

Trend Analysis of the Burden of Hypertensive Heart Disease in China from 1990 to 2021

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Abstract: *Objective:* To quantitatively analyze the burden of hypertensive heart disease (HHD) in China and provide a scientific basis for prevention and control strategies. *Methods:* Data from the Global Burden of Disease 2021 database were used to assess the disease burden, deaths, years lived with disability (YLDs), and risk factors for HHD in the Chinese population from 1990 to 2021. *Results:* From 1990 to 2021, HHD cases in China increased from 1.5 million to 3.9 million, with an average annual growth rate of 2.83%. Prevalence rose from 127.76/100,000 to 259.00/100,000, while age-standardized prevalence decreased by 0.68% annually. HHD deaths increased from 232,478 to 320,247, with a mortality rate rise from 19.76/100,000 to 22.56/100,000, though age-standardized mortality decreased by 2.68% annually. YLDs rose from 124,386 to 301,426, with the rate increasing by 2.20% annually, while age-standardized YLDs decreased by 0.67% annually. High sodium intake and low fruit consumption were key risk factors for HHD deaths. Deaths related to low vegetable intake decreased until 2005 and then rose, while deaths from lead exposure showed a similar pattern. *Conclusion:* HHD cases and prevalence increased significantly, but age-standardized prevalence and mortality rates declined, reflecting the impact of an aging population and improved health interventions. The rise in YLDs highlights the long-term impact on patients' quality of life. Key risk factors included high sodium intake and low fruit consumption, emphasizing the importance of dietary improvements in HHD prevention. HHD remains a significant public health challenge in China, requiring continuous research and targeted prevention strategies.

Keywords: Hypertensive heart disease; Disease burden; Attribution risk factors; China

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1. Introduction

Hypertensive heart disease (HHD) is a significant global cardiovascular burden, with notable differences in incidence and mortality rates across various regions and populations ^[1]. As the world's most populous country, China has seen substantial changes in the burden of HHD over the past few decades ^[2]. Between 1990 and 2021, societal

development, lifestyle changes, and improvements in healthcare services have contributed to complex shifts in both the burden of HHD and its attributable risk factors among the Chinese population^[3]. The Global Burden of Disease (GBD) database offers a valuable resource for evaluating and comparing disease burdens across different regions and time periods^[4]. This study systematically analyzes trends in HHD burden in China from 1990 to 2021 using the GBD database and explores the primary risk factors, aiming to provide scientific evidence for targeted prevention and control strategies^[5]. Through this in-depth analysis, the study reveals the epidemiological characteristics of HHD in China, offering valuable insights for public health policy formulation and resource allocation^[6].

2. Materials and methods

2.1. General information

This study utilized data from the latest Global Burden of Diseases (GBD 2021) database, which provides detailed epidemiological information on ischemic heart disease in China from 1990 to 2021, including incidence, prevalence, and burden indicators by age, gender, and region. GBD 2021 analyzes and estimates the burden of 369 diseases and injuries across 204 countries and regions, using consistent and comparable methodologies. It also systematically assesses the attributable burden of 87 risk factors, making it the most comprehensive global database available. For this study, data was selected from GBD 2021, focusing on China as the region and hypertensive heart disease as the disease. Only level 3 risks were selected as risk factors, covering all years from 1990 to 2021, all ages, and both genders. Hypertensive heart disease was defined according to the Tenth Revision of the International Classification of Diseases (ICD-10).

2.2. Indicator selection

The study evaluated trends in the prevalence and burden of ischemic heart disease in China using indicators such as the number of cases, deaths, years lived with disability (YLDs), prevalence, mortality rate, YLD rate, and age-standardized rates (ASR) of prevalence, mortality, and YLDs. All data were obtained directly from the official GBD website (<https://www.healthdata.org/gbd>).

