



Hypertension management in England: a serial cross-sectional study from 1994 to 2011

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Summary

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Background Hypertension is the leading risk factor contributing to the global burden of disease. We aimed to assess the change in blood pressure management between 1994 and 2011 in England with a series of annual surveys.

Methods We did a serial cross-sectional study of five Health Survey for England surveys based on nationally representative samples of non-institutionalised adults (aged ≥ 16 years). Mean blood pressure levels and rates of awareness, treatment, and control of hypertension were assessed. Hypertension was defined as systolic blood pressure 140 mm Hg or higher, diastolic blood pressure 90 mm Hg or higher, or receiving treatment for high blood pressure.

Findings The mean blood pressure levels of men and women in the general population and among patients with treated hypertension progressively improved between 1994 and 2011. In patients with treated hypertension, blood pressure improved from 150.0 (SE 0.59)/80.2 (0.27) mm Hg to 135.4 (0.58)/73.5 (0.41) mm Hg. Awareness, treatment, and control rates among men and women combined also improved significantly across each stage of this 17-year period, with the prevalence of control among treated patients almost doubling from 33% (SE 1.4) in 1994 to 63% (1.7) in 2011. Nevertheless, of all adults with survey-defined hypertension in 2011, hypertension was controlled in only 37%.

Interpretation If the same systematic improvement in all aspects of hypertension management continues until 2022, 80% of patients with treated hypertension will have controlled blood pressure levels with a potential annual saving of about 50 000 major cardiovascular events.

Funding None.

Introduction

Raised blood pressure has recently been reaffirmed as the biggest single risk factor contributing to global death rates.¹ Furthermore, control of blood pressure is one of the most cost-effective methods to reduce premature cardiovascular morbidity and mortality.² Indeed, treatment of hypertension with any of several classes of generic drugs is cost saving compared with provision of no medication.³ Nevertheless, population-based surveys of hypertension management throughout the world consistently show variably inadequate control of blood pressure.^{4–6} This suboptimum situation will probably worsen at a global level, in view of anticipated increases in the prevalence and absolute number of people affected by hypertension.⁷ However, in several high-income countries, including England but particularly in Canada, rates of awareness, treatment, and control of hypertension have improved over time.^{8,9}

The role of the pay-for-performance system incorporated into the General Medical Services Contract for General Practitioners in the UK since 2004¹⁰ in improving blood pressure management has been controversial.^{11,12} However, data from the 2011 nationally representative Health Survey for England (HSE), which focused on cardiovascular disease and associated risk factors, allow an updated assessment of whether blood pressure management has continued to improve since 2006,⁸ when the HSE last focused on cardiovascular

disease. In this study we aimed to assess the change in blood pressure management between 1994 and 2011 in England with a series of five annual surveys.

Methods

Participants and data collection

The HSE is a series of annual surveys designed to measure health and health-related behaviours in a nationally representative sample of adults and children living in private households in England.¹³ As with all previous surveys, the 2011 HSE involved a multistage, stratified, random probability sample. The main focus of the HSE in 2011 (as in 1994, 1998, 2003, and 2006) was cardiovascular disease, with questions about associated disorders, hypertension, and diabetes. Details of the survey methods for 2011 are described elsewhere,¹⁴ and were essentially the same in as in the previous surveys included in this Article. Ethics approval was obtained from the relevant committees before each survey; for example, the 2011 survey was approved by the Oxford A Research Ethics Committee (reference number 10/H0604/56).

Data collection involved an interview followed by a nurse visit, each in the participant's home. During the interview, information about sociodemographic data, risk factors, and medical history was collected, and at the nurse visit blood pressure measurements and use of prescribed medicines were recorded and non-fasting blood samples were taken.

Blood pressure was measured with the use of Dinamap 8100 monitors before 2003, and Omron HEM207 from 2003 onwards. Therefore, a calibration study was done to provide suitable regression equations to derive predicted Omron readings from Dinamap readings and vice versa (comparison report available on request). The Dinamap to Omron translations for adults aged

16 years and older were derived as follows: predicted Omron= $8.90(\text{SE } 2.94)+0.91(\text{SE } 0.02)*\text{Dinamap}$ for systolic blood pressure; and predicted Omron= $19.78(\text{SE } 1.86)+0.73(\text{SE } 0.03)*\text{Dinamap}$ for diastolic blood pressure.

