1990 tended to have declined percentage changes in the age-standardized YLD rates of HF from 1990 to 2017 [e.g. Western Europe: -25.2% (95% UI -28.2 to -22.3); Australasia: -16.9% (95% UI -23.0 to -10.3); high-income Asia Pacific: -13.0% (95% UI -17.6 to -8.3); high-income North America: -5.7% (95% UI -14.4 to 4.6); and Southern Latin America: -13.9% (95% UI -20.3 to -7.8)], whereas increased percentage changes were seen in most regions with a SDI <0.59 in 1990 (*Figure 5* and Supplementary material online, *Table S3*).

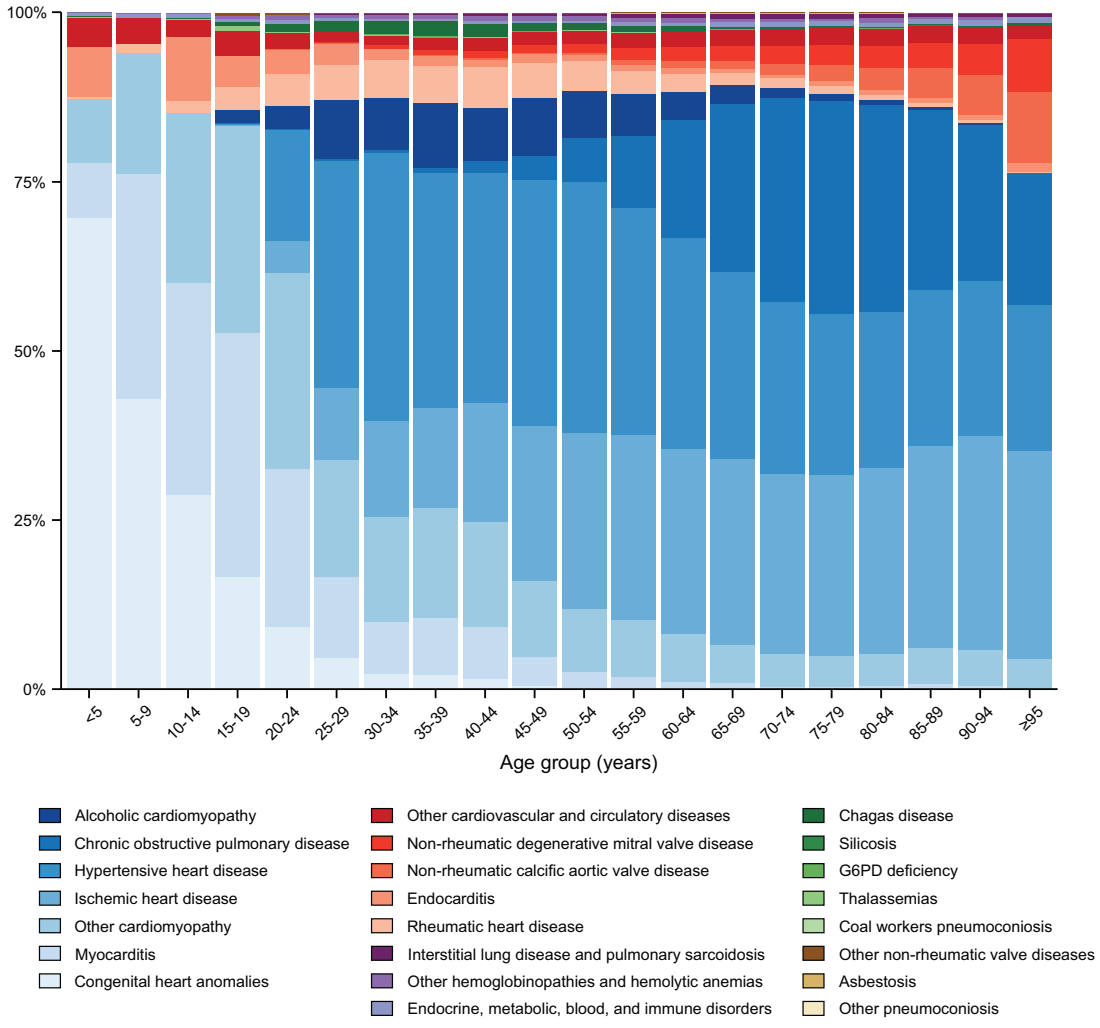

Figure 2 The proportion of age-standardized prevalence rate of heart failure due to each cause by age group, 2017.

