China cardiovascular diseases report 2015: a summary

Wei-Wei CHEN1, Run-Lin GAO1, Li-Sheng LIU1, Man-Lu ZHU1, Wen WANG1, Yong-Jun WANG2, Zhao-Su WU3, Hui-Jun LI1, Dong-Feng GU1, Yue-Jin YANG1, Zhe ZHENG1, Li-Xin JIANG1, Sheng-Shou HU1,*; on behalf of the writing group

1National Center for Cardiovascular Diseases, Beijing, China
2Beijing Tiantan Hospital, Beijing, China
3Beijing Anzhen Hospital, Beijing, China

J Geriatr Cardiol 2017; 14: 1–10. doi:10.11909/j.issn.1671-5411.2017.01.012

Keywords: Atrial fibrillation; Cardiovascular diseases; Hypertension; Risk factors; Statistics; Stroke

1 Introduction

Major and profound changes have taken place in China over the past 30 years. An epidemic of cardiovascular diseases (CVD) in China is emerging as a result of lifestyle changes, urbanization, and the accelerated process of aging. The incidence of CVD is continuously increasing and will remain an upward trend in the next decade. Since 2005, the National Center for Cardiovascular Diseases of China has organized experts of cardiology, neurology, nephrology, diabetes, epidemiology, community healthcare, health economics, biostatistics and other related fields to write the annual Report on Cardiovascular Diseases in China. The report aims to provide a timely review of the growing epidemic of CVD as well as to assess the progress of prevention and control of CVD. We present a summary of the Report on Cardiovascular Diseases in China 2015 that includes trends in CVD, morbidity and mortality of CVD, risk factors assessment, health resources for CVD, and a profile of medical expenditure.

2 Cardiovascular diseases mortality

In 2014, the mortality rate due to CVD was 295.63 per 100,000 people in rural areas and 261.99 per 100,000 people in urban areas, CVD mortality in rural areas has exceeded that of urban areas since 2009 (Figure 1). CVD was still the leading cause of death in 2014, accounted for 44.60% and 42.51% of all deaths in rural and urban areas, respectively, higher than deaths caused by cancer or any other diseases. Two in five deaths are attributed to CVD in China (Figure 2).

*Correspondence to: shengshouhu@yahoo.com

Data from China Centers for Disease Control and Prevention revealed that in 1990, in 16 of the 33 provinces, lower respiratory infections or preterm birth complications were the leading causes of Years of Life Lost (YLLs), while in 15 provinces stroke was the leading cause. By 2013, stroke was the leading cause of YLLs in 27 provinces and ischemia heart disease (IHD) in five provinces. The age-standardized mortality of CVD in 2013 decreased by 21% compared with 1990. Stroke is the leading cause of death in both men and women in China, with a 28.8% increase in ischemic stroke and a 37.7% decrease in hemorrhage stroke. However, due to population aging in China, the absolute number of CVD deaths raised by 46% from 1990 to 2013, with IHD and stroke deaths increasing by 90.9% and 47.7%, respectively.

3 Risk factors of CVD

3.1 Hypertension

Hypertension is one of the most common chronic non-infectious diseases and the most important risk factor for cardiovascular diseases. In 2010, hypertension accounted for 2.043 million deaths in China (1.15 million for males and 0.89 million for females), accounted for 24.6% of all deaths in the country. In 2013, hypertension alone accounted for 6.61% of the 3.1869 trillion RMB spent on healthcare in China.

According to data from four national, large-scale surveys focused on hypertension (1958–1959, 1979–1980, 1991, and 2002), the prevalence of hypertension among subjects aged over 15 has increased in China (5.1%, 7.7%, 13.6%, and 17.6%, respectively). The Survey on the Status of Nu-

http://www.jgc301.com; jgc@jgc301.com | Journal of Geriatric Cardiology
The China Health and Nutrition Survey (CHNS) conducted seven cross-sectional surveys among adults aged ≥18 years old in nine provinces from 1991 to 2009 (1991, 1993, 1997, 2000, 2004, 2006, and 2009). The data showed that the prevalence of high-normal blood pressure increased remarkably from 29.4% in 1991 to 38.7% in 2009.\(^1\)

The CHNS also showed an upward trend of awareness, treatment, and control rates of hypertension in populations aged ≥18 years from 1991 to 2009, however, these rates remained relatively low. The awareness, treatment, and control rates of hypertension in 2009 were 26.1%, 22.8%, and 6.1%, respectively.

The major risk factors of hypertension in the Chinese population include a high sodium and low potassium diet, obesity and overweight, high alcohol consumption, mental stress, family history of hypertension, and sedentary lifestyle.