These equations were used to translate Dinamap readings from the 1994 and 1998 surveys into Omron readings, to allow comparison with the following years. Three blood pressure readings were taken from each participant in a seated position at 1 min intervals with use of an appropriately sized cuff after a 5 min rest. Participants who had exercised, eaten, drunk alcohol, or smoked in the 30 min before measurements were excluded from analyses for all surveys. We used the mean of the second and third readings in the analysis.

Statistical analyses

We limited analyses to participants aged 16 years and older with valid blood pressure measurements. Hypertension was defined as systolic blood pressure of 140 mm Hg or higher, or diastolic blood pressure 90 mm Hg or higher, or receiving treatment for high blood pressure. In accordance with current guidelines,³ isolated systolic hypertension in individuals aged 30 years and older was defined as stage 1 (systolic blood pressure 140–159 mm Hg and diastolic blood pressure <90 mm Hg) or stage 2 (systolic blood pressure ≥ 160 mm Hg and diastolic blood pressure <90 mm Hg).

Details of which, if any, classes of antihypertensive drugs were being taken were recorded by the nurse. In accordance with previous analyses, participants who were not sure whether a blood-pressure-lowering drug they were taking had been prescribed to treat hypertension

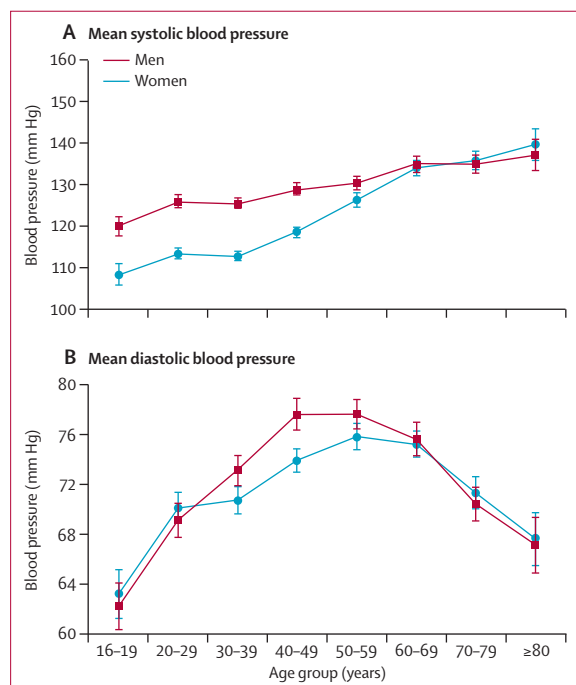


Figure 1: Mean systolic (A) and diastolic (B) blood pressure, Health Survey for England 2011

	16–19 years	20–29 years	30–39 years	40–49 years	50–59 years	60–69 years	70–79 years	≥ 80 years	Total
Men									
Number (weighted)	146	370	356	415	330	293	182	82	2174
% hypertensive (SE)	2% (1.5)	11% (3.1)	13% (2)	28% (2.5)	40% (2.8)	60% (2.8)	67% (3)	72% (4.4)	32% (1.1)
% ISH stage 1 (SE)*	NA	NA	5% (1.3)	10% (1.7)	13% (1.8)	24% (2.4)	23% (2.9)	26% (4.3)	14% (0.9)
% ISH stage 2 (SE)*	NA	NA	0	0	1% (0.6)	3% (1.0)	7% (1.6)	10% (3.0)	2% (0.3)
Women									
Number (weighted)	146	350	363	439	352	322	204	117	2292
% hypertensive (SE)	1% (1.3)	3% (1.1)	7% (1.2)	17% (1.7)	31% (2.2)	53% (2.3)	74% (2.9)	86% (3.1)	28% (1.0)
% ISH stage 1 (SE)*	NA	NA	0	2% (0.6)	12% (1.5)	23% (1.9)	29% (3.1)	30% (4.1)	12% (0.7)
% ISH stage 2 (SE)*	NA	NA	0	1% (0.5)	1% (0.5)	5% (1.1)	8% (1.5)	16% (3.6)	3% (0.4)
Total									
Number (weighted)	291	720	720	854	682	615	385	198	4466
Mean systolic blood pressure, mm Hg (SE)	114.2 (1.06)	119.7 (0.66)	119.0 (0.52)	123.3 (0.57)	128.2 (0.62)	134.2 (0.73)	135.3 (0.79)	138.5 (1.40)	125.4 (0.33)
Mean diastolic blood pressure, mm Hg (SE)	62.7 (0.70)	69.6 (0.50)	71.9 (0.41)	75.7 (0.43)	76.7 (0.39)	75.4 (0.47)	70.9 (0.48)	67.4 (0.82)	72.6 (0.23)
% hypertensive (SE)	2% (1)	7% (1.7)	10% (1.1)	22% (1.5)	35% (1.9)	56% (1.8)	71% (2)	80% (2.6)	30% (0.8)
% ISH stage 1 (SE)*	NA	NA	3%	6%	12%	23%	26%	28%	13%
% ISH stage 2 (SE)*	NA	NA	0	1%	1%	4%	7%	14%	3%