Discussion

In the present study, we have thoroughly evaluated the global burden and underlying causes of HF from 1990 to 2017, making comparisons across different age groups, sex, locations, and SDI levels. Our results suggested that the global burden of HF remains dramatically high, and the number of HF cases worldwide almost doubled from 33.5 million in 1990 to 64.3 million in 2017, while the age-standardized prevalence rate of HF showed a slow downward trend, indicating that population ageing and growth mostly accounted for the absolute increase in the number of HF cases.

HF is emerging as a pandemic, with a wide epidemiological heterogeneity among regions and countries.[1] However, despite its global relevance, most studies focus on East Asia, Western Europe, and North America, and realities outside these contexts are generally overlooked. Our findings aimed at filling this gap in knowledge. As shown in our results, Central Europe, and North Africa and Middle East got relatively higher age-standardized prevalence rates in 2017, while the lowest age-standardized prevalence rates were reported in Eastern Europe and Southeast Asia. Since an array of variables is involved, including ethnicity, socio-demographic status, availability of resources, implementation of adequate prophylactic measures and effective clinical interventions, the reasons behind the HF-related prevalence disparities are subtle and multifactorial. Moreover, we observed a large decrease in the age-standardized prevalence rate in countries in the high SDI quintile since 1990, whereas a slight increase was reported in countries in other SDI tiers. The increasing prevalence rate of HF in countries in the low, low-middle, or middle SDI quintile is driven by a surge of risk factors such as hypertension, diabetes mellitus, obesity, smoking, and other unhealthy lifestyles.[14]

Our results revealed that there was a different aetiology spectrum of HF across 20 age groups. Globally, ischaemic heart disease, hypertensive heart disease, and COPD were the top three causes of HF, accounting for almost three-quarters of the age-standardized prevalence rates of HF. However, effects of the three causes were mainly concentrated in adults. In children and adolescents, congenital heart anomalies, myocarditis, and other cardiomyopathy were the major underlying causes. Additionally, in older adults aged ≥70 years,

