

## ORIGINAL RESEARCH ARTICLE

# Current situation and trend of cardiovascular disease burden in China from a global perspective

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### ABSTRACT

**Objective:** Based on the global burden of disease (GBD) 2019 study, to analyze the epidemic trend and risk factors of cardiovascular disease (CVD) in China by comparing the world, the United States, Japan and India. Methods data were obtained from the global health data exchange (ghdx) database. The prevalence, morbidity, mortality, disability adjusted life year (DALY) and other disease burden status and main risk factors of CVD in China were analyzed by sex and age; the age standardized rate was used to compare the change trend of CVD disease burden in China, the United States, Japan and India from 1990 to 2019. **Results:** In 2019, the number of CVD patients in China was 12 billion, with 123.41 million new cases and 458.43 million deaths; the prevalence, incidence rate, mortality and Daly rates increased from 423,543/100,000, 44,781/100,000, 20,475/100,000 and 509,103/100,000 in 1990 to 84,608/100,000, 86,765/100,000, 32,230/100,000 and 646,347/100,000 in 2019 respectively. The prevalence, incidence rate, mortality and Daly rate increased with age, and the burden of CVD in men was higher than that in women. In addition, the top 4 risk factors for CVD in China in 2019 are hypertension, diet, air pollution and tobacco, which lead to higher CVD disease burden than the global average. **Conclusion:** due to hypertension, dietary factors, air pollution, tobacco and other reasons, coupled with the rapid aging of the population, the disease burden of CVD in China is still very serious, which needs to be paid attention to by relevant departments.

**Keywords:** Cardiovascular disease (CVD); be ill; onset; death; disability adjusted life year (DALY); risk factors

## 1. Introduction

With the improvement of social and economic level and the deepening of globalization and urbanization, people's eating habits and other lifestyles have undergone major changes. At the same time, with the intensification of global aging, more and more evidence shows that non communicable diseases, especially cardiovascular disease (CVD), have become the main cause of the global disease burden<sup>[1,2]</sup>. According to the 2019 global burden of disease (GBD), CVD caused a total of 1856.21 million deaths worldwide in 2019, which has become the world's largest cause of death. In order to reflect the current situation and trend of CVD disease burden in China and provide experience and basis for rational control of CVD in China, this study selected two countries with the largest population in the world—China and India, Japan, a highly aging developed country in Asia, and the United States, a traditional developed country, to conduct a comparative analysis of CVD disease burden in China.

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## **2. Data and methods**

### **2.1. Data source**

Cardiovascular disease (CVD) is a general term for a series of diseases of the circulatory system, including cardiovascular, cerebrovascular, peripheral vascular and microvascular diseases, such as acute myocardial infarction and stroke. CVD related data are from GBD 2019 research, which is led by the Institute for health metrics and evaluation (IHME) of the University of Washington in the United States. The relevant data are from the global health data exchange (ghdx) website (<http://ghdx.healthdata.org/Gbdresults> tool).

### **2.2. Statistical analysis**

The study used the prevalence, incidence rate, mortality, disability adjusted life years (DALY) rate and age standardized rate to assess the burden of CVD. DALY refers to the total life years lost from onset to death, which is the sum of years of life lost (YLL) and years live with disability (YLD). YLL was calculated by mortality and average age of death, and YLD was calculated by disability weight and prevalence rate<sup>[3]</sup>. The prevalence rate refers to the proportion of new and old CVD patients in the total population within a certain range within a year. Incidence rate refers to the frequency of new cases of CVD in a certain range of population within a year; mortality refers to the proportion of CVD deaths in the total population within a certain range within a year; DALY rate refers to the proportion of DALY of CVD in the total population of a certain range of people within a year. Because CVD mainly occurs in adults over 15 years old, the subjects of the study are people over 15 years old. Each age group is divided into groups at 5-year intervals. The prevalence, incidence rate, mortality and DALY rates are given by sex and age to describe the current situation of CVD disease burden in China. The age standardization rate is obtained by eliminating the influence of age composition differences through the world standard population. The age standardized rate was used to compare the change trend of CVD disease burden in China, the United States, Japan, India and the world from 1990 to 2019.