Based on the results of CHNS, the prevalence of hypertension among juvenile increased incrementally, from 7.1% in 1991 to 13.8% in 2009, with the average annual growth of 0.47%. Blood pressure levels among children of different genders and ages were all increasing. Analysis from 190,000 Han nationality school-age children (7 to 17 years old) in the National Student Health Study in 2010 found that the prevalence of hypertension in children and adolescents was 14.5% (Boys: 16.1%; Girls: 12.9%). Overweight/obesity, glucose-lipid metabolism abnormalities, family history of hypertension, low birth weight (< 2.6 kg), and sleep deprivation are risk factors for hypertension in children and adolescents. A birth weight greater than or equal to 4 kg, poor nutrition in the prenatal and early postnatal periods, suffering from famine at an early stage, and childhood sensitivity to salt are risk factors for developing hypertension in early adulthood. Children with hypertension were more likely to develop adult hypertension and cardiac remodeling, compared with those who had normal baseline blood pressures (odds ratios: 2.1 for hypertension, 1.05 for cardiac remodeling). Moreover, the risk of developing hypertension was higher in the older age group compared to the younger age group. The risk of developing cardiac and renal damage
among people who had continuously elevated blood pressure from childhood to adulthood was three times that of people with normal blood pressures.

3.2 Smoking

China continues to be one of the countries with the highest male smoking rates in the world since 1984. The Global Adult Tobacco Survey (GATS)-China Project in 2010, covering the population of China’s 28 provinces, found that the current smoking rate was 52.9% in men ≥ 15 years of age and 2.4% in women; the current smoking rates of male medical personnel and teachers between the ages of 15 and 69 were 40% and 36.5%, respectively. Among those who reported to have ever tried smoking, 55.9% of the males and 57.0% of the females begin smoking before the age of 13 years old; Furthermore, there were 738 million Chinese non-smokers exposed to second-hand smoke.

In 2010, investigation of 5486 residents in China’s Midwestern rural areas showed that the overall smoking rate was 20.9% (44.8% in men, 2.0% in women). Significant differences in smoking rates were found in populations with different ages, ethnic backgrounds, education levels and occupations. The residents between the ages of 50 and 55 had the highest rate of smoking (30.5%). The smoking rate of the Han ethnic group was higher than that of minority ethnic group (27.7% vs. 16.3%).

The China Non-communicable and Chronic Disease Risk Factor Surveillance in 2012 showed that among the migrant workers, the current smoking rate was 32.5%, with a significantly higher percentage of men (55.3%) than women (19%). The current smoking rate in men was highest (58.6%) in migrants working in the construction industry. Among the current smokers, the average number of cigarettes smoked per day was 15.7 (male 15.7 per day; female 10.3 per day). The percentage of people exposed to second-hand smoking in migrant workers was 68.7% (76.4% in men).

A study investigating the smoking status in young Chinese women in 2008 found that the prevalence of ever smoking was 22%, the prevalence of currently smoking was 3.2%, and the prevalence of having an intention to smoke was 2.7%. All three types of smoking prevalence were higher in urban female students than rural female students.

During the last years, the smoking cessation rate had increased slightly in individual ≥ 15 years of age, from 9.42% in 1996 to 11.5% in 2002 and 16.9% in 2010. The number of people who have quit smoking has increased by 15 million. The GATS-China project showed that in the year of 2010, 16.1% of current smokers intended to quit smoking within the next 12 months.

The Shanghai Men’s Health Study showed that cigarette smoking was responsible for 23.9% (95% CI: 19.4%–28.3%) and 2.4% (95% CI: 1.6%–3.2%) of deaths in men and women, respectively, in Shanghai’s citizens of 40-70 years old. In men, the percent population attributable risk of cigarette smoking was 37.5% for respiratory diseases deaths, 31.3% for cancer deaths and 24.1% for CVD deaths. In women, they were 1.1%, 1.1% and 4.0 %, respectively.

3.3 Dyslipidemia

The 2010 Chinese Chronic Disease Survey reported the levels of serum total cholesterol (TC) and triglyceride (TG) among people aged 18 years and older from 31 provinces. Both were found to be significantly higher than in 2002. The average TC levels in men and women were 4.06 mmol/L and 4.03 mmol/L, respectively. The average TG levels in men and women were 1.45 mmol/L and 1.21 mmol/L, respectively. The rates of TC ≥ 6.22 mmol/L in men and women were 3.4% and 3.2%, respectively, with higher levels in urban areas than in rural areas, and in the eastern than in the central or western regions. The prevalence of hypercholesterolemia was highest in men aged 45–59 years and in women aged ≥ 60 years. The rates of TG ≥ 2.26 mmol/L in men and women were 13.8% and 8.6%, respectively.

In a meta-analysis published in 2014 that included 14 studies among Chinese from 2003–2013, the estimated prevalence of increased TC, low-density lipoprotein cholesterol (LDL-C) and TG, and decreased high-density lipoprotein cholesterol (HDL-C) was 7.9%, 7.6%, 13.7% and 11.0%, respectively.

