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Rising prevalence, and improved but suboptimal management, of hypertension in South Africa: A comparison of two national surveys

Nasheeta Peer [a,b,*], Olalekan A. Uthman [c,d], Andre-Pascal Kengne [a,b]

[a] Non-communicable Diseases Research Unit, South African Medical Research Council, Durban and Cape Town, South Africa
[b] Department of Medicine, University of Cape Town, Cape Town, South Africa
[c] Warwick Centre for Global Health, Division of Health Sciences, University of Warwick Medical School, Coventry, United Kingdom
[d] Division of Epidemiology and Biostatistics, Department of Global Health, Faculty of Health Sciences, Stellenbosch University, Cape Town, South Africa

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ABSTRACT

Aim: To examine the changes in prevalence, awareness, treatment and control of hypertension between 1998 and 2016 in ≥15-year-old South African men and women and the sociodemographic characteristics associated with those changes.
Methods: In nationally representative surveys in 1998 and 2016, multi-stage sampling was used to select, interview and collect blood pressure and anthropometric measurements in ≥15-year-old adults. Logistic regression analyses evaluated the independent effects of selected sociodemographic characteristics on hypertension management.
Results: Among 13,217 participants in 1998 and 7830 in 2016 (59–60% women in both surveys), hypertension prevalence increased from 27% to 45% in men and 31% to 48% in women. Hypertension increased equally in participants with and without obesity and in daily cigarette smokers vs. their counterparts. Prevalence of awareness among participants with hypertension increased from 7% to 18% (men) and from 17% to 29% (women). Among those aware, hypertension treatment improved markedly from 8% to 85% (men) and from 12% to 82% (women). Hypertension control among those on treatment increased from 17% to 26% (men) and from 21% to 30% (women). Increasing age and survey year were consistently associated with higher prevalence, awareness, treatment and control of hypertension. The richest vs. poorer women, and lower vs. higher educated women were more likely to be treated for hypertension.
Conclusions: The high and rising hypertension burden together with suboptimal awareness and control levels warrant greater attention to curb hypertension-related morbidity and mortality in South Africans. Novel strategies involving community-based or workplace hypertension programmes may overcome some barriers to optimal care.

Introduction

The burden of raised blood pressure (BP) i.e. systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg and hypertension, which includes individuals on antihypertensive medication, is growing worldwide and the number of adults with raised BP has increased from an estimated 594 million in 1975 to 1.13 billion in 2015 [1]. Notably, these increases have occurred predominantly in low- and middle-income countries (LMICs) and have been attributed mainly to population growth and ageing. The shift in the burden of raised BP from high-income countries (HICs) to LMICs is of concern considering that the latter regions, particularly Sub-Saharan Africa (SSA), are afflicted by multiple disease burdens [2]. Healthcare services in SSA and other LMICs are buckling under pressure and unable to cope with the expanding disease burdens leading to suboptimal care of raised BP, and other non-communicable diseases.

Although the numbers with raised BP have risen worldwide, the prevalence of raised BP between 1975 and 2015 declined in HICs and in some middle-income countries while remaining unchanged in others [1]. This underscores that the trends of raised BP are not uniform across countries, and that each country needs to examine its specific patterns of raised BP, and hypertension prevalence and management. Such data have important implications for healthcare provision and for strategies

* Corresponding author at: Non-communicable Diseases Research Unit, South African Medical Research Council, 491 Ridge Road, Overport, Durban 4001, South Africa.
E-mail address: nasheeta.peer@mrc.ac.za (N. Peer).

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to control hypertension. Resources can be appropriately allocated, and cost-effective therapeutic strategies and programmes developed if the burden, care and changing patterns of raised BP and hypertension are clearly elucidated.

In South Africa, to our knowledge, the few population-based studies that have explored the changes in hypertension prevalence have been regional studies and conducted mainly in the Western Cape Province [3,4]. These studies reported increases in hypertension in urban residents of Cape Town. Hypertension prevalence increased in the black population from 22% in 1990 to 36% in 2008/09 among 25–64-year-old men and women (CRIBSA Study) [3]. In the mixed-ancestry population, hypertension increased between 2008/09 and 2014/16 from 31% to 45% [4]. These findings are not representative of rural residents nor of the other eight South African provinces and cannot be generalised to the national population.

Moreover, few population-based studies have examined the changing patterns of hypertension management i.e. awareness, treatment and control in South Africa. The CRIBSA Study reported worsening hypertension management in men but improvements in women over two decades [3]. The study in the mixed-ancestry population described a rising prevalence of unknown or undetected hypertension over seven years [4]. Neither study explored the associations of hypertension care.

This study aimed to describe the changing patterns of mean systolic BP (SBP) and diastolic BP (DBP), and hypertension prevalence and management from two South African Demographic and Health Surveys (SADHS) conducted in 1998 and 2016 in ≥15-year-old South African men and women. Further, the sociodemographic characteristics associated with hypertension management i.e. awareness, treatment and control were explored over this period.

