Factors associated with hypertension and its management among older rural Australians

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Conflict of interest

JB declares a traineeship supported by the Victorian Medical Specialist Training Program. DS holds an unrelated National Heart Foundation fellowship. MJA holds investigator-initiated grants from Pfizer and Boehringer-Ingelheim for unrelated research. He has also undertaken an unrelated consultancy for Sanofi. DL has received research support and honoraria from Abbvie, Astellas, AstraZeneca, Bristol-Myers Squibb, Novartis, Pfizer, Sanofi and Shire for work unrelated to this study. Other authors have no potential competing interests to declare.

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Abstract

Objectives

Hypertension is a leading risk factor for death and disability. We aimed to estimate the prevalence of hypertension in an older rural Australian cohort and identify predictors of hypertension management.

Design

Analysis of cross-sectional data collected from participants in a prospective cohort study.

Setting

The Victorian rural towns of Morwell and Sale in 2018-2019.

Participants

A weighted random sample of 1,119 eligible participants from Morwell or Sale, aged ≥ 55 – 90 years for males and ≥ 60 – 90 years for females, was drawn from the Hazelwood Health Study Adult Survey cohort.

Main outcome measures

Blood pressure (BP), body mass index (BMI), left ventricular hypertrophy (LVH) by electrocardiogram, estimated glomerular filtration rate (eGFR) and glycosylated haemoglobin

(HbA_{1c}) were measured. Participants with hypertension were categorised as managed, undermanaged or unmanaged.

Results

Testing undertaken of 498 participants estimated the weighted prevalence of hypertension (defined as BP $\geq$ 140/90 mmHg, a self-reported doctor-diagnosis of hypertension or taking antihypertensive medication) to be 79.9% (95% CI: 75.7-83.4). Of those, 54.5% (49.4-60.0) had managed hypertension (<140/90 mmHg), 37.1% (32.3-42.1) undermanaged hypertension and 8.4% (5.9-11.9) a new finding of hypertension (unmanaged hypertension). Current employment (RR 1.47, 95% CI: 1.06-2.02) and single marital status (RR 1.45, 1.4-1.84) were associated with under- or unmanaged hypertension. Compared with no hypertension, the hypertensive groups were more likely demonstrate markers of end organ damage such as LVH and impaired renal function.

Conclusion

Hypertension is a highly prevalent condition among older rural Australians which is suboptimally identified and managed.

Abbreviations

BP = blood pressure; eGFR = estimated glomerular filtration rate; HbA_{1c} = glycosylated haemoglobin

What is already known on this subject?

Rural Australians have a higher prevalence of hypertension and a higher risk of cardiovascular diseases, including death from ischaemic heart disease and stroke, compared to urban Australians. While treatment of hypertension is associated with a decrease in cardiovascular morbidity and mortality, the extent to which hypertension is optimally managed in rural settings was not well known.

What this paper adds?

Based on clinical testing, this study found hypertension in 80% of a sample of rural, older Australians. Almost half were not being managed to target. Participants with under- and

unmanaged hypertension were more likely to have evidence of end organ damage. Among those with hypertension, being employed (as opposed to being retired or unemployed) was associated with an increased risk of having under- or unmanaged hypertension, whereas being married was associated with lower risk of under- or un managed hypertension.

Introduction

Rural-dwelling Australians have a higher prevalence of hypertension and a higher risk of cardiovascular disease, such as mortality due to ischaemic heart disease and stroke, compared with urban-dwellers.¹ This potentially reflects a range of factors, including a higher prevalence of obesity and risky alcohol consumption, an older population and limited access to health services in rural areas.¹⁻³

More than ten years ago, as part of the Greater Green Triangle Risk Factor Study, Janus et al (2008) assessed the prevalence of hypertension among rural Australians in south-eastern Australia.⁴ They found that a third of participants had hypertension overall, increasing to 70-80% among those aged over 65 years. Furthermore, only 50% of participants with hypertension were being treated with medication and less than half (46.6%, 95%CI: 40.4 - 52.9%) of those on antihypertensive medication had their blood pressure (BP) controlled (<140/90mmHg).

