Untreated hypertension among Australian adults: the 1999–2000 Australian Diabetes, Obesity and Lifestyle Study (AusDiab)

Esther M Briganti, Jonathan E Shaw, Steven J Chadban, Paul Z Zimmet,
Timothy A Welborn, John J McNeil and Robert C Atkins

CARDIOVASCULAR DISEASE is the main contributor to loss of health in Australia, accounting for nearly 18% of the total disease burden.[1] There is good evidence that blood pressure reduction decreases the risk of cardiovascular disease. While lifestyle modification is recommended in the management of all individuals with hypertension, priorities for drug treatment for cardiovascular disease prevention are highest in individuals with established cardiovascular disease, as well as those at high risk of cardiovascular disease based on their risk profile and target organ damage.[2]

Identifying characteristics associated with untreated hypertension in the general population may help to develop strategies for appropriate management of hypertension in Australia. Using a nationally representative population-based sample (the Australian Diabetes, Obesity and Lifestyle Study [AusDiab][3]), we assessed the prevalence of untreated hypertension and its association with clinical and lifestyle factors, and determined the extent of inadequate blood pressure management based on current guidelines for primary and secondary prevention of cardiovascular disease in the adult Australian population. Potential opportunities for lifestyle modification were also examined.

ABSTRACT

Objective: To measure the prevalence of untreated hypertension in Australian adults, and examine the associations with clinical and lifestyle factors.

Design: AusDiab, a cross-sectional survey conducted between May 1999 and December 2000, involved participants from 42 randomly selected census districts throughout Australia.

Participants: Of 20 347 eligible people aged ≥ 25 years who completed a household interview, 11 247 attended a physical examination (response rate, 55%).

Main outcome measures: The prevalence of hypertension (blood pressure $\geq 140/90$ mmHg or self-reported use of antihypertensive drugs) and its treatment; associations of clinical and lifestyle factors with the treatment of hypertension; and adequacy of treatment for primary and secondary prevention of cardiovascular disease.

Results: The prevalence of hypertension was 28.6 per 100 (95% CI, 25.0–32.3), and the prevalence of untreated hypertension was 15.2 per 100 (95% CI, 13.2–17.2). Of those with untreated hypertension, 80.8% (95% CI, 74.7%–85.0%) had had a blood pressure check within the preceding 12 months. At least one modifiable lifestyle factor was present in 71.7% (95% CI, 68.5%–74.8%) of participants with untreated hypertension. Although lower risk clinical characteristics of younger age and lack of hyperlipidaemia were independently associated with untreated hypertension, 53.5% warranted treatment based on current cardiovascular disease prevention guidelines and multivariable absolute risk assessment.

Conclusions: Considerable scope remains for reducing the burden of cardiovascular disease through lifestyle modification and rational treatment of hypertension.

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Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, VIC.
Esther M Briganti, MB BS, MClinEpi, Senior Lecturer; John J McNeil, MB BS, PhD, Director.
International Diabetes Institute, Melbourne, VIC.
Jonathan E Shaw, MD, Physician in Diabetes; and Director of Clinical Research;
Paul Z Zimmet, MB BS, PhD, Director.
Department of Nephrology, Monash Medical Centre, Melbourne, VIC.
Steven J Chadban, MB BS, PhD, Senior Lecturer; Robert C Atkins, MB BS, DSc, Director.
Department of Endocrinology and Diabetes, Sir Charles Gairdner Hospital, Perth, WA.
Timothy A Welborn, MB BS, PhD, Director.
Reprints will not be available from the authors. Correspondence: Dr Esther M Briganti, Department of Epidemiology and Preventive Medicine, Central and Eastern Clinical School, Alfred Hospital, Commercial Road, Prahran, VIC 3181. Esther.Briganti@med.monash.edu.au

METHODS

Survey methods

Details of the AusDiab survey methods have been published elsewhere.[3] AusDiab was conducted between May 1999 and December 2000 to determine the prevalence of diabetes mellitus, obesity, and cardiovascular disease risk factors in people aged 25 years and over. The survey design was based on a stratified cluster method, using seven strata (six states and the Northern Territory) and six clusters (Census Collector Districts) for each stratum. These were randomly selected, with a probability of selection proportional to size.