Methodology

Study population and sampling procedure

Data were collected from a nationally representative, multistage cluster sample of households in the population-based SADHS. This included an adult health module for participants ≥15 years of age, similar to other Demographic and Health Surveys conducted globally [5]. These cross-sectional surveys were conducted in 1998 and 2016 using the same methodology as outlined in the respective reports [6,7].

The 1996 census was used in 1998 and the 2011 census in 2016 as sample-frames for the two-stage samples to select nationally representative samples of the total non-institutionalised population of South Africa. Using the probability proportional to size technique, the census enumeration areas were selected. These were stratified into urban formal, urban informal, rural formal, and tribal areas of the nine provinces. For the second stage, households were systematically sampled within the selected enumeration areas.

Data collection

Structured questionnaires, translated into the 11 South African official languages, were administered by trained fieldworkers who also measured anthropometry and BP levels. Sociodemographic variables included assets that defined wealth, which comprised ownership of consumer items (durable goods), dwelling characteristics, source of drinking water and toilet facilities.

Standardised techniques, with participants barefoot and in light clothing, were used to measure anthropometry [8]. These included height to the nearest 0.1 cm using a stadiometer, weight to the nearest 0.1 kg using a calibrated scale and waist circumference to the nearest 0.1 cm using a flexible tape measure.

Digital BP monitors using Omron M1 in 1998 and Omron 1300 in 2016 measured BP. Three BP reading were taken for each participant after s/he had been seated for five minutes, with about a 3-min interval between each reading.

Data access

The global ‘Demographic and Health Surveys Program’ is managed by the United States Agency for International Development (USAID) and specific data are available upon request via their website [5]. The relevant data from the 1998 and 2016 SADHS were requested and access granted by USAID in 2019.

Definitions

Daily smoking was defined as smoking ≥1 cigarette per day. Body mass index (BMI), calculated as weight in kilograms divided by height in metres squared (kg/m^2) categorised underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9) and obesity (≥30) [9]. Central obesity was defined by raised waist circumference (WC) of > 94 cm in men and > 80 cm in women [10]. Hypertension was defined as BP ≥140/90 mmHg or the use of antihypertensive medication [11]. Among participants with hypertension, awareness was defined as previously being informed by a doctor or nurse of their high BP status. Hypertension treatment was defined as taking anti-hypertensive medication daily or regularly among those who were aware of their diagnosis. Hypertension control in participants on anti-hypertensive medication was defined as BP <140/90 mmHg.

Statistical analyses

The analytical approach included descriptive as well as bivariable and multivariable analyses. The descriptive statistics show the distribution of participants by the key variables. Values are expressed as absolute numbers (percentages) for categorical variables and as mean (standard deviation) for continuous variables. Next, the bivariate analyses examined the association between each variable and the dependent variables - hypertension awareness, hypertension treatment and hypertension control. Contingency tables were analysed using Pearson $\chi 2$ test or Fisher exact test.

Multivariable logistic regression analyses were used to examine the net effects of the explanatory variables on the dependent variables. In the logistic regression models, the dependent variables were hypertension awareness, hypertension treatment and hypertension control, and the independent variables were survey year, age, residence, education and asset index. The asset index and wealth quintiles were developed using a principal component analysis of the pooled data [12]. Results of the multivariable analysis are presented as odds ratios (OR), with 95% confidence intervals (CI).

Data were collected and analysed using Stata 16. All cases in the SADHS data are given weights to adjust for differences in probability of selection of subjects and to adjust for the non-response in order to produce the proper representation of the whole country.

The South African Medical Research Council Ethical Committee approved the SADHS protocols. Informed consent was obtained from all participants.

Results

The study sample comprised 5477 men and 7740 women in 1998, and 3136 men and 4694 women in 2016. Between 1998 and 2016, in men, SBP increased by 8.3 mmHg (from 124 to 132 mmHg) and DBP by 7.9 mmHg (from 77 to 85 mmHg) (Table 1). In women, SBP increased by 10.3 mmHg (from 119 to 130 mmHg) and DBP by 8.6 mmHg (from 76 to 85 mmHg). Almost half of the participants had hypertension in 2016; this corresponds with a 65% rise in prevalence in men from 27% in 1998 to 45% in 2016, and a 54% increase in women from 31% to 48% over an 18-year period.

For general comparability with other adult populations i.e. ≥18-year-old men and women, sub-group analyses showed that mean SBP and DBP were 125 mmHg and 78 mmHg in 1998, and 133 mmHg and

Table 1
Mean systolic and diastolic blood pressures and prevalence of hypertension in ≥15-year-old men and women by socio-demographic characteristics in 1998 and 2016.

