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Trends and predictions of the global burden of ischemic heart disease in women of childbearing age attribute to high body mass index and hypertension,1990–2021: a systematic analysis for the Global Burden of Disease Study

Qi Gu[1†], Shuxiong Nong[2†], Chenang Liu[3†], Yongfeng Chen[4†], Meng Wu[5*], Chilin Liao[2*] and Cong Hu[5*]

Abstract

Background High body mass index (BMI) and hypertension are quite prevalent in women of childbearing age (WCBA) and are also common risk factors for ischemic heart disease (IHD). However, there are few studies globally evaluating the burden of IHD of WCBA attribute to high BMI and hypertension.

Methods The DALYs (Disability-adjusted life years), Deaths, YLDs (Year lived with disabilitys), YLLs (Year of life losts) of IHD in WCBA attributable to high BMI and hypertension were analyzed by age, sex, year, and geographical location and Socio-demographic Index (SDI). To assess the contribution of epidemiological changes, population growth, and population ageing, a decomposition analysis was used. Exponential Smoothing (ES) modeling and the Autoregressive Integrated Moving Average (ARIMA) model were used to predict the global ASDR (age-standardized DALYs rate), ASMR (age-standardized mortality rate) attributed to the 2 risk factors from 2022 to 2050. The cluster analysis was used to evaluate the changing pattern of burden across GBD regions.

Results In 2021, the number of global deaths attribution to high BMI was 9,865,138 (95% UI: 3,845,800–15,976,196), and the corresponding ASMR was 216.05 (95% UI: 84.26–349.49) per 100000 population. In various age groups, the largest increase occurred in 20–24 years group (EAPC = 1.26 (95% CI:1.13–1.39)). The number of DALYs of IHD in WCBA attribution to hypertension is 2,158,633 (95% UI:1,725,994–2,538,752) with a corresponding ASMR 46.05 (95% UI: 36.87–54.15) per 100,000 population. The number of DALYs of IHD in WCBA attribution to hypertension is 37,920,567 (95% UI: 30,389,745–44,641,339), and the corresponding ASDR is 817.79 (95% UI: 655.74–962.67)

†Qi Gu, Shuxiong Nong, Chenang Liu and Yongfeng Chen contributed equally to this work.

*Correspondence:
Meng Wu
wb000713@whu.edu.cn
Chilin Liao
chilinliao@126.com
Cong Hu
dr_hucong@126.com
Full list of author information is available at the end of the article

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per 100000 population. The largest number of Deaths and DALYs of IHD in WCBA was found between 45–49 years. From 1990 to 2021, ASMR and ASDR attributable to high BMI and hypertension led to a sustained upward trend in Low and Low-medium SDI regions. In addition, the ASMR and ASDR for high BMI and hypertension are highest in the Low-middle SDI regions. Globally, from 1990 to 2021, the overall changes in ASMR and ASDR indicate a relatively stable trend in IHD in WCNA attribute to high BMI. Meanwhile, ASMR and ASDR showed an overall downward trend for hypertension. The number of DALYs, deaths, YLLs, and YLDs of IHD in WCBA attribution to high BMI and hypertension based on the ES and ASMIR models are all increasing from 2022 to 2050.

Conclusions Over the past 30 years, the ASMR and ASDR of IHD in WCBA has continued to rise. Countries need to remain vigilant about the increasing burden of IHD in WCBA attribute to high BMI and hypertension. It requires proactive prevention strategies, strict control of risk factors, and increased medical coverage to alleviate the burden of IHD. Each region should develop more proactive and effective strategic measures.

Keywords Women of childbearing age, Hypertension, High BMI, Ischemic heart disease, DALYs, GBD

Introduction

Ischemic heart disease (IHD) is a major chronic cardiovascular disease, which brings a heavy burden to patients and their families. In recent years, with the aging of the global population structure, overall population growth and aging have led to a significant increase in the mortality rate of age-related non-communicable diseases [1, 2]. Currently, IHD has become the leading cause of death for non-communicable chronic diseases worldwide [3]. Compared with male, female also have a large number of IHD [4, 5]. The specific physical conditions of childbearing age, such as adverse pregnancy outcomes, including hypertensive pregnancy disorder, pregnancy diabetes, preterm delivery, early menopause, and the combination of polycystic ovary syndrome and smoking with oral contraceptives, significantly increase the risk of IHD [6, 7]. Therefore, understanding the risk factors of IHD has important clinical and public health intervention value for the epidemiological trends of IHD in WCBA.

In recent decades, high BMI and hypertension have become extremely important and common risk factors that endanger human health, and they also have a serious impact on the burden of IHD, continuously increasing the global public health burden [8]. However, there were limited analysis on the detailed impact of IHD in WCBA [9, 10]. Therefore, studying the burden of IHD in WCBA attributable to high BMI and hypertension is of great value. However, the survey of IHD in WCBA is very limited in geographical areas, mainly in specific national health system data, and lacks age standardized processes [9, 10]. In the past few decades, previous studies have focused on the disease burden of hypertension and high BMI. However, most of these studies are limited to one country or region [9, 10]. Only a few studies were conducted globally, and these studies did not assess high BMI and hypertension in WCBA.

This study utilized the GBD 2021 to analyze ASMR and ASDR and their changes globally in WCBA. The burden of IHD in WCBA caused by high BMI and hypertension was currently unclear, including the spatiotemporal patterns over the past 30 years and future trend. To address these gaps, the study used the data from the GBD 2021 database to estimate the global burden of IHD in WCBA attributable to high BMI and hypertension. Finally, the research predicted the burden of IHD in WCBA from 2022 to 2050. A detailed analysis of the trends and predictions of IHD in WCBA attributable to high BMI and hypertension can help to better understand epidemiology and promote medical practice. These findings may be helpful for health professionals and policy makers to provide and explore effective public health strategies to alleviate the burden of IHD in WCNA.

Method

Social demographic index

From 0 to 1, the Social Population Index (SDI) quantifies the level of social and demographic development of a country or region. Higher levels indicate better socioeconomic development [11–13]. This study classified countries and regions into 5 different SDI regions (High, High-medium, Medium, Low-medium, Low) to investigate the relationship between IHD in WCNA and SDI regions.

Data sources

The GBD 2021 study is the most comprehensive and assessed scientific research on the global disease burden, providing 371 data on diseases and injuries, as well as 88 risk factors. DisMod MR was used to estimate disease burden in this study. DisMod MR is a Bayesian model meta regression tool. In short, it is a standard GBD modeling tool used to describe disease burden by gender, age, location, and year. The data for the 2021 GBD study comes from multiple sources, such as household surveys and demographic statistics. In this study, the burden of

IHD in WCBA attributable to high BMI and hypertension in the population was assumed to be zero at the age of 20. Therefore, the older population was divided into 6 groups: 20–24 years old, 25–29 years old, 30–34 years old, 35–39 years old, 40–44 years old, and 45–49 years old. Based on the temporal trend of IHD in WCBA, the study extracted the data of IHD in WCBA to get 6 age groups (20 to 49 years old) at the global level, 5 SDI regions, and 204 countries from GBD 2021.

Time trend analysis and statistics

We conducted the following statistical analysis on the data: (1) Prevalence, DALY, and age-standardized rates calculation: Calculated the number of prevalent cases, ASPR, DALYs, and ASDALYR for each year. (2) Stratified analysis: Performed stratified analysis on the prevalence and DALY rates by age, gender, SDI, and geographical location. (3) Trend analysis: Analyzed the trend of change in age-standardized rates (ASR) from 1990 to 2021 using the estimated annual percentage change (EAPC) method through a log-linear regression model $y = \alpha + \beta x + \epsilon$ (where $y = \ln(ASR)$ and x is the year). The EAPC was reported along with a 95% confidence interval (CI).

$$CI = \overline{x} \pm z\left(\frac{\sigma}{\sqrt{n}}\right)$$

Z is the Z-score corresponding to the desired confidence level (e.g., 1.96 for 95% confidence). σ is the population standard deviation. n is the sample size.

