Temporal and Spatial Trends of Ischemic Heart Disease Burden in Chinese and Subgroup Populations from 1990 to 2016

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Abstract

Background Ischemic heart disease (IHD) is a leading cause of premature death which poses public health challenges worldwide. Previous studies have focused on the overall population in China. However variations in temporal and spatial pattern across subgroups remain unknown. This study was to analyze how the IHD burden among Chinese and subgroup populations changes in response to temporal and spatial trends from 1990-2016.

Methods Based on data from the updated estimates in the 2016 Global Burden of Disease (GBD) study, we used years lived with disability (YLDs), years of life lost (YLLs), and disability-adjusted life years (DALYs) to describe the IHD burden. The percentage and annual average percentage changes were applied to illustrate temporal and spatial variations of the IHD burden stratified by age-sex and province from 1990-2016, 1990-2005, and 2005-2016.

Results YLD rates, YLL rates, and DALY rates for IHD underwent a notable increase among all age groups and increased by 119.4%, 83.3%, and 84.5% nationally from 1990-2016. In YLD rates, an evident rise was seen in females (124.4%) compared to males (114.0%) while males experienced a more substantial increase than that in females in YLL rates (99.3% vs. 60.5%) and DALY rates (99.7% vs. 63.2%) from 1990 to 2016. Compared with 1990-2005, annual average changes in overall population in YLL (3.5% vs. 1.8%) and DALY rates (3.5% vs. 1.9%) showed a tardier increase whereas higher annual average growth of YLD rates (3.5% vs. 4.0%) was observed from 2005-2016. Geographically, all provinces saw declines in YLLs/YLDs ratios from 2005-2016 with seventeen provinces showing an upward trend between 1990 and 2005. Most of the provinces in China witnessed a remarkable upsurge in the age-standardized DALY rate from 1990-2016 whereas the economically advantaged region Macao (52.2%) saw the most marked reduction.

Conclusions China has made significant achievements in preventing premature death from IHD along with the increased risk of disability. Substantial disparities in the temporal and spatial trends of IHD burden emphasize concerns for elderly men and those in economically disadvantaged regions with resource constraints. By having identified these disparities, targeted IHD prevention and control will help to bridge these gaps in IHD burden.

Background

Ischemic heart disease (IHD), the main subcategory of cardiovascular diseases (CVDs), has been identified as the main chronic noncommunicable disease (NCDs). The World Health Organization (WHO) projected that by 2020, IHD will become the primary cause of global death and disability [1]. The 2016 Global Burden of Disease Study (GBD) showed that approximately 26.2 million people worldwide suffered from IHD and the deaths had increased by 19% from 8 million in 2006 to 9.5 million in 2016, thus making IHD the chief contributor to the increase of global CVD deaths [2, 3].

In China, the world's largest developing country with > 1.4 billion population, life expectancy has continued to rise over the past few decades, and a sharp increase in healthy life expectancy (HALE) has likewise been observed, from 59.8 years in 1990 to 69.9 years in 2016 [4]. However, the disease burden from CVDs has become a serious public health problem with IHD being the underlying cause of these growing health concerns [5, 6]. In 2016, YLLs (2.85 million person years) caused by IHD made it the second most common cause of premature death in China after ischemic stroke (3.27 million person years) [3]. As a recent review summarizing the current features and implications of the epidemiological transition of CVDs reported, the increased IHD mortality rate was responsible for the rise in the overall CVDs death rate and it was proposed that IHD is likely to soon become the leading cause of death in China [7].

Over the past two decades, demographic shifts, transitions in life styles, medical treatments, and health-care services, have all had a widespread and far-reaching influence on IHD epidemiology [8]. The temporal and spatial trends of IHD burden should therefore be major concerns, however, previous studies have focused mainly on overall populations and variations across population subgroups within China remain unknown. In addition, these studies were of inadequate perspectives focusing only on national or subnational levels with limited time frames, lacking specific and detailed trend analysis with annual average transition, and failing to provide comprehensive temporal and spatial studies which considered both demographic characteristics and provincial disparities [9–11]. To bridge these persistent gaps significant to informing public health, this study focuses on the systematic evaluation of variations of age-, sex-, and province-specific IHD burdens across demographic and geographic strata over the periods of 1990–2016, 1990–2005, and 2005–2016, based on data from the 2016 GBD study. Targeted preventive strategies and initiatives are then proposed to mitigate IHD burden and allocate health resources effectively [12].