Hypertension is multifactorial but contributed to by preventable lifestyle factors such as diets high in salt and fat, physical inactivity, alcohol consumption and poorly managed psychological stress.⁵ The 2017-2018 National Health Survey demonstrated an increase in the prevalence of obesity and experiences of psychological stress among Australian adults over the past decade, as well as low rates of physical activity and vegetable consumption.⁶ Moreover, since the analysis by Janus et al, several reviews have highlighted the significant reductions in cardiovascular morbidity and mortality from treating older adults with hypertension, which may have improved management over this period.^{7, 8}

Using data collected as part of a population health study in a sample of older rural Australians, we sought to describe the disease burden attributable to treated and untreated hypertension and identify predictors of hypertension management.

Methods

Study design, setting and participants

This cross-sectional analysis used data collected for the Cardiovascular Stream of the Hazelwood Health Study, the aim of which was to study the health effects of exposure to emissions from the 2014 Hazelwood mine fire.⁹

A weighted random sample of 1,119 eligible participants was drawn from the Hazelwood Health Study's Adult Survey cohort, the methods for which have been published previously.¹⁰

Participants were aged $\geq 55 - 90$ years for males and $\geq 60 - 90$ years for females who lived in, or within close proximity to, the Victorian rural towns of Morwell and Sale.

Participants who reported an underlying cardiovascular condition in the Adult Survey were oversampled to increase the probability of detecting cardiovascular events at follow-up, such that 50% met this criteria.

Data collection took place between October 2017 and May 2018.

Data sources

Three BP readings were taken using a digital automatic BP monitor (Omron, Matsusaka, Japan) with one minute rest between readings. The average of the last two measurements was used in the analysis.

Height and weight were measured and a questionnaire (see supplementary material) captured sociodemographic and health information.

Prescription medications taken over the past seven days were recorded, peripheral venous blood was collected (see supplementary material for laboratory processing methods) and a 12-lead electrocardiograph was obtained using a portable machine (Philips TC50, China).

Educational attainment, marital status and Index of Relative Socioeconomic Disadvantage (IRSD) scores¹¹ were derived from participants' previous responses on the Adult Survey.¹⁰

Definitions

Hypertension was defined as a BP of $\geq 140/90$ mmHg, a self-reported doctor-diagnosis of hypertension or use of antihypertensive medications according to the Anatomical Therapeutic

Chemical (ATC) classification (see supplementary material).¹² The cut-off of $\geq 140/90$ mmHg was chosen to facilitate comparison with previous studies.

‘Managed hypertension’ was defined as a known diagnosis of hypertension and/or taking antihypertensive medication, with a measured BP $< 140/90$ mmHg; ‘undermanaged hypertension’ was defined as a known diagnosis of hypertension and/or taking antihypertensive medication with a measured BP $\geq 140/90$ mmHg; and ‘unmanaged hypertension’ was defined as no known diagnosis of hypertension nor taking antihypertensive medication, but a measured BP $\geq 140/90$ mmHg.

Body mass index (BMI) was classified as ‘underweight/normal’ < 25 kg/m²; ‘overweight’ 25–30 kg/m²; and ‘obese’ ≥ 30 kg/m².¹³

History of cardiovascular disease implied the self-report of a medical diagnosis of atrial fibrillation, aneurysm, valvular disease, heart failure, myocardial infarction, coronary artery disease, stroke / transient ischaemic attack (TIA) or peripheral vascular disease.

Smoking status comprised ‘non-smoker’ (not more than 100 cigarettes over entire lifetime), ‘ex-smoker’ (smoked more than 100 cigarettes, but did not currently smoke) or ‘current smoker’ (smoked over 100 cigarettes and continued to smoke on a regular basis).

