






ORIGINAL RESEARCH

# Burden, Trends, and Inequalities of Heart Failure Globally, 1990 to 2019: A Secondary Analysis Based on the Global Burden of Disease 2019 Study

Tao Yan , MD\*; Shijie Zhu, MD\*; Xiujie Yin, MD\*; Changming Xie, MD; Junqiang Xue , MD; Miao Zhu , MD; Fan Weng, MD; Shichao Zhu , MD; Bitao Xiang, MD; Xiaonan Zhou, MD; Gang Liu, MD; Yang Ming, MD; Kai Zhu, MD; Chunsheng Wang , MD; Changfa Guo, MD

**BACKGROUND:** Heart failure is a public health issue worldwide. However, no comprehensive study on the global burden of heart failure and its contributing causes has been reported. The present study aimed to quantify the burden, trends, and inequalities of heart failure globally.

**METHODS AND RESULTS:** Heart failure data were extracted from the Global Burden of Diseases 2019 study. The number of cases, age-standardized prevalence, and years lived with disability in different locations from 1990 to 2019 were presented and compared. Joinpoint regression analysis was performed to assess trends in heart failure from 1990 to 2019.

In 2019, the global age-standardized prevalence and years lived with disability rates for heart failure were 711.90 (95% uncertainty interval [UI], 591.15–858.29) and 63.92 (95% UI, 41.49–91.95) per 100 000 population, respectively. In general, the age-standardized rate decreased globally at an average annual percentage change of 0.3% (95% UI, 0.2–0.3). However, the rate increased at an average annual percentage change of 0.6% (95% UI, 0.4–0.8) from 2017 to 2019. Several nations and territories demonstrated an increased trend from 1990 to 2019, especially in less-developed countries. Ischemic heart disease and hypertensive heart disease accounted for the highest proportion of heart failure in 2019.

**CONCLUSIONS:** Heart failure remains a major health problem, with increased trends possible in the future. Efforts for prevention and control of heart failure should focus more on less-developed regions. It is essential to prevent and treat primary diseases such as ischemic heart disease and hypertensive heart disease for the control of heart failure.

**Key Words:** epidemiology ■ Global Burden of Diseases ■ heart failure ■ prevalence

**H**ear failure (HF), a complex syndrome consisting of cardinal symptoms accompanied by multiple signs and comorbidities,<sup>1</sup> remains a major clinical and public health problem affecting approximately 1% to 2% of adults.<sup>2–4</sup> Because of the aging population, the prevalence of HF tends to increase,<sup>5</sup> reducing the quality of life of patients<sup>6</sup> and increasing the economic burden for

both individuals and public health.<sup>7</sup> Estimating the global burden and temporal trends of HF are essential to guide the clinical decision making and improve the prognosis of patients with HF.

The GBD (Global Burden of Diseases, Injuries, and Risk Factors Study) project is a systematic analysis to compare the magnitude of health loss attributable to

Correspondence to: Changfa Guo, MD, Chunsheng Wang, MD, and Kai Zhu, MD, Department of Cardiovascular Surgery, Zhongshan Hospital, Fudan University, 180 Fenglin Road, Shanghai 200032, China. Email: [guo.changfa@zs-hospital.sh.cn](mailto:guo.changfa@zs-hospital.sh.cn); [wangchunsheng@fudan.edu.cn](mailto:wangchunsheng@fudan.edu.cn); [zhu.kai1@zs-hospital.sh.cn](mailto:zhu.kai1@zs-hospital.sh.cn)

\*T. Yan, S. Zhu, and X. Yin contributed equally.

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## CLINICAL PERSPECTIVE

### What Is New?

- The present study is the first to comprehensively analyze the global burden of heart failure and its contributing causes.

### What Are the Clinical Implications?

- Heart failure remains a major health problem with a possible increased trend in the future.
- It is essential to prevent and treat primary diseases such as ischemic heart disease and hypertensive heart disease for the control of heart failure.

## Nonstandard Abbreviations and Acronyms

<b>AAPC</b>	average annual percentage change
<b>GBD</b>	Global Burden of Diseases, Injuries, and Risk Factors Study
<b>SDI</b>	Sociodemographic Index
<b>UI</b>	uncertainty interval
<b>YLDs</b>	years lived with disability

diseases, injuries, and risk factors by age, sex, and geography for specific points in time.<sup>8</sup> The GBD 2019 study<sup>9</sup> is the newest update of the GBD 2017 study,<sup>10</sup> comprising newly available data sets that enhance method performance and standardization. In the GBD 2019 study, the prevalence and years lived with disability (YLDs) of HF globally is estimated, including 369 diseases and injuries in 204 countries and territories and 21 GBD regions from 1990 to 2019.

Although some previous studies have described the epidemiology of HF,<sup>3,11–13</sup> those studies were mostly limited to cohorts in 1 country or region. No comprehensive study on the global burden of HF and its contributing causes was reported. In the present study, we extracted the HF data from the GBD 2019 study and performed a secondary analysis to quantify the burden, trends, and inequalities of HF by location, age, and sex, and to explore the underlying causes of HF.

## METHODS

### Data Source

We extracted data from the GBD 2019 and performed a secondary analysis of the GBD 2019 in the present study.<sup>9</sup> The GBD 2019 synthesizes a large and growing number of data input sources including surveys,

censuses, vital statistics, and other health-related data sources. The GBD 2019 collaborators explore and provide a systematic scientific estimate of incidence, prevalence, and burden of diseases and injuries globally, including 369 diseases and injuries in 204 countries and territories and 21 GBD regions from 1990 to 2019.<sup>9</sup> All data are available using the GBD results tool (<https://ghdx.healthdata.org/gbd-results-tool>). The institutional review board approval and patient informed consent are waived because the present study is a secondary analysis of published data that can be acquired in the public database.

### Definition of HF

The GBD 2019 extended the definition of HF in GBD 2017.<sup>10</sup> HF was diagnosed clinically using the Framingham or European Society of Cardiology criteria, which can be found in a previous study.<sup>10</sup> Briefly, Framingham criteria require patients with HF to fulfill 2 major criteria or 1 major criterion and 2 minor criteria. According to European Society of Cardiology criteria, typical signs and symptoms caused by structural and/or functional cardiac abnormality are necessary.<sup>14</sup> HF was divided into 4 subgroups of varying severity based on clinical symptoms, including treated, mild, moderate, and severe HF.

### Data Processing and Modeling

In the GBD 2019, heart failure estimation was modeled using spatiotemporal Gaussian process regression and DisMod–MR.<sup>9</sup> Briefly, spatiotemporal Gaussian process regression is a set of regression methods that allow for smoothing over age, time, and locations. The approach serves as a powerful tool for interpolating nonlinear trends. Unlike classical linear models, spatiotemporal Gaussian process regression assumes that the specific trend of interest follows a Gaussian process, which is defined by a mean function and a covariance function. Random draws of 1000 samples were obtained from the distributions above for every country for a given indicator. The final estimated mean for each country was the mean of the draws. DisMod–MR is a Bayesian metaregression method to evaluate all available data. A Gaussian, log-Gaussian, Laplace, or log-Laplace likelihood function was used in the DisMod–MR 2.1. For a given location, country coefficients are calculated by using both data and prior information available for that location. The default value of the minimum coefficient of variation is set as 0.8 to improve coverage and reduce errors based on simulation testing. The process of HF estimation begins with the compilation of data sources from a diverse set of possible sources, which include Global Health Data Exchange data types ranging from scientific literature to survey data to hospital and clinical data. The

GBD collaborator network provided data sources for the GBD 2019 study. Overall prevalence of heart failure was estimated in DisMod-MR 2.1 using literature data, hospital data, and claims data. YLDs were estimated as the product of prevalence estimate and a disability weight of HF. Age and sex standardization were performed based on the GBD reference population. More detailed methods can be found in the previous studies.<sup>8–10</sup>

### Sociodemographic Index

The Sociodemographic Index (SDI) is constructed using Human Development Index methodology, which is an indicator of social and economic conditions that influence health outcomes in each location. In the GBD 2019, SDI comprised the total fertility rates for those <25 years old, mean education for those ≥15 years old, and lag-distributed income per capita. Values of calculated SDI are multiplied by 100 to report for a scale of 0 to 100 to improve understanding of and broader engagement with the values. Countries with populations <1 million are excluded. According to different SDI levels, all locations are divided into 5 regions, called low SDI, low-middle SDI, middle SDI, high-middle SDI, and high SDI.<sup>9</sup>

### Joinpoint Regression Model

Joinpoint regression analysis was performed to assess trends in HF from 1990 to 2019 using Joinpoint software (version 4.9.0.1, <https://surveillance.cancer.gov/joinpoint/>). The average annual percentage change (AAPC) represents the weighted average of annual percentage change from the Joinpoint regression analysis. The Monte Carlo permutation test, with 4499 randomly permuted data sets, was used to calculate the AAPCs and their 95% CIs for prevalence attributable to HF. AAPCs are considered significantly different from 0 at the  $\alpha=0.05$  level. If 0 is within the 95% CIs, AAPCs are considered a constant trend. If both limits of the 95% CIs are positive or negative, AAPCs are increasing or decreasing trends.

### Statistical Analysis

To characterize the global, regional, national, and territorial burden of HF, a descriptive analysis was performed. The number of cases, age-standardized prevalence (per 100 000 population), and age-standardized YLDs (per 100 000 population) in different locations from 1990 to 2019 were compared. Because HF was not considered an underlying cause of some deaths in the GBD 2019, years of life lost could not be calculated. Uncertainty was calculated by sampling 1000 draws, and the uncertainty intervals (UIs) were defined as the 25th and 975th values of the 1000 ordered draws.

## RESULTS

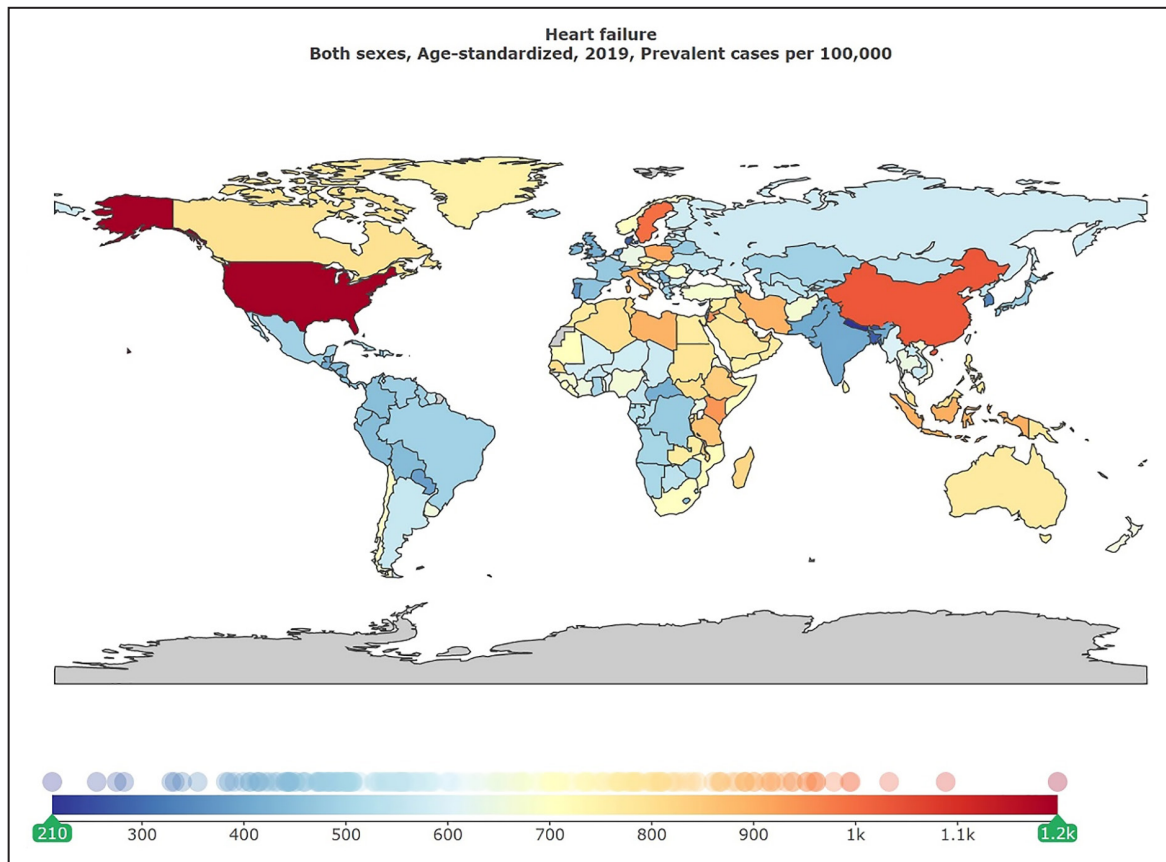
### Global Level

There were 56.19 million (95% UI, 46.45–67.79) prevalent cases of HF around the world, with an age-standardized rate (ASR) of 711.90 per 100 000 population (95% UI, 591.15–858.29), which is 7.06% lower than that in 1990 (765.99 per 100 000 population [95% UI, 626.29–936.03]) (Figure 1 and Table 1). In general, from 1990 to 2019, ASRs decreased globally at an AAPC of 0.3% (95% UI, 0.2–0.3). However, ASR prevalence of HF increased at an annual percentage change of 0.6% (95% UI, 0.4–0.8) from 2017 to 2019 (Figure 2). In 2019, HF resulted in 5.05 million (95% UI, 3.28–7.26) YLDs across the world, with an ASR of 63.92 per 100 000 population (95% UI, 41.49–91.95), which is 6.83% lower than that in 1990 (68.60 per 100 000 population [95% UI, 44.34–98.68]) (Figure 3 and Table 2).

According to the classification of HF severity, there were 20.79 million (95% UI, 16.81–25.37) treated cases, 10.44 million (95% UI, 7.35–14.15) mild cases, 6.78 million (95% UI, 4.75–9.40) moderate cases, and 18.19 million (95% UI, 14.49–22.75) severe cases globally in 2019, with ASRs (per 100 000 population) of 263.35 (95% UI, 214.26–321.08; Figure S1), 132.20 (95% UI, 93.06–178.44; Figure S2), 85.86 (95% UI, 60.11–119.53; Figure S3), and 230.49 (95% UI, 184.89–285.93; Figure S4), which are 7.23%, 7.05%, 6.99%, and 6.90% lower than those in 1990, respectively (Table S1). ASR of prevalence decreased at the AAPC of 0.3% (95% UI, 0.2–0.3) from 1990 to 2019 in all 4 subgroups, whereas it increased at the annual percentage change of 0.6% (95% UI, 0.4–0.8) from 2017 to 2019 (Figures S5 through S8), which is consistent with the general trend. Similarly, the 2019 global YLDs numbers for treated, mild, moderate, and severe HF are 1.00 million (95% UI, 0.58–1.52), 0.42 million (95% UI, 0.23–0.71), 0.47 million (95% UI, 0.27–0.75), and 3.15 million (95% UI, 2.04–4.61), respectively, with ASRs (per 100 000 population) of 12.62 (95% UI, 7.36–19.30), 5.37 (95% UI, 2.92–8.95), 6.00 (95% UI, 3.44–9.50), and 39.93 (95% UI, 25.96–58.21), respectively, which are 7.11%, 6.95%, 6.85%, and 6.71% lower, respectively, than those in 1990 (Table S2).

### Association With the SDI

In 1990, the age-standardized point prevalence of HF (per 100 000 population) was highest in the high SDI location (900.44 [95% UI, 746.49–1079.91]), whereas it was the lowest in the low-middle SDI location (501.99 [95% UI, 408.07–627.03]). However, in 2019, the middle SDI location replaced the high SDI location as the region with the highest ASRs of prevalence (787.39 [95% UI, 638.97–977.14]). The low-middle SDI location still had the lowest age-standardized point prevalence



**Figure 1. Global age-standardized point prevalence rate of heart failure per 100000 population in 2019.**

Visualization using the Global Burden of Diseases compare tool (<https://www.healthdata.org/data-visualization/gbd-compare>).

(513.12 [95% UI, 416.96–641.54]) in 2019. From 1990 to 2019, the low and low-middle SDI locations demonstrated slight increases in ASRs of HF, whereas high, high-middle, and middle SDI locations showed decreases, with the largest decreases in high SDI locations (Figures S9 through S13).

### Regional Level

East Asia, high-income North America, and Western Europe experienced the largest number of prevalent cases in 1990, which had not changed in 2019 (Table 1). Similarly, those 3 regions had the highest numbers of YLDs attributable to HF both in 1990 and 2019 (Table 2).

In 2019, the age-standardized point prevalence of HF (per 100000 population) was highest in high-income North America (1154.09 [95% UI, 1002.16–1327.60]), East Asia (1014.06 [95% UI, 830.18–1252.96]), and Oceania (827.64 [95% UI, 651.71–1060.65]). On the contrary, South Asia (389.97 [95% UI, 314.38–487.19]), high-income Asia Pacific (445.28 [95% UI, 384.66–514.55]), and Andean Latin America (453.01 [95% UI, 355.22–575.83]) had the lowest ASRs (Figure 4 and Table 1).

High-income North America (104.50 [95% UI, 70.05–146.02]), East Asia (90.93 [95% UI, 58.88–132.53]), and Oceania (73.85 [95% UI, 47.33–107.03]) had the highest age-standardized YLDs rates from HF in 2019. The ASRs were lowest for South Asia (34.41 [95% UI, 22.10–50.07]), Andean Latin America (38.77 [95% UI, 24.61–55.82]), and high-income Asia Pacific (40.50 [95% UI, 27.27–57.40]) (Table 2).

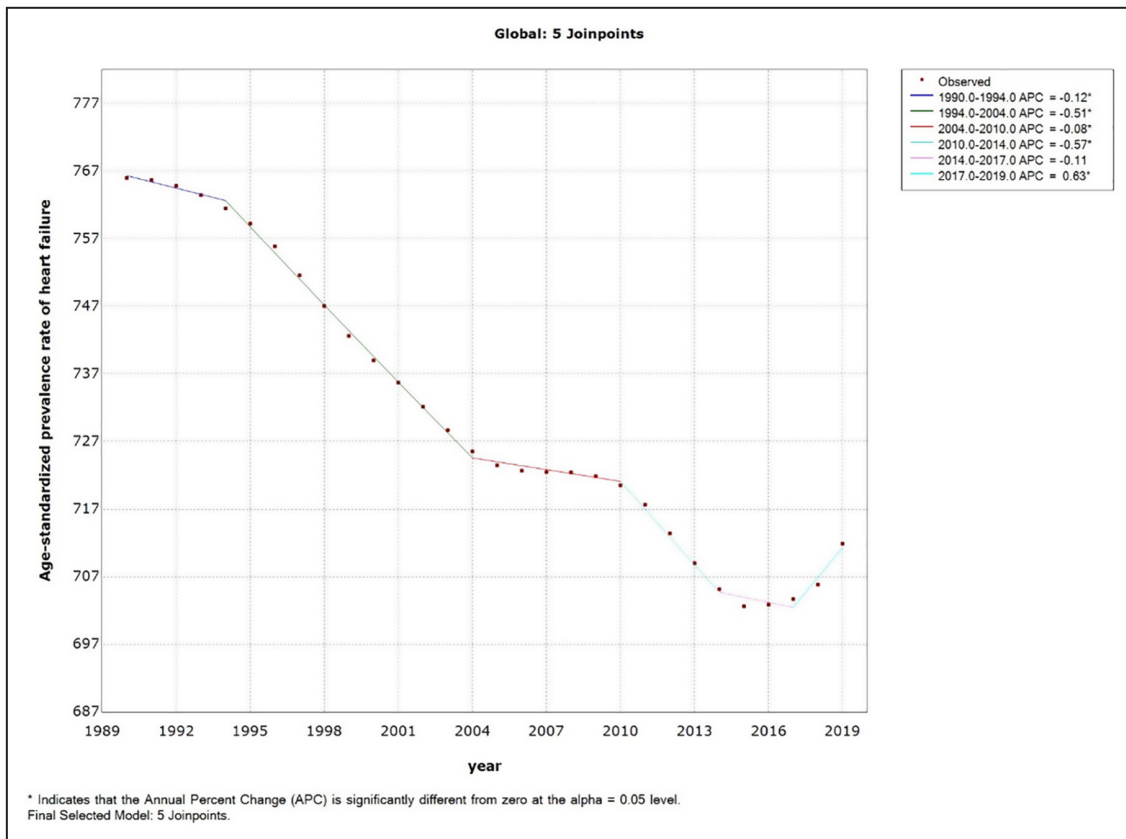
Despite some volatility, a total of 16 GBD regions showed a decrease in the ASRs of HF from 1990 to 2019, with the largest decreases being in Australasia (35.38%), high-income Asia Pacific (22.10%), and Western Europe (20.62%). On the contrary, only 5 GBD regions showed an increased trend, with the largest increase being in Western sub-Saharan Africa (6.98%). We also calculated AAPCs of 21 GBD regions (Figures S14 through S34). A total of 5 GBD regions demonstrated increasing AAPCs from 1990 to 2019, including Western sub-Saharan Africa, Eastern sub-Saharan Africa, South Asia, Southeast Asia, and Oceania. Eastern Europe, North Africa, and the Middle East showed a constant trend. Other 14 GBD regions showed decreasing trends from 1990 to 2019. Compared with the global level, only 9 GBD regions



**Table 1. Prevalent Cases and ASRs of Prevalence per 100000 Population for Heart Failure in 1990 and 2019 Globally and in 21 Global Burden of Diseases Regions**

Regions	1990, millions				2019, millions				1990				2019			
	No.	95% UI		No.	95% UI		ASRs per 100000	95% UI		ASRs per 100000	95% UI		ASRs per 100000	95% UI		
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper	
Global	27.24	22.17	33.36	56.19	46.45	67.79	765.99	626.29	936.03	711.90	591.15	858.29	711.90	591.15	858.29	
Andean Latin America	0.09	0.07	0.11	0.25	0.19	0.31	461.95	371.11	578.14	453.01	355.22	575.83	453.01	355.22	575.83	
Australasia	0.27	0.21	0.33	0.39	0.31	0.47	1161.07	929.14	1404.29	750.24	603.56	904.89	750.24	603.56	904.89	
Caribbean	0.13	0.10	0.17	0.27	0.21	0.35	542.61	424.44	694.40	521.68	405.62	672.18	521.68	405.62	672.18	
Central Asia	0.24	0.19	0.31	0.33	0.26	0.41	582.38	453.44	748.24	544.18	425.82	697.68	544.18	425.82	697.68	
Central Europe	1.07	0.84	1.34	1.59	1.32	1.91	789.04	628.59	983.55	719.85	607.69	855.24	719.85	607.69	855.24	
Central Latin America	0.41	0.33	0.50	1.07	0.86	1.33	531.55	425.65	660.74	471.07	375.38	589.79	471.07	375.38	589.79	
Central sub-Saharan Africa	0.09	0.07	0.12	0.21	0.16	0.28	499.26	368.39	658.74	482.70	356.27	639.34	482.70	356.27	639.34	
East Asia	7.20	5.83	9.02	18.91	15.31	23.50	1060.30	863.37	1310.49	1014.06	830.18	1252.95	1014.06	830.18	1252.95	
Eastern Europe	1.44	1.15	1.80	1.93	1.55	2.38	561.57	450.36	689.28	560.22	451.07	685.57	560.22	451.07	685.57	
Eastern sub-Saharan Africa	0.49	0.38	0.62	1.14	0.90	1.43	761.64	601.11	958.08	812.60	640.86	1019.90	812.60	640.86	1019.90	
High-income Asia Pacific	1.04	0.85	1.27	2.10	1.78	2.49	571.60	471.91	698.96	445.28	384.66	514.55	445.28	384.66	514.55	
High-income North America	4.52	3.73	5.45	7.22	6.22	8.40	1278.19	1068.01	1541.62	1154.09	1002.16	1327.60	1154.09	1002.16	1327.60	
North Africa and Middle East	1.28	1.00	1.63	3.21	2.57	3.98	793.57	614.74	1004.66	784.39	628.33	976.77	784.39	628.33	976.77	
Oceania	0.02	0.01	0.02	0.05	0.04	0.06	813.81	636.97	1050.36	827.64	651.71	1060.65	827.64	651.71	1060.65	
South Asia	1.64	1.33	2.03	4.69	3.79	5.83	374.17	302.18	470.48	389.97	314.38	487.19	389.97	314.38	487.19	
Southeast Asia	1.62	1.29	2.03	4.09	3.29	5.11	729.15	581.66	919.89	755.95	604.89	946.23	755.95	604.89	946.23	
Southern Latin America	0.32	0.25	0.40	0.51	0.40	0.66	721.46	572.87	908.55	604.39	473.51	771.47	604.39	473.51	771.47	
Southern sub-Saharan Africa	0.18	0.14	0.23	0.33	0.26	0.41	740.23	580.93	932.37	662.37	517.92	831.56	662.37	517.92	831.56	
Tropical Latin America	0.43	0.35	0.52	1.13	0.92	1.40	534.24	437.41	655.11	489.56	397.55	605.66	489.56	397.55	605.66	
Western Europe	4.29	3.44	5.25	5.75	4.76	6.91	732.23	597.60	886.75	581.27	483.77	690.57	581.27	483.77	690.57	
Western sub-Saharan Africa	0.45	0.36	0.57	1.02	0.81	1.27	593.12	467.71	746.63	634.53	497.17	807.21	634.53	497.17	807.21	

ASRs indicates age-standardized rates; and UI, uncertainty interval.