## **3. Results**

### **3.1. Current situation**

In 2019, the number of CVD cases in China was 12 billion, an increase of 310% over 2018, accounting for 883% of all-cause cases in China and 2300% of the global CVD cases. The prevalence of CVD in women (676.971 million) was higher than that in men (526.349 million), and the prevalence of CVD in women (970,527/100,000) was also higher than that in men (7261.78/100,000). The prevalence of CVD in China is increasing with age, especially after 40 years old.

In 2019, there were 123.41 million new cases of CVD in China, an increase of 355% over 2018, accounting for 021% of all-cause cases in China and 2226% of the global CVD cases. Among them, the number of female patients (667.15 million) was higher than that of male patients (566.95 million), and the female incidence rate (95,645/100,000) was also higher than that of male patients (78,220/100,000). The incidence rate of CVD in China increases rapidly with age, especially in the age group over 40.

The number of CVD deaths in China in 2019 was 458.43 million, an increase of 280% over 2018, accounting for 4303% of all-cause deaths in China and 2470% of global CVD deaths. The number of male deaths (254.32 million) was higher than that of female deaths (204.11 million), and the male mortality (350.87/100,000) was also higher than that of female deaths (29.262/100,000). The mortality rate of CVD in China increases with age, and the mortality rate in the age group after 60 years old shows an obvious and rapid upward trend.

In 2019, China's CVD led to a total of 9193.31 million DALYs, an increase of 197% over 2018, accounting

for 2405% of China’s all-cause dalys and 2339% of global CVD led dalys. The Daly caused by CVD in men (540.47 million) was higher than that in women (379.284 million), and the Daly rate in men (745,076/100,000) was also higher than that in women (543,754/100,000). The Daly rate of CVD in China shows an upward trend with age, especially in the age group over 60 (**Table 1**).

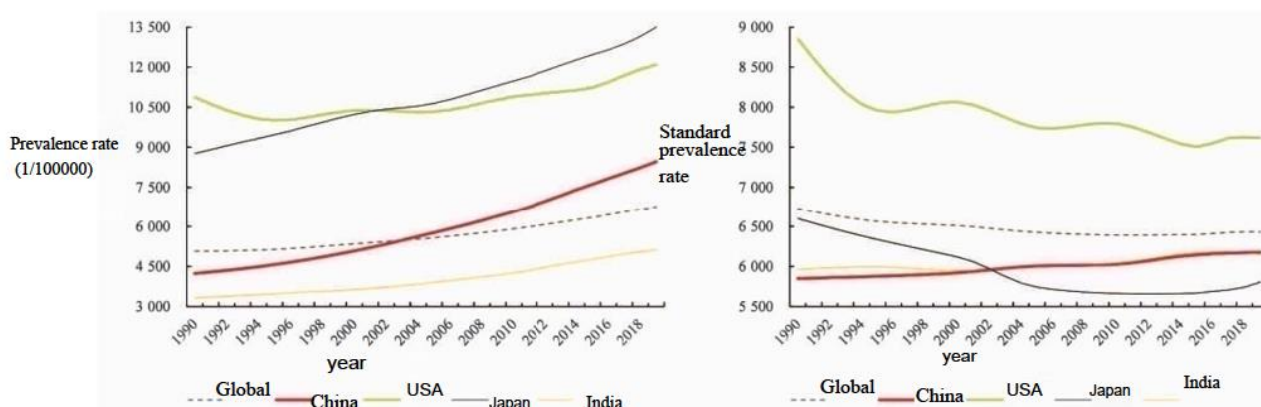
**Table 1.** The burden of cardiovascular disease for Chinese population by age and sex in 2019.

