CARDIOVASCULAR RISK AND COMORBID CONDITIONS AMONG BLACK SOUTH AFRICANS WITH HYPERTENSION IN PUBLIC AND PRIVATE PRIMARY CARE SETTINGS: THE HIHI STUDY

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Objective: To describe the HiHi Study and assess cardiovascular disease (CVD) risk profile and comorbid conditions of Black patients receiving hypertension (HTN) care.

Design: Cross sectional, descriptive.

Setting: Public and private primary care sites in three townships near Cape Town, South Africa.

Participants: 403 hypertensive Black patients (183 men, 220 women), ages 35–65 years.

Methods: Self-reported sociodemographic, lifestyle, and medical history factors were assessed. Height, weight, and blood pressure (BP) were measured and 12-lead electrocardiogram recorded. Blood and urine were collected to assess lipid profile, diabetes, and renal impairment. Type and number of medications were abstracted from medical records.

Results: Antihypertensive medication was prescribed for all participants, with HTN controlled (BP<140/90 mm Hg) for 36% of public and 51% of private patients. Mean systolic and diastolic BP were higher in the public than private sector (148/90±28/13 and 138/86±21/13 mm Hg) as was LVH (37% and 30%) but diabetes (18% and 29%) and obesity (55% and 75%) were less common in the public sector. There were no significant differences between public and private settings in use of antihypertensive medications, total cholesterol ≥ 5 mmol/L, daily tobacco use, or total CVD risk. More men than women smoked tobacco daily (30% and 6%) and used alcohol excessively (53% and 15%).

Conclusions: Despite attending HTN primary care, CVD risk factors were addressed inadequately. Differences in risk factor prevalence and control were identified by healthcare sector and sex. A critical need exists to improve HTN care and CVD risk management programs for this high risk group. (*Ethn Dis*. 2007;17:477–483)

Key Words: Cardiovascular Risk, Hypertension, South Africa, Blacks, Health Disparities, Ethnicity

INTRODUCTION

Cardiovascular disease (CVD) events are greatest in patients with hypertension (HTN) and other risk factors, which act synergistically to exponentially increase risk.[1] Evidence-based guidelines for the diagnosis and treatment of CVD risk factors[2] and assessment of total CVD risk[3,4] are widely promoted internationally, including in South Africa. To reduce the burden of CVD in developing countries, effective strategies for implementing recommendations to manage risk factors in primary care settings must be identified and activated, despite challenges of resource scarcity. The HiHi Study, a study of HTN care in South Africa, provides the first opportunity to characterize the treatment and risk factor status of Black South Africans.

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The purpose of this paper is to describe the total CVD risk and comorbidity profile of Black South African men and women receiving HTN treatment with comparison of profiles in public and private primary healthcare settings near Cape Town.

METHODS

The HiHi (Xhosa term for "high blood pressure") Study, a cross-sectional, descriptive study, was conducted from June 2003 to June 2004 to assess CVD risk factors, barriers to HTN care and control, and determinants of HTN control among hypertensive Black South Africans in three Black townships near Cape Town. The study conceptual framework (the Precede-Proceed Model)[5] and barriers to HTN care and control, and determinants of HTN control in this sample are described in the companion paper within this journal.[6]

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Setting

Black South African men and women with diagnosed HTN were recruited from primary care sites; three public sector community health centers (CHC), and eleven private sector general practitioner offices (GPs), in the Cape Town townships Langa, Guguletu, and Cross Roads. At CHCs, care was provided by clinically trained professional nurses and medical practitioners. Antihypertensive medication, from an essential drug list, was dispensed onsite monthly free-of-charge. The GPs provided services to patients who could afford to pay for care and medication or who had medical insurance through employers.

Sample

Inclusion criteria were: Black African people aged 35–65 years, residing in Langa, Guguletu, or Cross Roads townships and receiving care for at least the last 12 months, with diagnosed HTN (blood pressure [BP] ≥140/90 mm Hg or on HTN medication), and providing written informed consent after a description of the study in Xhosa, their primary language. Exclusion criteria included: an acute and/or terminal condition (ie, tuberculosis, AIDS, cancer), psychiatric diagnosis precluding participation, cognitive impairment by medical history or clinician assessment, or participating in another study.

