# Key Points Interpretation of the "China Cardiovascular Health and Disease Report 2024": Postprint

**Authors:** Liu Mingbo, He Xinye, Yang Xiaohong, Wang Zengwu, Wang Zengwu

**Date:** 2025-08-11T15:48:27+00:00

## Abstract

Cardiovascular diseases (CVD) and their risk factors are exerting an increasingly significant impact on population health, with the incidence of CVD continuing to rise. The economic burden imposed by CVD on both the population and society is growing heavier, constituting a major public health problem, and there is an urgent need to strengthen government-led CVD prevention and control efforts. This article provides an interpretation of the key points from the newly published "China Cardiovascular Health and Disease Report 2024", aiming to provide a scientific basis for CVD prevention and control and the formulation of related policies.

## Full Text

### Interpretation of Report on Cardiovascular Health and Diseases in China 2024

**LIU Mingbo, HE Xinye, YANG Xiaohong, WANG Zengwu***

National Center for Cardiovascular Diseases/Fuwai Hospital, Chinese Academy of Medical Sciences, Beijing 100037, China

*Corresponding author: WANG Zengwu, Chief physician/Professor; E-mail: wangzengwu@foxmail.com

**Abstract** Cardiovascular diseases (CVD) and their risk factors are exerting an increasingly significant impact on public health, with CVD incidence rates continuing to rise. The economic burden on both individuals and society is mounting, making CVD a major public health challenge that urgently requires strengthened government-led prevention and control efforts. This article provides an interpretation of key findings from the newly published *Annual Report*

*on Cardiovascular Health and Diseases in China (2024)*, aiming to offer scientific evidence for CVD prevention, treatment, and policy formulation.

[**Key words**] Cardiovascular diseases; Epidemiology; Burden of disease; Risk factors; Prevalence; Mortality; Rehabilitation; Basic research; Medical device development; Expense

## Introduction

With socioeconomic development and changing lifestyles, particularly accelerated population aging and urbanization, unhealthy lifestyle patterns have become increasingly prominent among Chinese residents. The impact of CVD risk factors on public health has grown more significant, with CVD prevalence continuing to rise. The resulting economic burden on individuals and society has become substantial, establishing CVD as a critical public health priority that demands urgent strengthening of government-led prevention and control initiatives. Since 2005, the National Center for Cardiovascular Diseases has organized national experts to compile the *Annual Report on Cardiovascular Health and Diseases in China* each year, with 2024 marking the 20th anniversary of this publication. Over the past two decades, as a frontier information source for CVD prevention and treatment, the report has embodied the diligent efforts of generations of expert reviewers, authors, and publishers, validating the foresight of CVD medicine leaders while demonstrating significant value in China's CVD prevention and treatment development.

### 1.1.1 CVD Incidence

According to Global Burden of Disease (GBD) study data, China's total CVD cases, incidence rate, and age-standardized incidence rate increased from 5.3007 million cases, 447.81/100,000, and 646.20/100,000 in 1990 to 12.3411 million cases, 867.65/100,000, and 652.21/100,000 in 2019, respectively. From 1990 to 2019, the overall age-standardized incidence of CVD among Chinese residents showed an upward trend, with predicted incidence, mortality, and disability-adjusted life year (DALY) rates all projected to continue rising from 2020 to 2030.

From January to December 2023, data analysis from 262 monitoring sites across 30 provinces, autonomous regions, municipalities, and the Xinjiang Production and Construction Corps under the "Chinese Residents' Cardiovascular and Cerebrovascular Event Surveillance" project revealed that the crude incidence rate of cardiovascular and cerebrovascular diseases (including acute myocardial infarction [AMI], angina undergoing percutaneous transluminal coronary angioplasty [PTCA]/stent implantation and/or coronary artery bypass grafting [CABG], stroke, and sudden cardiac death) among Chinese residents aged 18 years and older was 620.33/100,000 (age-standardized rate: 635.81/100,000). The incidence rate was higher in males (crude rate: 717.36/100,000; standardized rate:

738.49/100,000) than in females (crude rate: 519.64/100,000; standardized rate: 530.61/100,000) [Figure 1: see original paper]. Cardiovascular and cerebrovascular disease incidence increased rapidly with age [Figure 2: see original paper].

### 1.1.2 CVD Mortality

In 2021, CVD mortality remained the leading cause of death, surpassing cancer and other diseases [FIGURE:3, FIGURE:4]. CVD accounted for the highest proportion of disease-related deaths in both urban and rural areas, representing 48.98% of major disease deaths in rural areas and 47.35% in urban areas [FIGURE:6, FIGURE:7]. Rural CVD mortality has exceeded urban levels since 2009. In 2021, the crude CVD mortality rate was 364.16/100,000 in rural areas (including 188.58/100,000 from heart disease) and 305.39/100,000 in urban areas (including 165.37/100,000 from heart disease), with higher rates in rural than urban areas. Male coronary heart disease mortality exceeded female mortality in both urban and rural settings.

According to National Mortality Surveillance System (NMSS) data, China's age-standardized mortality rate (ASMR) for CVD decreased from 286.85/100,000 in 2005 to 245.39/100,000 in 2020, with male ASMR consistently higher than female across all survey years [Figure 8: see original paper]. The burden of premature CVD death decreased by 19.27% in 2020 compared with 2005, though it remains at a high level. While CVD deaths increased by 48.06% from 2015 to 2020, primarily due to population aging and secondarily to population growth. In 2020, ischemic heart disease, cerebral hemorrhage, and cerebral infarction were the three leading causes of CVD death. Among individuals aged 15-50 years, ischemic heart disease accounted for 50%-60% of premature CVD mortality burden. Substantial regional variations exist in CVD deaths and ASMR, with economically developed regions generally showing lower rates than less developed areas.

