Disparities in Management of Cardiovascular Disease in Rural South Africa

Data From the HAALSI Study (Health and Aging in Africa: Longitudinal Studies of International Network for the Demographic Evaluation of Populations and Their Health Communities)

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Background—Optimal secondary prevention is critical for the reduction of repeated cardiovascular events, and the control of cardiovascular risk factors in this context is essential. Data on secondary prevention of cardiovascular disease (CVD) in sub-Saharan Africa are needed to inform intervention strategies with a particular focus on local disparities. The aim of this study was to assess CVD management in a rural community in northeast South Africa.

Methods and Results—We recruited adults aged ≥40 years residing in the Agincourt subdistrict of Mpumalanga province. Data collection included socioeconomic and clinical data, anthropometric measures, blood pressure, human immunodeficiency virus status, and point-of-care glucose and lipid levels. CVD was defined as self-report of myocardial infarction and stroke or angina diagnosed by Rose Criteria. A linear regression model was built to identify variables independently associated with the number of cardiovascular risk factors controlled. Of 5059 subjects, 592 (11.7%) met CVD diagnostic criteria. Angina was reported in 77.0% of these subjects, stroke in 25.2%, and myocardial infarction in 3.7%. Percent controlled of the 5 individual risk factors assessed were as follows: tobacco 92.9%; blood pressure 51.2%; body mass index 33.8%; low-density lipoprotein 31.4%; and waist-to-hip ratio 29.7%. Only 4.4% had all 5 risk factors controlled and 42.4% had ≥3 risk factors controlled. Male sex (β coefficient=0.44; 95% confidence interval, 0.25–0.63; $P<0.001$), absence of physical disability (β coefficient=0.40; 95% confidence interval, 0.16–0.65; $P=0.001$), and socioeconomic status (β coefficient=0.10; 95% confidence interval, 0.01–0.19; $P=0.035$) were directly associated with the number of risk factors controlled.

Conclusions—Currently, CVD is not being optimally managed in this rural area of South Africa. There are significant disparities in control of CVD risk factors by sex, socioeconomic status, and level of disability. Efforts to improve secondary prevention in this population should be focused on females, subjects from lower socioeconomic status, and those with physical disabilities. **(*Circ Cardiovasc Qual Outcomes*. 2017;10:e004094. DOI: 10.1161/CIRCOUTCOMES.117.004094.)**

Key Words: aging ■ body mass index ■ cardiovascular diseases ■ secondary prevention ■ South Africa

Traditionally, sub-Saharan Africa (SSA) has been affected predominantly by maternal and perinatal disease, infectious communicable conditions, and nutritional deficiencies. However, during recent years, the burden of noncommunicable diseases, such as cardiovascular disease (CVD), has been added to the challenges that health systems from this region face.[1] In 1990, CVD and other major chronic diseases accounted for ≈28% of morbidity and 35% of mortality in SSA, but by 2020, it is projected that these will rise to 60% and 65%, respectively.[2]

Although CVD is not yet the leading cause of death in SSA, age-specific CVD mortality and morbidity are already higher in some parts of the region than in many developed countries.[3] Therefore, promotion of cardiovascular health and CVD prevention in an effort to mitigate the observed adverse trends in CVD is an immediate necessity.[4]

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WHAT IS KNOWN

- The burden of noncommunicable diseases, such as cardiovascular disease, has become an increasing challenge for health systems in sub-Saharan Africa.
- For cardiovascular disease in this region, optimal secondary prevention is critical for the reduction of repeated cardiovascular events and the control of cardiovascular risk factors.
- To date, few studies have focused on the management of established cardiovascular disease in sub-Saharan Africa.

WHAT THE STUDY ADDS

- Despite the growing prevalence of cardiovascular disease in sub-Saharan Africa, we found that secondary prevention is currently suboptimal, especially for the outcome of control of all cardiovascular risk factors.
- Fewer than 5% of our study population had all 5 cardiovascular risk factors under control, and the majority of the group had ≤2 risk factors controlled.
- In addition, there were differences in the rates of optimal risk factor management by sex, socioeconomic status, and physical disability, suggesting potential disparities in care.

It is well established that optimal secondary prevention is critical for the reduction of repeated cardiovascular events, and the control of cardiovascular risk factors in this context is essential.[5] Many studies have assessed the prevalence of cardiovascular risk factors[6–11] and primary prevention strategies,[1,12] but few have focused on the management of established CVD in the sub-Saharan region.

The lack of information about management of patients with established CVD in SSA prompted us to investigate this topic in an appropriate population: the HAALSI (Health and Aging in Africa: Longitudinal Studies of International Network for the Demographic Evaluation of Populations and Their Health Communities) cohort. One of the main purposes of this cohort is to understand the reasons for changes in the prevalence, incidence, and risk factors for cardiometabolic disease in rural South Africa. To fulfill that purpose, a cohort of 5059 men and women ≥40 years of age was recruited in the Agincourt Health and Demographic Surveillance System (HDSS) site in rural South Africa. The intention of this analysis is to determine CVD prevalence and its management in a rural community in northeast South Africa, focusing on identifying disparities within this population.

Methods

The HAALSI study is based in the Agincourt HDSS site, a subdistrict of the rural Mpumalanga province, South Africa, comprising some 115 000 people living in 21 000 households and 31 villages in an area of ≈450 km.^{2} An annual census update, conducted by experienced local field staff, provides up-to-date denominator data on the full population with systematic recording of all vital events (deaths, births, in-/out-migrations).

Eligibility

All adults aged ≥40 years as of July 1, 2014, who had permanently resided in the Agincourt subdistrict for at least 1 year before the 2013 census update were eligible.

Sampling and Sample Size

Participants were selected from an existing framework of the Agincourt HDSS site in Mpumalanga province. Using the full 2013 census data, a sampling frame of adults aged ≥40 years (8974 women and 3901 men) who met the residency criteria were identified. A target sample size, assuming an 80% response rate, was ≈5000 completed interviews. We selected a total of 6281 women and men for the main household study. Among these, 391 had moved outside of the study site or were deceased. Of the remaining 5890 eligible individuals, 5059 (85.9%) participated in the baseline survey.[13]

Ethics Approval

The study received ethical approvals from the Ethics Committees of 3 institutions directly involved in the project (University of the Witwatersrand Human Research Ethics Committee [ref M141159], the Harvard T.H. Chan School of Public Health, Office of Human Research Administration [ref C13-1608-02], and the Mpumalanga Provincial Research and Ethics Committee [approved on 22 October, 2014]).