The initial intent was to create a sampling frame of eligible individuals at each site, randomly select potential participants, and then approach these individuals for informed consent. However, no site had a paper or electronic database of patients or could identify hypertensive patients among their records (at each CHC this numbered approximately 30,000 to 80,000, including multiple records for many patients). Thus, a revised sampling process was devised. Trained research nurses from the Medical Research Council (MRC) visited CHCs on randomly selected days. After clinical staff identified the attending Black patients with HTN, these patients were screened consecutively by the trained research nurse and those meeting criteria and consenting to participate were enrolled.

In GP offices, the GPs discussed the study with patients who met inclusion criteria and provided the research nurse with their contact information. These patients were contacted by telephone or home visit. Advertisements for the study were posted in the office waiting area to encourage interested potential participants to call the study nurse directly. An appointment was scheduled to enroll interested potential participants.

The Johns Hopkins Medicine institutional review board and the MRC's Ethics Committee approved the study.

Data Collection Procedures

Validation methods, including forward and back translation into and from Xhosa and pilot-testing, were employed to maximize validity of self-report and cultural saliency for the South African context in the Black townships of Cape Town.[7,8] The research nurses collected data on standardized pre-coded forms. Sources of data included: patient self-report; direct measurement of anthropometrics, BP and ECG; laboratory testing of serum and urine; and medical record abstraction of prescribed medications. The self-report questionnaire, administered by the research nurse, assessed sociodemographics (ie, age, sex, employment, education, housing type and occupancy, and years living in urban setting); lifestyle behaviors (ie, current tobacco use, risk for alcoholism, physical activity); and personal and medical history including comorbid conditions. Degree of urbanization was defined as the percent of life years spent in an urban setting. Excess alcohol use was defined as positive response to two or more of the four CAGE questions.[9] Physical activity patterns were identified using the Global Physical Activity Questionnaire and analyzed after conversion to adjusted METS/week with CV protective exercise defined as ≥ 600 METS/week.[10] Additional study variables related to HTN care are described in the companion paper.[6]

Weight was measured to the nearest 0.5 kg, using a calibrated scale manufactured by Soehnle, Germany, with each subject in light clothing and bare feet. Height was measured to the nearest 0.1 cm, using a stadiometer. Body mass index (BMI) was calculated; underweight was defined as BMI <18.5 kg/m^2; overweight as BMI 25–29.9 kg/m^2; and obesity as BMI ≥ 30 kg/m^2.[11]

BP was measured three times at one-minute intervals, using the appropriate sized cuff and an Omron M4-I BP monitor after the participant was seated for five minutes with the left arm resting on a table at the level of the heart. The average of the second and third measurements was used for analysis. Controlled HTN was defined as BP <140/90 mm Hg. A standard 12-lead resting electrocardiograph (ECG) was obtained using a MAC 1200 machine. A diagnosis of left ventricular hypertrophy (LVH) was based on the Minnesota coding 3-1 and 3-3.[12]

Spot urine samples and non-fasting blood samples were analyzed at the Chemical Pathology Laboratory at Groote Schuur Hospital for serum total (TC) and HDL cholesterol (HDLC), triglyceride, random glucose, creatinine and glycosolated hemoglobin (HbA1C), and spot urine creatinine and albumin using standardized methods and quality control procedures. LDL-cholesterol (LDLC) levels were calculated using the Friedewald equation (LDLC= TC(HDLC + triglyceride/5)).[13] To define lipid profile, cut-off points of TC ≥ 5 mmol/L, LDLC ≥ 3.0 mmol/L, HDLC < 1.2 mmol/L, and HDLC/TC < 20% were used. The diagnosis of type 2 diabetes mellitus was defined as non-fasting blood glucose level ≥ 11.1 mmol/L and/or use of anti-diabetic medication. Creatinine clearance rate was calculated using the Cockroft-

