BMC Women's Health

RESEARCH

Open Access

The burden of ischemic heart disease among women of childbearing age in China from 1990 to 2021, and projections for the next 15 years

Chuankun Zhang[1], Penghui Yang[1*] and Qijian Yi[1*]

Abstract

Background There are no studies on the burden of ischemic heart disease (IHD) among women of childbearing age (WCBA) in China. This study aims to describe the IHD burden among WCBA in China from 1990 to 2021, predict the trends over the next 15 years, and identify the contributing factors associated with IHD-related deaths.

Methods The data was extracted from the Global Burden of Disease Database 2021. The Direct age-standardized method was used to estimate the age-standardized (AS) prevalence rate (ASPR), mortality rate (ASMR), incidence rate (ASIR), and disability-adjusted life years rate (ASDR) of IHD among WCBA. Joinpoint regression analysis was used to analyze the Annual Percent Change and Average Annual Percent Change from 1990 to 2021. The Autoregressive Integrated Moving Average model was used to predict the trend over the next 15 years.

Results From 1990 to 2021, the ASPR and ASIR increased by 17.44% and 25.83%, culminating in 616.50 (95% UI, 498.42-762.38) and 79.93 (95% UI, 49.43–113.88) cases per 100,000 individuals. Conversely, the ASMR and ASDR declined to 5.17 (95% UI, 4.14–6.33) and 261.24 (95% UI, 212.03–318.03) cases per 100,000 individuals. Over the next 15 years, the ASPR is projected to increase by 25.74%, culminating in 775.20 (95% UI, 637.98–912.42) cases per 100,000 individuals. The main contributor to increased IHD-related deaths among WCBA in China was high low-density lipoprotein.

Conclusions Despite the significant decline in the ASMR and ASDR of IHD among WCBA in China over the last 30 years, the ASPR and ASIR continue to increase. Additionally, the ASPR is projected to rise over the next 15 years. These findings emphasize that effective measures and timely interventions are needed to reduce the disease burden.

Keywords China, Ischemic heart disease, WCBA, Disease burden, GBD 2021

*Correspondence:
Penghui Yang
yangphzj@163.com
Qijian Yi
qjyi2003@hotmail.com

Introduction

Cardiovascular disease (CVD) is the leading cause of global mortality, with steadily increasing incidence in almost all countries in the last decades [1]. Despite ongoing efforts, the overall reduction of the CVD burden among women has stagnated over the past several decades, and as the predominant cause of CVD, the burden of IHD cannot be ignored [2]. In 2017, IHD continued to be the second leading cause of death in China, with a mortality rate reaching 124 (95% UI, 120–128) per 100,000 individuals, raising a significant public health concern [3]. The female population in China has reached 689 million, with women of childbearing age (WCBA) playing a pivotal role in the demographic makeup of society [4]. In addition, the Chinese government issued the *Healthy China 2030* plan in 2016 which proposed reducing maternal mortality to 12 per 100,000 people by 2030 and implementing a policy to encourage couples to have up to three children in 2021 [5, 6]. The Chinese government's targets are particularly relevant to WCBA with IHD population, as this demographic is associated with a higher incidence of ischemic events during pregnancy, leading to a higher risk of maternal mortality [7, 8]. Therefore, assessing and forecasting the epidemiological trends of IHD among WCBA in China is essential.

While previous studies have explored the burden of IHD globally and in China, the burden of IHD among WCBA globally, none have specifically analyzed long-term trends and future projections in IHD burden among WCBA in China [9, 10].

In epidemiological studies, age standardization is essential for neutralizing the effects of population age distribution disparities, enabling more accurate comparisons of disease trends across various periods and improving the precision of forecasting future trends. Currently, the age-standardized data on the burden of IHD among WCBA in China is lacking in the Global Burden of Disease (GBD) Database 2021, hampering the ability to conduct meaningful comparisons across different years and generate reliable future projections. Using the GBD 2021, we obtained the incidence, prevalence, mortality, and disability-adjusted life years (DALYs) associated with IHD among WCBA in China from 1990 to 2021, and utilized the demographic composition of China as a standard to calculate the age-standardized metrics for in-depth analysis of the burden of IHD among WCBA in China from 1990 to 2021 and for accurate projections of burden trends over the next 15 years.

Methods

Data source

The data was extracted from the GBD 2021 (https://ghdx.healthdata.org/gbd-2021/sources), which provides up-to-date estimates of incidence, prevalence, mortality, DALYs, attribution factors, and more for 371 diseases and injuries in 204 countries and territories from 1990 to 2021 [11]. Details have been published before [12]. GBD 2021 classifies causes and factors into four levels, IHD is classified as a level 4 cause [11]. To assess the status, trends, and projections of IHD among WCBA in China, we focused solely region in China, and included females between 15–49 years of age (across 8 groups in 5-year increments) and the cause of IHD. Then we extracted the data on incidence, prevalence, mortality, DALYs with 95% Uncertainty Intervals (UI) respectively, and the level 4 of attribution factors to IHD deaths. The definition of IHD in this study used the codes from the ninth and tenth editions of the International Classification of Diseases (ICD-9 and ICD-10). Specifically, ICD-9 codes for IHD range from 410 to 414.9 and included V17.3, while ICD-10 codes span I20 to I21.6, I21.9 to I25.9, and Z82.4 to Z82.49 [11].

Statistics and analysis

Using the standard population of GBD2021 China population composition, the direct standardization method was used to calculate the age-standardized prevalence rate (ASPR), mortality rate (ASMR), incidence rate (ASIR), and DALYs rate (ASDR) of IHD among WCBA in China from 1990 to 2021. Joinpoint regression analysis, performed using Joinpoint 5.1.0 software, was utilized to describe the temporal trend of the IHD burden by identifying time nodes of different trends and calculating the average change over the entire period, including the Annual Percent Change (APC) and Average Annual Percent Change (AAPC) with a 95% confidence interval (CI) [13]. The Autoregressive Integrated Moving Average (ARIMA) model, a remarkable method for analyzing time series, was used to predict the IHD burden among WCBA in China from 2022 to 2036. Based on an adjusted version of the observed values, the model minimizes the difference between the values generated by the model and the observations. Due to its effectiveness in predicting and analyzing time series data, the ARIMA model is prominently used in the medical field [14]. The proportion of attributable deaths to total deaths was used to measure the contribution of various factors to the risk of mortality.