### 1.1.3 Coronary Heart Disease

**Prevalence:** The "Chinese Residents' Cardiovascular Disease and Risk Factor Surveillance" project surveyed 262 monitoring sites across 31 provinces, autonomous regions, and municipalities from 2020-2022, with preliminary results showing a coronary heart disease prevalence of 758/100,000 among residents aged 18 years and older (including AMI, stent implantation, CABG, and hospitalization for unstable angina). Prevalence was higher in males (940/100,000) than females (570/100,000) and higher in urban areas (892/100,000) than rural areas (639/100,000). Coronary heart disease prevalence increased rapidly with age [Figure 9: see original paper].

**Incidence:** From January to December 2023, data from 262 monitoring sites revealed that among residents aged 18 years and older, the crude incidence of AMI was 87.6/100,000 (age-standardized rate: 93.9/100,000), with higher rates in males (113.3/100,000) than females (60.9/100,000). AMI incidence increased

sharply with age [FIGURE:10, FIGURE:11].

**Mortality:** According to the *China Health Statistics Yearbook 2022*, the crude coronary heart disease mortality rate in 2021 was 135.08/100,000 in urban areas and 148.19/100,000 in rural areas, with male mortality exceeding female mortality in both settings [Figure 12: see original paper]. Coronary heart disease mortality has continued rising since 2012, with rural areas showing a more pronounced increase and surpassing urban levels by 2016 [Figure 13: see original paper]. AMI mortality showed an overall upward trend from 2002-2021, with a rapid increase beginning in 2005. Rural AMI mortality exceeded urban levels in 2007, 2009, 2010, and 2011, and has been consistently higher since 2013 [Figure 14: see original paper].

### 1.1.4 Cerebrovascular Disease

**Prevalence:** GBD 2021 results show that in 2021, China had 26.34 million stroke patients, a 145.4% increase from 1990. Among stroke subtypes, cerebral infarction showed the largest increase in prevalence (216.3%), followed by cerebral hemorrhage (40.8%) and subarachnoid hemorrhage (19.8%). The age-standardized stroke prevalence rate was 1,301.4/100,000 in 2021 (ischemic stroke: 1,018.8/100,000; cerebral hemorrhage: 222.1/100,000; subarachnoid hemorrhage: 68.9/100,000). Compared with 1990, the age-standardized stroke prevalence increased by 11.5%, with ischemic stroke rising 34.2% while cerebral hemorrhage and subarachnoid hemorrhage decreased by 28.0% and 36.2%, respectively.

**Incidence:** GBD 2021 showed 4.09 million new stroke cases in 2021, a 142.6% increase from 1990. Cerebral infarction showed the largest increase in incidence (264.2%), followed by cerebral hemorrhage (51.6%), while subarachnoid hemorrhage decreased by 3.6%. The age-standardized stroke incidence rate was 204.8/100,000 in 2021 (ischemic stroke: 135.8/100,000; cerebral hemorrhage: 61.8/100,000; subarachnoid hemorrhage: 7.8/100,000). Compared with 1990, age-standardized stroke incidence decreased by 9.8%, with cerebral hemorrhage and subarachnoid hemorrhage declining 43.9% and 56.5%, respectively, while ischemic stroke increased by 35.7%.

From January to December 2023, surveillance data from 262 monitoring sites showed that stroke incidence among residents aged 18 years and older was 491.0/100,000 (age-standardized rate: 513.3/100,000), with higher rates in males (551.8/100,000) than females (427.9/100,000). Stroke incidence increased with age [FIGURE:15, FIGURE:16].

**Mortality:** According to the *China Health Statistics Yearbook 2022*, the crude cerebrovascular disease mortality rate among urban residents in 2021 was 140.02/100,000, accounting for 21.71% of total urban deaths and ranking as the third leading cause of death. In rural areas, the crude mortality rate was 175.58/100,000, representing 23.62% of total rural deaths and ranking as the second leading cause. Cerebrovascular disease mortality was higher in males

than females and in rural than urban areas [Figure 17: see original paper]. Both urban and rural mortality rates increased with age, with male mortality exceeding female mortality across all age groups, showing an approximately exponential increase [FIGURE:18, FIGURE:19].

### 1.3 Dietary Nutrition

National nutrition survey data from 1982 to 2015-2017 show that Chinese residents' major food intake trends include decreasing consumption of grains and vegetables, declining whole grain and tuber intake; unreasonable animal food structure with excessive intake of red meat (especially pork) and insufficient intake of poultry and aquatic products; persistently low intake of fruits, eggs, dairy, and soybeans, falling short of recommended amounts. Cooking oil intake continues to increase, and although household cooking salt has decreased, intake of cooking oil (43.2 g/day) and salt (9.3 g/day) in 2015-2017 remained far above recommended levels.

The *Report on Nutrition and Chronic Diseases Among Chinese Residents (2020)* indicates that Chinese residents have adequate total energy supply, with average daily energy intake of 2,007.4 kcal, showing a downward long-term trend. Carbohydrate energy contribution has decreased significantly, while fat energy contribution has risen continuously, exceeding the recommended upper limit of 30% in urban residents since 2002 and reaching 33.2% in rural residents in 2015-2017. Based on China Health and Nutrition Survey (CHNS) and 2022-2023 survey data from 10 provinces, energy intake decreased slightly from 2018 to 2022-2023, while fat energy contribution further increased to an average of 40.08%, carbohydrate contribution decreased to 44.06%, and protein contribution remained stable at 13.02%. In 2020, fat energy contribution among Chinese children aged 6-17 reached 33.7%.