Table 1. Sociodemographic characteristics by sex and site of health care

Sociodemographic characteristics	CHCs (Public Sector)			GPs (Private Sector)			Total Sample			
	F *n*=172	M *n*=151	All *n*=323	F *n*=48	M *n*=32	All *n*=80	F *n* =220	M *n*=183	All *N*=403	*P*
Age in years, mean (SD)	51(7)	55(6)	52(7)*	52(8)	52(6)	52(7)	51(8)	54(6)	52(7)*	.852
Employed†, %	37	30	34	55	66	59	41	36	39	<.0001
Education, %										<.0001
None	22	32	27*	6	3	5	19	27	22	
Primary school (1–7 years)	28	21	24	8	13	10	24	19	22	
Standard (8–12 years)	50	45	48	68	65	67	54	49	52	
Tertiary/diploma education	–	3	1	18	19	19	4	6	5	
Housing Type, %										<.0001
Private (Built formal unit)	23	17	20	59	88	70*	31	30	31	
Government (Subeconomic)	50	59	54	37	9	26	47	50	48	
Informal Settlements	27	24	26	4	3	3	22	21	22	
Occupancy rate (# of persons per room), mean (SD)	3(2)	2(2)	2(2)*	2(1)	1(1)	1(1)	2(2)	2(2)	2(2)	<.0001
Degree of urbanization (% of life in urban area), mean (SD)	63(30)	66(28)	64(24)	77(27)	84(20)	80(24)	66(30)	69(28)	67(29)	<.0001

* Significant within groups difference between females and males ($P<.05$)
P value for comparing CHC total sample to GPO total sample
† Unemployed status included unemployed, disabled, retired, and pensioners

Gault formula.[14] The total CVD risk scores and predicted risk of future CVD events were calculated using the Framingham risk formula based on the following risk factors: age, sex, BP, TC, smoking, and diabetes.[15]

Medications prescribed at the last visit for common chronic conditions were abstracted from patients' medical records by a research nurse and coded according to the Anatomical Therapeutic Chemical (ATC) classification categories.[16]

Data Analysis

Double-data entry methods were utilized, with checks for discordant errors. Statistical analyses were performed using SPSS software. Univariate analyses were conducted to describe sociodemographic and CV risk characteristics presented as means and standard deviation for continuous data and as percentages for categorical data. Between group differences were assessed using chi-square tests for categorical variables and unpaired t-tests for continuous variables. Comparisons were conducted to assess sex differences within the total sample, as well as within the public and private sector samples.

RESULTS

There were 403 participants (183 men, 220 women) from public (151 men, 172 women) and private (32 men, 48 women) care settings. Sample sociodemographic characteristics are presented in Table 1. The participants' mean age was 52 years. Public, in comparison to private, sector participants reported greater rates of unemployment, lower social class indicators (ie, lower education level, subeconomic and informal housing, higher home occupancy rate), and lower degree of urbanization (ie, spent less of their lives in an urban setting).

The level of BP and HTN control, prevalence of lifestyle risk factors, and CVD risk are reported in Table 2. Mean systolic and diastolic BP were higher in public sector participants compared to private, and in men compared to women. BP control was significantly greater in private compared to the public sector participants (51% vs 36%), while sex differences were not significant.

Mean serum lipid values were relatively low and clustered around the recommended cut-off points. A low HDL/TC ratio of < 20% was seen in 13% of the sample. The triglyceride level of all participants was below 4.5 mmol/L. Prevalence of diabetes was 20% in total sample; only 32.5% were on medication and only half of these had non-fasting blood glucose <11.1 mmol/L. The mean non-fasting glucose levels were higher in private compared to the public sector participants. Poor diabetes control (HbA1C >8%) was seen among 57% of diabetics.

Mean BMI for the total sample was within the obese category and was higher in private, compared to public sector, participants. Men, compared to women, reported smoking tobacco more and using smokeless tobacco less. More participants in the private compared to public sector reported physical activity at a cardio-protective level. Excessive alcohol use was reported by 32% of the total sample and was more common in the public, compared to private, sector and among men compared to women.

Total CVD risk calculated using the Framingham equation was remarkably low. Seven percent of the sample had risk levels greater than 20%. There were