The Chinese Diabetes and Abnormal Metabolism Study examined the prevalence as well as the rates of awareness, treatment and control for hypercholesterolemia in people over 20 years of age in 2007–2008. The prevalence of TC ≥ 6.22 mmol/L was 8.7% in men and 9.3% in women; the awareness rates were 27.6% and 20.7%; the treatment rates were 21.4% and 14.0%; the control rates were 18.3% and 11.2%; and the treatment-control rates were 88.1% and 78.4%, respectively.

A 2011 survey on dyslipidemia management and the compliance rate of cholesterol-lowering therapies in Chinese patients showed 39% of dyslipidemia patients received lipid-lowering therapies, with a majority using statins. The compliance rate for LDL-C lowering therapies was 25.8%. The compliance rates of cholesterol-lowering therapies in patients stratified as at high-risk or extremely high-risk for the cardiovascular disease were 19.9% and 21.1%, respectively. In the 2012 Dyslipidemia International Study-China (DYSIS-China) study, 88.9% of inpatients were treated with statins. Among patients who received lipid-lowering medi-
cal therapies, 38.5% failed to reach target levels of LDL-C, and patients with higher risk for cardiovascular disease had a higher non-compliance rate.[2]

3.4 Diabetes

The estimated prevalence of diabetes was 9.7% in Chinese adults based on the results of fasting blood glucose and 2-h postprandial blood glucose levels. Taking HbA1c level into consideration, the prevalence of diabetes was found to be 11.6%. For both genders, the prevalence of diabetes was higher in urban than in rural areas. In adults under the age of 60, prevalence of diabetes was higher in male than in female while in those 60 years or older, it was higher in female than in male.[3] The study noted that the prevalence of diabetes increased with both economic development and obesity.

The China Daqing Diabetes Prevention Study followed the subjects for 20 years and found that compared with control participants, the incidence of diabetes among combined lifestyle intervention group was reduced by 51% during 6 years active intervention period, and reduced by 43% over 20 years. The time of diabetes onset in the intervention group was an average of 3.6 years later than the control group. The CVD-related mortality rate and all-cause mortality rate in the lifestyle intervention group were all dramatically lower than those of the control group by 41% and 29%, respectively in 23 years.[4]

The Daqing IGT and Diabetes Study compared mortality rate and causes of death among newly diagnosed diabetes (NDD) and normal glucose tolerance (NGT) population. With 23 years of follow-up, there are 56.5% participants with NDD and 20.3% with NGT died. CVD was the predominant cause of the death in whom with diabetes (47.5% in male and 49.7% in female), almost half of which died from stroke. With age standardized, the incidence of all-cause mortality was three times higher in NDD than in NGT. Compared with NGT, the HRs of death from CVD in female with NDD is higher than in male, with HRs of 6.9 in female and 3.5 in male (Figure 3).[5]

The 3B (blood glucose, blood pressure, and blood lipids) Research Study recruited 25,817 type 2 diabetic patients from 104 hospitals. The study showed that 72% diabetes patients had hypertension and/or dyslipidemia and only 5.6% achieved the target goals for control of blood glucose, blood pressure, and blood lipids.

3.5 Overweight and obesity

The prevalence of overweight and obesity increased from 24.7% in 1991 to 44.0% in 2011. The 2010 China Chronic Disease Surveillance Program showed that the prevalence of overweight, obesity, and abdominal obesity were 30.6%, 12.0%, and 40.7%, respectively. These numbers were significantly higher than those in 2002. The prevalence of overweight and obese among subjects over 60 years old were 32.1% and 12.4%, respectively, with higher rates in urban areas than in rural areas.

Four cross-sectional health surveys among residents aged 18 to 69 years old in the Guangdong province showed that from 2002 to 2010, the prevalence of overweight and obese had increased from 15.8% to 16.6% without statistical significance; however, the prevalence of abdominal obesity had increased remarkably from 12.9% to 23.7%, indicating that the type of obesity may have changed in China.

The prevalence of overweight and obesity among children and adolescents is also on the rise. Five national surveys on the health status of Chinese students from 1985 to 2010 showed the prevalence rates of overweight and obesity in 2010 were 8.7 and 38.1 times as high as the rates in 1985 (9.6% vs. 1.1%, 5.0% vs. 0.1%), respectively.

In 2010, the Chronic Disease Surveillance Program of China conducted a survey which showed that the average time of adult spending on TV was 1.87 h a day; the risk of being obese was found to increase by 4% with every hour of TV watching.

Waist-height ratio (WHR) is an effective parameter for abdominal obesity. The value of 0.50 is used as a cut-off value to diagnose abdominal obesity in Chinese people. Analysis results from CHNS 2009 showed positive associations between abdominal obesity (WHR ≥ 0.50) and the risks of diabetes and other cardiovascular risk factors.

