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Journal of Human Hypertension
https://doi.org/10.1038/s41371-018-0125-3

ARTICLE

Predictors of hypertension awareness, treatment and control in South Africa: results from the WHO-SAGE population survey (Wave 2)

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Received: 24 May 2018 / Revised: 16 August 2018 / Accepted: 27 September 2018

Abstract

South Africa has one of the highest levels of hypertension globally, coupled with poor rates of diagnosis, treatment and control. Risk factors that predict hypertension in high income countries may perform differently in the African context, where communicable disease, obesity and malnutrition co-exist. This study investigated traditional risk factors alongside other health and sociodemographic indicators to determine predictors of hypertension prevalence and management. Participants were recruited from households across South Africa as part of WHO's Study on global AGEing and adult health (WHO SAGE) Wave 2 (2015). Blood pressure (BP) was measured in triplicate and sociodemographic and health data collected by survey ($n = 1847$; 30% 18–39 years, 39% 40–59 years, 31% 60 years+; median age 51 years; 68% female). Of all adults, 43% were hypertensive ($n = 802$), of which 58% ($n = 398$) were unaware, 33% ($n = 267$) were on medication, with only 18% ($n = 141$) controlled on medication (BP < 140/90 mmHg). Multivariate logistic regression showed waist-to-height ratio > 0.5 and diabetes comorbidity were the most significant predictors of hypertension presence, awareness and treatment. Individuals with diabetes were twice as likely to have hypertension, 7.0 times more likely to be aware, 3.3 times more likely to be on antihypertensive medication, and 2.4 times more likely to be controlled on medication. Women and individuals reporting lower salt use were more likely to be aware and treated for hypertension. Applying the 2017 AHA/ACC hypertension guidelines showed only 1 in 4 adults had normal BP. As with HIV, similarly intensive efforts are now needed in the region to improve non-communicable disease diagnosis and management.

Introduction

Sub-Saharan Africa has a high hypertension burden with many individuals remaining undiagnosed or inadequately treated [1]. The most recent national and regional surveys estimate that 35–49% of adults are hypertensive, with at least one third unaware of their hypertensive status, and, at best, 25% controlled on medication [2, 3]. With South Africa's overburdened public healthcare systems and low levels of private medical aid coverage [4], preventing hypertension is as important as management. However, identifying vulnerable individuals at risk for hypertension who are not aware or not treated for the condition remains a challenge. Many predictive models have been described that typically include 'traditional' risk factors such as: age, sex, body mass index, systolic and diastolic blood pressure, family history of hypertension, and cigarette smoking; [5] though few include socioeconomic predictors such as education, employment or marital status [6]. While one recent model to predict gestational hypertension was developed for

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Published online: 31 October 2018

Ghanaian women [7], the majority of these predictive models have originated outside of the African continent. Data from neighbouring sub-Saharan African countries suggest that psychosocial and economic indicators may be important for hypertension risk within the African context. For example, in Burkina Faso stress, religious well-being and household income were associated with the presence of pre-hypertension [8]. In Cameroon and Ethiopia, education was related to hypertension status [9, 10]. In Ghana, education and household income also predicted hypertension status, as did depression [11, 12]. Data from an adult population living in the slums of Nairobi, Kenya again suggested that income and marital status were important predictors of hypertension [13]. Some of these predictors may also be important in detecting awareness, treatment and control of hypertension. For example, in Mexico, younger age and having no health insurance predicted lower levels of awareness and control [14]. In New York, access to a routine place of medical care predicted better control among treated hypertensives [15]. The presence of co-morbidities (diabetes, renal impairment) and multidrug regimens has also been associated with poorer blood pressure control in hypertensives [16]. Several of the 'traditional' risk factors, such as obesity and smoking, may also predict blood pressure control in individuals receiving treatment [17, 18]. While data in Africa is scarce, one study conducted in primary healthcare clinics in Western Cape, South Africa showed lower education level predicted poorer blood pressure control [19]. However, as many studies recruit populations from clinics or hospitals, it is difficult to assess the predictors of hypertension awareness, treatment and control outside of these clinical populations. The aim of this study was therefore to assess 'traditional' and other potential predictors of hypertension status, awareness, treatment and control in South African adults as part of a World Health Organization (WHO) country-wide population survey.

Participants and methods

The WHO Study on global AGEing and adult health (WHO SAGE) is a multinational longitudinal study examining the health and wellbeing of adult populations and the ageing process in over 42,000 respondents from six countries (China, Ghana, India, Mexico, Russia and South Africa) [20]. This ongoing study aims to collect data on a range of health and well-being outcomes of public health importance in adults from the participating low-income and middle-income countries. SAGE South Africa Wave 2 data collection was implemented in 2015 (August–December) using a clustered household sampling strategy described in detail elsewhere [21].

Participants

In 2007, WHO-SAGE South Africa Wave 1 recruited 4223 respondents from selected probability sampled enumeration areas (EAs) using a multistage cluster sampling strategy, with stratification by province, residence and race designed to recruit nationally representative cohorts. The wave 2 sampling strategy was designed to follow-up these individuals (including a verbal autopsy for those participants no longer alive), with replacements for sample attrition using a systematic sampling approach as previously described [21].