(4) Cluster analysis: Grouped GBD regions with similar EAPC trends into clusters based on indicators such as prevalence and DALY rates using the K-means clustering method. DALYs represent the total number of years of healthy life lost, encompassing both years of life lost (YLLs) and years lived with disability (YLDs). The formula for DALYs is DALYs = YLL + YLD. The EAPC is a widely utilized metric for tracking changes in disease prevalence and incidence over a specific period [14–17]. This study aims to estimate the dynamic trends in mortality rates and the DALYs for IHD in WCBA from 1990 to 2021. The EAPC is calculated based on a regression model that fits time as a variable, plotting the natural logarithm of each observed value as a straight line and calculating the slope of this line. The formula is $y = \alpha + \beta x + \varepsilon$, where x represents the year, y is the natural logarithm of the rate, α is the intercept, β is the slope, and ε is the random error. The EAPC was reported along with a 95% confidence interval (CI). Furthermore, this study employs the percentage change to reflect the variation between the deaths, and DALYs in 2021 compared to 1990. The percentage change is calculated as (cases in 2021—cases in 1990)/cases in 1990.

ES and ARIMA prediction analysis

The ES and ARIMA model are composed of autoregressive models and moving average model. The basic assumption is that the correlation between random variables in a data sequence that change over time can be described by an ES model and an ARIMA model, enabling the prediction of abandoned individuals based on preprocessed future values. The expression of the equation is as follows: Yt = ϕ 1Yt- 1 + ϕ 2Yt- 2 + + ϕ pYt-p + et − θ 1et- 1 − … − θ qet-q. In this equation, (ϕ 1Yt- 1 + ϕ 2Yt- 2 + … + ϕ pYt-p + et) is a component of the autoregressive model, and (et − θ 1et- 1 − … − θ qet-q) represents the moving average portion. The values observed during the time period (t-p) are represented by (Yt-p), where p and q represent the model order autoregressive and moving average components, indicating that unpredictable biases occur during the time period. The ES model and ARIMA model is necessary to prove that a time series is a random sequence with a mean of zero and to demonstrate stationarity.

Statistical analysis

The data'dplyr'and'tidyr'facilitate cleaning and computation, as well as the'Gollum'package, while the'ggplot2'package is used for data visualization and computation using the'epitools'package age normalization rate. All analyses were conducted using R software (V.4.4.1).

Results

The burden of IHD in WCBA caused by high BMI and hypertension

In 1990, the number of deaths attribution to high BMI in WCBA was 243,512 (92,957–401,576), and DALYs attribution to high BMI of IHD in WCBA was 5,170,714 (2,022,321–8,402,456). In 1990, the number of deaths attribution to hypertension in WCBA was 1,416,908 (1,136,782–1,638,642), and DALYs attribution to hypertension of IHD in WCBA was 25,423,977 (20,645,317–29,677,449). In 2021, the number of global deaths attribution to high BMI was 9,865,138 (95% UI: 3,845,800–15,976,196), and the corresponding ASMR was 216.05 (95% UI: 84.26–349.49) per 100000 population. In various age groups, the largest increase occurred in 20–24 years (EAPC = 1.26 (95% CI:1.13–1.39)), the largest number of deaths in 45–49 years was 599,747 (95% UI: 239,153–942,137) (Table 1A). The number of DALYs of IHD

Table 1 The number of deaths cases, the ASMR and DALYs cases and the ASDR attributable to high (A)BMI and (B) hypertention in 1990 and 2021, and its trends from 1990 to 2021 globally

A					
Deaths					
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Global	5170714 (2022321–8402456)	247.28 (96.3–403.15)	9865138 (3845800–15976196)	216.05 (84.26–349.49)	− 0.06 (− 0.25–0.12)
Sex_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Female	243512 (92957–401576)	12.43 (4.71–20.62)	461122 (176421–763807)	9.92 (3.8–16.41)	− 0.98 (− 1.07–0.89)
Age_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
20–24 years	27286 (8981–46438)	11.18 (3.68–19.02)	50071 (19406–83889)	17.05 (6.61–28.56)	1.26 (1.13–1.39)
25–29 years	50238 (17812–85539)	22.82 (8.09–38.86)	86733 (34719–143031)	29.81 (11.93–49.15)	0.91 (0.77–1.05)
30–34 years	84782 (31666–137411)	44.6 (16.66–72.28)	168371 (65303–265026)	56.32 (21.85–88.66)	0.8 (0.71–0.89)
35–39 years	134051 (49409–215325)	77.28 (28.49–124.14)	264428 (109166–418136)	95.19 (39.3–150.52)	0.58 (0.49–0.67)
40–44 years	186033 (73183–293466)	132.67 (52.19–209.28)	416550 (173536–638605)	167.9 (69.95–257.41)	0.54 (0.43–0.65)
45–49 years	262416 (104219–412754)	230.59 (91.58–362.7)	599747 (239153–942137)	254.52 (101.49–399.82)	0.07 (− 0.02–0.17)
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
High-middle SDI	92695 (35154–154422)	17.78 (6.75–29.79)	158849 (60991–267740)	13.87 (5.36–23.32)	− 1.19 (− 1.45–0.93)
High SDI	88167 (33446–147818)	12.89 (4.91–21.54)	79968 (30721–132943)	5.87 (2.31–9.58)	− 2.89 (− 3.03–2.76)
Low-middle SDI	23227 (8849–37110)	8.27 (3.13–13.2)	81664 (32498–131348)	11.29 (4.41–18.3)	1.18 (1.12–1.25)
Low SDI	5402 (1837–8885)	4.99 (1.72–8.16)	15731 (5956–26072)	6.26 (2.33–10.36)	0.69 (0.61–0.77)
Middle SDI	33550 (12665–54896)	7.15 (2.66–11.79)	124301 (47333–202997)	9.23 (3.5–15.12)	0.79 (0.76–0.83)
DALYs					
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Global	5170714 (2022321–8402456)	247.28 (96.3–403.15)	9865138 (3845800–15976196)	216.05 (84.26–349.49)	− 0.06 (− 0.25–0.12)
Sex_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Female	5170714 (2022321–8402456)	247.28 (96.3–403.15)	9865138 (3845800–15976196)	216.05 (84.26–349.49)	− 0.69 (− 0.78–0.61)
Age_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
20–24 years	27286 (8981–46438)	11.18 (3.68–19.02)	50071 (19406–83889)	17.05 (6.61–28.56)	1.26 (1.13–1.39)
25–29 years	50238 (17812–85539)	22.82 (8.09–38.86)	86733 (34719–143031)	29.81 (11.93–49.15)	0.91 (0.77–1.05)
30–34 years	84782 (31666–137411)	44.6 (16.66–72.28)	168371 (65303–265026)	56.32 (21.85–88.66)	0.8 (0.71–0.89)
35–39 years	134051 (49409–215325)	77.28 (28.49–124.14)	264428 (109166–418136)	95.19 (39.3–150.52)	0.58 (0.49–0.67)
40–44 years	186033 (73183–293466)	132.67 (52.19–209.28)	416550 (173536–638605)	167.9 (69.95–257.41)	0.54 (0.43–0.65)
45–49 years	262416 (104219–412754)	230.59 (91.58–362.7)	599747 (239153–942137)	254.52 (101.49–399.82)	0.07 (− 0.02–0.17)
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
High-middle SDI	1848519 (721050–3026517)	335.86 (130.62–551.3)	2863450 (1141632–4703098)	260.45 (104–425.55)	− 1.31 (− 1.62–1)
High SDI	1578755 (605309–2604661)	245.12 (94.7–403.36)	1366037 (543575–2205683)	123.79 (51.16–195.58)	− 2.52 (− 2.66–2.38)
Low-middle SDI	671366 (255926–1061788)	204.43 (78.2–324.5)	2224289 (899676–3536991)	281.72 (113.32–449.71)	1.21 (1.14–1.27)
Low SDI	161615 (53953–269690)	130.43 (44.25–215.87)	466120 (176193–767544)	159.4 (60.5–263)	0.57 (0.49–0.65)
Middle SDI	900671 (350302–1454095)	163.9 (62.79–267.75)	2933397 (1122908–4714058)	207.55 (79.2–334.65)	0.69 (0.65–0.73)
B					
Deaths					
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Global	1416908 (1136782–1638642)	74.86 (58.99–86.63)	2158633 (1725994–2538752)	46.05 (36.87–54.15)	− 0.87 (− 1.12–0.62)
Age_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
25–29 years	1585 (842–2470)	0.72 (0.38–1.12)	1722 (991–2562)	0.59 (0.34–0.88)	− 0.73 (− 0.85–0.62)
30–34 years	2775 (1687–3965)	1.46 (0.89–2.09)	3718 (2357–5255)	1.24 (0.79–1.76)	− 0.58 (− 0.68–0.49)