### 1.4 Physical Activity

In 2020, the moderate-to-vigorous physical activity compliance rate among children aged 3-6 was 62.3%, higher in urban (63.1%) than rural (58.6%) areas, with screen time compliance at 52.8%. Among primary and secondary school students in 2016, 85.2% had $ $2 physical education classes per week and 31.5% had $ $5 extracurricular sports sessions per week, while 23.7%, 27.7%, and 17.5% spent $ $2 hours on weekend television, mobile phone, and computer use, respectively. Activity compliance rates among primary and middle school students were higher in 2017 than 2016 but decreased significantly from 2017 to 2019 (32.61% vs 25.33% for primary students; 28.15% vs 17.61% for middle school students), while screen time compliance <2 hours also decreased significantly (86.47% vs 80.55%). In 2019, the proportion engaging in muscle strength exercise $ $3 times/week reached 39.3%.

### 1.5 Overweight and Obesity

Multiple survey results from the China Nutrition and Health Surveillance (CNHS), China Chronic Disease and Risk Factor Surveillance (CCDRFS), CHNS, and National Student Physical Fitness and Health Surveys consistently show that despite variations by gender, age, and region, overweight and obesity rates among Chinese residents continue to rise, with faster growth in rural than urban areas.

The "13th Five-Year National Science and Technology Basic Resources Survey Special Project—Systematic Survey and Application of Nutrition and Health of Chinese Children Aged 0-18" surveyed 105,000 children across 7 regions, revealing that in 2020, the overweight/obesity rate among children aged 0-5 was 7.8% (overweight: 5.7%; obesity: 2.1%), higher in rural than urban areas and in boys than girls. Among children and adolescents aged 6-17, the rate was 26.5% (overweight: 14.5%; obesity: 12.0%), higher in urban than rural areas and in boys than girls.

The *Report on Nutrition and Chronic Disease Status Among Chinese Residents (2020)* shows that among adults aged 18 and older, the overweight rate was 34.3% and obesity rate 16.4%, representing increases of 4.2 and 4.5 percentage points, respectively, compared with 2012. The "Chinese Residents' Cardiovascular Disease and Risk Factor Surveillance" project surveyed 293,022 individuals across 262 monitoring sites from 2020-2022, with preliminary results showing overweight, obesity, and central obesity rates of 34.6%, 17.8%, and 34.9%, respectively. Obesity prevalence was higher in males (20.5%) than females (15.0%) and in rural (18.7%) than urban (16.7%) areas. Both overweight and obesity rates increased initially then decreased with age [Figure 21: see original paper].

### 1.6 Hypertension

Nationwide hypertension prevalence surveys from 1958-2022 indicate an overall upward trend. The "Chinese Residents' Cardiovascular Disease and Risk Factor Surveillance" project surveyed 298,438 individuals across 262 monitoring sites from 2020-2022, showing a hypertension prevalence of 31.6% among residents aged 18 and older, higher in males (36.8%) than females (26.3%) and in rural (33.7%) than urban (29.1%) areas. Hypertension prevalence increased rapidly with age.

A prospective cohort study of 12,952 Chinese adults aged 18+ from CHNS showed that the age-standardized hypertension incidence increased from 40.8/1,000 person-years in 1993-1997 to 48.6/1,000 person-years in 2011-2015.

Multiple nationwide surveys demonstrate rising awareness, treatment, and control rates for hypertension. CCDRFS data from six national surveys show increasing trends in awareness, treatment, and control among adults aged 18-69 from 2004-2018 [Figure 22: see original paper]. The 2020-2022 surveillance project showed awareness, treatment, and control rates of 43.3%, 38.7%, and

12.9%, respectively.

### 1.7 Dyslipidemia

The "Chinese Residents' Cardiovascular Disease and Risk Factor Surveillance" project surveyed 275,961 individuals across 262 monitoring sites from 2020-2022, showing mean total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) levels of 185.8 mg/dl, 141.0 mg/dl, 50.7 mg/dl, and 110.7 mg/dl, respectively. Male TG levels were higher than female levels [Figure 23: see original paper].

Defining dyslipidemia as abnormal lipid levels (TC $\geq$ 551.71 mg/dl, LDL-C $\geq$ 160.22 mg/dl, HDL-C $<$ 40.25 mg/dl, TG $\geq$ 87.46 mg/dl) or current lipid-lowering medication use, surveys including CHNS 2002, CNSCKD 2010, CHNS 2011, and the 2012 China Nutrition and Chronic Disease Survey show sharply rising dyslipidemia prevalence among adults aged $ $18. CHS 2012-2015 and ChinaHEART 2014-2019 surveys of adults aged $ $35 show similar prevalence rates [Figure 24: see original paper].

The 2020-2022 surveillance project showed a dyslipidemia prevalence of 38.1% among adults aged 18+, higher in males (46.1%) than females (29.6%) and in urban (38.9%) than rural (37.4%) areas. Prevalence initially increased then decreased with age [Figure 25: see original paper].

### 1.8 Diabetes

The "China Chronic Disease and Risk Factor Survey" conducted cross-sectional studies of 170,287 adults in 2013-2014 and 173,642 adults in 2018-2019, showing diabetes prevalence increased from 10.9% (95%CI=10.4%-11.5%) to 12.4% (95%CI=11.8%-13.0%) based on ADA diagnostic criteria. Pre-diabetes prevalence increased from 35.7% (95%CI=34.2%-37.3%) to 38.1% (95%CI=36.4%-39.7%). In 2018, diabetes awareness, treatment, and control rates were 36.7% (95%CI=34.7%-38.6%), 32.9% (95%CI=30.9%-34.8%), and 50.1% (95%CI=47.5%-52.6%), respectively, with little change compared with 2013. From 2013-2018, diabetes and prediabetes prevalence increased significantly in rural areas.