Data collection

The SAGE survey instruments and methods are adapted from those used by the World Health Survey (WHS, 2002–2004; 70 countries), with details available on the WHO-SAGE website (http://www.who.int/healthinfo/sage/en/). Data collection included: sociodemographic information (sex; age; marital status; education; ethnicity/background; and employment history); social cohesion (community involvement and social networks; perceptions of other people and institutions; safety in local area; stress); physical health including self-rated health plus blood pressure and anthropometric measures (height, weight, waist and hip circumferences); mental health and cognitive function including executive functioning (verbal recall, digit span forwards and backwards, verbal fluency); and subjective well-being and quality of life (perceptions about quality of life and well-being; 8-item WHO Quality of Life measure (WHOQoL) [22]). Blood pressure was measured by trained nurses using validated wrist-worn BP devices with positioning sensor (R6, Omron, Japan) [23]. Respondents were seated for at least 5 min before three sequential measures were taken on the left arm (1 min between each measure), with the wrist resting precisely at the level of the heart and the respondent seated with legs uncrossed. Hypertension status was determined by an average systolic blood pressure (SBP) reading of ≥140 mmHg; and/or an average diastolic blood pressure (DBP) reading of ≥90 mmHg; and/or current use (within the last 2 weeks) of antihypertensive medication. Assessment of hypertension status using the 2017 American Heart Association/American College of Cardiology (AHA/ACC) Guidelines [24] was also undertaken using the categories: Normal (<120 and <80 mmHg), Elevated (120–129 and <80 mmHg), Stage 1 (130–139 or 80–89 mmHg), Stage 2 (≥140 or ≥90 mmHg), and Hypertensive crisis (>180 or >120 mmHg).

All respondents provided written informed consent prior to taking part in the study. The study complied with the Declaration of Helsinki [25], with ethical approval from the WHO Ethics Review Committee [RPC149], the North-West University Health Research Ethics Committee (Potchefstroom, South Africa) and the University of the Witwatersrand Human Research Ethics Committee (Johannesburg, South Africa). Interviewers spoke the respondents' home languages with consent forms available in the most widely spoken languages for each area.

Data capture, analysis and statistical methods

Data was captured using an electronic data capture system. Stata Statistical Software: Release 15 (StataCorp LLC, 2017; College Station, USA) was used for statistical analysis. Normality of data was checked by visual inspection of histograms and tests of skewness and kurtosis, with non-parametric data presented as medians and interquartile range. Variables included in the logistic regression models (Table 2) were selected based on previous literature including analysis of SAGE Wave 1 data by Basu and Millet [26]. Further Chi-square, Mann–Whitney *U* and *T*-tests between hypertensives and normotensives across the measurement domains identified additional candidate variables for entry into the logistic regression models. Categorical variables where individual response items were less than 10 cases were recoded to combine categories. Within group correlation of independent variables was checked to remove any that were highly correlated, selecting those that were most significant for each condition to remain in the models, for example, waist-to-height ratio showed a more consistent significant association with the hypertension outcome variables when compared to body mass index. Logistic regression analyses (unadjusted, age-adjusted and fully adjusted) were performed to determine the variables that best predicted hypertension status, diagnosis, treatment and control. Awareness was based on self-reported previous diagnosis of hypertension by a health professional. Treatment was determined from self-reported medication use for hypertension within the last 2 weeks. Hypertension control was determined by self-reported medication use within the last 2 weeks and a measured BP less than 140/90 mmHg. Individuals reporting a previous diagnosis of hypertension, with no current medication use and a measured BP < 140/90 mmHg were categorised as non-hypertensive. No further data was collected to determine, for example, if these were hypertension cases that had been resolved by lifestyle change or pregnancy-induced hypertension that had resolved post-partum.

Results

A total of 1847 participants had valid blood pressure measurements with data on health, comorbidities and demographics. Anthropometry and/or education data were missing for 634 individuals. The characteristics of the sample are presented in Table 1. Data on health insurance was not included as coverage was poor with only 16 participants having used health insurance to pay for medical treatment within the 3 years (2012–2015) preceding the survey.

Prevalence of hypertension was high, with 43% of the sample having a measured mean BP of ≥140/90 mmHg and/or currently taking antihypertensive medication. Of the individuals with hypertension, less than half were aware (42%), one third (33%) were currently taking medication, and 18% were on effective medication with measured BP < 140/90 mmHg. The degree of awareness increased as blood pressure increased but remained low at all levels (SBP 140–159 mmHg, 70% unaware; SBP 160–179 mmHg, 64% unaware; SBP ≥ 180 mmHg, 58% unaware).

Based on logistic regression models (Tables 2, 3 and supplementary table 1), hypertension prevalence increased with older age, larger waist-to-height ratio, alcohol use, lower levels of education, diabetes comorbidity, and Coloured/mixed race (compared with black African). Older age, larger waist-to-height ratio, lower levels of education, and diabetes comorbidity were also predictive of individuals with hypertension being aware of their status. Additionally, women and individuals reporting not adding salt to food at the table were also more likely to be aware of their hypertension. Elevated waist-to-height ratio and having a diabetes diagnosis were the greatest predictors of both having hypertension and being aware of hypertension status.