**Figure 2.** Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure globally from 1990 to 2019.

met or exceeded the global decreasing AAPC. In the same period, a total of 16 GBD regions showed a decrease in the age-standardized YLDs rates of HF, with the largest decreases being in Australasia (35.19%), high-income Asia Pacific (21.82%), and Western Europe (20.52%). Another 5 GBD regions show an increased rate.

### National and Territorial Level

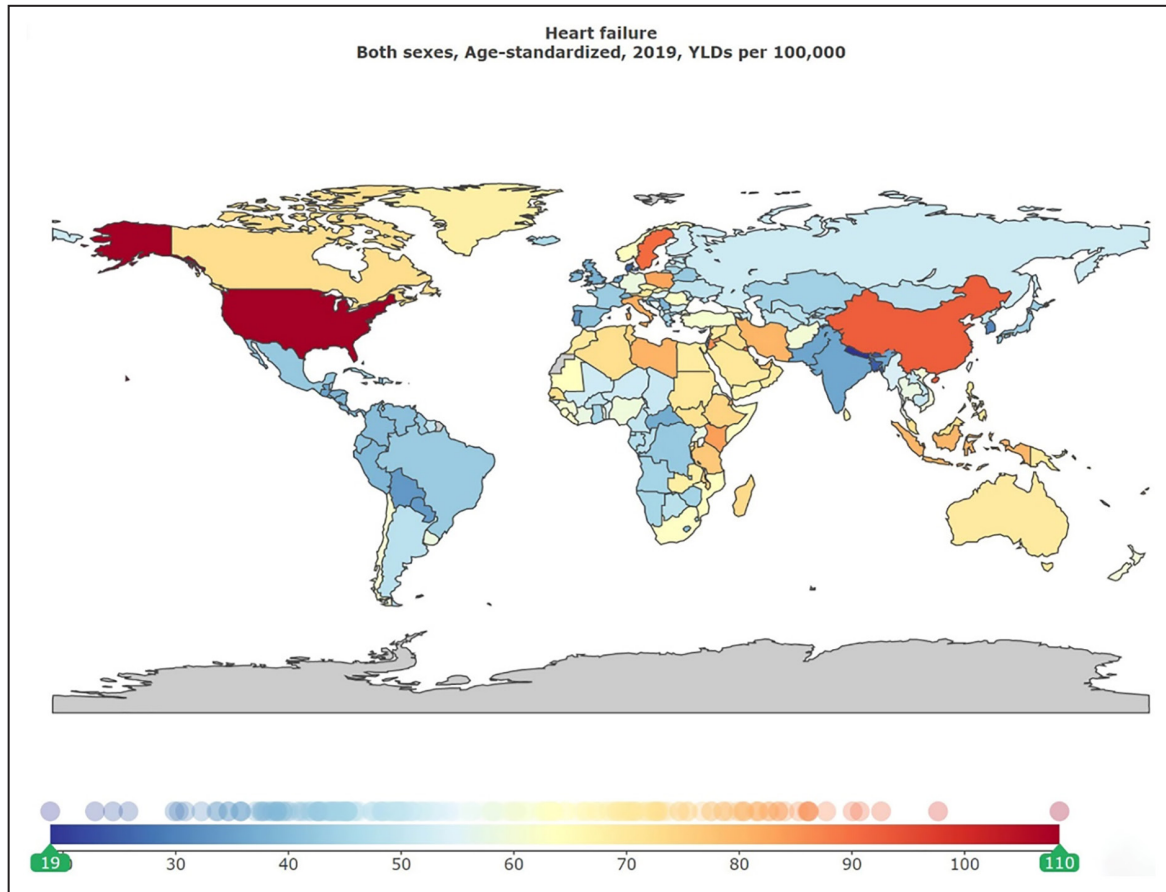
The national and territorial age-standardized point prevalence of HF ranged from 211.86 to 1198.06 cases per 100 000 population. The United States (1198.06 [95% UI, 1039.85–1385.34]), Guam (1088.30 [95% UI, 836.55–1411.95]), and China (1032.84 [95% UI, 846.57–1277.46]) had the highest age-standardized point prevalence rates of HF in 2019. On the contrary, Nepal (211.86 [95% UI, 164.68–276.13]), Bhutan (255.54 [95% UI, 199.01–330.03]), and Bangladesh (275.00 [95% UI, 213.50–355.43]) had the lowest rates (Figure S35).

In 2019, the national and territorial ASRs of YLDs because of HF varied from 18.86 to 108.41 per 100 000 population. Similar to prevalence rates, the highest ASRs of YLDs were calculated in the United States (108.41 [95% UI, 72.39–151.98]), Guam (97.64

[95% UI, 61.69–142.63]), and China (92.59 [95% UI, 59.89–135.06]).

From 1990 to 2019, the percentage change in the age-standardized point prevalence differed among 204 countries and territories. A total of 94 countries and territories showed increases, whereas others demonstrated decreases during the measurement period.

Over the period of 1990 to 2019, Oman (28.79%), Cameroon (25.71%), and Saudi Arabia (20.97%) showed the largest increases, whereas Canada (47.65%), France (44.78%), and Denmark (44.41%) demonstrated the largest decreases (Figure S36). According to the Joinpoint regression analysis, Oman, Cameroon, and Saudi Arabia showed the largest increases at AAPCs of 0.9%, 0.8%, and 0.7%, respectively (Figures S37 through S39), whereas Canada, France, and Denmark demonstrated the largest decreases from 1990 to 2019 at AAPCs of 2.2%, 2.0%, and 2.0%, respectively (Figures S40 through S42). The percentage change in the ASRs of YLDs is the same as ASRs of prevalence. From 1990 to 2019, Oman (29.57%), Cameroon (26.54%) and Saudi Arabia (22.42%) showed the largest increases, whereas Canada (47.58%), France (44.62%), and Denmark (44.29%) demonstrated the largest decreases.



**Figure 3.** Global age-standardized years lived with disability (YLDs) of heart failure per 100000 population in 2019. Visualization using the Global Burden of Diseases (GBD) compare tool (<https://www.healthdata.org/data-visualization/gbd-compare>).

### Sex and Age Differences

The global point prevalence of HF increased with age in 2019 for both men and women, with the highest ASRs of prevalence among those >75 years old (9193.41 [95% UI, 7114.68–11 721.51]; [Figure S43](#)). Compared with 1990, ASRs of prevalence had decreased in all age groups except the 50- to 55-year-old group. The age-standardized point prevalence in men was higher than that in women in all age groups both in 1990 and 2019. We also explored sex differences in 21 GBD regions ([Table S3](#)). In 1990, men demonstrated higher age-standardized point prevalence in all GBD regions, with the highest male–female ratio of 1.74 in the Caribbean. However, in 2019, the age-standardized point prevalence for women was slightly higher than for men in East Asia (1001.01 [95% UI, 819.06–1245.62] versus 991.23 [95% UI, 808.02–1228.71]; [Figure 5](#)). ASRs of YLDs demonstrated a similar pattern ([Table S4](#)).

### Causes of HF

Although there are sex and regional differences for the causes of HF, the main causes of HF globally are heart diseases. Ischemic heart disease (265.72

[95% UI, 197.23–346.43]) and hypertensive heart disease (233.77 [95% UI, 170.52–312.90]) accounted for the highest proportion of HF both for men and women in 2019. The difference between men and women was that ischemic heart disease took first place in men, whereas hypertensive heart disease led in women. In addition to heart diseases, chronic obstructive pulmonary disease (COPD) (65.64 [95% UI, 45.27–94.08]) is a main cause of HF ([Table 3](#)). Over the period 1990 to 2019, the age-standardized prevalence rate of HF attributable to hypertensive heart disease increased (219.54 [95% UI, 158.77–299.36] versus 233.77 [95% UI, 170.52–312.90]), whereas ASRs of HF from other causes all decreased.

### DISCUSSION

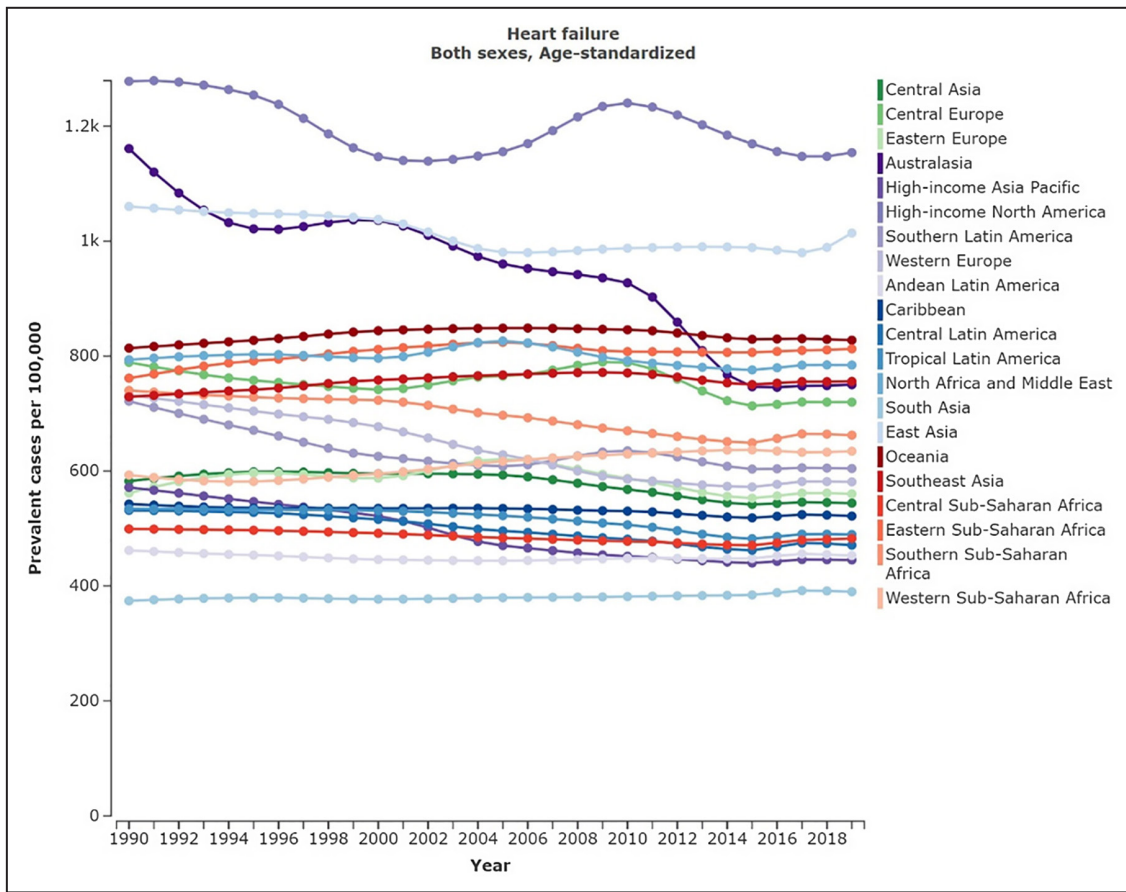
In the present study, we used HF data from the GBD 2019 study to comprehensively analyze the burden, trends, and inequalities of HF by location, age, and sex from 1990 to 2019. We found that the number of HF cases increased from 1990 to 2019 globally, which might be because of a demographic change, mainly

**Table 2. Years Lived With Disabilities and ASRs of Years Lived With Disabilities per 100 000 Population for Heart Failure in 1990 and 2019 Globally and in 21 Global Burden of Diseases Regions**

Regions	1990			2019			1990			2019		
	No.	95% UI		No.	95% UI		ASRs per 100 000	95% UI		ASRs per 100 000	95% UI	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Global	2 447 874.95	1 594 510.07	3 534 045.71	5 050 317.37	3 281 008.91	7 262 083.90	68.60	44.34	98.68	63.92	41.49	91.95
Andean Latin America	7226.88	4602.80	10 328.49	21 083.48	13 437.91	30 314.25	37.03	23.68	52.88	38.77	24.61	55.82
Australasia	24 209.86	15 458.24	35 348.94	35 467.45	22 645.02	52 188.64	104.93	67.59	151.55	68.00	43.74	98.90
Caribbean	12 130.00	7757.74	17 804.65	24 209.94	15 516.02	35 347.89	48.65	31.13	71.01	46.93	30.11	68.45
Central Asia	21 971.53	14 009.44	31 623.22	29 401.82	18 954.17	42 504.91	52.15	33.17	74.95	48.81	31.19	70.00
Central Europe	96 769.35	61 505.54	140 850.92	143 543.26	94 664.15	207 061.12	71.17	45.42	102.69	65.05	43.17	93.22
Central Latin America	34 923.61	22 525.24	50 238.40	92 741.01	59 617.60	133 984.01	45.55	29.47	65.98	40.96	26.22	59.32
Central sub-Saharan Africa	8235.17	5170.77	12 427.00	19 163.66	12 030.32	28 342.89	44.57	27.35	66.19	43.27	26.15	64.31
East Asia	646 539.92	410 778.64	956 726.68	1 702 046.98	1 086 142.54	2 501 819.10	94.36	61.18	136.99	90.93	58.88	132.53
Eastern Europe	129 802.19	85 278.66	186 060.86	173 924.82	113 699.42	249 434.93	50.45	33.26	71.77	50.40	33.17	71.93
Eastern sub-Saharan Africa	43 744.63	28 223.11	63 402.33	102 810.22	66 492.70	149 944.60	67.60	43.42	98.36	72.45	46.11	104.58
High-income Asia Pacific	94 907.53	61 525.06	138 108.72	190 367.02	126 436.20	267 005.76	51.80	33.74	74.81	40.50	27.27	57.40
High-income North America	409 944.77	265 755.91	593 839.77	652 237.76	435 716.08	913 955.75	116.03	77.10	166.97	104.50	70.05	146.02
North Africa and Middle East	116 030.04	73 419.48	169 481.63	290 350.79	186 461.95	421 310.26	71.15	44.96	103.14	70.74	45.15	101.86
Oceania	1669.92	1073.29	2420.96	4049.33	2598.96	5904.76	72.49	46.56	105.45	73.85	47.33	107.03
South Asia	145 578.36	92 926.97	209 651.91	416 556.10	268 503.49	603 755.73	32.76	20.87	47.68	34.41	22.10	50.07
Southeast Asia	145 012.95	92 769.70	210 104.65	367 150.03	237 223.16	532 655.34	64.66	41.73	93.81	67.56	43.32	97.73
Southern Latin America	26 097.28	16 361.15	37 968.46	44 562.28	28 822.03	65 334.32	59.91	37.73	86.84	52.62	34.19	77.17
Southern sub-Saharan Africa	16 308.14	10 406.04	23 743.87	29 513.40	18 816.44	43 354.10	65.99	42.04	97.14	59.26	37.86	86.84
Tropical Latin America	36 516.04	23 861.23	53 252.49	98 454.98	63 169.45	144 166.02	45.69	29.59	66.86	42.69	27.51	62.89
Western Europe	389 736.25	249 249.04	572 701.06	521 001.53	338 852.24	746 732.32	66.47	42.73	97.06	52.83	34.27	75.91
Western sub-Saharan Africa	40 520.53	26 155.11	58 212.25	91 681.53	59 703.65	132 512.32	52.72	33.92	76.55	56.61	36.09	83.50

ASRs indicates age-standardized rates; and UI, uncertainty interval.



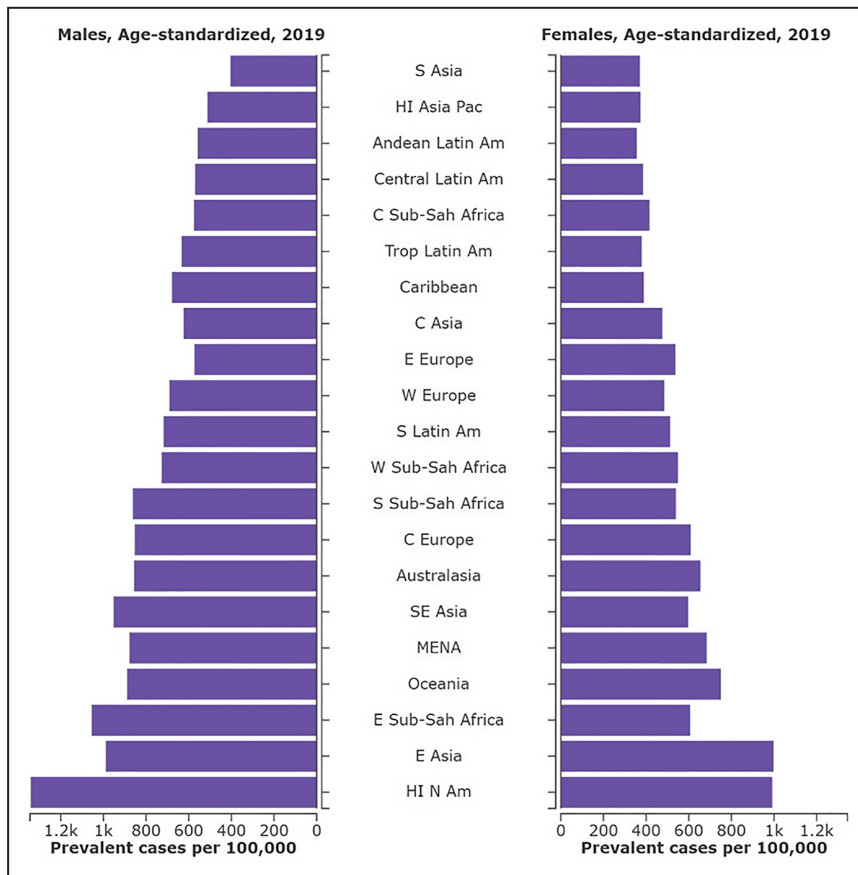


**Figure 4. Age-standardized point prevalence rate of heart failure per 100000 population in 21 Global Burden of Diseases (GBD) regions in 2019.**  
 Visualization using the GBD compare tool (<https://www.healthdata.org/data-visualization/gbd-compare>).

an aging population. In 1990, the population >65 years old accounted for about 6.1% of the global population; this number reached 9.3% in 2019.<sup>15</sup> Despite the enormous efforts of the global public health industry, the trend of an aging population will not be reversed for a period of time, so it is necessary to prepare for the continued increase in the number of people with HF worldwide. The good news is that compared with 1990, the age-standardized prevalence rate of HF decreased in 2019, albeit modestly. We used the Joinpoint regression model to find that ASRs decreased globally at an AAPC of 0.3% from 1990 to 2019. This might be because with economic development, more patients have received regular treatment. On the other hand, advances in HF treatment options also help reduce the age-standardized prevalence of HF.<sup>1,14</sup> Notably, according to our Joinpoint regression model, the age-standardized prevalence rate of HF globally increased at an annual percentage change of 0.6% from 2017 to 2019. We speculate that one of the possible reasons for this is because with the development of technology and the promotion of regular physical examinations, some early HF

that was not easily detected before was diagnosed. Conrad et al assessed temporal trends in the prevalence of heart failure in the United Kingdom from 2002 to 2014. They found that the standardized incidence of HF decreased from 358 to 332 per 100 000 population, which is consistent with the trends derived from our study.<sup>3</sup> Although the overall trend decreased from 1990 to 2019, given the burden of HF on patients and public health, we must pay attention to this possible increasing trend in recent years.

