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Low Blood Pressure is not an Independent Determinant of Survival in an Elderly Population

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Summary

The object of the study was to determine whether the increased mortality associated with low blood pressure in elderly people arises because of the adverse effects of hypotension or because of confounding variables.

A community sample of 782 people aged 70 years and older was followed for 3 years. Blood pressure measurements were taken on initial assessment and hypotension was defined separately for systolic and diastolic pressures as a pressure less than the tenth percentile for the sample (systolic $\leqslant 122$ mmHg, diastolic $\leqslant 68$ mmHg).

After 3 years 135 participants had died and of these 31 had low systolic or diastolic blood pressure at baseline. Low diastolic pressure was associated with an increased mortality over the 3 years (hazard ratio 1.85, 95% Confidence Interval 1.18–2.91). This increase in risk was explained by confounding variables. Low systolic pressure was not associated with increased mortality. The increased mortality of those with low blood pressure is explained by concurrent illness.

Keywords: Hypotension, Mortality, Elderly people, Coronary heart disease.

Introduction

In very elderly people low blood pressure has been associated with increased mortality [1, 2]. The low blood pressure may have been a marker of cardiac disease or frailty which were the primary causes of death [3]. In the European Working Party on High Blood Pressure in the Elderly study [4], mortality was highest in those in the lowest tertile of systolic and diastolic blood pressures in the treated group and in the lowest tertile of diastolic blood pressure in the placebo group. There were indicators of poor general health, such as decrease in body weight and haemoglobin in the lowest tertile groups, which may explain both the low blood pressure and increased mortality. Severe atherosclerosis may cause both increased mortality and low diastolic blood pressure through increased arterial rigidity [5]. Alternatively, the low blood pressure may decrease cardiac and cerebral perfusion and contribute to death in its own right.

In a cross-sectional analysis of a population aged 70 years and older we found low blood pressure was only partially explained by established cardiac disease and frailty [6]. We have followed this population prospectively and now report the influence of low blood pressure and confounding variables on mortality over 3 years.

Sample and Methods

The Mosgiel study sampling method, sample, variables and baseline data collection have been described previously [6]. Names and ages of all people 70 years and older on 1 August 1988 and living in Mosgiel, a rural town of 13 500 people, were obtained from the sole group practice in the area. From the initial sample of 856 people, 782 (91.4%) agreed to participate in the study and completed the full medical assessment. There were 500 women and 282 men with a mean (SD) age of 77.5 (5.4) years. All medications were inspected and recorded. The investigating physicians used the London School of Hygiene Cardiovascular Questionnaires, took a history of cardiac events and chronic obstructive respiratory disease [7], took anthropometric measurements and completed a physical examination and a 12-lead electrocardiogram (ECG). The ECG was coded using the Minnesota coding system 1982 [8]. Codes from 1-1-1 to 1-2-9 were taken as *evidence of previous myocardial infarction.*

Blood pressure was taken using the London School of Hygiene sphygmomanometer with a standard adult cuff, using first and fifth Korotkoff sounds to determine systolic and diastolic pressures. Two recordings were taken after the subject had been lying supine for 5 min and the lower pressure was used in the analysis.

Low systolic and diastolic pressures were defined as any pressure at or below the 10th percentile value for the sample as a whole. These pressures were systolic pressure $\leqslant 122$ mmHg and diastolic pressure $\leqslant 68$ mmHg. Blood

Table I. General characteristics of the study population

	Men (n = 282)	Women (n = 500)	Total sample (n = 782)	Lowest decile systolic blood pressure (n = 82)	Lowest decile diastolic blood pressure (n = 85)
Mean age (SD) years	77.0 (5.0)	77.8 (5.6)	77.5 (5.4)	77.3 (5.2)	78.4 (5.2)
Mean systolic blood pressure (SD) mmHg	146 (23)	151 (23)	150 (23)	113 (7)	131 (21)
Mean diastolic blood pressure (SD) mmHg	79 (11)	81 (11)	81 (11)	70 (8)	62 (8)
Mean corrected arm muscle area (SD) cm^2	39.1 (10.0)	33.8 (9.8)	35.7 (10.2)	35.4 (13.0)	31.8 (10.1)
History of myocardial infarction (%)	17.8	13.2	14.9	25.6	34.1
History of angina (%)	21.0	21.1	21.0	31.7	35.3
ECG evidence of myocardial infarction (%)	47.3	50.9	49.6	53.8	56.0
History of chronic obstructive respiratory disease (%)	16.7	8.1	11.2	19.5	21.2
Diabetes (%)	6.8	6.3	6.5	4.9	5.9
Current smokers (%)	15.5	8.8	11.2	13.8	15.9
Taking hypotensive drugs (%)	49.1	67.5	60.9	61.0	77.6

pressure was used as a dichotomous variable because we wished to explore the hypothesis that very low blood pressure contributed independently to mortality.

All participants were followed for 3 years and the date and cause of death were recorded. Cause of death was determined by examination of the death certificate and review of general practice and hospital notes. Deaths were coded as cardiovascular if ischaemic heart disease, heart failure, cardiac arrhythmia, cerebrovascular disease, or peripheral vascular disease were the cause of death or a major contributing factor.