Methods

GBD 2016 synopsis

The GBD was a statistical report examining the health status of the global population, providing comprehensive, dynamic, and accurate epidemiological models which would formulate health policies to meet public health needs and the rational deployment of health resources to meet the disease burden at global, regional, national and subnational levels.

The study provided years lived with disability (YLDs) of 328 diseases or injuries, disability-adjusted life years (DALYs) of 333 diseases or injuries, 84 risk factors, and the disease burden of 2892 sequelae in 195 countries and regions around the world between 1990 and 2016 [2–5]. Systematic subnational assessments in China adopting locational specific methodology had been put in place since the 2013 GBD study, based on cooperation between the Chinese Center for Disease Control and Prevention (CDC) and the Institute for Health Metrics and Evaluation (IHME) at the University of Washington in the US [13]. The detailed of the study have been fully described elsewhere [2–5].

Data sources

Updated data on the causes of death utilized by the GBD study to assess the disease burden in China were mainly obtained from the Disease Surveillance Points system, the Maternal and Child Surveillance System, and the Death Cause Reporting System of the China CDC. The incidence and prevalence data were collected from disease surveillance, relevant literature researches and national investigations. New systematic reviews or high quality meta-analyses associated with nationwide scientific research and updated data, including the Fifth National Health Service Survey and the Chronic Disease and Risk Factor Surveillance System, were also introduced into the GBD 2016 study [14–15].

The GBD collected all globally accessible data and used unified methods to evaluate the quality and statistical models to make estimations based on this data. The results obtained were comparable, and nationally and regionally representative. We also conformed to the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) to ensure the transparency and reproducibility of results. Data used in this study were derived from the revised estimation of the GBD 2016 study on the IHD burden, and IHD cases were classified as per the International Statistical Classification of Diseases (10th Revision) (ICD-10) with diagnosis codes I20-I25 [3].

Estimation of disease burden

The Bayesian meta-regression model DisMod-MR 2.1 was used as the main model to estimate the prevalence of non-fatal diseases. The Cause of Death Ensemble Model (CoDEM) was adopted to appraise cause-specific mortality [4]. The disease burden indicators describing the IHD burden selected by this study included YLDs using disability weights based on previous population surveys incorporated in the GBD 2013 and GBD 2015 studies [2, 4], YLLs calculated by multiplying life expectancy by cause-specific deaths, and DALYs which are the sum of two parts, YLD and YLL. The age-standardized rate for DALY was determined by the GBD 2016 world population age standard. We applied percentage and annual average percentage changes to demonstrate the temporal and spatial variations of the IHD burden in Chinese and subgroup populations from all 31 provinces in the mainland, Hong Kong, and Macao Special Administrative Region of China over the periods of 1990–2016, 1990–2005, and 2005–2016.

Results

IHD burden trends by age and sex

Table 1 shows the percentage change of estimated YLD, YLL, and DALY rates for IHD in different age-sex groups amongst Chinese people. From 1990 to 2016, YLD, YLL, and DALY rates from IHD in both sexes combined denoted an increase of 119.4%, 83.3%, and 84.5%, respectively. A marked discrepancy between sexes was observed in the variation of the IHD burden between 1990 and 2016: a greater increase in the YLD rate was seen in females (124.4%) compared to males (114.0%) while males experienced a greater increase than that in females in YLL rates (99.3% vs. 60.5%) and DALY rates (99.7% vs. 63.2%). The most

rapid growth in the DALY (35.1%) and YLL rates (34.9%) for IHD were seen in Chinese population aged 70+ years from 1990 to 2016.