An Alcohol Use Disorders Identification Test – Consumption (AUDIT-C) score of 0 indicated a ‘non-drinker’, 1–2 for females and 1–3 for males indicated ‘low risk’ and ≥ 3 for females or ≥ 4 for males indicated ‘high risk’ alcohol consumption.¹⁴

Participants were considered physically active if over the previous 7 days, they reported having done any vigorous physical activity or at least 150 minutes of moderate physical activity.¹⁵

The presence of diabetes (type 1 or 2) was determined by self-reported doctor diagnosis, taking diabetes-associated medications (see supplementary material) or HbA_{1c} $\geq 6.5\%$.

Left ventricular hypertrophy (LVH) was deemed present if stated on the automatically generated ECG interpretative statement using an algorithm based upon the Cornell criteria.¹⁶

Renal impairment implied an estimated glomerular filtration rate (eGFR) of < 60 ml/min/1.73 m².

Data analyses

Post-stratification weights¹⁷ were first obtained for the Adult Survey to correct for possible sampling bias. These were combined with over-sampling weights to correct for oversampling of participants with cardiovascular disease. The prevalences of managed, unmanaged and undermanaged hypertension were estimated using weighted proportions. Simple descriptive analyses examined the differences in participant characteristics in each group, utilising Pearson χ^2 tests for categorical variables and t-tests for continuous variables.

Log Poisson regression¹⁸ was used to estimate relative risks (RR) of having hypertension and un/undermanaged hypertension. Multiple imputation by chained equations (MICE) was used for missing data with 20 imputed datasets. All of the regression analyses accounted for weights, sampling stratification (Morwell versus Sale) and clustering at household level. Sensitivity analysis was conducted using unweighted and unimputed data.

Statistical analyses were undertaken using Stata version 15 (StataCorp, 2017, College Station, TX) and graphical displays were created using R version 3.4.4 (R Core Team 2008).

Ethics

Ethics approval was granted by the Monash University Human Research Ethics Committee (project number 1078).

Results

Figure 1 shows a flow diagram of participant recruitment. In total, 498 participants (recruitment rate 44.5%) underwent clinical testing, of whom 405 were found to have hypertension. We estimated that the weighted prevalence of hypertension in this population was 79.9% (95% CI 75.7-83.4).

Of the participants with hypertension, 226 (weighted 54.5% [95% CI 49.4-60.0]) had managed hypertension, 150 (weighted 37.1% [32.3-42.1]) had undermanaged hypertension and 29 (weighted 8.5% [5.9-11.9]) had unmanaged hypertension.

Compared with no hypertension, the hypertensive groups tended to have higher proportions of older, single/divorced/widowed and retired participants (Table 1). They were also more likely to have a history of diabetes or cardiovascular disease, to be less physically active and demonstrate markers of end organ damage such as LVH and impaired renal function (Table 2).

The majority of participants with under- and unmanaged hypertension demonstrated isolated systolic hypertension (systolic BP ≥ 140 mmHg and diastolic BP < 90 mmHg) (Figure 2). A few participants with managed hypertension had very low BP (Figure 2), implying overtreatment.

Among people taking antihypertensive medications, less than half (weighted 45%) were taking a single agent, with angiotensin converting enzyme (ACE) inhibitors or angiotensin II receptor blockers being the most frequently used single agents (see supplementary material). There were no significant differences in antihypertensive regimens between managed or undermanaged hypertension groups.

Compared to those without hypertension, participants with any form of hypertension were more likely to be older (RR 1.05, 95% CI 1.01-1.09, $p=0.01$), obese (RR 1.21, 1.05-1.40, $p=0.01$), and have a history of cardiovascular disease (RR 1.17, 1.06-1.28, $p=0.001$) (Table 3). Being physically active protected against hypertension (RR 0.90, 0.81-0.99, $p=0.03$).