An initial household interview was followed by a physical examination including blood pressure measurements, standard anthropometry, collection of a fasting blood specimen, an oral glucose tolerance test; and administration of a questionnaire enquiring about medical history, medication use, smoking status, alcohol intake, physical activ-

ity, and when blood pressure was last measured. All blood tests were performed at a central laboratory (HITECH Laboratories, Melbourne, VIC).

Study variables

Blood pressure

Blood pressure measurement was performed in a seated position after participants had rested for at least 5 minutes. An appropriate cuff size was used and the arm was supported by a table at heart level. Three readings were taken at 1-minute intervals. The mean of the first two readings was recorded. If the difference between the three readings was greater than 10 mmHg, the mean of the two closest measurements was used.

In Victoria, a standard mercury sphygmomanometer was used, recording the first and fifth Korotkoff sounds to the nearest 2 mmHg. In the other states, the Dinamap semiautomatic oscillometric recorder was used. A comparison study of the sphygmomanometer and the Dinamap showed that an adjustment was required for diastolic blood pressure readings recorded in Victoria. This was derived from a regression analysis of the data in the comparison study. The adjustment was: Victorian adjusted diastolic blood pressure = 4.636 + (0.905 × Victorian manual diastolic blood pressure).

Hypertension was defined as systolic blood pressure ⩾ 140 mmHg or diastolic blood pressure ⩾ 90 mmHg,[2] or use of antihypertensive drugs irrespective of the blood pressure.

Severity of hypertension was defined as mild (140–159/90–99 mmHg), moderate (160–179/100–109 mmHg) and severe (⩾ 180/110 mmHg).[2]

Categories of hypertension were no hypertension, and untreated hypertension and treated hypertension (based on self-reported use of antihypertensive drugs).

A history of cardiovascular disease was defined as self-reported physician-diagnosed angina, myocardial infarction or stroke.

Clinical factors

Clinical factors recorded included age; sex; body mass index (normal, < 25 kg/m^2; overweight, 25–30 kg/m^2; obesity,

> 30 kg/m^2); diabetes mellitus (self-reported diagnosis of diabetes mellitus and use of hypoglycaemic therapy; fasting plasma glucose level ⩾ 7.0 mmol/L or 2-hour plasma glucose level ⩾ 11.1 mmol/L); and hyperlipidaemia (total cholesterol level > 6.0 mmol/L or low-density lipoprotein [LDL] cholesterol level > 4.0 mmol/L, or use of lipid lowering drugs). Lifestyle factors included current smoking (smoking at least daily); excessive alcohol intake (⩾ 20 g per day[2]); and insufficient physical activity (based on the amount of physical activity sufficient to confer a health benefit[4]).

Cardiovascular disease

Framingham prediction probabilities for cardiovascular disease were based on the systolic blood pressure equation, using age, sex, systolic blood pressure, serum total and HDL cholesterol levels, and the presence or absence of diabetes mellitus, cigarette smoking and left ventricular hypertrophy (electrocardiograph criteria).[5] As results of an electrocardiograph were not available, all subjects were considered not to have left ventricular hypertrophy.

Ethical approval

The ethics committee of the International Diabetes Institute approved the study design, and written informed consent was obtained from all participants.