Annual average percentage changes in the IHD burden are shown in Table 1. Compared with 1990-2005, annual average changes in the YLL (1.8% vs. 3.5%) and DALY rates (1.9% vs. 3.5%) decreased between 2005 and 2016 for both sexes combined whereas YLD rates (4.0% vs. 3.5%) increased. There was an evident reduction in the annual average percentage change in the YLL and DALY rates for IHD among all ages after 2005 and a slight increase in the YLD rate among those aged 50~69 and above 70 years between 2005 and 2016 in both sexes.

The longitudinal age curves of the YLD, YLL, and DALY rates by sex and year are shown in Figure 1 (A-F). For males, females, and both sexes combined, YLD, YLL, and DALY rates increased from ages <5 and reached at peak at 70+ years old in 1990, 2005, and 2016. YLL and DALY rates for IHD in males were higher than those in females who (except for those aged 5~14) had higher YLD rates.

IHD burden trends by province

Spatial variation in YLD and YLL

Despite higher YLLs than YLDs being consistently observed in all regions of China, a substantial decline (16.5%) in the YLLs/YLDs ratio for both sexes combined was observed from 28.9 in 1990 to 24.1 in 2016. The YLLs/YLDs ratio varied across provinces. While Guizhou (6.4%), Yunnan (6.3%), and Hunan (4.9%) saw an increase in the YLLs/YLDs ratio, the remaining thirty provinces showed a decrease from 1990 to 2016. While sixteen provinces saw an increase and seventeen a decrease in the YLLs/YLDs ratio from 1990-2005, all provinces in China saw a reduction from 2005 to 2016 (Table 2).

Comparison maps of age-standardized YLD and YLL rates across provinces were employed to visualize the variation in IHD burden in China before 2005 and after 2005 (Figure 2, C-F). Age-standardized YLD rates in all provinces increased both in 1990-2005 and 2005-2016, with a larger increase seen in seventeen provinces and smaller increases seen in sixteen provinces from 2005-2016. The age-standardized YLL rates in most provinces increased from 1990 to 2005 except for several economically advantaged regions such as Hainan, Zhejiang, Hong Kong, and Macao. Twenty-six provinces saw reductions in age-standardized YLL rates between 2005 and 2016.

Spatial variation in DALY rates

The age-standardized DALY rate increased by 10.1% from 1818.1 per 100,000 in 1990 to 2002.1 per 100,000 in 2016. Geographic variation in the age-standardized DALY rate from 1990 to 2016 between provinces was observed. Most provinces in China showed a marked increase in IHD burden since 1990, although economically developed provinces had lower age-standardized DALY rates. A significant reduction in age-standardized DALY rates between 1990 and 2016 was particularly notable in Macao (52.2%), Hong Kong (45.8%), and Beijing (20.2%), whereas the most substantial increases were observed in Hunan (37.1%) followed by Yunnan (33.9%) and Guizhou (33.5%)

The rates of growth of age-standardized DALY rates among Chinese provinces between 2005 and 2016 were considerably lower than those seen from 1990 to 2005. Twenty-nine provinces showed an increase in age-standardized DALY rates with the remaining four provinces showing a decrease from 1990 to 2005 while the age-standardized DALY rates from 2005 to 2016 increased in seven provinces and decreased in the remaining twenty six. In age-standardized DALY rates in southeastern coastal provinces, such as Fujian, Guangdong, and Zhejiang, a smaller increase was observed from 1990-2005 and a larger decrease seen from 2005-2016 (Figure 2, A-B).

Discussion

Most previous studies have only assessed the disease burden of IHD across overall populations without any further stratification regarding age, sex, or provincial and temporal or spatial patterns. To the best of our knowledge, this study is the first overall analysis focusing on the temporal and spatial trends of age-, sex-, and province-specific IHD burden based on representative data from the GBD 2016 study over the periods of 1990 to 2016, 1990 to 2005, and 2005 to 2016, in Chinese and subgroup populations. Its results should provide important information for developing IHD prevention and control strategies.