Recruitment and Follow-Up

Before the survey, the HAALSI study was introduced to community members across the study villages and discussed with a representative Community Advisory Group. This facilitated community review of study objectives and contributed to the effective response achieved.

Between November 2014 and November 2015, all identified individuals were visited at home by a supervised local field worker who briefly described the study in the local language (Shangaan) and requested permission to read and explain the relevant informed consent forms. Those who agreed to participate signed a consent form or, if not able to sign their name, were asked to have a literate witness sign and date the informed consent on their behalf. Field workers also signed and dated the informed consent form.

Study Procedures

Interviews lasting 2 to 3 hours were conducted in participants' homes. The visit included a questionnaire in 2 parts: household and socioeconomic data then individual interview data; followed by anthropometric, physical, and cognitive functioning assessments plus blood sample collection in the form of capillary blood sample and dried blood spots. Data were captured on laptop computers using a Computer-Assisted Personal Interview program.

Data collected included blood pressure (Omron M6W automated cuff; Omron, Kyoto, Japan), weight (Genesis Growth Management Electronic Scale; Johannesburg, South Africa), height using a sensor with infrared measurement, and waist and hip circumferences with a flexible tape measure (SECA, Hamburg, Germany). Blood drops were used to measure glucose (Caresense N Monitor, Seoul, Korea) and individual lipid levels (Cardiocheck PA Silver version; Indianapolis, IN) in point-of-care machines. The dried blood spots were collected via finger prick on Whatman 903 paper (Whatman, Buckinghamshire, UK) and used to measure human immunodeficiency virus (HIV) status and high-sensitivity C-reactive protein. Three blood pressure readings (systolic and diastolic) were obtained with 2 minutes between each reading, and the mean blood pressure was calculated using the average between the second and third reading.[14]

Definition of Cardiovascular Disease

Cardiovascular disease was defined by self-report of stroke and myocardial infarction or a diagnosis of angina by Rose criteria (World Health Organization Rose questionnaire is widely used in epidemiological studies and is a validated and standardized method for defining angina pectoris).[15]

Control of Cardiovascular Risk Factors

Smoking status was defined by self-report of current smoking status, and the nonsmokers were considered as having this risk factor controlled. Low-density lipoprotein cholesterol was considered controlled with a value <1.8 mmol/L according to the South African Dyslipidaemia Guidelines.[16] Body mass index in kg/m^2 was categorized using World Health Organization cutoffs,[17] and values lower than 25 kg/m^2 were considered controlled. Waist-to-hip ratios were considered controlled if ≤0.90 for men and ≤0.85 for women.[18] Hypertension was considered controlled if systolic blood pressure <140 mm Hg and diastolic blood pressure <90 mm Hg.[19]

Other Covariates

Treatment of stroke, angina, and myocardial infarction was assessed by self-report. Clinical determination of HIV status was made by first using the Vironostika Uniform 11 (Biomeriuex, France) screening assay. Negative results were assigned an HIV-negative status while positive results trigged a second (confirmatory) test using the Roche Elecys (Indianapolis, IN) assay to determine the viral load. If both screening and confirmatory tests were positive, a final status of HIV positive was assigned. If the screening and confirmatory tests yielded opposing results, a third assay was run on the Siemens Centaur XP (Erlangen, Germany) immunoassay. This third test served as the tie-breaker to determine a final HIV-positive or -negative status, in accordance with World Health Organization guidelines.[20,21] HIV-positive status was defined as a self-report of being informed of the condition by a health professional or a positive result from blood analysis. Physical disability (PD) was assessed by self-reported presence or absence of limitations in activities of daily living (excluding difficulty in dressing as an activities of daily living).[22] Socioeconomic status (SES) was measured using the wealth asset index that is a quintile ranking of scores constructed following the Demographic Health Surveys methodology to create a composite indicator of living standards using data on household ownership of assets. This index includes information on durables, such as televisions and refrigerators, as well as housing conditions.[23,24] Immigrants were defined as the subjects who were born outside South Africa. Illiteracy was assessed separately from education; respondents were asked whether they could read or write.

Analyses

All analyses were conducted using STATA V14 software (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX). Continuous variables were compared using *t* test (expressed in mean values and SDs because they were normally distributed) and categorical variables using χ^2 test (expressed in absolute numbers and percentiles). The distribution of modifiable risk factors under control was assessed by HIV and immigration status because these 2 conditions were highly prevalent in this cohort, have been shown to impact on noncommunicable diseases management in the region, and yet need to be better studied.[25] A linear regression model was built to identify factors associated with the number of cardiovascular risk factors controlled. The predictors included in this model were sex, PD, age, SES, HIV status, immigrant status, and illiteracy. These variables were included because they were previously reported as possible factors interfering with health management in this setting.[25–29] The results are presented using β coefficients and 95% confidence intervals; level of significance was set as 5%.

Missing Data

Several categories had varying levels of missing data. No imputation was performed for missing height (5%), weight (7%), waist circumference (6%), glucose (9%), total cholesterol (16%), high-density lipoprotein cholesterol (16%), triglycerides (16%), and high-sensitivity C-reactive protein (15%). Descriptive statistics in Table 1 reflect the results for all people who had values for the respective variable. For the wealth index, 231 individuals were missing data, and for these individuals, the mean value for their village was imputed for this variable. In the subset of individuals with CVD, the analysis excluded subjects with missing key variables: blood pressure (3%), body mass index (7%), waist-to-hip ratio (7%), and low-density lipoprotein cholesterol (16%).

