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May Measurement Month 2017: an analysis of blood pressure screening results in South Africa—Sub-Saharan Africa

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Elevated blood pressure (BP) is a growing burden worldwide, leading to over 10 million deaths each year. May Measurement Month (MMM) is a global initiative of the International Society of Hypertension (ISH) aimed at raising awareness of high BP and to act as a temporary solution to the lack of screening programs worldwide. A surveillance study in 2016 in South Africa revealed that 45% of adults have hypertension and only 6–9% of men and women respectively had controlled BP on medication, highlighting the need for regular screening and awareness campaigns. An opportunistic cross-sectional survey of volunteers aged $\geq$18 years was carried out in May 2017. Blood pressure measurement, the definition of hypertension, and statistical analyses followed the MMM protocol. The sites screened were primarily university campuses and general populations in preference to hospitals and clinics, aiming to raise awareness and allow access to screening in those less likely to be aware of their BP. In total, 3250 individuals (mean age 31.0 $\pm$ 13.3 years) were screened. After multiple imputation for missing BP readings, 795 (24.5%) had hypertension. Of individuals not receiving antihypertensive medication, 459 (15.7%) were hypertensive, and 157 (46.9%) of individuals receiving antihypertensive medication had uncontrolled BP. These results suggest that opportunistic screening campaigns can identify significant numbers with undiagnosed and uncontrolled hypertension, even amongst the fairly young. The high proportions of individuals with undiagnosed and treated uncontrolled hypertension, highlight the need for campaigns to increase hypertension awareness and control.

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Introduction

In South Africa, similar to other countries worldwide, hypertension is a major contributor to the burden of cardiovascular disease. Indeed, in 2007 in individuals aged 30 years or older, 41.7% of deaths due to ischaemic heart disease and 49.6% of deaths due to stroke were attributed to hypertension.[1] The high mortalities due to hypertension are likely to increase given the prevalence of hypertension almost doubling (24% in 1998 to 45% in 2016)[2,3] over an 18-year period. Although many effective antihypertensive medications exist, a large proportion of individuals remain untreated or uncontrolled. Limited access to treatment for hypertension is multifactorial; however, key factors include low awareness and lack of adequate hypertension screening facilities.[4,5] Indeed, in a surveillance study conducted in South Africa in 1998, low proportions of hypertension awareness, treatment, and control were reported (men: 26%, 21%, and 10% respectively; women: 51%, 36%, and 18% respectively).[2] A subsequent surveillance study conducted in South Africa in 2016, revealed that only 6% of men and 9% of women were taking medication and had normal blood pressure (BP).[3] Hence, there is clearly a need for surveillance programs to raise awareness and screen for hypertension in South Africa.

Methods

Study group

The present study was approved by the Committee for Research on Human Subjects of the University of the Witwatersrand (approval number: M170334), the Health Research Ethical Committee of the North-West University (approval number: NWU-00026-17-A5) and the Human Sciences Research Council (approval number 10/22/03/17). Participants gave written informed consent. In total, 3250 participants aged 18 years and older were screened at the University of the Witwatersrand (Parktown, East and West campuses), in Johannesburg, Gauteng; the North-West University (Potchefstroom campus) and Ikageng Gate Shopping Centre in Potchefstroom, North-West Province, and at a few retail and community pharmacies throughout the country.

Blood pressure, demographic, and anthropometric measurements

Before the commencement of data collection, volunteers were trained in accurate BP measurement techniques using validated automated devices (Omron MIT5 Connect and Omron M6 Comfort devices, Omron Healthcare). Screening was primarily on weekdays and was done daily at each site for the duration of May. At least three seated BP and heart rate recordings were taken on the left arm (preferably) after at least 5 min rest with 1 min intervals. A questionnaire was used to collect limited clinical and demographic data as previously described.[6] The data were either entered directly onto a study-specific mobile application or entered on paper forms. The data were cleaned by each of the site PIs before submitting to May Measurement Month (MMM) centrally.

Data analysis

The data were analysed centrally by the MMM/project team previously described.[6] Brief, crude analyses were done using the mean of the second and third BP readings where available. For comparisons of BP between all individuals, multiple imputation was used to estimate the average of the second and third readings where either reading was not documented ($n = 65$). Linear mixed models were run separately for systolic BP (SBP) and diastolic BP (DBP). Hypertension was defined as BP $\geq$ 140/90 mmHg and/or in those on antihypertensive treatment.