3.6 Physical inactivity

Results from the 1991–2011 CHNS showed a significant decreasing trend in physical activity among Chinese citizens.
aged 18–60 years. The declines were largely driven by reductions in occupational physical activities for both genders. Physical activity levels fell from 382 MET-h/week in 1991 to 264 MET-h/week in 2011 among adult men (a 31% decrease) and from 420 MET-h/week in 1991 to 243 MET-h/week in 2011 among adult women (a 42% decrease). Active physical activity (exercise) remained low—less than 7 MET-h/week for men and 3 MET-h/week for women in 2011. Adolescents aged 11–18 from 10 cities showed that only 19.9% of them reach the recommended level of physical activity, and the proportions of adolescents with physical inactivity and low physical activity were both about 40%.

The results from China Chronic Disease Monitoring Program in 2010 showed that the proportion of people who participated in regular exercise was only 11.9% and that this proportion was lowest among younger adults in the 25–44 year age group.

Physical activity level was negatively associated with BMI, waist and body fat. Low physical activity level was associated with a substantial increasing in the risk of type 2 diabetes. Physical inactivity and low physical activity were both associated with higher risks of ischemic heart disease, ischemic stroke, and type 2 diabetes deaths.

3.7 Diet and nutrition

The CHNS reported that in the past two decades, total energy intake has decreased in Chinese residence, with decrease in energy from carbohydrates but increase in from fats, as well as increasing intake of cholesterol. Fruit and vegetable consumption is still relatively low. Sodium intake decreased significantly and potassium intake increased. However, sodium intake remained at a high level of 4.7 g/day (the equivalent of the salt intake of 12.0 g/day), and potassium intake was still below the recommended amount of 2 g/day.

3.8 Metabolic syndrome

The 2002 China Health and Nutrition Survey reported that the prevalence of metabolic syndrome in adults above 18-years of age were, respectively, 6.6% and 13.8%, based on criteria from the CDS and the NCEP-ATP III.

3.9 Air pollution

In recent years, a large number of studies have confirmed that particular matter (PM) is a risk factor for CVD. PM$_{2.5}$ is a major pathogenic composition in PM, which is more closely related to CVD. Several studies indicated that the concentrations of PM$_{2.5}$, SO$_2$, NO$_x$ and total suspended particle were positively correlated with CVD incidence and mortality. From 2010 to 2012, the mean daily PM$_{2.5}$ concentration was 96.2 μg/m$^3$ in Beijing and that a 10 μg/m$^3$ increase in PM$_{2.5}$ concentration was associated with a 0.27% (95% CI: 0.21%–0.33%) increase in IHD morbidity. [6]

4 Cardiovascular diseases statistics

4.1 Stroke

According to China Health Statistics Yearbook, cerebrovascular disease mortality rates increased from 2003 to 2014. The mortality rate of cerebrovascular diseases in 2014 was 125.78 per 100 000 for urban residents, and 151.91 per 100 000 in rural areas (Figure 4). Based on the data from the Sixth National Population Census in 2010, it was estimated that 837,300 urban residents and 1,023,400 rural residents died from cerebrovascular diseases in 2014.

![Figure 4. Trends in stroke mortality in China: 2003–2014.](http://www.jgc301.com; jgc@mail.sciencep.com | Journal of Geriatric Cardiology)
A study recruiting the patients admitted to 109 grade III class A hospitals during 2007–2010 with a discharge diagnosis of stroke, demonstrated that stroke hospitalizations increased from 79,894 in 2007 to 85,475 in 2010, while the in-hospital mortality of stroke decreased from 3.16% to 2.30%.[7]

Tianjin Brain Study was a population-based stroke surveillance study. The age-standardized incidence of first-ever stroke increased rapidly from 124.5 in the years of 1992–1998 to 190.0 in 1999–2005, and reached 318.2 in 2006–2012. The incidence increased annually by 6.5%, and by 12% among men aged 45–64 years. From 1992 to 2012, the age at first-ever stroke in men decreased by 3.3 years.[8]

China Chronic Disease and Risk Factor Surveillance (CCDRFS) in 2010 found that the age-standardized prevalence of transient ischemic attack (TIA) was 2.27%. The prevalence of TIA was higher in women and in subjects who were older, less educated, current smokers, residents in rural or undeveloped areas, or with a history of stroke, hypertension, myocardial infarction, dyslipidemia, or diabetes. Approximately 3.08% of Chinese adults were informed and had knowledge of TIA. Among patients with TIA, only 5.02% received treatment and 4.07% received guideline-recommended therapy.

Non-disabling cerebrovascular events consist of TIA and minor stroke. The Clopidogrel in High-risk patients with Acute Non-disabling Cerebrovascular Events (CHANCE) trial revealed that the early benefit of clopidogrel-aspirin treatment in reducing the risk of subsequent stroke sustained during 1-year of follow-up. Compared with aspirin alone, a 90-day clopidogrel-aspirin therapy was more cost-effective for the treatment of nondisabling cerebrovascular events.