Age group (years)	Prevalence rate (1/100,000)			Incidence rate (1/100,000)			Mortality rate (1/100,000)			Daly rate (1/100,000)		
	Male	Female sex	Total	Male	Female sex	Total	Male	Female sex	Total	Male	Female sex	Total
15–19	632.59	791.26	706.58	74.68	71.73	73.31	3.89	1.79	2.91	333.26	211.55	276.50
20–24	735.59	920.96	824.12	80.11	71.27	75.89	8.02	3.32	5.77	601.58	322.14	468.11
25–29	976.30	1157.54	1065.29	93.15	79.70	86.55	11.07	4.00	7.60	771.32	371.76	575.14
30–34	1267.81	1460.53	1363.06	121.81	96.79	109.44	22.00	6.70	14.44	1361.06	531.93	951.29
35–39	1865.37	1955.31	1909.49	163.72	121.61	143.06	40.59	11.83	26.48	2259.53	803.86	1545.42
40–44	3522.30	4128.91	3819.30	330.15	336.49	333.25	71.72	23.26	47.99	3618.20	1383.39	2524.03
45–49	5345.76	6133.76	5732.29	543.92	578.31	560.79	100.13	38.33	69.82	4584.68	2002.71	3318.16
50–54	8248.46	9592.33	8917.28	843.86	935.18	889.31	170.87	74.71	123.02	6942.38	3369.87	5164.41
55–59	12,223.12	14,461.07	13,336.82	1235.29	1411.68	1323.07	276.37	132.68	204.86	9892.65	5260.67	7587.57
60–64	17,407.46	20,924.64	19,157.72	1728.56	2045.78	1886.42	471.18	252.22	362.22	14,531.95	8569.02	11,564.60
65–69	24,048.49	29,246.78	26,695.25	2309.50	2821.03	2569.95	808.99	485.09	644.07	20,960.93	13,778.11	17,303.73
70–74	30,832.17	37,951.41	34,481.05	3130.26	3623.13	3382.87	1591.93	1014.11	1295.78	33,263.05	22,965.68	27,985.26
75–79	37,765.59	46,281.52	42,247.97	4222.08	4489.40	4362.79	2875.23	1909.74	2367.05	47,171.80	33,576.93	40,016.11
≥80	46,408.85	56,637.65	52,657.59	7468.17	6579.98	6925.58	7759.37	5739.68	6525.55	82,960.22	59,528.74	68,646.00
Total	7261.78	9705.27	8460.08	782.20	956.45	867.65	350.87	292.62	322.30	7450.76	5437.54	6463.47

### 3.2. Trends

#### 3.2.1. Prevalence

From 1990 to 2019, the prevalence of CVD in the world and in China, the United States, Japan and India showed an upward trend. Among them, China increased from 423,543/100,000 in 1990 to 846,008/100,000 in 2019, an increase of 9975%, followed by India 5412% and Japan 5393%; the growth rate of the United States during the study period was the smallest, rising from 1,087,171/100,000 in 1990 to 1,209,506/100,000 in 2019, an increase of 1125% (**Figure 1**). By eliminating the age difference and comparing the standardized rate, it is found that the global standardized prevalence of CVD shows a downward trend, in which the United States and Japan decreased by 1398% and 1204% respectively from 1990 to 2019, but the standardized prevalence of the United States remained the highest among the four countries during the study period. The standardized prevalence of CVD in China and India showed an upward trend over time. The standardized prevalence of CVD in China increased by 562% during the study period, from 584,792/100,000 in 1990 to 617,675/100,000 in 2019, but both were lower than the global average.



**Figure 1.** Trends in prevalence (left) and age-standardized prevalence rate (right) of cardiovascular diseases in the world, China, the USA, Japan and India from 1990 To 2019.

### 3.2.2. Incidence rate

The trend of incidence rate was the same as that of prevalence. From 1990 to 2019, the incidence rate of CVD in China showed an upward trend, increasing from 44,781/100,000 in 1990 to 86,765/100,000 in 2019, with a 9375% increase, followed by 4753% in India and 3947% in Japan. The United States showed a downward trend before 2009, followed by a slight increase. Compared with the standardized incidence rate, it is found that the standardized incidence rate in China has not changed significantly in the past 30 years, with an increase of 093%. The United States and Japan, two developed countries, showed an obvious downward trend, down 3008% and 1817% respectively, but the downward trend has stagnated in recent years. In addition, the standardized incidence rate of India and the United States in 2019 was higher than the global average (68,432/100,000), with India ranking first with 76,134/100,000, followed by the United States (69,348/100,000). From 1990 to 2019, the standardized incidence rate in China was lower than the global average.