We also explored the burden of HF in regions with a different SDI. In general, the age-standardized prevalence rate of HF in regions with a middle or above SDI is significantly higher than low-middle and low SDI regions. People in high-level SDI regions have good nutritional status, adequate access to health services, and higher education. Meanwhile, populations that are increasing and aging are more pronounced in high-level SDI regions. Lack of adequate medical resources for people in low SDI areas may also be a factor. The prevalence of HF in low SDI regions might be underestimated because a subset of the population is underdiagnosed. Similar to our study, socioeconomically



**Figure 5. Sex differences of age-standardized prevalence rate of heart failure per 100,000 population in 21 Global Burden of Diseases (GBD) regions in 2019.** Visualization using the GBD compare tool (<https://www.healthdata.org/data-visualization/gbd-compare>). S indicates south; HI, high-income; Pac, Pacific; Am, America; C, central; Sub-Sah, sub-Saharan; Trop, tropical; E, eastern; W, western; SE, southeast; MENA, Middle East and North Africa; and N, north.

deprived individuals were more likely to develop HF than affluent individuals in the United Kingdom.<sup>3</sup>

East Asia, high-income North America, and Western Europe experienced the largest number of prevalent cases both in 1990 and 2019. A total of 5 GBD regions demonstrated increasing AAPCs from 1990 to 2019, including Western sub-Saharan Africa, Eastern sub-Saharan Africa, South Asia, Southeast Asia, and Oceania. Several previous studies also support this finding. Compared with Western regions, the prevalence rate in Asia seemed to be higher, ranging from 1.3% to 6.7%.<sup>16-20</sup> South Asia accounts for a quarter of the world's population, which is at an increased risk and earlier ages of HF.<sup>21</sup> Compared with the global level, only 9 GBD regions meet or exceed the global decreasing AAPC. This demonstrated clear inequalities between regions, suggesting that we need to strengthen education, improve the quality of health services, and conduct early screening in most parts of Africa and parts of Asia to reduce the prevalence

of HF. Oman, Cameroon, and Saudi Arabia showed the largest increases at AAPCs of 0.9%, 0.8%, and 0.7%, respectively. This may be because of a lack of emphasis on HF and inadequate medical resources in these nations. On the contrary, Canada, France, and Denmark demonstrated the largest decreases from 1990 to 2019 at AAPCs of 2.2%, 2.0%, and 2.0%, respectively. Development of abundant economic and medical resources, and regular examinations might contribute to the considerable decreases. It is essential to study the experiences of the countries that have been the most successful at HF control to reverse the increasing prevalence trends of HF in countries such as Oman, Cameroon, and Saudi Arabia. In addition, related international aid is necessary and should be focused on these countries.

Exploring the underlying causes is of great significance for the prevention and treatment of HF. Unsurprisingly, ischemic heart disease and hypertensive heart disease accounted for the highest proportion

**Table 3. ASRs of Prevalence per 100000 Population for Heart Failure in 2019 Globally by Causes**

Causes	Men			Women		
	ASRs per 100000	95% UI		ASRs per 100000	95% UI	
		Lower	Upper		Lower	Upper
Alcoholic cardiomyopathy	13.33	10.32	17.25	4.13	3.18	5.36
Asbestosis	0.07	0.05	0.09	0.01	0.01	0.01
Chagas disease	4.67	3.20	6.35	2.27	1.29	3.60
Chronic obstructive pulmonary disease	75.55	53.22	104.32	57.51	39.01	85.02
Coal worker's pneumoconiosis	0.07	0.05	0.09	0.01	0.00	0.01
Congenital heart anomalies	7.04	4.97	9.87	7.55	5.39	10.49
Endocarditis	4.29	3.51	5.32	4.82	3.96	5.97
Endocrine, metabolic, blood, and immune disorders	2.28	1.91	2.78	2.28	1.92	2.79
G6PD deficiency	0.27	0.21	0.34	0.16	0.12	0.20
Hypertensive heart disease	241.25	176.26	324.85	224.60	162.85	302.06
Interstitial lung disease and pulmonary sarcoidosis	1.45	1.06	1.92	1.19	0.86	1.60
Ischemic heart disease	316.12	236.51	411.40	222.48	163.75	291.22
Myocarditis	5.54	4.50	6.73	4.76	3.85	5.79
Nonrheumatic calcific aortic valve disease	11.17	7.00	16.91	9.07	5.70	13.88
Nonrheumatic degenerative mitral valve disease	16.63	10.53	24.88	24.20	15.48	35.93
Other cardiomyopathy	56.89	44.75	71.27	39.82	30.97	51.12
Other hemoglobinopathies and hemolytic anemias	0.62	0.50	0.79	0.61	0.50	0.76
Other nonrheumatic valve diseases	0.25	0.20	0.34	0.41	0.32	0.53
Other pneumoconiosis	0.06	0.05	0.08	0.02	0.01	0.02
Rheumatic heart disease	20.60	15.98	26.12	31.59	24.49	40.34
Silicosis	0.35	0.25	0.48	0.02	0.01	0.02
Thalassemia	0.32	0.22	0.44	0.30	0.21	0.40

ASRs indicates age-standardized rates; UI, uncertainty interval; and G6PD, glucose-6-phosphate dehydrogenase.

of HF in 2019. Notably, over the period 1990 to 2019, the age-standardized prevalence rate of HF attributable to hypertensive heart disease increased, whereas ASRs of HF from rheumatic heart disease decreased. Hypertension is considered a significant risk factor for HF.<sup>22–24</sup> Long-term elevated blood pressure can lead to structural changes in the myocardium and aggravate the progression of HF.<sup>25</sup> In the present study, we found that the age-standardized prevalence rate of HF attributable to hypertensive heart disease increased from 1990 to 2019. Considering hypertension is a modifiable risk factor, control of high blood pressure is important to prevent hypertensive HF. In addition to heart diseases, we found that COPD is a main cause of HF. COPD is one of the most prevalent chronic diseases worldwide, which shares various symptoms with HF.<sup>26</sup> COPD and HF also have several common risk factors, including advanced age, smoking, and obesity.<sup>27</sup> Therefore, clinicians must pay more attention to the cardiac function of patients with COPD, and objectively identify HF in patients with COPD at an early stage.

Roth and colleagues report that the burden of cardiovascular diseases continues to increase globally,<sup>28,29</sup> which is consistent with a potential upward trend in HF worldwide. Despite the consensus on associations between HF and common diseases or factors such as atrial fibrillation and obesity, the GBD 2019 did not identify these factors as underlying causes in HF, which might be improved in a future GBD study. The GBD 2019 study continuously evaluates, improves, and applies statistical methods to achieve reliability and accuracy in the diagnosis of HF. Moreover, the GBD case definition does not allow for remission from heart failure; once diagnosed, all patients remain in 1 of the 4 severity categories. Therefore, it seems that HF treatment advances are not enough to explain the decreases seen in some locations. Prevention or early treatment of underlying causes, such as ischemic heart diseases, hypertensive heart diseases, and COPD, might be plausible reasons.

To the best of our knowledge, this is the first time the global burden of HF and its contributing causes were

comprehensively analyzed. The prevalence, trends, and inequalities of HF found in the present study might help guide the development and implementation of interventions for HF. However, our study also has some limitations. First, because of economic underdevelopment in some areas, data collection is limited, and the true prevalence and burden of HF may be underestimated. In this case the results depend on the validity of the GBD predictive model. Although the data processing and modeling methods have been improved in the GBD 2019 study, there is still a need to improve the quality of collected data and strengthen data sharing. Moreover, the prevalence of HF in low SDI regions may be underestimated because of insufficient medical resources and the low priority given to HF, because GBD 2019 counts diagnosed HF. Second, we did not analyze HF subtypes such as HF with preserved ejection fraction, because of the lack of relevant data in the GBD 2019 study. We recommend that data collection on HF subtypes be included in future GBD studies. Third, because HF was not considered an underlying cause of deaths in the GBD 2019 study, disability-adjusted life-years could not be evaluated appreciably.

HF remains a major public health problem worldwide, with a possible increased trend in the future. Although the age-standardized prevalence rate of HF decreased globally from 1990 to 2019 in general, the rate seemed to increase from 2017. Regional inequalities were also found in the burden of HF. Efforts for prevention and control of HF should focus more on less-developed regions with substantial HF burden. It is essential to prevent and treat primary diseases such as ischemic heart disease and hypertensive heart disease for the control of HF.

## ARTICLE INFORMATION

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### Affiliations

Department of Cardiovascular Surgery, Zhongshan Hospital, Fudan University, Shanghai, China (T.Y., S.Z., X.Y., M.Z., F.W., S.Z., B.X., X.Z., G.L., Y.M., K.Z., C.W., C.G.); Department of Cardiology, The Eighth Affiliated Hospital, Sun Yat-sen University, Shenzhen, Guangdong, China (C.X.); and Department of Cardiology, Zhongshan Hospital, Fudan University, Shanghai, China (J.X.).

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### Disclosures

None.

### Supplemental Material

Tables S1–S4  
Figures S1–S43

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## **SUPPLEMENTAL MATERIAL**

**Table S1.** The age-standardized rates (ASRs) of prevalence per 100,000 populations for subtypes of heart failure in 1990 and 2019 globally and in 21 Global Burden of Diseases (GBD) regions

Regions	Treated heart failure						Mild heart failure						Moderate heart failure						Severe heart failure					
	1990			2019			1990			2019			1990			2019			1990			2019		
	95% uncertainty interval (UI)						95% UI						95% UI						95% UI					
	ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs	
	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper
	100,000			100,000			100,000			100,000			100,000			100,000			100,000			100,000		
Global	283.86	22638	34894	263.35	21426	32108	142.23	99.69	191.72	132.20	93.06	178.44	92.32	64.19	127.59	85.86	60.11	119.53	247.59	196.04	308.51	230.49	184.89	285.93
Andean Latin America	210.32	16774	26044	184.49	14498	23312	84.25	61.11	111.98	83.47	58.33	113.64	50.05	35.02	71.54	52.20	36.62	74.11	117.33	86.96	158.12	132.84	99.83	177.66
Australasia	427.90	33404	52547	276.43	21855	33713	215.73	146.15	29807	139.41	94.87	19030	140.22	99.57	19234	90.62	64.39	12351	377.21	29498	46849	243.79	19271	303.74
Caribbean	200.00	15258	25890	192.23	14754	25041	100.79	68.12	13994	96.92	65.65	13482	65.53	44.79	92.60	63.02	43.09	89.91	176.28	13459	23067	169.51	12955	224.75
Central Asia	214.54	16223	27795	200.47	15258	25844	108.19	72.10	15187	101.10	67.96	14073	70.38	48.38	101.58	65.76	44.55	94.36	189.27	14536	24754	176.85	135.70	232.34
Central Europe	290.67	22560	36374	265.18	21668	31837	146.59	100.53	20231	133.73	94.50	17929	95.34	66.31	13507	86.98	61.35	11834	256.43	19996	32573	233.96	189.16	289.18
Central Latin America	214.23	17147	26373	186.18	14709	23262	98.00	69.65	13259	87.00	61.13	11821	61.58	43.10	86.51	55.10	38.43	77.57	157.74	120.50	20747	142.78	110.25	187.17
Central Sub-Saharan Africa	183.90	13248	24854	177.80	12917	23822	92.78	61.47	13350	89.71	59.02	12855	60.32	39.85	89.90	58.32	38.27	85.54	162.26	11586	21663	156.87	11239	212.57

East Asia	390.58	31051	48740	373.55	29713	46362	196.95	13614	26890	188.37	13152	25595	128.15	87.70	17918	122.56	84.32	17150	344.63	26987	43780	329.59	25799	41655
Eastern Europe	206.88	16277	25816	206.39	16388	25644	104.33	73.01	14033	104.08	72.61	14084	67.85	47.41	93.23	67.69	47.02	93.04	182.51	14365	23092	182.07	14285	22997
Eastern Sub-Saharan Africa	280.58	21515	35565	299.35	23044	38151	141.51	95.83	19755	150.98	10232	21066	91.99	62.10	13028	98.15	66.34	14087	247.56	18525	31977	264.12	19648	34039
High-income Asia Pacific	210.58	17019	26133	164.04	13862	19382	106.21	73.59	14432	82.73	58.77	10897	69.08	49.11	97.07	53.80	38.67	72.38	185.73	14786	23094	144.71	12003	17456
High-income North America	471.16	38116	57259	425.36	36043	50103	237.46	16757	31989	214.39	15197	28409	154.40	10936	21253	139.38	99.44	18582	415.17	33052	51290	374.95	30738	44934
North Africa and Middle East	292.36	22209	37826	288.98	22433	36391	147.42	10031	20592	145.70	10084	20218	95.89	64.99	13943	94.77	65.28	13501	257.90	19712	33971	254.94	19872	32951
Oceania	299.79	22931	39132	304.88	23341	39695	151.17	10166	20868	153.75	10340	21593	98.33	67.67	14313	100.02	68.42	14468	264.51	19989	34928	268.99	20417	35163
South Asia	137.83	10895	17327	143.65	11292	17981	69.50	48.18	96.10	72.44	49.91	10007	45.22	31.03	63.09	47.13	32.62	66.08	121.62	94.69	15540	126.75	99.19	16309
Southeast Asia	268.62	20873	34399	278.49	21754	35478	135.45	93.14	18591	140.41	97.30	19173	88.10	60.01	12514	91.34	62.49	12917	236.99	18348	30540	245.70	19192	31326
Southern Latin America	314.82	25183	38789	242.22	19147	30477	132.11	94.98	17710	111.51	77.39	15493	80.13	55.51	11317	70.23	49.09	10021	194.40	14410	26062	180.43	13622	23547
Southern Sub-Saharan Africa	272.70	21019	34904	244.01	18800	31348	137.52	94.64	19018	123.05	84.58	17066	89.42	61.05	12795	80.02	54.76	11450	240.59	18198	31077	215.29	16208	27723

Tropical

Latin	216.03	17399	26360	193.20	15559	23851	98.48	70.79	13328	90.43	64.90	12362	61.79	43.20	86.30	57.31	40.00	80.35	157.93	12085	20486	148.62	11377	19313
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America

Western

Europe

	269.81	21385	33255	214.24	17386	25869	136.02	93.62	18494	107.97	75.84	14523	88.46	62.57	12127	70.20	49.77	96.39	237.94	18845	29608	188.85	15087	23315
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Western Sub-

Saharan

	218.48	16909	27713	233.73	17963	29884	110.20	75.70	15204	117.89	79.96	16300	71.67	48.04	10020	76.67	51.22	10809	192.77	14502	25029	206.23	15448	26700
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Africa

**Table S2.** The age-standardized rates (ASRs) of years lived with disabilities (YLDs) per 100,000 populations for subtypes of heart failure in 1990 and 2019 globally and in 21 Global Burden of Diseases (GBD) regions

Regions	Treated heart failure						Mild heart failure						Moderate heart failure						Severe heart failure					
	1990			2019			1990			2019			1990			2019			1990			2019		
	95% uncertainty interval (UI)						95% UI						95% UI						95% UI					
	ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs		ASRs	
	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper	per	lower	upper
	100,000			100,000			100,000			100,000			100,000			100,000			100,000			100,000		
Global	13.58	7.92	20.79	12.62	7.36	19.30	5.78	3.13	9.59	5.37	2.92	8.95	6.44	3.67	10.18	6.00	3.44	9.50	42.80	27.66	62.22	39.93	25.96	58.21
Andean Latin America	10.04	5.95	15.07	8.82	5.21	13.46	3.41	1.86	5.53	3.39	1.84	5.60	3.48	1.99	5.44	3.64	2.07	5.73	20.10	12.43	30.36	22.92	14.20	34.61
Australasia	20.60	12.14	32.23	13.33	7.90	21.03	8.81	4.74	14.81	5.71	3.08	9.57	9.84	5.62	15.65	6.38	3.69	10.03	65.68	42.82	97.17	42.58	27.44	62.95
Caribbean	9.56	5.69	14.99	9.21	5.43	14.38	4.09	2.14	6.93	3.94	2.10	6.81	4.57	2.63	7.27	4.41	2.50	7.06	30.43	19.22	45.78	29.37	18.69	43.96
Central Asia	10.24	6.11	16.08	9.58	5.73	14.95	4.38	2.34	7.38	4.10	2.19	6.95	4.90	2.75	7.85	4.58	2.58	7.38	32.64	20.65	48.12	30.54	19.44	44.84
Central Europe	13.95	8.21	21.48	12.75	7.60	19.36	5.97	3.23	10.05	5.46	3.00	9.06	6.68	3.79	10.56	6.10	3.52	9.65	44.57	28.74	64.95	40.74	26.79	59.35
Central Latin America	10.22	6.06	15.57	8.91	5.24	13.59	3.97	2.15	6.56	3.53	1.90	5.92	4.28	2.48	6.78	3.85	2.20	6.12	27.09	17.18	40.82	24.67	15.44	37.64
Central Sub-Saharan Africa	8.76	4.99	13.84	8.50	4.77	13.34	3.76	1.96	6.51	3.64	1.92	6.21	4.19	2.27	6.92	4.06	2.19	6.65	27.86	16.96	42.31	27.07	16.42	40.88



East Asia	18.55	10.81	28.47	17.85	10.35	27.52	7.94	4.28	13.45	7.64	4.11	12.75	8.87	5.01	14.28	8.54	4.84	13.74	59.00	37.82	87.04	56.91	36.30	84.06
Eastern Europe	9.90	5.86	15.21	9.88	5.88	15.11	4.23	2.27	7.09	4.23	2.27	7.11	4.73	2.68	7.48	4.73	2.71	7.40	31.59	20.23	46.01	31.56	20.05	45.93
Eastern Sub-Saharan Africa	13.31	7.70	20.91	14.25	8.31	22.15	5.70	3.05	9.39	6.10	3.25	10.18	6.36	3.55	10.28	6.81	3.82	10.90	42.24	26.52	62.84	45.30	28.29	67.81
High-income Asia Pacific	10.15	6.06	15.82	7.93	4.82	12.12	4.35	2.37	7.09	3.39	1.89	5.52	4.86	2.78	7.67	3.80	2.21	5.87	32.44	21.01	46.88	25.38	16.69	36.48
High-income North America	22.74	13.53	34.67	20.49	12.68	30.41	9.73	5.37	16.08	8.76	4.97	14.50	10.88	6.30	17.29	9.80	5.81	15.13	72.68	46.55	106.08	65.44	43.02	94.83
North Africa and Middle East	13.98	8.17	21.49	13.87	8.13	21.37	5.98	3.16	10.00	5.94	3.17	9.99	6.68	3.80	10.97	6.64	3.72	10.77	44.51	28.30	66.85	44.30	28.85	66.35
Oceania	14.25	8.33	22.21	14.51	8.40	22.77	6.10	3.27	10.32	6.21	3.31	10.58	6.82	3.83	11.00	6.94	3.89	11.10	45.32	28.58	67.20	46.18	29.40	68.18
South Asia	6.47	3.76	9.94	6.78	3.93	10.40	2.77	1.48	4.60	2.90	1.54	4.85	3.09	1.75	5.00	3.24	1.83	5.22	20.43	13.05	30.18	21.49	13.74	32.33
Southeast Asia	12.73	7.39	19.46	13.28	7.82	20.27	5.45	2.90	9.12	5.68	3.05	9.54	6.09	3.49	9.76	6.35	3.64	10.17	40.40	25.82	60.07	42.25	27.19	62.67
Southern Latin America	15.15	9.05	22.85	11.67	6.94	17.95	5.39	2.90	8.80	4.56	2.49	7.70	5.62	3.22	8.72	4.93	2.82	7.81	33.75	20.79	50.42	31.45	19.91	47.61
Southern Sub-Saharan Africa	12.98	7.70	20.51	11.64	6.87	18.36	5.56	3.04	9.24	4.98	2.69	8.23	6.20	3.53	9.71	5.57	3.15	8.76	41.26	25.66	62.77	37.07	22.91	56.03



**Table S3.** The age-standardized rates (ASRs) of prevalence per 100,000 populations for heart failure in 1990 and 2019 globally and in 21 Global Burden of Diseases (GBD) regions by sex

Regions	1990						2019					
	Males			Females			Males			Females		
	95% uncertainty interval (UI)			95% UI			95% UI			95% UI		
	ASRs per 100,000	lower	upper	ASRs per 100,000	lower	upper	ASRs per 100,000	lower	upper	ASRs per 100,000	lower	upper
Global	864.24	703.70	1048.41	685.99	561.61	834.72	785.70	649.52	944.89	646.15	537.36	783.01
Andean Latin America	562.82	449.81	715.01	369.03	294.38	457.73	559.75	433.68	718.77	357.88	282.69	450.79
Australasia	1265.88	1000.01	1538.13	1075.23	856.46	1308.97	857.90	688.50	1050.53	656.12	532.05	788.83
Caribbean	702.08	539.88	909.26	404.44	321.37	513.01	682.17	528.13	880.77	390.64	307.71	501.97
Central Asia	652.99	508.28	834.48	529.14	409.11	684.46	627.34	491.04	795.36	478.48	370.40	617.10
Central Europe	904.97	717.50	1123.44	697.14	548.91	872.07	855.08	713.84	1016.43	610.74	509.86	731.43
Central Latin America	629.40	499.20	780.87	443.51	357.40	557.66	573.32	455.64	718.72	388.21	310.20	488.80
Central Sub-Saharan Africa	581.64	428.38	774.88	430.13	316.15	573.84	579.17	427.70	766.85	419.58	305.98	553.02
East Asia	1085.73	875.57	1339.93	1005.90	814.21	1249.35	991.23	808.02	1228.71	1001.01	819.06	1245.62
Eastern Europe	582.92	464.72	714.88	536.95	427.34	661.27	574.95	467.34	700.80	538.38	427.98	659.54
Eastern Sub-Saharan Africa	961.68	765.25	1207.38	581.54	453.13	736.81	1059.12	844.06	1322.71	609.98	475.46	770.77