To assess the contribution of low blood pressure to the risk of death over the 3 years, variables related to both low blood pressure and mortality were added progressively to a Cox's regression model using Biomedical Programs (BMDP).

Results

Baseline characteristics of the sample are shown in Table I. All subjects were included in the analysis irrespective of whether or not they were taking antihypertensive medication. Of the 782 participants enrolled in the study, accurate blood pressure recordings were obtained at baseline from 764 participants. Three participants were lost to follow-up. At the end of 3 years 135 participants had died (65 men, 70 women) and of these 16 had low systolic blood pressure at baseline, and 23 low diastolic blood pressure. The cause of death was recorded as cardiovascular for 64 of the participants.

The crude mortality rates at 1 and 3 years by quartiles and the lowest decile of systolic and diastolic blood pressures are shown in Table II.

Low diastolic pressure, but not low systolic pressure, was associated with an increased mortality over the 3

Table II. Crude mortality rates at 1 and 3 years by systolic and diastolic blood pressure quartiles and lowest decile

	Mortality rate at 1 year			Mortality rate at 3 years		
	Men	Women	Total	Men	Women	Total
Systolic blood pressure						
75–100 quartile	0.03	0.03	0.03	0.23	0.15	0.17
50–74 quartile	0.04	0.01	0.02	0.11	0.10	0.10
25–49 quartile	0.08	0.02	0.04	0.29	0.17	0.22
1–24 quartile	0.09	0.09	0.09	0.27	0.13	0.20
1–9 decile	0.08	0.09	0.09	0.26	0.14	0.20
Diastolic blood pressure						
75–100 quartile	0.03	0.03	0.03	0.24	0.13	0.16
50–74 quartile	0.07	0.03	0.04	0.22	0.13	0.16
25–49 quartile	0.10	0.05	0.07	0.21	0.15	0.17
1–24 quartile	0.05	0.03	0.04	0.27	0.13	0.18
1–9 decile	0.11	0.04	0.07	0.40	0.17	0.27

Table III. Hazard ratio for at or below the 10th percentile diastolic blood pressure compared with remaining sample, entering variables successively to a Cox's regression model predicting mortality over 3 years

	Hazard ratio	95% CI
Risk for lowest 10th percentile compared with remainder controlling for no other variables	1.85	1.18–2.91
Controlling for:		
age	1.68	1.07–2.64
sex in addition	1.54	0.98–2.42
history of myocardial infarction in addition	1.38	0.87–2.19
history of angina in addition	1.32	0.83–2.11
corrected arm muscle area in addition	1.21	0.75–1.95
chronic obstructive respiratory disease in addition	1.11	0.68–1.78

years. The risk of death was almost twice as great for those whose diastolic blood pressure was at or less than the 10th percentile when compared with the rest of the population. However, this increase in risk was explained by the confounding variables, particularly sex, history of cardiac disease, low corrected arm muscle area and chronic obstructive lung disease. Addition of further variables including evidence of myocardial infarction on ECG, diabetes mellitus and smoking history did not reduce the hazard ratio further. The hazard ratio for the low diastolic blood pressure term in each model is shown in Table III.

When the same analyses were repeated for those aged 80 years and older only, the hazard ratio for the low diastolic blood pressure term in the final model was 0.90 [95% Confidence Interval (CI) 0.45–1.81]. When similar sub-group analyses were carried out for those 59 participants with complete data sets whose cause of death was cardiovascular, the hazard ratio for low diastolic pressure in the final model was 1.12 (95% CI 0.56–2.25), and for the 68 participants with a non-cardiovascular cause of death 1.21 (95% CI 0.63–2.32).

Discussion

We conclude that the increase in mortality found with low blood pressure in elderly people occurs because the hypotension is a marker of established disease, particularly cardiac disease. We found no evidence that in a population of elderly people, hypotension in its own right is a risk factor for increased mortality. Studies over longer periods indicate that, after the period of initial increased mortality associated with low blood pressure and concurrent illness, there is a linear relationship between blood pressure and mortality [3]. This result is also consistent with trials of antihypertensive treatment where although mortality has been highest in those in the lowest tertile of blood pressure, this increased mortality has occurred in both treatment and placebo groups and in conjunction with other markers of poor health [4].

Although our results indicate that low blood pressure is not a cause of increased mortality in its own right, care must be taken in applying the results of population studies such as this to individual situations. Adverse events may be precipitated by lowering blood pressure too far, too fast. Also susceptible individuals, such as those with cerebrovascular disease, may not tolerate a low blood pressure.

Although the response rate in the study was satisfactory and the follow-up comprehensive, the total number of deaths, particularly cardiovascular deaths, was small. A larger sample, or our 6-year follow-up, may show an independent risk of mortality associated with low blood pressure. However, given that the hazard ratio for low diastolic pressure was close to unity when confounding factors were entered in the model, and low systolic pressure was not associated with any increase in mortality, it seems unlikely that low blood pressure is an independent factor contributing to mortality. The previously reported paradoxically increased mortality of those with low blood pressure is explained by concurrent illness and should not be a deterrent to the appropriate treatment of raised blood pressure in elderly people.

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Key Messages

- Low diastolic but not low systolic blood pressure was associated with increased mortality in a community study of elderly men and women
- This increased mortality with low blood pressure can be explained by concurrent illness

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