Compared with managed hypertension, participants with under- or unmanaged hypertension were more likely to be employed, (RR 1.47, 1.06-2.02, $p=0.02$) and be single/divorced/widowed (RR 1.45, 1.14-1.84, $p=0.003$). Having a history of cardiovascular disease was associated with a lower risk of having under- or unmanaged hypertension (RR 0.75, 0.60-0.94, $p=0.01$).

Discussion

The weighted prevalence of hypertension among our sample of rural, older Australians was high (80%) but similar to that estimated by Janus et al approximately ten years prior in western Victoria.⁴ The most recent US guidelines define hypertension as a systolic BP ≥ 130 mmHg or a diastolic BP ≥ 80 mmHg.¹⁹ Using this definition would have increased the proportion in our sample with hypertension, but this was not applied so as to facilitate comparison with previous studies and because current Australian guidelines maintain a cut-off $\geq 140/90$ mmHg in the general population.²⁰

Among those with hypertension, almost half were not being managed to target (BP $< 140/90$ mmHg). While lower than the 76% observed by Janus et al, this level is still suboptimal, particularly considering that participants with under- and unmanaged hypertension were more likely to have evidence of LVH on ECG - a marker of end organ damage and independent risk factor for future cardiovascular events.^{4, 21}

Several barriers to the optimal management of hypertension among older adults have been identified, and tend to be system-, physician-and patient-related, such as uncertainty around the applicability of management guidelines for older persons and patient adherence to treatment for a largely asymptomatic condition.²² This is despite the fact that treatment of hypertension in the elderly has been associated with a decrease in cardiovascular morbidity and mortality.⁸

Among those with hypertension, being employed (as opposed to being retired or unemployed) was associated with a 45% greater likelihood of having under- or unmanaged hypertension compared with managed hypertension, after controlling for known confounders. Workplaces are increasingly sedentary environments, and can be psychologically stressful—both factors associated with the development of hypertension and cardiovascular disease.^{23, 24} Considering people spend the vast majority of their adult life at work, the workplace offers an ideal setting for health promotion programs targeting the primary prevention of cardiovascular risk factors.

Among those with hypertension, single, divorced, separated or widowed participants had a 47% higher risk of under- or unmanaged hypertension compared to married participants. Marital status has previously been shown to impact BP, as well as other cardiovascular risk factors and cardiovascular events, with married persons generally demonstrating more favourable cardiovascular outcomes.²⁵ This is possibly due to more social contact, less psychological stress, healthier meals and financial benefits.²⁵

This study has many strengths. We were able to capture clinical information beyond merely the self-report of hypertension, including an objective measure of BP, possible confounding variables and clinical markers of end organ damage from prolonged hypertension. Our analysis addressed an important information gap in terms of quantification of the prevalence of hypertension and its management among an older, rural cohort.

However, several limitations warrant mention. Participants were drawn from the Hazelwood Health Study Adult Survey, which averaged a 31% recruitment rate. While weightings were applied to best reflect the source population, it remains possible that healthier and independent adults were possibly more likely to participate in the clinic-based assessments. Our study sample comprised predominantly Caucasians, which limited our ability to generalise the findings to the broader Australian population and to those from particular ethnic backgrounds, including indigenous Australians.

Not all factors associated with BP were able to be assessed and included in our analysis. Notably, dietary factors and other medical conditions could affect BP. Finally, history of hypertension and other conditions were based on self-report, and were not verified. It was uncertain if any information bias existed as a consequence and if it did, in what direction it took.

It is highly unlikely that the limitations of our study altered its conclusion: that hypertension is common and not well managed in rural communities. A renewed focus should be placed on the primary prevention of hypertension and cardiovascular disease. Active monitoring for hypertension by medical practitioners is recommended, including frequent checks to ensure that treatment is adequate. Given workforce shortages and high demands on medical services, there is likely a role for practice nurses, pharmacists and automated devices at home.