2.3. Statistical analysis

Statistical analyses were conducted using R software (version 4.2.1) and SAS software (version 9.4) to ensure accuracy and reliability. A significance level of $P < 0.05$ was used to assess the statistical significance of the results.

3. Results

3.1. Trends in prevalence of hypertension-related heart disease (1990–2021)

The prevalence of hypertension-related heart disease in the Chinese population showed varying trends from 1990 to 2021. The number of affected individuals increased from 1,503,019 in 1990 to 3,912,518 in 2021, with an average annual growth rate of 2.83%. The prevalence rose from 127.76 per 100,000 to 259.00 per 100,000, with an average annual growth rate of 2.23%. However, the age-standardized prevalence decreased from 218.24 per 100,000 to 175.37 per 100,000, with an average annual decline of 0.68%. These data suggest that while the total number of cases and prevalence have significantly increased, the disease burden has decreased when adjusting for changes in the population's age structure. This may reflect improvements in medical care and health interventions but also highlights the need for continued attention to potential changes in disease burden due to an aging population. See **Table 1**.

Table 1. Prevalence of hypertension-related heart disease in the Chinese population (1990–2021)

Years	Prevalence number	Prevalence rate (per 100,000)	Age-standardized prevalence rate (per 100,000)
1990	1503019.28 (1161178.42–1916381.58)	127.76 (98.70–162.89)	218.24 (169.31–274.83)
1991	1555270.30 (1209199.56–1968685.15)	130.39 (101.37–165.05)	218.33 (169.67–273.72)
1992	1605685.47 (1251424.43–2026792.18)	133.11 (103.75–168.03)	218.04 (170.84–272.29)
1993	1654185.00 (1290308.54–2081207.07)	135.90 (106.00–170.98)	217.47 (171.02–271.59)
1994	1701875.11 (1331710.71–2135778.42)	138.78 (108.60–174.16)	216.72 (170.77–270.10)
1995	1748616.63 (1372910.30–2193865.78)	141.73 (111.28–177.82)	215.79 (170.65–269.07)
1996	1791369.48 (1406841.98–2248224.74)	144.48 (113.47–181.33)	214.20 (169.72–266.31)
1997	1827245.80 (1434410.33–2291535.22)	146.77 (115.21–184.06)	211.63 (167.82–262.60)
1998	1858198.53 (1458836.87–2328428.02)	148.70 (116.74–186.33)	208.43 (165.02–258.28)
1999	1888060.52 (1482659.93–2364639.87)	150.54 (118.22–188.54)	204.93 (161.94–254.41)
2000	1916575.22 (1507698.50–2402680.11)	152.22 (119.75–190.83)	201.42 (159.24–250.94)
2001	1932620.83 (1523221.43–2420734.71)	152.79 (120.43–191.38)	196.42 (155.74–244.35)
2002	1931559.83 (1530836.00–2411383.38)	151.94 (120.42–189.68)	189.42 (150.61–235.38)
2003	1925541.42 (1533264.07–2397912.05)	150.65 (119.96–187.61)	182.14 (145.32–225.62)
2004	1929809.09 (1542574.43–2398384.13)	150.15 (120.02–186.61)	176.30 (141.28–217.90)
2005	1962248.58 (1572755.27–2436891.92)	151.78 (121.65–188.49)	173.60 (139.42–214.62)
2006	2022084.09 (1621011.06–2511005.90)	155.39 (124.57–192.96)	173.21 (139.14–214.33)
2007	2091436.68 (1676970.28–2597479.08)	159.59 (127.96–198.20)	173.06 (138.88–214.35)
2008	2164187.34 (1735473.86–2687954.26)	163.96 (131.48–203.64)	173.09 (138.70–214.49)
2009	2244041.02 (1797912.38–2785856.57)	168.86 (135.29–209.63)	173.31 (139.14–214.99)
2010	2326318.36 (1867957.30–2886170.19)	174.00 (139.72–215.88)	173.73 (139.63–215.54)
2011	2425868.09 (1947116.08–3011495.27)	180.51 (144.89–224.09)	174.74 (140.39–216.75)
2012	2541967.18 (2036398.85–3157088.69)	188.13 (150.71–233.65)	176.41 (142.18–218.92)
2013	2666071.99 (2138470.73–3309008.29)	196.13 (157.32–243.43)	178.40 (144.01–221.34)
2014	2808439.07 (2252082.16–3492818.11)	205.31 (164.64–255.34)	180.33 (145.57–223.47)
2015	2937362.25 (2352509.37–3654876.71)	213.26 (170.80–265.35)	181.84 (146.59–225.30)
2016	3077738.83 (2469681.74–3829479.96)	221.76 (177.95–275.93)	183.11 (148.20–226.45)
2017	3221494.31 (2574557.26–4012461.26)	230.41 (184.14–286.98)	184.50 (148.19–228.84)
2018	3365007.60 (2671844.17–4207281.13)	239.13 (189.87–298.99)	185.84 (148.11–231.91)
2019	3523980.35 (2785112.00–4433317.11)	249.16 (196.92–313.45)	186.93 (148.04–234.48)
2020	3676490.52 (2887110.91–4629014.97)	259.00 (203.39–326.11)	188.12 (149.55–235.49)
2021	3912158.01 (2989416.83–5056001.54)	274.97 (210.12–355.37)	192.47 (146.68–245.02)
Estimate annual percentage change	2.83 (2.55–3.11)	2.23 (1.96–2.50)	-0.68 (-0.91–0.45)