Because n is weighted and rounded, totals might not add from individual values in all cases. ISH=isolated systolic hypertension. *ISH in individuals aged 30 years or older was defined as stage 1 (systolic blood pressure 140–159 mm Hg and diastolic blood pressure <90 mm Hg) or stage 2 (systolic blood pressure ≥ 160 mm Hg and diastolic blood pressure <90 mm Hg).

Table 1: Mean systolic and diastolic blood pressure levels and prevalence of hypertension by age group and sex in the 2011 Health Survey for England

were recorded as a treated patient with hypertension if they also reported a history of hypertension. The class of antihypertensive drug used was assessed by age and ethnic origin (<55 years and not black vs ≥55 years or black) and compared with current recommendations.³

Awareness was defined as a self-report of having been diagnosed as hypertensive by a doctor or nurse, excluding women diagnosed during pregnancy. For control rates, two blood pressure target levels were included—lower than 140/90 mm Hg, the target recommended in most hypertension guidelines,^{3,15,16} and lower than 150/90 mm Hg, an audit standard which was also

included in earlier British guidance¹⁷—to acknowledge the difficulties of achievement of the so-called optimum target in some patients. This is the level used for payment for usual blood pressure control in the general practitioners' contract.¹⁰ The Framingham-based equation was used to estimate the 10-year cardiovascular disease risk in individuals aged 30 years or older without self-reported coronary heart disease or stroke. Age, sex, smoking, systolic blood pressure, total and HDL cholesterol, and self-reported doctor-diagnosed diabetes were included in the equation.

When relevant, selection weights were produced by the survey organisation to correct for probabilities of selection. Starting from 2003, the survey organisations have also generated non-response weights to minimise bias from non-response. We used all relevant, available weights, and from 2003 onwards the analyses took into account the sample design characteristics such as multistage, clustering, stratification, and unequal probabilities of selection. Variance was estimated with the method of Taylor series linearisation. Analyses were done with IBM SPSS v20.

The estimate of the number of cardiovascular events (ie, stroke, coronary heart disease, heart failure, or cardiovascular death) that could have been saved in 1994 if 2011 treatment patterns had been achieved, was calculated applying the relative risk reduction associated with blood pressure reduction reported by the Blood Pressure Lowering Treatment Trialists' Collaboration (BPLTTC)¹⁸ to the changes in blood pressure observed between 1994 and 2011. Two components were considered for this change: the reduction in average systolic blood pressure for the proportion of adults with hypertension that was untreated in 1994 but treated in 2011; and the reduction in average systolic blood pressure between 1994 and 2011 in those treated.

To translate these estimates in number of events, we used the Office of National Statistics population estimate for 1994.

Role of the funding source

The HSE was funded by the Department of Health until HSE 2004, and by the Health and Social Care Information Centre from HSE 2005 onwards; these funders had no role in study design, data collection, data analysis, data interpretation, or writing of this study. There was no funding source for this study. All authors had access to the data and were responsible for the decision to submit the manuscript for publication.

Results

In 2011, 8610 adults aged 16 years or older were interviewed, of whom 5715 had a nurse visit and 4753 had valid blood pressure readings (785 had eaten, drunk alcohol, or smoked in the 30 min before blood pressure recording; three valid measurements were unavailable for 92 people; 30 people refused or had invalid results;