Data cleaning, shaping, and visualization were all performed using R software (V.4.3.3). The"dplyr"(for data manipulation and transformation) and"tidyverse"(for data science) packages were used for data cleaning and calculation, the"ggplot2"(for complex graphics construction) and"ggpubr"(for customizing the theme and style of graphics) packages were used for data visualization, the"magick"(for the reading, editing, compositing,

and exporting of images) package was used for image arrangement, the"epitools"(for epidemiological analysis) package was used to calculate the age-standardized rate, and the"forecast"(for time series forecasting) package was used for ARIMA prediction model (http://www.r-project.org). The spreadsheet was made using Excel 2019 (https://www.microsoft.com/zh-cn/microsoft-365/excel).

Results

Burden change analysis

In 2021, the ASMR, ASIR, ASPR, and ASDR of IHD among WCBA in China increased with age, culminating in 2.29 (95% UI, 1.83–2.78), 34.20 (95% UI, 21.10–49.94), 305.37 (95% UI, 255.17–370.45), 102.44 (95% UI, 83.37–122.94) per 100,000 people in the 45–49 age group, respectively (Table 1). From 1990 to 2021, the ASMR of IHD among WCBA in China declined from 10.34 per 100,000 people (95% UI, 8.75–12.06) to 5.17 per 100,000 people (95% UI, 4.14–6.33), with a percentage change of 50.00%. The ASDR of IHD among WCBA in China declined from 511.79 per 100,000 people (95% UI, 433.24–595.00) to 261.24 per 100,000 people (95% UI, 212.03–318.03), with a percentage change of 48.96%. Conversely, the ASIR

Table 1 The ASMR, ASIR, ASPR, and ASDR of IHD among WCBA in China in 1990 and 2021, with the percentage change and AAPCs of age groups of IHD among WCBA in China

IHD Burden	Age groups	1990	2021	Percentage Change	AAPC	Lower 95%CI	Upper 95%CI	*P-value*
ASMR	15–49	10.34(8.75–12.06)	5.17(4.14–6.33)	−50.00%	−2.23	−2.49	−1.96	*< 0.001*
	15–19	0.13(0.11–0.14)	0.06(0.05–0.07)	−53.85%				
	20–24	0.22(0.18–0.26)	0.14(0.11–0.17)	−36.36%	−1.51	−2.06	−0.96	*< 0.001*
	25–29	0.40(0.33–0.48)	0.21(0.16–0.26)	−47.50%	−2.31	−2.91	−1.71	*< 0.001*
	30–34	1.01(0.85–1.21)	0.50(0.39–0.63)	−50.50%	−2.17	−2.74	−1.59	*< 0.001*
	35–39	1.60(1.34–1.87)	0.75(0.60–0.93)	−53.13%	−2.44	−2.71	−2.17	*< 0.001*
	40–44	2.51(2.11–2.92)	1.23(0.99–1.51)	−51.00%	−2.27	−2.64	−1.91	*< 0.001*
	45–49	4.48(3.82–5.18)	2.29(1.83–2.78)	−48.88%	−2.08	−2.55	−1.62	*< 0.001*
ASIR	15–49	63.52(38.92–91.27)	79.93(49.43–113.88)	25.83%	0.76	0.69	0.82	*< 0.001*
	15–19	0.47(0.06–1.08)	0.47(0.06–1.08)	0.00%	0.00	0.00	0.00	
	20–24	1.52(0.84–2.38)	1.57(0.87–2.47)	3.29%	0.12	0.07	0.16	*< 0.001*
	25–29	3.24(1.56–5.06)	3.38(1.61–5.30)	4.32%	0.15	0.11	0.19	*< 0.001*
	30–34	7.85(4.87–10.64)	8.89(5.58–11.90)	13.25%	0.42	0.34	0.49	*< 0.001*
	35–39	10.81(6.25–15.93)	13.04(7.66–19.12)	20.63%	0.61	0.57	0.65	*< 0.001*
	40–44	14.30(9.51–18.87)	18.38(12.55–24.07)	28.53%	0.83	0.75	0.91	*< 0.001*
	45–49	25.32(15.83–37.32)	34.20(21.10–49.94)	35.07%	1.00	0.90	1.10	*< 0.001*
ASPR	15–49	524.97(438.48–621.69)	616.50(498.42–762.38)	17.44%	0.50	0.44	0.56	*< 0.001*
	15–19	1.77(1.05–2.68)	1.91(1.12–2.89)	7.91%	0.23	0.18	0.27	*< 0.001*
	20–24	4.72(3.39–6.15)	5.07(3.66–6.79)	7.42%	0.22	0.17	0.26	*< 0.001*
	25–29	15.45(12.00–19.66)	16.63(12.50–21.49)	7.64%	0.23	0.20	0.26	*< 0.001*
	30–34	47.68(36.98–59.32)	52.32(39.39–67.26)	9.73%	0.29	0.26	0.32	*< 0.001*
	35–39	80.50(66.59–95.05)	91.43(72.04–113.07)	13.58%	0.39	0.33	0.45	*< 0.001*
	40–44	122.90(102.08–147.28)	143.77(114.54–180.43)	16.98%	0.49	0.43	0.54	*< 0.001*
	45–49	251.94(216.37–291.55)	305.37(255.17–370.45)	21.21%	0.60	0.53	0.68	*< 0.001*
ASDR	15–49	511.79(433.24–595.00)	261.24(212.03–318.03)	−48.96%	−2.16	−2.42	−1.90	*< 0.001*
	15–19	9.26(8.37–10.45)	4.40(3.77–5.09)	−52.48%	−2.43	−2.72	−2.15	*< 0.001*
	20–24	15.04(12.59–17.54)	9.52(7.76–11.60)	−63.30%	−1.49	−1.93	−1.04	*< 0.001*
	25–29	25.39(21.12–30.57)	13.31(10.66–16.52)	−47.58%	−2.24	−2.80	−1.68	*< 0.001*
	30–34	59.06(49.74–69.90)	29.64(23.49–37.20)	−49.81%	−2.10	−2.65	−1.54	*< 0.001*
	35–39	85.51(71.98–99.53)	41.00(33.23–50.48)	−52.05%	−2.36	−2.60	−2.13	*< 0.001*
	40–44	121.78(102.44–141.23)	60.93(49.76–74.21)	−49.97%	−2.21	−2.56	−1.86	*< 0.001*
	45–49	195.75(167.00–225.78)	102.44(83.37–122.94)	−47.67%	−2.04	−2.46	−1.61	*< 0.001*