Age and sex disparities

The disease burden of IHD varied between ages and sexes among the Chinese population. The age-sex-specific analysis demonstrated that the IHD burden among seniors, particularly those aged 70+ years, was markedly higher than those under 49 years old, indicating that age was positively associated with increased risks of IHD. Since this is related to a growing population and rapid aging, it is expected that middle-aged and elderly individuals should be the foremost concern when assessing future IHD burden in China [16,17]. This suggests that a major health education initiative, rallying community members to extend care for seniors and tertiary intervention providing timely diagnosis, treatment, and rehabilitation for geriatrics suffering from IHD should be encouraged by health authorities at the grassroots level.

Marked discrepancies in the disease burden from IHD between sexes were found. YLDs in females were consistently higher than those in males whereas females experienced lower YLLs and DALYs. Behavioral patterns might partly explain the different trends seen in the IHD burden between sexes. In addition to males being more likely to have dreadful habits such as smoking, alcohol consumption, and poor diet which increases their baseline mortality rate of CVD [3], women are more active in seeking health care because they were more concerned in general about physical and mental health [10,18]. These findings show that the IHD burden among middle-aged and elderly males should be more widely publicized to manage the overall IHD burden.

Regional trends and disparities

Marked regional disparities in the IHD burden were observed in the spatial trend studies across various provinces of China. Most of the provinces saw a remarkable increase in IHD burden between 1990 and 2016. The age-standardized DALY rate experienced a sharp decline in several economically developed

provinces, particularly in southeastern coastal areas such as Zhejiang, Hong Kong, and Macao, which may be due to the growing population and extended life expectancy in these economically advantaged areas. Socioeconomic status is one possible explanation for the provincial discrepancies with poorer socioeconomic development correlated with a higher prevalence and death rate of diseases [11,12,19]. Equitable access to essential health services within provinces is a concern in China and the significantly growing IHD burden over the past two decades is particularly obvious in certain remote provinces of less economically developed regions, such as Guizhou and Yunnan, where there is generally lower public awareness of preventive self-care, limited education, weaker health services, and inability to pay for treatment, all of which exacerbates the situation of unmet needs. Furthermore, north-south, and west-east disparities in medical resource allocation, regional environmental conditions, individual metabolism, distribution of risk factors, lifestyles and behavioral habits may also be factors in the discrepancies seen in locational variation of IHD burden [8,11,13,20,21].

Trends in IHD burden over time

Disparities in the IHD burden over various time periods in China were observed. When comparing the variation in IHD burden in 1990-2005 and 2005-2016, we found that the rapid increase in IHD-related premature death had been effectively controlled in the most recent decade by the increase in IHD-related disability, which can be correlated with the improvement in health care services, prolonged HALE, extensive health insurance coverage, and timely medical treatments over the same time period [8,20]. While the IHD burden increased from 2005 to 2016, it did so at a relatively slower rate. National leadership has launched critical strategies and valuable prevention and control programs related to cardiovascular rehabilitation and tobacco control, along with widely advocating a balanced diet and healthy lifestyles to ameliorate growing IHD hazards. In the new epoch seeking to achieve the “Healthy China 2030” [22], the “13th Five-Year Public Health and Health Care Plan” [23], and the “Sustainable Development Goals” (SDGs), managing an increasing IHD burden is anticipated to be an uphill battle.