	1994*	1998*	2003†	2006†	2011†
Number					
Men	5605	5222	4279	4019	2174
Women	6512	6307	4555	4374	2292
Total	12117	11529	8834	8393	4466
Mean systolic blood pressure in total population, mm Hg (SE)					
Men	134.1 (0.22)	133.4 (0.22)	131.4 (0.25)	130.8 (0.24)	128.9 (0.37)
Women	130.9 (0.25)	129.4 (0.24)	125.7 (0.30)	124.0 (0.28)	122.1 (0.44)
Total	132.4 (0.17)	131.2 (0.17)	128.4 (0.20)	127.3 (0.19)	125.4 (0.33)
Mean diastolic blood pressure in total population, mm Hg (SE)					
Men	75.5 (0.12)	75.4 (0.13)	74.5 (0.18)	74.2 (0.17)	73.1 (0.3)
Women	72.9 (0.11)	72.6 (0.11)	73.3 (0.17)	72.4 (0.16)	72.0 (0.28)
Total	74.1 (0.08)	73.9 (0.08)	73.9 (0.12)	73.3 (0.12)	72.6 (0.23)
% hypertensive‡ (SE)					
Men	32% (0.6)	32% (0.6)	33% (0.8)	32% (0.8)	32% (1.1)
Women	29% (0.6)	29% (0.6)	30% (0.7)	29% (0.8)	28% (1.0)
Total	31% (0.4)	30% (0.4)	32% (0.6)	30% (0.7)	30% (0.8)
% of treated patients receiving monotherapy (SE)					
Men	64% (2.2)	61% (2.1)	43% (1.8)	42% (2.0)	43% (2.4)
Women	66% (2.8)	60% (1.7)	46% (1.8)	37% (1.7)	47% (2.4)
Total	65% (1.3)	60% (1.4)	45% (1.3)	39% (1.4)	45% (1.7)
Mean systolic blood pressure in treated population, mm Hg (SE)					
Men	148.3 (0.86)	144.6 (0.79)	141.7 (0.77)	139.5 (0.72)	135.1 (0.77)
Women	151.2 (0.79)	148.2 (0.73)	143.3 (0.75)	139.5 (0.71)	135.6 (0.88)
Total	150.0 (0.59)	146.7 (0.54)	142.6 (0.74)	139.5 (0.51)	135.4 (0.58)
Mean diastolic blood pressure in treated population, mm Hg (SE)					
Men	81.6 (0.40)	80.7 (0.38)	76.8 (0.49)	76.1 (0.50)	73.8 (0.57)
Women	79.2 (0.37)	77.5 (0.34)	76.0 (0.44)	73.4 (0.42)	73.2 (0.56)
Total	80.2 (0.27)	78.8 (0.26)	76.4 (0.33)	74.6 (0.32)	73.5 (0.41)
% of treated patients achieving blood pressure control of <140/90 mm Hg (SE)					
Men	35% (2.2)	40% (2.1)	48% (2.2)	52% (2.3)	65% (2.4)
Women	32% (1.7)	37% (1.7)	44% (1.9)	53% (2.3)	61% (2.5)
Total	33% (1.4)	38% (1.3)	46% (1.4)	52% (1.7)	63% (1.7)
% of treated patients achieving blood pressure control of <150/90 mm Hg (SE)					
Men	58% (2.3)	61% (2.1)	66% (2.0)	70% (2.2)	81% (2.0)
Women	53% (1.9)	59% (1.7)	62% (1.8)	69% (2.1)	76% (2.2)
Total	55% (1.4)	59% (1.3)	64% (1.4)	69% (1.6)	78% (1.5)

Blood pressure values stated as Omron readings. *Blood pressure values recorded with Dinamap 8100 monitors and converted to predicted Omron HEM207 readings to allow comparison with data from subsequent surveys. †From 2003 onwards, data are weighted for non-response and analysis takes into account complex survey design. ‡Blood pressure ≥140/90 mm Hg or receiving treatment for high blood pressure.

Table 2: Blood pressure levels and hypertension from 1994 to 2011

and 55 were pregnant). A further 213 individuals were excluded because they reported taking medication that lowered blood pressure but did not report a history of hypertension. We included the remaining 4540 people (1961 men and 2579 women; corresponding to 2174 men and 2292 women, when analyses were weighted) in the analysis; the mean age was 46 years (SE 0·6) in men and 47 years (0·4) in women.

In 2011, mean systolic blood pressure increased with increasing age across the whole age range in both men and women, but was higher in men than in women until the age of 60 years (figure 1). Diastolic blood pressures also increased with age in both sexes but only until the age of 60 years, above which diastolic blood pressures fell consistently. Diastolic blood pressures were generally higher in men than in women, except among participants aged 16–29 years and 70 years or older (figure 1). Overall, mean blood pressure levels were 128·9 (SE 0·37)/73·1 (0·3) mm Hg in men and 122·1 (0·44)/72·0 (0·28) mm Hg in women. Hypertension rates increased with age in both sexes and were more prevalent in men than in women, except in participants aged 70 years or older, among whom the overall prevalence of hypertension was more than 70% (table 1).