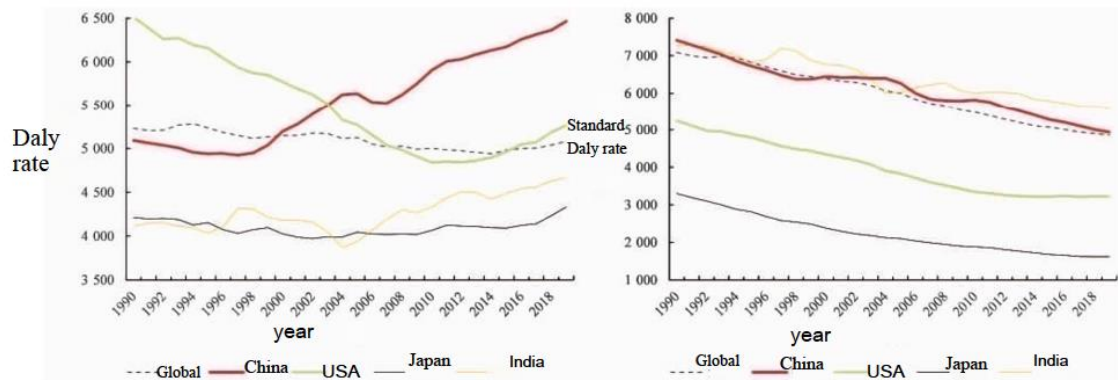
### 3.2.3. Mortality

The mortality rate of CVD in the world, China, Japan and India all showed an upward trend. The mortality rate of CVD in China rose from 20,475/100,000 in 1990 to 32,230/100,000 in 2019, an increase of 5738%. During this period, the mortality rate in the United States generally showed a downward trend. After 2010, it increased slightly, from 34,686/100,000 in 1990 to 26,547/100,000 in 2010, and then slowly increased to 29,193/100,000 in 2019. Compared with the standardized mortality rate, the standardized mortality rates in the world, China, the United States, Japan and India decreased with time. China dropped from 38,121/100,000 in 1990 to 27,693/100,000 in 2019, but still higher than the world and the other three countries. The standardized mortality rates of the United States and Japan are both lower than the global average, and the two countries also experienced the largest decline during 1990–2019, with 4067% and 5931% respectively. Japan maintained the lowest standardized mortality rate during this period.

### 3.2.4. Daly rate

The global Daly rate of cardiovascular disease decreased by 287% from 1990 to 2019, of which the United States decreased from 651,028/100,000 in 1990 to 483,935/100,000 in 2010, and then increased to 526,466/100,000 in 2019, with an overall decrease of 1913%. The Daly rate of cardiovascular diseases in China increased significantly (up 2696%), from 509,103/100,000 in 1990 to 646,347/100,000 in 2019, while India and Japan only increased by 1360% and 285% respectively. After standardization, the age standardized Daly rates in the world and the four countries showed a downward trend. As developed countries, Japan and the United States performed best, and the standardized Daly rate decreased by 5090% and 3850% respectively