Hyperhomocysteinemia (Hcy) in hypertensive patients was significantly associated with the risk of ischemic stroke, while folic acid supplementation for primary hypertension could efficiently down-regulate Hcy levels. The combined application of enalapril and folic acid, in contrast to enalapril alone, significantly reduced the risk of first stroke.[9]

### 4.2 Coronary heart disease

According to data from China Health and Family Planning Commission’s Statistical Yearbook, the mortality rate from coronary heart diseases increased from 2002 to 2014. In 2014, the mortality rate from coronary heart diseases was 107.5 per 100,000 in urban areas and 105.37 per 100,000 in rural areas (Figure 5). Overall, coronary heart disease mortality is higher in urban than in rural populations, and higher in men than in women.

Acute myocardial infarction (AMI) mortality rate increased from 2002 to 2014. Since 2005, the mortality rate of AMI has increased rapidly. AMI mortality in rural areas actually exceeded that in urban areas in 2007, 2009 and 2011, increased dramatically in 2012, and significantly exceeded that of urban areas in both 2013 and 2014 (Figure 6). Mortality from AMI increased with age regardless of gender or urban/rural distinction, and increased most significantly after age 40.[10]

Based on data of the PCI network of National Health and Family Planning Commission Coronary Heart Disease Interventional Treatment Quality Control Center, the number of PCI performed in China has been increasing during the last years. The total number of PCI procedures in 2014 was 500,946.

The China Acute Myocardial Infarction (CAMI) study found that the top three cardiovascular disease risk factors among AMI patients in China are smoking, overweight/
obese and hypertension, followed by diabetes and dyslipidemia. Late arrival at hospital was common. Among ST-segment elevation myocardial infarction patients receiving emergency reperfusion therapy, significant differences existed in time from admission to emergency reperfusion therapy. The median time was 165 min from admission to emergency PCI, and 130 min from admission to thrombolysis.[11]

4.3 Cardiac pacing and atrial fibrillation

According to statistics from the Ministry of Health’s online enrollment system, about 52,382 pacemakers were implanted in 2014, an increase of 3.2% when compared to that in 2013. Among these cardiac pacing procedures, 51.1% were for sick sinus syndrome, and 39.8% were for atrioventricular block. The proportion of dual-chamber pacemakers is about 67%, including 2918 pacemakers that are remote monitoring pacemakers.

The number of ICD implantations was 1959 in 2014, an increase of 2.9% when compared to that in 2013. The percentages of single-chamber and dual-chamber ICD implantations were 67.1%, and 32.9%. The proportion of ICDs for secondary prevention was 52.1%, and for primary prevention was 47.9%. The proportion for primary prevention increased compared to 2012 (42.7%) and 2013 (45%).

The number of CRT implantations was 2379, an increase of 8.2% when compared to 2013. CRT-D accounted for 55% of implantations and CRT-P for 45%. The number of radiofrequency catheter ablation (RFCA) procedures was 88,200 in 2015, of which 19.7% was for the treatment of atrial fibrillation (AF). Since 2008, China has been building a national online platform for AFs statistics to facilitate data collection. Statistics have shown that RFCA therapies for AF have increased steadily. Currently, circumferential pulmonary vein isolation is still the most commonly used technique within RFCA for AF. The overall success rate was 77.1%, the recurrence rate was 22.9%, and the complication rate was 5.3%.

Based on a survey conducted in 2004 in 10 different districts, the prevalence rate of AF in people 35–59 years was 0.77% (males: 0.78%, females: 0.76%). In patients with AF, 19% of males and 30.9% of females had valvular heart diseases. Another study of population over 60 years old showed that the prevalence of AF was 2.0% for males and 1.6% for females. The incidence of AF was 4.0/1000 person-years. Only 1% of the AF patients received warfarin anticoagulant treatment. Patients with AF had significantly higher risks of all-cause, cardiovascular, and stroke mortality.

A prospective observational study recruited 2016 patients (54.8% female) who were admitted to emergency departments due to AF or atrial flutter in twenty representative medical centers showed 30.7% were diagnosed with paroxysmal AF, 22.4% with persistent AF, and 46.9% with permanent AF. Only 16.2% of all the patients received more than one anti-thrombotics agent, whereas 68.4% patients received ventricular rate control agents. Among the patients with valvular disease, 41.4% of patients received oral anticoagulant treatment. Only 26.4% of these patients showed international normalized ratio values that were within the target range (2.0–3.0).

4.4 Heart failure

In 2000, the prevalence of chronic heart failure (HF) in the Chinese population aged 35–74 years was 0.9%, 0.7% in men and 1.0% in women. Prevalence was higher in the north than the south, and higher in urban areas. The prevalence of HF increased significantly with age. During the past
two to three decades, the main cause for HF has shifted from rheumatic valvular heart disease to coronary heart disease.