Potential risk factors of IHD

Over the past 20 years, quality of life, life expectancy, health life expectancy, and income conditions of general populations have dramatically improved, which leads to an ageing population [4]. The rises seen in IHD DALYs and the age-standardized DALYs from 1990 to 2016 were inconsistent. This indicates that in addition to critical drivers such as the rapid growth and ageing of the Chinese population, they may also be closely related to the epidemiology of four behavioral NCD risk factors, i.e., tobacco use, alcohol consumption, unhealthy diet, and physical inactivity [11,16,17]. Demographic shifts, with transitions in economic systems, social structures, environmental factors, life styles, and medical treatments and health-care services have gradually had a widespread and far-reaching impact on potential IHD risk factors [8,24]. Previous studies have attempted to assess the disease burden attributable to risk factors and their findings highlighted the changes in major controllable lifestyles hazards for IHD in China, signaling the need to take effective steps to mitigate exposure to risk factors such as physical inactivity, hypertension, high LDL-cholesterol levels, diabetes, and the low rates of education regarding the tertiary

prevention of IHD, all of which are considered to pose a serious threat to IHD prevention and treatment [7,25-30]. We speculate that the diverse trends in IHD burden among different ages, sexes, and regions is most likely affected by these risk factors.

Study strengths and implications for policies

Several studies paying attention to the problems of the increased disease burden of IHD in China have been carried out. Most previous studies mainly worked at the local level with a limited time frame and failed to provide an overall temporal and geographical trend analysis which systematically considered both demographic characteristics and provincial disparities [9-11,16,17,31]. Our study revealed more comprehensive statistics in IHD burden among Chinese and subgroup populations according to age, sex, and regions, based on results derived from the advanced GBD 2016 study [2-5]. Through this we have uncovered some potentially valuable insights which can influence policy decisions. Firstly, we call for priorities aimed at improving the health level of general populations, particularly among middle-aged and elderly males engaging in high-risk behaviors. Better guidance in implementing targeted health policies at the provincial level needs to be emphasized, while also allowing for more accessible approaches based on the different economic levels of the various provinces of China, which would ensure that medical and health care services can be equally available. Health authorities should also pay more attention to the issue of “health inequality” affecting the Chinese population and ensure everyone must be given equal opportunities to enjoy a state of physical-and-mental health regardless of their socio-economic status, gender, ethnicity, and residency, in order to manage the IHD burden.

While it improves on previous studies, this study also has its limitations. Firstly, although our analysis of IHD burden was conducted at national and provincial levels, the disease burden at the county level and any urban-rural discrepancies were not examined. The gaps between assessments at national or provincial levels and district levels were somewhat limited to measure a shift in the local disease burden and effectively and specifically influence public policies, which underscores the need for future district level studies [32]. Although the GBD 2016 study had updated the scientific data and analytic methodology of the GBD 2015 study, changes in diagnostic technology over time periods might exert great impact on time trends of IHD, thus making inevitable measurement errors in the acquisition of data [2-5]. With regard to the estimation of YLDs, the disability weighting came from multiple national statistical results all over the world, which leads to uncertainty when estimating YLDs specifically for China [2].

Conclusion

Our findings identified variations in the disease burden from IHD among different ages, sexes, and provinces in China over the periods of 1990 to 2016, 1990 to 2005, and 2005 to 2016. Some targeted public health strategies are expected to be adopted which take into account a subgroup populations’ characteristics in various regions, particularly in middle-aged and elderly males and those in economically disadvantaged provinces with resource constraints. We also found that premature death

remained the leading cause of IHD burden in China along with the increased risk of disability. Although the IHD burden increase since 2005 has been effectively controlled, better guidance on measures at the provincial and district levels which aim to protect vulnerable populations should be urgent priorities. The central and provincial health authorities also need to make concerted efforts to reduce the IHD burden inequality seen between economically rich and deprived regions. Future studies should focus on linking various relevant risk factors with IHD to explore the drivers behind the diverse temporal and spatial trends seen in the IHD burden among different subgroup populations.

Abbreviations

IHD, Ischemic heart disease; NCDs, non-communicable disease; WHO, World Health Organization; GBD, Global Burden of Disease; CVDs, cardiovascular diseases; YLDs, years lived with disability; YLLs, years of life lost; DALYs, disability-adjusted life years; ICD, International Statistical Classification of Diseases; CDC, Center for Disease Control and Prevention

Declarations

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Authors' contributions

CW and SL initiated the study and provided overall guidance. CW, C. W drafted the first manuscript. ML analyzed the data. ZC provided significant intellectual advice. CW and S L revised the manuscript critically for improvement. All authors read and approved the final manuscript.

