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Race, geographical location and other risk factors for hypertension: South African National Health and Nutrition Examination Survey 2011/12

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A R T I C L E I N F O

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A B S T R A C T

Background: Hypertension is the leading cardiovascular disease in Africa. It is increasing in prevalence due partly to the epidemiological transition that African countries, including South Africa, are undergoing. This epidemiological transition is characterised by a nutrition transition andurbanisation; resulting in behavioural, environmental and stress changes that are subject to racial and geographic divides. The South African National Health and Nutrition Examination Survey (SANHANES) examined the association of traditional risk factors; and less traditional risk factors such as race, geographical location, social stressors and psychological distress with hypertension in a national population-based sample of South Africans.
Methods: Data were analysed on individuals ≥15 years who underwent a physical examination in the SANHANES (n = 7443). Hypertension was defined by blood pressure ≥140/90 mmHg or self-reported hypertension medication usage. Stepwise regression examined the association of demographic, socioeconomic, life stressors, and health risk factors with systolic blood pressure, diastolic blood pressure, and hypertension. Secondly, the risk factor associations and geographical location effects were investigated separately for the African race group.
Results: Increasing age (AOR = 1.069, p < 0.001); male gender (AOR = 1.413, p = 0.037); diabetes (AOR = 1.66, p = 0.002); family history of high blood pressure (AOR = 1.721, p < 0.001); and normal weight, overweight and obesity (relative to underweight: AOR = 1.782, p = 0.008; AOR = 2.232, p < 0.001; AOR = 3.874, p < 0.001 respectively) were associated with hypertension. Amongst African participants (n = 5315) age (AOR = 1.068, p < 0.001); male gender (AOR = 1.556, p = 0.001); diabetes (AOR = 1.717, p = 0.002); normal weight, overweight and obesity (relative to underweight: AOR = 1.958, p = 0.006; AOR = 2.118, p = 0.002; AOR = 3.931, p < 0.001); family history of high blood pressure (AOR = 1.485, p = 0.005); and household crowding (AOR = 0.745, p = 0.037) were associated with hypertension. There was a significantly lower prevalence of hypertension in rural informal compared to urban formal settings amongst African participants (AOR = 0.611, p = 0.005). Other social stressors and psychological distress were not significantly associated with hypertension.
Conclusion: There was no significant association between social stressors or psychological distress and hypertension. However, the study provides evidence of high-risk groups for whom hypertension screening and management should be prioritised, including older ages, males, people with diabetes or with family history of hypertension, and Africans who live in urban formal localities.

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1. Introduction

Hypertension is estimated to affect 1.13 billion people globally. High systolic blood pressure was the number one risk factor for attributable deaths in the world in 2019 causing 10.8 million deaths; followed by tobacco, which accounted for 8.71 million deaths (GBD 2019 Risk Factors Collaborators, 2020). Globally, high systolic blood pressure is the leading cause of morbidity and mortality in those aged 50–74 years (16.1% of disability-adjusted life years lost (DALYs)) and 75 years and older (19.5% of DALYs lost) (GBD 2019 Risk Factors Collaborators, 2020). Most of the mortality and morbidity attributable to hypertension is from the other cardiovascular diseases (CVDs) that hypertension causes - such as stroke, myocardial infarction and heart failure, and kidney failure. Two-thirds of the global burden of CVDs occur in low and middle-income countries (LMICs) (GBD 2019 Risk Factors Collaborators, 2020).

The increasing prevalence of hypertension and other CVDs globally is thought to be in part due to ecological determinants accompanying the epidemiological transition - a concept that was first established by Omran (Omran 1971, 2005). The concept describes how in societies experiencing increasing ageing and life expectancy, the national disease profile changes from predominantly communicable diseases to that of noncommunicable diseases (NCDs) such as CVDs: "Degenerative and man-made diseases displace pandemics of infection as the primary causes of morbidity and mortality" (Omran, 2005, p. 732). Omran's theory focussed on the "complex change in patterns of health and disease; and on the interactions between these patterns and their demographic, economic and sociologic determinants; and their consequences". (Omran, 2005, p. 732). The ecological changes of the epidemiological transition include nutrition transitions and urbanisation occurring as a result of increasing globalisation and socioeconomic development. The epidemiological transition is occurring across the African continent; resulting in an increase in the prevalence of NCDs including CVDs such as hypertension. As the total burden of disease in sub-Saharan Africa increased over 27 years from 1990 (486·0 million [469·6–503·3] DALYs) to 2017 (507·6 million [477·7–543·7] DALYs); the proportion attributable to NCDs increased from 18·6% in 1990 (95% UI 17·1–20·4) to 29·8% in 2017 (27·6–32·0) (GBD 2019 Risk Factors Collaborators, 2020). There is a paucity of studies documenting the epidemiological transition in sub-Saharan Africa. One such study (Fezeu et al., 2011) revealed increases in blood pressure levels in urban and rural populations in Cameroon over a 10-year interval in both men and women. In another study, in the Seychelles the proportion of deaths due to CVD increased over 18 years from 26.3% in 1976 to 39.5% in 1994 (Bovet, 1995).

The prevalence of hypertension and other NCDs are also increasing in South Africa as it moves through the epidemiological transition (Bradshaw et al., 2019; Mayosi et al., 2009; Mbewu 2006). This is caused by increasing life expectancy, and by the social and nutrition transitions that increasing wealth has brought amongst Africans, whose personal income per capita grew by 50% between 1995 and 2008 (Leibbrandt et al., 2010); while the African middle class has almost doubled in number from 2.235 million in 1993 to 5.377 million in 2008 (Goldman Sachs, 2013). The nutrition transition has also been observed in South Africa; with an increase in fat consumption noted amongst urban dwellers compared to rural populations; with increases in obesity noted in both populations (Bourne et al., 2002).

The prevalence of hypertension amongst adults in Africa increased from 19.7% in 1990 to 27.4% in 2000, and 30.8% in 2010 (Adeloye & Basquill, 2014). In addition, awareness of hypertension is increasing in Africa: amongst those found to be hypertensive at screening, the percentage who were aware of their condition was 16.9% in 1990, 29.2% in 2000, and 33.7% in 2010 (Adeloye & Basquill, 2014). In South Africa, hypertension has become the leading CVD at both local and national levels. Locally, in an African township in Cape Town the prevalence of hypertension rose over 18 years from 21.6% in 1990 to 35.6% in 2008 (Peer et al., 2009). Nationally the prevalence of hypertension in 2008 in the National Income Dynamics Study (NIDS) was 31% for men and 36% for women (Ardington & Case, 2013). Hypertension prevalence was 35.3% for men and women in the South African National Health and Nutrition Examination Survey (SANHANES) in 2011 (Shisana et al., 2013); and in 2016 it was 46% for women and 44% for men in the Demographic Health Survey (South Africa National Department of Health (NDoH et al., 2019)).

The SANHANES (Shisana et al., 2013) showed that mean systolic blood pressure for males (130 mmHg) was significantly higher than for females (127.5 mmHg); but diastolic blood pressure did not differ significantly by gender. Mean systolic blood pressure increased progressively with increasing age from a mean of 118.1 mmHg (15–24 years group) to over 149.3 mmHg in those over 65 years of age (Shisana et al., 2013). The mean systolic blood pressure reached prehypertension levels (120–139 mmHg) in the group aged 25–34 years. Mean diastolic blood pressure increased with increasing age for age groups 15–24 (66.4 mmHg) to 45–54 (80.6 mmHg), plateaued between 54 and 64 years, and declined in the older age groups with a mean of 77.6 mmHg in the 65 and older age group (Shisana et al., 2013). Of those with high blood pressure, more than two thirds were overweight or obese, and less than a third consumed alcohol. The prevalence of overweight and obesity were significantly higher in females than males (Shisana et al., 2013).

Hypertension is a continuous variable; whose causation includes both genetic factors, as well as environmental factors, such as migration to urban settings and changing dietary patterns (Marmot, 1984), increasing age, overweight/obesity, excess dietary sodium, too little potassium in the diet (lack of fruit and vegetables), lack of physical activity, excessive alcohol consumption, the post-menopausal state in women, stress, nonsteroidal painkillers, diabetes, sleep apnoea, and chronic kidney disease (The University of California, 2020). Family medical history of CVD, a widely recognised risk factor for hypertension and other CVDs in individuals (Valerio et al., 2016), comprises both genetic characteristics and shared environmental and behavioural factors. As the prevalence of hypertension grows, the sequelae of hypertension are also increasing; sequelae such as stroke, myocardial infarction, heart failure, and renal failure (Mayosi et al., 2009; Mbewu 2006, 2009). Early detection and control of systemic hypertension is therefore important (Mbewu, 2009) to prevent these sequelae. Early detection is complicated by the fact that hypertension is a largely asymptomatic disease; and thus many cases go undetected unless community-based, or opportunistic screening programmes for hypertension are introduced (Madela et al., 2020). In South Africa, once hypertension is detected, the proportion of those initiated on treatment, and controlled on therapy is low (Berry et al., 2017; Shisana et al., 2013).

Different race groups in South Africa have experienced socioeconomic growth at different rates, probably due to the immense socioeconomic distortions that colonialism and apartheid produced in South African society. These distortions persist between the races; and are increasingly manifested within race groups (Leibrandt et al., 2010), 27 years after the demise of apartheid. For example, the Gini coefficient for Africans rose from 0.54 in 1993 to 0.62 in 2008; during a time in which the country's Gini coefficient increased from 0.66 in 1993 to 0.70 in 2008 (Leibbrandt et al., 2010). There has also been a marked increase in inequality between urban and rural Africans (Leibbrandt et al., 2010); and between those who live in formal settings compared to informal settings.