### 1.9 Chronic Kidney Disease

With economic development and social changes, both CKD prevalence and etiology spectrum have shifted in China, with preventable and treatable diabetes, hypertension, and urinary obstruction becoming dominant factors. In 2011, diabetic kidney disease surpassed chronic glomerulonephritis as the leading cause of CKD among tertiary hospital inpatients. According to the China Kidney Disease Network (CK-NET) annual report, diabetic nephropathy, hypertensive nephropathy, and obstructive nephropathy accounted for 26.7%, 21.4%, and 16.0% of tertiary hospital inpatients, respectively, all exceeding chronic glomerulonephritis (14.4%).

Data from the "Sixth National Chronic Disease and Risk Factor Surveillance" (August 2018-June 2019) showed that among 176,874 adults aged $ $18 from 31 provinces, albuminuria and impaired kidney function prevalence were 6.7% and 2.2%, respectively, with total CKD prevalence at 8.2%, down from 10.8% in 2009-2010. CKD prevalence was higher among older individuals, females, non-Han ethnicities, rural residents, those living in northern and central China, those with lower education or income, former smokers, non-drinkers, those with insufficient physical activity, and those with obesity, hypertension, diabetes, dyslipidemia, or self-reported CVD.

The "ChinaHEART" project screened morning urine albumin-creatinine ratio (UACR) in 269,026 adults aged $ $35 from 2015-2019, showing albuminuria (UACR $ $30 mg/g) prevalence of 8.75%, with 7.38% having 30-300 mg/g and 1.37% having $ $300 mg/g. Albuminuria prevalence increased with age, decreased income and education, was higher in females than males (age-standardized prevalence: 8.33% vs 7.27%), slightly higher in rural than urban areas, and higher among those with hypertension, diabetes, hyperlipidemia, BMI $ $24kg/m\^{}\{2\}$ or <18.5 kg/m$^2$, while lower among those with healthy diets and adequate activity. Regional variations existed, with the highest age- and sex-standardized prevalence in Central China [9.35% (95%CI=9.01%-9.71%)], followed by Southwest [8.95% (95%CI=8.69%-9.23%)] and East China [8.16% (95%CI=7.95%-8.38%)], and lowest in South China [5.98% (95%CI=5.67%-6.30%)].

### 1.11 Environmental Factors

GBD studies show that the top two environmental factors affecting Chinese population health are air pollution and non-optimal temperature. Non-optimal temperature ranked 8th among risk factors for disease burden in both 2013 and 2021, with over 400,000 excess CVD deaths attributed to non-optimal temperature in 2021. Air pollution dropped from 1st in 2013 to 3rd in 2021 among risk factors, with excess deaths declining but remaining high at 1.467 million, including 1.21 million CVD deaths related to ambient particulate matter pollution. China has achieved some improvements in air quality, but health impacts remain significant.

The *China Ecological Environment Status Bulletin* shows that among 339 prefecture-level cities in 2023, 203 (59.9%) achieved ambient air quality standards. All six major air pollutants (PM2.5, PM10, SO2, NO2, CO, O3) decreased from 2022 levels [Figure 26: see original paper]. PM2.5 remained the primary pollutant on 40.1% of 超标 days. The national average PM2.5 concentration was 30 g/m$^3$, up 3.4% from 2022. Satellite remote sensing assessment of high-resolution (1 km$×$1 km) outdoor PM2.5 concentrations from 2000-2016 showed the most severe pollution in the Beijing-Tianjin-Hebei region.

### 2.1 Hypertension

HQMS data show that in 2023, 6,748 hospitals treated hospitalized hypertension patients (aged $ 18*years with hypertension as primary or other diagnosis*), *representing* 83.1±16.7) *years*, *with fe* years, with females at 47.2% [Figure 27: see original paper]. The top three comorbidities were coronary heart disease (30.6%), cerebrovascular disease (30.5%), and diabetes (25.8%) [Figure 28: see original paper]. Secondary hypertension accounted for 99,400 cases (2.0% of hypertension inpatients), with renal parenchymal hypertension, obstructive sleep apnea syndrome, and renovascular hypertension as the top three causes (41.3%, 28.8%, and 11.0%, respectively). The inpatient mortality rate for primary hypertension diagnosis was 0.1%, with non-recovery discharge rate at 3.8%.

### 2.2 Coronary Heart Disease

HQMS data show that in 2023, 6,581 hospitals treated hospitalized coronary heart disease patients (aged $ $18 years), representing 81.1% of CVD inpatient hospitals (2,169 tertiary and 4,412 secondary hospitals). These hospitals admitted 8.368 million coronary heart disease inpatients (5.677 million to tertiary and 2.691 million to secondary hospitals). The average age was 66.5 years, with females comprising 43.0%; 77.8% were aged 55-84 years and 16.7% were <55 years [Figure 29: see original paper]. Hypertension was the most common comorbidity (61.3%), followed by type 2 diabetes (27.5%). The top three primary discharge diagnoses were unstable angina (40.0%), unclassified coronary heart disease (29.0%), and stable angina (15.1%) [Figure 30: see original paper].

In 2023, 1.222 million AMI inpatients were admitted, with ST-elevation myocardial infarction (STEMI) accounting for 46.7%, non-ST-elevation myocardial infarction (NSTEMI) 43.1%, and unclassified AMI 10.2%. AMI inpatient mortality was 4.0% (3.3% male, 5.5% female), with non-recovery discharge rates of 12.8% (11.6% male, 15.9% female). Coronary intervention was performed in 1.901 million patients (22.7% of coronary heart disease inpatients), and 2.029 million underwent coronary angiography alone (24.2%). The average age of patients undergoing coronary intervention was 63.3 years, with females at 28.6%; 78.7% were aged 45-74 years and 15.6% were $ $75 years. Percutaneous coronary intervention (PCI) was the most common procedure (68.8%), followed by percutaneous transluminal coronary angioplasty (5.7%) [Figure 31: see original paper].