Table 1. Overall and CVD Population Characteristics, Agincourt Subdistrict, South Africa, 2015 (n=5059*)

	Overall	Non-CVD	CVD	*P* Value†
n	5059	4467	592	
Male sex	2345 (46.4%)	2121 (47.5%)	224 (37.8%)	<0.001
Age, y	61.74 (±13.06)	61.34 (±13.07)	64.71 (±12.63)	<0.001
Weight, kg	71.87 (±17.64)	71.80 (±17.65)	72.43 (±17.57)	0.430
Height, m	1.63 (±0.09)	1.63 (±0.09)	1.61 (±0.09)	<0.001
Body mass index, kg/m^2	27.25 (±6.88)	27.16 (±6.88)	27.98 (±6.90)	0.009
Waist circumference, cm	92.39 (±15.08)	92.18 (±14.89)	93.95 (±16.52)	0.009
Waist-to-hip ratio	0.91 (±0.08)	0.91 (±0.08)	0.91 (±0.09)	0.070
Average SBP, mm Hg	137.99 (±23.34)	137.88 (±23.23)	138.79 (±24.13)	0.380
Average DBP, mm Hg	82.14 (±12.71)	82.15 (±12.69)	82.04 (±12.84)	0.840
Glucose, mmol/L	6.67 (±3.16)	6.65 (±3.15)	6.81 (±3.23)	0.270
Total cholesterol, mmol/L	4.24 (±1.26)	4.22 (±1.26)	4.38 (±1.25)	0.006
High-density lipoprotein, mmol/L	1.57 (±0.55)	1.57 (±0.53)	1.58 (±0.63)	0.830
Triglycerides, mmol/L	1.76 (±1.57)	1.77 (±1.64)	1.67 (±0.84)	0.170
Low-density lipoprotein, mmol/L	2.12 (±1.50)	2.11 (±1.56)	2.19 (±1.03)	0.240
hs C-reactive protein, mg/L	3.26 (±3.03)	3.24 (±3.02)	3.42 (±3.10)	0.210
Current smokers	460 (9.1%)	418 (9.4%)	42 (7.1%)	0.072
HIV positive	1134 (22.5%)	1028 (23.1%)	106 (18.0%)	0.005
Illiterate	2108 (41.7%)	1831 (41.0%)	277 (46.8%)	0.007

Statistically significant at α=0.05; Data given as mean±SD or n (%). CVD indicates cardiovascular disease (self-report of stroke/myocardial infarction or angina by Rose criteria); DBP, diastolic blood pressure; HIV, human immunodeficiency virus; hs, high-sensitivity; and SBP, systolic blood pressure.

*Not shown, missing: height (5%), weight (7%), body mass index (7%), waist circumference (6%), waist-to-hip ratio (7%), blood pressure (3%), glucose (9%), total cholesterol (16%), high-density lipoprotein cholesterol (16%), triglycerides (16%), low-density lipoprotein cholesterol (16%), and C-reactive protein (15%).

†*P* value for comparison between non-CVD and CVD individuals.

Results

Of the 5890 eligible people, 85.9% (5059) agreed to be interviewed, 7.3% refused to participate, 6.0% could not be located, and 0.8% were unable to participate. The number of subjects

living with self-reported CVD was 592, which was 11.7% of the overall population. In this subset of CVD patients, angina was reported in 77.0% of the subjects, stroke in 25.2%, and myocardial infarction in 3.7%. The population of patients with CVD was more likely to be female, older, with higher body mass index, larger waist circumference, higher total cholesterol, and less likely to be smokers when compared with the non-CVD population. The overall population characteristics, as well as results of those with CVD compared with the non-CVD population, are summarized in Table 1.

Among the subjects with angina, 6.1% (28 of 456) were receiving treatment. In the group with stroke, 65.8% (98 of 149) were being treated and in the subset with previous myocardial infarction 86.4% (19 of 22) reported treatment of their disease. Collectively, 24% (142 of 592) of those with CVD were being treated.

To understand the impact of HIV on CVD in the community, we compared the proportion of individuals with angina, myocardial infarction, and stroke based on their HIV status. We found that 18.6% (85 of 456) of those who were HIV positive had angina compared with 22.9% (1048 of 4576) among those who were HIV negative, and this difference was statistically significant (P=0.036). The prevalence of stroke and myocardial infarction for HIV-positive people was 16.3% (24 of 147) and 9.1% (2 of 22), respectively, compared with 22.7% (1110 of 4894) and 22.5% (1132 of 5020) for HIV-negative people. These differences were not statistically significant (stroke: P=0.068; myocardial infarction: P=0.132).

The percentage of those with CVD who attained control for each of 5 modifiable risk factors was assessed, and the results are presented in Table 2. Higher proportions of control were attained for smoking, with 92.9% of the patients with history of CVD reported to be nonsmokers. Lower levels of control were attained for adiposity, as indicated by 29.7% of patients with waist-to-hip ratio below the cutoff values (0.90 for males and 0.85 for women). When these rates of modifiable risk factors were compared according to HIV and immigration status, higher numbers of patients with controlled blood pressure were found in the HIV-positive patients, and fewer smokers were observed in the immigrant population (Table 2).

Figure 1 shows the cumulative number of risk factors under control in this secondary prevention population. More than 57% of the patients with CVD had only ≤2 risk factors controlled and <5% had all 5 risk factors under control. When the number of risk factors controlled was assessed by sex, 55.8% of the male subjects had ≥3 risk factors controlled compared with 34.2% of the females (P<0.001). In contrast, 28.3% of the females had only 1 risk factor controlled compared with 13.0% of the males (P<0.001).

An additional analysis was conducted to address the individual impact of each of the 5 risk factors on angina, myocardial infarction, and stroke. The only statistically significant difference we found was a higher percentage of waist-to-hip ratio in the ideal range among those with angina when compared with those with stroke (31.4% versus 22.8%; P=0.045). All other comparisons for the remaining risk factors were not statistically significantly different (Figure 2).

A multivariable linear regression model was developed to identify factors independently associated with the number of cardiovascular risk factors controlled, as shown in Table 3. Better management of CVD in this context was associated with male sex, absence of PD, and higher SES.

Discussion

Many different aspects of CVD have been studied in SSA, particularly the prevalence of cardiovascular risk factors and primary prevention strategies.[1,6,7,9–12,30] However, to our knowledge, no publications have assessed the management of patients with established CVD focusing on individuals' disparities related to cardiovascular risk factors control. Even though CVD prevalence is increasing in SSA, our results suggest that the secondary prevention of the disease is currently not being optimally managed, especially considering the need to have all cardiovascular risk factors controlled. Less than 5% of our study population had all 5 risk factors that were assessed under control, and the majority of the group had ≤2 risk factors controlled. In addition to that, sex, SES, and PD were identified as associated with CVD management in this setting.