WCBA women of childbearing age, *ASMR* age-standardized mortality rate, *ASIR* age-standardized incidence rate, *ASPR* age-standardized prevalence rate, *ASDR* age-standardized disability-adjusted life years rate, *AAPC* average annual percent change, *CI* confidence interval

of IHD among WCBA in China increased from 63.52 per 100,000 people (95% UI, 38.92–91.27) to 79.93 per 100,000 people (95% UI, 49.43–113.88), with a percentage change of 25.83%. The ASPR of IHD among WCBA in China increased from 524.97 per 100,000 people (95% UI, 438.48–621.69) to 616.50 per 100,000 people (95% UI, 498.42–762.38), with a percentage change of 17.44% (Table 1).

Within the age groups, from 1990 to 2021, the ASMR of IHD in the 20–24 age group declined from 0.22 per 100,000 people (95% UI, 0.18–0.26) to 0.14 per 100,000 people (95% UI, 0.11–0.17), with the lowest percentage change of 36.36%. For other age groups, the percentage change of ASMR remained at around 50%. The ASDR of IHD in the 20–24 age group declined from 15.04 per 100,000 people (95% UI, 12.59–17.54) to 9.52 per 100,000 people (95% UI, 7.76–11.60), with the highest percentage change of 63.3%. For other age groups, the percentage change of ASDR remained at around 50%. The percentage change of ASIR increased with age groups, reaching 35.07% in the 45–49 age group. Interestingly, there was no change in ASIR in the 15–19 age group, with 0.47 per 100,000 people (95% UI, 0.06–1.08). The percentage change of ASPR increased with age groups, reaching 21.21% in the 45–49 age group (Table 1, Sfig. 1).

Temporal trends analysis

From 1990 to 2021, the ASMR of IHD among WCBA in China showed a prominent downward trend [AAPC = −2.23, 95% CI: −2.49–−1.96, $P < 0.001$] (Table 1 and Fig. 1A). The most prominent changes occurred between 2004 and 2007 [APC = −4.70, 95% CI: −5.68–−3.72, $P < 0.001$] (Stable 1 and Fig. 1A). There was an overall downward trend in all age groups with the AAPC around −2.00 (Table 1). Interestingly, in the 25–29, 30–34, and 45–49 age groups, the ASMR showed a prominent growth trend between 2007 and 2010 [APC = 9.23, 95% CI: 4.10–14.62, $P = 0.001$; APC = 4.01, 95% CI: 1.71–6.36, $P = 0.002$; APC = 4.42, 95% CI: 1.74–7.18, $P = 0.003$] (Stable 1, Sfig 2C, Sfig 2D and Sfig 2G). The most prominent downward trend appeared in the 30–34 age group between 2004 and 2007 [APC = −7.61, 95% CI: −10.14–−5.01, $P < 0.001$] (Stable 1 and Sfig 2D). The ASMR within the 15–19 age group was not analyzed due to the limited sample size.

From 1990 to 2021, the ASPR of IHD among WCBA in China showed an overall upward trend [AAPC = 0.50, 95% CI: 0.44–0.56, $P < 0.001$] (Table 1 and Fig. 1B). The most prominent changes occurred between 1995 and 1999 [APC = 1.23, 95% CI: 0.97–1.49, $P < 0.001$] (Stable 1 and Fig. 1B). Within the age groups, there was an overall upward trend in all age groups and the AAPC gradually increased with age to 0.60 (95% CI:0.53–0.68, $P < 0.001$) in the 45–49 age group (Table 1). The most prominent