Table 1 (continued)

35–39 years	4807 (3078–6989)	2.77 (1.77–4.03)	6887 (4522–9078)	2.48 (1.63–3.27)	− 0.42 (− 0.51–0.34)
40–44 years	9067 (6063–12178)	6.47 (4.32–8.68)	14378 (10053–18484)	5.8 (4.05–7.45)	− 0.46 (− 0.54–0.38)
45–49 years	16610 (12070–20933)	14.6 (10.61–18.39)	27396 (19929–34225)	11.63 (8.46–14.52)	− 0.86 (− 0.92–0.8)
Sex_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Female	1416908 (1136782–1638642)	74.86 (58.99–86.63)	2158633 (1725994–2538752)	46.05 (36.87–54.15)	− 1.69 (− 1.75–1.64)
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
High-middle SDI	483760 (395145–556577)	96.34 (77.38–110.79)	696046 (559246–837195)	59.51 (47.87–71.58)	− 1.8 (− 2–1.6)
High SDI	504584 (400240–587268)	70.75 (55.84–82.54)	323443 (240090–393519)	20.64 (15.43–24.97)	− 4.38 (− 4.54–4.21)
Low-middle SDI	159363 (125407–192161)	64.82 (51.3–77.29)	409411 (329384–486681)	61.91 (49.98–73.14)	0.01 (− 0.07–0.1)
Low SDI	48319 (36459–59792)	54.58 (41.86–67.01)	100612 (77342–125074)	48.38 (37.73–59.82)	− 0.3 (− 0.41–0.18)
Middle SDI	218459 (170568–260838)	52.87 (42.02–63.16)	626593 (489073–754219)	48.63 (37.92–58.5)	− 0.11 (− 0.2–0.02)
DALYS					
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Global	25423977 (20645317–29677449)	1256.43 (1016.18–1464.73)	37920567 (30389745–44641339)	817.79 (655.74–962.67)	− 0.84 (− 1.04–0.63)
Age_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
25–29 years	100540 (53529–156387)	45.68 (24.32–71.05)	109824 (63166–163406)	37.74 (21.71–56.16)	− 0.71 (− 0.83–0.6)
30–34 years	162075 (98618–231047)	85.25 (51.87–121.53)	218197 (138485–308017)	72.99 (46.33–103.04)	− 0.57 (− 0.66–0.48)
35–39 years	256890 (164018–373756)	148.1 (94.56–215.48)	369967 (241853–487679)	133.18 (87.06–175.55)	− 0.41 (− 0.49–0.32)
40–44 years	439856 (294658–591349)	313.68 (210.13–421.71)	700005 (487812–900989)	282.16 (196.63–363.17)	− 0.45 (− 0.53–0.37)
45–49 years	723144 (526222–912937)	635.45 (462.41–802.22)	1201040 (871753–1501246)	509.69 (369.95–637.09)	− 0.84 (− 0.9–0.78)
Sex_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
Female	25423977 (20645317–29677449)	1256.43 (1016.18–1464.73)	37920567 (30389745–44641339)	817.79 (655.74–962.67)	− 1.54 (− 1.59–1.48)
Location_name	Num_1990	ASR_1990	Num_2021	ASR_2021	EAPC_CI
High-middle SDI	8223009 (6760071–9510246)	1529.76 (1250.06–1769.7)	10617879 (8595382–12737102)	931.56 (754.23–1115.76)	− 1.93 (− 2.19–1.67)
High SDI	7623954 (6175517–8804631)	1107.49 (896.09–1280.38)	4377866 (3298284–5286696)	325.63 (246.87–391.55)	− 4.39 (− 4.59–4.19)
Low-middle SDI	3729639 (2897704–4536983)	1300.59 (1020.89–1572.94)	8915629 (7077996–10638395)	1226.81 (982.74–1458.92)	− 0.05 (− 0.13–0.02)
Low SDI	1158677 (867236–1441680)	1104.13 (835.08–1372.73)	2297287 (1766211–2877162)	943.58 (727.83–1175.87)	− 0.48 (− 0.57–0.38)
Middle SDI	4646421 (3601533–5643532)	958.86 (737.95–1150.79)	11670872 (9199254–14037640)	854.6 (671.63–1026.89)	− 0.29 (− 0.36–0.23)

in WCBA attribution to hypertension is 2,158,633 (95% UI:1,725,994–2,538,752) with a corresponding ASMR 46.05 (95% UI: 36.87–54.15) per 100,000 population. The number of DALYs of IHD in WCBA attribution to hypertension is 37,920,567 (95% UI: 30,389,745–44,641,339), and the corresponding ASDR is 817.79 (95% UI: 655.74–962.67) per 100,000 population. In various age groups, the largest number of DALYs of IHD in WCBA was found between 45–49 years, with 1,201,040 (95% UI: 871,753–1,501,246) (Table 1B). Globally, from 1990 to 2021, the overall changes in ASMR and ASDR indicate a relatively stable trend in the impact of high BMI on IHD in WCNA mortality rate and DALYs. Meanwhile, the impact of hypertension on mortality rates and disability-adjusted life years (DALYs) shows an overall downward trend.

The number of DALYs, Deaths, YLDs, YLLs in IHD in WCBA in 2021 are shown in the Fig. 1. The ASMR and ASDR expectancy continue to increase with age groups. The number of deaths and DALYs follows the same age pattern as the ASMR and ASDR. At the SDI regional level, the High-middle SDI region has the largest number of deaths (696,046 (95% UI: 559,246–837,195)) cases, while the Middle SDI region has the largest DALYs with 11,670,872 (95% UI: 9,199,254–14,037,640) cases. The largest ASMR occurs in the Low-middle SDI