These stark socioeconomic disparities have resulted in great health inequalities (Ataguba et al., 2012; Chatterjee, 2019; Francis et al., 2019); and the persistence of communicable disease and diseases of poverty together with rising NCDs in poorer segments of the population (Frenk et al., 1989; Mbewu, 2009). Additionally, the continuing TB epidemic in South Africa in the past 100 years; as well as the surging HIV/AIDS epidemic from 1990 to 2020 affected black South Africans disproportionately (Gomez-Olivé et al., 2017). It is therefore important to consider the risk factors for hypertension within the African subpopulation, in the context of the ongoing social and epidemiological transitions they are experiencing.

The rising prevalence of hypertension in South Africa has occurred during a period of increasing urbanisation, which has culminated in two-thirds of individuals residing in urban areas; and the population becoming the oldest in sub-Saharan Africa (CIA 2017). By 2016, 46% of women and 44% of men had hypertension (South Africa National Department of Health (NDoH) et al., 2019). Indeed, as the first country in Africa to undergo urbanisation following the "Witwatersrand Gold Rush" in the 1970s, South Africa has been undergoing an epidemiological transition for over a century, though there is very little evidence to document this, particularly amongst the African and rural populations. The epidemiological transition seems to have progressed at different rates amongst different race groups, predicated upon income disparities and geographic location. For example, the prevalence of ischaemic heart disease reached epidemic proportions in the 1970s, similar to high-income countries; but was uncommon amongst Africans even as late as the 1990s (Mbewu, 2009). By 2003 coronary heart disease had long become the major cause of death among White people and South Africans of Indian descent, with incidence rates of 165.3 and 101.2 per 100,000 people, respectively; but only 55.1 per 100,000 among people of mixed descent and 5.3 per 100,000 among Africans (Bradshaw et al., 2003). Cerebrovascular disease was the most common cause of CVD death among those of mixed descent, followed by White people and South Africans of Indian descent, and then Africans (73.6, 62.5, and 36.5 per 100,000, respectively). Much of these differences are thought to relate to socioeconomic inequalities. Indeed, in South Africa, race has often been a proxy for socioeconomic status when analysing health inequalities. Often these intra-racial household income disparities are mirrored in differences between formal and informal housing settlements; and rural and urban settings.

Furthermore, in South Africa, health inequalities are geographically distributed as a result of the Group Areas Act that cantoned different race groups to live in different urban formal or informal settlements; or allocated poor black South Africans to live in rural slums (Mbewu, 2009). Such health inequalities include the prevalence of NCDs such as hypertension; which we hypothesize may vary in prevalence between different race groups; between urban and rural; and between formal and informal settlements. Since the demise of apartheid in 1994, black South Africans have experienced particularly rapid social transitions that vary by housing type areas and rurality. Part of these transitions have resulted from massive poverty alleviation projects such as social grants; school feeding schemes for learners from poor families; large housing projects to convert informal housing settlements to formal settlements; electrification of homes; and provision of clean water and sanitation (Leibrandt 2010).

Psychosocial stressors such as the experience of racism or perceived racism may increase the risk for hypertension (Brondolo et al., 2011). Racism may the increase risk for hypertension via stress exposure and reactivity. This may emerge more clearly for institutional racism than for individual level racism; and includes the historical experience of racism (Brondolo et al., 2011). In South Africa, because of its history, racial inequality may foster conditions that undermine health behaviours, raising the barriers to lifestyle change (Brondolo et al., 2011). Racism may increase the prevalence of hypertension through intermediary risk factors such as obesity, low levels of physical activity and alcohol use (Brondolo et al., 2011).

The prevalence of hypertension (and other NCDs) in South Africa, and its changing prevalence over time is, therefore, a consequence of not simply genetic and biomedical factors; but also changing social determinants of health. Our objective was to explore the traditional and less traditional risk factors and determinants of hypertension such as race, social stressors (such as crowding and neighbourhood crime), and psychological distress (factors associated with the aftermath of the racial divisions of apartheid; and the widening socioeconomic inequality that characterised those years) using data from the SANHANES study. Stepwise regression examined the association of demographic, socioeconomic, life stressors, and health risk factors with each of systolic blood pressure, diastolic blood pressure and hypertension in the entire SANHANES sample. Given the marked heterogeneity in health risk behaviours and socio-economic characteristics within the African population by geographic locality type, and the rapid social transitions experienced by the African subpopulation in various geographic areas in recent decades; the study further investigates the association of urbanicity, and formal or informal housing areas with elevated blood pressure and hypertension amongst the African subgroup; whilst adjusting for life stressors, behavioural risk factors and demographic and socioeconomic characteristics. This study sought to identify sections of the population that are at heightened risk of hypertension to plan targeted screening in prioritised groups.

2. Materials and methods

2.1. Study design

Secondary data analyses were conducted using data from the South African National Health and Nutrition Examination Survey (SANHANES), a population-based national biobehavioural survey conducted in 2011–2012 (Shisana et al., 2013), that included interviews, medical examinations, and biomarker analyses.

Multi-stage disproportionate, stratified cluster sampling was used to select households within enumeration areas (EAs) stratified by province and locality type. A total of 500 EAs were selected and a random sample of 20 households was selected from each enumeration area, yielding a sample of 10,000 households. Within the occupied households, 27,580 individuals of all ages were eligible to be interviewed and agreed to participate, 25,532 (92.6%) of whom completed the interview. Of these, 12,025 (43.6%) individuals agreed to undergo a physical examination, including the measurement of blood pressure.

2.2. Measures

2.2.1. Outcome measures

The primary outcome measure was hypertension, and the secondary outcomes were systolic and diastolic blood pressure. Three systolic and diastolic blood pressure measurements were obtained following 5–10 min of rest by an Omron Automatic Digital BP monitor (model M2, Omron Healthcare, Bannockburn, Illinois, USA) (Shisana et al., 2013). The mean of the second and third measures was used in the analyses. Hypertension was coded as a binary variable, where individuals who had blood pressure $\geq$ 140/90 mmHg or self-reported current use of hypertension medication were defined as having hypertension.

2.2.2. Explanatory variables

The explanatory variables used in this paper are summarised in Table 1 and were divided into five domains: demographic, socioeconomic, psychological distress, social stressor variables, and behavioural and risk factors for hypertension. In addition, geographic locality type was investigated in the analyses on the African sub-sample.

2.2.3. Demographic variables

Race was reported as per Statistics South Africa's standard population groups, namely African, Coloured, Indian/Asian, and White (Statistics South Africa, 2020). Age was categorised into 10-year groups.

2.2.4. Socio-economic variables

Highest education level attained was partitioned into three categories: 'Less than secondary school education', 'Secondary school (Educated through grades 8–12)', or 'Higher Education (with or without matriculation)' based on the distribution of the data and guided by similar national health surveys. Based on the distribution of the data and informed

Table 1
Explanatory variables used in the regression models.

Variable	Categories
Demographic variables (n = 3)	
Age	<25, >25 & < 35, >35 & < 45, >45 & < 55, >55 & < 65, >65
Race	African, White, Coloured, Indian/Asian
Gender	Male, Female
Socio-economic variables (n = 3)	
Highest education level	Less than secondary school, secondary school (Grade 8–12 or equivalent), Higher Education
Income category	< R5000, R5000 to < R10000, R10000 to R < 25000, R25000 to < R50000, > R50000
Wealth index quintile	5 categories: Wealth Index Quintile 1 (Low) - Wealth Index Quintile 5 (High)
Psychological distress variables (n = 1)	
Psychological distress	Minimal distress, High distress
Social stressor variables (n = 7)	
Household hunger-related stress (food insecurity)	Food secure, Food insecure
Home alcohol-related stress	Low, High
Household crowding	Low, High
Neighbourhood Inaccessibility	Low, High
Economic Stress	Low, High
Interpersonal Conflict	Low, High
Neighbourhood crime & alcohol related stress	Low, High
Behavioural and risk factor variables (n = 9)	
Family History of Cardiovascular disease (CVD)	No, Yes
Family History of high blood pressure	No, Yes
Family History of stroke	No, Yes
Diabetes	No diabetes, diabetes
Body mass index (BMI)	Underweight BMI <18.5 kg/m2, Normal weight BMI:18.5–24.9 kg/m2, Overweight BMI:25–29.9 kg/m2, Obese BMI ≥ 30 kg/m2
Smoking status	Never Smoked, Former Smoker, Current Smoker
Physically active lifestyle	Active, Inactive
Fruit/veg consumption	Low, high
Individual alcohol use	Low, high
Geographic locality (n = 1)	
Locality type	Urban formal, urban informal, rural formal, rural informal

by national statistics on income quintiles, *income* was categorised into five groups: <R5,000, R5,000 to < R10,000, R10,000 to < R25,000, R25,000 to < R50,000 and R50,000 or more. Sixteen variables, including housing type, water and sanitation services, and asset ownership were used to calculate a household *wealth index* and corresponding wealth quintiles using Multiple Correspondence Analysis (Gordon et al., 2020). Asset ownership comprised thirteen assets, namely, ownership of a fridge, television, stove, mobile phone, radio, DVD, washing machine, computer, satellite TV, motorcar, vacuum cleaner, telephone (landline), and internet access.