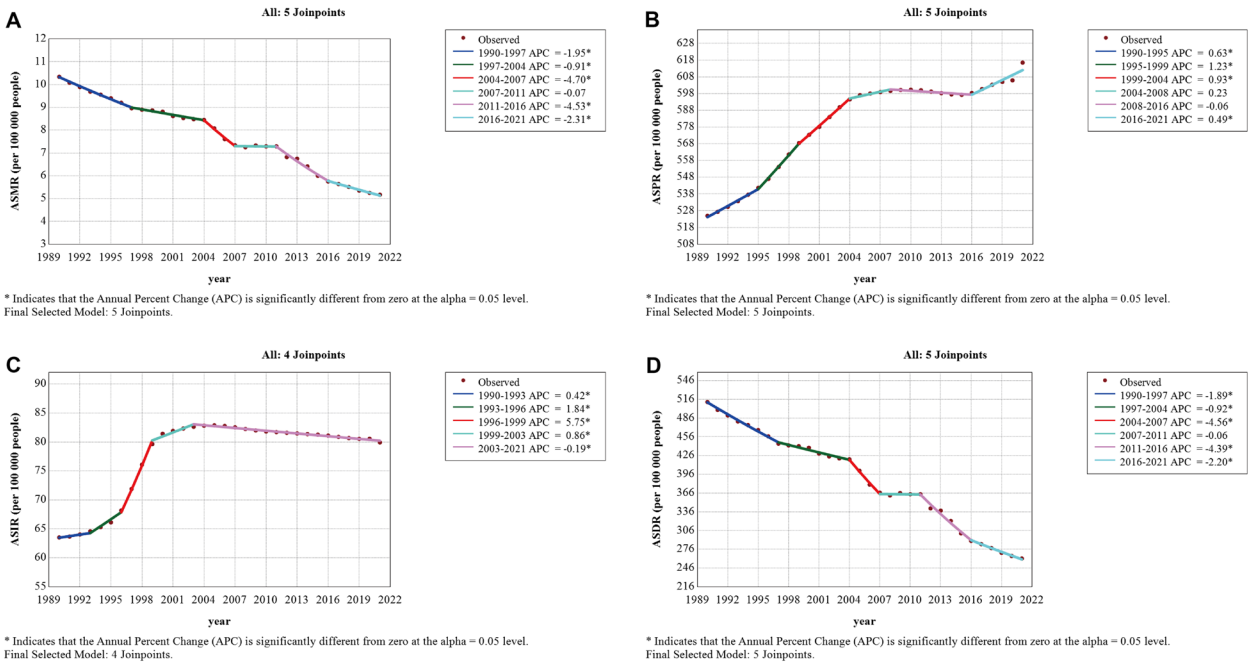

Fig. 1 Joinpoint regression analysis of ASMR (A), ASPR (B), ASIR (C), and ASDR (D) of IHD among WCBA from 1990 to 2021. ASPR age-standardized prevalence rate, ASIR age-standardized incidence rate, ASDR age-standardized disability-adjusted life years rate, ASMR age-standardized mortality rate, IHD ischemic heart disease, WCBA women of childbearing age, *P*-value *$P < 0.05$

trend appeared in the 45–49 age group between 1995 and 1999 [APC = 1.51, 95% CI: 1.24–1.78, $P < 0.001$] (Stable 1 and Sfig 3H).

From 1990 to 2021, the ASIR of IHD among WCBA in China showed a trend from increase (1990–2003) to decline (2003–2021), but overall showed an upward trend [AAPC = 0.76, 95% CI: 0.69–0.82, $P < 0.001$] (Table 1 and Fig. 1C). The most prominent changes occurred between 1995 and 1999 [APC = 5.75, 95% CI: 5.29–6.21, $P < 0.001$] (Stable 1 and Fig. 1C). Within the age groups, there was an overall upward trend after the age of 20, and the AAPC gradually increased with age to 1.00 (95%CI: 0.90–1.10, $P < 0.001$) in the 45–49 age group (Table 1). The most prominent trend appeared in the 45–49 age group between 1995 and 1999 [APC = 6.56, 95% CI: 6.11–7.01, $P < 0.001$] (Stable 1 and Sfig 4H).

From 1990 to 2021, the ASDR of IHD among WCBA in China showed a prominent downward trend [AAPC = −2.16, 95% CI: −2.42–−1.90, $P < 0.001$] (Table 1 and Fig. 1D). The most prominent changes occurred between 2004 and 2007 [APC = −4.56, 95% CI: −5.49–−3.62, $P < 0.001$] (Stable 1 and Fig. 1D). There was an overall downward trend in all age groups with the AAPC around 2.00 (Table 1). Interestingly, in the 25–29, 30–34, and 45–49 age groups, the ASDR showed a prominent growth trend between 2007 and 2010 [APC = 9.01, 95% CI: 3.87–14.41, $P < 0.001$; APC = 4.16, 95% CI: 1.96–6.41, $P = 0.001$; APC = 4.43, 95% CI: 1.80–7.13, $P = 0.003$] (Stable 1, Sfig 5D, Sfig 5E and Sfig 5H). The most prominent downward trend appeared in the 15–19 age group between 2004 and 2007 [APC = −8.04, 95% CI: −8.61–−7.47, $P < 0.001$] (Stable 1 and Sfig 5B).

Predictions for the next 15 years

Over the next 15 years, the ASIR of IHD among WCBA in China is predicted to decline from 79.97 (95% UI 49.43–113.88) per 100,000 people in 2021 to 60.47 (95% UI, 15.10–105.83) per 100,000 people in 2036, with a percentage change of −24.38% (Stable 2 and Fig. 2A). The ASDR of IHD among WCBA in China is predicted to decline from 261.24 (95% UI 212.03–318.03) per 100,000 people in 2021 to 140.01 (95% UI, 89.64–190.37) per 100,000 people in 2036, with a percentage change of −46.41%. The ASMR of IHD among WCBA in China is predicted to decline from 5.17 (95% UI 4.14–6.33) per 100,000 people in 2021 to 2.67 (95% UI, 1.62–3.71) per 100,000 people in 2036, with a percentage change of −48.36% (Stable 2 and Fig. 2C). The ASPR of IHD among WCBA in China is predicted to increase from 616.50 (95% UI 498.42–762.38) per 100,000 people in 2021 to 775.20(95% UI, 637.98–912.42) per 100,000 people in 2036, with a percentage change of 25.74% (Stable 2 and Fig. 2D).

Risk factors analysis

In 2021, the top five factors contributing to the increased risk of IHD-related deaths among WCBA were all greater than 20%, including high low-density lipoprotein (LDL) cholesterol, high systolic blood pressure, ambient particulate matter pollution, diet low in whole grains, and secondhand smoke.

Notably, among WCBA in China, the risk factor of high LDL cholesterol reached 55.7% (Fig. 3A) and ranked first across all age groups with a percentage of more than 50%. Excluding high LDL cholesterol, the factor of a diet low in whole grains had a more important proportion in the 25–29 age group, reaching 27.34% (Fig. 3B); the factor of ambient particulate matter pollution had a more important proportion in the 30–34 and 35–39 age groups, reaching 28.02% and 28.04% (Fig. 3C and D); the factor of high systolic blood pressure had a more important proportion in the 40–44 and 45–49 age groups, reaching 32.69% and 38.47% (Fig. 3E and F).

Discussion

In 2016, the Chinese government issued the *Healthy China 2030* plan, which aimed to reduce maternal mortality to 12 per 100,000 people by 2030 [5]. Women with IHD, particularly within WCBA, are remarkably relevant to this initiative as this demographic is associated with a higher incidence of ischemic events during pregnancy, leading to a higher risk of maternal morbidity and mortality [7, 8], and a higher incidence of complications of IHD, exacerbating the overall disease burden on healthcare systems [15]. Undoubtedly, a comprehensive understanding of the disease trends and future projections of IHD among WCBA in China is essential. However, research on the disease burden of IHD among WCBA in China is currently lacking, indicating the urgent need for such a study. In this study, to eliminate the heterogeneity due to the varying age structures of the populations, we standardized the mortality, prevalence, incidence, and DALYs by using the GBD 2021 China population composition regardless of the standard population used, the target is not altered by the change in standard [16]. This study is the first comprehensive exploration of the mortality, prevalence, incidence, and DALYs of IHD among WCBA in China over the past 32 years and the projections of trends over the next 15 years by using GBD 2021 data.