Table 2. Distribution of Modifiable Risk Factors Under Control Among the Subjects With CVD by HIV and Migration Status, Agincourt Subdistrict, South Africa, 2015

	Overall (%)	HIV Positive (%)	HIV Negative (%)	*P* Value	Immigrant (%)	Nonimmigrant (%)	*P* Value
Waist-to-hip ratio*	29.7	34.9	28.7	0.207	29.1	30.1	0.809
LDL cholesterol†	31.4	36.8	30.4	0.197	28.5	32.7	0.317
Body mass index‡	33.8	41.5	32.2	0.068	33.1	34.1	0.817
Blood pressure§	51.2	61.3	48.8	0.019‖	48.8	52.0	0.480
Not smoking	92.9	88.7	93.8	0.063	96.5	91.4	0.028‖

CVD indicates cardiovascular disease (self-report of Stroke/Myocardial Infarction or Angina by Rose criteria); HIV, human immunodeficiency virus; and LDL, low-density lipoprotein.

*Waist-to-hip ratio: ≤0.90 (men) or ≤0.85 (women).

†LDL cholesterol <1.8 mmol/L.

‡Body mass index <25 kg/m^2.

§Blood pressure <140×90 mm Hg.

‖Statistically significant at α=0.05.

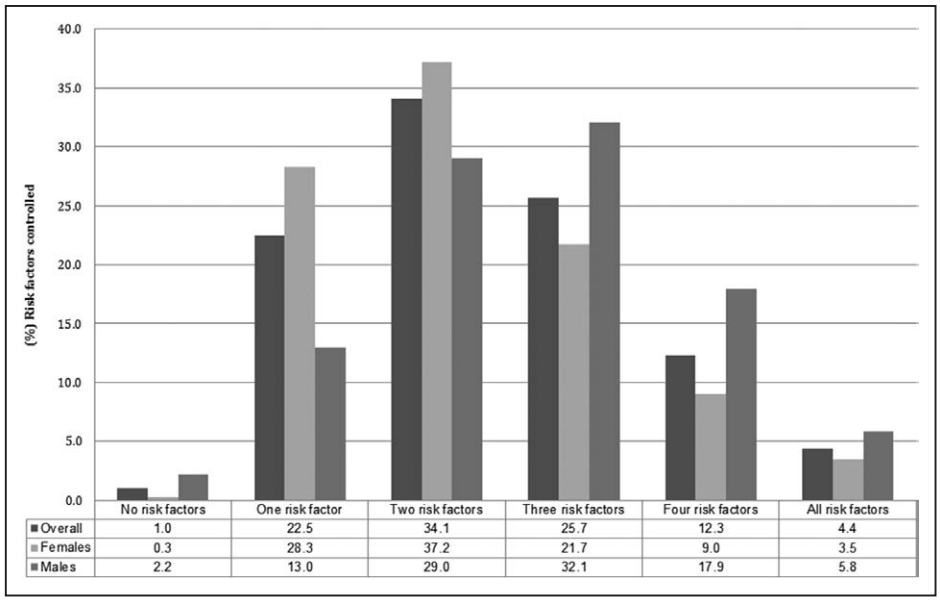

Figure 1. Number of risk factors controlled among subjects with CVD stratified by sex, Agincourt subdistrict, South Africa, 2015 (n=592). Risk factors include low-density lipoprotein cholesterol <1.8 mmol/L; blood pressure <140×90 mm Hg; not smoking; waist-to-hip ratio: ≤0.90 (men) or ≤0.85 (women); body mass index <25 kg/m^2. CVD indicates cardiovascular disease (self-report of stroke/myocardial infarction or angina by Rose criteria).

The prevalence of CVD in our population was 13% and is similar to the 10% for combined angina, stroke, and myocardial infarction reported in the adult US population from the 2010 American Heart Association estimates.[31] According to SANHANES, the South African National Health and Nutrition Examination Survey from 2013, the self-reported prevalence of heart disease (2.2%) and stroke (1.8%) was lower than was found in our cohort (10.7% and 3%, respectively).[32] However, it should be noted that in both the American Heart Association and SANHANES studies, the CVD prevalence was estimated for the adult population (>18 years) while for HAALSI, only subjects >40 years were included so we would anticipate higher prevalence rates in our older population.

The overall prevalence of self-reported angina in our study was 2.35%, similar to previous findings reported for the same Agincourt population (4.02%)[33] while the prevalence of angina as determined using the Rose criteria is 9.04%. It is likely that relying only on self-report underestimates the true prevalence of angina.

It is well established that HIV-infected individuals are at increased risk for CVD because of, among other factors, the high prevalence of cardiovascular risk factors in HIV-infected individuals.[34] Despite the fact that prevalence of HIV positivity

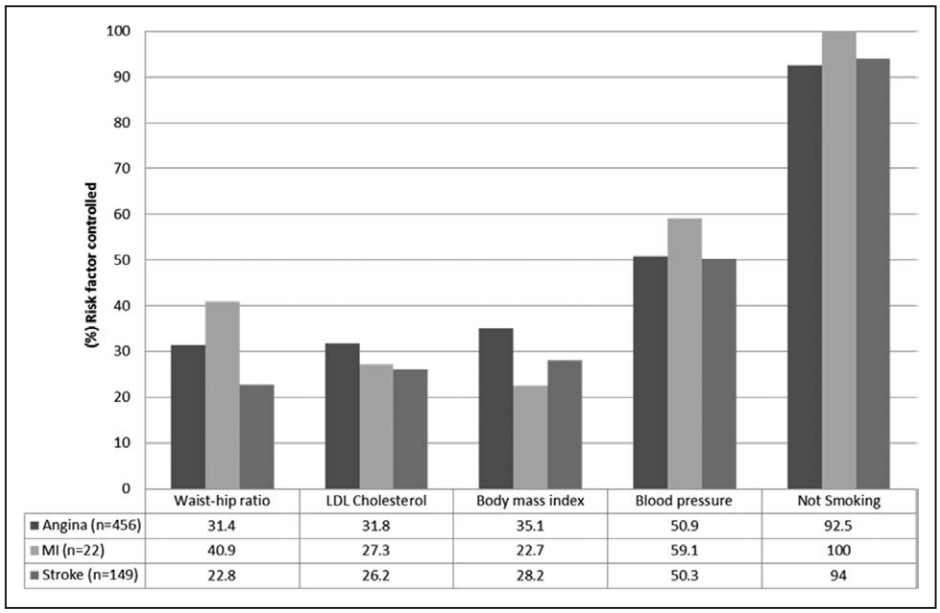

Figure 2. Cardiovascular risk factors controlled stratified by angina, myocardial infarction, and stroke, Agincourt subdistrict, South Africa, 2015. Risk factors include low-density lipoprotein (LDL) cholesterol <1.8 mmol/L; blood pressure <140×90 mm Hg; not smoking; waist-to-hip ratio: ≤0.90 (men) or ≤0.85 (women); body mass index <25 kg/m^2. MI indicates myocardial infarction.

