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ORIGINAL ARTICLE

Burden of Hypertensive Heart Disease and High Systolic Blood Pressure in Australia from 1990 to 2019: Results From the Global Burden of Diseases Study

Sheikh Mohammad Shariful Islam, MBBS, PhD [a,*], Reza Daryabeygi-Khotbehsara, MSc [a], Mohammad Payam Ghaffari, MSc [a], Riaz Uddin, PhD [a,1], Lan Gao, PhD [b], Xiaoyue Xu, PhD [c,d], Muhammad Umer Siddiqui, MD [e], Katherine M. Livingstone, PhD [a], George Siopis, PhD [a,f,1], Nizal Sarrafzadegan, MD, PhD [g,1], Markus Schlaich, MD [h], Ralph Maddison, PhD [a,1], Rachel Huxley, PhD [i,1], Aletta E. Schutte, PhD [c,d,1]

[a]Institute for Physical Activity and Nutrition, Deakin University, Geelong, Vic, Australia
[b]School of Health and Social Development, Faculty of Health, Deakin University, Geelong, Vic, Australia
[c]School of Population Health, University of New South Wales, Sydney, NSW, Australia
[d]The George Institute for Global Health, Sydney, NSW, Australia
[e]Department of Internal Medicine, Thomas Jefferson University Hospital Philadelphia, PA, USA
[f]Faculty of Medicine, Nursing and Health Sciences, Monash University, Melbourne, Vic, Australia
[g]Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
[h]Dobney Hypertension Centre, Medical School—Royal Perth Hospital Unit, The University of Western Australia, Perth, WA, Australia
[i]Faculty of Health, Deakin University, Geelong, Vic, Australia

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Background There is a dearth of comprehensive studies examining the burden and trends of hypertensive heart disease (HHD) and high systolic blood pressure (SBP) among the Australian population. We aimed to explore the burden of HHD and high SBP, and how they changed over time from 1990 to 2019 in Australia.

Methods We analysed data from the Global Burden of Disease study in Australia. We assessed the prevalence, mortality, disability-adjusted life-years (DALY), years lived with disability (YLD) and years of life lost (YLL) attributable to HHD and high SBP. Data were presented as point estimates with 95% uncertainty intervals (UI). We compared the burden of HHD and high SBP in Australia with World Bank defined high-income countries and six other comparator countries with similar sociodemographic characteristics and economies.

*Corresponding author at: Associate Professor Sheikh Mohammed Shariful Islam, MBBS, MPH, PhD, FESC, NHMRC Emerging Leadership Fellow, Group Leader, Global Health, Institute for Physical Activity and Nutrition , Deakin University, 221 Burwood Highway, Burwood, VIC 3125, Australia; Email: shariful.islam@deakin.edu.au; Twitter: @drsislam

[1]Equal contribution

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Results From 1990 to 2019, the burden of HHD and high SBP in Australia reduced. Age standardised prevalence rate of HHD was 119.3 cases per 100,000 people (95% UI 86.6–161.0) in 1990, compared to 80.1 cases (95% UI 57.4–108.1) in 2019. Deaths due to HDD were 3.4 cases per 100,000 population (95% UI 2.6–3.8) in 1990, compared to 2.5 (95% UI 1.9–3.0) in 2019. HHD contributed to 57.2 (95% UI 46.6–64.7) DALYs per 100,000 population in 1990 compared to 38.4 (95% UI 32.0–45.2) in 2019. Death rates per 100,000 population attributable to high SBP declined significantly over time for both sexes from 1990 (155.6 cases; 95% UI 131.2–177.0) to approximately one third in 2019 (53.8 cases; 95% UI 43.4–64.4). Compared to six other countries in 2019, the prevalence of HHD was highest in the USA (274.3%) and lowest in the UK (52.6%), with Australia displaying the third highest prevalence. Australia ranked second in term of lowest rates of deaths and third for lowest DALYs respectively due to high SBP. From 1990–2019, Australia ranked third best for reductions in deaths and DALYs due to HHD and first for reductions in deaths and DALYs due to high SBP.

Conclusion Over the past three decades, the burden of HHD in Australia has reduced, but its prevalence remains relatively high. The contribution of high SBP to deaths, DALYs and YLLs also reduced over the three decades.

Keywords Hypertension • Global burden of disease • Cardiovascular disease • Blood pressure • Australia

Introduction

Hypertension is a leading preventable risk factor for all-cause mortality and disability from cardiovascular diseases [1,2]. In 2017, high blood pressure (BP) attributed to 10·4 million (95% uncertainty interval [UI] 9.39 to 11.5) deaths and 218 million (95% UI 198 to 237) disability-adjusted life years (DALYs) globally, whereas it was the fifth cause of death in 1990 [3]. Hypertension can cause left ventricular hypertrophy and diastolic dysfunction leading to congestive heart failure, myocardial infarction, arrhythmias, and sudden cardiac death [4]. Hypertension is also associated with substantial financial burden, imposing direct (e.g., medications, hospitalisation) and indirect (e.g., lost productivity due to disability) costs on health care systems, representing approximately 10% of health systems' expenditures [5]. The risk factors for hypertension include aging, family history, smoking, unhealthy diet, physical inactivity, overweight and obesity, alcohol consumption, as well as chronic conditions (e.g., kidney disease, diabetes and hormone imbalance) [6]. Targeting modifiable risk factors, such as diet, physical activity, and alcohol intake, is important for preventing and managing hypertension [7]. Moreover, the need for sex- and age-differences to be accounted for in hypertension prevention and management has been highlighted in the previous studies [8,9].