High-income Asia Pacific	645.81	534.51	782.54	504.36	412.33	623.04	515.80	444.92	598.55	376.87	325.60	436.41
High-income North America	1528.53	1259.67	1856.70	1094.97	918.09	1303.05	1344.62	1159.53	1556.54	993.84	866.22	1140.37
North Africa and Middle East	912.98	703.30	1163.90	675.26	527.26	854.68	879.44	697.33	1101.27	686.58	557.61	850.08
Oceania	875.69	679.90	1133.87	744.66	579.73	972.67	893.47	697.66	1160.60	753.88	591.97	969.00
South Asia	391.80	316.14	489.41	355.18	286.64	444.32	406.15	326.94	503.61	374.85	303.13	465.75
Southeast Asia	910.84	723.55	1154.72	582.76	463.50	736.41	956.76	767.92	1202.26	599.25	478.71	750.96
Southern Latin America	850.06	681.47	1074.46	620.96	491.30	785.88	721.30	563.95	915.07	514.42	403.38	655.19
Southern Sub-Saharan Africa	891.21	696.19	1124.96	642.49	499.62	808.31	864.36	674.75	1091.08	542.55	425.12	684.92
Tropical Latin America	690.38	559.34	851.78	411.99	339.53	505.28	636.92	514.39	789.46	382.03	312.82	472.13
Western Europe	885.49	715.83	1077.81	624.96	509.21	757.02	693.11	574.34	830.22	488.09	405.60	583.42
Western Sub-Saharan Africa	675.39	532.58	847.80	522.06	411.12	658.54	728.99	569.09	920.63	551.20	434.55	701.13

**Table S4.** The age-standardized rates (ASRs) of years lived with disabilities (YLDs) per 100,000 populations for heart failure in 1990 and 2019 globally and in 21 Global Burden of Diseases (GBD) regions by sex

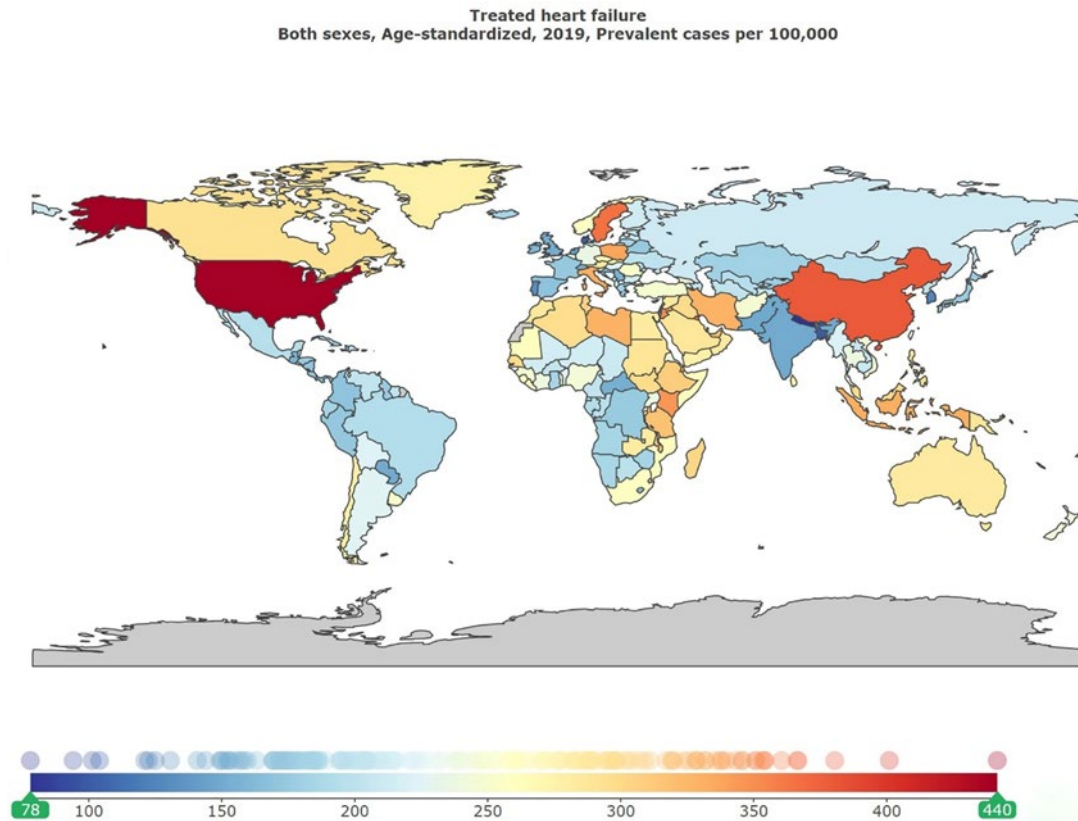
Regions	1990						2019					
	Males			Females			Males			Females		
	95% uncertainty interval (UI)			95% UI			95% UI			95% UI		
	ASRs per 100,000	lower	upper	ASRs per 100,000	lower	upper	ASRs per 100,000	lower	upper	ASRs per 100,000	lower	upper
Global	77.38	50.15	111.97	61.44	39.63	88.87	70.58	45.81	101.35	57.99	37.72	83.46
Andean Latin America	45.31	28.60	65.88	29.43	18.63	42.40	47.83	30.25	69.25	30.71	19.25	44.76
Australasia	114.19	73.82	165.71	97.30	61.93	142.04	77.67	49.56	113.63	59.54	39.45	86.60
Caribbean	62.84	39.77	90.81	36.34	23.22	52.57	61.26	39.04	89.23	35.22	22.39	51.33
Central Asia	58.55	36.77	83.88	47.31	30.01	68.91	56.38	35.76	81.55	42.82	27.26	61.78
Central Europe	81.69	52.14	117.52	62.81	40.39	90.75	77.32	51.22	110.71	55.13	36.09	79.17
Central Latin America	53.50	34.52	77.18	38.42	24.83	56.21	49.48	31.45	71.71	34.09	22.03	49.50
Central Sub-Saharan Africa	51.90	32.09	77.42	38.40	23.25	57.23	51.85	31.25	77.03	37.62	22.83	55.92



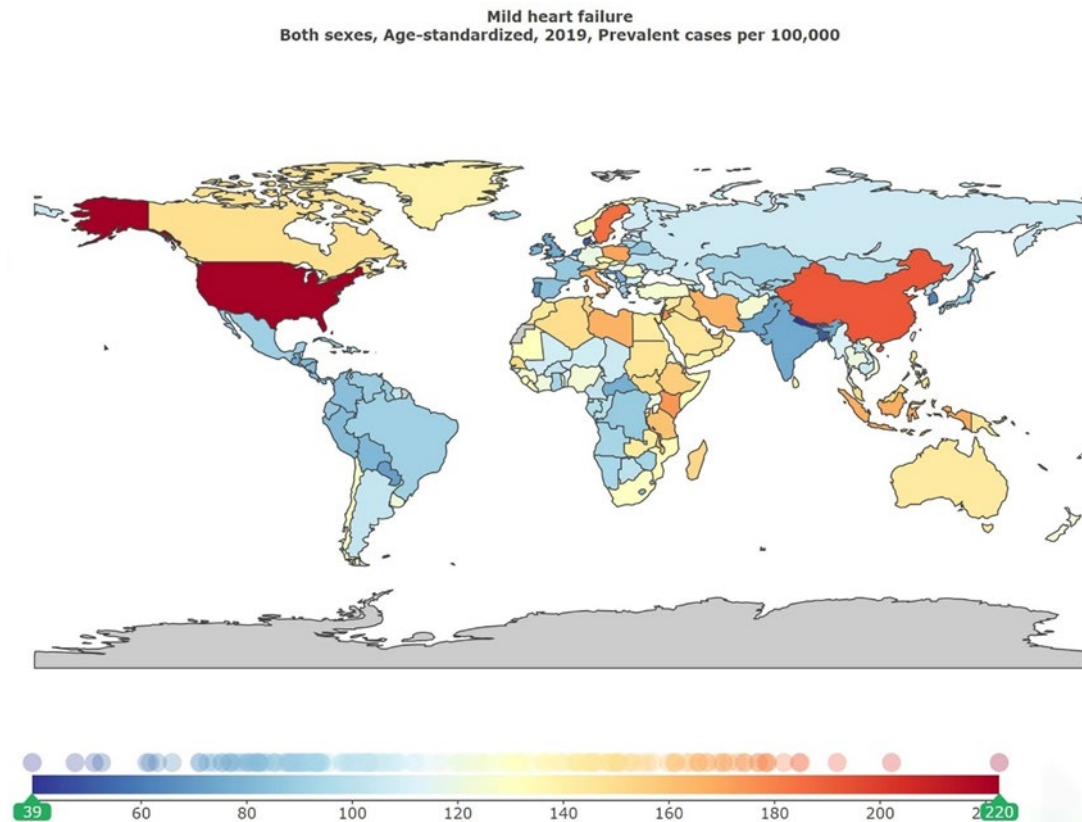
East Asia	96.97	62.64	142.02	89.35	57.7 8	130.9 3	89.16	57.1 6	129.9 7	89.65	58.2 5	131.7 2
Eastern Europe	52.46	34.28	75.79	48.19	31.3 6	69.15	51.83	33.8 6	74.10	48.38	31.2 0	69.88
Eastern Sub-Saharan Africa	85.36	54.80	122.80	51.56	33.1 0	75.37	94.38	60.6 6	135.6 3	54.37	34.8 0	79.99
High-income Asia Pacific	58.59	38.09	85.05	45.65	29.6 9	66.49	46.93	31.4 6	66.57	34.25	23.0 8	48.26
High-income North America	138.53	90.65	200.14	99.51	64.7 0	143.0 8	121.62	81.7 6	170.6 0	90.06	60.0 9	126.1 8
North Africa and Middle East	82.03	51.34	119.51	60.37	38.2 8	87.96	79.41	50.0 9	114.0 3	61.81	40.3 4	89.58
Oceania	78.37	49.83	113.15	66.00	42.6 5	96.93	80.14	50.5 4	115.9 0	66.88	43.3 2	97.47
South Asia	34.40	22.11	49.89	30.99	19.8 8	45.15	35.94	23.2 2	52.08	32.99	21.0 4	48.09
Southeast Asia	80.97	51.77	117.60	51.49	33.1 4	74.55	85.64	54.9 9	124.4 7	53.42	34.5 5	77.06
Southern Latin America	69.47	44.29	101.13	52.56	33.3 3	76.38	62.23	40.0 7	92.15	45.27	28.6 7	66.12
Southern Sub-Saharan Africa	79.35	50.34	116.18	57.30	36.4 8	84.53	77.21	48.8 8	112.0 6	48.56	30.9 4	71.66
Tropical Latin America	58.74	37.70	85.95	35.54	23.0 0	52.02	55.30	35.7 3	81.10	33.55	21.7 0	49.28
Western Europe	80.36	51.39	117.59	56.72	36.6 9	82.89	62.98	40.7 3	90.54	44.36	29.1 7	63.74

Western Sub-Saharan Africa	60.02	38.27	86.59	46.38	30.0 7	67.82	64.99	41.4 6	95.66	49.20	31.5 4	72.76
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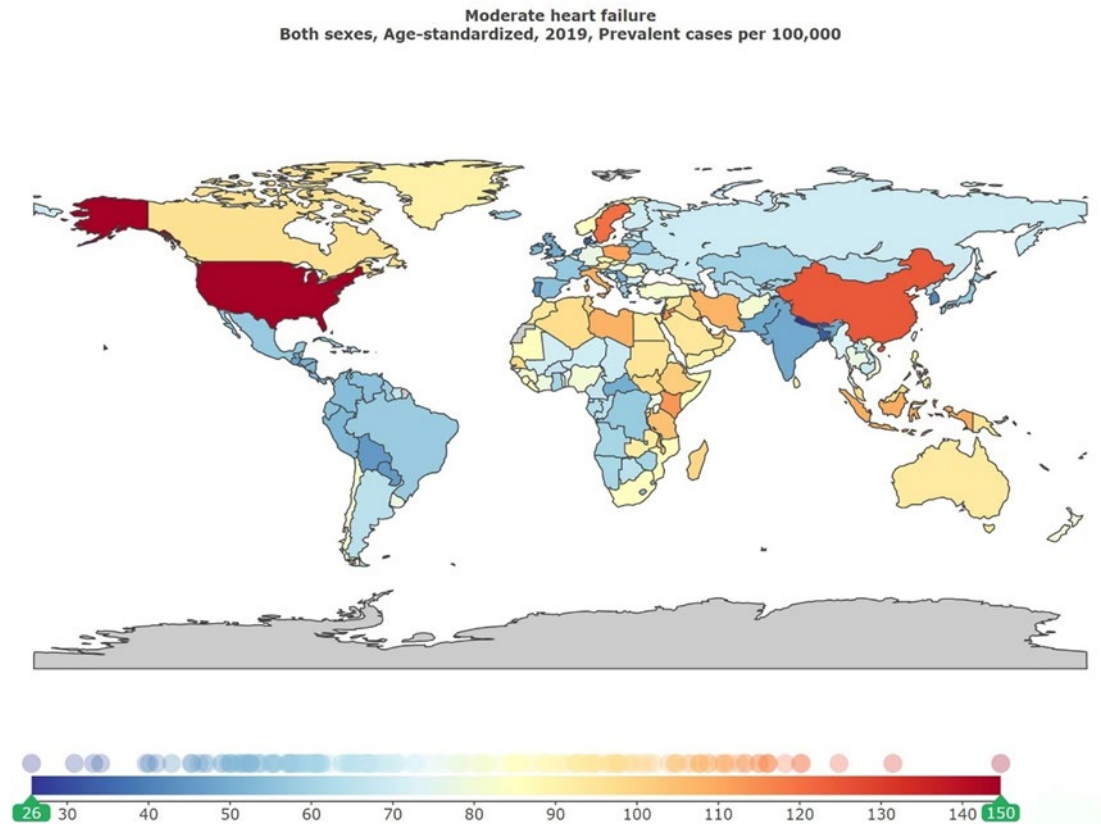
**Figure S1.** Global age-standardized point prevalence rate of treated heart failure per 100,000 population in 2019. Visualization using the Global Burden of Diseases (GBD) Compare Tool (<https://www.healthdata.org/data-visualization/gbd-compare>).



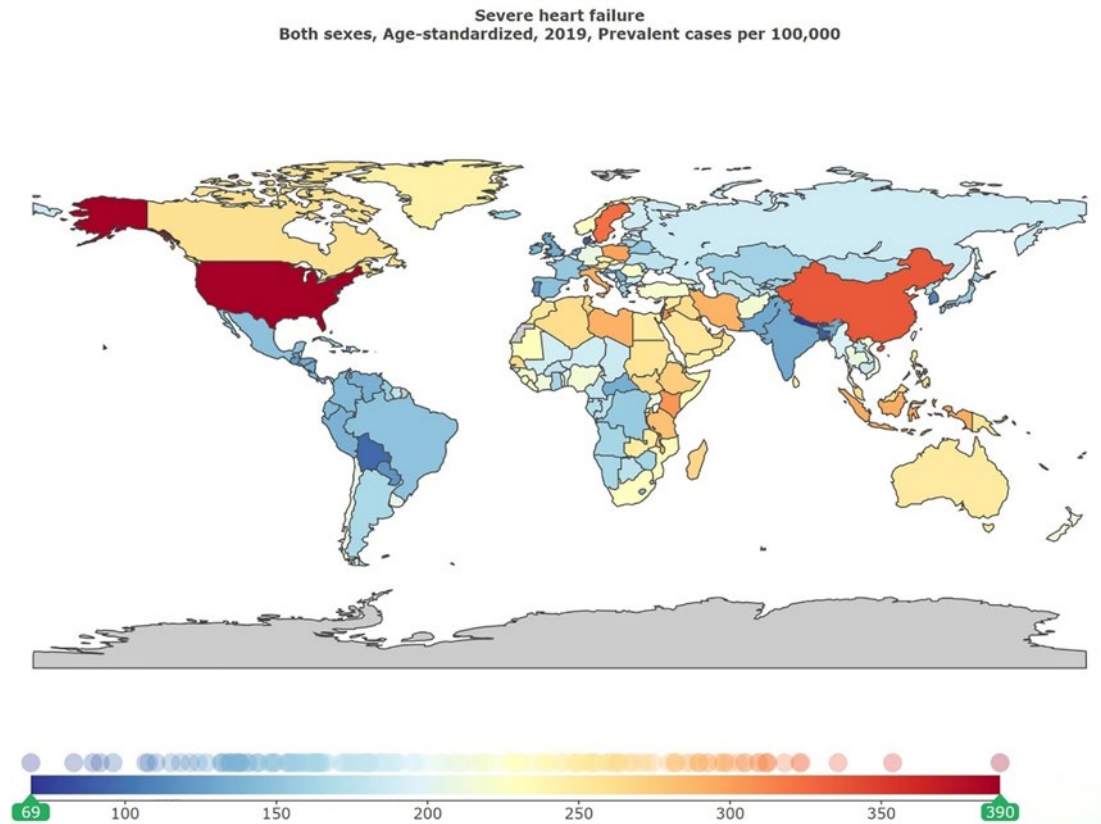
**Figure S2.** Global age-standardized point prevalence rate of mild heart failure per 100,000 population in 2019. Visualization using the Global Burden of Diseases (GBD) Compare Tool (<https://www.healthdata.org/data-visualization/gbd-compare>).



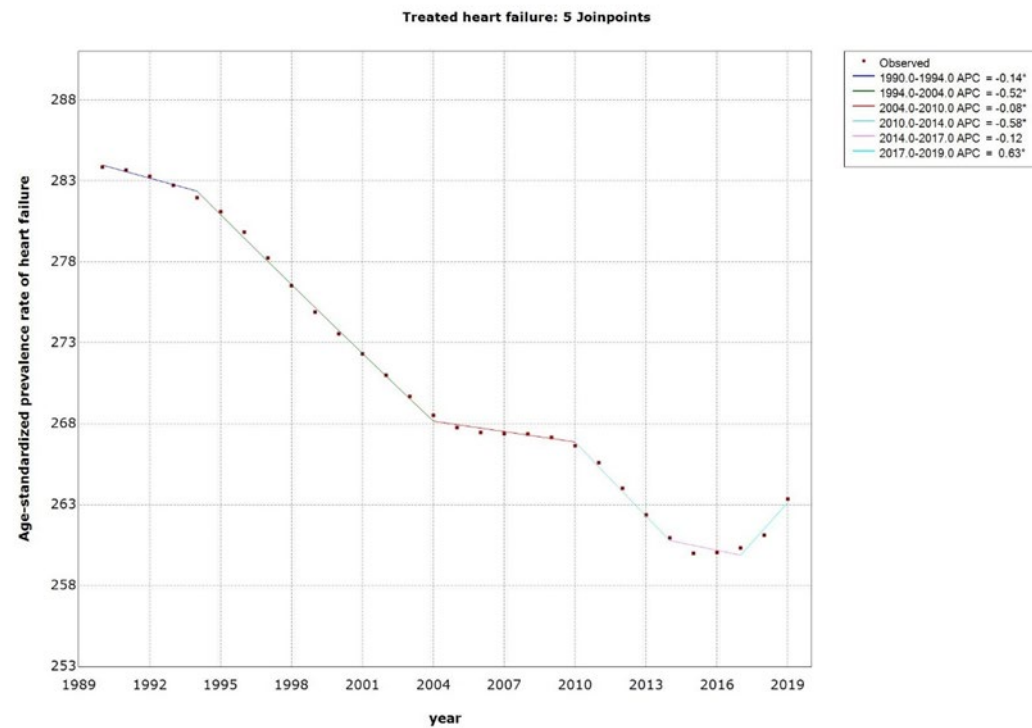
**Figure S3.** Global age-standardized point prevalence rate of moderate heart failure per 100,000 population in 2019. Visualization using the Global Burden of Diseases (GBD) Compare Tool (<https://www.healthdata.org/data-visualization/gbd-compare>).



**Figure S4.** Global age-standardized point prevalence rate of severe heart failure per 100,000 population in 2019. Visualization using the Global Burden of Diseases (GBD) Compare Tool (<https://www.healthdata.org/data-visualization/gbd-compare>).