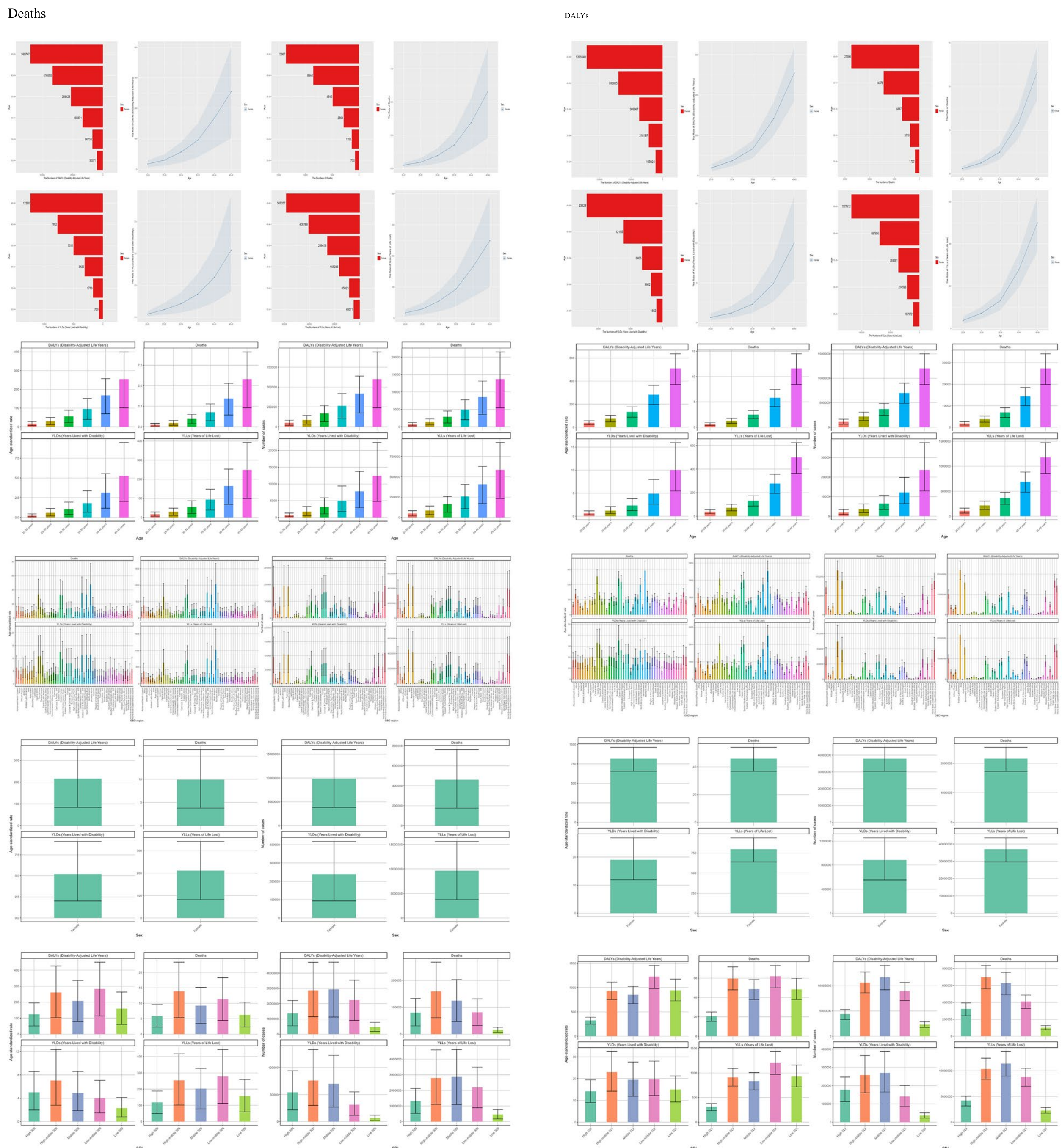


Fig. 1 DALYs, Deaths, YLDs, YLLs of IHD in WCBA in 2021 attribution to (**A**) high BMI and (**B**) hypertension by age groups, SDI regions, gender and 5 SDI regions

region. The SDI level and burden of different countries and regions remain stable according to the pattern of regularity. It can be seen that the number of deaths and DALYs shows an inverted"U"—shaped relationship (Fig. 1 and Table 1).

Decomposition analysis of IHD in WCBA

The research conducted a decomposition analysis of the 3 reasons for IHD in WCBA (population, age, and epidemiological changes). From 1990 to 2021, the analysis found that high BMI and hypertension were the main driving factors for the increase in DALYs, Deaths, YLDs,

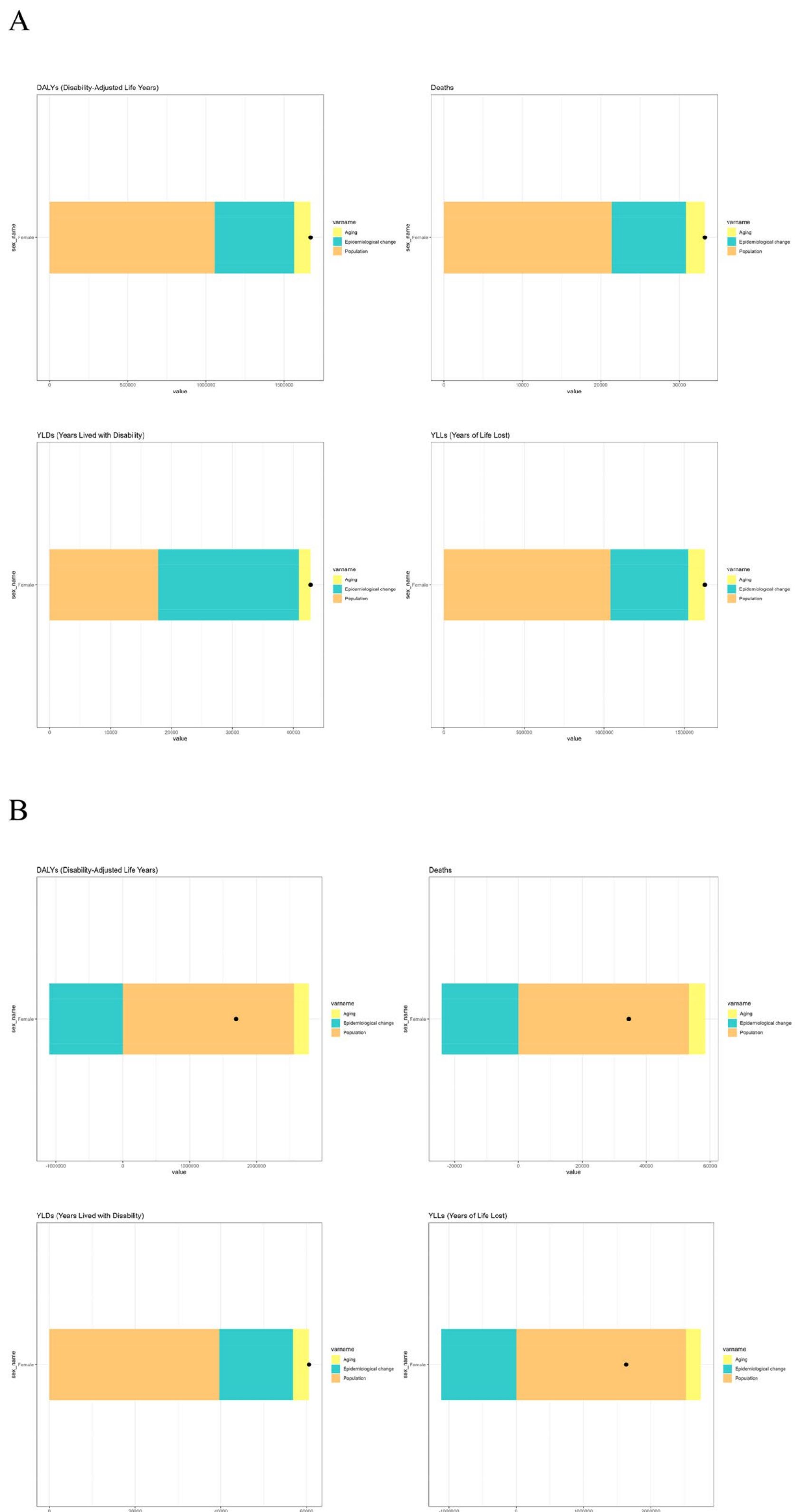


Fig. 2 Decomposition analysis of 3 causes of IHD in WCBA attributed to (**A**) high BMI and (**B**) hypertension from 1990 to 2021, including DALYs, Deaths, YLDs, and YLLs

and YLLs globally and SDI, with demographic factors being the main drivers all of them (Fig. 2).

In the all GBD region, Eastern Africa ranked the top one attribution to high BMI risk for number of deaths (191,937 (95% UI:69,524–314,174)) or DALYs ((5,347,178 (95% UI: 2,572,253–8,253,800)), while Central Sub-Saharan Africa ranked the bottom one for ASMR (624 (95% UI:260–1034)) per 100,000 population. The number of the top of GBD region was Asia (4,633,715 (95% UI:1,720,673–7,378,941)). For the corresponding ASR, the top region is Northern Africa (DALYs: 1032.16 (95% UI:436.93–1664.98)) per 100,000 population, with the bottom being Western Europe (DALYs: 69.10 (95% UI:26.95–114.38)) per 100,000 population. The burden of IHD in WCBA attributed to high BMI varies greatly around the world, with Egypt having the top ASMR 96.93 (95% UI:40.34–153.82) per 100,000 population and a population of 17,936 (95% UI:7832–28150), followed by the United Arab Emirates with an ASMR 80.56 (95% UI:33.07–134.21) per 100,000 population. In Japan, the ASMR is bottom (0.89 (95% UI:0.31–1.49)) per 100,000 population. The ASDR observed in the Syrian Arab Republic was highest (1367.56 (95% UI:570.46–2264.33)) per 100,000 population, with a population of 83,806 (95% UI:35,739–137,773), followed by the United Arab Emirates with an ASDR (1339.58 (95% UI:561.25–2229.73)) per 100,000 population. Japan also has the lowest ASDR (17.56 (95% UI: 6.44–28.38)) per 100,000 population, followed by the Republic of Korea (22.26 (95% UI: 8.03–38.36)) per 100,000 population. The top number of DALYs was in China at 1,456,067 (95% UI: 534,453–2,551,754), followed by India. However, San Marino recorded the lowest number of DALYs (19 (95% UI:7–35)) per 100,000 population (Fig. 3, Table BMI Death S-region S-countries, Table BMI DALYs S-region S-countries).