Hypertension was noted in 30% (SE 0·8) of participants (32% [1·1] of men and 28% [1·0] of women; table 1). Among participants aged 30 years or older, between a third and a half of the reported hypertension was attributed to stage 1 isolated systolic hypertension (14% [SE 0·9] of men and 12% [0·7] of women; table 1).

The mean blood pressure levels of men and women in the general population and among patients with treated hypertension show a progressive improvement between 1994 and 2011, whereas the prevalence of hypertension has remained stable (table 2). Awareness, treatment, and control rates among men and women combined have also improved significantly across each stage of this 17-year period (figure 2); control rates among treated individuals show large incremental benefits over time (table 2, figure 3). Control rates among all people with hypertension more than tripled from 11% in 1994 to 37% in 2011 (figure 2). Age-stratified analyses are consistent with this overall trend (data not shown).

Between 1994 and 2006, the proportion of participants with treated hypertension receiving monotherapy reduced as mean blood pressures fell and control rates increased, whereas between 2006 and 2011, no link between use of monotherapy and blood pressure levels or control was apparent (table 2).

The proportion of adults with untreated hypertension was 13% (SE 0·6) in 2011 compared with 21% (0·4) in 1994. A 20 mm Hg lower average systolic blood pressure was reported in this additional 8% (21%–13%) of adults who would not have been treated in 2011 if the prevalence of untreated hypertension had stayed the same as in 1994 (average systolic blood pressure among adults with untreated hypertension in 1994 [155·0 mm Hg, SE 0·28]

minus average systolic blood pressure among adults with treated hypertension in 2011 [135·3 mm Hg, SE 0·55]).

A 15 mm Hg lower average systolic blood pressure was reported between 1994 and 2011 in those treated for hypertension (table 2), with an associated estimated relative risk reduction in major cardiovascular events of 0·57.¹⁸

Assuming an annual event rate of 2% or 3%, about 68 000 or 100 000, respectively, of these major cardio, for the NAC-MD-01 Study Investigatorsvascular events would have been prevented among the 1994 English population had they been exposed to the improved treatment rates and blood pressure control achieved by 2011.

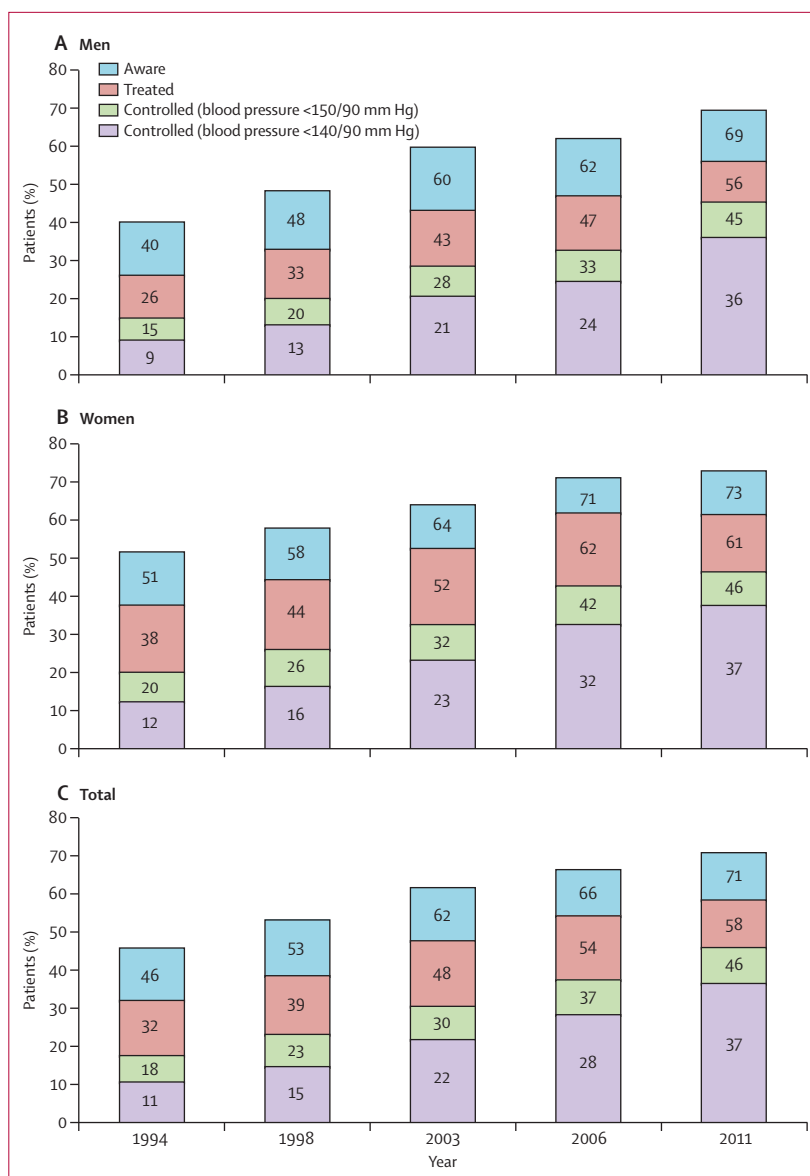


Figure 2: Awareness, treatment and control of hypertension between 1994 and 2011 for men (A), women (B), and all adults (C)