Raised blood pressure is the leading risk factor for death in Australia [10–12], to-date, there has been a lack of comprehensive studies on the burden of hypertensive heart disease (HHD) and high systolic blood pressure (SBP) among the Australian population over time. The Australian Institute of Health and Welfare (AIHW) 2019 report showed that about one in three adults (34%) have high BP, but only 32% of those with hypertension have it controlled with medication, resulting in a recent call-to-action to improve control rates in Australia [12,13]. Two cross-sectional studies in Australia in 2017 and 2018, respectively, screened volunteers for hypertension [14,15] and reported that 18.4% and 20.8% of non-antihypertensive agents treated participants were hypertensive, and 40.1% and 57.1% of existing high BP patients had uncontrolled hypertension. However, a major limitation of these studies is that they did not quantify the burden of hypertension and its changes over time to potentially inform public health policy planning and programs. A 2015 study reported the association between SBP and the burden of different causes of death and disability for 195 countries and territories from 1990–2015 using the Global Burden of Disease (GBD) datasets [16]. There are no studies in Australia that reported the burden of HHD over-time. Therefore, this study aims to provide updated data on the burden of HHD and high SBP in Australia from 1990–2019.

Methods

Data source

Data on SBP and HHD were obtained from the 2019 Global Burden of Disease (GBD) database. GBD 2019 is a multinational collaborative research effort to estimate disease burden and trends worldwide and in every country, managed by the Institute of Health Metrics and Evaluation. We extracted the data via The Global Health Data Exchange (GHDx), and the GBD Result Tool. Given the tool's ability to narrow down on details, relevant data for Australia were downloaded to a prefixed Excel template (Microsoft Excel for Microsoft 365, Microsoft Corporation, Redmond, WA, USA). A systematic assessment was carried out for HHD and high SBP conditions to compare rates (per 100,000 population) of prevalence, death, DALY, YLD, and YLL in both sexes, in females, in males, and across age groups from 1990 to 2019. Age groups included are as follow: 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, and ≥95. Age-standardised and age group data are reported for both

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Table 1 Age-standardised rates* of prevalence, YLDs, DALYs, deaths and YLLs of hypertensive heart disease in both sexes in Australia.

Year	Prevalence	YLDs	DALYs	Deaths	YLLs
HHD					
1990	119.3 (86.6–161)	9.6 (5.9–14.3)	57.2 (46.6–64.7)	3.4 (2.6–3.8)	47.6 (36.8–51.6)
1995	95.6 (70.8–125.5)	7.7 (4.7–11.5)	48.3 (42–55.6)	3 (2.4–3.4)	40.6 (34.9–46.1)
2000	101.6 (77.4–129.1)	8.1 (5.2–11.8)	41.7 (36.8–51.8)	2.6 (2.1–3.1)	33.6 (29.2–42.6)
2005	96.2 (73.8–122.8)	7.7 (4.9–11.3)	37.7 (33–48.9)	2.4 (1.9–3)	30 (25.8–40.3)
2010	104 (79.5–134.1)	8.3 (5.3–12.1)	39.1 (33.2–49)	2.5 (2–2.8)	30.7 (26.2–39.6)
2015	80.6 (58.4–109.4)	6.5 (4–9.6)	40 (33–46.4)	2.7 (2–3.1)	33.6 (27.1–39)
2019	80.1 (57.4–108.1)	6.4 (4–9.8)	38.4 (32–45.2)	2.5 (1.9–3)	32 (26.1–38.8)
High SBP					
1990	229.1 (164.1–298.5)	2822.6 (2506.5–3140.8)	155.6 (131.2–177)	2593.5 (2289.7–2877.7)	
1995	214.3 (153.2–280.6)	2330.1 (2048.8–2600.4)	132.8 (111.3–152.4)	2115.8 (1863.8–2353.7)	
2000	201.6 (145.9–262.3)	1777.9 (1552.4–1989.5)	101.1 (83.6–117.8)	1576.3 (1375.2–1762.2)	
2005	181.4 (129.3–238.5)	1308.5 (1135–1484.7)	74.6 (60.9–88)	1127.1 (970.1–1274.6)	
2010	172.9 (123.1–226.1)	1079.6 (937.3–1222.9)	60.9 (49.7–72)	906.7 (781.1–1028.7)	
2015	165.2 (117.5–218.6)	975.1 (839.2–1114.1)	54.2 (44.1–63.7)	809.9 (697–918.5)	
2019	165 (117.7–219.6)	966.5 (824.7–1111.5)	53.8 (43.4–64.4)	801.5 (680.6–918.7)	

*Rates (95% uncertainty interval [UI]) per 100,000 population.

Abbreviations: YLDs, years lived with disability; DALYs, disability-adjusted life years; YLL, years of life lost; HHD, hypertensive heart disease; SBP, systolic blood pressure.

sexes and separately for females and males. Data were not available for age groups below 15 years for some measures.

Variables and Definition

HHD is defined as, "a constellation of changes in the left ventricle, left atrium and coronary arteries as a result of chronic blood pressure elevation, which increases the workload on the heart inducing structural and functional changes. These changes include hypertrophy of the left ventricle, which can progress to heart failure. Patients with left ventricular hypertrophy exhibit significantly increased morbidity and mortality. HHD ultimately encompasses all of the direct and indirect sequelae of chronic high blood pressure which includes systolic or diastolic heart failure, conduction arrhythmias, especially atrial fibrillation, and increased risk of coronary artery disease" [6]. The GBD definitions web page [17] provides a description of the burden of disease metrices (i.e., prevalence, death, DALYs, YLDs, and YLLs), as well as conditions (i.e., HHD and high SBP). Hypertension is defined by Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7), the European Society of Hypertension (ESH) 2023, the World Health Organization (WHO) 2022, and the International Society of Hypertension (ISH) 2020, as systolic blood pressure (SBP) of equal or above 140 mmHg and/or diastolic blood pressure (DBP) of equal or above 90 mmHg or taking blood-pressure lowering medications [18]. A 2017 American College of Cardiology/American Heart Association (ACC/AHA) guideline has revised the cut-off point for blood pressure to 130 mmHg or above for SBP and 80 mmHg or above for DBP [19]. Institute for Health Metrics and Evaluation (IHME) defines high blood pressure as "blood pressure higher than 110–115 mm Hg" [17]. For the purposes of the analyses in this study, the IHME definition was used.