In the context of hypertension risk, Asia stands out as the top region in terms of death numbers in 2021 (1,163,830 (95% UI: 916,735–1,414,641)). However, Northern Africa has the top ASMR (146.41 (95% UI: 112.95–179.33)) per 100,000 population, while the High-income Asia Pacific region has the bottom ASMR (7.92 (95% UI: 5.62–10.21)). per 100,000 population China accounts for the top number of deaths (463,644 (95% UI: 321,060–642,210)), followed by India (316,025 (95% UI: 244,689–385,386)). Japan exhibits the bottom ASMR in 2021(7.69 (95% UI: 5.36–9.94)) per 100,000 population. Togo has the top ASMR (99.47 (95% UI: 72.43–125.51)) per 100,000 population and also the largest decline (EAPC =(− 6.12 (95% UI: − 7.28–4.94)). Conversely, Benin shows the largest increase (EAPC (3.49 (95% CI: 1.84–5.16)). Thailand has the top number of DALYs (6,976,296 (95% UI: 5,375,400–8,592,353)). Egypt has the highest ASDRs (3,993.95 (95% UI: 3,049.68–4,953.54)) per 100,000 population. Denmark experiences the largest decline in DALYs (EAPC =− 6.33 (95% CI: − 7.35–5.3)), while Lesotho has the largest increase (EAPC =3.73 (95% CI: 2.93–4.52)). These figures underscored the significant regional disparities in the burden of IHD in WCBA attribution to hypertention and highlight the need for health policies to address these varying challenges (Fig. 3, Table hypertention Death S-region S-countries, Table hypertention DALYs S-region S-countries).

Time trend of burden of IHD in WCBA attribution to high BMI and hypertention from 1990 to 2021

Furthermore, we conducted further analysis to derive the burden trends of IHD in WCBA attribution to high BMI and hypertention in different age groups and SDI globally, specifically comparing data from 1990 and 2021.The number of deaths of IHD in WCBA attribution to high BMI increased from 243,512 (95% UI: 92,957–401,576) to 461,122 (95% UI:176,421–763,807) from 1990 to 2021. However, the corresponding ASMR were the opposite trend, ranging from (12.43 (95% UI: 4.71–20.62)) per 100,000 population to (9.92 (95% UI: 3.8–16.41)) per 100,000 population (EAPC =− 0.22 (95% CI: − 0.45–0.01)). The number of deaths of IHD in WCBA attribution to hypertention increased from 25,423,977 (95% UI: 20,645,317–29,677,449) to 37,920,567 (95% UI: 30,389,745–44,641,339) from 1990 to 2021(EAPC − 0.84 (95% CI: − 1.04–0.63)). The estimation of DALYs, YLDs and YLLs also follows the same pattern, with an increase in the number of cases and a decrease in ASR. Moreover, the trends are consistent across most of age groups (Figs. 4 and 5). The largest number of IHD in WCBA attribution to high BMI and hypertention in 2021 occurred in the 45–49 years age group. At the SDI regional level, the ASMR and ASDR increased in Low SDI, Low-medium SDI, and Medium SDI regions, while these indicators decreased in other SDI regions. In terms of DALYs and deaths cases, High SDI regions show a stable downward trend, while other SDI regions show an upward trend (Figs. 4 and 5). Overall, the burden of IHD in WCBA, measured by deaths and DALYs, was bottom one in individuals aged <25 years and gradually increasing to a higher level before the age of 49 years.

From 1990 to 2021, the changes in number of DALYs has shown the most significant increasing in Zambia (EAPC =5.73 (95% CI: 4.41–7.06)), with ASDR (162.78 (95% UI: 59.8–290.22)) in 2021.The Afghanistan, Yemen, Albania and Bahamas showed a similar pattern, with an overall modest stable trend. The largest increase in mortality rate was in Zimbabwe (EAPC =5.42 (95% CI:

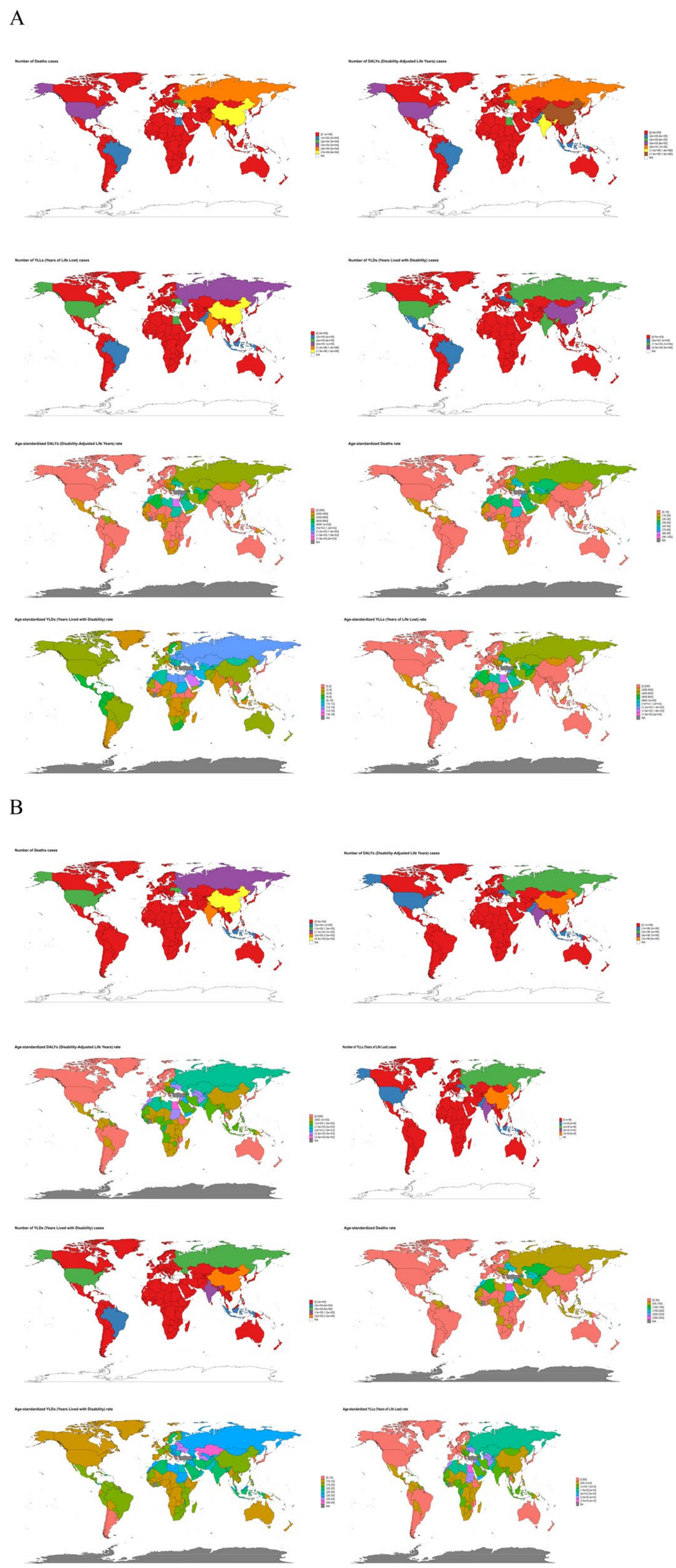


Fig. 3 Numbers and age standardized rates of DALYs, Deaths, YLDs, YLLs of IHD in WCBA attributed to (**A**) high BMI and (**B**) hypertension in 204 countries and regions in 2021