In 2021, among WCBA in China, the mortality, incidence, prevalence, and DALYs of IHD increased with age, respectively. This phenomenon may be associated with a combination of biological, psychological, and social factors. The decline in sex hormones with age, particularly estradiol and progesterone, may play a significant role in the onset of IHD, as deficiencies in these hormones can

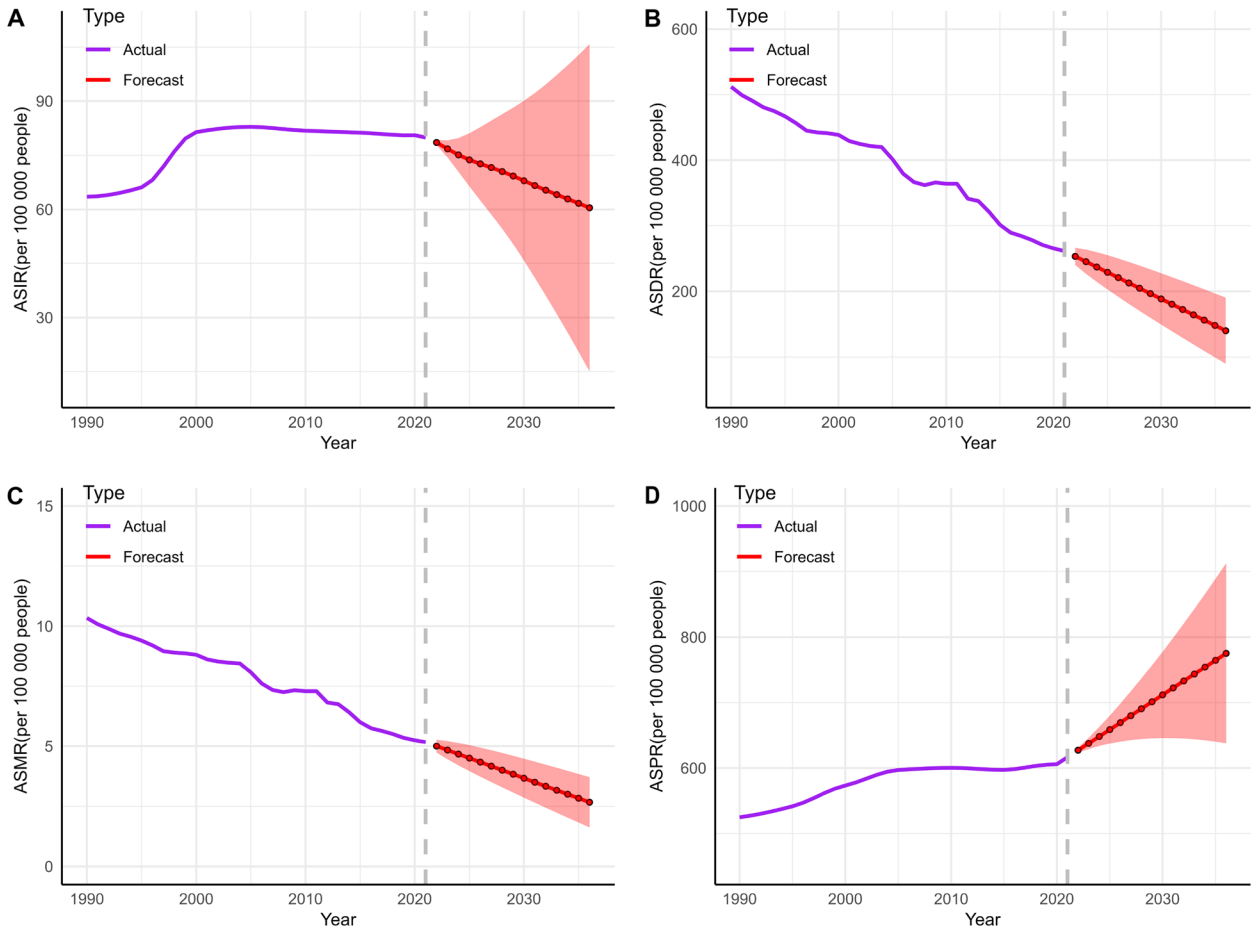

Fig. 2 The ASMR, ASIR, ASPR, and ASDR of IHD among WCBA in 2021 and the predictions for the next 15 years. ASPR age-standardized prevalence rate, ASIR age-standardized incidence rate, ASDR age-standardized disability-adjusted life years rate, ASMR age-standardized mortality rate, IHD ischemic heart disease, WCBA women of childbearing age

accelerate the development of CVD [17]. In addition, older women are more prone to multiple comorbidities, which may contribute to the increased frequency of IHD attacks [18]. As WCBA, they face a variety of mental challenges stemming from family changes, children's education, financial burdens, midlife crises, etc., and assume more onerous responsibilities from work and society, which are thought to be cardiovascular risk modulators [19, 20]. The aforementioned study underscores the necessity for targeted intervention measures, specifically focusing on the prevalent risk factors among older WCBA.

From 1990 to 2021, there was a significant increase in the incidence and prevalence of IHD among WCBA in China. The IHD trends in China are probably due to the rapid social transformation and economic development in the past few decades. Since the reform and opening up in China, the economy has continued to grow, and the diverse needs have led to various types and periods of economic activities, resulting in unhealthy diets, lack of exercise, irregular work and rest, sleep deprivation, high mental stress, psychological pressure, long-term poor mood, and other health problems among the people [21]. Furthermore, rapid economic transformations such as industrialization, marketization, urbanization, globalization, and informatization have contributed to an aging population. These social phenomena may increase cardiovascular risk factors and lead to a pandemic of CVD [22]. Surprisingly, at the beginning of the twenty-first century, the growth of ASIR and ASPR of IHD among WCBA in China slowed down significantly or even declined. Published studies reveal that the incidence and prevalence of IHD were rising in many other regions globally during the same period at the beginning of the twenty-first century [23, 24]. This starkly contrasts the trends of incidence and prevalence among WCBA with IHD in China. Additionally, studies have shown that the prevalence of IHD among WCBA were rising in many