Table 2. Cardiovascular risk factors by sex and site of health care

	CHCs (Public Sector)			GPs (Private Sector)			Total Sample			
	F *n*=172	M *n*=151	All *n*=323	F *n*=48	M *n*=32	All *n*=80	F n=220	M *n*=183	All *N*=403	*P*
Systolic BP mm Hg, mean (SD)	144(25)	153(30)	148(28)*	137(21)	140(22)	138(21)	142(24)	151(29)	146(27)*	.002
Diastolic BP mm Hg, mean (SD)	89(12)	92(14)	90(13)	84(12)	89(15)	86(13)	88(12)	91(14)	89(13)*	.004
Hypertension control BP<140/90 mm Hg, %	41	30	36	54	47	51	44	33	39	.016
Total serum cholesterol mmol/L, mean (SD)	5.1(1.3)	5.0(1.1)	5.1(1.2)	5.2(1.0)	5.2(1.2)	5.2(1.1)	5.2(1.3)	5.0(1.1)	5.1(1.2)	.660
LDL serum cholesterol mmol/L, mean (SD)	3.0(1.2)	2.8(1.0)	2.9(1.1)	3.0(1.0)	2.9(1.0)	3.0(1.0)	3.0(1.2)	2.8(1.0)	2.9(1.1)	.814
HDL serum cholesterol mmol/L, mean (SD)	1.5(0.4)	1.4(0.5)	1.5(0.4)	1.5(0.4)	1.3(0.5)	1.4(0.4)*	1.5(0.4)	1.4(0.5)	1.5(0.4)*	.202
Triglyceride serum mmol/L, mean (SD)	1.5(0.9)	1.8(1.4)	1.6(1.1)*	1.4(1.0)	2.7(2.6)	2.0(1.9)*	1.5(0.8)	1.9(1.7)	1.7(1.3)*	.027
TC ≥ 5 mmol/L, %	50	49	50	52	50	51	51	50	50	.898
HDL-C ≤ 1.2 mmol/L, %	25	32	28	19	60	36*	24	37	30*	.199
LDL-C ≥ 3 mmol/L, %	45	41	43	52	42	49	46	41	44	.461
HDL-C/TC ratio (%), mean (SD)	31(10)	30(10)	30(10)	31(10)	26(10)	29(10)*	31(10)	29(10)	30(10)	.166
HDL-C/TC ratio < 20%, %	13	12	13	7	28	16*	12	15	13	.468
Non-fasting blood glucose mmol/L, mean (SD)	6.2(4.3)	5.9(2.8)	6.0(3.6)*	7.1(5.0)	7.4(4.0)	7.2(4.5)	6.4(4.4)	6.1(3.1)	6.3(3.8)	.018
Diabetes diagnosis or non-fasting glucose ≥ 11.1 mmol/L or on antidiabetic med, %	16	20	18	27	31	29	18	22	20	.026
HbA1C, mean (SD)	7.1(2.1)	6.7(1.7)	6.9(1.9)	7.2(2.3)	6.6(1.8)	7.0(2.1)*	7.1(2.1)	6.7(1.7)	6.9(2.0)*	.688
HbA1C > 8, %	12	11	12	17	16	16	13	12	13	.297
Body mass index (BMI) kg/m^2, mean (SD)	35(7)	28(5)	32(7)	38(8)	32(8)	36(8)*	36(7)	29(6)	33(8)*	<.0001
Overweight (BMI ≥25 and <30), %	17	40	28*	8	31	18*	15	38	26*	.007
Obese (BMI ≥ 30), %	75	31	55*	88	56	75*	78	36	59*	.007
Daily smoker, %	8	29	18	–	31	13	6	30	17	.652
Daily smokeless tobacco user, %	9	1	5	8	3	6	9	2	6	.157
Physical activity, Adjusted METS / wk ≥600, %	22	28	25	41	41	41	26	30	28	.069
High risk for alcoholism (CAGE ≥ 2), %	19	52	34*	–	53	21*	15	53	32*	.024
Family history of CHD	19	17	18	29	53	39	21	23	22	<.0001
Total CVD risk (Framingham), Mean (SD)	6.0 (4.8)	10.2 (5.8)	8.0 (5.7)*	5.7 (4.3)	10.7 (8.1)	7.6 (6.6)	5.9 (4.7)	10.3 (6.3)	7.9 (5.9)*	.636
Moderate (15–19.99), %	3	12	7*	8	6	7*	4	11	7*	.824
High (≥ 20), %	4	10	7	0	13	5	3	10	7	

* Significant within group difference between females and males ($P<.05$)

P value for comparing CHC total sample to GPO total sample

Table 3. Comorbid conditions and target organ damage by sex and site of health care