2.2.5. Psychological distress

Psychological distress was measured using the Kessler-10 (Kessler et al., 2009), a 10-item screening questionnaire that includes questions about anxiety and symptoms of depression experienced in the most recent four-week period. The scale has been validated in the South African context (Andersen et al., 2011). Scores ≥ 20 indicate mild, moderate, or severe distress (Andrews & Slade, 2001).

2.2.6. Social stressor variables

Indicators for seven social stress-related constructs were computed: *hunger-related stress* (food insecurity), *home alcohol-related stress*, *household crowding, neighbourhood inaccessibility, economic stress, interpersonal conflict*, and *neighbourhood crime and alcohol-related stress*. Supplementary file 1 presents the items used to construct each index.

Food insecurity or hunger was assessed by the Community Childhood Hunger Identification Project (CCHIP) (Kleinman et al., 1998). The index is internationally used and validated, and is based on eight questions related to whether adults and/or children are affected by food shortages, perceived food insufficiency, or altered food intake due to constrained economic resources in the household. Scores of 5–8 indicate household food shortages, which we used to represent *hunger-related stress*. The other six constructs were created by standardizing and summing items related to each construct, then creating indicators for the highest quintile of each, based on a prior approach (Sternthal et al., 2011). The highest-quintile threshold captures severity and accumulation of stressors and is based on literature suggesting that the negative effects of stressors are most evident among individuals with cumulative and severe stress (Sternthal et al., 2011; Williams & Mohammed, 2009). *Home alcohol related-stress* was based on three items assessing the severity of problems of drinking and driving, misuse of alcohol, and alcohol-related violence/disturbances amongst members of the household. *Household crowding* measured the number of household members per sleeping rooms in the household. *Neighbourhood inaccessibility* measured the availability of facilities such as shops, public transport and recreational areas in the participant's neighbourhood and how accessible these facilities were from the participant's home. *Economic stress* was based on three items: cost of living, and perceptions of income and financial outlook. *Interpersonal conflict* was based on a single item assessing the level of difficulty in dealing with conflict with others. *Neighbourhood crime and alcohol-related stress* was based on three items assessing the seriousness of alcohol-related disturbances, drinking and driving, and general crime in the participants' neighbourhood.

2.2.7. Behavioural and risk factor variables

Height in meters and weight in kilograms were used to calculate *body mass index (BMI)* in kg/m^2, which was categorised as: <25: Normal, 25–29.9: Overweight, and ≥30: Obese. Other risk factors for hypertension, including *tobacco smoking, diabetes, family history of cardiovascular disease (CVD), high blood pressure and stroke, physical inactivity, individual alcohol use,* and *fruit and vegetable consumption,* were obtained during the interviews. *Tobacco smoking* was categorised into current smoker, former smoker, and never smoked, based on two questions on current and ever smoking of tobacco products. *Diabetes* was based on HbA1c ≥ 6.5% or self-report of currently taking blood sugar medication. *Family history of CVD, stroke, and high blood pressure* were assessed by three respective questions on whether participants had a close blood relative who had each of these conditions. *Physical inactivity* was assessed by the WHO Global Physical Activity Questionnaire (GPAQ), where less than 2000 Metabolic Equivalents (MET) minutes per week were categorised as physically inactive. *Individual alcohol use* was measured by the AUDIT-C, a 3-item alcohol screening tool, where scores ≥ 4 for men and ≥ 3 for women indicate high alcohol use (Bush et al., 1998). Fruit and vegetable consumption was assessed by four questions on the frequency of consumption of fresh fruit, fresh fruit juice, dark green leafy or dark yellow vegetables, and other vegetables excluding potatoes during the preceding 7-days, on a scale of 0–2. The sum score ranged from 0 to 8 and the lowest quantile was used to categorise *low fruit and vegetable consumption*. One question assessed salt preference: "Do you prefer to eat your food usually very salty, lightly salted, or not salted?", which was deemed as too subjective to quantify salt consumption and frequency and was therefore excluded.

2.2.8. Geographic location

Enumeration areas were categorised as urban formal, urban informal, rural formal (typically farm areas) and rural informal (typically traditional tribal areas), and the geographic locality type was determined based on the enumeration area that a participant's household was located in.

2.3. Statistical analysis

Data were analysed on individuals aged 15 years or older who underwent a physical examination that included blood pressure measurement. Data analysis was performed using Stata 15.0. (StataCorp, Texas, USA 2016). When compared to South Africa's 2012 mid-year population estimates, the analytic sample who underwent the physical exam comprised higher proportions of females, individuals who identified as being from the Coloured race group, and ages older than 55. The sample weights were applied in the regression analyses that adjust for sampling at the EA, household, and individual levels, and are adjusted for nonresponse bias at the interview and physical examination stage. Sampling weights had been benchmarked to the 2012 midyear population estimates. We calculated descriptive statistics (means and standard errors) for the demographic, socioeconomic, health risk, and stressor variables, by race, and then by geographic locality type within the African population. The descriptive statistics of these variables, including an account of missing data, are presented in Tables 2a and 2b. One-way ANOVA and Chi-square tests were used to assess the bivariate associations between race and each of the explanatory variables in the overall sample (Table 2a) and between locality type and each of the explanatory variables in the African subsample (Table 2b). To maintain the power of our analyses, we imputed missing values for all the variables included in the analyses using chained equations. When correctly implemented, multiple imputation procedures produce asymptotic unbiased estimates and standard errors (White et al., 2011). The chained equation procedure allows us to impute multiple missing variables. We produced and analysed 25 imputations of the dataset. While smaller numbers of imputations are commonly accepted for the validity of point estimates, larger numbers of imputations increase confidence in the replicability of the standard error estimates (von Hippel, 2020). Using the imputed data, we weighted the dataset using Stata's 'svyset' prefix based on the SANHANES study design and performed a series of multivariable regressions on each of the three outcomes: systolic blood pressure, diastolic blood pressure and hypertension. Logistic regression was used for hypertension and ordinary least-squares regression was used for systolic blood pressure and diastolic blood pressure. Model 1 included the demographic variables: race, sex, and age. Model 2 added the socioeconomic variables: education, income, and the wealth index quintile. Model 3 added the Kessler 10 psychological distress score. Model 4 added the seven social stressor variables: hunger, home alcohol stress, crowding, neighbourhood inaccessibility, economic stress, interpersonal conflict, and neighbourhood crime and alcohol. Model 5 added the nine behavioural and health risk factors for hypertension, namely family history of coronary heart disease, family history of high blood pressure, family history of stroke, diabetes, BMI status, tobacco smoking status, physical inactivity, low fruit and vegetable consumption, and high individual alcohol use. The regression analyses were then performed separately for the African sub-population, and locality type was included as an additional explanatory variable. Correlations among all the demographic variables, socio-economic variables, psychological distress, social stressor variables, and behavioural and risk factor variables were low (between 0.001 and 0.37).

3. Results

3.1. Description of the sample

Of the 7443 participants, 67% were African, 4.6% White, 19.8% Coloured, and 8.5% Indian. Overall, 35.3% of participants had hypertension. Hypertension was more prevalent in Indian/Asian (44.9%), Coloured (40.5%), and White (40.4%) participants than African participants (32.9%).

The demographic and socioeconomic characteristics, health risk factors for hypertension, psychological distress, and social stressors varied significantly between race groups (Table 2a). The African sample comprised a higher proportion of participants younger than 35 years. Almost a third of African participants and 26.9% of Coloured participants had less than secondary school education compared to 7.5% and 15.9% of White and Indian/Asian participants respectively. A higher proportion of African participants were in the lowest wealth quintile (24.9%) compared to Coloured (9.6%), White (2.7%) and Indian/Asian (0.3%) participants. Psychological distress was present in 20.9% of African participants compared to less than 13% of participants from other race groups. Similarly, African participants reported a disproportionately higher prevalence of food insecurity, economic stress, home alcohol stress and interpersonal conflict compared to the other race groups. Living in crowded conditions was most prevalent among Coloured (25.2%) and African (21.9%) participants. Family history of heart disease, stroke and hypertension were least prevalent among African participants. White and Coloured participants reported higher current smoking and alcohol use. Diabetes was prevalent in 7% of participants and varied from 5.5% in Africans to 19.4% in Indians/Asians.

Among African participants (n = 5315), the prevalence of hypertension was highest in urban formal areas (36.3%) followed by rural informal areas (33.8%), rural formal areas (30.9%), and was lowest in urban informal areas (24.8%) (Table 2b). The socio-economic characteristics, health risk factors for hypertension, and social stressors varied significantly between African participants living in urban formal, urban informal, rural formal, and rural informal areas (Table 2b). Almost 7% of African participants in urban formal areas had higher education compared to 4% of those in rural informal areas. Urban formal participants had the highest prevalence of being in the high wealth and income groups. Food insecurity was prevalent in 46.4% of participants from rural formal localities compared to 28.8% in urban formal localities. Rural formal areas also had higher rates of crowding and home alcohol stress followed by urban informal localities. Obesity (30.6%), current smoking (10.6%), high alcohol use (12.6%), and diabetes (7.1%) were most prevalent in urban formal areas.