3.2. Trends in mortality of hypertension-related heart disease (1990–2021)

From 1990 to 2021, the number of deaths from hypertension-related heart disease in China increased from 232,478 to 320,247, with an average annual growth rate of 0.99%. The mortality rate rose from 19.76 per 100,000 to 22.56 per 100,000, with an average annual growth rate of 0.40%. However, the age-standardized mortality rate decreased significantly from 42.64 per 100,000 in 1990 to 18.85 per 100,000 in 2021, with an average annual decline of 2.68%. These trends suggest that although the total number of deaths has increased, the actual risk of death when adjusted for age has significantly decreased. This may reflect advances in medical technology, public health measures, and chronic disease management. However, population growth and aging continue to affect the overall number of deaths, underscoring the need to optimize medical resources and strengthen health intervention measures. See **Table 2**.

Table 2. Mortality of hypertension-related heart disease in the Chinese population (1990–2021)

Years	Death number	Death rate (per 100,000)	Age-standardized death rate (per 100,000)
1990	232478.52 (155805.88–275583.86)	19.76 (13.24–23.42)	42.64 (30.32–49.56)
1991	238308.74 (163092.05–277088.27)	19.98 (13.67–23.23)	42.24 (30.38–48.63)
1992	238034.02 (163859.98–272984.86)	19.73 (13.58–22.63)	40.86 (29.35–46.35)
1993	234837.32 (161299.24–270652.58)	19.29 (13.25–22.23)	39.13 (28.23–44.63)
1994	230710.39 (166536.41–261554.91)	18.81 (13.58–21.33)	37.42 (27.85–42.20)
1995	228829.47 (167862.75–257876.56)	18.55 (13.61–20.90)	36.03 (27.02–40.23)
1996	226290.51 (166635.13–251461.05)	18.25 (13.44–20.28)	34.51 (26.45–38.36)
1997	222893.42 (170555.27–249912.91)	17.90 (13.70–20.07)	32.96 (25.57–36.81)
1998	220903.60 (170180.34–246126.95)	17.68 (13.62–19.70)	31.65 (25.06–35.08)
1999	219895.04 (174614.27–244302.27)	17.53 (13.92–19.48)	30.52 (24.21–34.01)
2000	218240.88 (177234.43–245869.02)	17.33 (14.08–19.53)	29.43 (24.40–33.21)
2001	213278.72 (179203.24–243959.93)	16.86 (14.17–19.29)	27.98 (23.58–32.05)
2002	204499.60 (176454.20–234857.42)	16.09 (13.88–18.47)	26.01 (22.31–30.42)
2003	197348.29 (165208.75–232690.90)	15.44 (12.93–18.21)	24.59 (20.63–29.56)
2004	191541.86 (160989.76–238241.96)	14.90 (12.53–18.54)	23.22 (19.39–29.10)
2005	187376.68 (157649.12–230331.73)	14.49 (12.19–17.82)	22.03 (18.55–27.20)
2006	180966.01 (160223.36–219811.05)	13.91 (12.31–16.89)	20.36 (17.81–24.82)