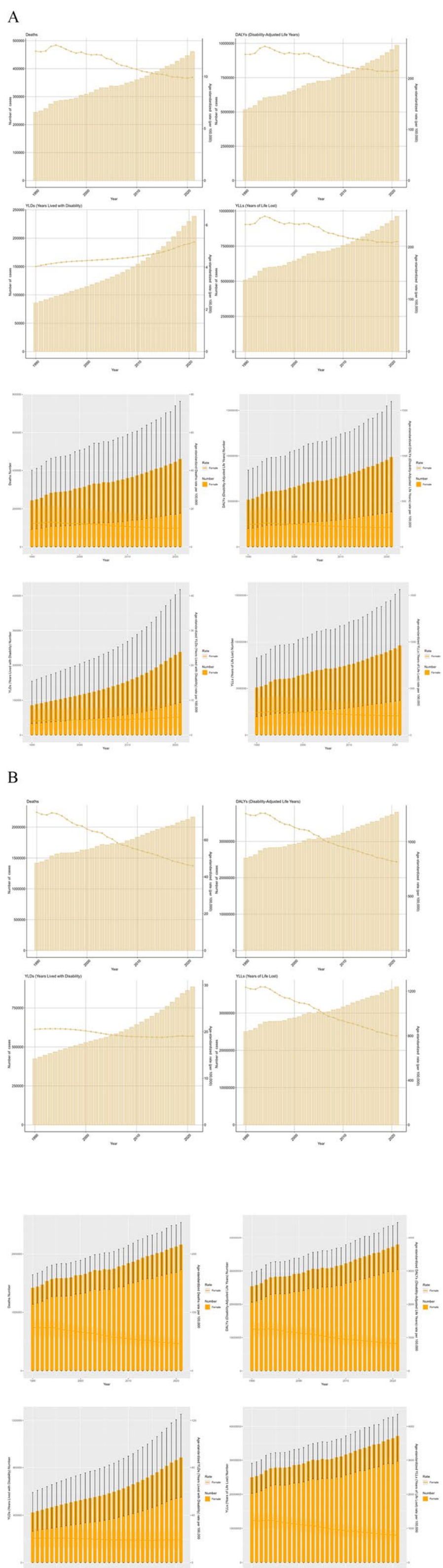


Fig. 4 The global burden of IHD in WCBA attributable to (**A**) high BMI and (**B**) hypertention from 1990 to 2021.Number and age-standardized rates of deaths, DALYs, YLDs and YLLs attributable to High BMI and hypertention, 1990–2021

3.98–6.89)), while Israel largest decreased (EAPC = − 5.15 (95% CI: − 5.55–4.74)) (Fig. 6).

Forecast results from 2022 to 2050

The ASMR, ASDR, YLLs and YLDs worldwide from 1990 to 2050 was used the ES model (Fig. 7A) and ARIMA model (Fig. 7B). The number of DALYs, deaths, YLLs, and YLDs based on the ES and ASMIR models are all increasing. However, the increasing of ASR is more pronounced in the ASMIR model. In contrast, the ASR shows relatively stable trends in DALYs, deaths, YLLs, and YLDs in ES model, while it exhibits a stable trend in deaths and YLDs in ASMIR model. Notably, the ASR of DALYs have significantly decreased, whereas the YLLs of ASR was growing fastest. Overall, the prediction results of the ES and ARIMA model show that from 2022 to 2050, the number of deaths and DALYs will increase globally.

Clustering analysis

In GBD regions, the IHD in WCBA attribution to high BMI and hypertension varied. Hierarchical clustering analysis was conducted to identify regions with similar changes in disease burden in this study, as shown in the Fig. 8. To find regions with similar variation in IHD in WCBA, a hierarchical clustering analysis was conducted in this study. The results were shown in Fig. 8. The significant ASMR and ASDR increase occurred in regions with red color, while the significant decrease was in regions with blue color.

Discussion

This study provides a detailed analysis of the global disease burden trends for IHD in WCBA caused by high BMI and hypertension from 1990 to 2021 and predicts future trends using two models. The results show that although the total number of global disease burden trends for IHD in WCBA caused by high BMI and hypertension have increased during this period, the global ASDALYR and ASDR for IHD in WCBA caused by hypertension have declined. This phenomenon may be attributed to improvements in diagnostic and therapeutic approaches worldwide. However, despite advancements in treatment methods, the overall number of DALYs for IHD in WCBA caused by high BMI and hypertension continues to increase, indicating that a large number

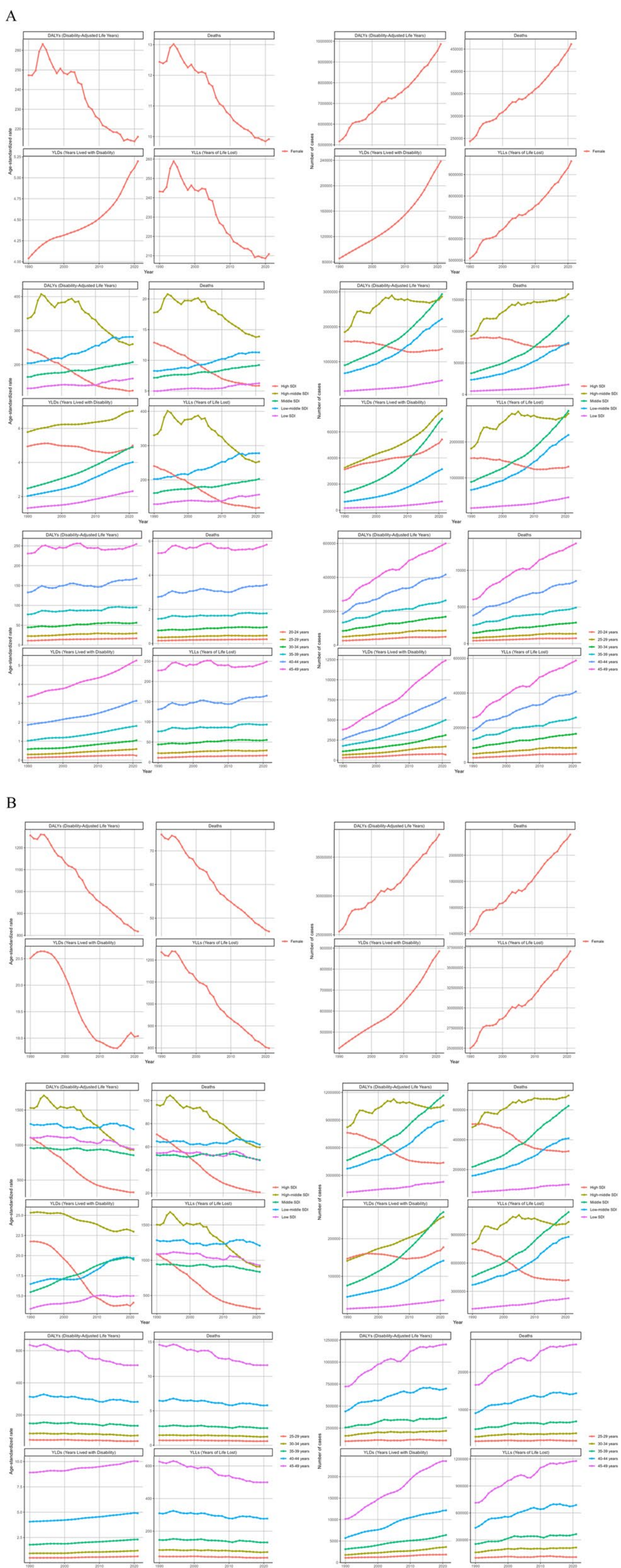


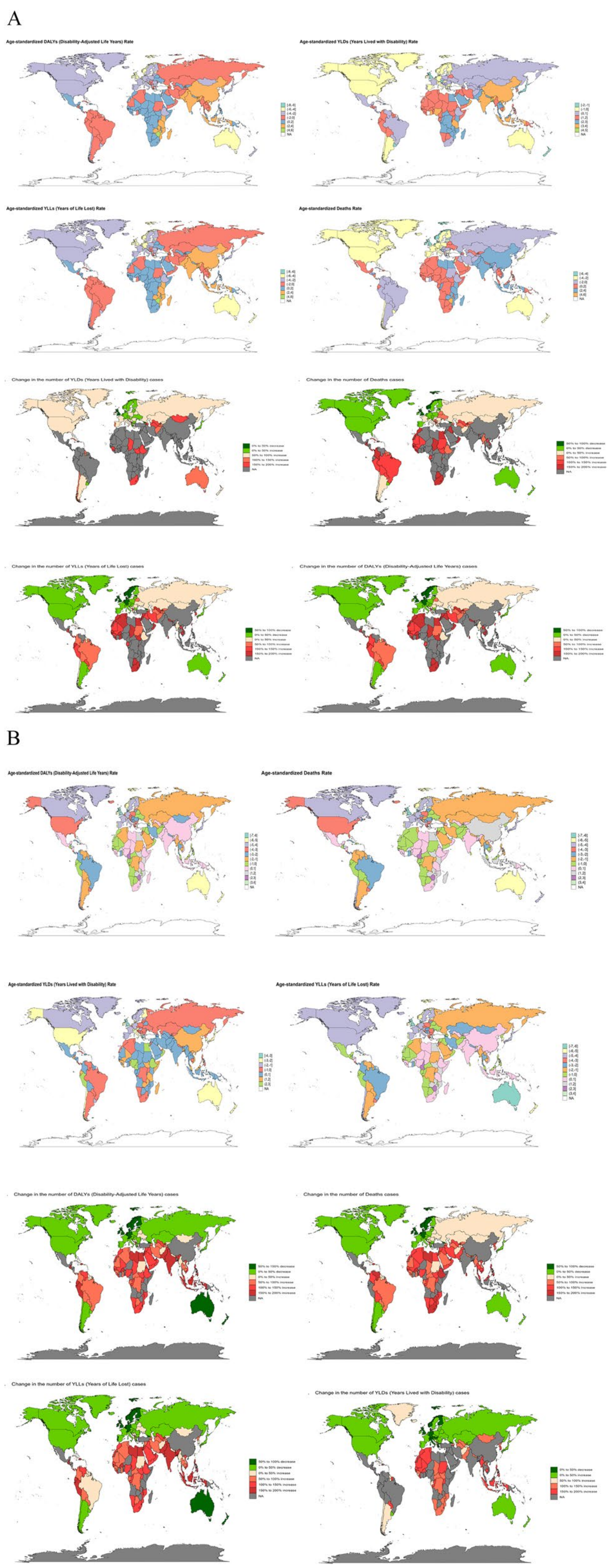
Fig. 5 Age-standardized rates of DALYs, YLLs, YLDs and deaths attributable to (**A**) high BMI and (**B**) hypertention to IHD in WCBA by gender, SDI quintiles and age groups from 1990 to 2021