	Men (1998: n = 5477; 2016: n = 3136)						Women (1998: n = 7740; 2016: n = 4694)					
Socio-demographic characteristic	Systolic blood pressure (mmHg)		Diastolic blood pressure (mmHg)		Hypertension prevalence, %		Systolic blood pressure (mmHg)		Diastolic blood pressure (mmHg)		Hypertension prevalence, %	
	1998	**2016**	**1998**	**2016**	**1998**	**2016**	**1998**	**2016**	**1998**	**2016**	**1998**	**2016**
Age (years)												
15–24	115.9	124.1	70.0	77.3	9.9	21.2	107.1	116.9	68.4	77.9	8.3	20.1
25–34	120.8	128.8	75.9	84.5	17.9	35.8	111.6	120.0	73.7	82.6	16.1	30.1
35–44	123.7	132.3	80.0	89.3	29.4	52.5	118.9	127.0	78.3	86.6	29.0	45.2
45–54	129.8	135.7	83.2	90.2	43.3	57.0	126.8	137.6	81.8	89.9	48.6	64.8
55–64	133.7	141.3	82.9	90.7	46.8	72.8	134.3	144.3	82.6	90.7	59.7	79.1
65+	139.6	148.7	82.6	88.1	59.7	83.5	141.3	149.2	82.9	87.1	70.1	85.0
Residence												
Urban	124.7	132.2	77.4	85.6	28.3	46.6	119.5	129.2	76.3	84.7	31.9	49.4
Rural	122.0	131.6	76.0	83.4	24.2	42.1	119.4	130.3	76.0	84.9	30.4	46.7
Education (years)												
No education	129.2	140.4	80.6	89.0	37.9	63.6	130.4	146.1	81.2	90.5	49.8	76.1
Primary	124.1	136.1	77.2	86.5	27.8	52.6	123.1	137.1	78.4	87.2	38.4	62.1
Secondary	122.1	129.6	75.8	83.6	23.7	39.5	114.8	125.3	73.8	83.2	23.5	40.1
Higher	124.5	133.8	77.6	86.4	26.5	53.5	113.3	126.3	73.1	84.3	16.4	44.6
Asset Index (quintiles)												
Poorest	120.9	133.0	75.6	85.5	21.3	44.0	120.7	129.9	76.8	86.1	30.4	47.0
Poor	121.3	130.7	76.2	83.6	24.6	41.2	119.0	128.1	76.3	83.5	30.9	43.2
Average	122.0	130.3	76.2	83.7	25.3	40.9	119.2	130.0	76.2	85.3	32.2	50.2
Rich	123.0	131.8	76.1	85.1	25.6	44.6	119.2	130.5	75.9	85.3	32.6	50.7
Richest	129.6	134.3	79.5	86.2	34.5	56.2	119.3	129.6	75.8	83.6	30.1	50.3
Total	123.6	131.9	76.8	84.7	26.7	44.9	119.4	129.7	76.2	84.8	31.3	48.2

86 mmHg in 2016 in men (Data not shown). Mean SBP and DBP in women were 121 mmHg and 77 mmHg in 1998, and 131 mmHg and 85 mmHg in 2016. Hypertension prevalence increased from 29% to 49% in men and from 34% to 51% in women between 1998 and 2016.

Mean SBP and DBP, and hypertension prevalence were higher in 2016 compared with 1998 across all age categories, education levels, wealth quintiles and area of residence (Table 1). Hypertension prevalence increased with older age, and was higher in urban vs. rural residents and in the least educated participants.

Hypertension prevalence generally increased with higher BMI category in men and women in 1998 and 2016 (Fig. 1). A similar pattern was found for WC with a higher prevalence in those with, compared to without, raised WC. Interestingly, the prevalence of hypertension increased between 1998 and 2016 across all BMI categories, including underweight (men: 13% vs. 31%; women: 18% vs. 35%) and normal weight (men: 22% vs. 37%; women: 21% vs. 34%). Similarly, hypertension prevalence increased almost 2-fold (men: 1.89; women: 1.77) in participants with normal WC between 1998 and 2016.

Hypertension prevalence increased between 1998 and 2016 in men and women who did, and did not, smoke daily (Fig. 1). The highest hypertension prevalence across both time points was in women who smoked daily, at 42% in 1998 and 55% in 2016.

The prevalence of hypertension awareness among participants with hypertension was low but increased between 1998 and 2016 from 7% to 18% in men and from 17% to 29% in women (Table 2). These rates increased across all age categories, place of residence, education level and wealth quintiles between 1998 and 2016. Hypertension awareness generally increased with older age and there were higher awareness levels across both time points in urban vs. rural residents and in the richest vs. the poorer quintiles. Surprisingly, and except for men in 1998, participants with primary education or less vs. secondary or higher education had higher levels of hypertension awareness.