Hypertension was defined as blood pressure $\geq 140/90$ mm Hg or receiving treatment for high blood pressure.

In 2011, 89% (SE 2.4) of people with a self-reported history of cardiovascular disease had hypertension, of whom 97% (1.1) were treated for hypertension, and 65% (3.3) had controlled hypertension (67% [3.3] among those treated). 81% (SE 2.6) of the cohort with type 2 diabetes had hypertension, of whom 87% (2.6) were

treated and 57% (3.5) had controlled hypertension (66% [3.6] among those treated). By contrast, although 71% (SE 2.1) of participants whose estimated 10-year cardiovascular risk was 20% or higher had hypertension, only 57% (2.8) of these people were treated, and only 24% (2.4) had controlled hypertension (42% [3.7] among those treated).

In 2011, most participants treated for hypertension were taking at least two antihypertensive drugs (table 3). The commonest drugs used for monotherapy—irrespective of age and race—were blockers of the renin-angiotensin system (RAS), either angiotensin converting enzyme inhibitors or angiotensin receptor blockers. The next commonest single therapy was calcium channel blockers and third was diuretics, although in the younger age stratum (age <55 years) β blockers were used slightly more commonly than were diuretics (table 3).

The commonest pairing of antihypertensive drugs used together overall was RAS blockers plus calcium channel blockers, although among older patients

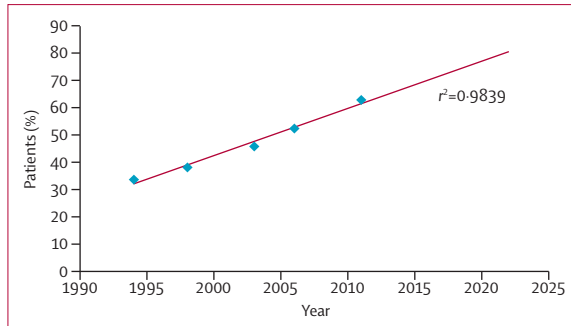


Figure 3: Percentage of adults with controlled hypertension among those treated, by survey year

	Age <55 years and not black (SE), n=154	Age ≥55 years or black (SE), n=618	Total (SE), n=772
One drug (45%, n=350)			
Number (weighted)	94	256	350
Diuretics	8% (3.4)	18% (2.1)	15% (1.7)
β blockers	9% (3.2)	11% (1.9)	11% (1.6)
RAS blockers	67% (4.7)	47% (2.8)	53% (2.5)
Calcium antagonist	15% (2.8)	22% (2.2)	20% (1.8)
Other drugs affecting blood pressure	1% (0.7)	2% (0.5)	1% (0.4)
Two drugs (36%, n=277)			
Number (weighted)	43*	234	277
Diuretics plus β blockers	0	4% (0.7)	3% (0.6)
Diuretics plus calcium antagonist	8% (5.0)	11% (1.5)	11% (1.6)
Diuretics plus RAS blockers	23% (5.2)	28% (2.1)	27% (2.0)
β blockers plus RAS blockers	15% (4.2)	17% (1.9)	16% (1.7)
β blockers plus calcium antagonist	15% (4.6)	9% (1.6)	10% (1.6)
RAS blockers plus calcium antagonist	32% (5.4)	27% (2.0)	28% (2.0)
Other combination	7% (2.5)	5% (1.1)	5% (1.0)
Three drugs (14%, n=112)			
Number (weighted)	13†	99	112
Diuretics plus β blockers plus calcium antagonist	..	6% (1.2)	6% (1.1)
Diuretics plus β blockers plus RAS blockers	..	25% (3.3)	22% (2.8)
Diuretics plus RAS blockers plus calcium antagonist	..	29% (3.3)	32% (2.9)
β blockers plus RAS blockers plus calcium antagonist	..	12% (2.5)	13% (2.2)
Other combination	..	29% (2.7)	27% (2.5)
Four drugs (4%, n=33)			
Number (weighted)	4†	29†	33*
Diuretics plus β blockers plus calcium antagonist plus RAS blockers	..	..	53% (2.6)
Diuretics plus calcium antagonist plus RAS blockers plus α blockers	..	..	15% (0.2)
Diuretics plus β blockers plus RAS blockers plus α blockers	..	..	11% (0.1)
Other combination	..	..	21% (2.5)

RAS=renin-angiotensin system. *Interpret with caution because of small numbers. †No data provided for some groups because of small numbers.