Table 3. Linear Regression Coefficients for the Number of Risk Factors Controlled Among Subjects With CVD, Agincourt Subdistrict, South Africa, 2015

Variables	β-Coefficient	95% CI	*P* Value
Male sex	0.44	0.25 to 0.63	<0.001*
Absence of PD	0.40	0.16 to 0.65	0.001*
SES	0.10	0.01 to 0.19	0.035*
Age	0.00	−0.01 to 0.00	0.687
HIV positive	0.20	−0.04 to 0.44	0.106
Immigrant	−0.05	−0.26 to 0.15	0.582
Illiterate	−0.04	−0.24 to 0.16	0.675

CI indicates confidence interval; CVD, cardiovascular disease (self-report of stroke/myocardial infarction or angina by Rose criteria); HIV, human immunodeficiency virus; PD, physical disability—self-reported presence or absence of limitations in activities of daily living; and SES, socioeconomic status (measured using the wealth asset index).

*Statistically significant at α=0.05.

was higher in the non-CVD population (23.1%) when compared with the CVD population (18%) of our study, we stratified our analysis of angina, myocardial infarction, and stroke by HIV status. This approach addresses the important interaction between stroke and HIV.[35] Our results showed similar HIV infection numbers in individuals with and without myocardial infarction and stroke and an even lower percentage of HIV-infected subjects with angina (18.6%) when compared with those without angina (22.9%). These findings might be explained by previous findings from the same cohort that showed that HIV-positive patients are more likely to receive healthcare services for diabetes mellitus and hypertension,[36] which ultimately can lead to fewer cardiovascular events.

In the CLARIFY registry (Prospective Observational Longitudinal Registry of Patients with Stable Coronary Artery Disease)[37] that included 33 283 outpatients (77% male, mean age: 64 years) with proven stable coronary artery disease from 45 countries, 12% of patients smoked, 78% were overweight, 71% of patients had hypertension, and the control rates ranged from 47% to 66%. Dyslipidemia was reported in 75% of patients, and low-density lipoprotein cholesterol control was between 35% and 76%. The HAALSI cohort is notably different from this study that assessed patients with CVD in its lower smoking rate (7.1%). Because we only investigated currently smoking, this lower smoking rates in the CVD group may be attributable to smoking cessation after a cardiovascular event.[38]

Within the current study, only 4.4% of the population had all risk factors controlled, and the majority of the subjects (57.6%) had ≤2 risk factors under control. A similar analysis from the National Health and Nutrition Examination Survey showed that 10.6% of the US population (with no significant differences noted across subgroups defined by race–ethnicity) on secondary prevention had all risk factors controlled, as well as an increasing temporal trend in this result.[39] Considering that having all risk factors under control is the most effective action in secondary prevention of CVD,[5,40] we can conclude that the management of CVD in the region is far from optimal. Even more concerning is the poor level of CVD control found in women especially considering the greater effects of cardiovascular risk factors on women when compared with men.[41,42]

Because each risk factor assessed in this population has a different impact as a secondary prevention strategy on angina, myocardial infarction, and stroke,[43,44] we assessed the proportion of control for each the 5 risk factors individually. Once again, this stratification is of particular interest when dealing with stroke because it is already known that hypertension is the most dominant risk factor for cerebrovascular events,[43] and additionally a focus on blood pressure and excess weight control would yield best preventive results for stroke in this population.[44] Our results show that across all 3 CVD groups, blood pressure is better controlled than lipids, and this is consistent for what has been observed with stroke prevention in the Agincourt population.[44] However, still only 50% of stroke sufferers have controlled blood pressure and this need to be improved.

Using the HAALSI data, we developed a multivariable linear regression model to identify the factors associated with the number of CVD risk factors controlled. Included in this model were variables previously reported as possible factors interfering with health management in this setting,[25–29] including illiteracy, immigration status, PD, and SES. Male sex, absence of PD, and SES were positively associated with the number of risk factors controlled. Higher SES has been consistently associated with better risk factor control[45] in secondary prevention of CVD, and even within the HAALSI cohort, hypertension was better managed in those individuals from higher SES.[25] A possible explanation for the male sex and absence of PD results might be related to a better adherence to treatment in these 2 groups when compared with females and individuals with comorbidities.[46,47]

A potential limitation of this particular study is the fact that the subdistrict from which the cohort was recruited has been part of an HDSS since 1992. This may create a specific environment of improved healthcare surveillance that might increase the level of risk factor control among patients with CVD when compared with subjects with CVD living in other parts of South Africa, as we previously showed in a study addressing hypertension management.[25] The low control rates of CVD risk factors, observed in this particular area under surveillance, suggest that levels of risk factor's control may be even worse at sites not covered by a HDSS.

Another limitation is the absence of data about specific drugs/strategies for secondary prevention. Information about antiplatelet drugs, β-blockers, blockers of the renin–angiotensin system, and statins was not obtained, limiting these specific comparisons with other epidemiological studies.[48] However, we were able to make comparisons with another study for the number of individuals with established CVD not taking any appropriate medication. In this scenario, our results (24% not being treated) are better than the mean level observed in South Africa and other upper middle-income countries (Argentina, Brazil, Chile, Malaysia, Poland, and Turkey; 48.4%),[49] reinforcing the hypothesis of better healthcare associated with HDSS coverage.[25]

The strengths of this study include the investigation of variables, such as immigration and HIV status, which have not previously been assessed for their effects on CVD risk factor management. In these analyses, fewer immigrants with

CVD were found to be smokers when compared with non-immigrants. This suppression of smoking in the immigrant population was previously shown in the literature, although not in individuals with known CVD, and may reflect more general social sanctions against personal consumption among immigrants who have taken on the responsibility of leaving home to earn money and build savings for their households.[50] The better blood pressure control in HIV-positive subjects is aligned with the results of a recent meta-analysis that assessed the association between HIV and cardiometabolic diseases in SSA.[51] Their results suggested that HIV-positive patients have, on average, lower blood pressure than their HIV-negative counterparts. An additional strength is the fact that this study provides relevant information on disparities in CVD management, which ultimately can be used to develop more equitable health models in a setting with limited resources.