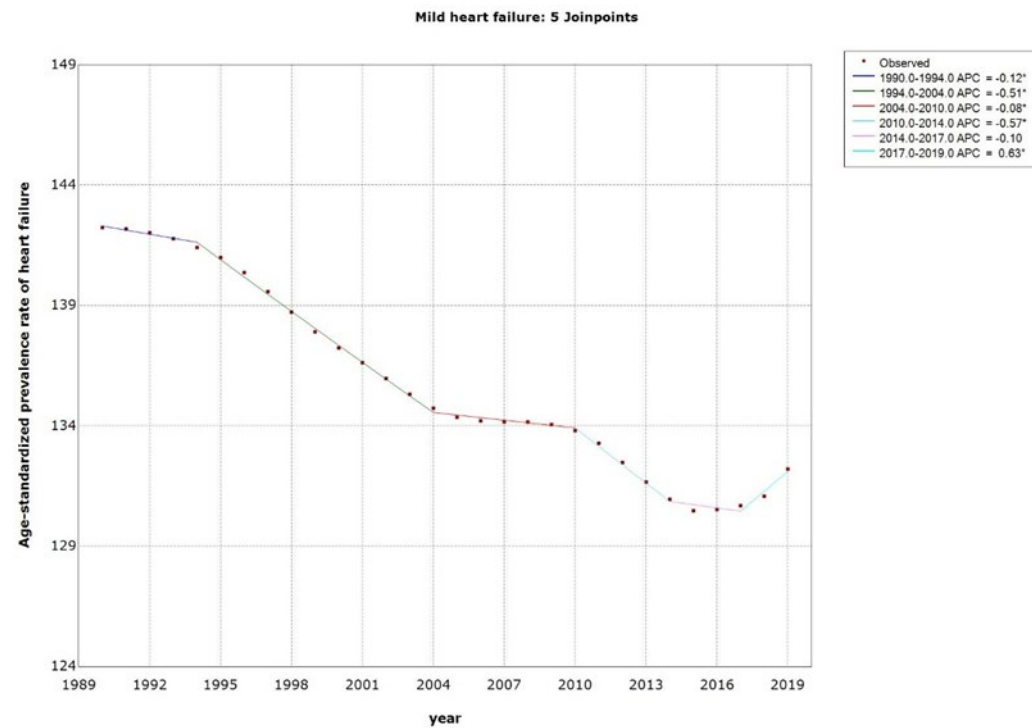


**Figure S5.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of treated heart failure globally from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

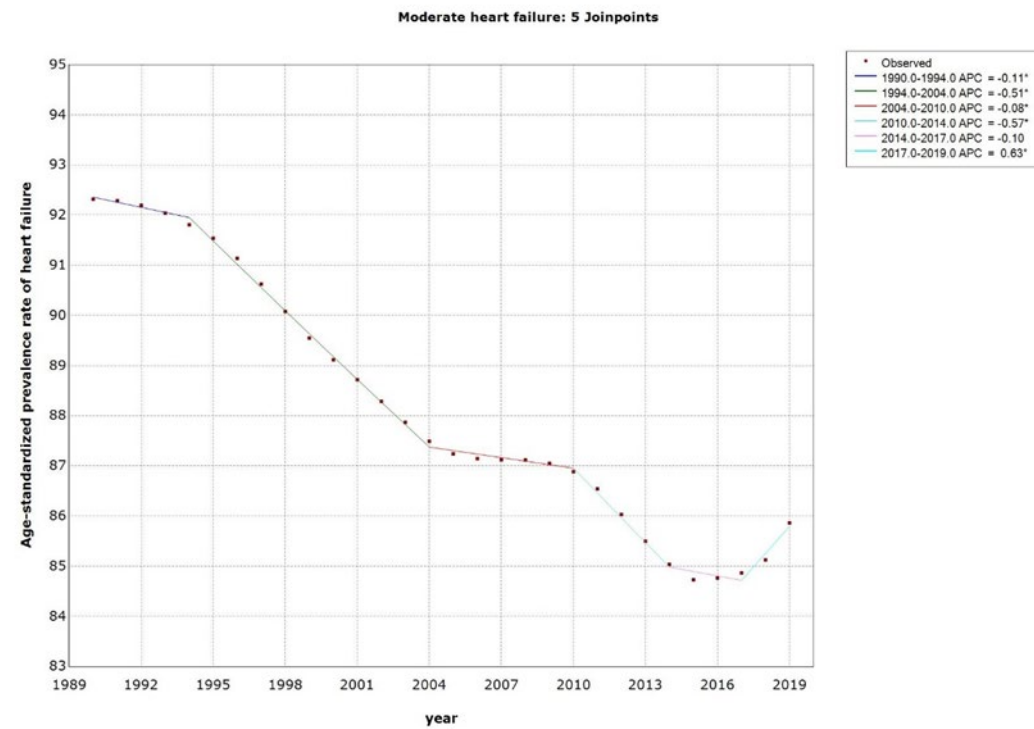
**Figure S6.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of mild heart failure globally from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

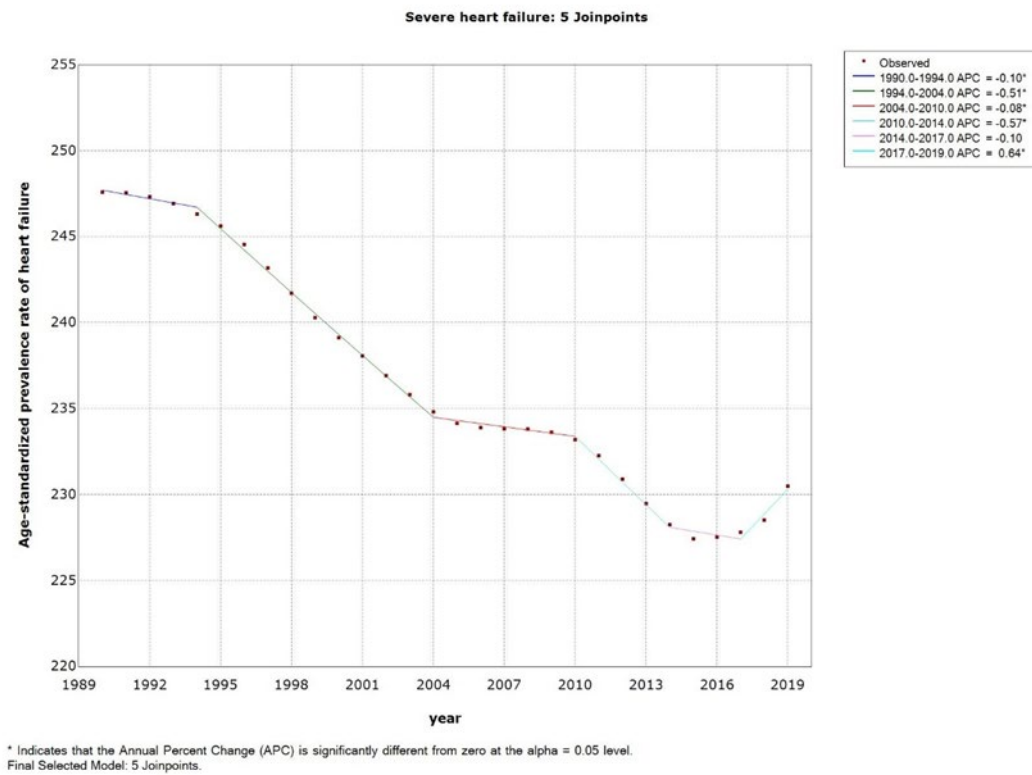


**Figure S7.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of moderate heart failure globally from 1990 to 2019.

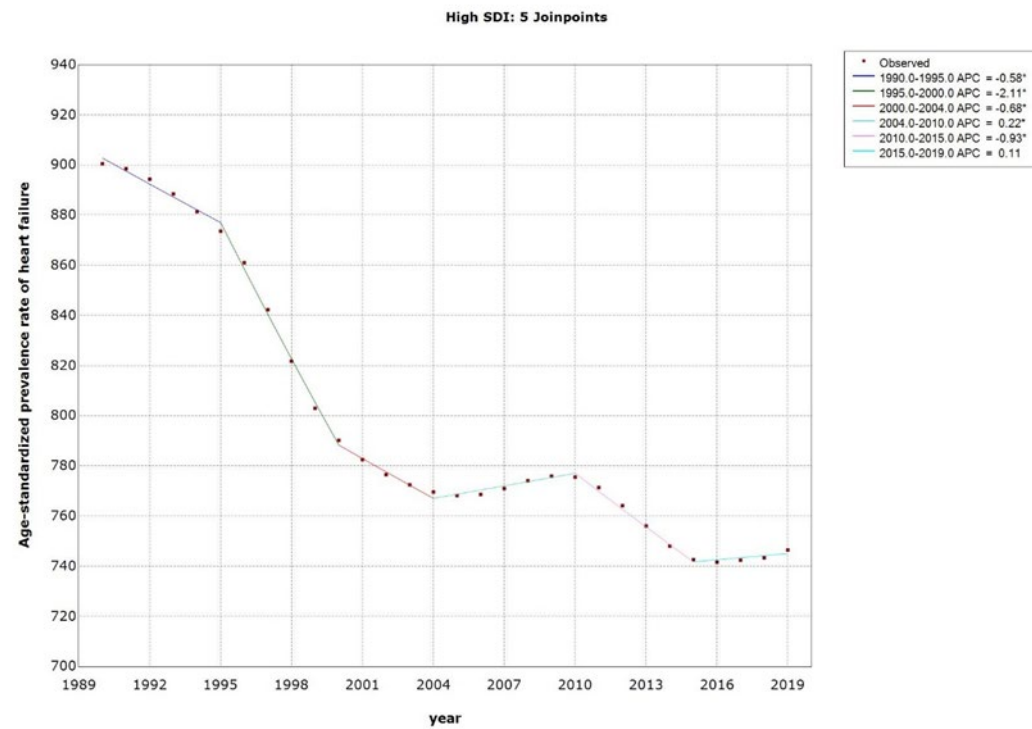


\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S8.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of severe heart failure globally from 1990 to 2019.

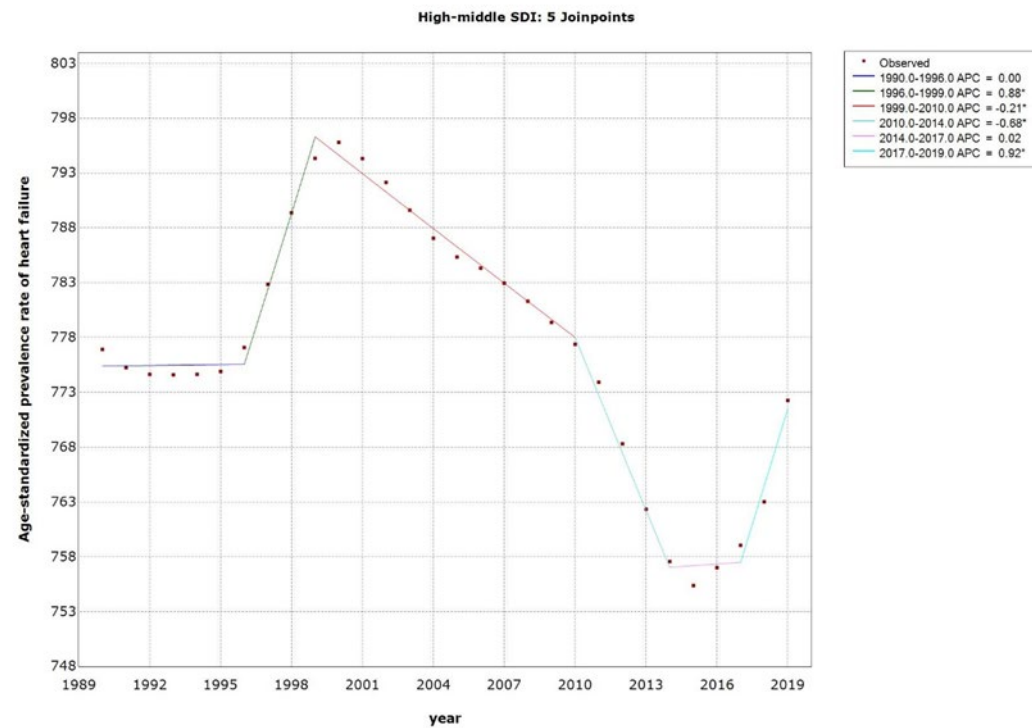


**Figure S9.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in High Socio-demographic Index (SDI) regions from 1990 to 2019.



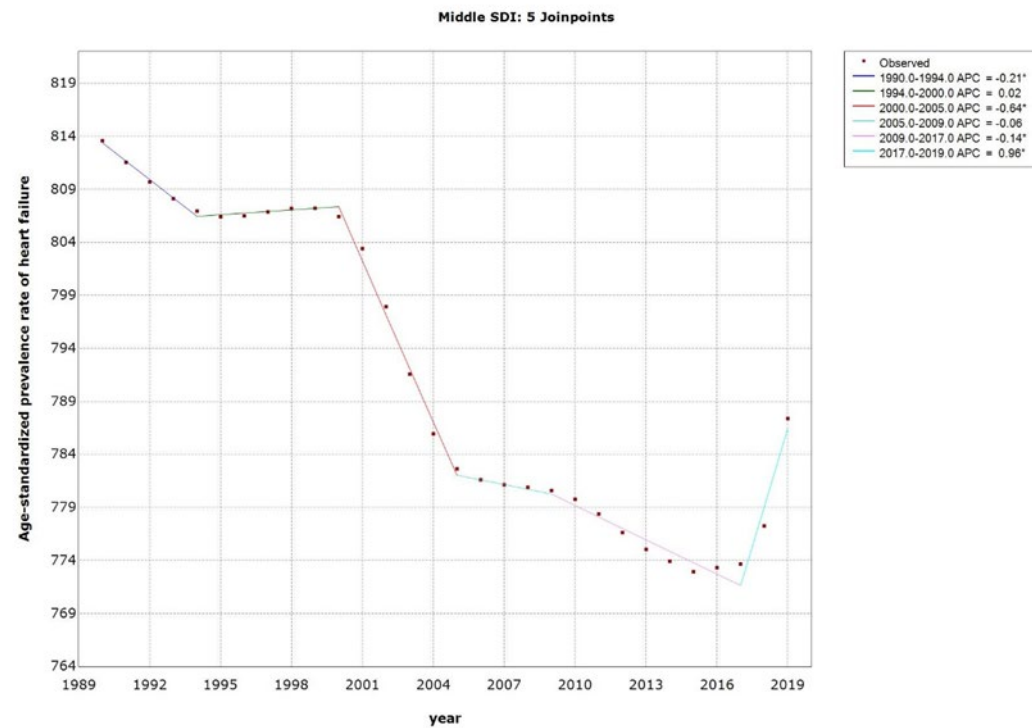
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S10.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in High-middle Socio-demographic Index (SDI) regions from 1990 to 2019.



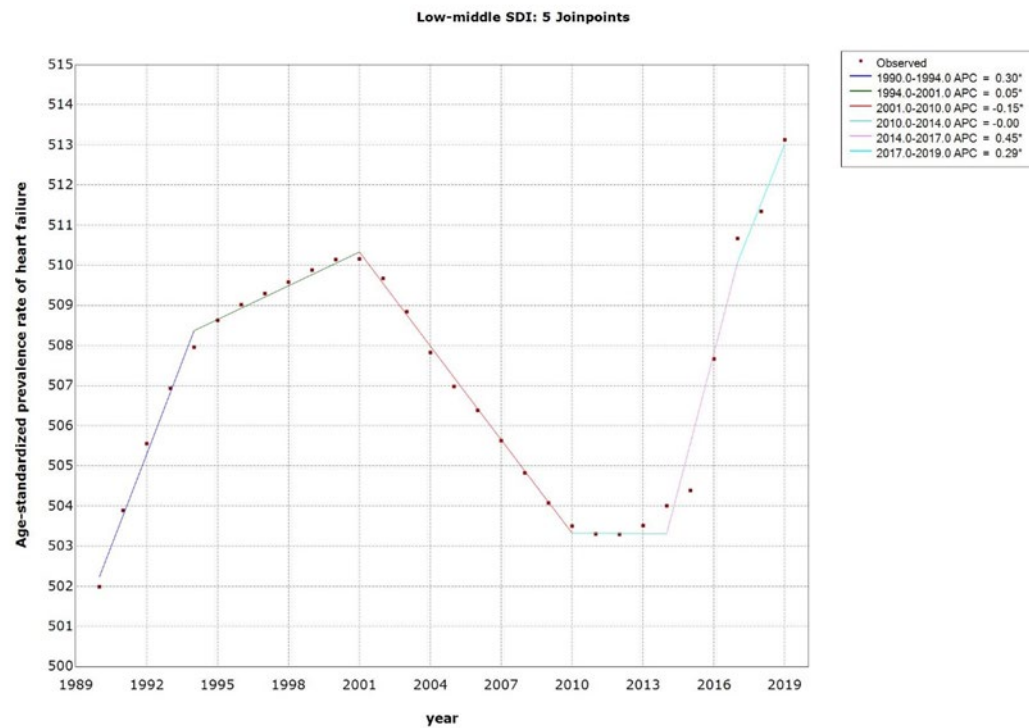
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S11.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Middle Socio-demographic Index (SDI) regions from 1990 to 2019.



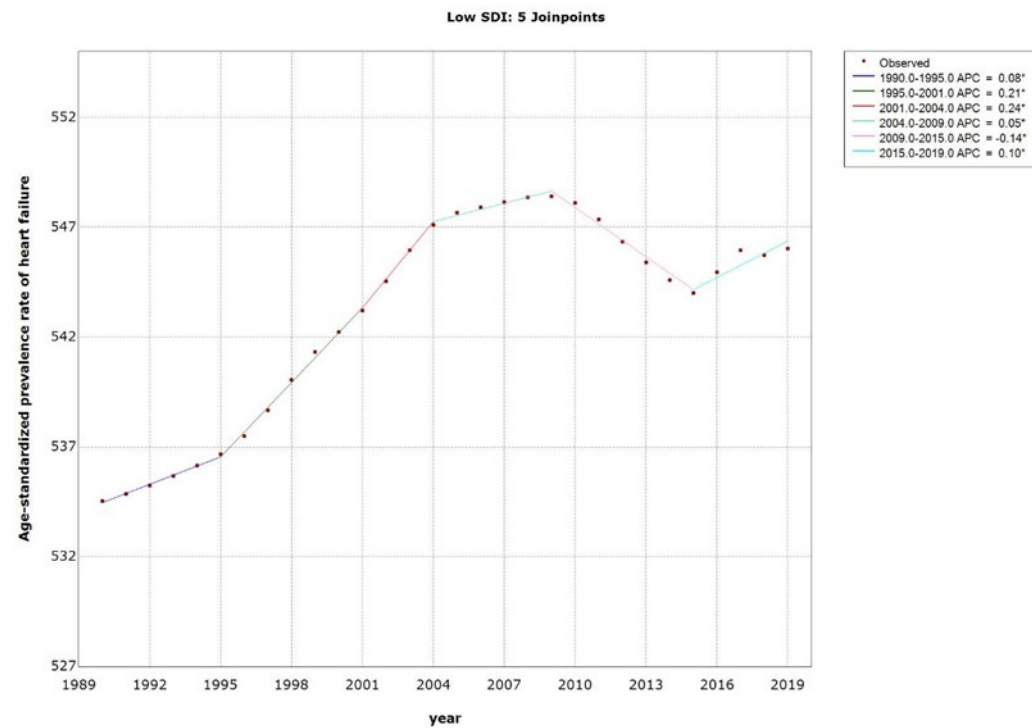
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S12.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Low-middle Socio-demographic Index (SDI) regions from 1990 to 2019.



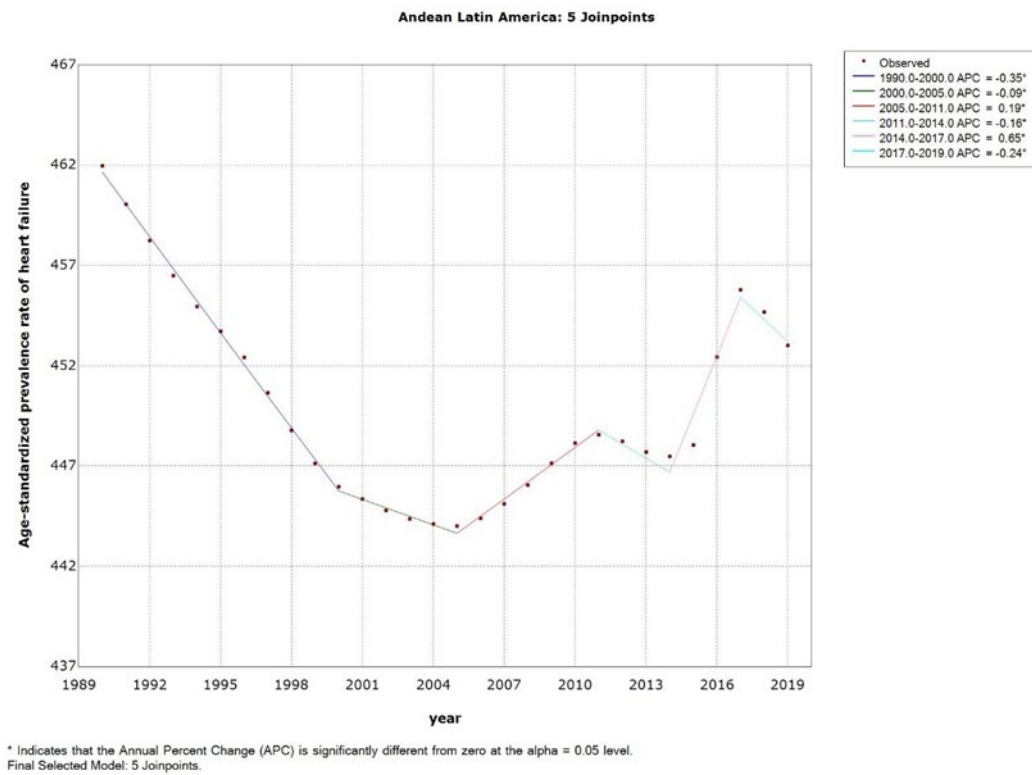
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S13.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Low Socio-demographic Index (SDI) regions from 1990 to 2019.



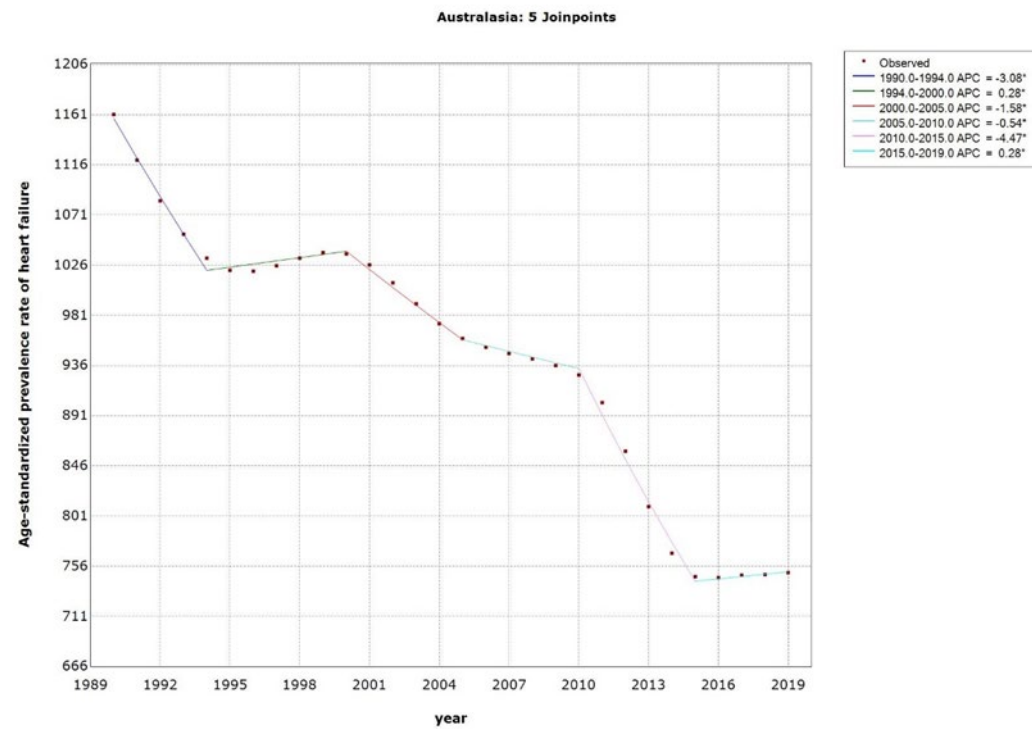
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S14.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Andean Latin America from 1990 to 2019.