3.2. Factors associated with hypertension, and raised systolic or diastolic blood pressure in the overall sample

In the multiple regression analysis (Table 3), after adjusting for the demographic, socioeconomic, social stressor and health risk factor variables, hypertension was significantly associated with increasing age (adjusted odds ratio (AOR) = 1.069, $p < 0.001$), male gender (AOR = 1.413, $p = 0.037$), diabetes (AOR = 1.66, $p < 0.001$), family history of high blood pressure (AOR = 1.721, $p < 0.001$), and normal weight, overweight and obesity (compared with underweight: AOR = 1.782, $p = 0.008$; AOR = 2.322, $p < 0.001$ and AOR = 3.874, $p < 0.001$ respectively) in the overall sample. In Model 1, hypertension was significantly associated with being Coloured (compared to African: AOR = 1.382, $p = 0.011$) but after adjusting for the other explanatory variables in Models 2–5, the association weakened and was no longer statistically significant. The regression results for Models 1–5 are presented in Supplementary Material, Tables 2 and 3 The goodness of fit of the models increased with the addition of explanatory variables from each model to the next, ranging from Model 1 (Pseudo $R^2 = 0.202$) to Model 5 (Pseudo $R^2 = 0.243$).

Systolic blood pressure had a significant positive association with increasing age ($\beta = 0.535$, $p < 0.001$), male gender ($\beta = 4.962$, $p < 0.001$), family history of high blood pressure ($\beta = 2.598$, $p = 0.007$), high alcohol consumption ($\beta = 3.675$, $p = 0.012$), diabetes ($\beta = 2.609$, $p = 0.034$); and normal weight, overweight and obesity (compared to underweight: $\beta = 3.843$, $p = 0.001$; $\beta = 6.142$, $p < 0.001$ and $\beta = 8.595$, $p < 0.001$ respectively). Increasing age ($\beta = 0.212$, $p < 0.001$), family history of high blood pressure ($\beta = 2.052$, $p = 0.003$), high alcohol consumption ($\beta = 3.4$, $p = 0.003$) and overweight and obesity (compared with underweight: $\beta = 4.753$, $p < 0.001$ and $\beta = 7.519$, $p < 0.001$ respectively) were significantly associated with increased diastolic blood pressure. The goodness of fit of the models increased with each subsequent model from $R^2 = 0.233$ in Model 1 to $R^2 = 0.262$ in Model 5 for systolic blood pressure, and from $R^2 = 0.118$ in Model 1 to $R^2 = 0.184$ in Model 5 for diastolic blood pressure.

Table 2a
Description of the sample by race.

	Overall		African		White		Coloured		Indian/Asian		P-value
	N =	7443	N =	5315	N =	146	N =	1610	N =	372	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Demographic variables											
Age group (years)											
Age <25	27.3%	0.01	29.3%	0.01	16.4%	0.03	24.4%	0.01	14.8%	0.02	0.00
Age >25 & < 35	16.7%	0.00	17.1%	0.01	10.3%	0.03	17.5%	0.01	11.3%	0.02	
Age >35 & < 45	15.1%	0.00	14.7%	0.00	13.7%	0.03	16.4%	0.01	15.1%	0.02	
Age >45 & < 55	15.9%	0.00	14.5%	0.00	11.6%	0.03	19.0%	0.01	23.1%	0.02	
Age >55 & < 65	13.2%	0.00	12.3%	0.00	28.8%	0.04	13.2%	0.01	19.9%	0.02	
Age >65	11.8%	0.00	12.0%	0.00	19.2%	0.03	9.6%	0.01	15.9%	0.02	
Missing											
Gender											
Female	64.9%	0.01	65.2%	0.01	52.1%	0.04	65.3%	0.01	62.1%	0.03	0.08
Male	35.1%	0.01	34.8%	0.01	47.9%	0.04	34.7%	0.01	37.9%	0.03	
Missing	0.0%	0.00					0.1%	0.00			
Socio-economic variables											
Highest education level											
Less than secondary school	29.4%	0.01	31.7%	0.01	7.5%	0.02	26.9%	0.01	15.9%	0.02	0.00
Grade 8–12 (or equivalent)	51.2%	0.01	48.5%	0.01	56.8%	0.04	56.2%	0.01	66.4%	0.02	
Higher Education	4.6%	0.00	4.0%	0.00	24.7%	0.04	3.0%	0.00	10.8%	0.02	
Missing	14.8%	0.00	15.8%	0.00	11.0%	0.03	13.9%	0.01	7.0%	0.01	
Income category											
Income < R5000	29.7%	0.01	33.0%	0.01	9.6%	0.02	21.0%	0.01	28.2%	0.02	0.00
Income > R5000 & < R10000	19.1%	0.00	19.9%	0.01	5.5%	0.02	19.8%	0.01	9.4%	0.02	
Income > R10000 & R < 25000	22.5%	0.00	20.7%	0.01	19.9%	0.03	30.2%	0.01	16.9%	0.02	
Income > R25000 & < R50000	8.2%	0.00	6.9%	0.00	13.7%	0.03	11.4%	0.01	10.5%	0.02	
Income > R50000	7.2%	0.00	6.0%	0.00	38.4%	0.04	7.3%	0.01	12.9%	0.02	
Missing	13.2%	0.00	13.5%	0.00	13.0%	0.03	10.2%	0.01	22.0%	0.02	
Wealth index quintile											
Wealth Index Quintile 1 (Low)	19.9%	0.00	24.9%	0.01	2.7%	0.01	9.6%	0.01	0.3%	0.00	0.00
Wealth Index Quintile 2	18.5%	0.00	22.2%	0.01	1.4%	0.01	10.9%	0.01	5.6%	0.01	
Wealth Index Quintile 3	18.7%	0.00	19.0%	0.01	4.8%	0.02	21.1%	0.01	8.6%	0.01	
Wealth Index Quintile 4	15.4%	0.00	11.7%	0.00	17.1%	0.03	25.1%	0.01	25.3%	0.02	
Wealth Index Quintile 5 (High)	9.9%	0.00	4.8%	0.00	58.2%	0.04	13.9%	0.01	47.6%	0.03	
Missing	17.6%	0.00	17.5%	0.01	15.8%	0.03	19.4%	0.01	12.6%	0.02	
Psychological distress											
Low Psychological Distress Score (<20)	71.0%	0.01	68.3%	0.01	88.4%	0.03	77.7%	0.01	74.5%	0.02	0.00
High Psychological Distress Score (≥20)	18.1%	0.00	20.9%	0.01	5.5%	0.02	12.4%	0.01	9.1%	0.01	
Missing	10.9%	0.00	10.7%	0.00	6.2%	0.02	9.9%	0.01	16.4%	0.02	
Household hunger-related stress (food insecurity)											
Food secure	62.0%	0.01	56.6%	0.01	85.6%	0.03	72.2%	0.01	86.3%	0.02	0.00
Food insecure	29.4%	0.01	35.6%	0.01	6.8%	0.02	16.3%	0.01	6.7%	0.01	
Missing	8.6%	0.00	7.9%	0.00	7.5%	0.02	11.6%	0.01	7.0%	0.01	
Home alcohol-related stress											
Low Home Alcohol Stress	73.9%	0.01	72.7%	0.01	81.5%	0.03	74.1%	0.01	85.8%	0.02	0.00
High Home Alcohol Stress	19.0%	0.00	20.8%	0.01	11.0%	0.03	16.0%	0.01	9.7%	0.02	
Missing	7.1%	0.00	6.5%	0.00	7.5%	0.02	9.9%	0.01	4.6%	0.01	
Household crowding											
Low Crowding	72.1%	0.01	71.9%	0.01	91.8%	0.02	66.5%	0.01	90.6%	0.02	0.00
High Crowding	21.4%	0.00	21.9%	0.01	3.4%	0.02	25.2%	0.01	4.6%	0.01	
Missing	6.6%	0.00	6.2%	0.00	4.8%	0.02	8.4%	0.01	4.8%	0.01	
Neighbourhood Inaccessibility											
Low Neighbourhood Inaccessibility	72.4%	0.01	71.2%	0.01	72.6%	0.04	72.5%	0.01	89.2%	0.02	0.00
High Neighbourhood Inaccessibility	20.1%	0.00	21.9%	0.01	22.6%	0.03	17.5%	0.01	4.3%	0.01	
Missing	7.5%	0.00	6.9%	0.00	4.8%	0.02	10.0%	0.01	6.5%	0.01	
Economic Stress											
Low Economic Stress	70.8%	0.01	70.3%	0.01	78.1%	0.03	71.2%	0.01	74.2%	0.02	0.00
High Economic Stress	19.0%	0.00	20.5%	0.01	13.0%	0.03	15.1%	0.01	16.9%	0.02	
Missing	10.2%	0.00	9.2%	0.00	8.9%	0.02	13.7%	0.01	8.9%	0.01	
Interpersonal Conflict											
Low Interpersonal Conflict	72.6%	0.01	70.3%	0.01	82.9%	0.03	79.6%	0.01	71.5%	0.02	0.00
High Interpersonal Conflict	18.1%	0.00	20.5%	0.01	11.6%	0.03	11.7%	0.01	15.1%	0.02	
Missing	9.4%	0.00	9.2%	0.00	5.5%	0.02	8.7%	0.01	13.4%	0.02	
Neighbourhood crime & alcohol related stress											
Low Neighbourhood Crime & Alcohol	71.5%	0.01	70.2%	0.01	83.6%	0.03	73.7%	0.01	76.9%	0.02	0.00
High Neighbourhood Crime & Alcohol	19.8%	0.00	21.3%	0.01	6.8%	0.02	16.2%	0.01	18.0%	0.02	
Missing	8.7%	0.00	8.5%	0.00	9.6%	0.02	10.1%	0.01	5.1%	0.01	
Behavioural and risk factor variables											
Family History of CVD											
No Family History of CVD	78.6%	0.00	80.0%	0.01	69.9%	0.04	78.8%	0.01	63.4%	0.02	0.00
Family History of CVD	8.8%	0.00	6.7%	0.00	24.0%	0.04	10.9%	0.01	23.7%	0.02	
Missing	12.6%	0.00	13.3%	0.00	6.2%	0.02	10.2%	0.01	12.9%	0.02	
Family History of HBP											