of patients have not fully benefited from existing treatments, which may be related to the aging population and the increasing prevalence of IHD in WCBA caused by high BMI and hypertension.

The incidence of IHD in WCBA is lower than that in the elderly. Pregnancy is a risk factor for IHD, as pregnancy is a challenging event in the context of IHD, leading to numerous complications and significant maternal mortality rates. Many women experience life events such as menstruation, pregnancy, childbirth, and menopause, which expose them to specific risk factors (like pregnancy-related diseases, polycystic ovary syndrome, etc.) that can increase their risk of cardiovascular diseases [18, 19]. However, the ASMR and ASDR of IHD in WCBA have been surveyed in very limited geographical areas, mainly within a specific country, using data from national health systems and lacking age-standardization processes [9, 10], which further constrains cross-regional and cross-national comparisons. These studies are mostly limited to one region or country [9, 10]. Only a few studies have been conducted on a global scale. Due to the fact that this queue is only conducted locally, there may be some limitations that result in insufficient extrapolation accuracy of the method. In contrast, the data for the GBD 2021 study comes from multiple sources, such as household surveys, demographic statistics, and other sources. This study has been conducted in many countries. Therefore, The GBD research provides more accurate estimates of burden of IHD in WCNA. A global analysis of the ASR of IHD in WCNA over the past decades can fill the gap [20–25].

To our knowledge, this is a comprehensive assessment and quantification of the global burden of IHD in WCBA attribution to high BMI and hypertension. In-depth analysis of the trends can help better understand the epidemiology of the IHD in WCBA and promote medical practices, thereby contributing to the achievement of sustainable development goal. The burden of IHD in WCBA varies significantly by age, SDI region, GBD region, and country. In 2021, despite the estimated global ASMR and ASDR of IHD in WCBA being different, they were highest in the Americas and Europe, indicating that relatively developed regions may disproportionately bear a higher burden of IHD in WCBA. This is similar to previous studies, suggesting that the level of socio-demographic development may not be directly proportional to the burden of IHD [25–27]. At the national level, there were significant differences in ASMR and ASDR across 204 countries and territories, highlighting the strong heterogeneity of the burden of IHD in WCBA globally [28, 29].

From few decades, the global ASMR and ASDR of IHD showed an improvement trend. The deaths and DALYs cases remained very severe and is on the rise [30–34]. In



◀ **Fig. 6** Percentage change of age-standardized DALYs, deaths, YLLs, YLDs rate and change of the number in IHD in WCBA attribution to (**A**) High BMI and (**B**) hypertention in 204 countries from 1990 to 2021

this study, GBD 2021 was used to estimate the ASMR and ASDR of IHD in WCBA attribution to hypertension and high BMI, as well as to further analyze their global and regional trends. From 1990 to 2021, IHD attribution to hypertension and high BMI showed an upward trend in ASMR and ASDR. In addition, our forecast results indicate that the number of deaths and DALYs will continue to increase in the next 30 years. This may be due to the increasing number of deaths and DALYs caused by population aging. Therefore, the prevention measures should be included in early health interventions for IHD in WCBA attribution to hypertension and high BMI.

Developing targeted prevention strategies is crucial for reducing the burden of IHD. Controlling modifiable risk factors such as hypertension and high BMI can significantly lower the incidence of IHD. For example, implementing community-based hypertension screening programs, providing essential medicines at affordable prices (such as lowering the cost of antihypertensive drugs), and improving dietary patterns (such as reducing the intake of high-sodium foods) have been proven to be effective preventive measures. In addition, using artificial intelligence technology for early diagnosis and risk assessment can further enhance the precision and effectiveness of prevention strategies. In low- and middle-income countries, where resources are limited, the implementation of prevention strategies is particularly important. These countries can reduce the burden of IHD by strengthening primary health care infrastructure, raising public health awareness, and promoting healthy lifestyles. For instance, tracking and managing high-risk populations through community health networks and mobile applications can increase the coverage and effectiveness of preventive measures.

Due to the dependence on GBD database data, this study has been limited by several factors. The burden of IHD in WCBA may be underestimated in GBD studies, particularly in less developed countries due to poor medical record-keeping systems [35]. The availability of the primary data in the database is another major limitation that should be considered. This disease burden data was estimated using the standardized Bayesian method DisMod MR regression tool [36]. The data extracted from the GBD database may heavily rely on modeled estimates, as a multitude of statistical models are used to overcome issues of uneven