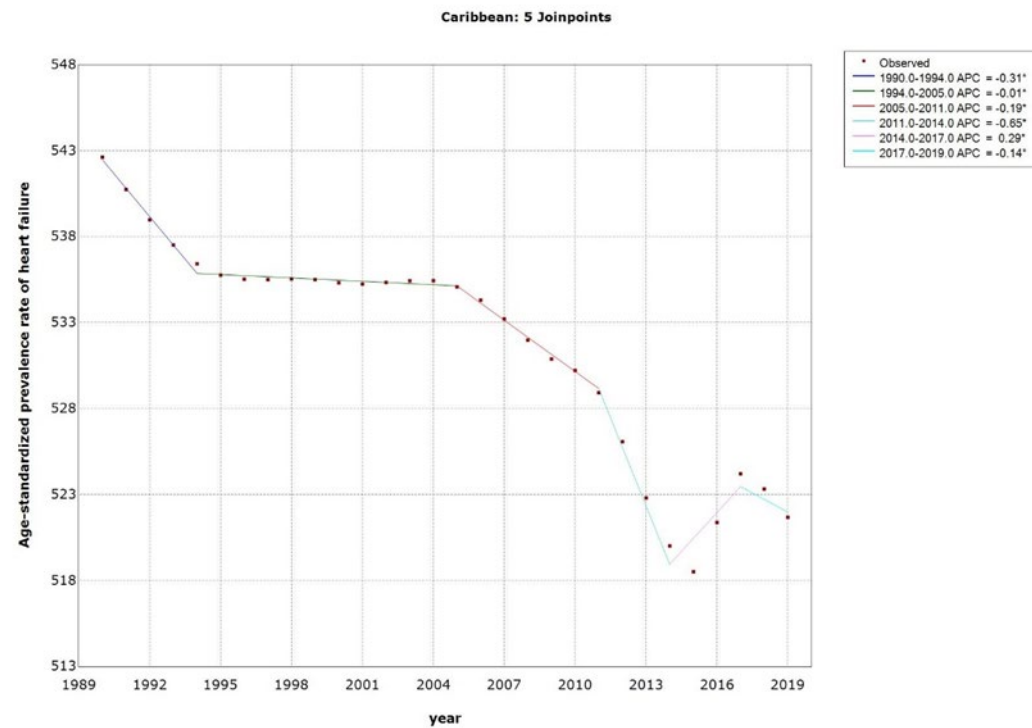


**Figure S15.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Australasia from 1990 to 2019.



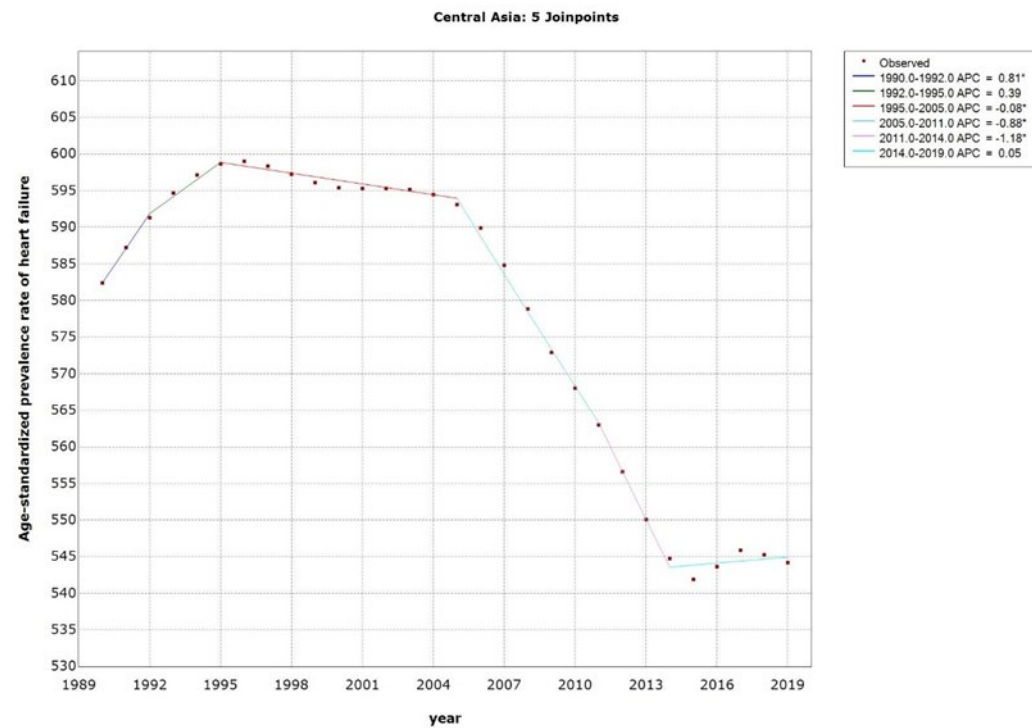
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S16.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Caribbean from 1990 to 2019.



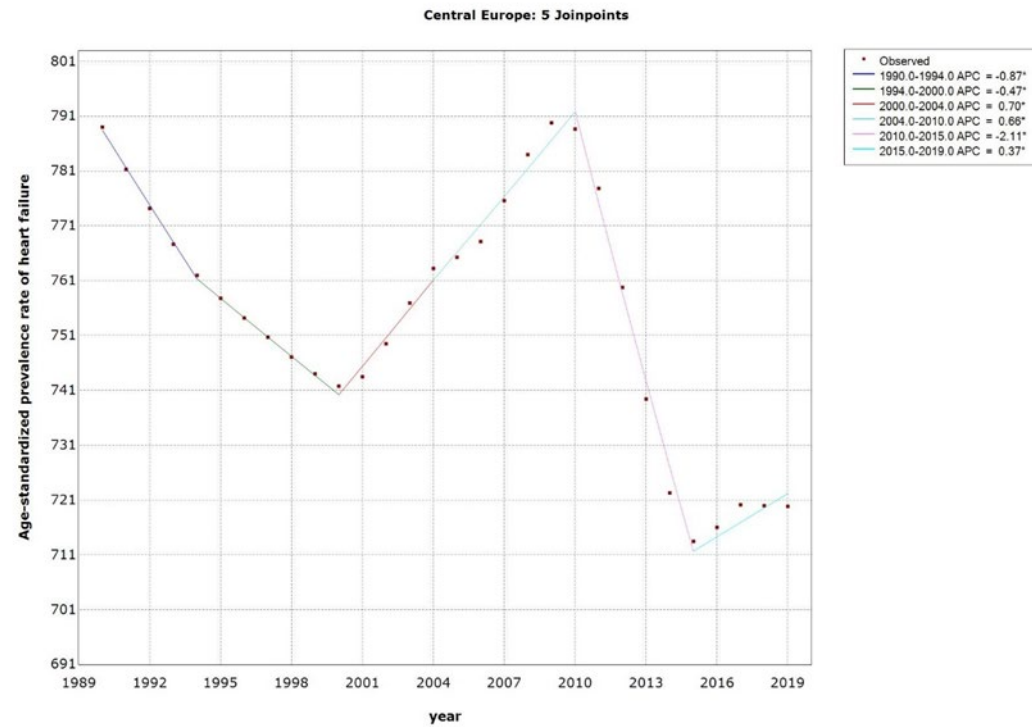
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S17.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Central Asia from 1990 to 2019.



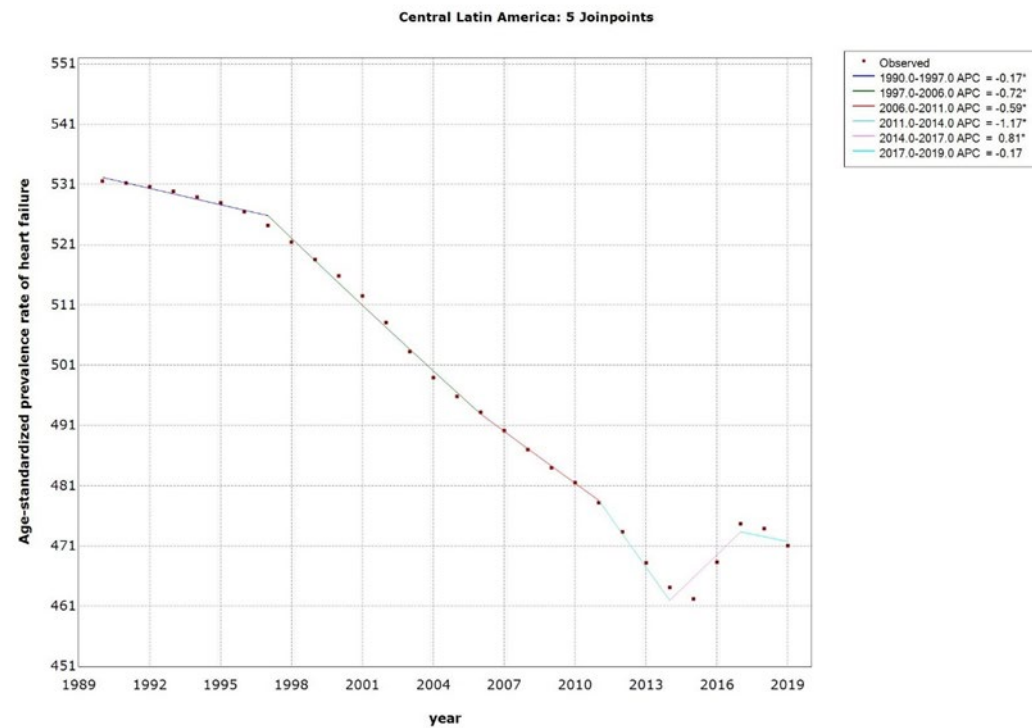
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 3 Joinpoints.

**Figure S18.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Central Europe from 1990 to 2019.



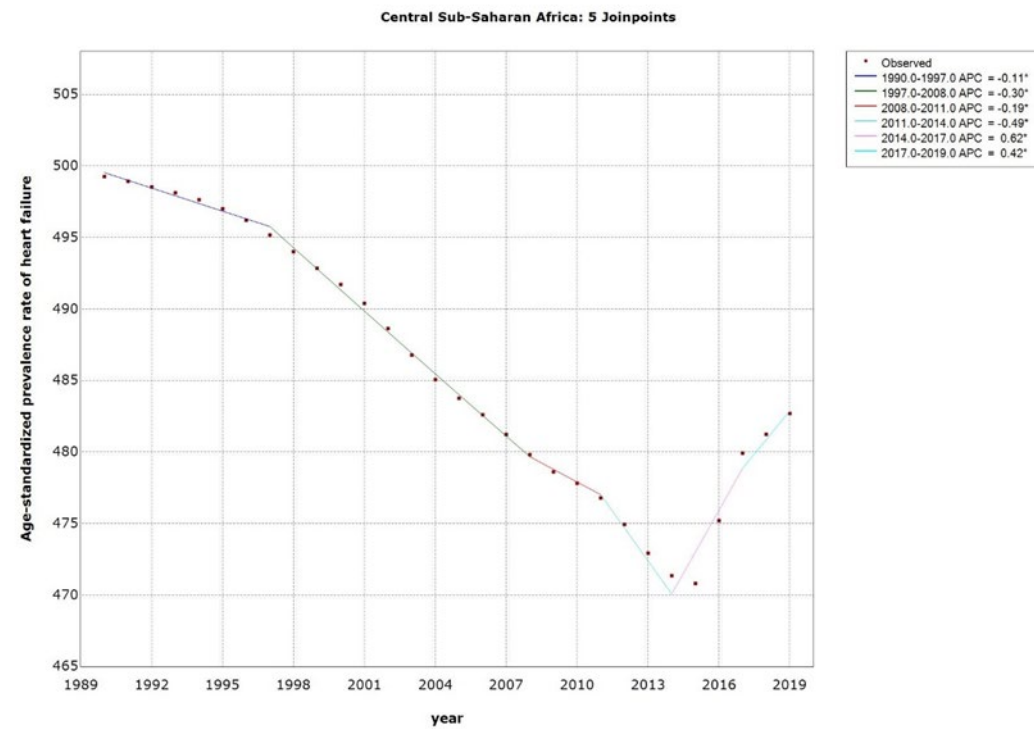
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S19.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Central Latin America from 1990 to 2019.



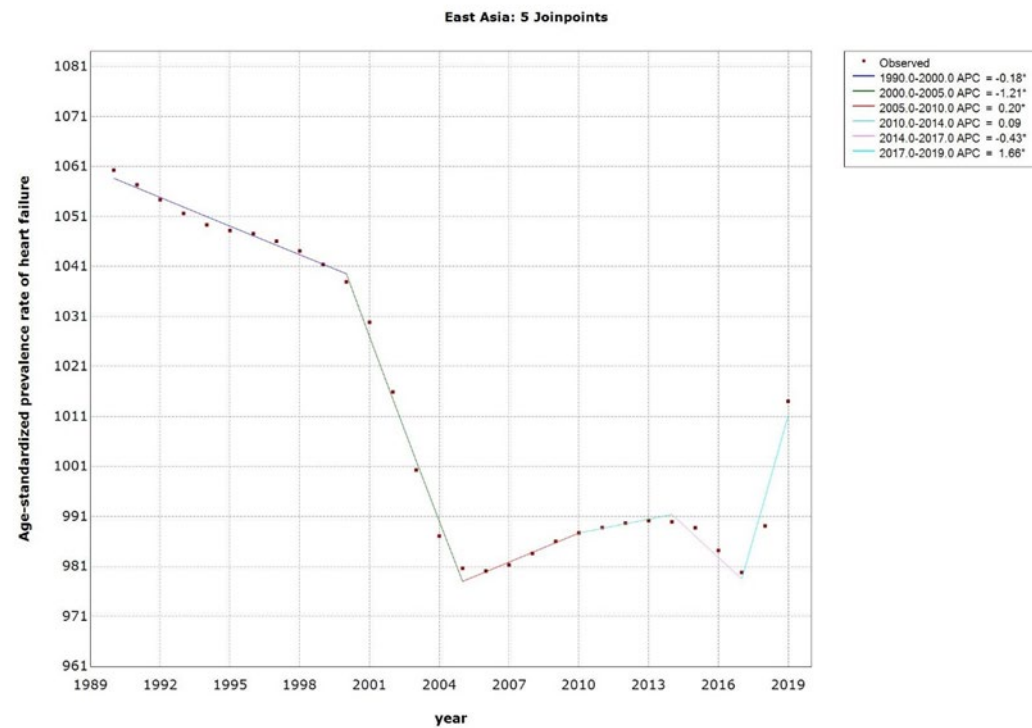
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S20.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Central Sub-Saharan Africa from 1990 to 2019.



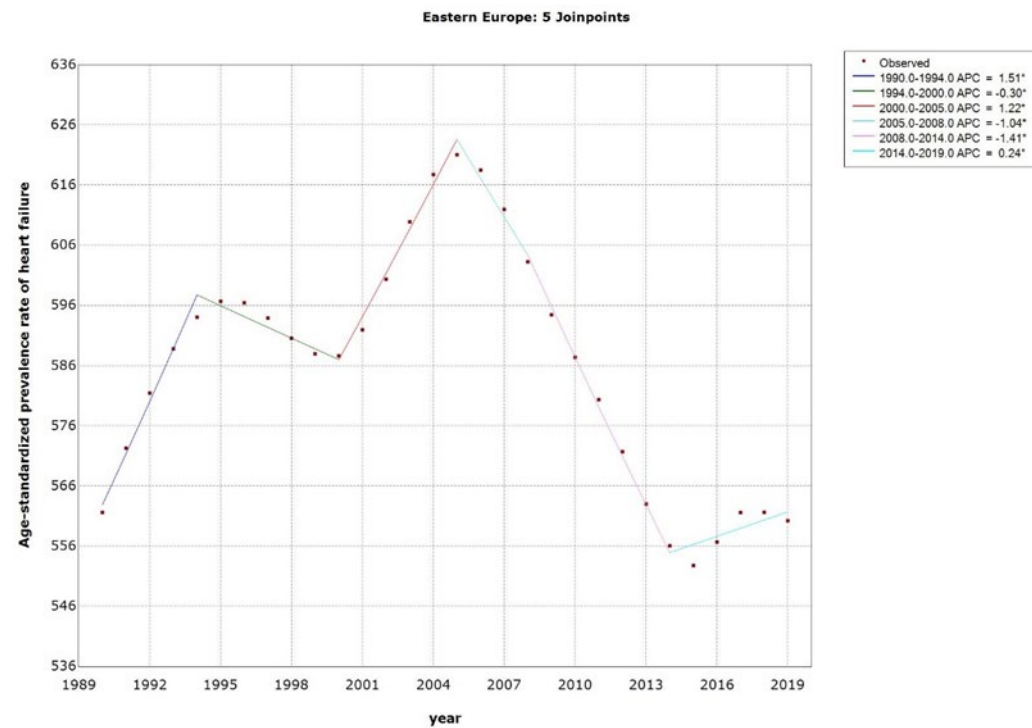
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 2 Joinpoints.

**Figure S21.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in East Asia from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

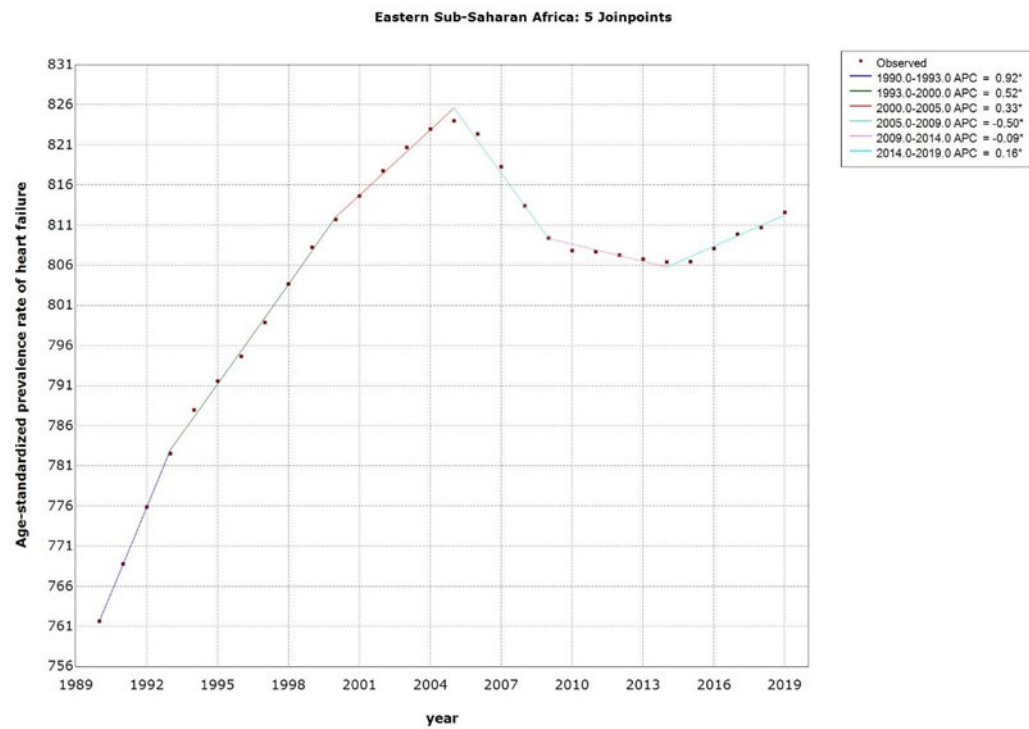
**Figure S22.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Eastern Europe from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

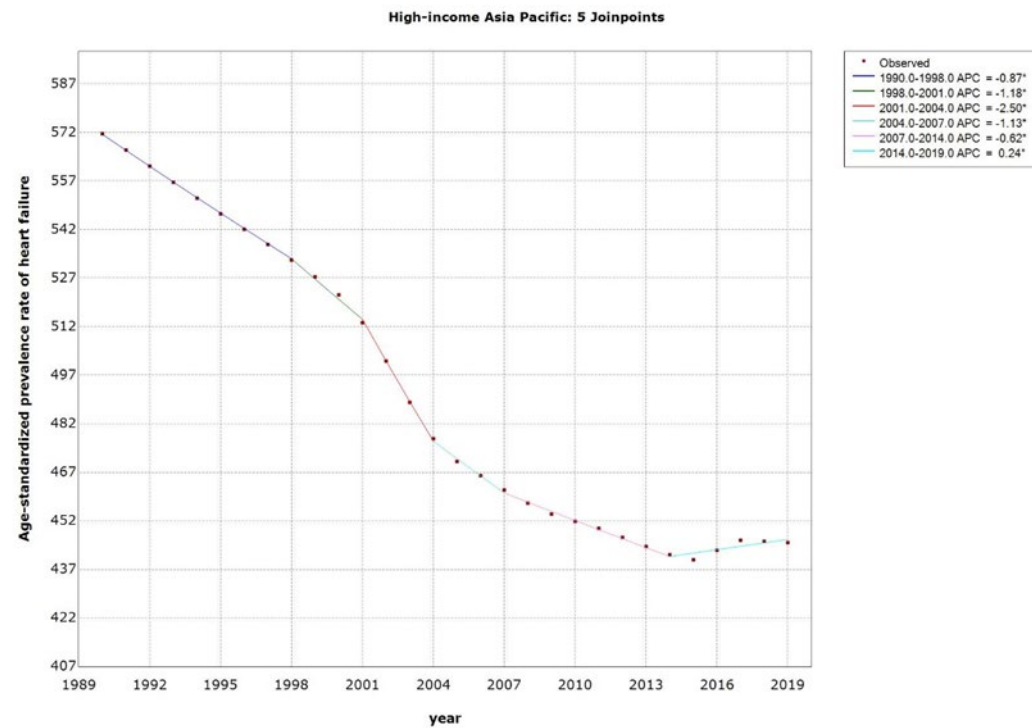


**Figure S23.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Eastern Sub-Saharan Africa from 1990 to 2019.



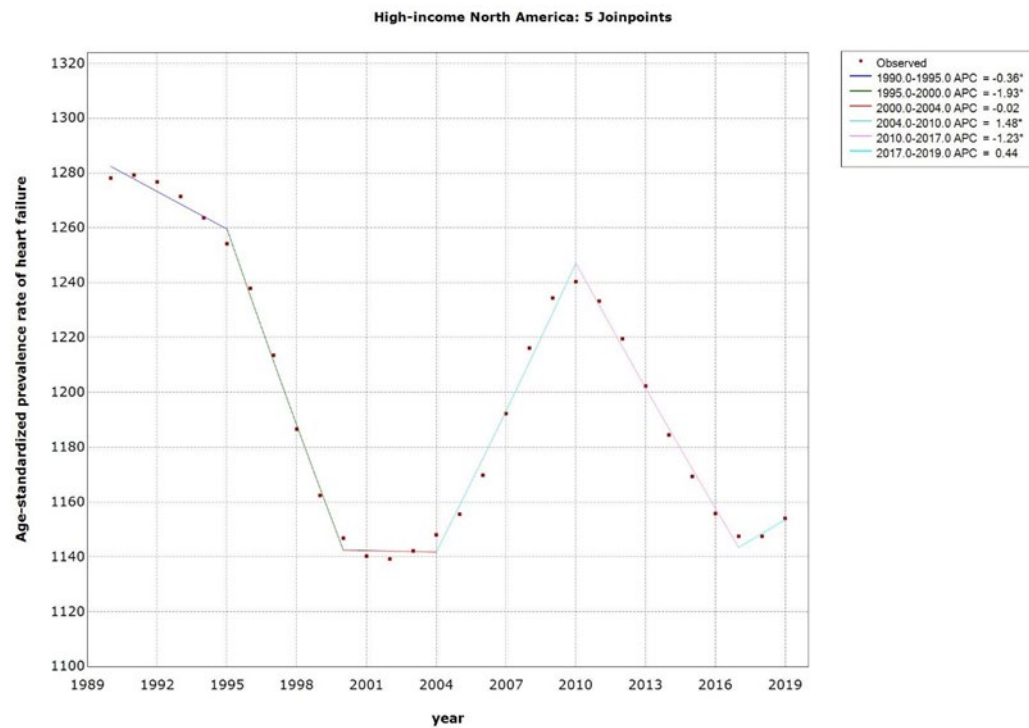
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S24.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in High-income Asia Pacific from 1990 to 2019.