Older age, female sex, larger waist-to-height ratio, diabetes comorbidity, lower levels of education, and not adding salt to food at the table were also predictive of current antihypertensive medication use. Effective blood pressure control with medication was more frequently observed in older individuals, those with diabetes comorbidity and those reporting not adding salt to food at the table. When assessing hypertension prevalence using the 2017 AHA/ACC hypertension guidelines [24], 63% of the population were hypertensive (50% of 18 to 39-year olds, 67% of 40 to 59-year olds, and 71% of 60-plus year olds with either Stage 1 or Stage 2 hypertension). Of the 654 Stage 2 hypertensives, 71 (11%) were classified as in hypertensive crisis based on measured BP.

Discussion

The aim of the study was to assess factors related to hypertension prevalence, awareness, treatment and control in South African adults. Overall prevalence in this sample was 43% of adults using the 140/90 mmHg diagnostic threshold of which 58% were unaware and untreated for the condition. Using the 2017 AHA/ACC lower thresholds,

Table 1 Characteristics of participants by hypertension category ($n = 1847$)

	All	No hypertension	Hypertensive	Aware	Treated	Treated controlled
Sample size, *n* (%)	1847	1045 (57)	802 (43)	340	267	141
Age (years)	51 (35–62)	45 (30–57)	57 (48–67)	62 (53–69)	61 (53–69)	61 (53–68)
Female, *n* (%)	1249 (68)	698 (67)	551 (69)	271 (80)	217 (81)	117 (83)
Urban, *n* (%)	1128 (61)	609 (59)	519 (65)	214 (63)	170 (64)	88 (62)
Ethnicity, n (%)						
Black African	1281 (72)	782 (77)	499 (65)	198 (59)	147 (56)	82 (60)
White	73 (4)	36 (4)	37 (5)	16 (5)	13 (5)	9 (7)
Coloured/mixed race	270 (15)	122 (12)	148 (19)	67 (20)	55 (21)	24 (18)
Indian/Asian	159 (9)	73 (7)	81 (11)	53 (16)	47 (18)	22 (16)
Depression, *n* (%)	49 (3)	19 (2)	30 (4)	20 (6)	16 (6)	7 (5)
Working, *n* (%)	391 (21)	253 (24)	138 (17)	44 (13)	34 (13)	16 (11)
Systolic BP (mmHg)	129 (118–143)	121 (113–129)	146 (136–161)	141 (127–158)	137 (123–154)	124 (115–131)
Diastolic BP (mmHg)	80 (73–89)	76 (70–81)	91 (82–98)	84 (75–95)	82 (73–92)	68 (68–81)
Diabetic, *n* (%)	229 (12)	64 (6)	165 (21)	138 (41)	110 (41)	60 (43)
Never used tobacco, *n* (%)	1536 (83)	880 (84)	656 (82)	273 (81)	211 (80)	112 (80)
Never used alcohol, *n* (%)	1479 (80)	840 (80)	639 (80)	276 (81)	219 (82)	112 (80)
Anthropometry and education data, *n*	1174	679	495	219	179	86
BMI (kg/m^2)	28 (24–34)	28 (24–33)	29 (25–35)	30 (26–36)	30 (26–37)	31 (26–37)
Waist circumference (cm)	92 (80–104)	89 (78–101)	96 (86–106)	99 (88–111)	99 (88–111)	100 (89–110)
Hip circumference (cm)	101 (90–114)	99 (89–112)	103 (91–115)	107 (96–118)	107 (96–118)	107 (96–117)
Waist-to-height ratio	0.58 (0.50–0.66)	0.56 (0.49–0.64)	060 (0.53–0.68)	0.63 (0.56–0.72)	0.63 (0.56–0.73)	0.63 (0.58–0.71)
Education (years)	10 (7–12)	11 (8–12)	9 (7–11)	8 (6–10)	8 (6–10)	8 (6–10)

All data are presented as median (Interquartile range, IQR) unless otherwise indicated. Hypertension defined as measured mean systolic blood pressure (SBP) ≥ 140 mmHg or mean diastolic blood pressure (DBP) ≥ 90 mmHg or currently taking medication for blood pressure. Treated refers only to current use (within the last 2 weeks) of blood pressure medication. Treated controlled; on medication for blood pressure with reading less than 140/90 mmHg

hypertension prevalence increased to 63%. Abdominal obesity (waist-to-height ratio > 0.5) and diabetes comorbidity were the largest predictors of hypertension presence, awareness and treatment, with sociodemographic variables (sex, age, education, ethnicity), and health behaviours (salt and alcohol use) also predictive of hypertension status.

These results support previous work in sub-Saharan Africa showing high levels of hypertension with poor diagnosis, treatment and control rates, including the previous WHO SAGE data collection (2007–2010) reporting 78% of over 50-year olds South Africans were hypertensive, of which 38% were unaware of their condition [27]. Older age, abdominal obesity, and lower education levels remain a clear risk for hypertension in both Wave 1 and the current Wave 2 of data collection in South Africa. Older, more overweight/obese, or less educated hypertensive individuals are also more likely to be aware of their hypertension status. Although it is unclear if this is due to more frequent interaction with healthcare services, more likely recipients of blood pressure assessments when at healthcare facilities, or a combination of these and other factors. Individuals with diabetes were twice as likely to

Table 2 Unadjusted logistic regression to identify determinants of: hypertension (BP ≥ 140/90 mmHg or on antihypertensive medication); and in hypertensive individuals, determinants of previous diagnosis (awareness of hypertensive status); antihypertensive medication use within the last two weeks (treatment); and of having controlled blood pressure (BP < 140/90 mmHg) on antihypertensive medication