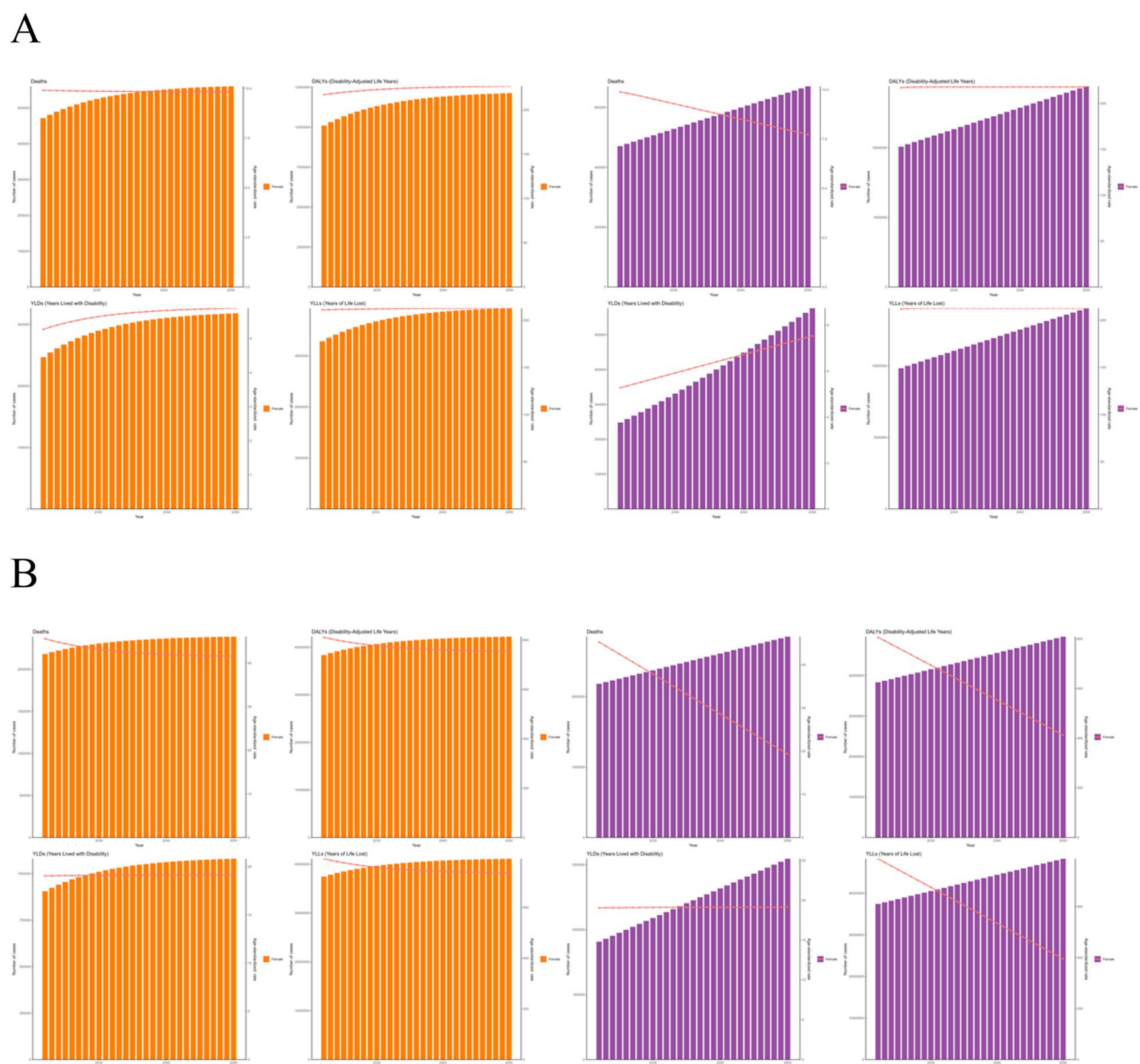


Fig. 7 ES and ASMIR models predicted the trend of DALYs, deaths, YLLs, YLDs in IHD in WCBA due to high (**A**)BMI and (**B**)hypertension from 2022 to 2050

data quality, especially in countries lacking primary data. The limited IHD data included in the GBD database may restrict the ability to explore more broadly [37]. Finally, the predictions of this study assume that other factors remain constant over the next 30 years. However, it is worth noting that some variables may change [38, 39]. A significant strength of this research is the accurate estimation of ASDR for this population, which can be adjusted for the heterogeneity of age structures to eliminate the age confounding effects across different geographical regions, ensuring effective comparisons and providing a basis for further scientific research.

Conclusion

In summary, high BMI and hypertension pose a significant disease burden globally, especially in regions with moderate economic development. The study found that the number of cases will continue to increase in the future. Over the past 30 years, it indicates that high BMI and hypertension remain important public health

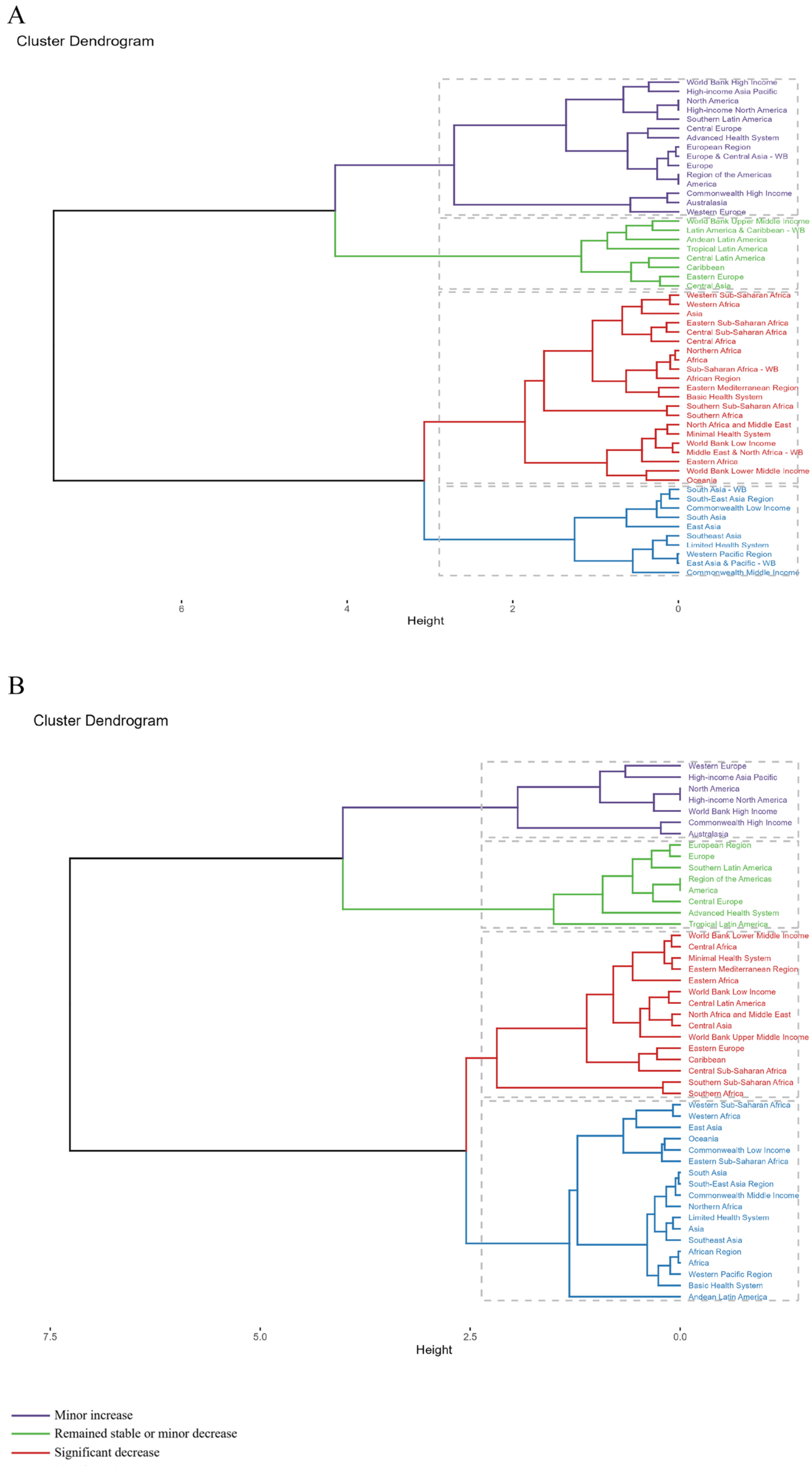


Fig. 8 Cluster analysis results based on EAPC values of the age-standardized rates for deaths and DALYs of IHD attribution to (**A**) high BMI and (**B**) hypertention from 1990 to 2021. Abbreviations: EAPC, estimated disability-adjusted-life-years

issues that need to be addressed. Stricter mitigation and adaptation strategies should be implemented and designed to protect individuals and control high BMI and hypertension. It implies that governments should develop adaptable health policies and allocate resources judiciously to cater to the varying needs associated with IHD in WCBA within their respective populations.

Abbreviations

WCBA	Women of childbearing age
BMI	Body Mass Index
DALYs	Disability-adjusted life years
IHD	Ischemic heart disease
YLL	Year of life lost
YLD	Year lived with disability
ASDR	Age-standardized DALYs rate
ASMR	Age-standardized mortality rate
SDI	Socio-demographic index
GBD	Global Burden of Disease
APC	Age-period-cohort
BAPC	Bayesian age-period-cohort
ASR	Age-standardized rate
EAPC	Estimated annual percentage change

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12872-025-04741-5.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

Supplementary Material 5.

Supplementary Material 6.

Supplementary Material 7.

Supplementary Material 8.

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Authors' contributions

Cong Hu, Qi Gu, Chenang Liu, Yongfeng Chen: Conceptualization, formal analysis, methodology, software, visualization, and writing-original draft. Shuxiong Nong and Chilin Liao, Meng Wu: Investigation, project administration, supervision, and writing-review & editing.

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Data availability

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Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

All the authors have reviewed and approved the manuscript for publication.

Competing interests

The authors declare no competing interests.

Author details

[1]The Third Affiliated Hospital of Chongqing Medical University (FangDa Hospital), Chongqing, China. [2]Department of Cardiology, Baise People's Hospital, Affiliated Southwest Hospital of Youjiang Medical University for Nationalities, Baise 533000, Guangxi, China. [3]Zhongnan Hospital of Wuhan University, Teaching Office, Wuhan, Hubei, China. [4]Social medical development department of Zhongnan Hospital of Wuhan University, Wuhan, Hubei, China. [5]Department of Ultrasound, Zhongnan Hospital of Wuhan University, Wuhan 430071, Hubei, China.

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