The preliminary results from the China Heart Failure Registry Study (China-HF) showed that the prevalence of HF increased with aging, the average age of patients with HF is 66 ± 15 years old. 54.5% of HF patients are males and 84.7% of the patients were at III-IV levels according to the NYHA functional classification criteria. The main comorbidities with HF have changed significantly: the proportion with valvular diseases has gradually decreased; coronary artery disease (49.4%), hypertension (54.6%), and chronic kidney disease (29.7%) have become the most common comorbidities. Infection (45.9%) continues to be the primary inducing factor for the onset of HF symptoms, followed by physical activity or emotional stress (26.0%), and then myocardial ischemia (23.1%). The usage of diuretics in patients during hospitalization has not changed significantly: the usage of digoxin showed a downward trend. The use of angiotensin II receptor antagonist (24.6%), aldosterone receptor antagonist (55.4%) and β-receptor blocker (50.6%) has increased significantly.

4.5  Pulmonary disease

Results of a 2007 epidemiological study among people over the age of 40 showed that the prevalence of Chronic Obstructive Pulmonary Disease (COPD) was 8.2% (8.8% in rural areas and 7.8% in urban areas). The COPD prevalence was higher in men (12.4%) than in women (5.1%). The estimated number of patients with COPD in China was 43 million.[12] According to statistics released by the National Health and Family Planning Commission in 2008, COPD ranked fourth leading cause of death in urban areas and the third in rural areas. From 1990 to 2008, the COPD mortality rate declined annually.

From 1997 to 2008, a registration study on patients with pulmonary embolism (PE) was conducted in 60 tertiary hospitals involved in the National Cooperative Project for the Prevention and Treatment of Venous Thromboembolism (NCPPT). Among 16,972,182 hospitalized patients, the incidence of PE was 0.1%.[13]

Data from 504 patients with Chronic Thromboembolic Pulmonary Hypertension (CTEPH) admitted at Beijing Anzhen Hospital were collected from 1989 to 2008. For patients with central CTEPH, those who underwent pulmonary thromboendarterectomy demonstrated a higher long-term survival rate (10 year survival rate: 94.6%; 15 years survival rate: 91.0%) than patients treated with the medical regimen (10 year survival rate: 81.4%; 15 years survival rate: 56.4%). For peripheral CTEPH, there was no significant difference between two groups.

4.6  Cardiovascular surgery

The annual volume of cardiovascular surgery in China has increased over the last decade. In 2014, 209,765 cardiovascular surgeries were performed in Mainland China. Among these, 82,882 (39.5%) were for congenital heart disease (CHD) of all cardiovascular surgeries. 60,485 were valvular surgeries, 41,636 cases of coronary artery bypass grafting, 11,013 cases of aortic surgeries, 370 cases of heart transplantation (including 12 heart-lung transplants), and 711 cases of extracorporeal membrane oxygenation adjuvant treatment.

The monitoring of birth defects has been continuously increased in Mainland China. The incidence of CHD varies in different areas: ventricular septal defects, atrial septal defects, and patent ductus arteriosus constitute approximately 75% to 80% of all CHD cases. Transcatheter device closure and surgical repair are effective interventions with optimal midterm results for treating peri-membranous ventricular septal defect. Application of transcatheter device closure demonstrates relatively low incidence of myocardial injury, slight blood transfusion, fast recovery, short hospital stays, and low medical expenses.

4.7  Chronic kidney diseases

A nationwide survey on chronic kidney diseases (CKD) prevalence was performed from September 2009 to September 2010 by applying stratified multistage sampling with 47,204 adults across 13 provinces, municipalities, and autonomous regions. The results revealed that the adjusted prevalence of estimated glomerular filtration rate (eGFR) less than 60 mL/min per 1.73 m² was 1.7%, and of albuminuria (defined as the urine albumin-creatinine ratio > 30 mg/g) was 9.4%. The overall prevalence of chronic kidney disease was 10.8%. The estimated number of patients with CKD was approximately 120 million in China.[14]

A cross-sectional survey using four-stage cluster sampling was employed in the China Health and Retirement Longitudinal Study (CHARLS) during 2011–2012 on 17,708 adults ≥ 45 years of age from 450 villages/communities across 28 provinces. eGFR was calculated using the creatinine-cystatin C equation. CKD was defined as an eGFR less than 60 mL/min per 1.73 m². The overall prevalence of CKD was 11.5% in people over 45. Urban populations displayed higher CKD rates than urban populations (13.0% vs. 10.0%). The prevalence of CKD also increased with age. 8.7% of the participants aware of having CKD and 4.9% received treatments. The awareness and treatment rates decreased with age.