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Availability of data and materials

The data are based on the 2016 GBD study and available from the corresponding authors on reasonable request.

Ethics approval and consent to participate

All analyses here are based on data from the 2016 GBD study and this research is considered exempt.

Consent for publication

There are no materials here that require consent for publication.

Competing interests

The authors declare that they have no conflict of interest.

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Tables

Table 1. Variation in burden of IHD stratified by age and sex with percentage change from 1990 to 2016, 1990 to 2005, and 2005 to 2016 in China

	age group	Male			Female			Total		
		% change	% annual average change		% change	% annual average change		% change	% annual average change	
		1990-2016	1990-2005	2005-2016	1990-2016	1990-2005	2005-2016	1990-2016	1990-2005	2005-2016
YLD rate	<5 y	16.3	0.6	0.7	20.3	0.8	0.6	18.2	0.7	0.7
	5-14 y	18.3	0.9	0.5	23.0	1.0	0.6	20.5	1.0	0.5
	15-49 y	62.1	2.3	1.8	78.9	2.9	2.2	70.5	2.6	2.0
	50-69 y	25.3	0.8	1.1	27.4	0.7	1.4	26.6	0.7	1.3
	70+ y	38.7	1.3	1.4	42.7	1.1	2.0	40.5	1.2	1.7
	total	114.0	3.5	3.7	124.4	3.5	4.3	119.4	3.5	4.0
YLL rate	<5 y	-85.5	-3.7	-6.1	-86.3	-4.0	-6.0	-85.9	-3.9	-6.0
	5-14 y	-68.1	-3.0	-3.9	-67.5	-3.1	-3.6	-67.7	-3.0	-3.8
	15-49 y	36.6	1.9	0.6	-19.6	0.0	-1.8	16.8	1.2	-0.1
	50-69 y	11.9	0.8	0.1	-21.9	0.0	-2.0	-2.1	0.4	-0.7
	70+ y	39.6	2.1	0.6	27.9	2.4	-0.6	34.9	2.3	0.0
	total	99.3	3.7	2.6	60.5	3.2	0.8	83.3	3.5	1.8
DALY rate	<5 y	-83.1	-3.6	-5.7	-84.2	-3.9	-5.6	-83.6	-3.8	-5.7
	5-14 y	-60.3	-2.6	-3.2	-57.0	-2.6	-2.7	-58.8	-2.6	-2.9
	15-49 y	37.3	1.9	0.6	-14.7	0.2	-1.5	18.7	1.3	0.0
	50-69 y	12.3	0.8	0.1	-19.7	0.0	-1.8	-1.2	0.4	-0.7
	70+ y	39.6	2.1	0.6	28.4	2.4	-0.5	35.1	2.3	0.1
	total	99.7	3.7	2.6	63.2	3.2	0.9	84.5	3.5	1.9

Table 2. YLLs/YLDs and age-standardised DALY rates from IHD with percentage change from 1990 to 2016, in provinces of China