Statistical Analysis

To estimate HHD and high SBP burden (i.e., prevalence, death, DALY, YLD, and YLL), GBD tools use the Monte Carlo approach by repeating all calculations 1,000 times using one draw of each parameter at each iteration. These 1,000 draws have been used to calculate the median (point estimate) and 95% uncertainty interval (UI; 2.5th and 97.5th percentiles) for the final estimates calculated by the GBD web-based analytical suite. Differences between two estimates for a parameter (e.g., DALYs for males vs females or DALYs for the year of 2016 vs 2017) were considered statistically significant if their 95% UI did not overlap. We compared the burden of HHD and high SBP in Australia with World Bank defined high-income countries and six other comparator countries with similar sociodemographic and economic index including the United States of America, United Kingdom, New Zealand, Japan, Canada and Switzerland.

Results

Prevalence of Hypertensive Heart Disease

In 1990, the overall age-standardised prevalence rate of HHD in Australia was 119.3 cases per 100,000 people (95% UI 86.6

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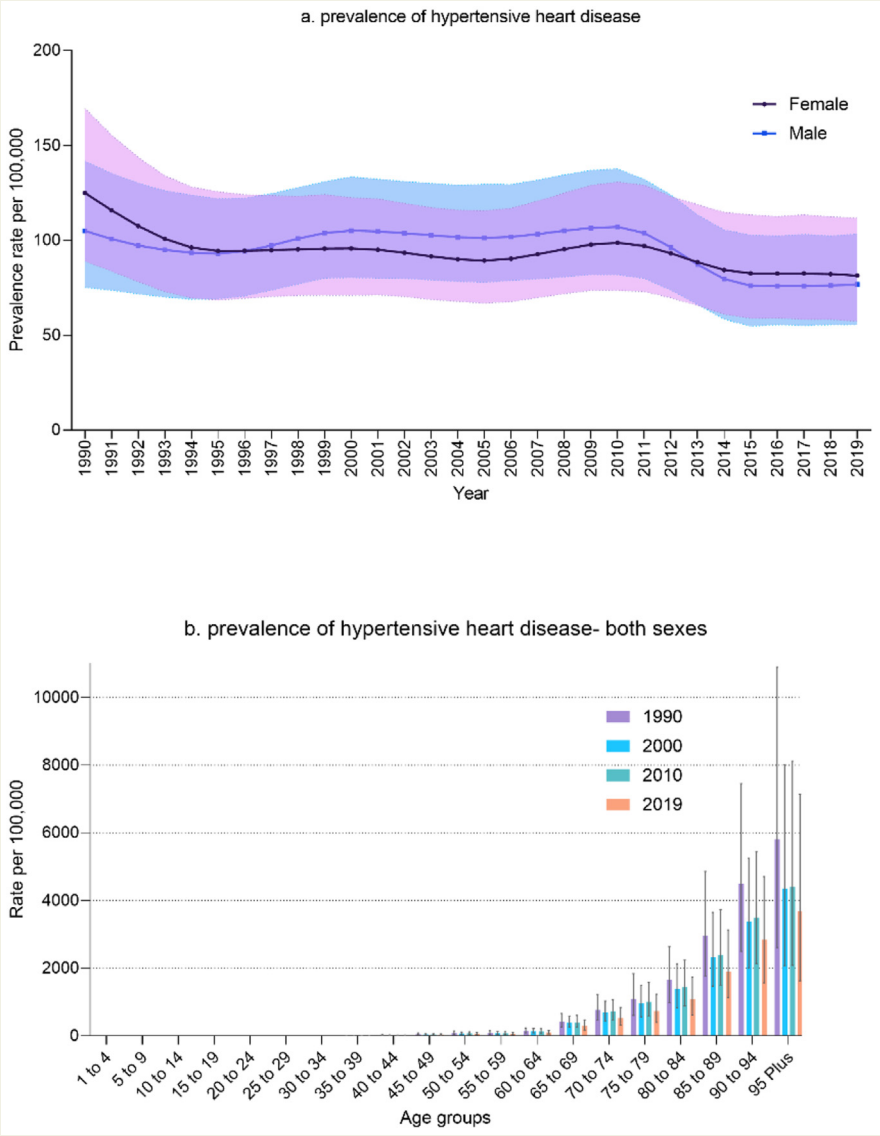

Figure 1 Age-standardised prevalence rates of hypertensive heart disease (HHD) in females and males (a) and age-group specific prevalence rates of HHD in both sexes (b) from 1990 to 2019 in Australia. Note: dotted lines represent point estimates and the colour bands shows 95% uncertainty intervals. Error bars represent 95% uncertainty intervals.

to 161.0), compared to 80.1 cases per 100,000 people (95% UI 57.4 to 108.1) in 2019. Sex-specific prevalence rates were 125.0 cases per 100,000 people (95% UI 89.0 to 169.6) in females and 105.0 cases per 100,000 people (95% UI 75.2 to 141.8) in males in 1990. In 2019, the respective prevalence rates for females and males were 81.5 (95% UI 57.3 to 111.8) and 76.8 cases per 100,000 people (95% UI 55.5 to 103.4) (see Table 1). Prevalence rate was non-significantly higher among males between 1997 to 2012 (see Figure 1). With respect to age groups, approximately 98% of HHD cases were in the 60-years-plus age group across all time periods. For both sexes across all year periods, the lowest prevalence rates were in the 15- to 19-years-old age group and the highest prevalence rates were in the 90-years-plus age group. In 2019, for example, the prevalence rate for the age group of 15 to 19 years old was 0.1 cases per 100,000 population (95% UI 0.0 to 0.2), and for the age group of 90 years plus was 3,684.5 cases per 100,000 population (95% UI 1625.4 to 7139.6) (see Figure 1).