The prevalence of hypertension treatment among participants who were aware of their hypertension diagnosis, was very low in 1998 (men: 8%; women: 12%) but increased substantially in 2016 (men: 85%; women: 82%) (Table 2). These increases were across sociodemographic categories; however, in 2016, treatment rates of <80% were found in men aged 15–34 years and in women aged 15–44 years. Women who lived in rural areas, had higher education and belonged to the two poorest wealth quintiles also had hypertension treatment rates of <80%.

Hypertension control among participants receiving treatment increased between 1998 (men: 17%; women 21%) and 2016 (men: 26%; women 30%) but remained unacceptably low (Table 2). Hypertension control generally increased with older age in all participants, with lower education level in women and was highest in men with no education across both time points. In contrast, hypertension control was generally highest in the wealthiest men and women but with no clear patterns across wealth quintiles.

In ≥18-year-old men, between 1998 and 2016, hypertension awareness increased from 8% to 20%, hypertension treatment from 9% to 85% and hypertension control from 19% to 23% (Data not shown). In ≥18-year-old women, hypertension awareness increased from 18% to 31%, hypertension treatment from 13% to 82% and hypertension control from 23% to 32% between 1998 and 2016.

In the logistic regression analyses, in both men and women, hypertension awareness, treatment and control were higher in 2016 compared with 1998, and in older compared with younger participants (Table 3). In women, but not men, rural compared with urban residents were less likely to be aware of their hypertension status (OR: 0.70. 95% CI: 0.58–0.84) or receiving treatment (OR: 0.78. 95% CI: 0.63–0.95).

In both men and women, there were no consistent patterns across education levels and wealth quintiles to clearly identify individuals whose hypertension was better managed. For example, compared with the most educated women, those with lower education levels i.e. secondary education or less were more likely to be on hypertension treatment. However, this pattern was not reflected for hypertension awareness and control in women. In men, the odds for hypertension awareness and treatment were highest in the richest men. The lowest odds were in the poorest men: awareness: OR: 0.39, 95% CI: 0.27–0.60 and treatment: OR: 0.24, 95% CI: 0.15–0.39 (Table 3). In women, this pattern was reflected for hypertension treatment (poorest vs. richest: OR: 0.24, 95% CI: 0.17–0.34) but not for hypertension awareness.

Residence, education and wealth were not related to hypertension control in women (Table 3). While residence and education were not related to hypertension control in men and there was not clear pattern by wealth, the poorest men (OR: 0.74, 95% CI: 0.57–0.97) had the