Statistical analysis

All analyses were conducted using Stata version 8.0[6] survey commands for analysing complex survey data. To account for the clustering and stratification of the survey design and to adjust for non-response, the data were weighted to match the age and sex distribution of the 1998 estimated residential population of Australia aged ⩾ 25 years. The weighting factor was based on the probability of selection in each cluster. Crude prevalence rates per 100 population and 95% CIs were calculated, accounting for the clustering and stratification. Differences in prevalence rates were tested by 2-tailed unpaired *t*-tests. Univariate and multivariate logistic regression analyses were used to identify associations between clinical and life-

1: Independent predictors of untreated hypertension among participants with hypertension

	Odds ratio (95% CI)*	P
Sex		
Women	1.00	
Men	1.87 (1.51–2.33)	< 0.001
Age (years)		
25–44	1.00	
45–64	0.46 (0.27– 0.76)	0.004
⩾ 65	0.31 (0.17–0.55)	< 0.001
Body mass index		
Normal	1.00	
Overweight	0.93 (0.70–1.24)	0.605
Obese	0.77 (0.53–1.11)	0.160
Diabetes mellitus		
No	1.00	
Yes	0.67 (0.53–1.11)	0.058
Hyperlipidaemia		
No	1.00	
Yes	0.67 (0.51– 0.90)	0.008
Smoking status		
No	1.00	
Yes	1.251 (0.76–2.08)	0.396
Excessive alcohol intake		
No	1.00	
Yes	1.09 (0.85–1.41)	0.481
Insufficient physical activity		
No	1.00	
Yes	1.01 (0.87–1.19)	0.900

*Adjusted for all other factors in the Box.

style factors and lack of treatment of hypertension, and given as odds ratios and 95% CIs.

RESULTS

Participants

Of the 19 215 households able to be contacted, 17 130 (89.1%) were eligible for inclusion in the study. Of these, 11 479 (67.0%) agreed to be interviewed. A total of 20 347 adults from these households were interviewed, and of these 11 247 (55.3%) presented for the physical examination. Complete data on blood pressure, self-reported use of antihypertensive drugs, and clinical and lifestyle factors were available for 10 601 (94.3%) participants.

Hypertension prevalence

Overall, the prevalence of hypertension in the adult Australian population was 28.6 per 100 (95% CI, 25.0–32.3) — 15.2 per 100 (95% CI, 13.2–17.2) were untreated and 13.4 per 100 (95% CI, 11.4–15.5) were treated. Mean blood pressure for those with hypertension was 148.8/78.3 mmHg (95% CI, 147.9/77.0 – 149.7/79.7); in participants with untreated hypertension it was 151.0/80.6 mmHg (95% CI, 150.0/79.1 – 152.0/82.1), and for those with treated hypertension 146.3/75.7 mmHg (95% CI, 144.4/74.3 – 148.1/77.2).

Of participants with untreated hypertension, 78.3% (95% CI, 74.5%–82.0%) had mild, 17.4% (95% CI, 14.6%–20.1%) had moderate and 4.3% (95% CI, 2.8%–5.9%) had severe elevations in blood pressure. For those with treated hypertension, 39.7% (95% CI, 35.9%–43.7%) had blood pressure readings in the normal range (< 140/90 mmHg), 35.7% (95% CI, 32.2%–39.1%) had mild, 17.7% (95% CI, 15.0%–20.3%) had moderate and 6.9% (95% CI, 5.0%–8.8%) had severe elevations in blood pressure.

Associations of untreated hypertension

Male sex, younger age, not being obese or having diabetes mellitus, having normal lipid levels, current smoking, excessive alcohol intake and insufficient physical activity were significantly associated with untreated hypertension, compared with treated hypertension. Box 1 shows that only male sex, younger age and normal lipid levels were independently associated with untreated hypertension when all clinical and lifestyle factors were considered simultaneously.

Cardiovascular disease and risk factors for hypertension

Box 2 gives the prevalence of cardiovascular disease, and Box 3 the prevalence of a predicted 10-year risk of cardiovascular disease of ⩾ 20% among participants without cardiovascular disease, according to clinical and lifestyle factors and hypertension category. For those without a history of cardiovascular disease, the predicted 10-year risk of cardiovascular disease was ⩾ 20% in 5.2 per 100 participants without hypertension (95% CI, 4.1–6.4) compared with 48.0 per 100 of those with untreated hypertension (95% CI, 41.3–54.6; P < 0.001), and 50.6 per 100 with treated hypertension (95% CI, 46.4–54.8; P < 0.001).