Death, YLLs, DALYs, and YLDs due to HDD

Death, YLLs, and YLDs rates due to HHD per 100,000 population were at 3.4 cases (95% UI 2.6 to 3.8), 47.6 cases (95% UI 36.8 to 51.6), and 9.6 cases (95% UI 5.9 to 14.3) in 1990, compared to 2.5 (95% UI 1.9 to 3.0), 32.0 cases (95% UI 26.1 to 38.8), and 6.4 cases (95% UI 4.0 to 9.8) in 2019, respectively. DALYs due to HHD reduced significantly from 1990 to 2019. DALYs due to HHD decreased from 57.2 (95%

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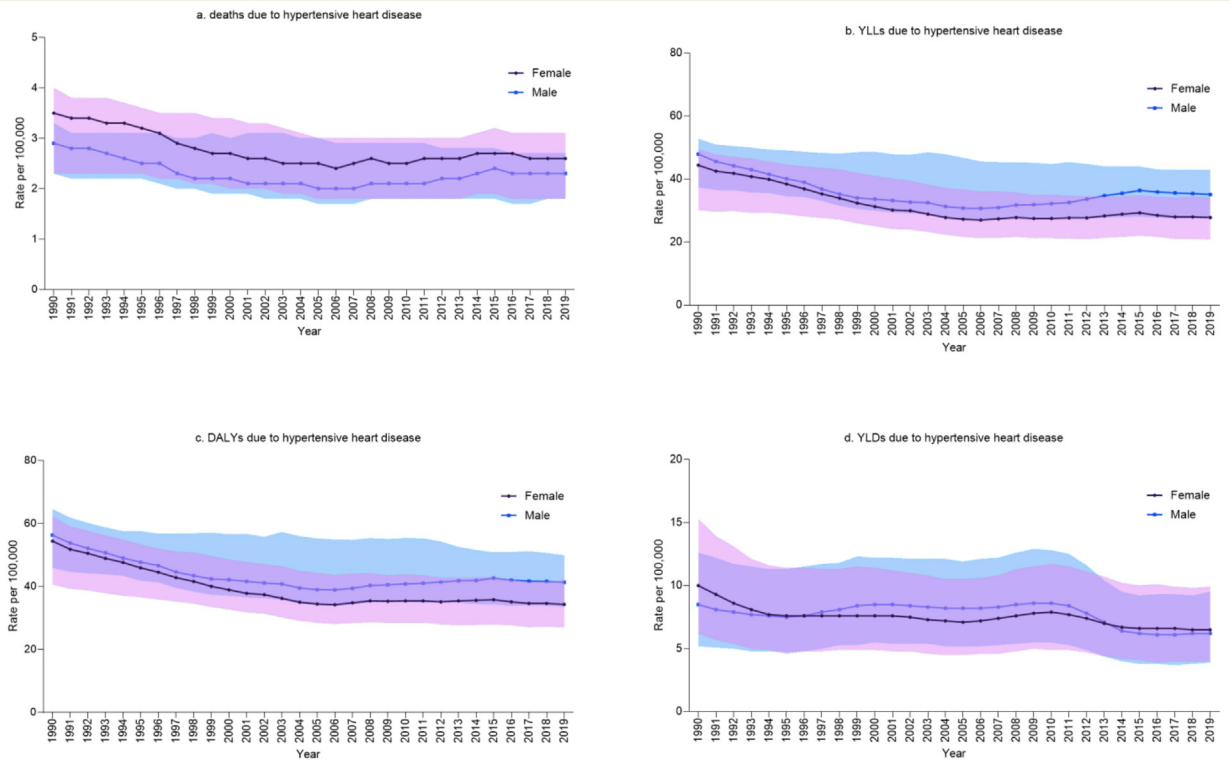

Figure 2 Age-standardised rates of deaths, YLLs, DALYs, and YLDs for hypertensive heart disease (HHD) in females and males from 1990 to 2019 in Australia. Note: dotted lines represent point estimates and the colour bands shows 95% uncertainty intervals.
Abbreviations: YLDs, years lived with disability; DALYs, disability-adjusted life years; YLL, years of life lost.

UI 46.6 to 64.7) in 1990 to 38.4 (95% UI 32.0 to 45.2) in 2019 (Table 1).

Sex-specific results showed that the death rate was higher (not statistically significant) in females than males across all years. In 1990, death rates for males were 2.9 cases per 100,000 population (95% UI 2.3 to 3.3) and for females were 3.5 cases per 100,000 population (95% UI 2.3 to 4.0). In 2019, males recorded 2.3 cases of death per 100,000 population (95% UI 1.8 to 2.7) and females recorded 2.6 cases per 100,000 population (95% UI 1.8 to 3.1). In comparison, YLLs rate for females was 44.4 cases per 100,000 population (95% UI 30.2 to 49.4) and for males was 47.9 cases per 100,000 population (95% UI 37.4 to 52.7) in 1990. In 2019, YLLs rate for females stood at 27.8 cases per 100,000 population (95% UI 20.9 to 34.0) and for males at 35.1 cases per 100,000 population (95% UI 27.4 to 42.8). DALYs rates in 1990 were 56.3 (95% UI 45.9 to 64.5) and 54.4 cases per 100,000 population (95% UI 40.6 to 62.1) for males and females, respectively. In 2019, DALYs decreased to 41.3 (95% UI 33.6 to 49.8) and in females it was 34.3 (95% UI 27.0 to 41.7). YLDs rate for males, in 1990, was 8.5 cases per 100,000 population (95% UI 5.2 to 12.6) and for females was 10.0 cases per 100,000 population (95% UI 6.2 to 15.3) and, in 2019, YLDs in males was 6.2 cases per 100,000 population (95% UI 3.9 to 9.5) and for females 6.5 cases per 100,000 population (95% UI 4.0 to 9.9). See Figure 2 for details.