	Global	Male	Female	Central Sub-Saharan Africa	Eastern Sub-Saharan Africa	Southern Sub-Saharan Africa	Western Sub-Saharan Africa	Andean Latin America	Tropical Latin America	Central Latin America	Southern Latin America	Caribbean	Central Europe	Eastern Europe	North Africa and Middle East	Central Asia	South Asia	Southeast Asia	East Asia	Oceania	High-income Asia Pacific	High-income North America	Western Europe	Australasia
Ischemic heart disease	1	1	2	1	1	1	4	2	2	2	2	2	1	1	2	1	2	3	3	3	1	1	1	1
Hypertensive heart disease	2	3	1	2	2	4	1	1	1	1	1	1	2	3	1	2	3	1	2	1	2	3	2	3
Chronic obstructive pulmonary disease	3	2	3	3	3	3	2	3	3	3	3	3	4	4	3	3	1	2	1	2	3	2	3	2
Other cardiomyopathy	4	4	4	4	4	2	3	5	4	4	4	4	3	5	4	4	4	4	6	5	4	4	4	4
Non-rheumatic degenerative mitral valve disease	5	7	5	5	5	6	5	7	6	7	7	7	8	7	6	6	5	5	7	4	9	7	8	11
Other cardiovascular and circulatory diseases	6	6	7	8	8	8	7	6	7	6	8	6	6	9	5	8	7	6	9	6	8	8	6	7
Alcoholic cardiomyopathy	7	5	10	7	7	7	6	16	8	13	10	5	5	2	12	5	11	11	11	13	11	5	5	5
Non-rheumatic calcific aortic valve disease	8	8	8	10	9	9	10	10	9	9	6	9	7	6	7	7	9	10	10	9	6	6	7	9
Rheumatic heart disease	9	10	6	6	6	5	8	12	14	15	11	13	11	11	10	10	6	13	4	8	15	14	15	14
Myocarditis	10	9	9	11	10	11	9	11	13	11	15	8	9	10	8	9	8	7	5	7	5	12	9	6
Congenital heart anomalies	11	11	12	13	13	14	12	14	11	10	16	12	10	8	9	11	10	9	8	11	14	13	12	13
Endocarditis	12	12	11	12	12	13	11	9	10	12	9	11	12	13	11	13	13	8	13	10	10	10	10	10
Interstitial lung disease and pulmonary sarcoidosis	13	13	14	15	15	12	14	8	16	14	12	15	13	12	15	12	12	15	15	14	7	11	14	12
Endocrine, metabolic, blood, and immune disorders	14	14	13	14	14	10	15	13	12	8	14	10	15	14	13	15	15	14	14	12	13	9	11	8
Other hemoglobinopathies and hemolytic anemias	15	16	15	9	11	15	13	15	15	16	13	14	14	15	14	14	14	12	12	15	12	15	13	15
Chagas disease	16	15	16					4	5	5	5	18						23			21	16	16	17
Other non-rheumatic valve diseases	17	19	17	17	17	16	17	18	18	18	19	16	16	16	16	16	17	18	16	16	17	20	18	18
G6PD deficiency	18	17	18	16	16	17	16	17	17	17	18	17	18	20	17	17	16	16	18	17	20	18	17	19
Silicosis	19	18	23	20	20	20	20	20	21	19	17	20	19	19	20	22	18	20	17	19	22	21	21	20
Coal workers pneumoconiosis	20	20	22	21	21	21	22	22	20	22	23	22	17	17	22	21	22	22	19	22	18	19	20	21
Asbestosis	21	21	20	18	18	18	19	21	22	21	20	21	21	21	21	20	20	21	22	20	19	17	19	16
Other pneumoconiosis	22	22	21	19	19	19	18	19	19	20	21	19	20	18	19	18	19	19	21	18	16	23	23	23
Thalassemias	23	23	19	22	22	22	21	23	23	23	22	23	22	22	18	19	21	17	20	21	23	22	22	22
Ranking Legend		**1-5**			**6-10**			**11-15**			**16-20**			**21-23**			**Blank cells indicate GBD estimate = 0**							

Figure 3 Ranking for all underlying causes of heart failure according to the proportion of age-standardized prevalence rate due to each cause, by sex and GBD region, 2017. For each cause, a higher ranking indicates that it contributed to a higher proportion of age-standardized prevalence rate of heart failure within a gender group or GBD region. GBD, Global Burden of Disease, Injuries, and Risk Factors Study.

NDMVD and NCAVD were noteworthy underlying causes. Although the prevalence rate of HF is relatively low in children and adolescents compared to adults, the complications and mortality of paediatric HF are still substantial. Children whose hospitalizations are complicated by HF have an over 20-fold increase in the risk of death compared to children without HF.[15] From a gender perspective, we noted a similar prevalence rate between males and females across all age groups, while females had significantly higher number of HF cases than males in the age groups of ≥70 years due to a higher life expectancy in females.

Furthermore, the aetiology spectrum of HF varied widely across regions, mainly because of varying risk factor exposure.[10] Smoking and air pollution, which are the most common risk factors for developing respiratory disease, also increase the risk of cardiovascular events and HF. Our results showed that COPD accounted for the highest age-standardized prevalence rate of HF in South Asia and East Asia. In 2011, the current smoking rate among males was 52.9% and 67.0% in mainland China and Indonesia, respectively, which is much higher than in other countries.[16] Moreover, air pollution is a very critical variable in China[17] and India,[18] raising incidence of cardiovascular disease along with respiratory disease. The relationship

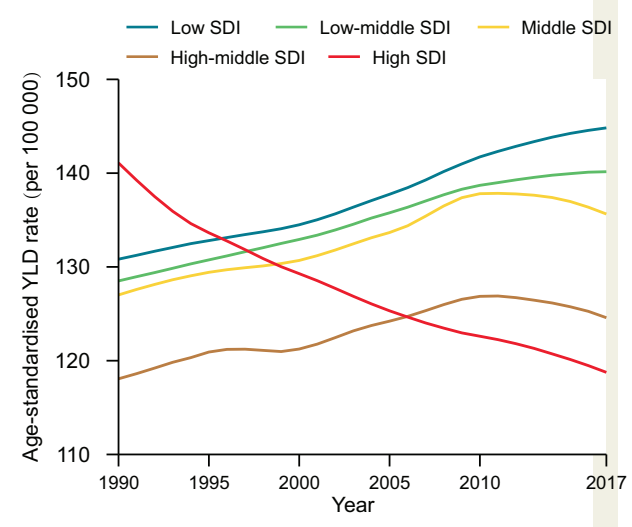

Figure 4 Trends in age-standardized YLD rates of heart failure by SDI quintiles, 1990–2017. SDI, Socio-demographic Index; YLD, year lived with disability.