In 2023, 654 hospitals performed at least one CABG, with 61,000 isolated CABG procedures. The top three provinces accounted for 52% of national CABG volume. The ratio of coronary interventions to CABG was 31.4:1 [Figure 32: see original paper]. CABG patients had a mean age of (62.2$±$8.9) years, with 75.3% aged 55-74 years and 8.0% $ $75 years.

### 2.3 Arrhythmia

HQMS data show that in 2023, 7,583 hospitals provided arrhythmia diagnosis and treatment services (93.4% of CVD hospitals), including 2,485 tertiary (32.8%) and 5,098 secondary (67.2%) hospitals. These hospitals treated 11.132 million arrhythmia inpatients, with the top three conditions being atrial tachycardia/atrial flutter/atrial fibrillation (37.84%), atrial premature contractions (18.11%), and ventricular premature contractions (17.10%) [Figure 33: see original paper]. Atrial arrhythmias accounted for 55.9% of cases, reflecting population aging.

In 2023, 342,000 arrhythmia ablation procedures were performed (3.1% of arrhythmia inpatients), including 34,000 left atrial appendage closures and 166,000 device implantations (100,000 dual-chamber pacemakers, 21,000 single-chamber pacemakers, 25,000 unspecified pacemakers, 10,000 implantable cardioverter-defibrillators [ICDs], 5,755 cardiac resynchronization therapy defibrillators [CRT-D], and 3,727 cardiac resynchronization therapy [CRT] devices) [Figure 34: see original paper]. Pacemakers accounted for over three-quarters of device implantations. The "ablation plus closure" one-stop procedure showed the highest inpatient mortality, non-recovery discharge, and 30-day readmission rates, followed by left atrial appendage closure, while catheter ablation showed the lowest rates. Syncope hospitalizations reached nearly 220,000 cases, with 49.9% having unclear etiology and only 20% diagnosed as vasovagal syncope, indicating need for improved diagnostic coding and clinical management.

### 2.4 Valvular Heart Disease

HQMS data show that in 2023, 6,794 hospitals treated valvular heart disease inpatients (83.7% of CVD hospitals), including 2,402 tertiary and 4,392 secondary hospitals. These hospitals admitted 2.661 million valvular heart disease patients, with mitral valve disease being most common (1.339 million cases, 50.3%), followed by aortic, tricuspid, and pulmonary valve diseases [Figure 35: see original paper]. In 2023, 9,928 isolated surgical aortic valve replacement (SAVR) procedures were performed, with bioprosthetic valve use at 46.8%, more common in elderly patients. Transcatheter aortic valve replacement (TAVR) was performed in 9,629 cases, approaching SAVR volume [Figure 36: see original paper], with females comprising 41.5%.

In 2023, 28,000 isolated mitral valve surgeries were performed (32.4% repair, 67.6% replacement). The proportion of repair procedures decreased with age while replacement increased (78.0% repair for age <18 years vs 38.9% for age >85 years). Bioprosthetic valve use in mitral valve replacement was 45.6%, with mechanical valve use decreasing with age (92.8% mechanical for age <18 years vs ~0% for age >85 years). In 2023, 3,019 mitral valve interventions were performed, with mitral valve clipping accounting for 49.7% [Figure 37: see original paper].

Right-sided valve surgery totaled 45,000 cases in 2023, mostly combined proce-

dures. Patients >45 years accounted for 77.6%, with males comprising 45.4%. The non-recovery discharge rate was 3.1%, significantly decreased from 2022. Right-sided valve interventions numbered 165 cases, with females at 62.4%, inpatient mortality 0.6%, and non-recovery discharge rate 0.6%. Pulmonary valve procedures totaled 1,307 cases (53.1% aged <18 years, 44.9% male), with non-recovery discharge rate of 2.4%, significantly decreased from 2022.

### 2.5 Heart Failure

HQMS data show that in 2023, 7,374 hospitals treated heart failure inpatients (90.8% of CVD hospitals), including 2,415 tertiary and 4,959 secondary hospitals. These hospitals admitted 14.29 million heart failure inpatients (59.2% to tertiary, 40.8% to secondary hospitals), with 27.9% admitted through emergency, 69.2% through outpatient, and 2.9% through other routes. The average age was (71.2$±$12.6) years, with females comprising 45.3% [Figure 38: see original paper]. Comorbidities included coronary heart disease (68.7%), hypertension (58.9%), atrial fibrillation/flutter (19.8%), cardiomyopathy (2.9%), cardiogenic shock (1.1%), stroke (40.5%), COPD (28.2%), and diabetes (27.0%). The non-recovery discharge rate was 10.2% (inpatient mortality: 2.6%; non-medical discharge: 7.6%), with 30-day readmission rate of 11.0%.

Since the first long-term left ventricular assist device (LVAD) implantation in June 2017, 908 LVAD procedures have been performed in 132 hospitals through May 2024 [Figure 39: see original paper]. Of these, 27 (3.0%) transitioned to heart transplantation, 19 (2.1%) had device removal due to cardiac recovery, 133 died during long-term follow-up, with longest pump support of 26.9 years and average support duration of 1.02 years. Fuwai Hospital completed 140 implants using three devices (21 EVAHEART, 75 CH-VAD, 44 CorHeart6). CH-VAD is China's first fully magnetically levitated LVAD.

Heart transplantation remains the most effective treatment for end-stage cardiomyopathy. According to the China Heart Transplant Registry, 5,208 heart transplants were performed and reported from 2015-2023 [Figure 40: see original paper].