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Table 1: Sociodemographic characteristics of participants according to hypertension classification.

Table 2: Clinical characteristics of participants according to hypertension classification.

Table 3: Relative risk of factors associated with hypertension vs no hypertension or un-/undermanaged hypertension vs managed hypertension.

Figure 1: Flow diagram of participant recruitment.

Figure 2: Scatter plot and frequency distributions for systolic and diastolic blood pressures by hypertension category.

Tables

Table 1: Sociodemographic characteristics of participants according to hypertension classification

Characteristic	No hypertension N=93	Managed hypertension N=226	Undermanaged hypertension N=150	Unmanaged hypertension N=29	p-value
Age, weighted mean (SD)	67.5 (7.5)	71.2 (8.4)	73.3 (8.7)	68.9 (7.9)	<0.001
Age group	n (weighted %)	n (weighted %)	n (weighted %)	n (weighted %)	
<70	56 (64%)	96 (44%)	54 (37%)	16 (56%)	<0.001
≥70 and <80	31 (29%)	93 (40%)	58 (34%)	8 (23%)	
≥80	6 (8%)	37 (16%)	38 (28%)	5 (21%)	
Gender					
Male	53 (61%)	129 (55%)	81 (52%)	15 (57%)	0.674
Marital status					
Married/de facto	67 (72%)	155 (69%)	77 (52%)	17 (56%)	0.005
Single, divorced, separated or widowed	26 (28%)	70 (31%)	73 (48%)	12 (44%)	
Ethnicity					
Caucasian / White	88 (97%)	221 (98%)	140 (95%)	28 (96%)	0.370
Employment status					
Employed	25 (30%)	29 (15%)	31 (23%)	6 (20%)	0.021
Retired	57 (58%)	180 (78%)	114 (74%)	21 (71%)	
Other	10 (12%)	16 (7%)	5 (3%)	2 (9%)	
Highest educational qualification					
Secondary up to year 10	30 (31%)	89 (39%)	61 (41%)	11 (35%)	0.734
Secondary year 11-12	22 (23%)	38 (18%)	21 (13%)	5 (18%)	
Certificate (trade/ apprenticeship/ technicians)	26 (31%)	77 (33%)	49 (34%)	9 (33%)	
University or other Tertiary degree	14 (14%)	21 (10%)	18 (11%)	4 (14%)	
IRSD, weighted mean (SD)	897.8 (80.6)	887.9 (98.4)	883.8 (101.9)	854.8 (104.4)	0.338

IRSD = Index of Relative Socioeconomic Disadvantage

Table 2: Clinical characteristics of participants according to hypertension classification, n (weighted %)

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Characteristic	No hypertension N=93 n (weighted %)	Managed hypertension N=226 n (weighted %)	Undermanaged hypertension N=150 n (weighted %)	Unmanaged hypertension N=29 n (weighted %)	p-value
Unweighted base					
History of cardiovascular diseases[†]	24 (23%)	133 (52%)	83 (49%)	2 (4%)	<0.001
Diabetes	10 (10%)	65 (27%)	35 (22%)	3 (12%)	0.008
Smoking status					
Non-smoker	53 (55%)	105 (47%)	71 (48%)	14 (48%)	0.654
Ex-smoker	33 (37%)	103 (45%)	71 (47%)	12 (41%)	
Current smoker	7 (9%)	18 (8%)	8 (5%)	3 (12%)	
Alcohol consumption					
Non-drinker	23 (23%)	52 (23%)	44 (28%)	5 (19%)	0.883
Low risk	31 (34%)	85 (36%)	47 (31%)	12 (41%)	
High risk	38 (43%)	89 (41%)	59 (40%)	12 (40%)	
Physically active	62 (67%)	106 (48%)	65 (42%)	15 (48%)	0.004
BMI					
Underweight/Normal (BMI<25 kg/m ²)	28 (29%)	32 (14%)	30 (21%)	6 (19%)	0.068
Overweight (25≤BMI<30 kg/m ²)	33 (37%)	74 (34%)	50 (33%)	12 (40%)	
Obese (BMI≥30 kg/m ²)	32 (34%)	120 (51%)	70 (46%)	11 (41%)	
LVH on ECG	3 (3%)	25 (12%)	24 (17%)	7 (24%)	0.004
Renal impairment[‡]	3 (3%)	48 (21%)	30 (21%)	1 (3%)	<0.001