4.8  Peripheral vascular disease

Lower extremity atherosclerotic disease (LEAD) is com-
monly seen in middle-aged and elderly people. The prevalence of LEAD among those with major risk factors is particularly high and increases with age. Thirty percent of patients with cerebrovascular disease and 25% of patients with ischemic heart disease also had LEAD. The mortality rate among patients with LEAD was much higher than that of same-age patients without LEAD. Results from a 3-year follow-up study comparing the mortality rates of patients with high risk of atherosclerotic diseases categorized by their ankle-brachial index (ABI) suggested that all-cause mortality rate doubled in the group with ABI < 0.4 compared with that with ABI within 1.0 to 1.4.\[13\]

A collaborative cross-sectional study involving investigators from China and the United States reported that the ultrasound detection rate of carotid atherosclerotic plaques among patients from 43 to 81 years of age was 60.3% (males 66.7%, females 56.2%), with lesions predominantly located at the carotid sinus. Baseline intima-media thickness is an independent predictor of ischemic heart disease in patients without carotid atherosclerotic plaques; in patients with carotid plaques, the risk of ischemic heart disease increased with an increase in overall plaque surface area and number of plaques.

5 Community based prevention and control of CVD

5.1 An overview of the community-based prevention and control of CVD in China

The first hypertension prevention and control center in China, established in 1969 at the Capital Iron and Steel Company by Fuwai Hospital, was a model of functional community-based prevention program. The risks of stroke can be reduced by 50% through successful control of hypertension. Over 40 years, the community-based prevention and control of CVD has gradually developed to the comprehensive prevention and control with the multi-functional cooperation and collaboration under the government and with the large scale participation of the whole society.

5.2 A community-based information management model for prevention and control of hypertension in Minhang District, Shanghai

By creating an innovative medical reform model, the Minhang District has achieved an outstanding success in CVD prevention such as hypertension control. Since 2006, the Health Bureau of Minhang District began establishing a regional health information management platform based on the Electronic Health Record (EHR), and continually established a “Trinitarian Management Model on CVD comprehensive prevention and control” in 2007. By circulating information, sharing resources and standardizing hypertension management processes, the district has achieved a scientific and efficient management system for hypertension patients in the community. Currently, more than 200,000 hypertension patients in the Minhang district are managed by the aforementioned system, which is more than twice of that number in 2007. All the hypertension files are managed in the electronic information form, with the standardized management rate of 98%. Compared to that of hypertension patients who were not included in the system, the blood pressure control rate of hypertension patients in the system apparently increased, while stroke and myocardial infarction incidence rates decreased significantly.

In October 2011, the “Shanghai Institute of Hypertension Research Base on Community Hypertension Prevention and Control at Xinzhuang Community Health Service Center” was established in the Minhang District. Since 2012, the research base has gradually developed a system and management platform for automatic blood pressure measurement and the direct transmission of results. Through modern communications technology, a fully automated and seamless process from hypertension data acquisition to data collection and transmission and import into the management system and platform can be achieved. This ensures the accuracy, reliability and authenticity of data. Currently, at Xinzhuang community health service centers and all subordinate service sites, automatic blood pressure measurement has been achieved and results are transferred directly to the doctor’s workstation and the patient’s EHR. Telemetry blood pressure monitors for home have also been configured to each community health service center in Minhang district.

6 Medical treatment and expenditure of CVD

Since 1980, the number of patients with CVD and diabetes discharged from hospitals in China has increased. This rising trend has accelerated, especially since 2000. Correspondingly, the total cost of the hospitalization of patients with CVD also increased rapidly. Since 2004, the average annual rate of increase of the cost has been growing faster than the annual rate of increase of China’s GDP. The increase mainly springs from the growing demands of hospitalization and the high proportion of inappropriate prescriptions.

6.1 Number of discharged patients with CVD and its changing trend

In 2014, the number of discharged patients with CVD reached 17,938,600, accounting for 12.8% of the total...
number of discharged patients during the same period. Patients with CVD accounted for 6.63% of total hospitalized patients, while patients with cerebrovascular disease accounted for 6.1%. Among the discharged patients with CVD, IHD and cerebral infarction contributed to 36.5% and 29.7% respectively, making up the majority of these patients, while the remaining were patients with hypertension, intracranial hemorrhage, and rheumatic heart diseases. Additionally, in 2013, the number of discharged patients with diabetes was 3,204,400.

From 1980 to 2014, the average annual growth rate of discharged patients with CVD was 10.1%, exceeding that of general discharged patients (6.33%) for the same period. The annual growth rates of all subtypes of CVD in descending order were: cerebral infarction (12.3%), IHD (11.74%), intracranial hemorrhage (9.76%), AMI (8.12%), hypertension heart disease and kidney disease (8.06%), hypertensive heart disease and kidney disease (5.82%). In addition, from 1980 to 2014, the annual growth rates (from 2004) of 8.72%, 6.63% and 2.81%, respectively, making up the majority of these patients, while patients with cerebrovascular disease accounted for 6.63% of total hospitalized patients during the same period. Patients with CVD accounted for 6.63% of total hospitalized patients, while patients with cerebrovascular disease accounted for 6.1%. Among the discharged patients with CVD, IHD and cerebral infarction contributed to 36.5% and 29.7% respectively, making up the majority of these patients, while the remaining were patients with hypertension, intracranial hemorrhage, and rheumatic heart diseases. Additionally, in 2013, the number of discharged patients with diabetes was 3,204,400.