	Hypertension			Awareness			Treatment			Control		
	n	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*
Age, years	1847	1.04 (1.04–1.05)	<0.001	802	1.05 (1.03–106)	<0.001	802	1.04 (1.03–105)	<0.001	802	1.03 (1.01–1.04)	0.001
Sex												
Male	598	Ref		251	Ref		251	Ref		251	Ref	
Female	1249	1.09 (0.90–1.33)	0.385	551	2.55 (1.85–3.53)	<0.001	551	2.61 (1.83–3.72)	<0.001	551	2.55 (1.60–4.07)	<0.001
Ethnicity												
Black African	1281	Ref		499	Ref		499	Ref		499	Ref	
White	73	1.61 (1.00–2.58)	<0.001	37	1.16 (0.59–2.27)	<0.001	37	1.30 (0.64–2.62)	<0.001	37	1.63 (0.74–3.59)	0.101
Coloured/mixed race	270	1.90 (1.46–2.48)		148	1.26 (0.87–1.82)		148	1.42 (0.96–2.08)		148	0.98 (0.60–1.62)	
Indian	154	1.74 (1.24–2.43)		81	2.88 (1.76–4.71)		81	3.31 (2.04–5.36)		81	1.90 (1.10–3.27)	
Waist-to-height ratio	1546	8.60 (3.72–19.83)	<0.001	660	33.12 (8.82–124.43)	<0.001	660	29.91 (7.71–116.06)	<0.001	660	9.56 (1.88–48.65)	0.007
Ever used alcohol												
No	1479	Ref		639	Ref		639	Ref		639	Ref	
Yes	366	1.04 (0.83–1.31)	0.715	162	0.84 (0.59–1.19)	0.321	162	0.78 (0.54–1.14)	0.200	162	0.98 (0.62–1.55)	0.942
Ever used tobacco												
No	1536	Ref		656	Ref		656	Ref		656	Ref	
Yes	308	1.19 (0.93–1.53)	0.159	145	1.17 (0.82–1.68)	0.391	145	1.29 (0.89–1.87)	0.186	145	1.16 (0.73–1.84)	0.525
Do you add salt to food at the table?												
No	565	Ref		261	Ref		261	Ref		261	Ref	
Yes	1282	0.85 (0.70–1.04)	0.111	541	0.36 (0.27–0.49)	<0.001	541	0.39 (0.28–0.53)	<0.001	541	0.48 (0.33–0.69)	0.0001
Exercise												
No	1682	Ref		742	Ref		742	Ref		742	Ref	
Yes	163	0.70 (0.50–0.98)	0.034	58	1.29 (0.75–2.20)	0.358	58	1.34 (0.78–2.32)	0.298	58	0.85 (0.41–1.77)	0.657
Residence area												
Urban	1128	Ref		519	Ref		519	Ref		519	Ref	
Rural	711	0.78 (0.64–0.94)	0.009	283	1.14 (0.85–1.53)	0.368	283	1.07 (0.78–1.45)	0.663	283	1.13 (0.77–1.64)	0.530
Education, years	1447	0.89 (0.87–0.92)	<0.001	616	0.89 (0.85–0.94)	<0.001	616	0.92 (0.87–0.96)	<0.001	616	0.97 (0.91–1.02)	0.245
Currently working												
No	1455	Ref		663	Ref		663	Ref		663	Ref	
Yes	391	0.65 (0.52–0.82)	<0.001	138	0.58 (0.40–0.86)	0.006	138	0.61 (0.40–0.92)	0.016	138	0.57 (0.33–0.99)	0.037
Diabetic diagnosis												
No	1618	Ref		637	Ref		637	Ref		637	Ref	
Yes	229	3.97 (2.93–5.39)	<0.001	165	11.01 (7.05–17.17)	<0.001	165	6.11 (4.22–8.86)	<0.001	165	3.92 (2.65–5.81)	<0.001

Table 2 (continued)

	Hypertension			Awareness			Treatment			Control		
	n	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*
Depression diagnosis												
No	1798	Ref		722	Ref		772	Ref		772	Ref	
Yes	49	2.10 (1.17–3.76)	0.011	30	2.83 (1.30–6.12)	0.006	30	2.37 (1.14–4.94)	0.021	30	1.45 (0.61–3.45)	0.416
Sleep quality												
Very good/good	1571	Ref		676	Ref		676	Ref		676	Ref	
Moderate	230	1.09 (0.83–1.44)	0.648	104	1.08 (0.71–1.64)	0.044	104	1.13 (0.73–1.74)	0.003	104	0.77 (0.43–1.38)	0.556
Poor/very poor	46	1.21 (0.67–2.18)		22	3.03 (1.22–7.53)		22	4.56 (1.83–11.36)		22	1.35 (0.49–3.73)	

have hypertension, 7.0 times more likely to be aware of the condition, 3.3 times more likely to be taking anti-hypertensive medication, and 2.4 times more likely to be controlled on medication suggesting that more frequent interaction with healthcare services may be key. The finding that women are more likely than men to be managing their hypertension is also consistent across the two most recent waves of SAGE data collection in South Africa. Analysis of Wave 1 data from all six LMICs suggests that women are more likely to use outpatient services [28], possibly as men see public clinics as facilities for women [29]. This suggests campaigns that target men specifically may be needed. Our finding of elevated risk in particular ethnic groups is supported by previous work in South African adults, showing that coloured/mixed race adults have higher risk of hypertension, while Asians/Indians are at increased risk for multimorbidity [30].