2007	184064.88 (160319.97–216488.45)	14.04 (12.23–16.52)	19.90 (17.25–23.90)
2008	197153.44 (171210.93–223280.20)	14.94 (12.97–16.92)	20.51 (17.59–23.57)
2009	209643.89 (173842.89–231980.52)	15.78 (13.08–17.46)	20.92 (17.24–23.18)
2010	222432.93 (179534.11–249855.60)	16.64 (13.43–18.69)	21.27 (17.22–23.80)
2011	231667.50 (185156.95–263636.20)	17.24 (13.78–19.62)	21.17 (16.79–24.15)
2012	239788.57 (184233.02–284950.93)	17.75 (13.63–21.09)	20.81 (15.85–24.75)
2013	251495.27 (184377.52–309505.40)	18.50 (13.56–22.77)	20.89 (15.09–25.69)
2014	263212.70 (184110.13–333057.04)	19.24 (13.46–24.35)	20.87 (14.37–26.43)
2015	273769.33 (191201.86–351871.47)	19.88 (13.88–25.55)	20.69 (14.24–26.67)

Table 2 (Continued)

Years	Death number	Death rate (per 100,000)	Age-standardized death rate (per 100,000)
2016	287093.33 (194607.04–365390.64)	20.69 (14.02–26.33)	20.71 (13.90–26.41)
2017	296268.37 (199861.06–387331.05)	21.19 (14.29–27.70)	20.41 (13.67–26.82)
2018	302637.38 (205101.50–398995.93)	21.51 (14.58–28.35)	19.90 (13.30–26.28)
2019	311535.97 (207934.77–408259.07)	22.03 (14.70–28.87)	19.55 (12.93–25.76)
2020	320247.89 (216757.98–428462.28)	22.56 (15.27–30.18)	19.25 (12.83–25.66)
2021	328118.86 (224716.63–425287.90)	23.06 (15.79–29.89)	18.85 (12.89–24.47)
Estimate annual percentage change	0.99 (0.45–1.54)	0.40 (-0.13–0.94)	-2.68 (-3.06–-2.30)

3.3. Trends in years lived with disability due to hypertension-related heart disease (1990–2021)

The number of YLDs, YLD rate, and age-standardized YLD rate for hypertension-related heart disease in China all increased between 1990 and 2021. The number of YLDs rose from 124,386 in 1990 to 301,426 in 2021, with an average annual growth rate of 2.80%. The YLD rate increased from 10.57 per 100,000 to 21.52 per 100,000, with an average annual growth rate of 2.20%. However, the age-standardized YLD rate decreased from 17.79 per 100,000 in 1990 to 15.34 per 100,000 in 2021, with an average annual decline of 0.67%. These findings suggest that while the total YLDs and YLD rate have increased, the risk of disability has decreased when considering the population's age structure. The upward trend in YLDs may be driven by population aging, the rising burden of chronic diseases, and lifestyle changes. Although public health advances have helped control the risk of disability, the increasing demand for medical resources due to aging and chronic diseases necessitates further strengthening of health management and preventive measures. See **Table 3**.