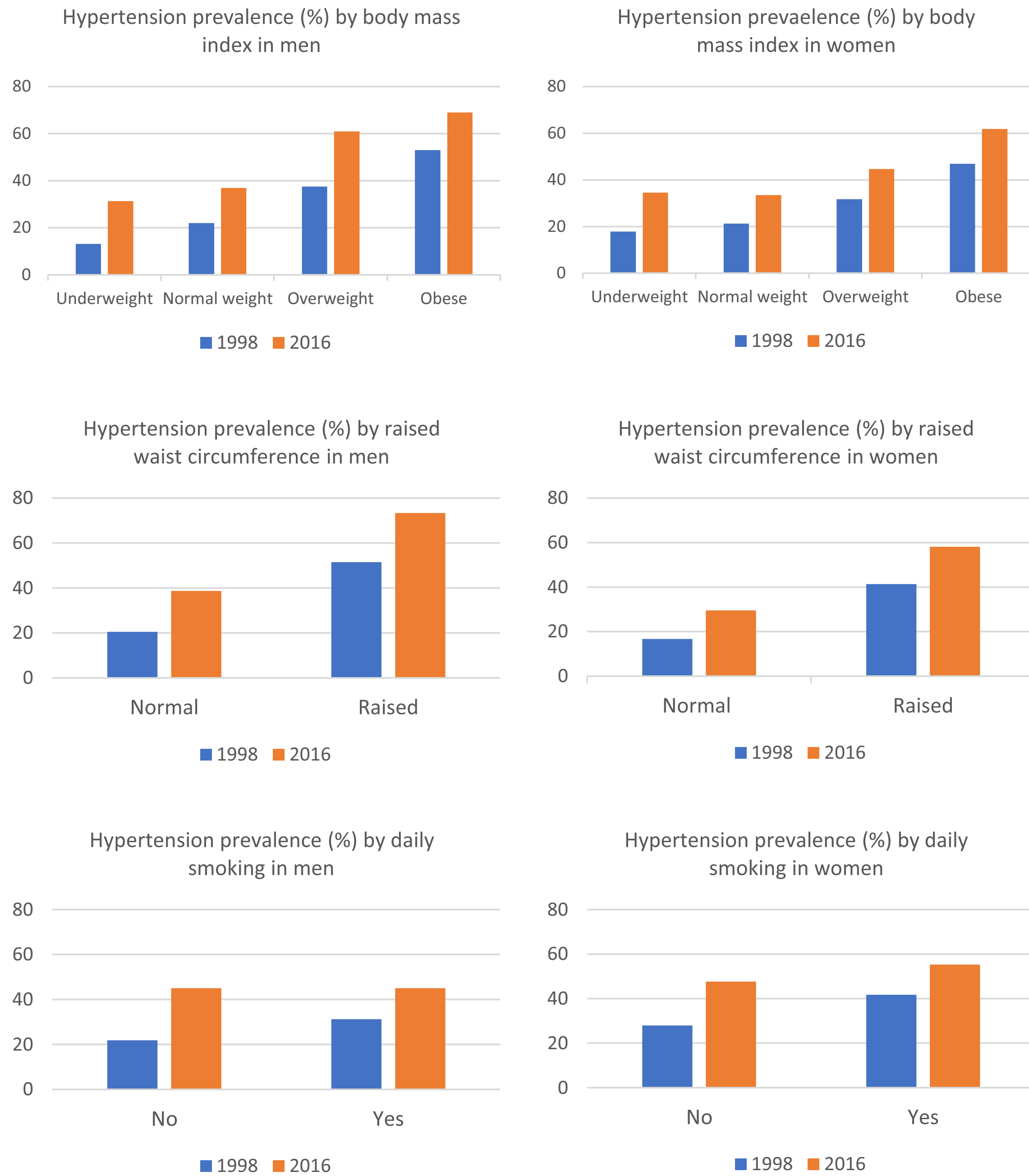

Fig. 1. Prevalence of hypertension by adiposity and smoking status in ≥15-year-old men and women in 1998 and 2016.
Body mass index (kg/m^2): underweight: <18.5, normal weight: 18.5–24.9, overweight: 25–29.9 and obesity: ≥30; Raised waist circumference: men: >94 cm and women >80 cm; Daily smoking: smoke ≥1 cigarette/day.

lowest likelihood of their hypertension being controlled.

Discussion

To our knowledge, this is the first nationally representative population-based study to report on the changing patterns of BP, and hypertension prevalence and management in South Africa. This study describes the high and substantial rise in the hypertension burden in South Africa over almost two decades, which has been accompanied by improvements in hypertension management. This study further examined the sociodemographic associations with hypertension prevalence and management. Only increasing age and survey year were found to be consistently associated with prevalence, awareness, treatment and control of hypertension. Hypertension increased with greater adiposity level and was higher in daily smokers compared with their counterparts in 1998 and 2016. Further, hypertension prevalence increased consistently across all adiposity categories and in both smoking groups over this period.

That almost one in two adult South Africans had hypertension in 2016 accords with the high prevalence of 46% found in SSA, which was the highest reported globally [13]. Unsurprisingly, among the top 10 leading causes of mortality in South Africa in 2017 were cerebrovascular diseases (3rd) and ischaemic heart diseases (IHD) (9th), whose major risk factors include hypertension, and hypertensive diseases (6th) [14]. This highlights that hypertension is a key public health problem in the country that requires urgent attention to curb the tide of adverse outcomes. Together with health consequences, hypertension contributes substantially to the financial burden, which includes the loss of income

Table 2
Prevalence of hypertension awareness, treatment and control in ≥15-year-old men and women by socio-demographic characteristics in 1998 and 2016.

Socio-demographic characteristic	Men: Hypertension awareness 1998	2016	Men: Hypertension treatment 1998	2016	Men: Hypertension control 1998	2016	Women: Hypertension awareness 1998	2016	Women: Hypertension treatment 1998	2016	Women: Hypertension control 1998	2016
Age (years)												
15–24	0.2	6.0	0.7	35.7	8.1	13.9	3.6	10.5	1.5	53.8	7.5	16.4
25–34	2.5	9.6	2.1	53.4	13.4	22.7	7.2	13.5	4.2	55.9	12.6	23.2
35–44	6.7	15.7	8.2	80.0	18.8	30.9	14.4	22.2	10.1	67.9	18.6	28.8
45–54	16.1	24.8	17.2	93.5	25.4	24.7	28.3	37.4	22.0	86.6	32.5	32.8
55–64	14.5	40.4	21.3	86.1	25.4	36.9	37.4	52.9	28.4	86.4	37.5	43.1
65+	23.9	55.3	24.5	92.7	37.3	50.5	38.8	63.0	29.5	90.1	47.2	53.1
Residence												
Urban	8.6	20.5	9.9	87.2	18.2	27.1	19.1	30.0	15.3	85.2	21.7	31.3
Rural	4.9	16.0	5.8	81.7	16.0	23.7	14.3	27.0	8.0	77.8	21.0	28.6
Education (years)												
No education	11.0	28.9	12.4	93.5	24.7	37.3	24.3	48.6	15.3	88.4	32.3	40.8
Primary	6.2	25.6	7.7	88.6	18.1	24.1	22.1	40.5	14.2	84.4	25.5	35.8
Secondary	6.3	15.0	7.0	81.2	15.6	24.1	12.9	22.2	10.6	80.7	16.9	26.4
Higher	10.1	23.9	11.9	86.4	16.7	33.7	10.8	28.8	10.2	68.0	12.6	33.5
Asset Index (quintiles)												
Poorest	3.6	13.2	4.2	83.4	14.6	22.3	12.7	25.9	6.1	73.3	19.7	29.1
Poor	4.6	15.3	4.6	79.5	16.1	24.5	14.2	24.5	6.3	77.7	21.5	26.6
Average	4.9	17.3	4.6	90.8	16.8	25.9	18.9	31.7	11.2	83.9	22.1	30.9
Rich	7.2	18.4	8.9	85.7	16.3	22.2	18.6	28.9	14.6	85.2	21.8	30.4
Richest	13.7	32.2	17.1	85.2	21.5	35.5	19.9	33.4	21.4	88.5	21.8	34.6
Total	7.1	18.8	8.3	85.3	17.3	25.8	17.1	28.8	12.2	82.2	21.4	30.2