(continued on next page)

Table 2a (*continued*)

	Overall		African		White		Coloured		Indian/Asian		P-value
	N =	7443	N =	5315	N =	146	N =	1610	N =	372	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
No Family History of HBP	52.9%	0.01	56.1%	0.01	51.4%	0.04	45.2%	0.01	42.5%	0.03	0.00
Family History of HBP	32.9%	0.01	29.1%	0.01	41.1%	0.04	42.4%	0.01	44.6%	0.03	
Missing	14.2%	0.00	14.8%	0.00	7.5%	0.02	12.5%	0.01	12.9%	0.02	
Family History of Stroke											
No Family History of Stroke	77.6%	0.00	78.7%	0.01	78.1%	0.03	76.1%	0.01	71.0%	0.02	0.00
Family History of Stroke	10.0%	0.00	8.4%	0.00	14.4%	0.03	13.2%	0.01	16.7%	0.02	
Missing	12.5%	0.00	12.9%	0.00	7.5%	0.02	10.6%	0.01	12.4%	0.02	
Diabetes											
No Diabetes	54.7%	0.01	51.7%	0.01	62.3%	0.04	67.1%	0.01	40.9%	0.03	0.00
Diabetes	7.0%	0.00	5.5%	0.00	8.2%	0.02	9.2%	0.01	19.4%	0.02	
Missing	38.3%	0.01	42.8%	0.01	29.5%	0.04	23.7%	0.01	39.8%	0.03	
Body mass index (BMI)											
Underweight BMI <18.5 kg/m2	8.0%	0.00	7.6%	0.00	2.1%	0.01	9.6%	0.01	9.1%	0.01	0.00
Normal weight BMI:18.5–24.9 kg/m2	39.1%	0.01	40.0%	0.01	28.1%	0.04	39.1%	0.01	31.5%	0.02	
Overweight BMI:25–29.9 kg/m2	21.1%	0.00	20.4%	0.01	28.8%	0.04	21.0%	0.01	28.8%	0.02	
Obese BMI ≥ 30 kg/m2	26.9%	0.01	27.2%	0.01	34.2%	0.04	26.0%	0.01	23.9%	0.02	
Missing	4.9%	0.00	4.9%	0.00	6.8%	0.02	4.3%	0.01	6.7%	0.01	
Smoking status											
Never Smoked	66.6%	0.01	73.0%	0.01	58.2%	0.04	45.8%	0.01	68.8%	0.02	0.00
Former Smoker	10.6%	0.00	9.4%	0.00	15.8%	0.03	15.5%	0.01	5.6%	0.01	
Current Smoker	13.6%	0.00	8.8%	0.00	20.5%	0.03	29.3%	0.01	12.1%	0.02	
Missing	9.3%	0.00	8.8%	0.00	5.5%	0.02	9.4%	0.01	13.4%	0.02	
Physically active lifestyle											
Active	33.1%	0.01	34.0%	0.01	34.2%	0.04	32.9%	0.01	23.1%	0.02	0.00
Inactive	53.4%	0.01	52.5%	0.01	58.2%	0.04	54.5%	0.01	59.4%	0.03	
Missing	13.5%	0.00	13.5%	0.00	7.5%	0.02	12.5%	0.01	17.5%	0.02	
Fruit/Veg consumption											
High Fruit/Veg Intake	61.8%	0.01	59.7%	0.01	80.8%	0.03	65.2%	0.01	72.8%	0.02	0.00
Low Fruit Veg Intake	27.1%	0.01	29.6%	0.01	11.0%	0.03	24.0%	0.01	12.6%	0.02	
Missing	11.1%	0.00	10.7%	0.00	8.2%	0.02	10.9%	0.01	14.5%	0.02	
Individual Alcohol Use											
Low Alcohol Use	78.6%	0.00	80.1%	0.01	79.5%	0.03	73.0%	0.01	84.4%	0.02	0.00
High Alcohol Use	11.7%	0.00	10.4%	0.00	15.1%	0.03	18.1%	0.01	1.9%	0.01	
Missing	9.7%	0.00	9.6%	0.00	5.5%	0.02	8.8%	0.01	13.7%	0.02	
Hypertension and blood pressure variables											
Systolic Blood Pressure (mmHg)	130.98	0.28	130.19	0.33	130.74	1.90	133.35	0.59	130.95	1.21	0.00
Diastolic Blood Pressure (mmHg)	75.41	0.16	74.95	0.19	75.03	1.10	76.78	0.33	75.63	0.62	0.00
Hypertension											
No Hypertension	64.6%	0.01	67.0%	0.01	59.6%	0.04	59.4%	0.01	55.1%	0.03	0.00
Hypertension	35.3%	0.01	32.9%	0.01	40.4%	0.04	40.5%	0.01	44.9%	0.03	
Missing	0.1%	0.00	0.1%	0.00			0.1%	0.00			

CVD: cardiovascular disease, HBP: high blood pressure, BMI: body mass index.

The multiple regression analysis did not detect any significant associations between hypertension, systolic and diastolic blood pressure with the other demographic, socioeconomic, psychological distress, social stressor, and health risk and behaviour variables.

3.3. *Factors associated with hypertension, and raised systolic or diastolic blood pressure among African participants*

Among African participants, living in rural informal localities was associated with a significantly lower probability of being hypertensive relative to living in urban formal areas (AOR = 0.611, $p = 0.005$) (Table 4). Male gender (AOR = 1.556, $p = 0.001$), age (AOR = 1.068, $p < 0.001$), having diabetes (AOR = 1.717, $p = 0.002$), family history of high blood pressure (AOR = 1.485, $p = 0.005$), household crowding (AOR = 0.745, $p = 0.037$), and normal weight, overweight and obesity (compared with underweight: AOR = 1.958, $p = 0.006$; AOR = 2.118, $p = 0.002$ and AOR = 3.931, $p < 0.001$ respectively) were also significantly associated with hypertension. The goodness of fit of the models improved with the addition of explanatory variables from Pseudo $R^2 = 0.199$ in Model 1 to Pseudo $R^2 = 0.235$ in Model 5.

African participants in rural informal localities had significantly lower systolic blood pressure than those from urban formal localities ($\beta = -2.683$, $p = 0.024$). Male gender ($\beta = 6.179$, $p < 0.001$), age ($\beta = 0.535$, $p < 0.001$), family history of high blood pressure ($\beta = 1.795$, $p = 0.045$), diabetes ($\beta = 2.73$, $p = 0.042$), and normal weight, overweight and obesity (compared with underweight: ($\beta = 4.153$, $p = 0.002$; $\beta = 5.42$, $p < 0.001$ and $\beta = 8.701$, $p < 0.001$ respectively) were significantly associated with increased systolic blood pressure, while higher education (compared with less than secondary school education: $\beta = -3.543$, $p = 0.04$) and crowding ($\beta = -1.86$, $p = 0.018$) were significantly associated with decreased systolic blood pressure.

Living in rural informal localities was significantly associated with lower diastolic blood pressure when compared with urban formal localities ($\beta = -2.372$, $p = 0.003$). Age ($\beta = 0.237$, $p < 0.001$), family history of high blood pressure ($\beta = 1.531$, $p = 0.012$), high alcohol use ($\beta = 2.349$, $p = 0.034$) and overweight and obesity (compared with underweight: $\beta = 3.889$, $p < 0.001$ and $\beta = 6.93$, $p < 0.001$ respectively) were significantly associated with higher diastolic blood pressure. The goodness of fit of the models increased in each subsequent model from $R^2 = 0.236$ in Model 1 to $R^2 = 0.261$ in Model 5 for systolic blood pressure, and from $R^2 = 0.137$ in Model 1 to $R^2 = 0.178$ in Model 5 for diastolic blood pressure.

4. Discussion

Hypertension is the most common cardiovascular disease in Africa and South Africa; and is also an important risk factor for other NCDs such as stroke, myocardial infarction, heart failure, and kidney failure.

Table 2b
Description of the African sub-sample by geographic locality subtype.