[†]Self-reported doctor diagnosis of hypercholesterolemia, atrial fibrillation, aneurysm, valvular disease, heart failure, myocardial infarction, coronary artery disease, stroke / TIA and/or peripheral vascular disease.

[‡]eGFR < 60ml/min/1.73m²

BMI= Body Mass Index; LVH= left ventricular hypertrophy; ECG=electrocardiogram; eGFR = estimated glomerular filtration rate

Table 3: Relative risk of factors associated with hypertension vs no hypertension or un-/undermanaged hypertension vs managed hypertension.

	Hypertension vs No hypertension			Un-/undermanaged hypertension vs managed hypertension		
	RR	95% CI	p-value	RR	95% CI	p-value
Age (per 5 years)	1.05	1.01, 1.09	0.010	1.07	0.98, 1.17	0.113

Males	0.96	0.87, 1.06	0.384	1.13	0.90, 1.43	0.294
Single, divorced, separated or widowed	1.05	0.95, 1.15	0.367	1.45	1.14, 1.84	0.003
Employed	1.01	0.86, 1.19	0.865	1.47	1.06, 2.02	0.020
Highest educational qualification						
Secondary up to year 10	Ref			Ref		
Secondary year 11-12	0.97	0.84, 1.12	0.664	0.81	0.56, 1.18	0.278
Certificate (trade/ apprenticeship/technicians)	1.05	0.95, 1.17	0.343	1.01	0.78, 1.32	0.916
University or other Tertiary Institute degree	1.03	0.87, 1.22	0.716	0.95	0.67, 1.35	0.762
BMI						
Underweight/Normal(BMI<25kg/m ²)	Ref	-	-	Ref	-	-
Overweight (25≤BMI<30)	1.13	0.98, 1.32	0.102	0.79	0.58, 1.07	0.132
Obese (BMI ≥30)	1.21	1.05, 1.40	0.011	0.78	0.59, 1.02	0.072
Smoking status						
Non-smoker	Ref	-	-	Ref	-	-
Ex-smoker	1.08	0.97, 1.21	0.138	1.02	0.79, 1.32	0.860
Current smoker	1.07	0.85, 1.34	0.570	0.83	0.47, 1.46	0.520
Alcohol consumption						
Non-drinker	Ref	-	-	Ref	-	-
Low risk	1.01	0.89, 1.13	0.902	0.90	0.68, 1.19	0.461
High risk	1.04	0.92, 1.19	0.526	0.89	0.65, 1.21	0.448
Physically active	0.90	0.81, 0.99	0.031	0.88	0.69, 1.10	0.260
History of cardiovascular diseases[†]	1.17	1.06, 1.28	0.001	0.75	0.60, 0.94	0.014
Diabetes	1.08	0.99, 1.18	0.086	0.79	0.59, 1.06	0.119
IRSD (per 100 score)	1.00	0.96, 1.05	0.932	0.93	0.84, 1.03	0.183

[†]Self-reported doctor diagnosis of hypercholesterolemia, atrial fibrillation, aneurysm, valvular disease, heart failure, myocardial infarction, coronary artery disease, stroke / TIA and/or peripheral vascular disease.

BMI = Body Mass Index; IRSD = Index of Relative Socioeconomic Disadvantage

Figures

Figure 1: Flow diagram of participant recruitment

Figure 2: Scatter plot and frequency distributions for systolic and diastolic blood pressures by hypertension category

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