Age group results showed a significant decreasing trend for DALYs per 100,000 population in the age group of 70 to 74 years from 1990 (304.7 cases; 95% UI 238.1 to 367.4) to 2019 (167 cases; 127.5 to 231.4). No significant changes were observed for death, YLDs and YLLs across age groups. The age group with the highest measures of death, YLLs, DALYs and YLDs in all time periods was 95 plus years (Figures 2–5). The burden of HHD starts at relatively lower ages for males compared to females (Figure 3).

Prevalence of High SBP

The age standardised prevalence of high SBP in Australia decreased from 106.6 (95% UI 84.4 to 127.4) to 84.8 (95% UI 70.5 to 102) cases per 100,000 population in 2019. In 1990, the prevalence of high SBP was higher in females (115.8, 95% UI 88.4 to 127.4) compared to males (83.3, 95% UI 71.5 to 106.5). The age standardised prevalence of high SBP was 95. 3 (95% UI 78.7 to 116) in females and 70.4 (95% UI 57.3 to 85.1) in males.

Death, YLLs, DALYs, and YLDs of High SBP

Death rates per 100,000 population attributable to high SBP declined significantly over time for both sexes from 1990 (155.6 cases; 95% UI 131.2 to 177.0) to approximately one third

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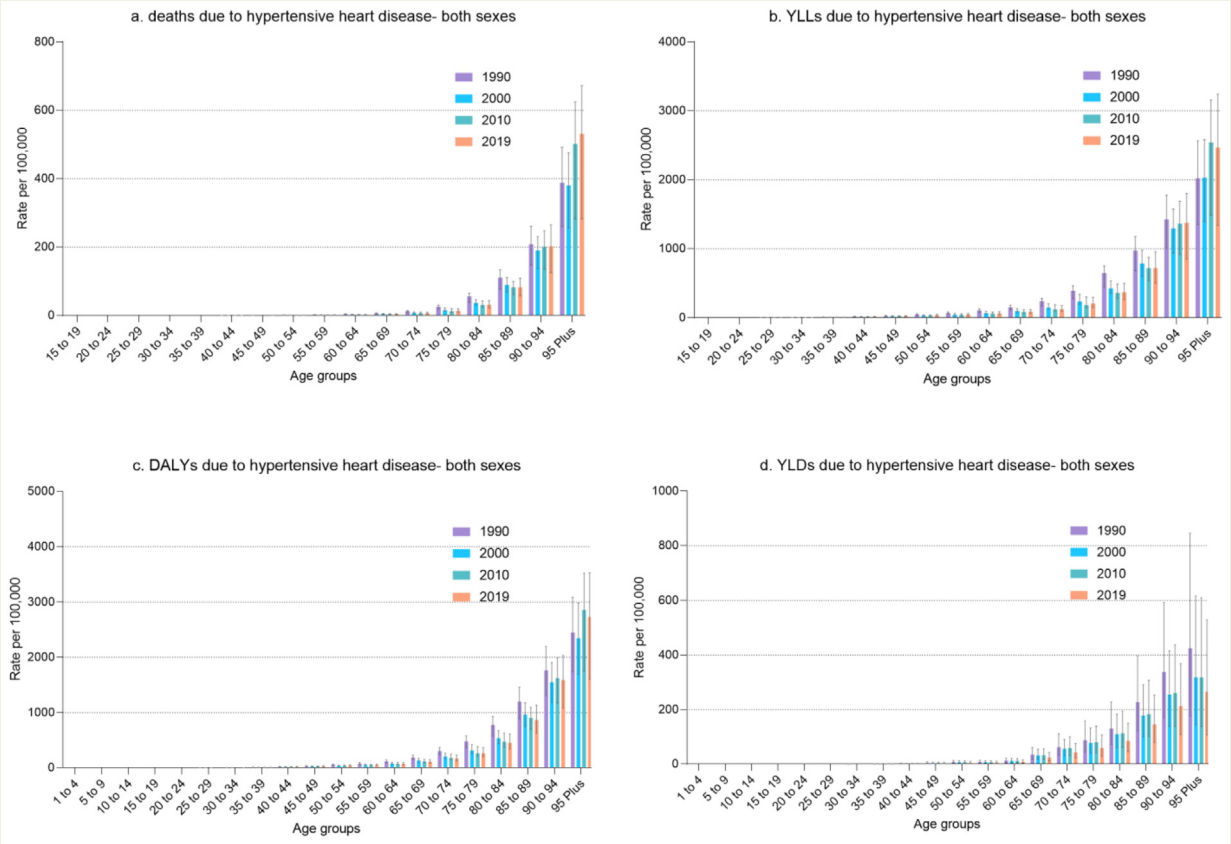

Figure 3 Age-group specific rates (per 100,000 population) of deaths, YLLs, DALYs, and YLDs due to hypertensive heart disease (HHD) in both sexes from 1990 to 2019 in Australia. Note: Error bars represent 95% uncertainty intervals. Abbreviations: YLDs, years lived with disability; DALYs, disability-adjusted life years; YLL, years of life lost.

in 2019 (53.8 cases; 95% UI 43.4 to 64.4). Death rates for females were significantly lower than for males from 1990 until to 2005, following which the difference became non-significant until 2019. In 1990, there were 126.5 deaths per 100,000 population (95% UI 104.0 to 146.5) in females and 188.6 deaths per 100,000 population (95% UI 160.6 to 215) in males, while in 2019, there were 44.4 deaths (95% UI 33.4 to 55.2) for females and 64.0 deaths (95% UI 52.7 to 75.5) for males per 100,000 population, respectively. YLLs and DALYs rates also declined significantly from 1990 (2593.5 YLLs cases; 95% UI 2289.7 to 2877.7 and 2822.6 DALYs cases; 95% UI 2506.5 to 3140.8) to one third in 2019 (801.5 YLLs cases; 95% UI 680.6 to 918.7 and 966.5 DALYs cases; 95% UI 824.7 to 1111.5). Furthermore, females had significantly lower rates of YLLs and DALYs than males in all years. In 1990 YLDs rates were 229.1 (95% UI 164.0 to 298.5) reaching 165.0 cases (95% UI 117.7 to 219.6) in 2019. There were no sex differences in YLDs during this period (see Table 2). Sex differences in DALYs are likely to be driven by YLLs rather than YLDs (Figure 4).