	Overall		Urban Formal		Urban Informal		Rural Informal (tribal)		Rural Formal (farms)		P-value
	N =	5315	N =	1933	N =	819	N =	1871	N =	692	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Demographic variables											
Age group (years)											
Age <25	29.3%	0.01	28.9%	0.01	31.7%	0.02	28.7%	0.01	29.0%	0.02	0.00
Age >25 & < 35	17.1%	0.01	16.2%	0.01	24.5%	0.02	14.1%	0.01	18.9%	0.01	
Age >35 & < 45	14.7%	0.00	14.5%	0.01	18.6%	0.01	12.9%	0.01	15.8%	0.01	
Age >45 & < 55	14.5%	0.00	16.5%	0.01	13.1%	0.01	12.7%	0.01	15.9%	0.01	
Age >55 & < 65	12.3%	0.00	12.7%	0.01	7.4%	0.01	14.6%	0.01	10.8%	0.01	
Age >65	12.0%	0.00	11.2%	0.01	4.6%	0.01	17.0%	0.01	9.5%	0.01	
Missing											
Gender											
Female	65.2%	0.01	64.6%	0.01	67.3%	0.02	66.6%	0.01	61.1%	0.02	0.04
Male	34.8%	0.01	35.4%	0.01	32.7%	0.02	33.4%	0.01	38.9%	0.02	
Missing											
Socio-economic variables											
Highest education level											
Less than secondary school	31.7%	0.01	23.3%	0.01	31.1%	0.02	35.5%	0.01	45.5%	0.02	0.00
Grade 8–12 (or equivalent)	48.5%	0.01	55.0%	0.01	51.6%	0.02	45.1%	0.01	35.7%	0.02	
Higher Education	4.0%	0.00	6.5%	0.01	1.3%	0.00	4.0%	0.00	0.4%	0.00	
Missing	15.8%	0.00	15.2%	0.01	15.9%	0.01	15.4%	0.01	18.4%	0.01	
Income category											
Income < R5000	33.0%	0.01	29.5%	0.01	34.3%	0.02	37.1%	0.01	30.2%	0.02	0.00
Income > R5000 & < R10000	19.9%	0.01	16.0%	0.01	20.3%	0.01	22.4%	0.01	23.6%	0.02	
Income > R10000 & < R25000	20.7%	0.01	23.1%	0.01	19.8%	0.01	17.4%	0.01	23.7%	0.02	
Income > R25000 & < R50000	6.9%	0.00	9.1%	0.01	8.1%	0.01	5.3%	0.01	3.3%	0.01	
Income >50000	6.0%	0.00	9.9%	0.01	1.7%	0.00	5.5%	0.01	1.4%	0.00	
Missing	13.5%	0.00	12.3%	0.01	15.9%	0.01	12.2%	0.01	17.8%	0.01	
Wealth index quintile											
Wealth Index Quintile 1 (Low)	24.9%	0.01	6.3%	0.01	36.5%	0.02	29.8%	0.01	49.7%	0.02	0.00
Wealth Index Quintile 2	22.2%	0.01	15.4%	0.01	21.2%	0.01	31.3%	0.01	17.6%	0.01	
Wealth Index Quintile 3	19.0%	0.01	26.6%	0.01	16.0%	0.01	15.2%	0.01	11.8%	0.01	
Wealth Index Quintile 4	11.7%	0.00	23.0%	0.01	6.3%	0.01	5.6%	0.01	3.0%	0.01	
Wealth Index Quintile 5 (High)	4.8%	0.00	11.8%	0.01	0.9%	0.00	0.8%	0.00	0.4%	0.00	
Missing	17.5%	0.01	17.0%	0.01	19.0%	0.01	17.4%	0.01	17.3%	0.01	
Psychological distress											
Low Psychological Distress Score	68.3%	0.01	67.1%	0.01	70.2%	0.02	69.0%	0.01	67.8%	0.02	0.00
High Psychological Distress Score	20.9%	0.01	23.7%	0.01	21.4%	0.01	19.6%	0.01	16.3%	0.01	
Missing	10.7%	0.00	9.2%	0.01	8.4%	0.01	11.4%	0.01	15.9%	0.01	
Social Stressor variables											
Household hunger-related stress (food insecurity)											
Food secure	56.6%	0.01	63.5%	0.01	57.0%	0.02	52.1%	0.01	48.6%	0.02	0.00
Food insecure	35.6%	0.01	28.8%	0.01	33.7%	0.02	39.4%	0.01	46.4%	0.02	
Missing	7.9%	0.00	7.7%	0.01	9.3%	0.01	8.5%	0.01	5.1%	0.01	
Home alcohol-related stress											
Low Home Alcohol Stress	72.7%	0.01	72.5%	0.01	68.5%	0.02	76.1%	0.01	69.4%	0.02	0.00
High Home Alcohol Stress	20.8%	0.01	21.2%	0.01	23.3%	0.01	17.5%	0.01	25.9%	0.02	
Missing	6.5%	0.00	6.4%	0.01	8.2%	0.01	6.4%	0.01	4.8%	0.01	
Household crowding											
Low Crowding	71.9%	0.01	73.0%	0.01	65.3%	0.02	78.7%	0.01	58.5%	0.02	0.00
High Crowding	21.9%	0.01	21.5%	0.01	27.1%	0.02	15.2%	0.01	34.7%	0.02	
Missing	6.2%	0.00	5.4%	0.01	7.6%	0.01	6.1%	0.01	6.8%	0.01	
Neighbourhood Inaccessibility											
Low Neighbourhood Inaccessibility	71.2%	0.01	84.0%	0.01	77.4%	0.01	68.4%	0.01	35.5%	0.02	0.00
High Neighbourhood Inaccessibility	21.9%	0.01	8.4%	0.01	14.5%	0.01	25.2%	0.01	59.7%	0.02	
Missing	6.9%	0.00	7.6%	0.01	8.1%	0.01	6.4%	0.01	4.8%	0.01	
Economic stress											
Low Economic Stress	70.3%	0.01	73.7%	0.01	66.9%	0.02	67.7%	0.01	72.0%	0.02	0.00
High Economic Stress	20.5%	0.01	16.7%	0.01	23.6%	0.01	23.0%	0.01	20.8%	0.02	
Missing	9.2%	0.00	9.6%	0.01	9.5%	0.01	9.4%	0.01	7.2%	0.01	
Interpersonal Conflict											
Low Interpersonal Conflict	70.3%	0.01	70.3%	0.01	74.0%	0.02	68.8%	0.01	70.4%	0.02	0.00
High Interpersonal Conflict	20.5%	0.01	22.0%	0.01	19.2%	0.01	21.5%	0.01	15.0%	0.01	
Missing	9.2%	0.00	7.7%	0.01	6.8%	0.01	9.7%	0.01	14.6%	0.01	
Neighbourhood crime & alcohol-related stress											
Low Neighbourhood Crime & Alcohol	70.2%	0.01	64.9%	0.01	57.6%	0.02	74.8%	0.01	87.3%	0.01	0.00
High Neighbourhood Crime & Alcohol	21.3%	0.01	26.5%	0.01	33.6%	0.02	16.0%	0.01	6.5%	0.01	
Missing	8.5%	0.00	8.6%	0.01	8.8%	0.01	9.2%	0.01	6.2%	0.01	
Behavioural and health risk factor variables											
Family history of CVD											
No Family History of CVD	80.0%	0.01	80.9%	0.01	83.0%	0.01	80.5%	0.01	72.8%	0.02	0.00
Family History of CVD	6.7%	0.00	7.9%	0.01	7.3%	0.01	6.0%	0.01	4.2%	0.01	
Missing	13.3%	0.00	11.2%	0.01	9.6%	0.01	13.5%	0.01	23.0%	0.02	

(*continued on next page*)

Table 2b (*continued*)

	Overall		Urban Formal		Urban Informal		Rural Informal (tribal)		Rural Formal (farms)		P-value
	N =	5315	N =	1933	N =	819	N =	1871	N =	692	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Family History of HBP											
No Family History of HBP	56.1%	0.01	51.4%	0.01	56.9%	0.02	60.4%	0.01	56.8%	0.02	0.00
Family History of HBP	29.1%	0.01	35.3%	0.01	31.9%	0.02	25.0%	0.01	19.5%	0.02	
Missing	14.8%	0.00	13.3%	0.01	11.2%	0.01	14.6%	0.01	23.7%	0.02	
Family History of Stroke											
No Family History of Stroke	78.7%	0.01	78.5%	0.01	84.9%	0.01	78.6%	0.01	72.0%	0.02	0.00
Family History of Stroke	8.4%	0.00	10.8%	0.01	5.7%	0.01	8.2%	0.01	5.5%	0.01	
Missing	12.9%	0.00	10.7%	0.01	9.4%	0.01	13.2%	0.01	22.5%	0.02	
Diabetes											
No Diabetes	51.7%	0.01	53.0%	0.01	58.1%	0.02	43.3%	0.01	63.3%	0.02	0.00
Diabetes present	5.5%	0.00	7.1%	0.01	4.5%	0.01	5.1%	0.01	3.3%	0.01	
Missing	42.8%	0.01	39.9%	0.01	37.4%	0.02	51.6%	0.01	33.4%	0.02	
Body mass index (BMI)											
Underweight BMI <18.5 kg/m2	7.6%	0.00	6.1%	0.01	8.4%	0.01	8.1%	0.01	9.5%	0.01	0.00
Normal weight BMI: 18.5–24.9 kg/m2	40.0%	0.01	37.9%	0.01	39.9%	0.02	39.9%	0.01	46.4%	0.02	
Overweight BMI: 25–29.9 kg/m2	20.4%	0.01	19.6%	0.01	22.3%	0.01	20.8%	0.01	18.9%	0.01	
Obese BMI ≥ 30 kg/m2	27.2%	0.01	30.6%	0.01	25.4%	0.02	27.2%	0.01	19.7%	0.02	
Missing	4.9%	0.00	5.8%	0.01	3.9%	0.01	4.1%	0.00	5.5%	0.01	
Smoking status											
Never Smoked	73.0%	0.01	72.6%	0.01	72.9%	0.02	75.5%	0.01	67.6%	0.02	0.00
Former Smoker	9.4%	0.00	9.4%	0.01	10.7%	0.01	9.4%	0.01	7.5%	0.01	
Current Smoker	8.8%	0.00	10.6%	0.01	9.3%	0.01	6.5%	0.01	9.5%	0.01	
Missing	8.8%	0.00	7.4%	0.01	7.1%	0.01	8.7%	0.01	15.3%	0.01	
Physically active lifestyle											
Active	34.0%	0.01	33.8%	0.01	31.0%	0.02	37.0%	0.01	29.5%	0.02	0.00
Inactive	52.5%	0.01	53.8%	0.01	56.8%	0.02	49.3%	0.01	52.9%	0.02	
Missing	13.5%	0.00	12.4%	0.01	12.2%	0.01	13.7%	0.01	17.6%	0.01	
Fruit/veg consumption											
High Fruit/Veg Intake	59.7%	0.01	67.1%	0.01	59.8%	0.02	56.6%	0.01	46.8%	0.02	0.00
Low Fruit Veg Intake	29.6%	0.01	22.8%	0.01	32.1%	0.02	33.0%	0.01	36.4%	0.02	
Missing Fruit Veg Intake	10.7%	0.00	10.0%	0.01	8.1%	0.01	10.4%	0.01	16.8%	0.01	
Individual alcohol use											
Low Alcohol Use	80.1%	0.01	79.3%	0.01	82.9%	0.01	82.2%	0.01	73.1%	0.02	0.00
High Alcohol Use	10.4%	0.00	12.6%	0.01	9.9%	0.01	8.1%	0.01	11.0%	0.01	
Missing	9.6%	0.00	8.1%	0.01	7.2%	0.01	9.7%	0.01	15.9%	0.01	
Hypertension and blood pressure variables											
Systolic Blood Pressure (mmHg)	130.19	0.33	131.66	0.55	126.00	0.79	130.41	0.54	130.32	1.02	0.00
Diastolic Blood Pressure (mmHg)	74.95	0.19	75.99	0.32	73.61	0.48	74.09	0.31	76.27	0.62	0.00
Hypertension											
No Hypertension	67.0%	0.01	63.7%	0.01	75.1%	0.02	66.1%	0.01	69.1%	0.02	0.00
Hypertension	32.9%	0.01	36.3%	0.01	24.8%	0.02	33.8%	0.01	30.9%	0.02	
Missing	0.1%	0.00	0.1%	0.00	0.1%	0.00	0.1%	0.00			