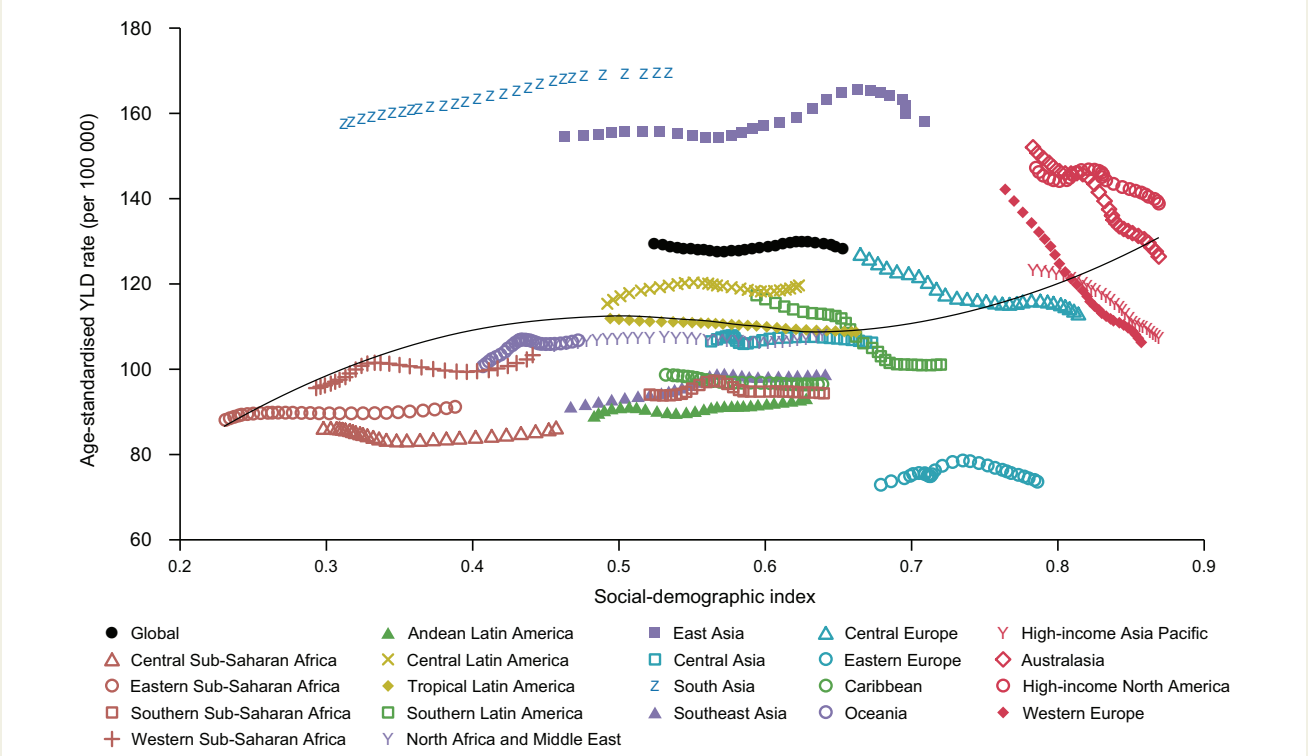

Figure 5 Trends in age-standardized YLD rates of heart failure for 21 GBD regions by SDI, 1990–2017. For each region, points from left to right depict estimates from each year from 1990 to 2017. GBD, Global Burden of Disease, Injuries, and Risk Factors Study; SDI, Socio-demographic Index; YLD, Year lived with disability.