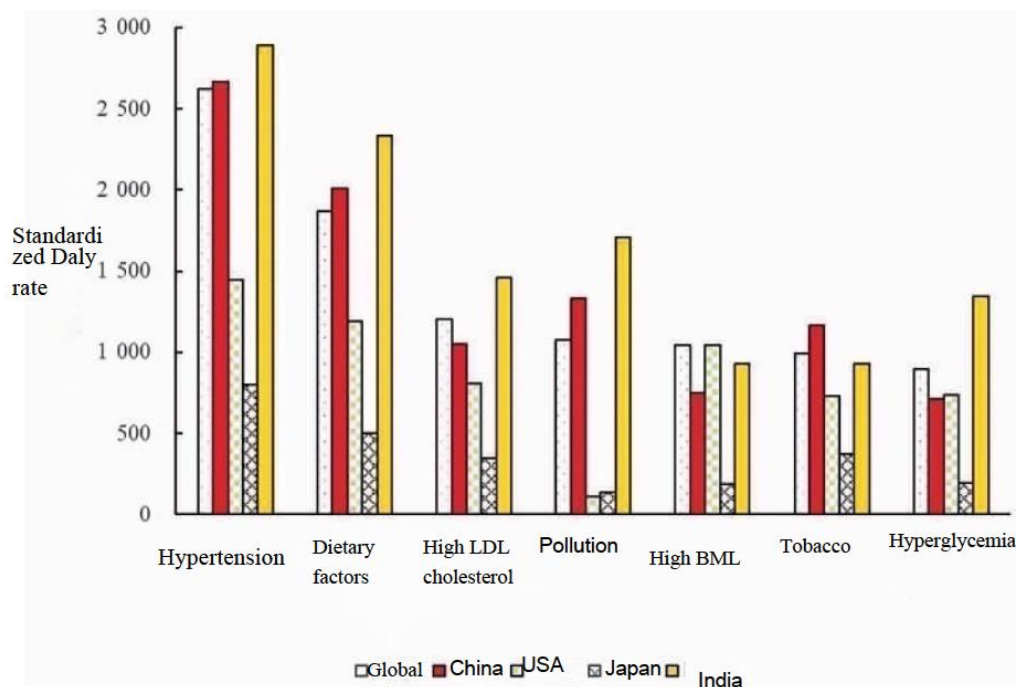
from 1990 to 2019. In 2019, China’s standardized DALY rate was 493,838/100,000, which was close to the global average (486,364/100,000), and slightly higher than the global average in the past 10 years (**Figure 2**).



**Figure 2.** Trends in DALY rate (left) and age-standardized DALY rate (right) of cardiovascular diseases in the world, China, the USA, Japan and India from 1990 To 2019.

### 3.2.5. Risk factors

In 2019, the standardized DALY rates of risk factors for cardiovascular diseases in China are hypertension, dietary factors, air pollution, tobacco, high LDL cholesterol, high BMI and high blood sugar. Hypertension and dietary factors are the top two risk factors in the world and in China, the United States, Japan and India. As a developing country, air pollution and tobacco are still important risk factors for cardiovascular disease in China. In 2019, the standardized DALY rates of air pollution and tobacco in China were 132,887/100,000 and 116,372/100,000 respectively, much higher than those in the United States and Japan; in developed countries such as the United States and Japan, the disease burden of cardiovascular disease caused by metabolic related factors such as high BMI, high LDL cholesterol and high blood glucose is relatively heavy. In particular, the standardized DALY rate of high BMI and high blood glucose in the United States in 2019 exceeded that in China, which were 104,759/100,000 and 73,933/100,000 respectively (**Figure 3**).



**Figure 3.** Main risk factors of cardiovascular diseases in the world, China, the USA, Japan and India in 2019.

## **4. Discussion**

In terms of morbidity, incidence rate, mortality and Daly, the burden of CVD disease in China will be higher than that in the world in 2019; from 1990 to 2019, the change steepness of the four indicators of CVD in China was also much higher than that in the world, especially in the past 10 years. It fully shows that the disease burden of CVD in China is still very serious, which should be paid great attention by relevant departments. The specific characteristics of CVD are as follows:

### **4.1. Gender differences**

Although the prevalence and incidence rate of CVD in women were higher than that in men, the mortality and Daly rates in women were lower than those in men. This may be related to the differences in physiological characteristics, eating habits, work types and lifestyle between the sexes<sup>[4]</sup>. Estrogen can prevent the deterioration of CVD in women. Consistent with previous reports, the differences in mortality and Daly rates between men and women gradually decrease with age<sup>[5]</sup>.

### **4.2. Age differences**

The older the age, the heavier the burden of CVD. With the increase of age, the prevalence, incidence rate, mortality and Daly rate of CVD increased, especially in people over 60 years old. Since China entered an aging society in 2000, by 2019, the number of people aged 65 and above will reach 16.5 billion, and the population aged 80 and above will reach 26 million. The United Nations Population Development Programme predicts that by 2050, China's elderly population over the age of 65 will reach 33.4 billion<sup>[6]</sup>. The increase of elderly CVD cases caused by aging and other chronic comorbidities of elderly cases have brought great challenges to the prevention and treatment of CVD<sup>[7]</sup>. After eliminating the influence of age composition, the standardized mortality rate and standardized Daly rate of Japan and the United States decreased rapidly due to the large elderly population. The aging in China has become more and more serious in the past 10 years. Although the non standardized Daly rate is significantly higher than that in the world, the age standardized Daly rate is close to that in the world.