Hypertension awareness: among all participants with hypertension; Hypertension treatment: among participants aware of their hypertension diagnosis; Hypertension control: among participants receiving hypertension treatment.

Table 3
Logistic regression of hypertension awareness, treatment and control in men and women on socio-demographic characteristics and year.

	Men: Hypertension awareness OR (95% CI)	Men: Hypertension treatment OR (95% CI)	Men: Hypertension control OR (95% CI)	Women: Hypertension awareness OR (95% CI)	Women: Hypertension treatment OR (95% CI)	Women: Hypertension control OR (95% CI)
Survey year						
1998	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
2016	**3.64 (3.02 to 4.38)**	**47.57 (30.71 to 73.69)**	**1.67 (1.46 to 1.92)**	**2.06 (1.79 to 2.37)**	**26.99 (21.10 to 34.52)**	**1.54 (1.37 to 1.73)**
Age (years)						
15–24	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
25–34	**2.23 (1.51 to 3.29)**	**3.15 (1.56 to 6.31)**	**1.74 (1.41 to 2.13)**	**1.59 (1.24 to 2.02)**	**2.39 (1.60 to 3.54)**	**1.64 (1.35 to 1.99)**
35–44	**4.72 (3.19 to 6.99)**	**12.76 (7.09 to 22.95)**	**2.66 (2.17 to 3.26)**	**3.25 (2.54 to 4.15)**	**5.37 (3.61 to 7.99)**	**2.41 (1.98 to 2.93)**
45–54	**10.43 (7.15 to 15.19)**	**27.97 (15.94 to 49.06)**	**3.01 (2.43 to 3.72)**	**7.16 (5.60 to 9.14)**	**14.43 (10.00 to 20.83)**	**4.10 (3.37 to 4.99)**
55–64	**13.86 (9.28 to 20.69)**	**32.51 (17.84 to 59.20)**	**3.78 (2.99 to 4.78)**	**12.56 (9.81 to 16.08)**	**21.09 (14.71 to 30.24)**	**5.78 (4.71 to 7.10)**
65+	**26.28 (17.98 to 38.41)**	**45.51 (24.9 to 83.14)**	**6.70 (5.30 to 8.45)**	**16.24 (12.69 to 20.79)**	**25.50 (17.53 to 37.09)**	**8.78 (7.09 to 10.86)**
Residence						
Urban	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Rural	0.86 (0.67 to 1.10)	1.01 (0.71 to 1.41)	0.91 (0.77 to 1.08)	**0.70 (0.58 to 0.84)**	**0.78 (0.63 to 0.95)**	0.85 (0.72 to 1.00)
Education (years)						
No education	0.96 (0.63 to 1.46)	1.15 (0.69 to 1.91)	0.99 (0.71 to 1.38)	1.06 (0.79 to 1.40)	**1.75 (1.11 to 2.75)**	1.00 (0.78 to 1.29)
Primary	1.12 (0.78 to 1.62)	1.04 (0.65 to 1.69)	0.93 (0.69 to 1.24)	**1.40 (1.08 to 1.83)**	**2.03 (1.32 to 3.14)**	1.15 (0.89 to 1.42)
Secondary	1.16 (0.82 to 1.64)	1.07 (0.71 to 1.60)	1.06 (0.81 to 1.39)	1.15 (0.90 to 1.45)	**1.89 (1.28 to 2.80)**	1.10 (0.89 to 1.35)
Higher	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Asset Index (quintiles)						
Poorest	**0.39 (0.27 to 0.60)**	**0.24 (0.15 to 0.39)**	**0.74 (0.57 to 0.97)**	0.83 (0.62 to 1.11)	**0.24 (0.17 to 0.34)**	1.02 (0.78 to 1.33)
Poor	**0.50 (0.35 to 0.71)**	**0.29 (0.19 to 0.44)**	0.86 (0.68 to 1.11)	0.89 (0.70 to 1.14)	**0.29 (0.21 to 0.39)**	1.06 (0.85 to 1.32)
Average	**0.55 (0.40 to 0.75)**	**0.33 (0.29 to 0.48)**	0.91 (0.73 to 1.13)	**1.27 (1.03 to 1.57)**	**0.51 (0.39 to 0.66)**	1.17 (0.96 to 1.430
Rich	**0.66 (0.49 to 0.87)**	**0.60 (0.43 to 0.83)**	**0.78 (0.63 to 0.97)**	1.02 (0.85 to 1.22)	**0.67 (0.53 to 0.85)**	1.06 (0.89 to 1.27)
Richest	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)