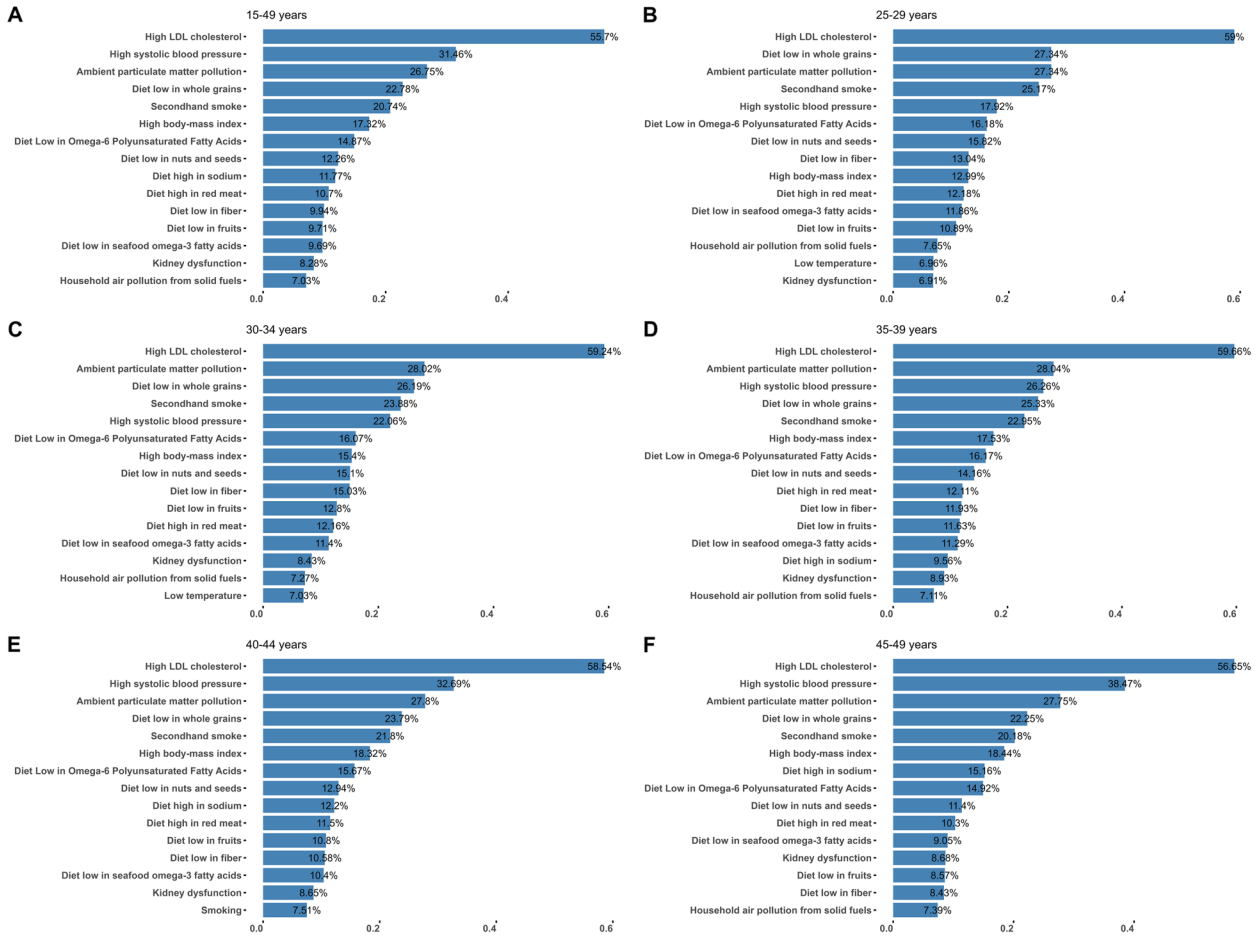

Fig. 3 The proportion of IHD among WCBA deaths is attributable to the top 15 risk factors in 2021 by age group. IHD, ischemic heart disease; WCBA, women of childbearing age

other regions globally over the past 30 years, with the most pronounced change occurring between 2005 and 2012 [10]. These differences may be attributable to the improved living environments and medical conditions among WCBA as the population migrates from rural to urban areas during the rapid urbanization process during that period [25]. Conversely, the mortality and DALYs of IHD among WCBA in China declined significantly. This may result in the Chinese government developing high-quality public health and medical services and dramatically increasing fiscal investment to strengthen its primary healthcare system, ensuring the health needs of a large population, and greatly reducing the incidence of fatal IHD [26, 27]. This indicates that timely interventions, such as improvements in living environments and medical services, are capable of mitigating the health impacts on the population resulting from social transformations and economic growth.

As with many reports, high LDL cholesterol remains the most dominant factor of IHD among different age groups of WCBA in China. Over time, as more LDL becomes trapped within the arterial wall, the burden of atherosclerotic plaque gradually increases, raising the risk of acute cardiovascular events [28]. Low whole grain consumption is a significant issue in the 25–29 age group, likely due to young people's preference for fast food, energy drinks, and the neglect of dietary fiber in their diets. Studies have shown that a single high intake of energy drinks is associated with an increased risk of adverse cardiovascular events in young, healthy individuals [29]. In addition, dietary fiber intake is linked to overall metabolic health (through key pathways including insulin sensitivity) and a variety of other conditions, such as cardiovascular disease, colon health, bowel motility, and the risk of colorectal cancer [30]. High systolic blood pressure is a significant issue in the 35–49 age group, which is likely related to the steady increase in the prevalence of hypertension in China over the past few decades, particularly among those aged 35–44 [31]. Furthermore, the poor

management of high systolic blood pressure in this age group due to a lack of education and poor adherence to treatment, exacerbates the risk of death from IHD. Secondhand smoke accounts for a significant proportion of IHD mortality among WCBA in China, possibly as non-smoking middle-aged women face an increased risk of IHD and are more likely to experience stillbirth, congenital malformations, and low birth weight after exposure to secondhand smoke. However, the mechanism behind these effects remains unclear, underscoring the importance of implementing measures to reduce secondhand smoke exposure among WCBA [32, 33]. Therefore, effective intervention measures, in-depth academic research, and the cooperation of the public are advocated to reduce these risk factors. Fine particulate matter (PM2.5), one of the most common outdoor air pollutants, ranks in the top three attributable mortality factors of IHD across all age groups among WCBA in China. Studies have found that long-term exposure to higher levels of PM2.5 increases the risk of CVD in China, with more pronounced effects at higher PM2.5 concentrations [34]. These findings expand our current understanding of the adverse health effects of severe air pollution and highlight the potential cardiovascular benefits of air quality improvement in China.