Age group results showed a significant decreasing trend for DALYs per 100,000 population from 1990 to 2019 in the age groups of 40 to 44 years and beyond, excluding 90 years plus. The death rate saw a significant decreasing trend from 1990 to 2019 in 25 to 29 years and beyond, except 90 years plus. YLL rates decreased significantly from 1990 to 2019 in the age groups of 35 to 39 and beyond, excluding 90 years plus. The age group with the highest measures of death, YLLs, DALYs and YLDs in all time periods was 95 plus years (Figure 5). The age-group specific rates of deaths, YLLs, DALYs, and YLDs attributable to high SBP in females and males are shown in Supplementary Figure 2.

Comparison of HHD and High SBP With Comparator Countries

The prevalence of HHD per 100,000 population in 2019 was highest in the USA (274.3%) and lowest in the UK (52.6%). Australia had lower rates (80.1%) compared to World Bank high-income countries (161.3%), USA and Switzerland. Deaths due to HHD was highest in the USA and Switzerland (9.0%) and lowest in Canada. The USA had the highest DALYs due to HHD (212.2 [138.1, 230.5]), while Japan had the lowest (34.7 [28.1. 56.1]) and Australia the second lowest (38.4 [32.0, 45.2]). Australia ranked second in term of lower rates of deaths and second lowest for DALYs due to high SBP (Table 2). Australia ranked third best (lower rates) for changes in deaths and DALYs due to HHD and best (lowest rates) for high SBP deaths and DALYs (Supplementary Table 1).

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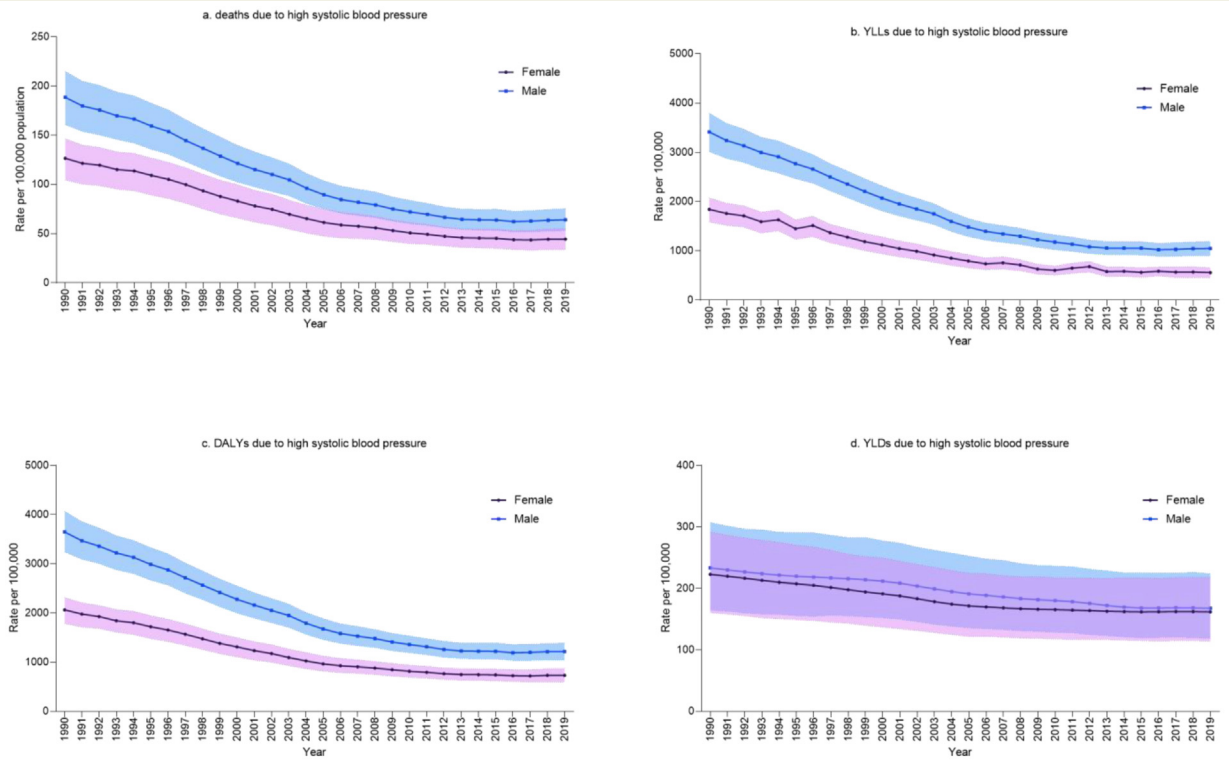

Figure 4 Age-standardised rates of deaths, YLLs, DALYs, and YLDs for high systolic blood pressure (HSBP) in females and males from 1990 to 2019 in Australia. Note: dotted lines represent point estimates and the colour bands shows 95% uncertainty intervals.
Abbreviations: YLDs, years lived with disability; DALYs, disability-adjusted life years; YLL, years of life lost.

Discussion

This is the first study to examine the burden of HHD and high SBP among the Australian population by sex and age group between 1990 and 2019. Our findings indicate that although the burden of HHD in Australia has reduced over the last thirty years, its prevalence remains relatively high in 2019. Compared with similar high-income countries, Australia ranked in top three positions for reductions in prevalence, mortality, DALYs, and YLLs over thirty years.