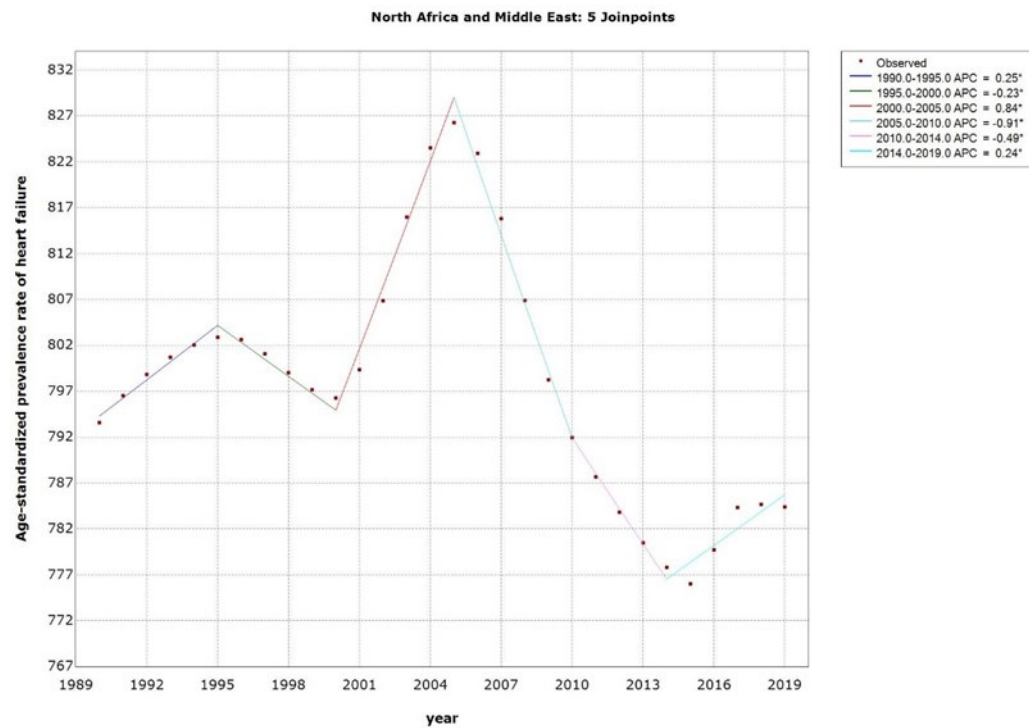
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 3 Joinpoints.

**Figure S25.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in High-income North America from 1990 to 2019.



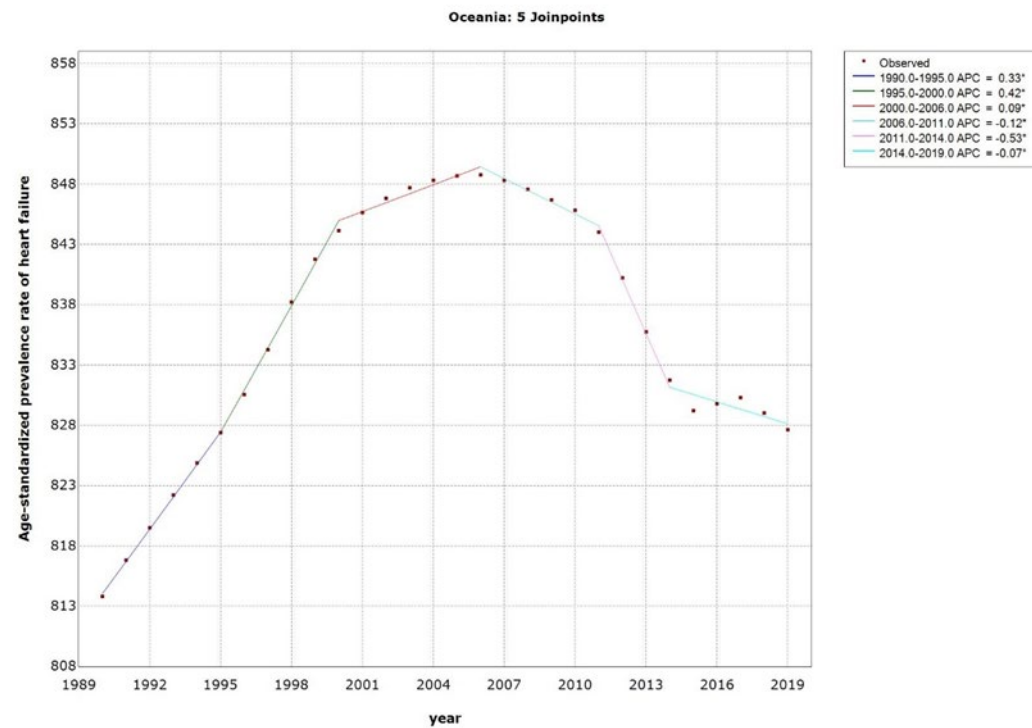
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S26.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in North Africa and Middle East from 1990 to 2019.



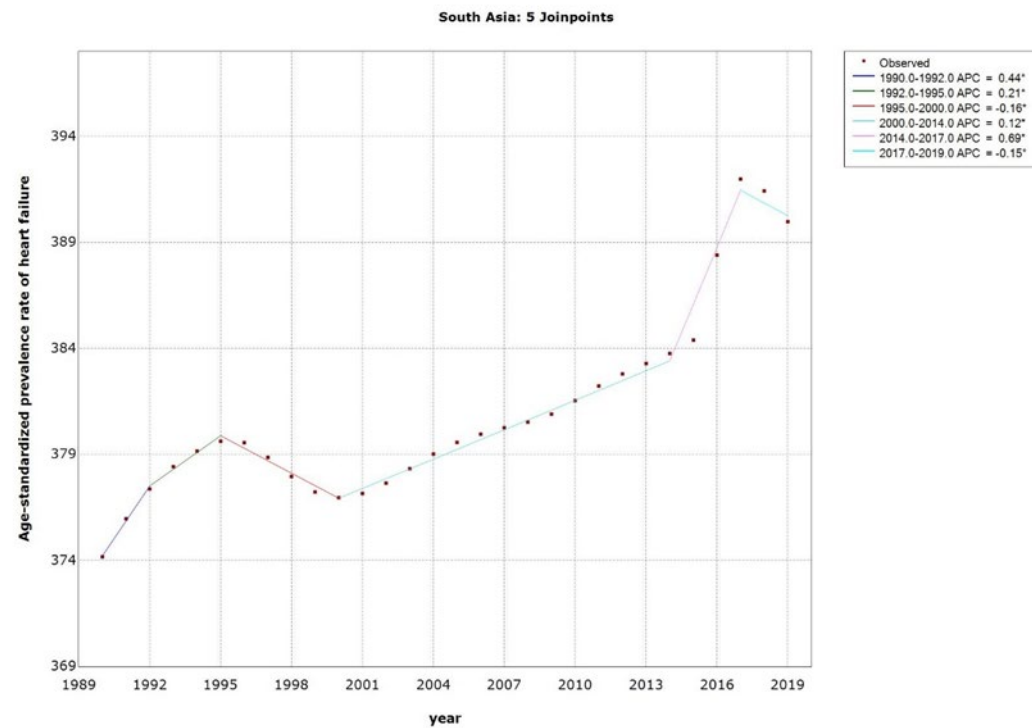
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S27.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Oceania from 1990 to 2019.



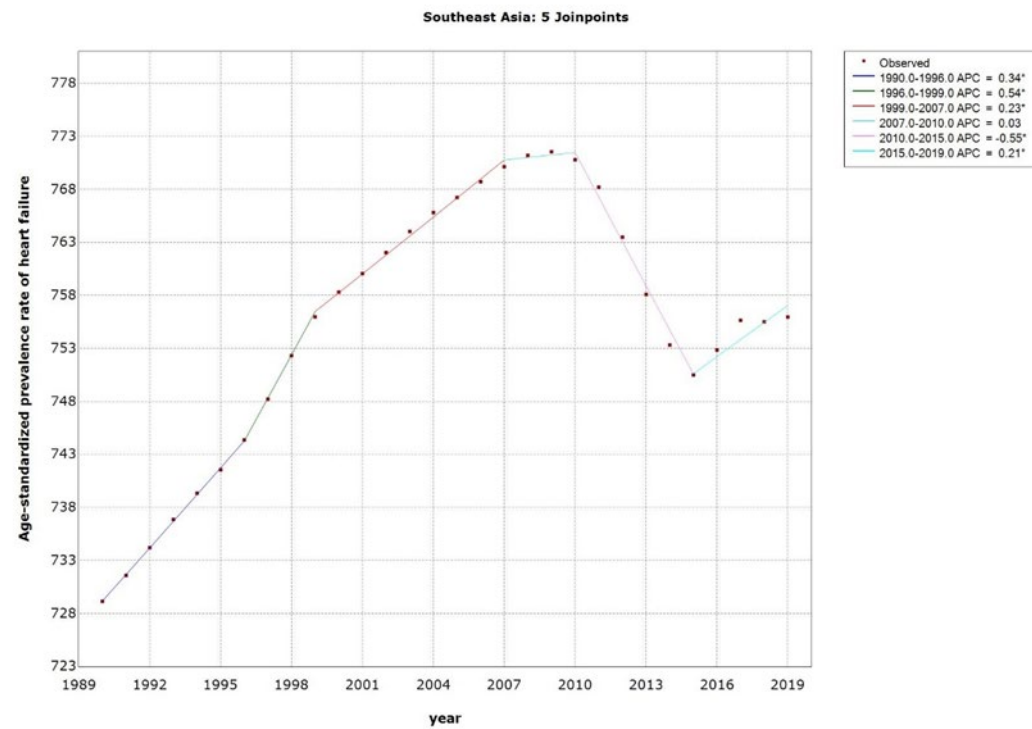
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S28.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in South Asia from 1990 to 2019.



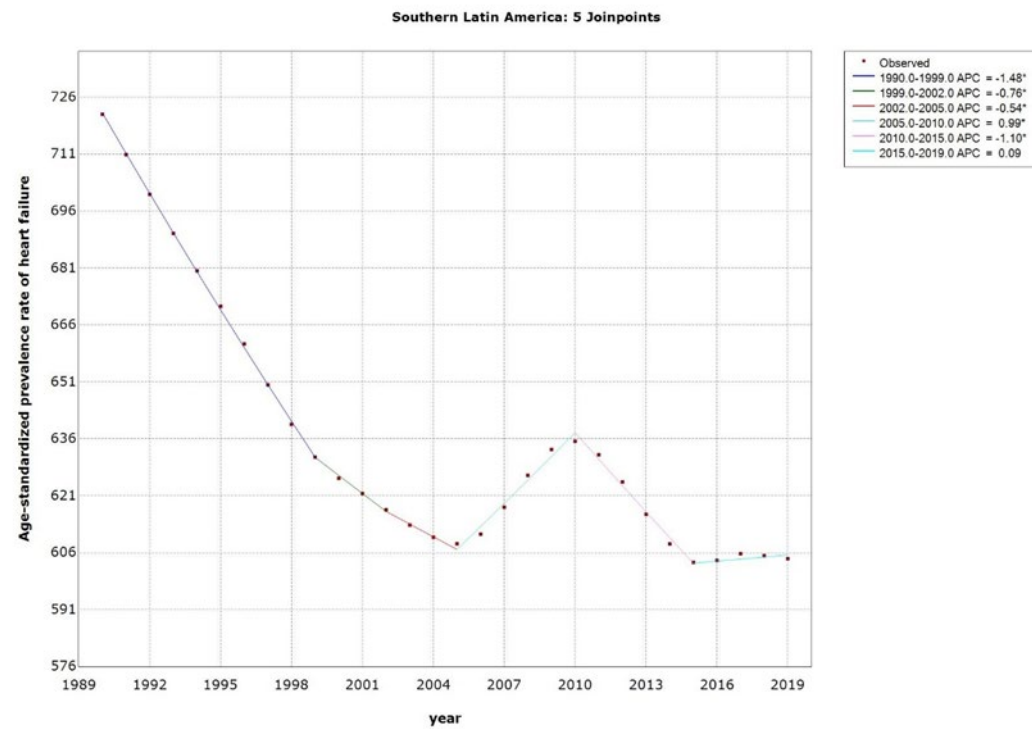
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S29.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Southeast Asia from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

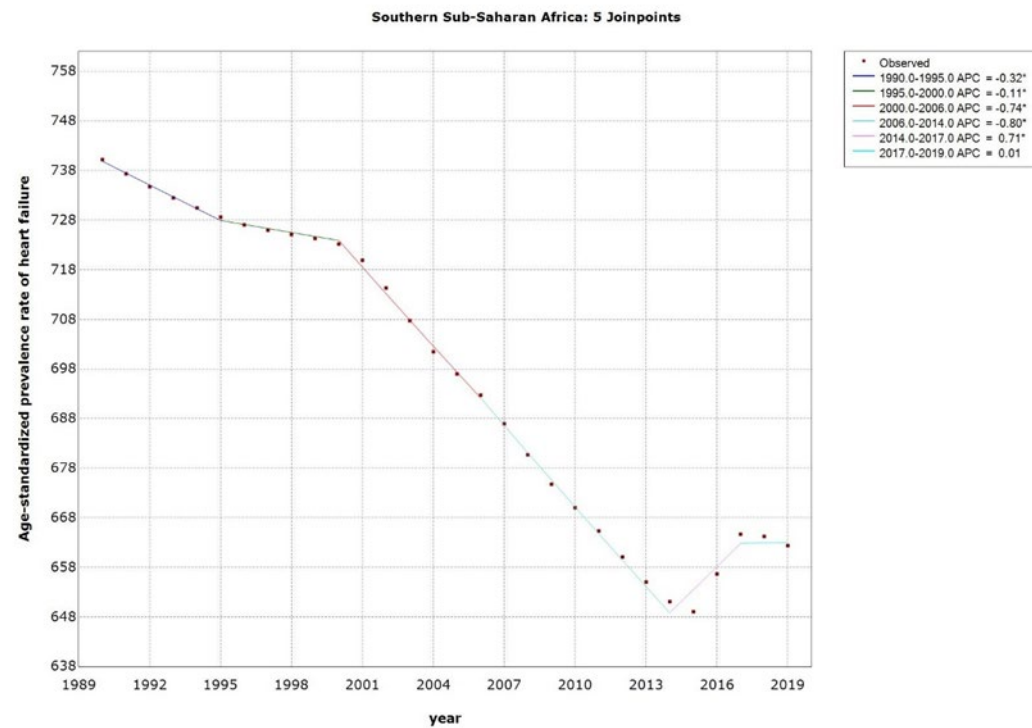
**Figure S30.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Southern Latin America from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

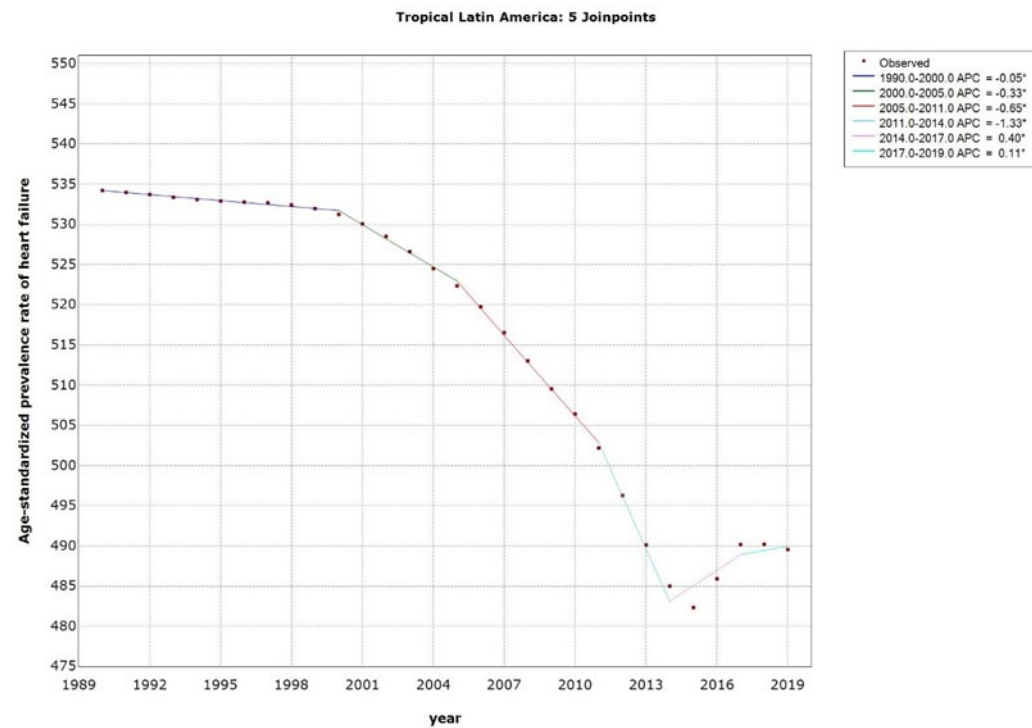


**Figure S31.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Southern Sub-Saharan Africa from 1990 to 2019.



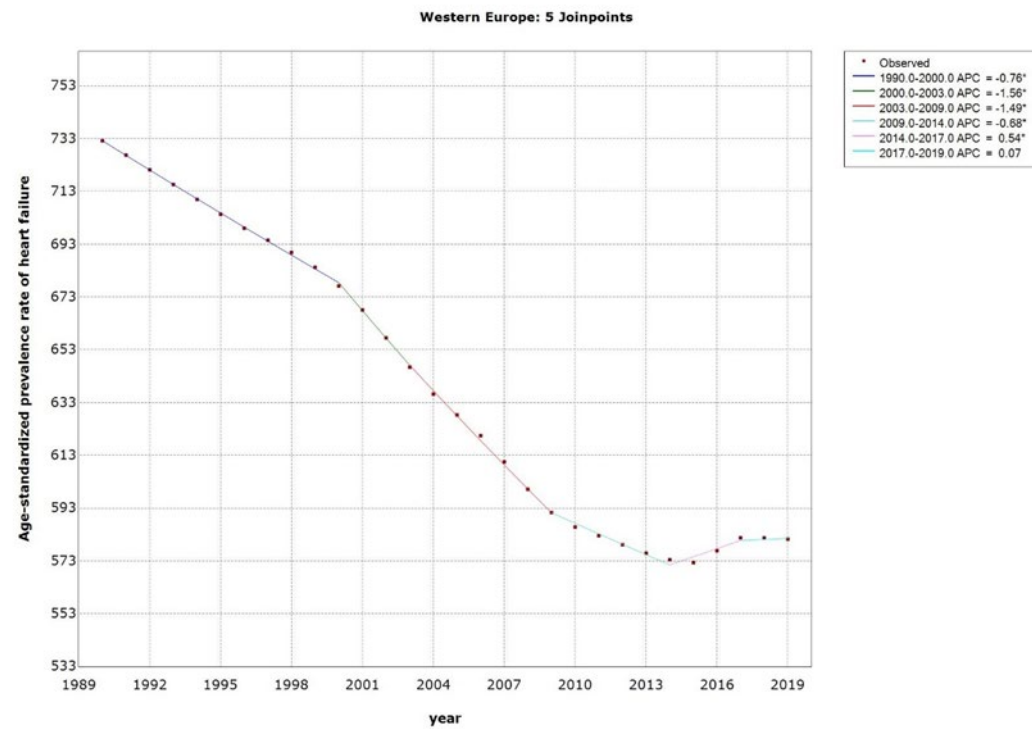
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 2 Joinpoints.