Table 3: Type of drugs used among participants treated for hypertension

diuretics plus RAS blockers was a slightly more common combination (table 3). Among patients receiving three or more drugs, insufficient numbers pre-empted stratification by age, and some caution in interpretation of these data should therefore be exercised. However, among patients taking three drugs, RAS blockers plus calcium channel blockers plus diuretics was the commonest combination (table 3). The prevalence of resistant hypertension, defined as being uncontrolled despite taking three drugs or being on four or more drugs irrespective of blood pressure level, was 8% (SE 0·8).

Discussion

These data from a large representative sample of the English adult population in 2011 show that awareness and all aspects of hypertension management have improved systematically across the five national surveys that focused on cardiovascular disease since 1994.^{8,19–21} Whereas once the “rule of halves”²² prevailed (ie, that half of patients with high blood pressure in a population have been diagnosed, half of those detected have been treated, and half of those treated have been controlled), current management in England is better than a rule of two-thirds (panel).

The mean blood pressure levels of men and women in the general population have fallen, although the prevalence of hypertension seems to be stable. The significant fall in salt consumption in England from 9·5 g/day in 2000–01 to 8·1 g/day in 2011,²³ although remaining substantially higher than the recommended 6 g/day, might have contributed to falling blood pressure in the general population in addition to the improved treatment and control rates of hypertension described. Importantly, treatment rates have almost doubled, and among adults with treated hypertension systolic blood pressure levels have fallen by 15 mm Hg since 1994. Furthermore, control rates (<140/90 mm Hg) among patients receiving treatment have also almost doubled in the same period. With extrapolation of these improved aspects of management reported in 2011 to the English hypertensive population of 1994, we estimate that between 68 000 and 100 000 major fatal and non-fatal cardiovascular events would have been prevented in 1994. Our estimate is in line with the decrease in cardiovascular mortality that has been actually reported in UK and other high-income countries.²⁴ Data from the Office of National Statistics show that mortality from ischaemic heart disease in England and Wales fell from 135 045 in 1994²⁵ to 64 435 in 2011, a reduction of more than 70 000 fatal events. Perhaps surprisingly, the trend between 1994 and 2006 for an increasing proportion of treated patients to be on at least two antihypertensive drugs⁸ (table 2) did not continue to 2011. However, the prevalence of control among patients receiving monotherapy in 2011 was 63%, whereas it was only 47% in 2006. Moreover, the types of antihypertensive drugs used has changed between 2006

and 2011, to be more in keeping with contemporary UK guidance.³ Among patients receiving monotherapy, the use of diuretics and β blockers has fallen and the use of RAS blockers has increased by comparison with previous years, such that most of this group took RAS blockers in 2011.^{8,19–21} Differences in drugs used by the age and race strata recommended in recent UK guidelines^{3,26} are also apparent but are less stringently adhered to regarding optimum therapy for older or black patients.

In keeping with the results of the ACCOMPLISH trial²⁷ and the NICE guidelines of 2011,³ the commonest two-drug combination used in 2011 was RAS blocker plus calcium channel blocker, replacing RAS blockers plus diuretics in 2006⁸ and diuretics plus β -blockers in earlier years.¹⁹