Several limitations should be noted in this study. Firstly, the smaller sample size within the younger age group may lead to a greater bias in data processing. The Bayesian Age-Period-Cohort model, which provides more nuanced predictions and effectively reduces biases associated with small sample sizes, was used to address the potential biases [35]. Second, the GBD database lacks specific influencing factors for WCBA, such as pregnancy complications, preterm birth, breastfeeding, etc. Additionally, the potential impact of the COVID-19 pandemic on IHD burden among WCBA was not directly accounted for in this study. Studies have revealed a significant rise in the proportion of people who died at home due to IHD during the COVID-19 pandemic [36]. Future research could consider incorporating COVID-19-related factors through additional data sources or modeling techniques to better understand its influence on IHD burden. Third, the prediction of disease burden trends has not yet included influencing factors like social change and population change, which may cause the results to deviate from real data, necessitating real-world verification. Fourth, the GBD database categorizes individuals into age groups of 5-year intervals, thereby precluding a more nuanced delineation of disease burden within specific age cohorts. Additionally, the lag of the GBD database cannot be ignored.

Conclusions

Our findings underscore the incidence, mortality, prevalence, and DALYs associated with IHD among WCBA in China, highlighting significant variations across different age groups. Over the past three decades, while the DALYs and mortality have exhibited a downward trend, the incidence and prevalence have significantly increased. Furthermore, caution is advised regarding a potential rise in prevalence over the next 15 years. Healthcare professionals and policymakers should enhance the early detection of IHD and improve healthcare standards, while individuals in WCBA should take a more proactive approach to self-management. Collectively, the successful implementation of these multifaceted strategies is vital for China to reduce the disease burden among WCBA and elevate the national health standards.

Abbreviations

IHD	Ischemic Heart Disease
GBD	Global Burden of Disease
WCBA	Women of Childbearing Age
ASPR	Age-standardized Prevalence Rate
ASIR	Age-standardized Incidence Rate
ASMR	Age-standardized Mortality Rate
ASDR	Age-standardized Disability-adjusted Life Years Rate
APC	Annual Percent Change
AAPC	Average Annual Percent Change
DALYs	Disability-adjusted Life Years
CVD	Cardiovascular Disease
PM2.5	Fine particulate matter
ARIMA	Autoregressive Integrated Moving Average
LDL	Low-density lipoprotein
ICD	International Classification of Diseases
CI	Confidence Intervals
UI	Uncertainty Intervals

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12905-025-03773-5.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

We appreciate the works of the GBD Study 2021 collaborators.

Authors' contributions

CZ: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Software, Visualization, Writing– original draft. PY: Investigation, Supervision, Validation, Writing review & editing. QY: Investigation, Supervision, Validation, Writing review & editing. PY: Investigation, Supervision, Validation, Writing review & editing. QY: Investigation, Supervision, Validation, Writing review & editing.

Funding

No financial support was received for the research, authorship, and/or publication of this article.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Cardiovascular Medicine, Ministry of Education Key Laboratory of Child Development and Disorders, Chongqing Municipal Health Commission Key Laboratory of Children's Vital Organ Development and Diseases, National Clinical Research Center for Child Health and Disorders, National Clinical Key Cardiovascular Specialty, Children's Hospital of Chongqing Medical University, Chongqing 400014, China.