between alcohol consumption and cardiovascular diseases has been found to be complex and, to a certain extent, inconclusive.[19] Referring to the 2018 WHO Global status report on alcohol and health, the prevalence rate of HF-related alcoholic cardiomyopathy seemed largely proportional to the total alcohol per capita consumption and percentage of current drinkers.[20] In European countries, where the levels of alcohol consumption are the highest around the world, alcohol contributed to 10.5% of all cardiovascular disease deaths.[20] Notably, Chagas disease, an anthropozoonosis caused by Trypanosoma cruzi, was a major cause of HF in Latin America. Our study provides data concerning the HF-related aetiology spectrum for every region, enabling public health policy-makers to formulate preventative programs targeting underlying causes and risk factors for HF.

Globally, HF-related YLDs in 2017 doubled to 9.9 million since 1990, while the age-standardized YLD rate remained stable. As expected, through primary prevention and better treatment programs,[21] a great decline in age-standardized YLD rate of HF could be observed in countries in the high SDI quintile during 1990–2017, and a downward trend in countries in the high-middle and middle SDI quintile was reported from 2010 on. However, the YLD rate of HF continued to deteriorate in countries in the low and low-middle SDI quintile. In low- and middle-income countries, the compliance to healthy lifestyle behaviours including healthy diets, physical activity and smoking cessation was rather poor.[22] More worse, four basic cardiovascular medicines (aspirin, β-blockers, angiotensin-converting enzyme inhibitors, and statins) were generally unavailable or unaffordable for many populations in low- and middle-income countries.[23] Therefore, it is noteworthy that the burden of HF in countries in the low and low-middle SDI quintile was getting worse, and more targeted strategies aimed to modify multiple risk factors and improve the availability and affordability of medical care for HF are urgently needed for these countries.[24,25]

Our findings concerning regional and national differences in the burden and underlying causes of HF can be compared with data collected by other HF registries and, in particular, by the international prospective REPORT-HF registry.[26,27] The REPORT-HF registry has sampled from 44 countries, recruiting more than 18 000 patients in a span of over 32 months, with the aim of giving a snapshot of HF worldwide. The REPORT-HF registry has enabled to capture treatment-related disparities as well as variability in hospitalization rates, comorbidities patterns and determinants/precipitants of HF. All these data could be useful to inform and implement guidelines, based on local availability of drugs and medical devices, clinical practice patterns, and geographically specific public health strategies.

Limitations

Despite its strength, including the methodological rigour and the statistical robustness of the approaches utilized, several limitations affect the present investigation. Firstly, comparability of data is at least partly hindered by different collection methods, sources and reporting

standards. Secondly, HF data are absent or sparse in some countries, particularly in Latin America, sub-Saharan Africa, and Asia. For these countries, results mainly relied on covariates known to be associated with HF, trends in neighbouring countries, or a combination of both methods. Thirdly, even though socio-cultural and ethnic background differences impact the burden of HF, they are not recognized by the GBD methodology and, as such, are not accounted for. Finally, another limitation is represented by the lack of data concerning the various phenotypes of HF patients, such as HF with reduced or preserved ejection fraction.

Conclusions

HF remains a serious public health problem worldwide. Although the age-standardized prevalence and YLD rates of HF have significantly decreased in countries in the high SDI quintile, increasing rates were still observed in countries with relatively low SDI. Given the significant geographic variation in the burden and underlying causes of HF across regions and countries, more geo-specific strategies aimed at preventing underlying causes and improving medical care for HF are warranted to reduce the future burden of this condition.

Supplementary material

Supplementary material is available at *European Journal of Preventive Cardiology* online.

Acknowledgements

We thank all members of the Institute for Health Metrics and Evaluation (IHME), University of Washington, and all collaborators involved in GBD 2017 study.

Funding

The GBD 2017 study was funded by the Bill and Melinda Gates Foundation. The present study was also funded by the National Natural Science Foundation of China (81974090) and Hospital Pharmacy Research Fund of Guangdong (2019YX18). However, the funders were not involved in any way in the preparation of this manuscript.

Conflict of interest: none declared.

Data availability

The data underlying this article were derived from sources in the public domain: Institute for Health Metrics and Evaluation (IHME), at https://gbd2017.healthdata.org/gbd-search/, accessed December 21, 2020.

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