Modifiable lifestyle factors in participants with untreated hypertension

At least one modifiable lifestyle factor was present in 71.7% (95% CI, 68.5%–74.8%) of participants with untreated hypertension. The prevalence of current smoking (25.2 per 100 [95% CI, 16.5–33.9]), excessive alcohol intake (34.7 per 100 [95% CI, 27.4–42.1]), and inactivity (54.3 per 100 [95% CI, 44.4–64.3]) was highest among the younger age group (25–44 years). However, even among the older age group (⩾ 65 years), the prevalence of current smoking was 9.1 per 100 (95% CI, 2.9–15.2), the prevalence of excessive alcohol intake was 27.4 per 100 among men (95% CI, 21.1–33.7), and the prevalence of inactivity was high for both men and women (51.8 per 100 [95% CI, 44.7–58.9]).

Blood pressure checks before study

Blood pressure had been checked in the preceding 12 months in 71.4% (95% CI, 69.3%–73.4%) of those without hypertension, 80.8% (95% CI, 76.7%–

2: Prevalence (per 100 population; 95% CI) of cardiovascular disease in the whole study population, by clinical and lifestyle factors and hypertension category (n = 11 105)

	No hypertension	Untreated hypertension	Treated hypertension
Total	3.5 (2.8–4.1)	10.6 (7.3–14.0)	24.9 (21.2–28.7)
Sex			
Women	2.8 (2.1–3.5)	12.9 (6.1–19.7)	22.7 (18.5–26.9)
Men	4.2 (3.2–5.2)	9.2 (5.6–12.7)	28.0 (23.9–32.1)
Age			
25–44 years	1.0 (0.6–1.4)	1.3 (0.0–3.6)	2.2 (0.0–5.2)
45–64 years	3.9 (2.9–4.8)	5.7 (3.2–8.2)	16.1 (13.4–18.8)
⩾ 65 years	22.7 (18.1–27.4)	20.8 (15.6–26.0)	33.7 (28.0–39.4)
Body mass index			
Normal	2.7 (1.8–3.6)	10.1 (5.9–14.4)	27.7 (20.6–34.7)
Overweight	4.3 (3.0–5.6)	10.5 (7.3–13.7)	27.8 (23.4–32.2)
Obese	4.2 (2.9–5.6)	11.0 (5.1–17.0)	20.0 (14.4–25.5)
Diabetes mellitus			
No	3.0 (2.5–3.6)	8.4 (6.0–10.8)	23.1 (19.6–26.6)
Yes	18.3 (14.0–22.6)	24.1 (14.4–33.8)	31.1 (22.7–39.4)
Hyperlipidaemia			
No	2.2 (1.5–2.8)	10.0 (5.8–14.1)	19.1 (11.7–26.4)
Yes	6.2 (4.8–7.6)	11.3 (7.7–14.8)	28.9 (24.8–32.9)
Current smoking			
No	3.5 (2.8–4.3)	11.2 (7.5–14.9)	24.2 (20.1–28.4)
Yes	2.8 (1.7–4.0)	5.1 (0.5–9.6)	27.4 (18.8–35.9)
Excessive alcohol intake			
No	3.5 (2.7–4.3)	11.9 (8.2–15.6)	25.5 (20.5–30.5)
Yes	1.6 (0.8–2.4)	3.5 (1.4–5.7)	22.7 (17.8–27.7)
Insufficient physical activity			
No	3.3 (2.5–4.1)	10.9 (7.1–14.7)	21.7 (16.7–26.7)
Yes	3.7 (3.0–4.4)	10.2 (6.6–13.8)	27.7 (22.4–33.0)

Data relating to body mass index, diabetes mellitus, hyperlipidaemia, smoking, alcohol intake and activity level were not available for all participants.