Received: 8 December 2024 Accepted: 5 May 2025
Published online: 13 May 2025

References

1. Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, Barengo NC, Beaton AZ, Benjamin EJ, Benziger CP, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990–2019: Update From the GBD 2019 Study. J Am Coll Cardiol. 2020;76(25):2982–3021.
2. Vogel B, Acevedo M, Appelman Y, Bairey Merz CN, Chieffo A, Figtree GA, Guerrero M, Kunadian V, Lam CSP, Maas A, et al. The Lancet women and cardiovascular disease Commission: reducing the global burden by 2030. Lancet. 2021;397(10292):2385–438.
3. Zhou M, Wang H, Zeng X, Yin P, Zhu J, Chen W, Li X, Wang L, Wang L, Liu Y, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2019;394(10204):1145–58.
4. Main Data of the Seventh National Population Census [https://www.gov.cn/guoqing/2021-05/13/content_5606149.htm]
5. Outline of the Healthy China 2030 Plan [https://www.gov.cn/zhengce/2016-10/25/content_5124174.htm]
6. Decision of the Central Committee of the Communist Party of China and the State Council on Optimizing Fertility Policy to Promote Long-term Equilibrium Development of the Population [https://www.gov.cn/zhengce/2021-07/20/content_5626190.htm]
7. Solola Nussbaum S, Henry S, Yong CM, Daugherty SL, Mehran R, Poppas A. Sex-specific considerations in the presentation, diagnosis, and management of ischemic heart disease: JACC focus seminar 2/7. J Am Coll Cardiol. 2022;79(14):1398–406.
8. Baris L, Hakeem A, Moe T, Cornette J, Taha N, Farook F, Gaisin I, Bonanomi C, Parsonage W, Johnson M, et al. Acute coronary syndrome and ischemic heart disease in pregnancy: data from the EURObservational Research Programme-European Society of Cardiology Registry of Pregnancy and Cardiac Disease. J Am Heart Assoc. 2020;9(15):e015490.
9. Li Y, Zhang J. Disease burden and risk factors of ischemic heart disease in China during 1990–2019 based on the Global Burden of Disease 2019 report: A systematic analysis. Front Public Health. 2022;10: 973317.
10. Hu B, Wang Y, Chen D, Feng J, Fan Y, Hou L. Temporal trends in the prevalence and death of ischemic heart disease in women of childbearing age from 1990 to 2019: a multilevel analysis based on the Global Burden of Disease Study 2019. Front Cardiovasc Med. 2024;11:1366832.
11. GBD 2021 Diseases and Injuries Collaborators. Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet 2024;403(10440):2133–61.
12. GBD 2021 Causes of Death Collaborators. Global burden of 288 causes of death and life expectancy decomposition in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet 2024;403(10440):2100–32.
13. Li Z, Zhang X, Sun C, Li Z, Fei H, Zhao D. Global, regional, and national burdens of early onset pancreatic cancer in adolescents and adults aged 15–49 years from 1990 to 2019 based on the Global Burden of Disease Study 2019: a cross-sectional study. Int J Surg. 2024;110(4):1929–40.
14. Schaffer AL, Dobbins TA, Pearson SA. Interrupted time series analysis using autoregressive integrated moving average (ARIMA) models: a guide for evaluating large-scale health interventions. BMC Med Res Methodol. 2021;21(1):58.
15. Park K, Bairey Merz CN, Bello NA, Davis M, Duvernoy C, Elgendy IY, Ferdinand KC, Hameed A, Itchhaporia D, Minissian MB, et al. Management of women with acquired cardiovascular disease from pre-conception through pregnancy and postpartum: JACC focus seminar 3/5. J Am Coll Cardiol. 2021;77(14):1799–812.
16. Thurber KA, Thandrayen J, Maddox R, Barrett EM, Walker J, Priest N, Korda RJ, Banks E, Williams DR, Lovett R. Reflection on modern methods: statistical, policy and ethical implications of using age-standardized health indicators to quantify inequities. Int J Epidemiol. 2022;51(1):324–33.
17. Gersh F, O'Keefe JH, Elagizi A, Lavie CJ, Laukkanen JA. Estrogen and cardiovascular disease. Prog Cardiovasc Dis. 2024;84:60–7.
18. Davies RE, Rier JD. Gender disparities in CAD: women and ischemic heart disease. Curr Atheroscler Rep. 2018;20(10):51.
19. Montone RA, Camilli M, Calvieri C, Magnani G, Bonanni A, Bhatt DL, Rajagopalan S, Crea F, Niccoli G. Exposome in ischaemic heart disease: beyond traditional risk factors. Eur Heart J. 2024;45(6):419–38.
20. Eng A, Denison HJ, Corbin M, Barnes L. t Mannetje A, McLean D, Jackson R, Laird I, Douwes J: Long working hours, sedentary work, noise, night shifts and risk of ischaemic heart disease. Heart. 2023;109(5):372–9.
21. Chai KC, Li Q, Bao XL, Zhu J, He XX. An empirical study of economic cycle, air quality, and national health since reform and opening up. Front Public Health. 2021;9:706955.
22. Wu Y, Benjamin EJ, MacMahon S. Prevention and control of cardiovascular disease in the rapidly changing economy of China. Circulation. 2016;133(24):2545–60.
23. Chen W, Li Z, Zhao Y, Chen Y, Huang R. Global and national burden of atherosclerosis from 1990 to 2019: trend analysis based on the Global Burden of Disease Study 2019. Chin Med J (Engl). 2023;136(20):2442–50.
24. Guan C, Wu S, Xu W, Zhang J. Global, regional, and national burden of ischaemic heart disease and its trends, 1990–2019. Public Health. 2023;223:57–66.
25. Mou J, Griffiths SM, Fong H, Dawes MG. Health of China's rural-urban migrants and their families: a review of literature from 2000 to 2012. Br Med Bull. 2013;106:19–43.
26. Wang L, Wang Z, Ma Q, Fang G, Yang J. The development and reform of public health in China from 1949 to 2019. Global Health. 2019;15(1):45.
27. Li X, Krumholz HM, Yip W, Cheng KK, De Maeseneer J, Meng Q, Mossialos E, Li C, Lu J, Su M, et al. Quality of primary health care in China: challenges and recommendations. Lancet. 2020;395(10239):1802–12.
28. Ference BA, Braunwald E, Catapano AL. The LDL cumulative exposure hypothesis: evidence and practical applications. Nat Rev Cardiol. 2024;21(10):701–16.
29. Basrai M, Schweinlin A, Menzel J, Mielke H, Weikert C, Dusemund B, Putze K, Watzl B, Lampen A, Bischoff SC. Energy drinks induce acute cardiovascular and metabolic changes pointing to potential risks for young adults: a randomized controlled trial. J Nutr. 2019;149(3):441–50.
30. Barber TM, Kabisch S, Pfeiffer AFH, Weickert MO. The health benefits of dietary fibre. Nutrients. 2020;12(10):3209.
31. Wang JG, Zhang W, Li Y, Liu L. Hypertension in China: epidemiology and treatment initiatives. Nat Rev Cardiol. 2023;20(8):531–45.
32. Kobayashi Y, Yamagishi K, Muraki I, Kokubo Y, Saito I, Yatsuya H, Iso H, Tsugane S, Sawada N. Secondhand smoke and the risk of incident cardiovascular disease among never-smoking women. Prev Med. 2022;162: 107145.
33. Nwosu C, Angus K, Cheeseman H, Semple S. Reducing secondhand smoke exposure among nonsmoking pregnant women: a systematic review. Nicotine Tob Res. 2020;22(12):2127–33.
34. Liang F, Liu F, Huang K, Yang X, Li J, Xiao Q, Chen J, Liu X, Cao J, Shen C, et al. Long-term exposure to fine particulate matter and cardiovascular disease in China. J Am Coll Cardiol. 2020;75(7):707–17.

35. Wang F, Ma B, Ma Q, Liu X. Global, regional, and national burden of inguinal, femoral, and abdominal hernias: a systematic analysis of prevalence, incidence, deaths, and DALYs with projections to 2030. Int J Surg. 2024;110(4):1951–67.
36. Porter A, Brown CC, Tilford JM, Cima M, Zohoori N, McCormick D, Wilson MP, Amick BC 3rd, Romero JR. Association of the COVID-19 pandemic and dying at home due to ischemic heart disease. Prev Med. 2021;153: 106818.

Publisher's Note