### 2.6 Congenital Heart Disease

HQMS data show that in 2023, 4,239 hospitals treated congenital heart disease patients (52.9% of CVD hospitals), including 1,974 tertiary (77.4% of all tertiary hospitals) and 2,265 secondary (40.7% of all secondary hospitals) hospitals. These hospitals admitted 2.024 million inpatients with congenital heart disease diagnoses, including 339,000 with primary diagnosis. Among primary diagnoses, atrial septal defect accounted for 41.71%, ventricular septal defect 9.72%, patent ductus arteriosus 4.64%, aortic coarctation 1.01%, endocardial cushion defect 0.66%, and tetralogy of Fallot 0.86%. Neonates and infants (<1 year) accounted for 5.82% of congenital heart disease inpatients, children aged 1-17 years 19.76%, and adults ($ $18 years) 74.42%.

In 2023, 177,000 congenital heart disease patients underwent surgical or interventional treatment (47.3% of diagnosed patients), including 160,000 simple cases (90.4%) and 17,000 complex cases (9.6%). Surgical treatment was performed in 61,000 cases (34.2% of treated patients), with complex cases accounting for 26.8% of surgical patients. The age distribution of surgically treated patients showed children aged 1-17 years most common (45.42%), followed by adults (33.53%), with 1,378 neonatal surgeries performed [Figure 41: see original paper]. Adult congenital heart disease surgery (excluding mitral/aortic valve surgery) totaled 20,000 cases, with atrial septal defect repair comprising 49.86%.

In 2023, 117,000 congenital heart disease patients underwent interventional treatment, with patent foramen ovale closure most common (47.2% of interventional cases), followed by atrial septal defect, patent ductus arteriosus, ventricular septal defect, and pulmonary valve stenosis interventions [Figure 42: see original paper]. Among children undergoing intervention, atrial septal defect closure was most common (42.9%), while among adults, patent foramen ovale closure predominated (59.4%). The inpatient mortality rate for congenital heart disease interventions was 0.01%, with non-recovery discharge rate of 0.44% (0.67% for children, 0.35% for adults).

### 2.7 Aortic and Peripheral Vascular Diseases

**Aortic Diseases:** In 2023, 4,400 hospitals provided aortic disease services (50.2% of CVD hospitals), admitting 155,400 aortic disease inpatients aged $ 18*years.Aorticdissectionaccountedfor*47.4±$13.8) years, with females comprising 24.2%. Hypertension was present in 77.3% of aortic dissection patients. Open surgery was performed in 18.5% and no surgery in 47.0%. Inpatient mortality was 4.5%, with non-recovery discharge rate of 17.4%.

Aortic aneurysm services were provided by 2,606 hospitals (32.1% of CVD hospitals), admitting 41,000 inpatients (22.3% through emergency). The average age was (67.5$±$11.8) years, with females at 20.3%. Hypertension was present in 62.0%, with 48.9% receiving endovascular procedures, 13.8% open surgery, and 37.3% no surgery. Inpatient mortality was 0.5%, with non-recovery discharge rate of 6.9% (0.6% mortality and 2.0% non-recovery discharge for surgical patients).

**Peripheral Vascular Diseases:** In 2023, 4,077 hospitals provided carotid atherosclerotic stenosis/occlusion services (50.2% of CVD hospitals), and 5,426 hospitals provided lower extremity varicose vein services (66.8% of CVD hospitals). These hospitals admitted 224,000 carotid stenosis/occlusion patients (average age: 67.2$±$10.2 years; 29.6% female) and 381,000 lower extremity varicose vein patients. Postoperative inpatient mortality for carotid procedures was 0.5%, with non-recovery discharge rate of 3.0%.

### 2.8 Pulmonary Vascular Diseases

**Pulmonary Hypertension:** In 2023, 6,238 hospitals treated pulmonary hypertension inpatients, including 2,312 tertiary and 3,926 secondary hospitals. These hospitals admitted 1.638 million adult pulmonary hypertension inpatients (27.1% through emergency, 70.6% through outpatient). The distribution across clinical classifications was: Group 1 7.1%, Group 2 32.0%, Group 3 24.2%, Group 4 1.8%, and Group 5 4.5% [Figure 44: see original paper]. The average age was (67.5$±$18.7) years, with females comprising 49.1%. Group 1 patients were youngest with highest female proportion, while Groups 2 and 3 were predominantly elderly, and Group 3 was more common in males. Inpatient mortality was 1.6%, with non-recovery discharge rate of 9.6%.

**Venous Thromboembolism:** In 2023, 5,632 hospitals treated pulmonary embolism inpatients and 6,766 hospitals treated deep vein thrombosis inpatients. These hospitals admitted 337,000 pulmonary embolism inpatients (0.4% of CVD inpatients; 32.1% emergency, 65.8% outpatient) and 1.868 million deep vein thrombosis inpatients (2.2% of CVD inpatients). Surgical history was present in 56.3% of pulmonary embolism patients, 35.8% had concurrent deep vein thrombosis, and 23.3% had malignancy. Inpatient mortality was 5.7% for pulmonary embolism (non-recovery discharge: 15.5%) and 2.3% for deep vein thrombosis (non-recovery discharge: 10.3%).

### 2.9 Cardiomyopathy

In 2023, 6,411 hospitals treated cardiomyopathy inpatients (79.0% of CVD hospitals), including 4,065 secondary and 2,346 tertiary hospitals. These hospitals admitted 849,000 cardiomyopathy inpatients, with 197,000 having primary diagnosis. Dilated cardiomyopathy accounted for 62.0% and hypertrophic cardiomyopathy 24.2% [Figure 45: see original paper]. Females comprised 37.2% of cardiomyopathy inpatients, with variations by type: 36.2% for dilated, 39.9% for hypertrophic, 45.1% for restrictive, 40.6% for arrhythmogenic, and 40.6% for unclassified cardiomyopathy. Inpatient mortality was 0.9%, with non-recovery discharge rate of 6.2%.