Table 3. Years lived with disability due to hypertension-related heart disease in the Chinese population (1990–2021)

Years	YLDs number	YLDs rate (per 100,000)	Age-standardized YLDs rate (per 100,000)
1990	124386.45 (79287.61–175197.13)	10.57 (6.74–14.89)	17.79 (11.34–24.85)
1991	128763.35 (83151.19–181445.18)	10.79 (6.97–15.21)	17.81 (11.39–24.90)
1992	132945.61 (86187.57–187499.47)	11.02 (7.15–15.54)	17.79 (11.48–24.85)
1993	137017.70 (88901.58–194463.82)	11.26 (7.30–15.98)	17.75 (11.58–24.91)
1994	140943.93 (91669.84–199244.32)	11.49 (7.48–16.25)	17.69 (11.64–24.86)
1995	144777.25 (94298.02–204406.58)	11.73 (7.64–16.57)	17.61 (11.62–24.71)
1996	148275.67 (96714.05–209746.83)	11.96 (7.80–16.92)	17.48 (11.57–24.51)
1997	151187.20 (98669.50–213688.53)	12.14 (7.93–17.16)	17.27 (11.42–24.18)
1998	153592.86 (100621.41–216596.91)	12.29 (8.05–17.33)	17.00 (11.21–23.82)
1999	156039.82 (101432.74–220639.01)	12.44 (8.09–17.59)	16.72 (11.01–23.37)
2000	158274.99 (102352.30–222846.92)	12.57 (8.13–17.70)	16.42 (10.80–22.96)
2001	159689.19 (103826.36–225475.32)	12.63 (8.21–17.83)	16.03 (10.51–22.41)
2002	159796.23 (103984.79–225107.20)	12.57 (8.18–17.71)	15.48 (10.17–21.65)

Table 3 (Continued)

Years	YLDs number	YLDs rate (per 100,000)	Age-standardized YLDs rate (per 100,000)
2003	159428.70 (104128.76–224219.32)	12.47 (8.15–17.54)	14.90 (9.80–20.87)
2004	160035.46 (105169.65–224355.41)	12.45 (8.18–17.46)	14.44 (9.58–20.16)
2005	162753.82 (108142.07–228426.19)	12.59 (8.36–17.67)	14.23 (9.51–19.88)
2006	167535.02 (110631.51–234078.91)	12.87 (8.50–17.99)	14.19 (9.40–19.79)
2007	173262.14 (114153.49–242652.19)	13.22 (8.71–18.52)	14.18 (9.41–19.79)
2008	179226.23 (118224.26–251906.35)	13.58 (8.96–19.08)	14.19 (9.41–19.88)
2009	185650.09 (121666.49–260407.61)	13.97 (9.15–19.59)	14.20 (9.38–19.76)
2010	192397.91 (126303.40–270349.23)	14.39 (9.45–20.22)	14.24 (9.44–19.96)
2011	200470.95 (132596.95–281644.10)	14.92 (9.87–20.96)	14.31 (9.51–20.04)
2012	210037.30 (138225.90–293818.46)	15.54 (10.23–21.75)	14.46 (9.55–20.23)
2013	220260.39 (145681.22–308363.09)	16.20 (10.72–22.68)	14.62 (9.70–20.48)
2014	231834.12 (153162.90–324457.97)	16.95 (11.20–23.72)	14.77 (9.77–20.72)
2015	242359.84 (161089.43–339819.33)	17.60 (11.70–24.67)	14.90 (9.86–20.92)
2016	253628.34 (167812.93–357078.67)	18.28 (12.09–25.73)	14.99 (9.97–21.00)
2017	265268.61 (174462.02–373721.42)	18.97 (12.48–26.73)	15.09 (9.96–21.15)
2018	276601.42 (181196.55–388948.92)	19.66 (12.88–27.64)	15.18 (9.94–21.34)
2019	289234.87 (188587.75–408055.11)	20.45 (13.33–28.85)	15.25 (9.93–21.45)
2020	301426.72 (196926.12–423780.41)	21.23 (13.87–29.85)	15.34 (10.07–21.48)
2021	320426.75 (202531.15–467147.54)	22.52 (14.24–32.83)	15.69 (9.99–22.48)
Estimate annual percentage change	2.80 (2.53–3.08)	2.20 (1.94–2.47)	-0.67 (-0.90–0.44)