	CHCs (Public Sector)			GPs (Private Sector)			Total Sample			
	F *n*=172	M *n*=151	All *n*=323	F *n*=48	M *n*=32	All *n*=80	F *n*=220	M *n*=183	All *N*=403	*P*
Comorbid conditions (self-reported)										
Heart attack or angina, %	8	8	8	10	13	11	8	9	9	.337
Diabetes, %	16	20	18	27	31	29	18	22	20	.026
Asthma, %	14	17	15	10	9	10	13	15	14	.381
Peripheral vascular disease, %	4	2	3	6	3	5	4	2	3	.329
Stroke, %	4	6	5	6	6	6	4	6	5	.575
Target organ damage										
LVH, per Minnesota Coding, %	30	45	37*	23	41	30*	28	44	35*	.037
Creatinine clearance (Cockroft-Gault), mean (SD)	125(43)	96(28)	111(40)	148(66)	113(38)	133(58)	130(50)	98(31)	115(45)	.002

* Significant within group (i.e., CHC group, GPO group, total sample) difference between females and males ($p<0.05$)
P value for comparing CHC total sample to GPO total sample

no differences among the private and public sector participants and men had higher scores than women in both sectors.

Table 3 presents the extent of the comorbid conditions and target organ damage in the study sample. Diabetes and asthma were the most common self-reported comorbid conditions. Diabetes was more prevalent among private compared to public sector patients. Asthma was the only self-reported comorbid condition with higher prevalence in the public sector participants.

The private sector participants had lower LVH prevalence and higher mean level of creatinine clearance than public sector participants. LVH was more common in men than women in both sectors.

The medication prescription patterns for HTN and five common chronic conditions are shown in Table 4. Diuretics were the most common and ACE- inhibitors the second most common class of anti-hypertension medication prescribed. Only one chronic disease agent was prescribed for about a quarter of participants, while four or more chronic disease agents were prescribed for 23% of public vs 9% of private sector patients. No participants received any cholesterol-lowering agent. Anti-diabetic and respiratory medications were used more in public sector participants while the opposite was true

Table 4. Medication prescription pattern for hypertension and five common chronic conditions (ATC Codes) (%)

Medication for:		CHCs (Public Sector) All *n*=322	GPs (Private Sector) All *n*=81	Total Sample All *N*=403	P
Hypertension	C02, C03, C07, C08, C09				
Diuretics (alone and in Combination)	C03A, C03B, C03C, C03D, C03E, C02AA52, C02AA53, C09BA, C07B, C07C, C07D	93	81	91	.0007
Antiadrenergic agents, centrally acting	C02A	30	15	28	.0075
Reserpine-containing agents	C02AA02, C02AA52	29	15	26	.0086
Methyldopa	C02AB01	1	1	1	.9956
Antiadrenergic agents – peripherally acting	C02C	1	0	1	.4770
Arteriolar smooth muscle agents	C02D	7	1	6	.0612
ACE inhibitors	C09	48	40	46	.1960
Beta-blocking agents	C07A, C07B, C07C, C07D	23	16	21	.1935
Calcium-channel blockers	C08	9	14	10	.2565
Diabetes	A10	7	5	6	.5351
Hyperlipidemia	C10A	0	0	0	.0
Asthma and chronic bronchitis	R03	5	0	4	.0346
Drugs for other atherosclerosis-related conditions	B01AC, C01DA, C01A, C01B	7	15	9	.0284
Aspirin	B01AC06	6	12	7	.0326
Chronic medication use					.125
Taking 1 chronic disease drug, %		24	32	26	
Taking 2–3 chronic disease drugs, %		53	59	54	
Taking ≥ 4 chronic disease drugs, %		23	9	20	

P value for comparing CHC total sample to GPO total samples for drug utilization patterns

Obesity, a contributing factor to HTN, was remarkably prevalent in both sectors, but significantly higher in private sector patients, reflecting the effects of urbanization with less healthy lifestyles.

for atherosclerosis-related medication and aspirin.

DISCUSSION

This is the first report of the CVD risk profile using the Framingham formula[15] for hypertensive Black South Africans receiving primary care. The low prevalence (7%) of high total CVD risk may be explained by the relatively low prevalence of tobacco smoking and elevated LDL-C, and high prevalence of protective HDL-C. Nonetheless, in this population the magnitude of CVD risk was determined primarily by high rates of uncontrolled diabetes and HTN, and the associated high rates of LVH. While the known major CVD risk factors have been shown to be associated with myocardial infarctions in the Black population of Southern Africa,[17] the new Framingham scores[15] were intended to provide a more precise estimation of absolute CVD risk. However, the validity of Framingham risk estimates in the black South African population remains to be determined.