Hypertension awareness: among all participants with hypertension; Hypertension treatment: among participants aware of their hypertension diagnosis; Hypertension control: among participants receiving hypertension treatment.

when working age individuals are afflicted, and the cost of caring for stroke, IHD and other hypertension related complications [2].

Although hypertension prevalence was similar in men and women in 2016, the contribution of the traditional risk factors to the burden was likely different by sex. For example, obesity levels were 41% in women compared with 11% in men, whereas alcohol and tobacco use were much higher in men than in women [7]. Alcohol intake was 61% in men versus 26% in women, and tobacco use was 37% in men versus 8% in women. The high levels of overweight and obesity (BMI $\geq$25 kg/m^2) in men (31%) and women (68%) in 2016 was likely linked to their intake of unhealthy diets. Over a third (37%) reported eating fried foods at least weekly and 36% reported drinking sugar sweetened beverages the previous day. Other unhealthy dietary behaviours included the intake of salt rich foods which would have directly contributed to higher BP levels. Over a quarter (29%) of participants reported eating salty snacks and processed foods at least once a week [7].

Nevertheless, hypertension aetiology is multifactorial with a complex combination of genetic and environmental influences and cannot be easily simplified [15]. It is likely that the interaction of the traditional risk factors, including ageing populations, with genetic and other factors contributed to the steep rise in hypertension prevalence over two decades. The multifactorial influences on hypertension development is underscored by the consistent increase in hypertension prevalence in both men and women between 1998 and 2016. This was irrespective of their adiposity levels or smoking status.

The high burden of hypertension in South Africa even in 1998, with high BP reported to be the 2nd leading risk factor for mortality in 2000 [16], should have been the impetus for improving hypertension care. However, although hypertension management was better in 2016 than in 1998, these improvements were from very low levels. Consequently, rates of hypertension awareness and control in 2016 were still unacceptable. Less than one in five men (19%) and over a quarter of women (29%) with hypertension were aware of their hypertension status in 2016. This underlines the need for a nationwide aggressive education and awareness campaign on this condition. Notably, such initiatives need to perhaps be implemented outside the confines of healthcare facilities. There needs to be regular BP testing in communities or mobile units vs. testing in formal healthcare facilities only.

Such nationwide public health strategies may also serve to improve hypertension control, which was equally poor. Only a quarter (26%) of men and less than a third (30%) of women on hypertension treatment had their BPs controlled. However, a multilevel approach is required to improve hypertension control. This is because numerous barriers need to be addressed at the three key levels i.e. healthcare system, healthcare provider and patient levels [2]. Among the constraints to optimal hypertension control include medicine stockouts or malfunctioning BP testing equipment at public healthcare facilities. Other barriers include healthcare provider inertia in failing to increase hypertension medication when BP is high, or time or financial restrictions on the part of the patient in accessing care, etc. [2,17].

To address the longstanding challenges to optimal non-communicable disease care, the South African government implemented the Integrated Chronic Disease Management model to improve the management of chronic conditions [18]. Unfortunately, this model has been unable to achieve optimal clinical outcomes for non-communicable diseases including hypertension [17]. Many of the barriers associated with suboptimal hypertension care were recently highlighted in a South African study. The setting included eight rural primary healthcare clinics which were burdened with an unmanageable workload. The study was conducted among patients attending the clinics for management of chronic diseases. The authors suggest that the current guidelines and policies be revisited, particularly the recommendation that *all* patients at the clinics undergo health checks. Thorogood and colleagues submit that a potential change in policy could lead to very large effects in efficiencies for hypertension care [17]. They recommend that workload estimates could be reduced by changing the policy and perhaps the criteria for hypertension screening. Other suggestions include reducing the frequency of BP checks for managing diagnosed hypertension. However, implementing such measures will need to be closely monitored to ensure that hypertension care is not further adversely affected.

Task-shifting of hypertension care to lower-level healthcare workers such as nurses and community healthcare workers may reduce the burden at overloaded clinics [2]. This strategy has been advocated in the Pan-African Society of Cardiology Roadmap on Hypertension [19]. Task-shifting has the potential to strengthen health system effectiveness and reduce the pressure experienced at primary care facilities. South Africa has extensive experience of task-shifting with the care of HIV-infected patients, which may be employed for the care of hypertension [20]. Such a strategy requires a well-designed training programme that imparts an appropriate skill and knowledge base to lower-level healthcare workers [21,22]. Close monitoring and evaluation of such a programme is important for the successful implementation of task-shifting for hypertension care.