3.4. Changes in deaths attributed to risk factors for hypertension-related heart disease (1990–2021)

From 1990 to 2021, significant changes occurred in the number of deaths from hypertension-related heart disease in China due to various risk factors. The data show that a high-sodium diet and low fruit intake were the primary contributors to deaths from hypertension-related heart disease. Deaths related to a high-sodium diet increased significantly over the period, reaching a peak in 2021. Deaths due to low fruit intake also rose substantially. In contrast, deaths from low vegetable intake decreased from 1990 to 2005 but then gradually increased. Deaths due to lead exposure followed a similar trend, declining from 1990 to 2005 before increasing again. Deaths related to extreme temperature environments remained relatively stable throughout the study period. Overall, dietary factors, especially high sodium intake and low fruit consumption, were the main drivers of deaths from hypertension-related heart disease. Public health authorities should focus on improving dietary habits and reducing environmental risks to lower the burden of related diseases. See **Figure 1**.

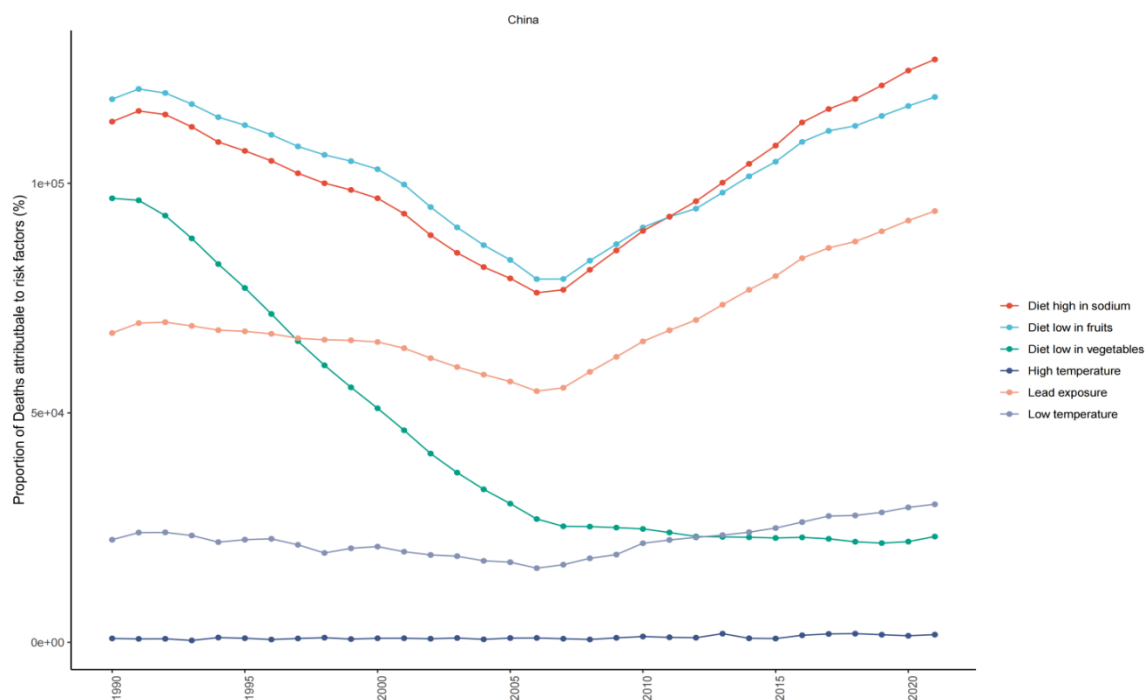


Figure 1. Changes in deaths attributed to hypertension-related heart disease in the Chinese population (1990–2021)

4. Discussion

This study, based on the GBD database, examines the changing trends in the burden of HHD in China from 1990 to 2021, along with its attributable risk factors. By quantifying the number of cases, deaths, YLDs, and deaths related to various risk factors, the study highlights the complexity of HHD’s burden in China and its association with socioeconomic development, lifestyle changes, and improvements in healthcare services.