85.0%) of those with untreated hypertension, and 98.1% (95% CI, 97.2%–99.0%) of those with treated hypertension. There was no sex difference in reporting that blood pressure had been measured in the previous 12 months (79.3% of men compared with 83.4% of women, $P = 0.19$).

DISCUSSION

Our study shows that there is still considerable scope for reducing cardiovascular disease in Australia by improving management of hypertension. About half the survey participants with hypertension were untreated. While clinical and lifestyle factors associated with untreated, compared with treated, hypertension in our participants generally reflected those at lower risk of cardiovascular disease, a high burden of cardiovascular disease and cardiovascular risk was found among those with untreated hypertension. In addition, those with untreated hypertension had a high prevalence of potentially modifiable lifestyle factors associated with raised blood pressure and increased cardiovascular disease risk.

Hypertension is the most frequently managed problem in general practice in Australia, accounting for 8.6% of encounters and 7.9% of prescriptions in general practice.[7] As many as 80% of participants with untreated hypertension reported having had their blood pressure measured in the preceding 12 months. Therefore, reluctance to treat hypertension, on the part of the doctor or the patient, is a probable contributor to the high prevalence of untreated hypertension. Clear guidelines for the management of hypertension in Australia have been published,[2] but studies overseas suggest that implementing such guidelines is hampered by a lack of awareness of the guidelines,[8] and the application of less aggressive treatment thresholds,[9-11] especially in the elderly.[12] Patient compliance[13-15] and attitudes to treatment[16,17] have also been implicated as important factors in the suboptimal management of hypertension. Little is known of the contributory factors in Australia.

The effectiveness of hypertension treatment as secondary prevention for cardiovascular disease is well established. Despite this, many of the participants with untreated hypertension had cardiovascular disease, particularly among the elderly and those with diabetes mellitus. Assessing appropriate hypertension treatment for primary prevention is more difficult. There is increasing acceptance that the intensity of hypertension management should be determined by the level of absolute cardiovascular risk, based on the contribution of all cardiovascular risk factors. This is reflected in both the New Zealand and British hypertension treatment guidelines,[18,19] with a predicted 10-year risk of cardiovascular disease $\geqslant 20\%$ (based on calculated Framingham risk estimates) being recommended as the treatment threshold. It is evident from our study that accurately identifying those who would particularly benefit from treatment is difficult without formal assessment of absolute cardiovascular risk. Even among apparent lower-risk groups with hypertension, who were more likely to be untreated, such as those without diabetes mellitus or hyperlipidaemia, a large proportion warranted antihypertensive drug treatment based on multivariable absolute risk assessment. This was also the case for most of the elderly people with untreated hypertension. Based on current hypertension treatment guidelines, it would be considered desirable for 53.5% of those with untreated hyperten-

3: Prevalence (per 100 population; 95% CI) of a predicted 10-year risk of cardiovascular disease of $\geqslant 20\%$ among participants without cardiovascular disease, by clinical and lifestyle factors and hypertension category ($n = 10\,167$)