For the first time in England, most men and women diagnosed with hypertension (receiving treatment or blood pressure $\geq 140/90$ mm Hg) were being treated with one or more antihypertensive drugs (figure 2). Although this development is a big improvement compared with previous years, it might seem inadequate, because among all these survey-defined adults with hypertension only 37% had controlled hypertension, by comparison with, for example, 65% of adults with hypertension in Canada in 2007–09.^{4,28} However, these different rates need to be put in the context of previous and current UK guidance, which does not recommend treatment for people with blood pressure of 140–159 mm Hg systolic and 90–99 mm Hg diastolic unless they are at high estimated cardiovascular risk or have diabetes or established cardiovascular disease. Canadian guidelines, by contrast, recommend treatment for all people with blood pressure levels of 140 mm Hg systolic or 90 mm Hg diastolic or higher. However, only 57% of study participants in England with estimated high cardiovascular risk were being treated. Similarly, although control rates (defined as blood pressure <140/90 mm Hg) among treated patients have risen from 52% in 2006 to 63% in 2011, this apparent shortfall in treatment for about a third of treated patients should be put in the context of the pay-for-performance system incorporated in the Quality and Outcomes Framework in the General Medical Services contract for general practitioners in the UK.¹⁰ Since 2004, remuneration is based on the definition of blood pressure control being less than 150/90 mm Hg, which was achieved by 78% of study participants being treated in 2011 (table 2). The blood pressure targets in the Quality and Outcomes Framework were more stringent in 2013–14 for patients younger than 80 years, having reduced in line with UK guidance, but have reverted to the 150/90 mm Hg threshold from April, 2014.

In view of the strong linear association between improvement in blood pressure treatment and control rates between 1994 and 2011 (figure 3), we estimate that if the improvement in all aspects of management continues at the same rate, 80% of the treated population will have controlled hypertension by 2022, which is predicted to be

Panel: Research in context**Systematic review**

We searched PubMed for papers published between January, 1994, and December, 2013, with the terms “hypertension” or “blood pressure” and “treatment” or “control” and “trend”. We searched for reports from population survey data that confirmed variously inadequate control of blood pressure in different populations and for studies and clinical trials showing how treatment of hypertension reduce cardiovascular mortality. We also searched the internet for official statistics for mortality data for cardiovascular disease in the UK and other countries. Trends in treatment and control of hypertension have been reported from countries such as the USA and Canada, and some comparisons across countries have also been published, but we did not identify any other reports of trends in awareness, treatment, and control of hypertension in England during the past 20 years.

Interpretation

The rates of diagnosis, treatment, and control of raised blood pressure remain suboptimum in England, particularly by comparison with Canada, although this difference partly results from more conservative treatment guidelines in the UK. However, there has been a steady rise in all three measures of blood pressure management from 1994 to 2011. The so-called rule of halves is now the rule of two-thirds, with a concomitant saving of tens of thousands of lives each year.

associated with a further annual saving of between 35 000 and 55 000 fatal and non-fatal cardiovascular events compared with 2011.

The strengths of our data include the nationally representative random samples used and that the data for drugs being used were reported by participants (and, in most cases, the packs seen by the nurses), which are more likely to more accurately represent treatments than are data based on drugs prescribed. Additionally, the use of identical questions and protocols across the surveys allows direct valid comparisons to be made.

The main weaknesses of these data are the low proportion of interviewed participants who received a nurse visit. However, bias was minimised by the use of non-response weighting that combined adjustment to ensure that the interviewed participants represented the national and regional population based on socio-demographic profiles, with further adjustment by using interview variables to minimise differences between those interviewed who did and did not have a nurse visit.¹⁴ There is also a small degree of inaccuracy from the comparison of estimated blood pressure levels in 1994 and 1998, measured on one type of machine, with measurements taken with a different machine thereafter.

The prevalence of hypertension might be exaggerated as a result of diagnosis made on the basis of one set of readings, contrary to optimum practice,^{3,16} which in turn could result in exaggerated estimations of people at

higher risk of cardiovascular disease. However some compensation for this potential bias could have been made by use of the last two of three readings, measured at home by a nurse under careful conservative conditions,¹⁴ all of which are likely to generate lower blood pressures than are those produced in routine clinical practice. The use of the Framingham equation could have identified a larger proportion of people at higher risk of cardiovascular disease than if QRISK,²⁹ had been used. Nonetheless, the derivation and use of QRISK is quite recent and, in 2011, the Framingham equation was more widely used.

Despite the shortcomings of any cross-sectional survey, these data from a large nationally representative sample of English adults provide clear evidence of an ever-improving approach to hypertension management such that since 1994 overall treatment rates have almost doubled, and control rates have trebled (figure 2). Several hundreds of thousands of major cardiovascular events might possibly have been prevented as a result of these improvements in practice.

Contributors

EF did the analyses, which were prespecified by all four authors. EF and NP wrote the first draft; all four authors contributed to subsequent versions and approved the final manuscript.

Declaration of interests

NP has received honoraria to speak at national and international meetings by most companies producing blood-pressure-lowering drugs. NP is supported by the National Institute for Health Research Senior Investigator Award, Biomedical Research Centre funding, and the British Heart Foundation Research Centre Excellence Awards. EF, JM, and CK declare no competing interests.

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