Obesity, a contributing factor to HTN, was remarkably prevalent in both sectors, but significantly higher in private sector patients, reflecting the effects of urbanization with less healthy lifestyles. The average BMI among the patients in this study was significantly higher than in an earlier study in the South African urban Black population of the same age for both men (29% vs 23.6%, respectively) and women (36% vs 28.4%, respectively).[18] Interestingly, the higher BMI levels in the private sector patients in this study did not correlate with poor HTN control; the most obese group, private sector women, demonstrated the best HTN control rate. However, as only 54% of these women had controlled HTN, active lifestyle modification with weight loss likely would contribute significantly to improving levels of HTN control.

More than half the men in this study reported excessive alcohol intake as demonstrated by a CAGE score ≥ 2. Almost a fifth of women in the public sector had a CAGE score ≥ 2 compared to none of the private sector women. Thus excessive alcohol intake is a risk factor among men in both sectors and women in the public sector.

The prevalence of diabetes among the hypertensive patients in this study (20%) was much higher than was found by Levitt et al among urban Black Africans in Cape Town (8%).[19] The significantly higher prevalence of diabetes in the private compared to the public sector participants may be due to the higher rates of obesity in the private sector as well as lower rates of diagnosed diabetes in the public sector.

The private sector patients had significantly greater HTN control than the public sector patients, despite having higher rates of obesity and diabetes. The better HTN control rates may be partially explained by the private sector patients exercising more, drinking less alcohol, and having lower level of social and economic challenges (i.e., unemployment, lack of education, housing conditions) than public sector patients. The higher rate of HTN control in the private sector was reflected in the lower prevalence of LVH and higher creatinine clearance rates than was seen in the public sector patients. These findings emphasize the physiological consequences of the poorer HTN care available in the public sector compared to the private GP practices in the same peri-urban townships of Cape Town. Additional barriers to HTN care were examined in the companion paper.[6]

The suboptimal level of HTN control in both public and private sector patients participating in care suggests that health care providers' inertia in treating HTN to goal levels may be contributing to the low rates of HTN control in these communities as it is in many settings globally despite far greater resources.[20] Nevertheless, it is encouraging that 92% of patients were prescribed diuretics alone, or in combination with other antihypertensive agents, per treatment recommendations. In 2003–2004, the time of this survey, no generic forms of ACEIs, the next most common agent, were available. Therefore their costs to patients and healthcare funders were high, yet they were the second most commonly prescribed class. Reserpine, an inexpensive antihypertensive drug, was used twice as often in the public compared to private sector. Almost 75% of the public sector patients were prescribed two or three drugs, which were provided at no cost to the patient, yet their BP control rate was lower compared to patients in the private sector who were more likely to be taking only one or two drugs. Given the greater BP control in the private sector, this pattern could suggest greater compliance with simpler drug regimens and/or that there may be greater prescription writing in the public sector due to uncontrolled BP levels.

Theoretically, Black South African patients have the choice of seeking health care from either the private or public sector. However, in reality, due to the unaffordable high cost of private health care and medication, with minimal medical insurance availability through their workplace, the majority of Black patients in the general population seek treatment in the public sector regardless of their preference.

The serendipitous finding of no mechanism to easily identify patients

with HTN in the private or public sectors for this study provides important implications for strategies to improve the quality of health care and health outcomes in South Africa. Such strategies (eg, electronic medical record, data monitoring systems) are relevant for many primary care facilities worldwide.

The limitations of this study include the inability to obtain a random sample of all hypertensive patients, which may make the presented data less generalizable to all hypertensive patients in the townships. Although this study is cross-sectional, it is assumed that the association found between poor HTN control and greater target organ damage in the public sector is causal. Forward and back translation into and from Xhosa and state-of-the art validation methods for cultural relevance and validity were employed to maximize the validity of self-report.[21]

CONCLUSION

Diagnosis and management of CVD risk factors and comorbid conditions among Black South Africans must be addressed urgently in both public and private settings before the burden placed by CVD on patients and the health system escalates to unmanageable proportions. Coordinated approaches that focus not only on educating and empowering patients to take control of their lifestyle and improve their CVD risk profile but also to transform public and private systems of health care are needed.

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