With regard to modifiable risk factors, obesity as assessed by waist-to-height ratio and self-reported salt use behaviour were most consistently associated with hypertension, awareness, treatment or control. The prevalence of obesity within South Africa is increasing, in line with increases in Type II diabetes incidence [31], with many diabetics also unaware of their status [32]. The National Strategic Plan for prevention and control of non-communicable disease (NCD, 2013–2017) presents physician counselling, food taxes on unhealthy foods, and reduced salt intakes as cost effective interventions [33]. While great leaps have occurred in sugar tax and toward sodium reduction, there are yet to be nationally coordinated efforts to support physician counselling for obesity. Our data indicate national strategies for salt reduction may at least have impacted awareness. In 2016, the South African Government implemented regulations mandating maximum sodium levels in a range of foods [34]. With significant media coverage in the 3 years leading up to the implementation, alongside targeted hypertension and salt public health campaigns [35], it is likely that increased awareness of the association between salt and blood pressure has improved, explaining the lower self-reported salt use in individuals with diagnosed hypertension.

In contrast to SAGE South Africa Wave 1 showing alcohol intake to have an inconsistent relationship with hypertension [27], we found alcohol intake to be a risk factor for hypertension and also observed, between Waves 1 and 2, a 5% reduction (from 85 to 80%) of the population reporting lifetime abstinence. The trend is in line with WHO findings that South Africa is now ranked in the top twenty countries for high alcohol consumption globally [36].

Rates of effective BP treatment, while remaining still too low at 18% of hypertensives, may also represent a considerable improvement when compared to SAGE Wave 1 reported at 8% [27] and 5% [37]. Although data on the factors associated with effective BP control in Africa are scarce, one study conducted in primary healthcare clinics in the Western Cape, South Africa showed lower education level predicted poorer blood pressure control, with subsequent treatment intensification more likely in patients with higher blood pressure at baseline, concurrent diabetes, higher education level, and where clinics offered off-site drug supply, had a doctor every day or more nurses [19]. While we failed to find a relationship with education, our findings do show diabetes comorbidity is associated with better BP control on medication.

The results of this study should be reviewed within the limitations of this research. While the survey takes place in households across the country, the specific aims of the WHO-SAGE study are to evaluate ageing across the six low-middle income countries. As such, there is an over-representation of older individuals and underrepresentation of younger individuals that is likely to overestimate the true population prevalence of hypertension, though the results suggest that hypertension is also prevalent in younger groups. Our prevalence rate of 43% hypertension is similar to the 35% reported by the national SANHANES survey conducted in 2011–2012 in South Africans from 15 years of

Table 3 Fully adjusted logistic regression to identify determinants of: hypertension (BP ≥ 140/90 mmHg or on antihypertensive medication); and in hypertensive individuals, determinants of previous diagnosis (awareness of hypertensive status); antihypertensive medication use within the last 2 weeks (treatment); and of having controlled blood pressure (BP < 140/90 mmHg) on antihypertensive medication

	Hypertension			Awareness			Treatment			Control		
	n	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*
Age (years)	1176	1.04 (1.03–1.05)	<0.001	497	1.04 (1.03–1.06)	<0.001	497	1.03 (1.02–1.05)	0.001	497	1.03 (1.01–1.05)	0.006
Sex												
Male	402	Ref		168	Ref		168	Ref		168	Ref	
Female	774	0.84 (0.63–1.12)	0.287	329	1.89 (1.13–3.16)	0.027	329	1.94 (1.15–3.29)	0.025	329	2.11 (1.09–4.06)	0.050
Ethnicity												
Black African	802	Ref		291	Ref		291	Ref		291	Ref	
White	50	1.07 (0.55–2.06)	0.030	26	0.52 (0.18–1.50)	0.635	26	0.83 (0.30–2.29)	0.895	26	0.87 (0.28–2.73)	0.612
Coloured	206	1.57 (1.10–2.23)		117	0.54 (0.31–0.94)		117	0.60 (0.34–1.04)		117	0.44 (0.22–0.90)	
Indian	118	1.30 (0.83–2.03)		63	1.46 (0.69–3.10)		63	1.70 (0.85–3.40)		63	1.33 (0.64–2.77)	
Waist-to-height ratio	1176	4.30 (1.44–12.86)	0.008	497	13.17 (2.02–85.68)	0.014	497	9.54 (1.53–59.41)	0.032	497	1.76 (0.22–14.08)	0.726
Ever used alcohol												
No	933	Ref		382	Ref		115	Ref		382	Ref	
Yes	243	1.49 (1.04–2.14)	0.025	115	1.07 (0.57–1.99)	0.968	382	0.88 (0.47–1.65)	0.595	115	1.58 (0.77–3.23)	0.301
Ever used tobacco												
No	977	Ref		394	Ref		394	Ref		394	Ref	
Yes	199	0.93 (0.63–1.38)	0.852	103	1.39 (0.72–2.69)	0.448	103	1.64 (0.86–3.11)	0.193	103	1.27 (0.62–2.60)	0.651
Add salt to food at the table?												
No	372	Ref		174	Ref		174	Ref		174	Ref	
Yes	804	0.94 (0.71–1.24)	0.757	323	0.38 (0.24–0.60)	<0.001	323	0.41 (0.26–0.64)	<0.001	323	0.56 (0.33–0.95)	0.009
Residence area												
Urban	740	Ref		322	Ref		322	Ref		322	Ref	
Rural	436	0.85 (0.66–1.11)	0.272	175	1.12 (0.70–1.78)	0.839	175	1.13 (0.72–1.79)	0.798	175	1.07 (0.62–1.84)	0.903
Education (years)	1176	0.95 (0.92–0.99)	0.014	497	0.93 (0.87–1.00)	0.014	497	0.98 (0.91–1.05)	0.381	497	1.03 (0.95–1.12)	0.479
Currently working												
No	905	Ref		403	Ref		403	Ref		403	Ref	
Yes	271	0.94 (0.69–1.29)	0.671	94	1.26 (0.70–2.27)	0.379	94	1.00 (0.55–1.82)	0.926	94	0.92 (0.44–1.91)	0.831
Diabetic diagnosis												
No	1041	Ref		403	Ref		403	Ref		403	Ref	
Yes	135	2.01 (1.31–3.07)	0.002	94	7.04 (3.65–13.56)	<0.001	94	3.27 (1.88–5.67)	<0.001	94	2.35 (1.31–4.23)	0.001
Depression diagnosis												
No	1146	Ref		481	Ref		481	Ref		16	Ref	
Yes	30	1.22 (0.55–2.72)	0.675	16	3.65 (0.91–14.70)	0.058	16	3.37 (0.94–12.03)	0.056	481	1.43 (0.39–5.20)	0.577