Results

The characteristics of those individuals screened are shown in Supplementary material online, *Table S1*. The participants were fairly young, more women than men, and predominantly of black (51%) or white (37%) ethnicity. The proportions of participants with diabetes or cardiovascular disease were low. The majority of BP readings were obtained in the left arm (79.9%) (0.4% not recorded). Most participants were screened on weekdays (14.6–24.6%) than Saturday (0.9%) or Sunday (0.2%).

A total of 795 (24.5%) of participants were found to have hypertension. Of individuals not receiving treatment, 459 (15.7%) were found to have hypertension. Of the 334 individuals on treatment with a mean BP available, 157 (46.9%) were uncontrolled. The majority of those with hypertension (57.7%) were untreated Supplementary material online, *Table S1*.

Based on a linear regression model, in those who were not receiving antihypertensive medication, both SBP and DBP showed a linear increase with age. In women BP was lower than in men (Supplementary material online, *Figure S1*). The increase in SBP with advancing age was steeper in women, but at 80 years of age no sex differences were noted for SBP. However, the increase in DBP with advancing age paralleled that of men. The SBP and DBP were higher in obese (9.6 ± 1.3 mmHg and 5.7 ± 0.4 mmHg respectively, $P < 0.0001$) or overweight subjects (7.8 ± 1.22 and $3.8 \pm 0.$ 9 mmHg, respectively, $P < 0.0001$) than in underweight. The SBP but not DBP was higher in those with normal weight (4.4 ± 1.2 mmHg, $P < 0.0001$) compared to those who were underweight. The SBP and DBP were higher (7.3 mmHg and 4.0 mmHg respectively, $P < 0.0001$) in treated than untreated subjects (Supplementary material online, *Figure S2*). Both SBP and DBP were higher in those reporting regular alcohol intake (2.5 and 1.9 mmHg respectively, $P < 0.0001$); whereas only DBP was higher in smokers (1.2 mmHg, $P < 0.02$) (Supplementary material online, *Figure S2*). Blood pressure was lower in pregnant women (SBP 5.3 mmHg, $p = 0.005$ and DBP 6.7 mmHg, $P < 0.0001$) (Supplementary material online, *Figure S2*).

Discussion

The main findings of this screening program are that in the 3250 participants evaluated, almost one quarter had hypertension, especially given the young mean age (30 years, largely a reflection of the sites where the

screening was done), and high proportions were untreated and/or had uncontrolled BP. The high proportion with hypertension is in keeping with the prevalence of hypertension (women: 27%; men: 33%) previously reported for those aged 25 to 34 years in 2016,[3] and in a cohort with a similar mean age (31 years) from a community based study (24.5%).[7] The low proportion receiving treatment also confirms previous reports in a cohort with a similar mean age (31 years) from a community based study (7.1%).[7] Similarly, the low proportion with controlled BP is in keeping with low proportions with controlled BP on medication (women: 5.1%; men: 2.0%) previously reported for those aged 25 to 34 years in 2016.[3] The proportions of South Africans with hypertension, receiving antihypertensive treatment and having uncontrolled BP are comparable with the worldwide data given that the latter were obtained in individuals at least one decade older.[6] The relatively high proportions with hypertension and uncontrolled BP and low proportion receiving medication, especially given the young mean age, highlight the need for campaigns to increase awareness in South Africa. In keeping with previous studies, increased BP was associated with advancing age, and SBP showed a more rapid increase with age in women compared to men.[6] Although BP was higher in those with increased body weight, similar to data worldwide (only 8 mmHg and 5 mmHg higher SBP and DBP respectively in obese compared to underweight),[6] the impact was small (only 10 mmHg and 6 mmHg higher SBP and DBP, respectively in obese compared to underweight). The positive relationship between regular alcohol intake and BP confirms previous studies.[8] Similarly, the positive relationship between DBP but not SBP and smoking confirms previous studies.[9] The consistent relationships between alcohol and tobacco use with BP underlines why the South African government have introduced taxes and policies in an attempt to reduce the use thereof. But when interpreting these relationships in a relatively young population, perhaps more stringent strategies should be put in place to change behaviours and societal acceptability of tobacco and excessive alcohol use. The lack of relationships between previous myocardial infarction, previous stroke, or diabetes, and BP is most likely due to the low proportions of individuals with these conditions.