Mortality from CVD has increased globally, particularly in the developing world from 1990 to 2013. Overall mortality from these conditions in SSA is low (ischemic heart disease 4.7%, stroke 5.0%) but South Africa's are slightly higher (7.6% and 6.3%, respectively).[52,53] Our data show that one of the reasons for these high levels of mortality from cardiovascular events may be because of the poor control of CVD risk factors. This suggests that mortality may be decreased through improvement in treatment of these risk factors coupled with greater community education on the importance of lifestyle modification. Initiatives to achieve these goals, such as population-wide screening for hypertension and diabetes mellitus, engagement of community resources and governance structures, geographic decentralization of care services, and group medical visits alone or integrated into microfinance groups, have been previously proposed in SSA,[54] and some of these interventions are currently under investigation.[55]

In conclusion, this analysis of the HAALSI study demonstrates that CVD is currently not being optimally managed in this rural area of South Africa and that there are significant opportunities to improve secondary prevention in this population. A particular focus should be placed on females, subjects from lower SES, and those with PD.

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Disclosures

None.

References

1. Sampson UK, Amuyunzu-Nyamongo M, Mensah GA. Health promotion and cardiovascular disease prevention in sub-Saharan Africa. *Prog Cardiovasc Dis*. 2013;56:344–355. doi: 10.1016/j.pcad.2013.10.007.
2. Madu EC, Richardson KD, Ozigbo OH, Baugh DS. Improving cardiovascular disease prevention and management in Africa: issues to consider for the 21st century. *Ethn Dis*. 2003;13(2 suppl 2):S71–S76.
3. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, Amann M, Anderson HR, Andrews KG, Aryee M, Atkinson C, Bacchus LJ, Bahalim AN, Balakrishnan K, Balmes J, Barker-Collo S, Baxter A, Bell ML, Blore JD, Blyth F, Bonner C, Borges G, Bourne R, Boussinesq M, Brauer M, Brooks P, Bruce NG, Brunekreef B, Bryan-Hancock C, Bucello C, Buchbinder R, Bull F, Burnett RT, Byers TE, Calabria B, Carapetis J, Carnahan E, Chafe Z, Charlson F, Chen H, Chen JS, Cheng AT, Child JC, Cohen A, Colson KE, Cowie BC, Darby S, Darling S, Davis A, Degenhardt L, Dentener F, Des Jarlais DC, Devries K, Dherani M, Ding EL, Dorsey ER, Driscoll T, Edmond K, Ali SE, Engell RE, Erwin PJ, Fahimi S, Falder G, Farzadfar F, Ferrari A, Finucane MM, Flaxman S, Fowkes FG, Freedman G, Freeman MK, Gakidou E, Ghosh S, Giovannucci E, Gmel G, Graham K, Grainger R, Grant B, Gunnell D, Gutierrez HR, Hall W, Hoek HW, Hogan A, Hosgood HD 3rd, Hoy D, Hu H, Hubbell BJ, Hutchings SJ, Ibeanusi SE, Jacklyn GL, Jasrasaria R, Jonas JB, Kan H, Kanis JA, Kassebaum N, Kawakami N, Khang YH, Khatibzadeh S, Khoo JP, Kok C, Laden F, Lalloo R, Lan Q, Lathlean T, Leasher JL, Leigh J, Li Y, Lin JK, Lipshultz SE, London S, Lozano R, Lu Y, Mak J, Malekzadeh R, Mallinger L, Marcenes W, March L, Marks R, Martin R, McGale P, McGrath J, Mehta S, Mensah GA, Merriman TR, Micha R, Michaud C, Mishra V, Mohd Hanafiah K, Mokdad AA, Morawska L, Mozaffarian D, Murphy T, Naghavi M, Neal B, Nelson PK, Nolla JM, Norman R, Olives C, Omer SB, Orchard J, Osborne R, Ostro B, Page A, Pandey KD, Parry CD, Passmore E, Patra J, Pearce N, Pelizzari PM, Petzold M, Phillips MR, Pope D, Pope CA 3rd, Powles J, Rao M, Razavi H, Rehfuess EA, Rehm JT, Ritz B, Rivara FP, Roberts T, Robinson C, Rodriguez-Portales JA, Romieu I, Room R, Rosenfeld LC, Roy A, Rushton L, Salomon JA, Sampson U, Sanchez-Riera L, Sanman E, Sapkota A, Seedat S, Shi P, Shield K, Shivakoti R, Singh GM, Sleet DA, Smith E, Smith KR, Stapelberg NJ, Steenland K, Stöckl H, Stovner LJ, Straif K, Straney L, Thurston GD, Tran JH, Van Dingenen R, van Donkelaar A, Veerman JL, Vijayakumar L, Weintraub R, Weissman MM, White RA, Whiteford H, Wiersma ST, Wilkinson JD, Williams HC, Williams W, Wilson N, Woolf AD, Yip P, Zielinski JM, Lopez AD, Murray CJ, Ezzati M, AlMazroa MA, Memish ZA. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380:2224–2260. doi: 10.1016/S0140-6736(12)61766-8.
4. Alwan A. *Global Status Report on Noncommunicable Diseases 2010*. Geneva, Switzerland: World Health Organization; 2011.
5. Smith SC, Benjamin EJ, Bonow RO, Braun LT, Creager MA, Franklin BA, Gibbons RJ, Grundy SM, Hiratzka LF, Jones DW, Lloyd-Jones DM, Minissian M, Mosca L, Peterson ED, Sacco RL, Spertus J, Stein JH, Taubert KA. AHA/ACCF secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update. *Circulation*. 2011;124:2458.
6. Kandala NB, Tigbe W, Manda SO, Stranges S. Geographic variation of hypertension in sub-Saharan Africa: a case study of South Africa. *Am J Hypertens*. 2013;26:382–391. doi: 10.1093/ajh/hps063.