**Figure S32.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Tropical Latin America from 1990 to 2019.



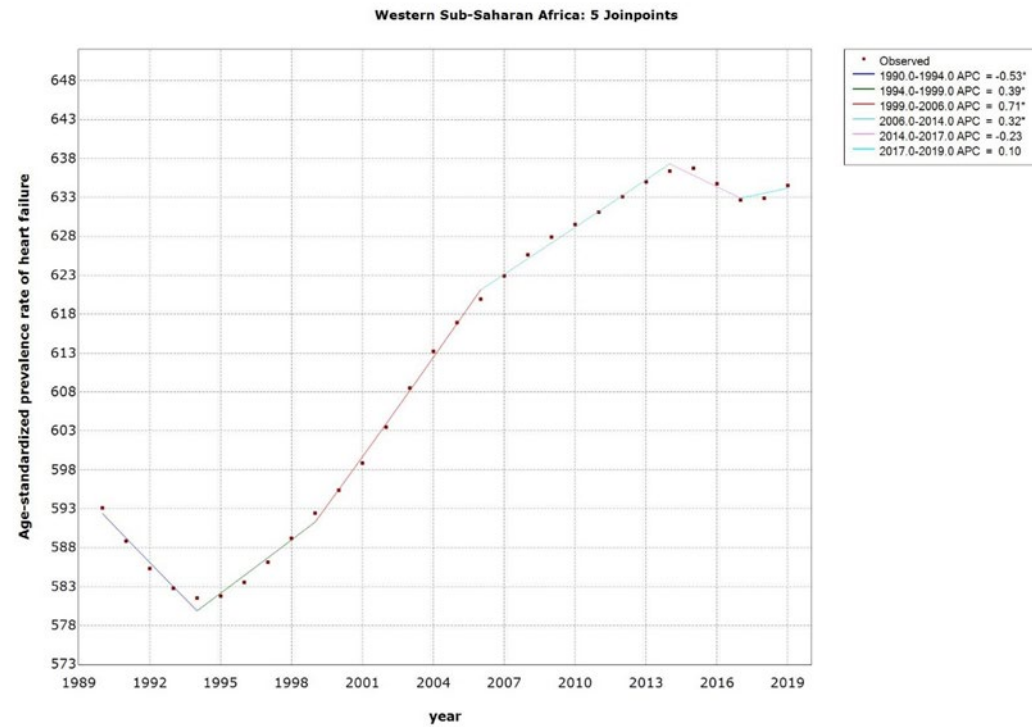
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 3 Joinpoints.

**Figure S33.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Western Europe from 1990 to 2019.



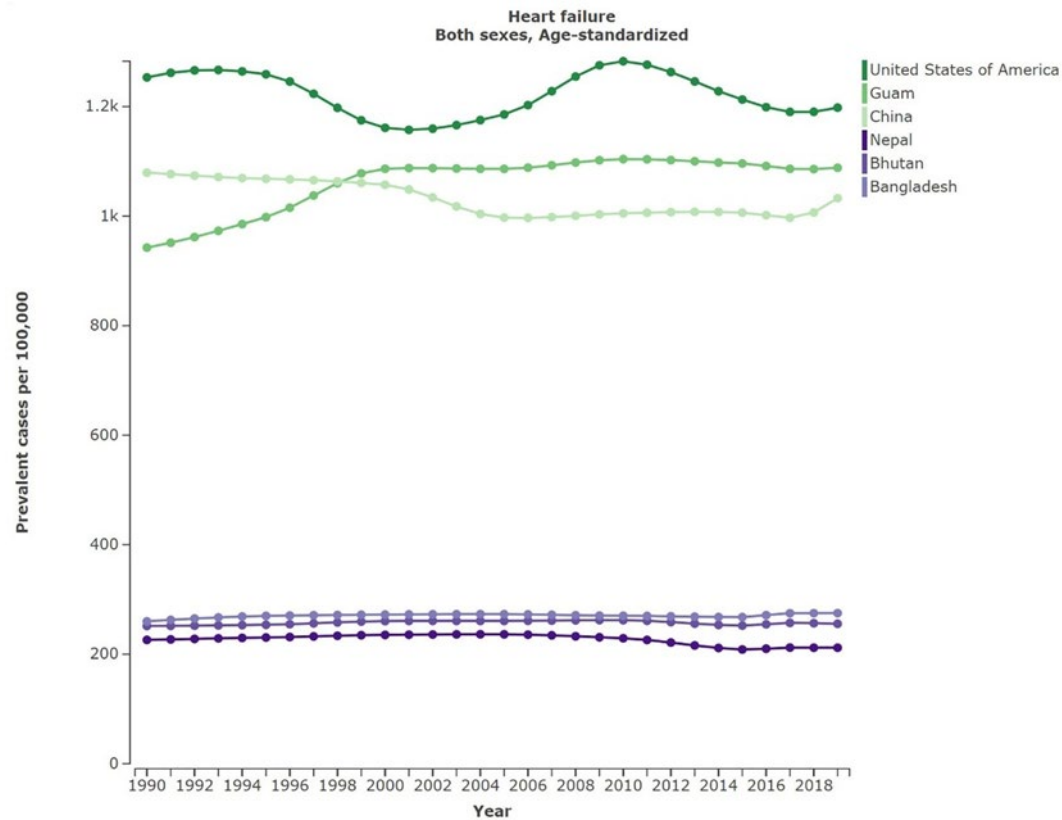
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 3 Joinpoints.

**Figure S34.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Western Sub-Saharan Africa from 1990 to 2019.

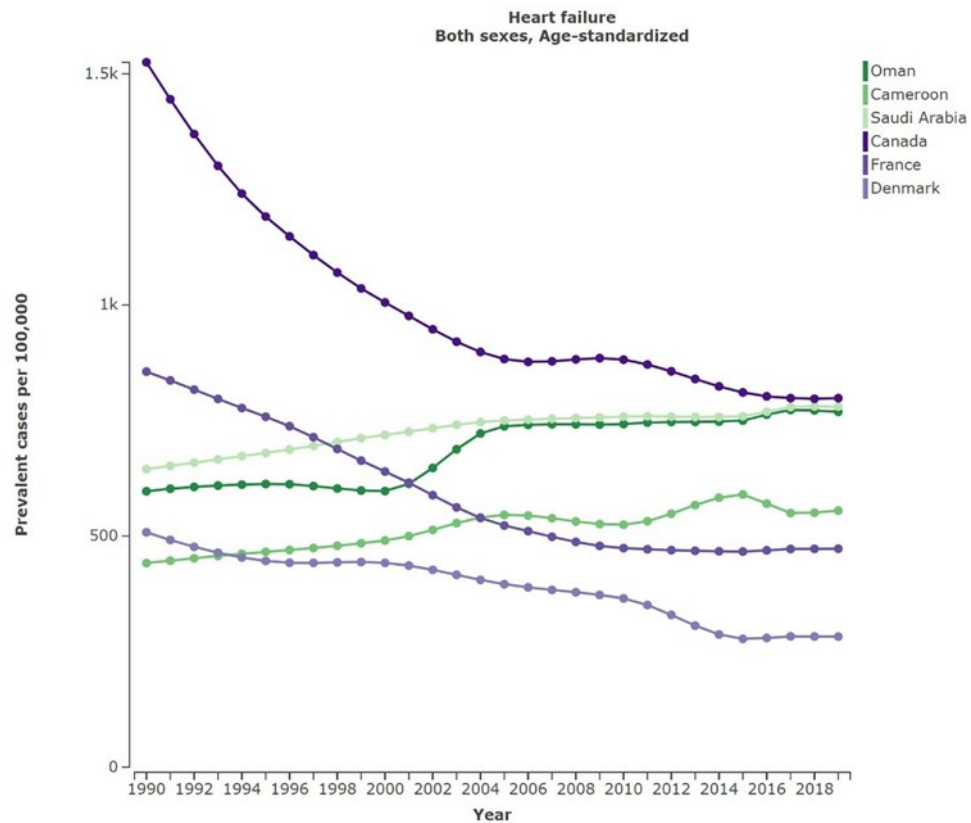


\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

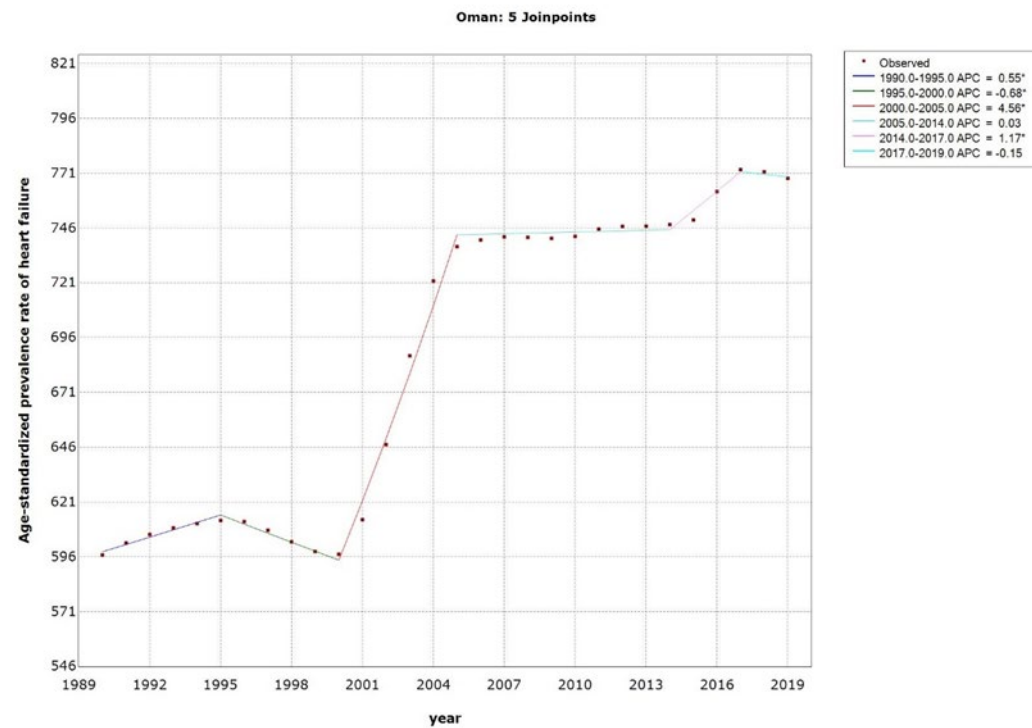
**Figure S35.** The top three nations or territories with the most or least age-standardized prevalence rate of heart failure per 100,000 population in 2019. Visualization using the Global Burden of Diseases (GBD) Compare Tool (<https://www.healthdata.org/data-visualization/gbd-compare>).



**Figure S36.** The top three nations or territories with increased or decreased trends of age-standardized prevalence rate of heart failure per 100,000 population in 2019. Visualization using the Global Burden of Diseases (GBD) Compare Tool (<https://www.healthdata.org/data-visualization/gbd-compare>).

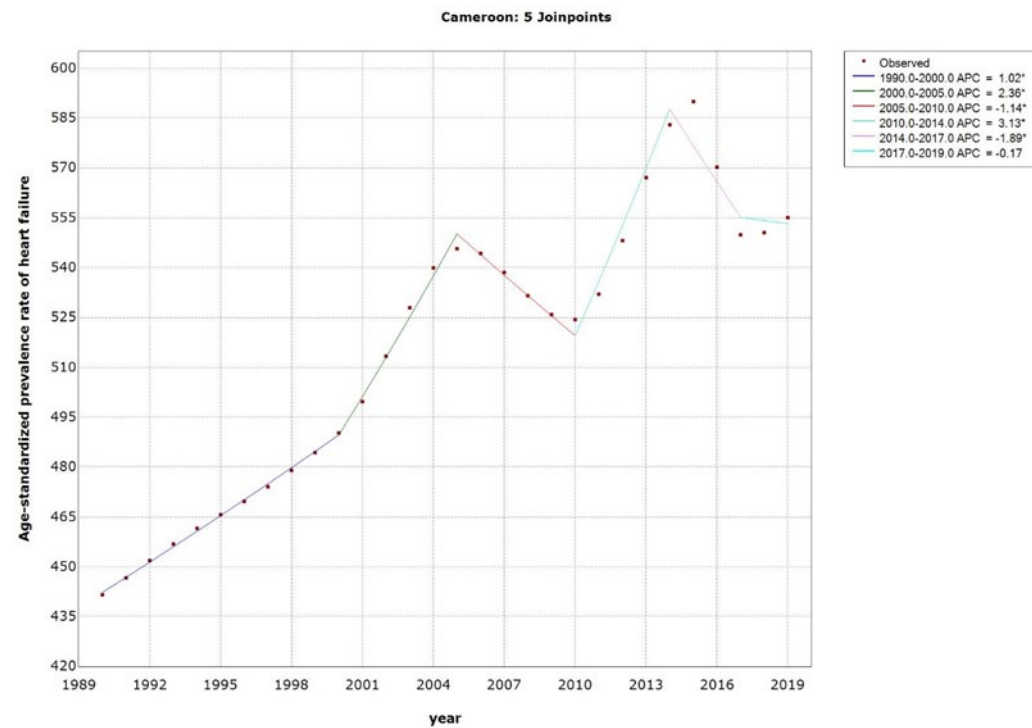


**Figure S37.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Oman from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

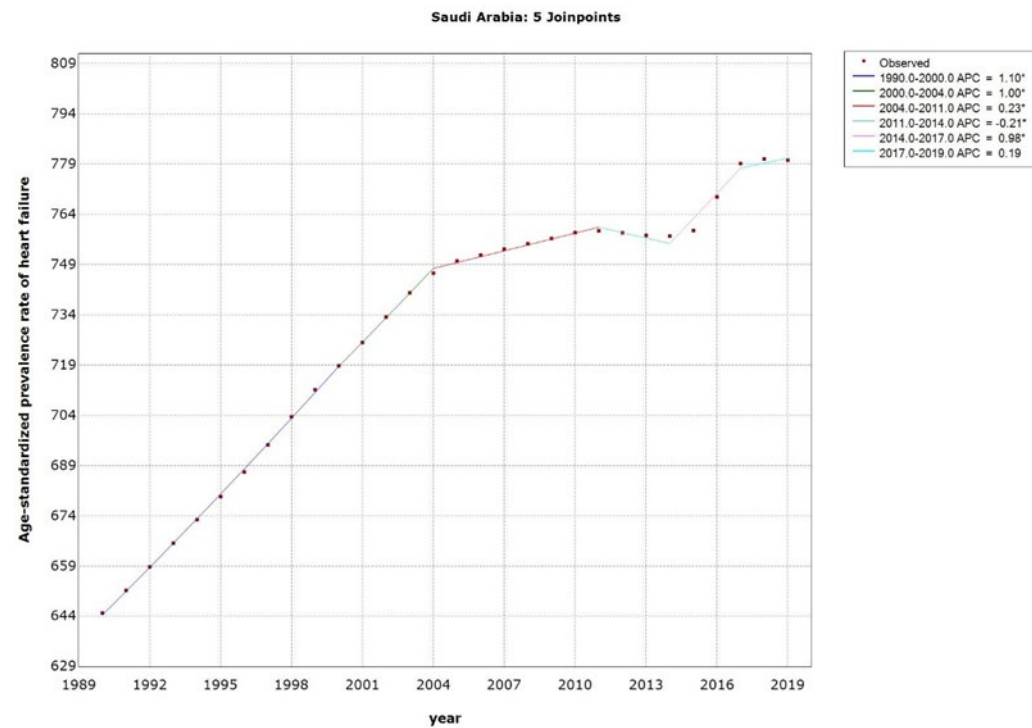
**Figure S38.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Cameroon from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

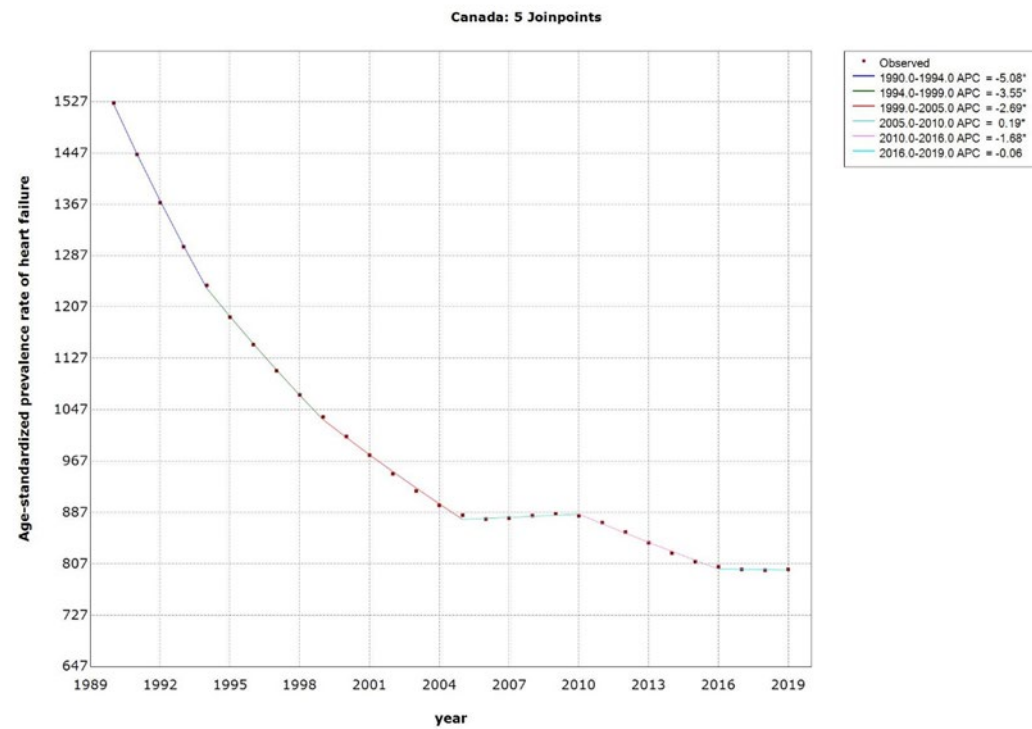


**Figure S39.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Saudi Arabia from 1990 to 2019.



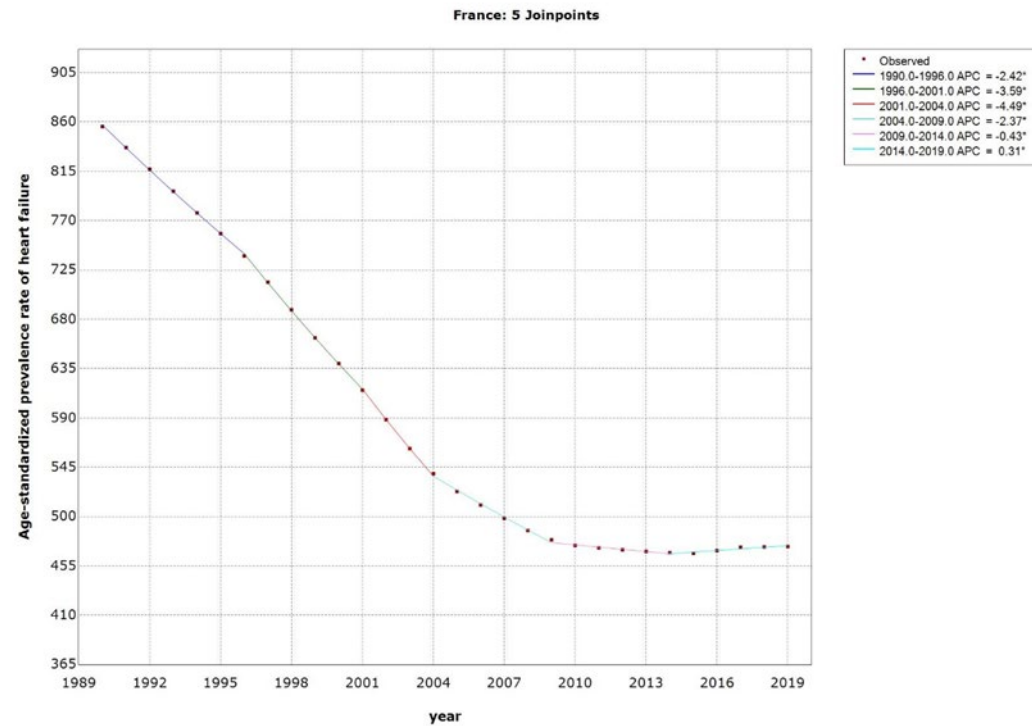
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S40.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Canada from 1990 to 2019.



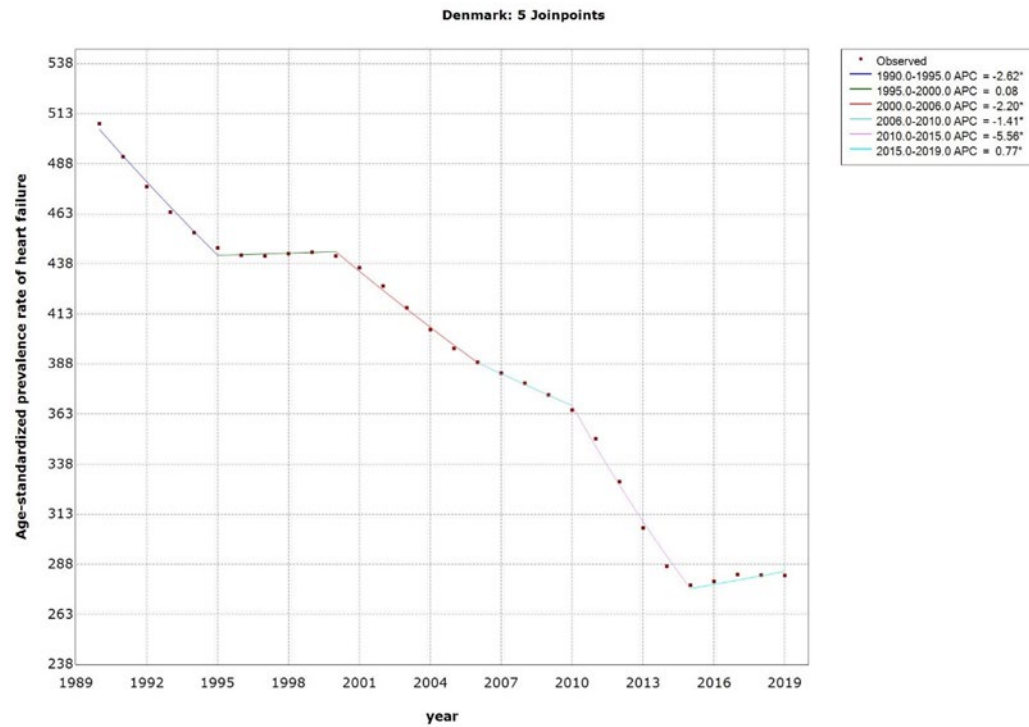
\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S41.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in France from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 5 Joinpoints.

**Figure S42.** The Joinpoint regression analysis showing annual percentage (APC) change for age-standardized prevalence rate of heart failure in Denmark from 1990 to 2019.



\* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.  
Final Selected Model: 4 Joinpoints.

**Figure S43.** Global age-standardized point prevalence rate of heart failure per 100,000 population in 2019 by different age groups. Visualization using the Global Burden of Diseases (GBD) Compare Tool (<https://www.healthdata.org/data-visualization/gbd-compare>).