From 1980 to 2014, the average annual growth rate of discharged patients with CVD was 10.1%, exceeding that of general discharged patients (6.33%) for the same period. The annual growth rates of all subtypes of CVD in descending order were: cerebral infarction (12.3%), IHD (11.74%), intracranial hemorrhage (9.76%), AMI (8.12%), hypertension heart disease and kidney disease (8.06%), hypertensive heart disease and kidney disease (5.82%). In addition, from 1980 to 2014, the annual growth rate of discharged patients with diabetes was 14.18%.

6.2 Hospitalization expenses of CVD

For hospitalizations associated with CVD in 2014, the total medical expenses for AMI, intracranial hemorrhage, and cerebral infarction were 13.375 billion, 20.707 billion, and 47.035 billion RMB, respectively (Figure 7). The expenses for AMI, intracranial hemorrhage, and cerebral infarction showed an annual increase from 2004 by 32.02%, 18.90% and 24.96%, respectively.

The average individual expenses in 2014 for AMI, intracranial hemorrhage and cerebral infarction were 24,706, 15,929,7, and 8841.4 RMB, respectively, with average annual growth rates (from 2004) of 8.72%, 6.63% and 2.81%, respectively.

![Figure 7. Trend of hospitalization expenses for CVD (China: 2004–2014). CVD: cardiovascular diseases.](image)

References

1. Liang Y, Liu R, Du S, Qiu C. Trends in incidence of hypertension in Chinese adults, 1991–2009: the China Health and Nutrition Survey. *Int J Cardiol* 2014; 175: 96–101.
2. Wang F, Ye P, Hu D, et al. Lipid-lowering therapy and lipid goal attainment in patients with metabolic syndrome in China: subgroup analysis of the Dyslipidemia International Study-China (DYSIS-China). *Atherosclerosis* 2014; 237: 99–105.
3. Xu Y, Wang L, He J, et al. Prevalence and control of diabetes in Chinese adults. *JAMA* 2013; 310: 948–959.
4. Li G, Zhang P, Wang J, et al. The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: A 20-year follow-up study. *Lancet* 2008; 371: 1783–1789.
5. Pan XR, Hu YH, Li GW, et al. Impaired glucose tolerance and its relationship to ECG-indicated coronary heart disease and risk factors among Chinese. Da Qing IGT and diabetes study. *Diabetes Care* 1993; 16: 150–156.
6. Xie WX, Li G, Zhao D, et al. Relationship between fine particulate air pollution and ischaemic heart disease morbidity and mortality. *Heart* 2015; 101: 257–263.
7. Wang J, Ning X, Yang L, et al. Sex differences in trends of incidence and mortality of first-ever stroke in rural Tianjin, China, from 1992 to 2012. *Stroke* 2014; 45: 1626–1631.
8. Wang Y, Pan Y, Zhao X, et al. Clopidogrel With Aspirin in Acute Minor Stroke or Transient Ischemic Attack (CHANCE) trial: one-year outcomes. *Circulation* 2015; 132: 40–46.
9. Huo Y, Li J, Qin X, et al. Efficacy of folic acid therapy in primary prevention of stroke among adults with hypertension in China: The CSPPT randomized clinical trial. *JAMA* 2015; 313: 1325–1335.
10. Li J, Li X, Wang Q, et al. ST-segment elevation myocardial infarction in china from 2001 to 2011 (the china PEACE-retrospective acute myocardial infarction study): a retrospective analysis of hospital data. *Lancet* 2015; 385: 441–451.
11. Song F, Yu M, Yang J, et al. Symptom-onset-to-balloon time, ST-segment resolution and in-hospital mortality in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention in China: from China acute myocardial infarction registry. *Am J Cardiol* 2016; 118: 1334–1339.
12. Yin P, Zhang M, Li Y, et al. Prevalence of COPD and its association with socioeconomic status in China: findings from China chronic disease factor surveillance 2007. *BMC Public Health* 2011; 11: 586.
13. Yang Y, Liang L, Zhai Z, et al. National Cooperative Project for the Prevention and Treatment of PTE-DVT pulmonary embolism incidence and fatality trends in Chinese hospitals from 1997 to 2008: a multicenter registration study. *PLoS One* 2011; 6: e26861.
14. Zhang L, Wang F, Wang L, et al. Prevalence of chronic kidney disease in China: a cross-sectional survey. *Lancet* 2012; 379: 815–822.