7. Oladapo OO, Salako L, Sodiq O, Shoyinka K, Adedapo K, Falase AO. A prevalence of cardiometabolic risk factors among a rural Yoruba south-western Nigerian population: a population-based survey. *Cardiovasc J Afr*. 2010;21:26–31.
8. Ngoungou EB, Aboyans V, Kouna P, Makandja R, Ecke Nzengue JE, Allogho CN, Laskar M, Preux PM, Lacroix P. Prevalence of cardiovascular disease in Gabon: a population study. *Arch Cardiovasc Dis*. 2012;105:77–83. doi: 10.1016/j.acvd.2011.12.005.
9. Solet JL, Baroux N, Pochet M, Benoit-Cattin T, De Montera AM, Sissoko D, Favier F, Fagot-Campagna A. Prevalence of type 2 diabetes and other cardiovascular risk factors in Mayotte in 2008: the MAYDIA study. *Diabetes Metab*. 2011;37:201–207. doi: 10.1016/j.diabet.2010.09.007.
10. Peltzer K, Phaswana-Mafuya N. Hypertension and associated factors in older adults in South Africa. *Cardiovasc J Afr*. 2013;24:67–71. doi: 10.5830/CVJA-2013-002.
11. Hall V, Thomsen RW, Henriksen O, Lohse N. Diabetes in Sub Saharan Africa 1999-2011: epidemiology and public health implications. A systematic review. *BMC Public Health*. 2011;11:564. doi: 10.1186/1471-2458-11-564.
12. Karwalajtys T, Kaczorowski J. An integrated approach to preventing cardiovascular disease: community-based approaches, health system initiatives, and public health policy. *Risk Manag Healthc Policy*. 2010;3:39–48. doi: 10.2147/RMHP.S7528.
13. Payne CF, Gómez-Olivé FX, Kahn K, Berkman L. Physical function in an aging population in rural South Africa: findings from HAALSI and cross-national comparisons with HRS sister studies. *J Gerontol B Psychol Sci Soc Sci*. 2017;72:665–679. doi: 10.1093/geronb/gbx030.
14. Centers for Disease Contro and Preventionl (CDC). National Health and Nutrition Examination Survey: 1999 - 2000 Data Documentation, Codebook, and Frequencies. 2002;2015.
15. Achterberg S, Soedamah-Muthu SS, Cramer MJ, Kappelle LJ, van der Graaf Y, Algra A; SMART Study Group. Prognostic value of the Rose questionnaire: a validation with future coronary events in the SMART study. *Eur J Prev Cardiol*. 2012;19:5–14. doi: 10.1177/1741826710391117.
16. Klug EQ, Raal F, Marais A, Taskinen M, Dalby A, Schamroth C, Rapeport N, Jankelow D, Blom D, Catsicas R. South African Dyslipidaemia Guideline Consensus Statement. A joint statement from the South African Heart Association (SA Heart) and the Lipid and Atherosclerosis Society of Southern Africa (LASSA): guidelines. *South African Family Practice*. 2015;57:22, 24–31.
17. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organization Technical Report Series*. Geneva, Switzerland: World Health Organization; 2000;894:i-xii, 1–253.
18. *Waist Circumference and Waist–Hip Ratio: Report of a WHO Expert Consultation, Geneva, 8–11 December 2008*. Geneva, Switzerland: World Health Organization, 2011.
19. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr, Roccella EJ; National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; National High Blood Pressure Education Program Coordinating Committee. The Seventh Report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. *JAMA*. 2003;289:2560–2572. doi: 10.1001/jama.289.19.2560.
20. *Consolidated Guidelines on HIV Testing Services: 5Cs: Consent, Confidentiality, Counselling, Correct Results and Connection*. Geneva, Switzerland: World Health Organization; 2015.
21. World Health Organization. *Consolidated Guidelines on HIV Prevention, Diagnosis, Treatment and Care For Key Populations*. Geneva, Switzerland: World Health Organization; 2014.
22. Sonnega A, Faul JD, Ofstedal MB, Langa KM, Phillips JW, Weir DR. Cohort profile: the Health and Retirement Study (HRS). *Int J Epidemiol*. 2014;43:576–585. doi: 10.1093/ije/dyu067.
23. Rutstein SO, Johnson K; MEASURE OM. *The DHS Wealth Index*: ORC Macro, MEASURE DHS; Rockville, MD: US Agency for International Development (USAID); 2004.
24. Rutstein SO. Steps to constructing the new DHS Wealth Index. (Wealth Index Construction). Available at: http://dhsprogram.com/programming/wealth%20index/Steps_to_constructing_the_new_DHS_Wealth_Index.pdf. Accessed on March 18, 2016. *The Demographic and Health Surveys (DHS) Program*. Rockville, MD: US Agency for International Development (USAID); 2014.
25. Jardim TV, Reiger S, Abrahams-Gessel S, Gomez-Olive FX, Wagner RG, Wade A, Bärnighausen TW, Salomon J, Tollman S, Gaziano TA. Hypertension management in a population of older adults in rural South Africa. *J Hypertens*. 2017;35:1283–1289. doi: 10.1097/HJH.0000000000001312.
26. Ginsburg C, Bocquier P, Béguy D, Afolabi S, Augusto O, Derra K, Herbst K, Lankoande B, Odhiambo F, Otiende M, Soura A, Wamukoya M, Zabré P, White MJ, Collinson MA. Healthy or unhealthy migrants? Identifying internal migration effects on mortality in Africa using health and demographic surveillance systems of the INDEPTH network. *Soc Sci Med*. 2016;164:59–73. doi: 10.1016/j.socscimed.2016.06.035.
27. Pillay-van Wyk V, Msemburi W, Laubscher R, Dorrington RE, Groenewald P, Glass T, Nojilana B, Joubert JD, Matzopoulos R, Prinsloo M, Nannan N, Gwebushe N, Vos T, Somdyala N, Sithole N, Neethling I, Nicol E, Rossouw A, Bradshaw D. Mortality trends and differentials in South Africa from 1997 to 2012: second National Burden of Disease Study. *Lancet Glob Health*. 2016;4:e642–e653.
28. Pisa PT, Behanan R, Vorster HH, Kruger A. Social drift of cardiovascular disease risk factors in Africans from the North West Province of South Africa: the PURE study. *Cardiovasc J Afr*. 2012;23:371–378, e379. doi: 10.5830/CVJA-2012-018.
29. Howitt SC, Jones MP, Jusabani A, Gray WK, Aris E, Mugusi F, Swai M, Walker RW. A cross-sectional study of quality of life in incident stroke survivors in rural northern Tanzania. *J Neurol*. 2011;258:1422–1430. doi: 10.1007/s00415-011-5948-6.
30. Shisana O, Labadarios D RT, Simbayi L, Zuma K, Dhansay A, Reddy P, Parker W HE, Naidoo P, Hongoro C, Mchiza Z, Steyn NP, Dwane N, Makoae M, Maluleke T, Ramlagan S, Zungu N, Evans MG, Jacobs L, Faber M; SANHANES-1 Team (2013). *The South African National Health and Nutrition Examination Survey (SANHANES-1)*. Cape Town, South Africa: HSRC Press.
31. Lloyd-Jones D, Adams RJ, Brown TM, Carnethon M, Dai S, De Simone G, Ferguson TB, Ford E, Furie K, Gillespie C, Go A, Greenlund K, Haase N, Hailpern S, Ho PM, Howard V, Kissela B, Kittner S, Lackland D, Lisabeth L, Marelli A, McDermott MM, Meigs J, Mozaffarian D, Mussolino M, Nichol G, Roger VL, Rosamond W, Sacco R, Sorlie P, Stafford R, Thom T, Wasserthiel-Smoller S, Wong ND, Wylie-Rosett J; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Executive summary: heart disease and stroke statistics–2010 update: a report from the American Heart Association. *Circulation*. 2010;121:948–954. doi: 10.1161/CIRCULATIONAHA.109.192666.
32. Shisana O LD, Rehle T, Simbayi L, Zuma K, Dhansay A, Reddy P, Parker W, Hoosain E, Naidoo P, Hongoro C, Mchiza Z, Steyn NP, Dwane N, Makoae M, Maluleke T, Ramlagan S, Zungu N, Evans MG, Jacobs L, Faber M; SANHANES-1 Team (2013). *South African National Health and Nutrition Examination Survey (SANHANES-1)*. 2013. Cape Town, South Africa: HSRC Press.
33. Gómez-Olivé FX, Thorogood M, Clark B, Kahn K, Tollman S. Self-reported health and health care use in an ageing population in the Agincourt sub-district of rural South Africa. *Glob Health Action*. 2013;6:19305.
34. Hemkens LG, Bucher HC. HIV infection and cardiovascular disease. *Eur Heart J*. 2014;35:1373–1381. doi: 10.1093/eurheartj/eht528. https://www.ncbi.nlm.nih.gov/pubmed/24408888. Accessed November 7, 2017.
35. Tipping B, de Villiers L, Wainwright H, Candy S, Bryer A. Stroke in patients with human immunodeficiency virus infection. *J Neurol Neurosurg Psychiatry*. 2007;78:1320–1324. doi: 10.1136/jnnp.2007.116103.
36. Manne-Goehler J, Montana L, Gómez-Olivé FX, Rohr J, Harling G, Wagner RG, Wade A, Kabudula CW, Geldsetzer P, Kahn K, Tollman S, Berkman LF, Bärnighausen TW, Gaziano TA. The ART advantage: health care utilization for diabetes and hypertension in rural South Africa. *J Acquir Immune Defic Syndr*. 2017;75:561–567. doi: 10.1097/QAI.0000000000001445.
37. Ferrari R, Ford I, Greenlaw N, Tardif JC, Tendera M, Abergel H, Fox K, Hu D, Shalnova S, Steg PG; CLARIFY Registry Investigators. Geographical variations in the prevalence and management of cardiovascular risk factors in outpatients with CAD: data from the contemporary CLARIFY registry. *Eur J Prev Cardiol*. 2015;22:1056–1065. doi: 10.1177/2047487314547652.
38. Snaterse M, Scholte Op Reimer WJ, Dobber J, Minneboo M, Ter Riet G, Jorstad HT, Boekholdt SM, Peters RJ. Smoking cessation after an acute coronary syndrome: immediate quitters are successful quitters. *Neth Heart J*. 2015;23:600–607. doi: 10.1007/s12471-015-0755-9.
39. Muntner P, DeSalvo KB, Wildman RP, Raggi P, He J, Whelton PK. Trends in the prevalence, awareness, treatment, and control of cardiovascular disease risk factors among noninstitutionalized patients with a history of myocardial infarction and stroke. *Am J Epidemiol*. 2006;163:913–920. doi: 10.1093/aje/kwj124.
40. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, Cooney M-T, Corrà U, Cosyns B, Deaton C, Graham I, Hall MS, Hobbs