Previous population-based studies have shown the high prevalence of hypertension in Australia. The AIHW 2023 report based on measured data from 2017–2018 National Health Survey showed that the prevalence of hypertension in Australia was 34% and has remained stable since 2011–12 [13]. A recent study in Australia reported the prevalence of hypertension among adults at 51.1% using the 2017 ACC/AHA guideline on the Australian National Health survey data and almost twice the prevalence rate of 25.6% using the JNC7 guideline. Given the substantial differences in case identification (self-report in the health survey data vs clinical diagnosis in the GBD database), case definition, tools and locations for BP measurement, the prevalence of hypertension from our study is not directly comparable with earlier studies.

Our study identified that deaths and YLLs due to high SBP are higher among males. Previous studies have reported similar findings. The AIHW 2023 report showed that men were more likely to have uncontrolled hypertension than women (25% and 20%) and the proportion of adults with uncontrolled hypertension increased with age ranging from 7.5% among 18–34 year-olds (10.2% men, 4.9% women) to 47% at age 85 and over (51% men, 48% women) [13]. The US National Health and Nutritional Examination Survey (NHANES) 2007–2010 revealed significant differences in hypertension control among males and females. The survey identified that hypertension awareness, treatment, and control rates were significantly higher in women. [20,21] Similarly, a cardiovascular research network in the US studied 150,000 hypertensive patients and revealed that control rates were higher in women (45.7%) than men (41.2%) [9]. In comparison to males, control rates were better in younger and middle-aged females and dropped in older females, according to subgroup analyses. A study among 26 million Canadians revealed similar findings and reported that the prevalence of hypertension was higher in older women than in men [22]. The hormonal changes that take place during menstruation could partly explain this age-dependent disparity. Previous studies have shown that oestrogen benefits the cardiovascular system, causing vascular relaxation,

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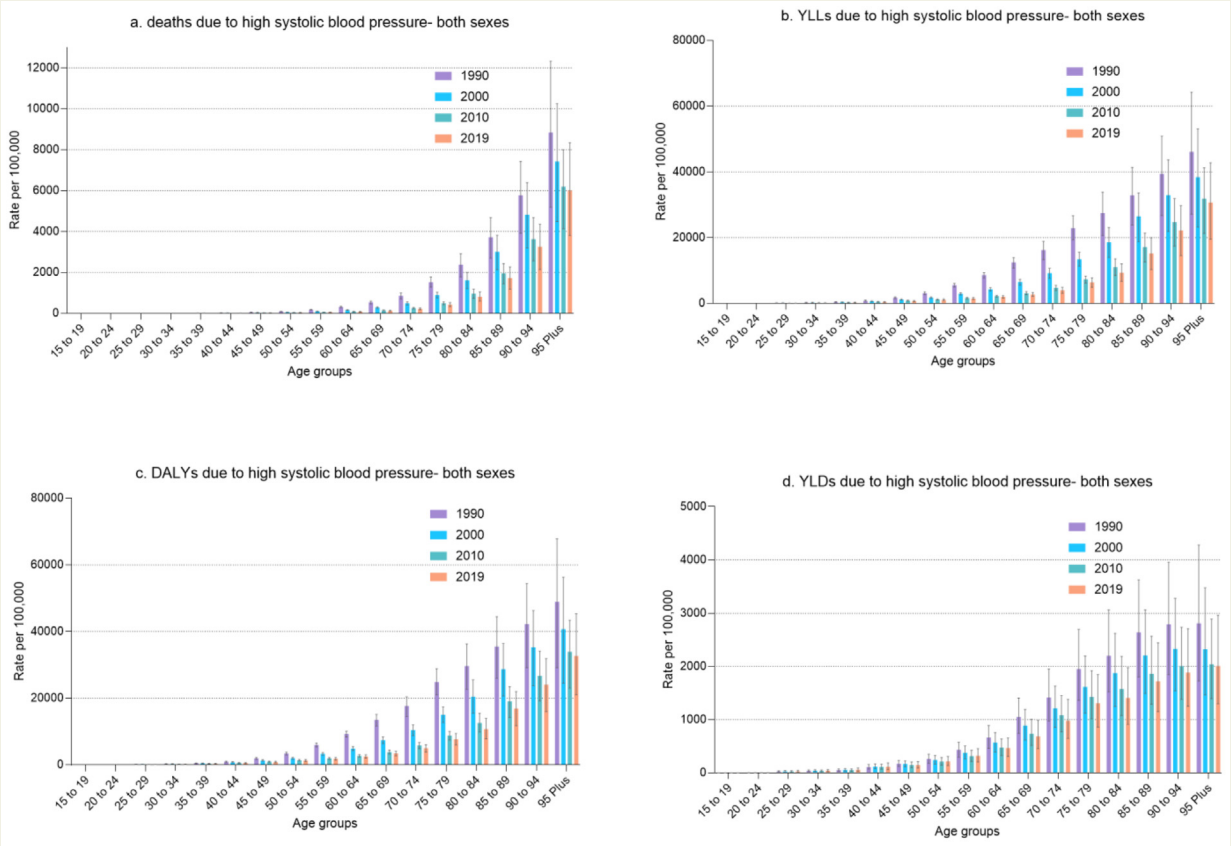

Figure 5 Age-group specific rates (per 100,000 population) of deaths, YLLs, DALYs, and YLDs attributable to high systolic blood pressure (SBP) in both sexes from 1990 to 2019 in Australia. Note: Error bars represent 95% uncertainty intervals. Abbreviations: YLDs, years lived with disability; DALYs, disability-adjusted life years; YLL, years of life lost.

sympathoinhibition, and renoprotection. As oestrogen declines in older females, this protective effect is removed, leading to hypertension or worsening of control [23].

Despite the HHD burden remaining high in Australia, data demonstrated a significant reduction in morbidity and mortality over the past thirty years. Australia achieved the highest rank for lowering high SBP deaths and DALYs compared to comparator countries. This is promising and it indicated the possible beneficial effects of current public health measures, clinical education, patient education, and of the availability of new and well-tolerated antihypertensive medicines drugs in the observed decreases in hypertension prevalence.