The limitations of the present study are the voluntary nature of the program, the inclusion of relative young adult sample and of a limited number of regions of South Africa. Hence, the data are unlikely to be representative of all provinces in South Africa. The low numbers of individuals with previous cardiovascular events or diabetes precluded meaningful analyses on the relationships with BP. As screening was only done on one occasion, there is a possibility of false positive diagnosis of hypertension.

In conclusion, the results of the present study highlight the need for repeated screening programs to increase awareness and education as well as to allow access to BP measurements for those who have never been screened before.

Supplementary material

Supplementary material is available at *European Heart Journal - Supplements* online.

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References

1. Norman R, Gaziano T, Laubscher R, Steyn K, Bradshaw D; South African Comparative Risk Assessment Collaborating Group. Estimating the burden of disease attributable to high blood pressure in South Africa in 2000. *S Afr Med J* 2007;**97**:692–698.
2. Steyn K, Gaziano T, Bradshaw D, Laubscher R, Fourie J. South African Demographic and Health Coordinating Team. Hypertension in South African adults: results from the Demographic and Health Survey, 1998. *J Hypertens* 2001;**19**:1717–1725.
3. National Department of Health (NDoH), Statistics South Africa (Stats SA), South African Medical Research Council (SAMRC), and ICF. 2017. *South Africa Demographic and Health Survey 2016: Key Indicators*. Pretoria, South Africa, and Rockville, Maryland, USA: NDoH, Stats SA, SAMRC, and ICF.
4. Adler AJ, Prabhakaran D, Bovet P, Kazi DS, Mancia G, Mungal-Singh V, Poulter N. Reducing cardiovascular mortality through prevention and management of raised blood pressure: a World Heart Federation roadmap. *Glob Heart* 2015;**10**:111–122.
5. Olsen MH, Angell SY, Asma S, Boutouyrie P, Burger D, Chirinos JA, Damasceno A, Delles C, Gimenez-Roqueplo A-P, Hering D, López-Jaramillo P, Martinez F, PerkovicV Rietzschel ER, Schillaci G, Schutte AE, Scuteri A, Sharman JE, Wachtell K, Guang Wang J. A call to action and a life course strategy to address the global burden of raised blood pressure on current and future generations: the Lancet Commission on hypertension. *Lancet* 2016;**388**: 2287–2712.
6. Beaney T, Schutte AE, Tomaszewski M, Ariti C, Burrell LM, Castillo RR, Charchar FJ, Damasceno A, Kruger R, Lackland DT, Nilsson PM, Prabhakaran D, Ramirez AJ, Schlaich MP, Wang J, Weber MA, Poulter NR; on behalf of the MMM Investigators. May Measurement Month 2017: an analysis of blood pressure screening results worldwide. *Lancet Glob Health* 2018;**6**:736–743.
7. Djami-Tchatchou AT, Norton GR, Redelinghuys M, Maseko MJ, Majane OHI, Woodiwiss AJ. Intrafamilial aggregation and heritability of office-day blood pressure difference in a community of African ancestry: implications for genetic association studies. *Blood Press Monit* 2014;**19**:346–352.
8. Schutte AE, Schutte R, Huisman HW, van Rooyen JM, Fourie CMY, Malan NT, Malan L, Mels CMC, Smith W, Moss SJ, Towers GW, Kruger HS, Wentzel-Viljoen E, Vorster HH, Kruger A. Are behavioural risk factors to be blamed for the conversion from optimal blood pressure to hypertensive status in Black South African? A 5-year prospective study. *Int J Epidemiol* 2012;**41**:1114–1123.
9. Woodiwiss AJ, Scott L, Maseko MJ, Majane OHI, Vengethasamy L, Redelinghuys M, Sareli P, Norton GR. Relationship of predominantly mild current smoking to out-of-office blood pressure in a community sample in Africa. *J Hypertens* 2011;**29**:854–862.