CVD: cardiovascular disease, HBP: high blood pressure, BMI: body mass index.

Table 3

Final regression results[1] for hypertension, and systolic and diastolic blood pressure outcomes in the overall sample (N = 7443).

	Hypertension			Systolic Blood Pressure			Diastolic Blood Pressure		
	AOR	S.E.	p-value	diff (bp)	S.E.	p-value	diff (bp)	S.E.	p-value
Race									
African	Ref	–	–	ref	–	–	ref	–	–
White	0.873	1.49	0.735	−4.886	3.05	0.11	−3.307	2.02	0.103
Coloured	1.244	1.19	0.208	1.507	1.19	0.206	0.026	0.93	0.978
Indian/Asian	0.885	1.25	0.59	−2.431	1.97	0.217	−1.446	1.01	0.152
Gender									
Female	Ref	–	–	ref	–	–	ref	–	–
Male	1.413 *	1.18	0.037	4.962 *	1.09	0.000	−0.09	0.7	0.898
Age	1.069 *	1.0	0.000	0.535 *	0.03	0.000	0.212 *	0.02	0.000
Family History of High Blood Pressure	1.721 *	1.15	0.000	2.598 *	0.96	0.007	2.052 *	0.69	0.003
Diabetes	1.66 *	1.18	0.002	2.609 *	1.22	0.034	0.621	0.89	0.489
BMI									
Underweight <18.5 kg/m2	Ref	–	–	ref	–	–	Ref	–	–
Normal weight 18.5–24.9 kg/m2	1.782 *	1.24	0.008	3.843 *	1.17	0.001	1.496	0.87	0.086
Overweight 25–29.9 kg/m2	2.232 *	1.25	0.000	6.142 *	1.26	0.000	4.753 *	0.96	0.000
Obese ≥ 30 kg/m2	3.874 *	1.28	0.000	8.595 *	1.69	0.000	7.519 *	1.11	0.000
High Alcohol Use	1.408	1.26	0.137	3.675 *	1.45	0.012	3.4 *	1.12	0.003

AOR: Adjusted odds ratio.

*$p < 0.05$.

1. Table presents the statistically significant results of the final regression Model 5 i.e. adjusted for demographic, socioeconomic, psychological distress, social stressor and behavioural and health risk factor variables.

Table 4
Final regression results[1] for hypertension, and systolic and diastolic blood pressure outcomes in the African sub-sample (N = 5315).

	Hypertension			Systolic Blood Pressure			Diastolic Blood Pressure		
	AOR	S.E.	p-value	diff (pr)	S.E.	p-value	diff (pr)	S.E.	p-value
Locality									
Urban Formal	Ref	–	–	ref	–	–	ref	–	–
Urban Informal	0.757	1.23	0.186	−2.763	1.43	0.054	−0.707	1.11	0.526
Rural Informal (Tribal)	0.611 *	1.19	0.005	−2.683 *	1.18	0.024	−2.372 *	0.78	0.003
Rural Formal (Farms)	1.151	1.24	0.507	−1.049	1.58	0.507	1.424	1.19	0.231
Gender									
Female	Ref	–	–	ref	–	–	ref	–	–
Male	1.556 *	1.14	0.001	6.179 *	0.81	0.000	0.347	0.51	0.496
Age	1.068 *	1.0	0.000	0.535 *	0.03	0.000	0.237 *	0.02	0.000
Education									
Less than secondary school	Ref	–	–	ref	–	–	ref	–	–
Grade 8–12 (or Equivalent)	0.875	1.14	0.316	−1.081	0.99	0.276	0.286	0.68	0.676
Higher Education	0.62	1.34	0.106	−3.543 *	1.7	0.04	−0.076	1.12	0.946
Household crowding	0.745 *	1.15	0.037	−1.86 *	0.78	0.018	−0.953	0.61	0.12
Family History of High Blood Pressure	1.485 *	1.15	0.005	1.795 *	0.89	0.045	1.531 *	0.6	0.012
Diabetes	1.717 *	1.19	0.002	2.73 *	1.33	0.042	0.308	0.89	0.729
BMI									
Underweight <18.5 kg/m2	Ref	–	–	Ref	–	–	ref	–	–
Normal weight 18.5–24.9 kg/m2	1.958 *	1.28	0.006	4.153 *	1.34	0.002	1.849	1.01	0.07
Overweight 25–29.9 kg/m2	2.118 *	1.28	0.002	5.42 *	1.4	0.000	3.889 *	1.09	0.000
Obese ≥ 30 kg/m2	3.931 *	1.27	0.000	8.701 *	1.53	0.000	6.93 *	1.1	0.000
High Alcohol Use	0.969	1.31	0.905	1.794	1.44	0.216	2.349 *	1.09	0.034

AOR: Adjusted odds ratio.
*$p < 0.05$.
1. Table presents the statistically significant results of the final regression Model 5 i.e. adjusted for demographic, socioeconomic, psychological distress, and social stressor and the behavioural and health risk factor variables.

The detection and control of hypertension is therefore important, primarily to reduce rates of stroke; but also to reduce the incidence of these other NCDs. Control can be achieved through primary prevention, secondary prevention, treatment, and rehabilitation. To prevent hypertension, the risk factors and social determinants for hypertension in South Africa should be understood; especially as they change over time as South Africa moves through the epidemiological transition. In addition, research should identify groups of the population that are at heightened risk of hypertension and its sequelae; to allow for the planning of targeted screening programmes aimed at prioritised groups.

The prevalence of hypertension in adults in the SANHANES in 2011 was 35.3%. The prevalence rose steadily with increasing BMI and was also associated with male gender, diabetes and family history of high blood pressure. Systolic and diastolic blood pressure was associated with high alcohol use. This has been noted in many studies, and complex pathophysiological causes have been mooted including imbalance of the central nervous system, impairment of the baroreceptors, enhanced sympathetic activity, stimulation of the renin-angiotensin-aldosterone system, and increased cortisol levels (Hussain et al., 2014). Some of these factors may be also associated with other risk factors such as crowding and psychological stress. The prevalence of hypertension rose with increasing age; an increase that has been attributed to the rise in systemic vascular resistance with increasing age, which is thought to be one of the causes of hypertension (Sever et al., 1980).

Despite the broad range of psychosocial measures used in SANHANES, no association was found between psychological and social stressors and hypertension in the entire cohort. It may be that optimal measures and concepts of psychological and social stress are not being captured for the South African context. Furthermore, high levels of stress and anxiety have been noted in all population groups in South Africa; measuring, for example, three-fold higher than in Nigeria (Stein et al., 2008). As a result, stress could become less of a discriminating factor for differences between the races in the prevalence of hypertension. In the African subgroup, crowding was protective of hypertension. Crowding may be a metric of social support after adjusting for all other markers of deprivation. It is well documented that social support is associated with health outcomes (Berkman, 2000; Osamor, 2015). Furthermore, social support, including living with many household members, has been linked to improved management of hypertension in a sub-Saharan African population (Nyaaba et al., 2019).