Successfully improving hypertension care in South Africa will have multi-fold benefits considering the high morbidity and mortality burden association with high BP [16]. This has been demonstrated in HICs where cardiovascular disease (CVD) prevention programmes, including those for hypertension, have likely averted much premature disease over the past few decades [23]. Consequently, age-standardised morbidity and mortality rates are lowest in HICs compared with LMICs [24]. Only about 20% of CVD mortality in HICs occur in those younger than 60 years old; in LMICs, however, almost 60% of CVD deaths occurred in this age group [25]. This illustrates the potential gains from improving hypertension care, among other CVD prevention initiatives. There have been marked decreases in mean BP in HIC, which once had the highest levels worldwide. This may likely be attributed, at least partially, to the effectiveness of anti-hypertensive drugs to lower BP levels [1]. Therefore, concerted efforts to improve hypertension care in South Africa is likely to improve hypertension control and decrease the attributable disease burden.

The sociodemographic characteristic most consistently associated with hypertension awareness, treatment and control was increasing age. The better management of hypertension with older age is understandable. It is likely due to the more frequent contact of men and women with healthcare services as they age and succumb to numerous ailments. Utilisation of healthcare services was shown to increase with older age [26], and management of hypertension improved with increasing age [27,28]. The increased contact of older participants with healthcare services probably translates to their greater likelihood of being screened for hypertension, their diagnosed hypertension being treated and perhaps their better compliance with treatment.

The associations of better hypertension treatment in women with lower education levels but with the richest wealth quintile appear counterintuitive. This may be related to the fact that older participants, who were more likely to have better hypertension management, also had lower education levels (Data not shown). In South Africa, adults over 60 years of age receive a state pension. Considering the high levels of poverty and unemployment in the country, this may render these pensioners wealthier than their compatriots, even though they may be less educated. However, there was no clear pattern of age by wealth quintile in this study which suggests that the association of wealth with hypertension treatment in women requires further investigation.

Hypertension awareness and control were higher in women compared with men in both 1998 and 2016 and accord with regional South African studies [3,27]. South African women were twice as likely to utilise healthcare services compared to men [26]. A multi-site Sub-Saharan African study, which included South Africa, reported higher rates of hypertension awareness, treatment and control in women than in men [29]. Another multi-country LMIC study, which included South Africa, also described a greater likelihood of hypertension awareness and control in older women compared with men [28]. The reasons for this are unclear but may be related to sociocultural and economic factors and require further investigation. A partial explanation may be that women are perhaps more likely to display health-seeking behaviour. They are in more frequent contact with health services because of maternal and child health programmes; this increases their potential for hypertension screening. Also, men may be more likely to be working or seeking employment and hence may be time-constrained to attend health services during work hours. This accords with a South African study that reported lower utilisation of healthcare services among employed versus unemployed participants [26]. A fear of being diagnosed with serious illness may be another reason for the lower likelihood of men seeking healthcare [3]. Workplace hypertension screening and treatment programmes could potentially overcome the barriers to optimal hypertension care in men. An in-depth understanding of the healthcare seeking behaviours among South African men and women is needed. This may contribute to improving healthcare service utilisation and the implementation of innovative solutions for hypertension management.

The strength of this study includes the national representativeness of the sample. The limitation includes that BP readings for a diagnosis of hypertension were taken on a single visit rather than on multiple occasions, which may have led to some overestimation of the prevalence. That different Omron BP monitors were used in the 1998 and 2016 SADHS may also be a limitation of this study. Population group or ethnicity data were collected in both SADHS; however, these data were not available in their entirety when accessed and could not be included in this study. The latter data would have enabled analyses of hypertension prevalence and care by the previously defined official South African population groups. In 2016, these groups comprised 81% black, 9% coloured, 8% white and 2.5% Indian/Asian, with approximately 51% being female [30].

Conclusions

Hypertension prevalence has increased substantially in South African men and women over two decades. Although hypertension management improved between 1998 and 2016, hypertension awareness and control remained suboptimal. This occurred despite the considerable disease burden attributable to high BP in South Africa. This study highlights the need for novel strategies and increased efforts to promote screening and care for hypertension and may inform appropriate healthcare service planning. Innovative solutions to improve hypertension management may require implementing strategies outside formal healthcare facilities. Community-based or workplace screening and treatment programmes may overcome some barriers and lead to improved hypertension care in South Africa.

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Authors' contributions

Manuscript concept and design: NP, OAU, APK. Analysis of data: OAU. Interpretation of data: NP, OAU, APK. Drafting of the manuscript: NP. All authors have read and approved the manuscript.

Declaration of Competing Interest

All authors report no potential conflicts of interest, including specific financial interests, relevant to the subject of this manuscript.

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