Table 3 (continued)

	Hypertension			Awareness			Treatment			Control		
	n	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*	*n*	OR (95% CI)	*p*
Sleep quality												
Very good/good	1002	Ref		416	Ref		416	Ref		416	Ref	
Moderate	147	0.89 (0.60–1.32)	0.126	68	0.73 (0.38–1.40)	0.907	68	0.96 (0.52–1.79)	0.213	68	0.47 (0.20–1.07)	0.068
Poor/very poor	27	0.48 (0.21–1.11)		13	2.88 (0.55–14.94)		13	4.72 (0.99–22.40)		13	0.33 (0.06–1.79)	

age and above [2]. A further limitation is the under-representation of other groups, predominantly whites and men, possibly also due to the nature of household surveys being less likely to capture data from individuals in full-time employment out of the home. Our 4% White participation rate is around half the estimated 8.9% representation of white population within South Africa. Blood pressure measurement, and therefore classification of hypertension, may have been influenced by the devices used, the context within which measurements were taken, and the nature of fluctuations in blood pressure—all of which could result in over-diagnosis or under-diagnosis. The study protocols and interview techniques were intended to reduce these biases. Additionally, the wrist BP monitors used were validated using the European Society of Hypertension Protocol (2010) [23]. This Omron wrist monitor has positional sensors ensuring the reading is taken with the bladder at the level of the heart to avoid the influence of hydrostatic pressure. Ambulatory 24-h blood pressure measurement (ABPM) is the ‘gold-standard’ for hypertension diagnosis, and using ABPM we have previously shown that office brachial blood pressure measurement underestimates hypertension in South African adults due to high levels of masked hypertension [38]. However, ABPM is not practical for large population surveys and wrist devices with positional sensors have been shown to correlate well with ABPM, with normotension/hypertension false classification rates at least as reliable as office brachial measures [39]. Furthermore, these devices may be better suited to fieldwork in low socioeconomic homes where there may not be a place to rest the forearm when taking brachial measures, or placement of a brachial cuff is challenging in individuals with mid-upper arm circumference exceeding the capacity of large brachial cuffs.

Despite potential limitations, our main findings from this household survey are similar to findings from previous studies in the South African population conducted in clinics or screening events. Indeed, the strength of this research lies in the household survey approach, as populations recruited from within clinics or attending screening events may introduce further selection bias. A further limitation is the cross-sectional analysis. SAGE Wave 3 data collection is currently being implemented in South Africa (2018), whereby we plan to combine multiple waves of data collection to conduct longitudinal analysis in this cohort.

Conclusion

Hypertension prevalence remains high in South African adults. When assessed against the latest ACC/AHA guidelines, our results suggest only 1 in 4 adults had a ‘normal’ blood pressure. Intensive efforts are now needed to build on the momentum of recent sodium legislation and public health campaigns to improve hypertension awareness and management. With awareness rates higher in older, more obese, females and individuals with known diabetes, screening campaigns targeted at individuals outside these groups may broaden hypertension diagnosis. The parallels between HIV and hypertension in sub-Saharan Africa are many, including largely asymptomatic presentation and ‘easy’ diagnosis from screening. As with HIV screening and treatment in the region, hypertension now requires more rigorous and extensive interventions to identify asymptomatic hypertension cases. South Africa can build on its recent public health successes through additional targeting of key populations, including younger men.

Summary table

What is known about the topic:

- Risk factors for hypertension in Africa are generally assumed from research in high-income countries.
- The predictors of hypertension and its management in African populations require clarification.

What this study adds:

- Hypertension prevalence is high, while awareness and effective treatment remain low.