	No hypertension	Untreated hypertension	Treated hypertension
Total	5.2 (4.1–6.4)	48.0 (41.3–54.6)	50.6 (46.4–54.8)
Sex			
Women	2.2 (1.3–3.1)	38.7 (29.8–47.6)	40.7 (33.0–48.4)
Men	8.6 (6.8–10.5)	53.7 (46.9–60.5)	65.7 (61.3–70.0)
Age			
25–44 years	0.2 (0.0–0.4)	4.2 (1.8–6.5)	2.4 (0.0–5.9)
45–64 years	9.0 (6.7–11.3)	38.9 (31.2–46.6)	30.6 (24.5–36.7)
$\geqslant 65$ years	40.3 (35.3–45.4)	87.4 (82.8–92.1)	76.2 (70.0–82.3)
Body mass index			
Normal	3.0 (2.1–3.9)	43.7 (34.8–52.6)	54.0 (45.4–62.6)
Overweight	6.9 (5.2–8.5)	51.1 (43.5–58.7)	53.0 (46.7–59.3)
Obese	8.8 (5.9–11.7)	47.4 (39.2–55.6)	45.6 (39.4–51.8)
Diabetes mellitus			
No	4.0 (3.2–4.7)	42.2 (35.4–48.9)	41.0 (35.4–46.7)
Yes	53.4 (39.2–67.6)	92.8 (88.5–97.0)	85.7 (80.1–91.3)
Hyperlipidaemia			
No	2.8 (2.0–3.5)	41.1 (33.9–48.2)	44.4 (38.1–50.8)
Yes	10.6 (8.5–12.7)	54.7 (47.2–62.1)	55.2 (50.5–60.0)
Current smoking			
No	3.9 (3.0–4.9)	46.7 (41.2–52.3)	49.5 (45.0–54.0)
Yes	10.5 (7.4–13.7)	55.6 (40.7–70.5)	59.4 (39.1–79.8)
Excessive alcohol intake			
No	5.1 (4.1–6.1)	48.0 (41.5–54.5)	47.5 (42.9–52.0)
Yes	5.0 (3.1–6.8)	44.8 (34.8–54.9)	55.3 (46.6–63.9)
Insufficient physical activity			
No	4.6 (3.5–5.7)	50.5 (40.2–60.8)	48.8 (44.4–53.3)
Yes	6.0 (4.5–7.5)	45.5 (40.6–50.5)	52.7 (46.0–59.5)

Data relating to body mass index, diabetes mellitus, hyperlipidaemia, smoking, alcohol intake and activity level were not available for all participants.

sion to be treated — 10.6% with existing cardiovascular disease, and 48.0% of those without cardiovascular disease but with an increased predicted risk of cardiovascular disease. This figure is as high as 90.0% among the elderly.

Considerable scope for lifestyle modification exists among those with untreated hypertension, with two-thirds of this group having at least one modifiable risk factor. For those with hypertension who are at low absolute risk of cardiovascular disease, drug treatment may not be cost-effective; however, lifestyle modification carries little or no risk, has no significant costs and is effective in compliant individuals.[20-22] Although not treating most younger participants with hypertension was appropriate, given their low absolute risk of cardiovascular disease, lifestyle modification is warranted and likely to make a significant impact on future cardiovascular disease — we found high levels of smoking, excessive alcohol intake and inactivity in this group. Particular focus among elderly people on increasing levels of physical activity, and, in older men, on reducing smoking and alcohol intake, provide non-pharmacological options for successfully managing hypertension and reducing the risk of future cardiovascular disease.

There are several limitations to the interpretation of our findings, given the cross-sectional nature of the study design. The prevalence of untreated hypertension may have been overestimated, as blood pressure was measured on a single occasion. Systolic blood pressure has been shown to decrease as much as 10 mmHg, and diastolic blood pressure as much as 5 mmHg, over 8 weeks in patients with untreated hypertension.[23] However, systolic blood pressure elevations above 160 mmHg have been shown to remain elevated in over 85% of cases after three reviews.[24] Furthermore, Framingham study results have shown that maximum blood pressure readings were as predictive of long-term cardiovascular outcomes as minimum or average blood pressure values at screening.[25] Self-reporting of antihypertensive drug use may also have underestimated the true levels of hypertension treatment. In other countries, accuracy of self-reported antihypertensive drug use has been shown to be reliable by validation against computerised pharmacy records,[26] but its accuracy in Australia is unknown.

Although lack of treatment for hypertension may be a result of a perceived low risk of hypertension-related disease, 53.5% of those with untreated hypertension have a high absolute risk of cardiovascular disease or already have cardiovascular disease. This represents 8.1% of the adult population, or about 1 million Australians, who could benefit from drug treatment of hypertension, with about 50% of this group being elderly. A greater understanding of the barriers to pharmacological and non-pharmacological treatment of hypertension in Australia, among patients and the medical profession, is needed. Inappropriate undertreatment of hypertension represents a missed opportunity to reduce the burden of cardiovascular disease in Australia.

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COMPETING INTERESTS

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