From 1990 to 2021, the number and prevalence of HHD in China significantly increased, likely driven by population aging, lifestyle Westernization, and improved diagnosis and treatment of high blood pressure [6]. However, the decline in age-standardized prevalence suggests a reduction in the actual disease burden when adjusting for changes in population age structure [7]. This may indicate better medical conditions and more effective health interventions [8]. Despite this, the rising number of cases puts pressure on medical resources, emphasizing the need for continuous optimization of resource allocation and enhanced disease prevention strategies [9].

In terms of mortality, while the number of HHD-related deaths has risen, the significant decrease in age-standardized death rates reflects reduced mortality risk due to advances in medical technology and improved public health measures [7]. This underscores the crucial role of medical interventions in lowering HHD mortality [10]. However, the growing number of deaths also points to the potential impact of population growth and aging on disease burden, which requires attention from policymakers and healthcare providers for future disease management and resource planning.

The increase in YLDs reflects the long-term impact of HHD on individuals’ quality of life [11]. Although age-standardized YLD rates have declined, the overall rise in YLDs highlights the persistent public health

impact of HHD. This may be due to challenges in managing chronic diseases, an aging population, and the rising prevalence of lifestyle-related conditions. Therefore, there is a need to strengthen long-term management and support for HHD patients to alleviate their burden on both individuals and society.

This study found that a high-sodium diet and low fruit intake are the primary attributable risk factors for HHD mortality ^[12]. This aligns with global research and underscores the importance of dietary factors in cardiovascular disease development. A high-sodium diet is closely linked to hypertension, a major risk factor for HHD. Low fruit intake may increase cardiovascular risk, as fruits provide antioxidants and fiber that help lower blood pressure and improve cardiovascular health. Additionally, although factors such as low vegetable intake, lead exposure, and extreme temperature environments have a smaller impact on HHD mortality, they still affect the health of specific populations. Thus, public health policies should address these risk factors through education, legislation, and environmental interventions.

The findings of this study have significant implications for formulating targeted prevention and control strategies ^[13]. First, it is important to enhance screening and management of hypertension, particularly in high-risk populations. Second, public health education should promote healthy diets, encouraging reduced sodium intake and increased consumption of fruits and vegetables. Policymakers should also consider implementing environmental interventions to mitigate lead exposure and the health impact of extreme temperatures. Lastly, with an aging population, healthcare services for the elderly should be strengthened to improve blood pressure management and quality of life ^[14].

While this study provides a comprehensive analysis of the burden of HHD in China and its attributable risk factors, some limitations must be considered for future research. The study relies on data from the GBD database, which is one of the most detailed sources on the global disease burden, but its accuracy depends on the completeness, quality, and sources of the data. Additionally, differences in data collection methods across regions could affect the comparison and interpretation of results ^[15]. Although age-standardized rates account for changes in population age structure, they may not fully capture differences between age groups. As the population continues to age, alternative standardization methods may be needed for a more accurate assessment of disease burden.

In summary, this study offers a comprehensive analysis of the burden and risk factors associated with HHD in China. Despite advancements in medical technology and public health measures, HHD remains a significant public health challenge. Future research should continue to monitor trends in HHD burden and evaluate the effectiveness of prevention and control strategies to further reduce the impact of HHD on Chinese society.

Disclosure statement

The authors declare no conflict of interest.

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