Provinces	YLLs/YLDs				Age-standardised DALY rate per 100,000people			
	1990	2005	2016	%change	1990	2005	2016	%change
China	28.9	28.9	24.2	-16.5	1818.1	2150.8	2002.1	10.1
Anhui	23.1	24.8	22.6	-2.3	1502.5	1840.6	1824.9	21.5
Beijing	24.9	23.3	15.6	-37.3	2020.3	2129.1	1612.9	-20.2
Chongqing	22.1	21.6	18.5	-16.3	1355.2	1515.4	1365.1	0.7
Fujian	20.3	21.0	14.4	-29.2	1285.4	1478.7	1138.5	-11.4
Gansu	30.5	33.6	28.0	-8.1	1741.2	2322.6	2206.2	26.7
Guangdong	24.1	23.8	19.0	-21.2	1734.7	1927.1	1697.4	-2.2
Guangxi	29.6	33.8	28.5	-3.6	1791.4	2298.1	2132.9	19.1
Guizhou	25.6	28.0	27.2	6.4	1505.2	1910.7	2009.1	33.5
Hainan	31.3	27.5	25.0	-20.0	1963.7	1862.3	1899.9	-3.3
Hebei	36.2	36.6	30.9	-14.7	2292.4	2926.7	2766.3	20.7
Heilongjiang	46.7	39.9	21.0	-55.1	3268.3	3518.9	3336.9	2.1
Henan	37.1	38.1	30.2	-18.6	2376.2	3035.3	2742.6	15.4
Hubei	25.6	26.5	22.9	-10.7	1696.0	1999.1	1805.2	6.4
Hunan	27.8	30.3	29.1	4.9	1704.7	2260.1	2337.6	37.1
Inner Mongolia	41.5	39.0	29.7	-28.3	2981.9	3594.9	2998.8	0.6
Jiangsu	16.5	16.7	12.1	-26.7	1006.9	1163.5	978.4	-2.8
Jiangxi	29.0	27.0	23.5	-18.9	1747.9	1886.3	1729.4	-1.1
Jilin	53.5	45.9	36.1	-32.6	3408.1	3646.5	3158.6	-7.3
Liaoning	31.0	28.0	23.2	-25.2	2316.1	2539.6	2468.0	6.6
Ningxia	36.2	35.9	30.1	-16.7	2428.6	3006.8	2849.2	17.3
Qinghai	37.6	38.1	34.7	-7.9	2147.7	2632.7	2784.6	29.7
Shaanxi	40.8	37.4	33.3	-18.4	2187.3	2425.9	2536.0	15.9

Table 2. YLLs/YLDs and age-standardised DALY rates from IHD with percentage change from 1990 to 2016, in provinces of China (Continued)

Provinces	YLLs/YLDs				Age-standardised DALY rate per 100,000people			
	1990	2005	2016	%change	1990	2005	2016	%change
Shandong	30.8	30.4	25.6	-16.8	1914.5	2372.2	2231.4	16.6
Shanghai	10.8	10.2	8.6	-20.3	789.8	800.8	742.7	-6.0
Shanxi	33.2	29.9	27.7	-16.6	2236.2	2410.9	2446.6	9.4
Sichuan	24.1	24.9	20.0	-17.1	1430.5	1659.3	1498.5	4.8
Tianjin	28.3	28.9	22.4	-20.8	2332.3	2918.2	2410.3	3.3
Tibet	47.7	58.0	42.4	-11.0	2416.3	3497.3	2852.1	18.0
Xinjiang	51.9	59.7	46.9	-9.6	3179.9	4127.1	3632.7	14.2
Yunnan	29.3	31.5	31.1	6.3	1525.9	1879.3	2044.6	34.0
Zhejiang	16.5	14.1	10.9	-34.1	963.4	922.6	790.6	-17.9
Hong Kong Special Administrative Region of China	18.6	11.3	8.9	-51.8	1370.8	919.9	743.6	-45.8
Macao Special Administrative Region of China	29.2	18.5	12.3	-57.8	2758.1	1813.5	1317.2	-52.2

Figures

Figure 1

Transition of disease burden caused by IHD by age-sex-year in China. (A) YLD rate of IHD stratified by age and sex in China in 1990, 2005, and 2016 (B) YLL rate of IHD stratified by age and sex in China in 1990, 2005, and 2016 (C) DALY rate of IHD stratified by age and sex in China in 1990, 2005, and 2016 (D) YLD rate of IHD in both sexes combined in China in 1990, 2005, and 2016 (E) YLL rate of IHD in both sexes combined in China in 1990, 2005, and 2016 (F) DALY rate of IHD in both sexes combined in China in 1990, 2005, and 2016.

Figure 2

Annual average changes of age-standardised DALY rates, age-standardised YLL rates, and age-standardised YLD rates for IHD in China from 1990-2005, 2005-2016. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.