Factors associated with hypertension are well known and have been extensively researched. Low dietary potassium and lack of physical activity contribute 20% to hypertension, while dietary salt and obesity combined contribute 30% [24,25]. Primary care physicians are trained to address these risk factors during clinic visits; however, these interventions have little impact on population-level health when administered alone [26,27]. Population-level interventions like creating policies and an environment that promote a healthy lifestyle can significantly decrease the disease burden and the public health sector in Australia needs to advocate for such policies [28]. These policies also need frequent review and reforms to align them to the current environment. The World Health Organization (WHO) has published multiple policies to help prevent hypertension and, when implemented correctly, can significantly reduce the burden of hypertension and HHD [29–32].

The high burden of hypertension and HHD has a negative economic impact, which is due to reduced productivity from days lost due to ill health and reduced efficiency at work [33]. Australia lost US$1.3 billion in 2009 due to hypertension and its sequelae. A 2017 study of working-age Australians (20–69 years) with hypertension identified 149,846 excess deaths with a simulated follow-up. This caused a loss of 609,801 productivity-adjusted life years equal to a loss of AUD$137.2 billion to the economy over the working lifetime [34].

Despite the high burden of hypertension, population-level awareness and government initiatives for hypertension prevention and management remains low. The Australian Bureau of Statistics survey in 2017 reported that 96.6% of the population aged 18–34 years with hypertension were unaware and untreated for this condition [34]. National and local public health institutions need to prioritise population-based approaches to increase awareness [25]. Policies for restricting

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Table 2 Age-standardised rates of prevalence, deaths and DALYs per 100,000 population for both sex due to HHD and high SBP in Australia and Comparator Countries in 2019.

Measures	Location	Value	Upper	Lower
HHD				
Deaths	United Kingdom	3.5	5.2	3.0
	Switzerland	9.0	11.0	3.6
	New Zealand	2.6	3.6	2.1
	Australia	2.5	3.0	1.9
	Canada	2.0	2.4	1.2
	Japan	2.4	3.3	1.7
	United States of America	9.0	9.8	5.9
	World Bank High Income	7.7	8.5	5.5
DALYs	Japan	34.7	56.1	28.1
	Canada	39.1	44.4	29.3
	United States of America	212.2	230.5	138.1
	New Zealand	41.9	56.1	35.9
	United Kingdom	60.7	74.0	54.3
	Australia	38.4	45.2	32.0
	Switzerland	94.9	111.5	50.5
	World Bank High Income	132.1	144.3	98.9
Prevalence	Japan	78.4	106.8	55.7
	New Zealand	73.8	100.8	51.6
	Switzerland	82.3	110.8	61.4
	Canada	78.9	102.8	59.2
	Australia	80.1	108.1	57.4
	United Kingdom	52.6	72.5	37.6
	United States of America	274.3	359.4	203.7
	World Bank High Income	161.3	211.7	120.7
High SBP				
Deaths	United States of America	81.6	94.2	68.6
	United Kingdom	62.6	72.1	52.4
	World Bank High Income	72.5	82.7	61.2
	New Zealand	69.2	81.4	55.6
	Japan	42.0	48.6	34.1
	Canada	54.3	64.5	42.6
	Switzerland	55.8	66.8	43.9
	Australia	53.8	64.4	43.4
DALYs	United States of America	1684.1	1880.9	1478.7
	Canada	1013.2	1169.2	852.5
	United Kingdom	1177.0	1317.1	1034.5
	Switzerland	844.0	975.9	714.0
	Japan	924.3	1040.9	806.0
	New Zealand	1216.2	1379.5	1039.9
	World Bank High Income	1411.2	1564.8	1248.9
	Australia	966.5	1111.5	824.7

Abbreviations: DALY, disability-adjusted life-years; HHD, hypertensive heart disease; SBP, systolic blood pressure.

salt and sugar in processed foods, promoting healthy lifestyle, and using innovative technologies for population-level screening of hypertension are needed [35]. Recent advances in information technologies, smartphones, artificial intelligence and wearables have shown potential for early detection of hypertension, monitor BP continuously and provide remote medication titration and support [36–47].

Our study is subject to the limitations of the GBD methodology, described previously [48,49]. Despite comprehensive vital registration data, information on morbidity and health outcomes associated with behavioural and metabolic risk factors are comparatively limited in Australia, and inpatient and outpatient hospital data were not available for the GBD 2019 study. We could not present state and territory level analysis for Australia due to the lack of such data in the GBD analytical tool. Given the large geographical, demographic, and cultural diversity of Australian population, as well as the state-level authority in the health system, sub-national estimation of health and behavioural patterns should be a key future priority for Australia. Additionally, stratifying data by urban–rural, as well as by Indigenous status, will be extremely valuable in terms of analysing inequities and allocating appropriate resources, mostly to disadvantaged groups in Australia.

Conclusion

Although the burden of hypertensive heart disease in Australia has been reduced modestly over the last decades, its prevalence is still relatively high compared to countries with similar sociodemographic characteristics. However, the findings for high systolic blood pressure are promising, showing a significant reduction in mortality, DALYs, and YLLs over thirty years. Efforts to identify people with high blood pressure early and population-level measures for improving the management of blood pressure are a priority for Australia.

Contributions

S.M.S.I., R.D., M.P.G. and R.U. conceptualised the paper. P.G., R.D. and R.U. downloaded the data and created the tables and visualisations. S.M.S.I., R.D., P.G. wrote the first draft. All other authors provided data, developed models, reviewed results, provided guidance on methodology, or reviewed and contributed to the manuscript. All authors approved the final version of the manuscript.

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Competing Interests

MPG is a staff member of Novo Nordisk Iran Novo Nordisk had no involvement in the design, findings, or interpretations of our study. All other authors declare no competing interests.

Appendices

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.hlc.2023.06.853.

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