- Hypertensive individuals with co-morbidities, such as diabetes, are much more likely to be diagnosed with hypertension.

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Acknowledgements The authors are grateful towards all individuals participating voluntarily in the study. The dedication of the support and research staff is also duly acknowledged. The authors would also like to acknowledge Dr Stephen Rule, Dr Robin Richards and Mr Godfrey Dlulane of Outsourced Insight who were subcontracted to conduct the surveys and coordinate data collection for WHO SAGE within South Africa.

Funding: WHO SAGE: Multi-country study is supported by WHO and the Division of Behavioural and Social Research (BSR) at the National Institute on Aging (NIA), US National Institutes of Health, through Interagency Agreements (OGHA 04034785; YA1323-08-CN-0020; Y1-AG-1005-01) with WHO, a Research Project Grant R01AG034479, and in-kind support from the South Africa Department of Health. The nested WHO SAGE Salt & Tobacco study is supported by an agreement with the CDC Foundation with financial support provided by Bloomberg Philanthropies and a Partnerships & Research Development Fund (PRDF) grant from the Australia Africa Universities Network. DPHRU are supported by the South African Medical Research Council.

Author's contributions: The authors' contributions were as follows: LW coordinated data collection for the WHO SAGE substudy in South Africa, conducted analysis, and wrote the manuscript; GC contributed to the statistical analysis and interpretation of data; AES is the South African PI for the WHO SAGE substudy in South Africa, contributed to data interpretation and writing of the manuscript; KC and PK designed the WHO SAGE Wave 2 sub-study. All authors read, edited and approved the final manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Ataklte F, Erqou S, Kaptoge S, Taye B, Echouffo-Tcheugui JB, Kengne AP. Burden of undiagnosed hypertension in sub-Saharan Africa: a systematic review and meta-analysis. Hypertension. 2015;65:291–8.
2. Berry KM, Parker W-a, Mchiza ZJ, Sewpaul R, Labadarios D, Rosen S, et al. Quantifying unmet need for hypertension care in South Africa through a care cascade: evidence from the SANHANES, 2011–2012. BMJ Glob Health. 2017;2:e000348.
3. Owolabi EO, Ter Goon D, Adeniyi OV, Seekoe E. Social epidemiology of hypertension in Buffalo City Metropolitan Municipality (BCMM): cross-sectional study of determinants of prevalence, awareness, treatment and control among South African adults. BMJ Open. 2017;7:e014349.
4. Harris B, Goudge J, Ataguba JE, McIntyre D, Nxumalo N, Jikwana S, et al. Inequities in access to health care in South Africa. J Public Health Policy. 2011;32:S102–S23.
5. Echouffo-Tcheugui JB, Batty GD, Kivimäki M, Kengne AP. Risk models to predict hypertension: a systematic review. PLoS One. 2013;8:e67370.
6. Fava C, Sjögren M, Montagnana M, Danese E, Almgren P, Engström G, et al. Prediction of blood pressure changes over time and incidence of hypertension by a genetic risk score in Swedes. Hypertension. 2012;1:319–26.
7. Antwi E, Groenwold RH, Browne JL, Franx A, Agyepong IA, Koram KA, et al. Development and validation of a prediction model for gestational hypertension in a Ghanaian cohort. BMJ Open. 2017;7:e012670.
8. Talato K Prevalence and risk factors for pre-hypertension among adults in Burkina Faso (Order No. 3614164). ProQuest Dissertations & Theses Global. (1513591236). Azusa Pacific University, California, 2014. http://nwulib.nwu.ac.za/login?url=https://search.proquest.com/docview/1513591236?accountid=12865.
9. Arrey WT, Dimala CA, Atashili J, Mbuagbaw J, Monekosso GL. Hypertension, an emerging problem in rural Cameroon: prevalence, risk factors, and control. Int J Hypertens. 2016;2016:5639146.
10. Naba T, Obse N. Prevalence of hypertension and associated risk factors among adult population in Wolaita Sodo town, Southern Ethiopia. Int J Med Res Pharm Sci. 2017;4:96–105.
11. Tenkorang EY, Kuuire V, Luginaah I, Banchani E. Examining risk factors for hypertension in Ghana: evidence from the Study on Global Ageing and Adult Health. Glob Health Promot. 2017;24:14–26.
12. Boateng GO, Luginaah IN, Taabazuing M-M. Examining the risk factors associated with hypertension among the elderly in Ghana. J Aging Health. 2015;27:1147–69.
13. Olack B, Wabwire-Mangen F, Smeeth L, Montgomery JM, Kiwanuka N, Breiman RF. Risk factors of hypertension among adults aged 35–64 years living in an urban slum Nairobi, Kenya. BMC Public Health. 2015;15:1251.
14. Bersamin A, Stafford RS, Winkleby MA. Predictors of hypertension awareness, treatment, and control among Mexican American women and men. J Gen Intern Med. 2009;24:521.
15. Angell SY, Garg RK, Gwynn RC, Bash L, Thorpe LE, Frieden TR. Prevalence, awareness, treatment, and predictors of control of hypertension in New York City: clinical perspective. Circulation. 2008;1:46–53.
16. Al Bannay R, Husain A, Böhm M. Blood pressure control and predictors of uncontrolled hypertension. Bahrain Med Bull. 2014;158:1–6.
17. Baltaci D, Erbilen E, Turker Y, Alemdar R, Aydin M, Kaya A, et al. Predictors of hypertension control in Turkey: the MELEN study. Eur Rev Med Pharmacol Sci. 2013;17:1884–8.
18. DeVore AD, Sorrentino M, Arnsdorf MF, Ward RP, Bakris GL, Blankstein R. Predictors of hypertension control in a diverse general cardiology practice. J Clin Hypertens. 2010;12:570–7.
19. Folb N, Bachmann M, Bateman ED, Steyn K, Levitt N, Timmerman V, et al. Socioeconomic and modifiable predictors of blood pressure control for hypertension in primary care attenders in the Western Cape, South Africa. SAMJ. 2016;106:1241–6.
20. Kowal P, Chatterji S, Naidoo N, Biritwum R, Fan W, Ridaura RL, et al. Data resource profile: the World Health Organization Study on global AGEing and adult health (SAGE). Int J Epidemiol. 2012;41:1639–49.