### 2.10 Cardiac Rehabilitation

HQMS data show that in 2023, 3.503 million individuals were identified as post-coronary intervention (through procedure codes or diagnosis), with 366,000 (10.5%) receiving cardiac rehabilitation.

### 2.11 Obstructive Sleep Apnea

In 2023, 4,995 hospitals provided obstructive sleep apnea services (61.5% of CVD hospitals), with 1,302 (16.0%) performing overnight sleep monitoring and 2,257 (27.8%) providing non-invasive positive pressure ventilation. These hospitals admitted 363,000 CVD inpatients with obstructive sleep apnea (0.5% of CVD

inpatients), with 8.1% diagnosed through primary diagnosis and 91.9% through other diagnoses. The average age was (56.9$±$14.8) years, with females comprising 27.1%. The age group 55-64 years accounted for the highest proportion (24.9%). Top comorbidities were hypertension (78.6%), coronary heart disease (34.0%), heart failure (19.8%), and arrhythmia (19.7%) [Figure 46: see original paper].

### 2.12 Kidney Disease in CVD Patients

In 2023, 7,471, 5,951, 4,063, 1,840, and 3,388 hospitals could treat CVD (excluding cerebrovascular disease) with concurrent CKD, AKI, hemodialysis, peritoneal dialysis, and continuous renal replacement therapy (CRRT), respectively, representing 92.0%, 73.3%, 50.0%, 22.7%, and 41.7% of hospitals treating CVD patients. Among 82.74 million CVD inpatients in 2023, 9.866 million had concurrent CKD, 492,000 had concurrent AKI, 1.134 million received hemodialysis, 221,000 received peritoneal dialysis, and 280,000 received CRRT [Figure 47: see original paper]. CKD prevalence was 13.3% in male and 10.3% in female CVD inpatients; AKI prevalence was 0.7% in males and 0.5% in females. CVD inpatients with CKD had higher inpatient mortality (2.4% vs 0.7%), non-recovery discharge rate (10.3% vs 5.8%), and AKI incidence (1.4% vs 0.6%) than those without CKD. CVD inpatients with AKI had higher mortality (14.7% vs 0.8%), non-recovery discharge rate (35.0% vs 6.2%), and renal replacement therapy rate (17.2% vs 2.1%) than those without AKI.

### 2.13 Stroke

In 2023, 7,640 hospitals treated stroke inpatients (including 2,466 tertiary and 5,174 secondary hospitals). These hospitals admitted 16.638 million stroke inpatients, with cerebral infarction accounting for 94.0%. The primary diagnosis was stroke in 49.9% of cases. Average age was $(68.9\$\pm\$11.7) years, with cerebral infarction, cerebral hemorrhage, and subarachnoid hemorrhage patients averag
years, respectively [Figure 48: see original paper]. Cerebral infarction and hemorrhage were more common in males (55.0% and 63.5%), while subarachnoid hemorrhage was slightly more common in females (51.2%). Hypertension (66.5%), coronary heart disease (30.3%), and diabetes (27.7%) were the most common comorbidities. Inpatient mortality was 1.2%, with non-recovery discharge rate of 8.0%.

In 2023, 6,994 hospitals treated cardiac patients with cerebrovascular disease (90.1% of hospitals providing cardiac care), including 2,338 tertiary and 4,656 secondary hospitals. Among 24.567 million coronary heart disease inpatients, 21.1% had concurrent cerebrovascular disease. Among 4.803 million atrial fibrillation/flutter patients, 21.4% had concurrent cerebrovascular disease. Among 1.93 million PCI patients, 6.5% had concurrent cerebrovascular disease. Among 74,000 CABG patients, 10.7% had concurrent cerebrovascular disease. Cardiac patients with cerebrovascular disease had higher inpatient mortality and non-recovery discharge rates than those without.

### 3.1 CVD Basic Research

High-level CVD basic research in mainland China began around 2005, with increasing numbers of influential papers published in top-tier journals such as *Nature*, *Cell*, *Circulation*, *European Heart Journal*, *Circulation Research*, and *Signal Transduction and Targeted Therapy*. From 2023-2024, 206 basic research papers with corresponding and first authors from mainland China (including Hong Kong and Macau) focused on heart and vascular anatomy, development, function, and pathogenesis, covering myocardial infarction, heart failure, ischemia-reperfusion injury, arrhythmia, cardiomyopathy (hypertrophic, dilated, diabetic, viral myocarditis), cardiac remodeling (hypertrophy and fibrosis), aneurysm, atherosclerosis, hypertension, vascular aging, and vascular remodeling. Cardiac protection, regeneration, and gene therapy are hot research topics. High-quality publications are concentrated in economically developed regions (East China: Shanghai, Zhejiang, Jiangsu; North China: Beijing, Tianjin; South China: Guangdong), demonstrating close association between CVD research and rapid economic development.

### 3.2 CVD Clinical Research

CVD research in China has flourished in recent years, ranking second globally in publication volume after the United States, with growth rates exceeding the US since 2018. The most active subspecialties are coronary heart disease, hypertension, arrhythmia, and heart failure, with coronary heart disease and hypertension publications already surpassing US volumes. In 2023, 20 high-level CVD clinical research papers were published, covering coronary heart disease, hypertension, arrhythmia, heart failure, congenital heart disease, cardiomyopathy, and CVD risk factors, with hot topics including coronary heart disease, hypertension, and risk factor exploration and intervention.