The lower rates of CVD observed amongst Africans may indicate that they are at an earlier stage of the epidemiological transition than other races; due partly to the discriminatory effects apartheid legislation had on their employment rates, educational attainment, household income, and access to healthcare (Mbewu 2006). These social determinants reduced life expectancy amongst Africans (Stats SA 2018); resulting in a shorter time of exposure to the environmental social determinants that drive the epidemiological transition (Gomez-Olivé et al., 2017; Mbewu, 2009). Increasing life expectancy, compounded by social and nutritional transitions produced an epidemiological transition in South Africa, manifests in the increased prevalence of hypertension and other CVDs. This epidemiological transition had been interrupted between the mid-1990s and 2008 (Kabudula et al., 2017) as the high mortality during the peak of the HIV/AIDS and tuberculosis epidemics caused life expectancy at birth to fall to a nadir of 58 years in 2007 (Statistics South Africa, 2020). With the introduction of antiretroviral treatment for HIV/AIDS in the public health sector in 2004 (Mbewu et al., 2003), life expectancy increased by 9 years from 2008 to 2016 (Statistics South Africa, 2020). Recent years have shown a resumption in the positive trajectory of the epidemiological transition partly attributed to increasing life expectancy as a result of the introduction of antiretroviral therapy for HIV/AIDS.

In addition, urbanisation has been increasing steadily in South Africa in the past five decades, rising from 24% in 1904; to 38% in 1946; 48% in 1980; 53% in 1991; 57% in 2001; to over 66% of the population residing in urban and peri-urban settings in 2019 (Kok & Collinson, 2006; The World Bank, 2020). This has been accompanied by a rising prevalence of hypertension, as urbanisation is commonly associated with increased prevalence of risk factors for hypertension such as increasing age, rising salt intake, lack of exercise, diminishing fruit and vegetable intake, and increasing rates of obesity, diabetes and social stress. However, it is challenging to determine the duration of exposure to urban environments, since South Africa is characterised by temporary migration of people between rural and urban areas as they seek work

(Kok & Collinson, 2006). Furthermore, the length of stay in urban or rural settlement types is complicated by the fact that many South Africans do not even have street addresses for their homes – particularly in rural areas and urban informal settings.

The prevalence of hypertension was highest amongst Africans in urban formal areas (36.3%) followed by rural informal areas (33.8%) and rural formal areas (30.9%) and was lowest in urban informal areas (24.8%). This may reflect the effects of geographical location and socioeconomic status on hypertension, with Africans in urban informal areas being particularly deprived despite their urban domicile. It could also be due to the various social and psychological stressors, that are known to be associated with hypertension, being more prevalent in different geographic locality types. The lower rates of hypertension among African participants in rural informal settings could perhaps be due to such communities being in the early phase of the epidemiological transition; these individuals may lack the income to buy salty, sugary, and fatty foods, and are not sedentary.

The lower rates of hypertension in our study in rural settings compared with urban areas have been observed before in hypertension studies in Africa dating back decades (Donnison, 1929; Opie & Seedat, 2005). Seedat et al. (1982) reported differences in the prevalence of hypertension amongst urban and rural Zulu people: 25% and 9.4% respectively (Seedat et al., 1982). Even when age-standardised data are used, to correct for the normal rise in blood pressure with age, hypertension rates were still lower in rural compared with urban areas (Poulter et al., 1984). Poulter et al. (1985), in a longitudinal study, showed that over 2 years, blood pressure amongst those migrating from rural to urban settings rose significantly compared to age and sex-matched rural controls. Changes in body weight and dietary electrolytes appeared to explain some of the blood pressure differences. This could have been due to lower consumption of potassium from vegetables and fruit; and higher consumption of sodium-rich fast foods amongst urban migrants. Higher pulse rates in the urban migrants suggested that a further mechanism operative through the autonomic nervous system was responsible for some of the elevation of systolic blood pressure, particularly on arrival in the urban area. These higher pulse rates might be indicators of higher psychosocial stress amongst the migrants – a risk factor that we investigated in our study. (Poulter et al., 1985).

The lack of association between socioeconomic and educational factors and hypertension could relate to the confounding effects of the rapid social transition that was occurring in South Africa between 1994 and 2014 (Leibbrandt et al., 2010, Goldman Sachs, 2013). These 20 years were marked by large increases in per capita income in all sectors of the population including African individuals, and by rapid urbanisation and increasing electrification, housing construction, and piped water and sanitation (Leibbrandt et al., 2010, Goldman Sachs, 2013). A rapid nutrition transition accompanied this social transition with growing prevalence of westernised foods, and salt, sugar and fat intake; declining physical activity; rapidly increasing prevalence of overweight and obesity; rising prevalence of diabetes; and the saturation of the entire population with mobile phone technologies, and to a lesser extent social media (Bourne et al., 2002). Therefore, while income and education levels increased, so did these other factors that contributed to the rising prevalence of hypertension.

Body mass index was a strong mediator of an adverse indirect effect of socioeconomic status on blood pressure. However, in the overall sample, we did not find any significant associations between socioeconomic status and blood pressure in the final adjusted models that included adjustment for age and gender. The prevalence of hypertension was significantly higher in males (AOR 1.413) possibly due to confounding effects operating. For example, the age structure of the South African population is very different to high-income countries with the result that there would be a much smaller proportion of post-menopausal women in SANHANES-1 than for example in the United States' population-based surveys (Fryar et al., 2020). Post-menopausal women have considerably higher blood pressure than pre-menopausal women due to the loss of the vasodilating of endogenous oestrogens. This is further aggravated in postmenopausal women by a high prevalence of obesity, the lack of regular physical exercise, and dietary salt intake (Barton et al., 2009). This effect of oestrogen levels on hypertension may also partly explain the finding in SANHANES that mean systolic blood pressure for males (130 mmHg) was significantly higher than for females (127.5 mmHg); but diastolic blood pressure did not differ significantly by gender. It may be that oestrogen levels have a greater effect on systolic blood pressure than on diastolic blood pressure.

Smaller, more focussed, community-based studies are needed to examine the effect of diet, social stress and psychological stress on blood pressure. Such studies could also incorporate instruments designed to measure the effect of racism and perceived racism on psychological stress, and thereafter on hypertension.

The findings of this study amplify the importance of community-based screening for hypertension and other cardiovascular-related outcomes; especially in communities where hypertension is more prevalent (as identified in this study) such as older age groups and in urban areas. It also indicates the need to implement health education and health promotion programmes for hypertension and other NCDs. Ultimately, there is a need for community-based interventions for the prevention, detection, and control of hypertension. These interventions should focus on traditional risk factors such as low fruit diets, obesity, physical inactivity, and alcohol intake; as well as less traditional risk factors such as geographic location and housing, and social stress and psychological distress. The study also highlights the importance of analysing differences in the prevalence of hypertension and the risk factors for hypertension between different historically entrenched race categories to understand the current inequities for these historically entrenched categories; how these inequities may translate to health outcomes; and to monitor changes over time.

It is also important that the SANHANES study should be repeated, ten years following the first study; to gauge South Africa's progress through the epidemiological transition with resultant changes in prevalence of risk factors for NCDs such as obesity, smoking, and physical inactivity; as well as changes in the prevalence of the actual NCDs such as hypertension, diabetes, heart attacks, heart failure, stroke, and cancer.

There were limitations to the current study. Its cross-sectional design did not allow for measurement of ecological changes over time in the prevalence of hypertension and the risk factors for hypertension. The lack of association between hypertension and low consumption of fruit may relate to a lack of sensitivity of the self-report instrument used to measure these variables. These variables are associated with high blood pressure in many studies (Li et al., 2016). Similarly, the lack of association between physical inactivity and hypertension may relate to deficiencies in the instrument used. Salt intake was insufficiently measured in the SANHANES and was therefore not included in this study. The time that participants lived in their current geographic location could not be captured in this study for reasons stated earlier and would have been an important variable to capture the recency of urbanisation and migration between areas. However, a strength of the study is that it included a large number and variety of risk factor variables for hypertension and is a national study. While the SANHANES study is relatively old, it provides population-based data on a large number of socioeconomic and social risk factors, that are not often measured in other large-scale health surveys.

The SANHANES, when compared with other studies over the past 50 years, confirmed the rising prevalence of hypertension amongst all race groups in South Africa; partially as a result of the ongoing epidemiological transition in South Africa encompassing increasing urbanisation and nutrition transitions. The SANHANES also showed that the traditional risk factors for hypertension operate in South Africa; namely age, male sex, being overweight, and diabetes mellitus. Also revealed were differences in hypertension prevalence between urban and rural settings; and between formal and informal settlements amongst African participants. These findings provide evidence to guide screening and treatment programmes for this largely asymptomatic disease, at the community level; prioritising high-risk groups, including older ages, males, people with diabetes or with family history of hypertension, and Africans who live in urban formal localities. Health promotion interventions to modify the proximal social determinants of hypertension could be introduced; to both reduce the prevalence of hypertension in primary prevention; as well as ameliorate the sequelae of established hypertension through secondary prevention and rehabilitation.

Author statement

Priscilla Reddy., Anthony David Mbewu., David R Williams., Sibusiso Sifunda: Conceptualization, Methodology, Software, Writing- Original draft preparation. Anthony David Mbewu., Justin Winston Morgan., Ronel Sewpaul., Nigel Walsch Harriman., Thabang Maanyapelo., Musawenkosi Mabaso: Data curation, Visualization, Investigation, Writing- Original draft preparation. Priscilla Reddy., David R Williams.: Supervision. Musawenkosi Mabaso, Ronel Sewpaul: Validation. Priscilla Reddy., Anthony David Mbewu., David R Williams., Sibusiso Sifunda, Nigel Walsh Harriman., Thabang Maanyapelo.: Writing- Reviewing and Editing.

Ethical approval

Ethical approval for the study was obtained from the Research Ethics Committee (REC) of the South African Human Sciences Research Council (HSRC) (REC number: 6/16/11/11).

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2021.100986.

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