21. Charlton K, Ware LJ, Menyanu E, Biritwum RB, Naidoo N, Pieterse C, et al. Leveraging ongoing research to evaluate the health impacts of South Africa's salt reduction strategy: a prospective nested cohort within the WHO-SAGE multicountry, longitudinal study. BMJ Open. 2016;6:e013316.
22. Caballero FF, Miret M, Power M, Chatterji S, Tobiasz-Adamczyk B, Koskinen S, et al. Validation of an instrument to evaluate quality of life in the aging population: WHOQOL-AGE. Health Qual Life Outcomes. 2013;11:177.
23. Takahashi H, Yoshika M, Yokoi T. Validation of Omron RS8, RS6, and RS3 home blood pressure monitoring devices, in accordance with the European Society of Hypertension International Protocol revision 2010. Vasc Health Risk Manage. 2013; 9:265.
24. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary. A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension. 2018; 71:1269–324.
25. World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects. Jama, Clinical Review & Education Special Communication, E2-E4. 2013; https://doi.org/10.1001/jama.2013.281053
26. Basu S, Millett C. Social epidemiology of hypertension in middle-income countries: determinants of prevalence, diagnosis, treatment, and control in the WHO SAGE study. Hypertension. 2013;113:01374.
27. Lloyd-Sherlock P, Beard J, Minicuci N, Ebrahim S, Chatterji S. Hypertension among older adults in low- and middle-income countries: prevalence, awareness and control. Int J Epidemiol. 2014;43:116–28.
28. Peltzer K, Williams JS, Kowal P, Negin J, Snodgrass JJ, Yawson A, et al. Universal health coverage in emerging economies: findings on health care utilization by older adults in China, Ghana, India, Mexico, the Russian Federation, and South Africa. Global Health Action. 2014;https://doi.org/10.3402/gha.v7.25314.
29. Leichliter JS, Friedman AL, Habel MA, Paz-Bailey G, Vezi A, Lewis DA, et al. 'Clinics aren't meant for men': sexual health care access and seeking behaviours among men in Gauteng province, South Africa. SAHARA. 2011;8:82–8.
30. Weimann A, Dai D, Oni T. A cross-sectional and spatial analysis of the prevalence of multimorbidity and its association with socioeconomic disadvantage in South Africa: a comparison between 2008 and 2012. Soc Sci Med. 2016;163:144–56.
31. Baleta A, Mitchell F. Country in focus: diabetes and obesity in South Africa. Lancet Diabetes Endocrinol. 2014;2:687–8.
32. Matsha TE, Hassan MS, Kidd M, Erasmus RT. The 30-year cardiovascular risk profile of South Africans with diagnosed diabetes, undiagnosed diabetes, pre-diabetes or normoglycaemia: the Bellville, South Africa pilot study. Cardiovasc J Afr. 2012;23:5.
33. Strategic plan for the prevention and control of non-communicable diseases 2013–17. Pretoria, South Africa: National Department of Health 2013.
34. Report number R214: Foodstuffs, cosmetics and disinfectants Act, 1972 (Act 54 of 1972). Regulations relating to the reduction of sodium in certain foodstuffs and related matters. South African Department of Health (2013).
35. Wentzel-Viljoen E, Steyn K, Lombard C, De Villiers A, Charlton K, Frielinghaus S, et al. Evaluation of a mass-media campaign to increase the awareness of the need to reduce discretionary salt use in the South African population. Nutrients. 2017;9:1238.
36. WHO. Global status report on alcohol and health. Geneva: World Health Organization; 2014. Management of Substance Abuse UnitISBN: 9789241564755
37. Echouffo-Tcheugui JB, Dzudie A, Epacka ME, Choukem SP, Doualla MS, Luma H, Kengne AP. Prevalence and determinants of undiagnosed diabetes in an urban sub-Saharan African population. Primary care diabetes. 2012;6:229.
38. Ware LJ, Rennie KL, Gafane LF, Nell TM, Thompson JE, Van Rooyen JM, Schutte R, Schutte AE. Masked Hypertension in Low-Income South African Adults. Journal of clinical hypertension (Greenwich, Conn.). 2016;18:396.
39. Uen S, Weisser B, Wieneke P, Vetter H, Mengden T. Evaluation of the performance of a wrist blood pressure measuring device with a position sensor compared to ambulatory 24-hour blood pressure measurements. Am J Hypertens. 2002;15:787–92.