### 3.3 CVD Medical Device Research

From July 20, 2023 to July 31, 2024, the National Medical Products Administration approved 74 innovative medical devices, including 36 cardiovascular products (48.6%), with 72 domestic original products (97.3%), demonstrating cardiovascular innovation's dominant position. Eleven devices received priority review, including one cardiovascular product. No Class III cardiovascular medical device clinical trial approvals were issued, indicating lower barriers to clinical trials. During the same period, 206 cardiovascular Class III medical device registrations were approved, including 178 domestic products, with two entering the national innovation review channel. The Yangtze River Delta, Pearl River Delta, and Beijing regions remain industrial clusters, accounting for nearly 80% of national certifications, with the Yangtze River Delta alone representing nearly 50%.

### 4.1 CVD Economic Burden

In 2022, cardio-cerebrovascular disease discharges from Chinese hospitals totaled 26.3387 million, accounting for 14.73% of all discharges, including 14.252 million CVD cases (54.1%) and 12.087 million cerebrovascular disease cases (45.9%) [Figure 49: see original paper]. Ischemic heart disease (8.764 million, including 4.177 million angina and 1.460 million AMI) and cerebral infarction (8.253 million) were the leading causes, accounting for 33.27% and 31.33%, respectively [Figure 50: see original paper]. From 1980-2022, average annual growth rates were 12.34% for diabetes, 11.00% for cerebral infarction, 10.16% for ischemic heart disease, 7.99% for cerebral hemorrhage, 5.54% for hypertension, and -0.87% for chronic rheumatic heart disease. From 2018-2022, heart failure discharges grew 21.41% annually, angina 14.33%, and AMI 10.98%.

In 2023, the average cost per CVD hospitalization was 15,944.0 RMB, with materials accounting for the highest proportion (35.7%, 5,689.8 RMB), followed by diagnostic fees (21.5%, 3,421.5 RMB), medication (15.3%, 2,431.7 RMB), and treatment (13.7%, 2,179.2 RMB). Surgical treatment costs were significantly higher than non-surgical (1,705.6 vs 570.4 RMB), and Western medication costs exceeded traditional Chinese medicine (2,100.9 vs 330.9 RMB). Valvular heart disease had the highest average hospitalization cost (71,274.3 RMB), followed by arrhythmia (30,067.6 RMB), coronary heart disease (14,234.6 RMB), heart failure (9,724.5 RMB), and hypertension (6,239.8 RMB). Material costs accounted for higher proportions in coronary heart disease, arrhythmia, and valvular heart disease, while diagnostic fees were more prominent in heart failure and hypertension. Average hospitalization duration was 8.3 days, longest for valvular heart disease (13.2 days) and heart failure (10.4 days).

In 2023, coronary heart disease accounted for the highest hospitalization costs among CVD patients. Among coronary heart disease inpatients, unstable angina accounted for 40.0% of cases (3.344 million) and 40.8% of costs (48.64 billion RMB), followed by unclassified coronary heart disease (27.0% cases, 18.8% costs), STEMI (6.8% cases, 13.3% costs), stable angina (17.1% cases, 12.3% costs), and NSTEMI (6.3% cases, 10.6% costs) [Figure 51: see original paper]. Total CVD hospitalization costs were 284.3 billion RMB, with coronary heart disease accounting for 64.7% (191.1 billion RMB), followed by arrhythmia (11.4%, 32.39 billion RMB) and heart failure (8.1%, 22.98 billion RMB) [Figure 52: see original paper].

CVD treatment costs were concentrated in elderly populations, with those aged $ $60 years accounting for 64.3% of costs. Based on seventh national census data, CVD treatment cost proportions exceeded population proportions starting at age 50, with the largest gap in the 70-79 age group (5.0% of population but 25.0% of costs) [Figure 53: see original paper]. Among patients aged $ $30 years, coronary heart disease accounted for the highest treatment cost proportion (60.7%), while arrhythmia was higher among those <30 years (46.8%) [Figure 54: see original paper]. Males accounted for higher CVD treatment costs

than females (60.5% vs 39.5%), with higher economic burden across coronary heart disease, heart failure, arrhythmia, and valvular heart disease [Figure 55: see original paper].

### 4.2 Cardiovascular Health Economics Evaluation

A study on return on investment for childhood/adolescent overweight and obesity prevention in China used a deterministic Markov cohort model to predict intervention impacts on morbidity and mortality from 2025-2092. Five evidence-based interventions were modeled: 20% sugar-sweetened beverage tax, restricting unhealthy food sales to children, breastfeeding promotion via mobile text messages, school-based obesity interventions, and physician nutrition counseling. Without interventions, China would face 3.3 billion DALYs and 218 trillion RMB in losses, with each affected child facing 2.5 million RMB in economic losses. Full implementation of all five interventions could reduce DALY loss by 179.4 million and generate 13.1 trillion RMB in economic benefits. Fiscal and regulatory policies (sugar-sweetened beverage tax and food sales restrictions) showed highest return on investment, with benefits appearing within 10 years.

A decision-analytic simulation model evaluated cost-effectiveness of antihypertensive medication for Chinese adults with SBP/DBP 130-139/80-89 mmHg and high cardiovascular risk. Over 10 years, medication yielded 0.034 incremental quality-adjusted life years (QALY) compared with non-pharmacological treatment, with an incremental cost-effectiveness ratio (ICER) of $13,321.29/QALY, below the per capita GDP threshold ($21,318), indicating high cost-effectiveness. Antihypertensive treatment was highly cost-effective across all ages, with greatest benefits in young and middle-aged populations.

**Conflict of Interest:** None declared.

[**References**] (The reference list is preserved as provided in the original text, with all citations maintained in their original format.)

*Note: Figure translations are in progress. See original paper for figures.*