### **4.3. Risk factors**

The main risk factors of CVD in China are hypertension, dietary factors, air pollution, tobacco, high LDL cholesterol, high BMI and high blood sugar. Hypertension is the first risk factor for CVD in China, and its prevalence has continued to increase in recent decades. Studies have shown that 889% of patients with hypertension have more than one risk factor for other cardiovascular diseases<sup>[8,9]</sup>. At the same time, the prevalence of other metabolic factors such as hyperlipidemia, obesity and diabetes is also rising. The 2015 nutrition survey shows that compared with 2002, the levels of total cholesterol (TC), triglyceride (TG) and low density lipoprotein cholesterol (LDL C) of Chinese residents are significantly higher<sup>[10,11]</sup>; the prevalence of diabetes among Chinese adults was 97% in 2010, 104% in 2013 and 128% in 2017<sup>[12,13]</sup>, and there are a large number of undiagnosed or untreated patients with hypertension, high cholesterol and diabetes<sup>[14]</sup>; the nutrition survey in 2020 found that the overweight and obesity rate of Chinese adults has exceeded 50%<sup>[15]</sup>.

Dietary factors are also one of the important risk factors for CVD disease burden in China<sup>[16]</sup>. The report on nutrition and chronic diseases of Chinese residents (2020) shows that the unhealthy lifestyle of Chinese residents, more salt and oil, and less intake of fruits and beans are still common<sup>[15]</sup>. Although the four national nutrition surveys from 1982 to 2012 showed that the proportion of dietary factors to the mortality of cardiovascular diseases in Chinese adults has decreased, with the growth of the total population and the aging of the population, the number of deaths from cardiovascular metabolic diseases caused by unhealthy diet is still gradually increasing<sup>[17]</sup>.

As the third risk factor of CVD disease burden in China, air pollution can increase the risk of cardiovascular death through inflammatory response, oxidative stress response and thrombosis<sup>[18]</sup>; at the same time, air pollution is associated with some CVD risk factors. A cohort study shows that long-term PM<sub>2.5</sub> exposure is related to the increased risk of hypertension and diabetes in Chinese adults. Every 10% increase in PM concentration  $\mu\text{G}/\text{m}^3$ , the risk of hypertension and diabetes increased by 11% and 16% respectively<sup>[19,20]</sup>. Although the average concentrations of PM<sub>2.5</sub> and PM<sub>10</sub> in cities at and above the prefecture level nationwide in 2017 decreased compared with 2013, the regional differences caused by China's geographical environmental factors and socio-economic factors still need to be paid attention to.

Although the smoking rate of Chinese people over the age of 15 decreased from 281% in 2010 to 266% in 2018, and the exposure rate of second-hand smoke decreased from 724% in 2010 to 681%<sup>[11]</sup>, China accounted for 229% of the 133.7 billion smokers in the world in 2018, and the huge smoking population is still an important challenge for China's cardiovascular disease prevention and control. Tobacco is the fourth risk factor of CVD disease burden in China.

The burden of CVD diseases in China is still very serious. It is necessary to thoroughly implement the outline of the "healthy China 2030" plan and improve the three-level prevention of cardiovascular diseases. Further improve the CVD treatment process, effectively improve the treatment efficiency, and reduce the incidence and mortality of CVD in the hospital. Advocate and promote healthy lifestyles, improve public health literacy, focus on strengthening lifestyle guidance such as reasonable diet, moderate exercise, smoking cessation and alcohol restriction, and psychological balance, so as to reduce the risk factors of cardiovascular diseases such as hypertension, hyperlipidemia and hyperglycemia, and finally achieve the purpose of preventing and controlling CVD and improve the overall health level of Chinese residents.

## Conflict of interest

The authors declare no conflict of interest.

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