FDR, Løchen M-L, Löllgen H, Marques-Vidal P, Perk J, Prescott E, Redon J, Richter DJ, Sattar N, Smulders Y, Tiberi M, van der Worp HB, van Dis I, Verschuren WMM. 2016 European Guidelines on cardiovascular disease prevention in clinical practice. *Eur Heart J*. 2016;37:2315–2381. doi: 10.1093/eurheartj/ehw106

41. Jousilahti P, Vartiainen E, Tuomilehto J, Puska P. Sex, age, cardiovascular risk factors, and coronary heart disease: a prospective follow-up study of 14 786 middle-aged men and women in Finland. *Circulation*. 1999;99:1165–1172.
42. Roeters van Lennep JE, Westerveld HT, Erkelens DW, van der Wall EE. Risk factors for coronary heart disease: implications of gender. *Cardiovasc Res*. 2002;53:538–549.
43. Kjeldsen SE, Narkiewicz K, Burnier M, Oparil S. The INTERSTROKE Study: hypertension is by far the most important modifiable risk factor for stroke. *Blood Press*. 2017;26:131–132. doi: 10.1080/08037051.2017.1292456.
44. Maredza M, Bertram MY, Gómez-Olivé XF, Tollman SM. Burden of stroke attributable to selected lifestyle risk factors in rural South Africa. *BMC Public Health*. 2016;16:143. doi: 10.1186/s12889-016-2805-7.
45. Phillips JE, Klein WM. Socioeconomic status and coronary heart disease risk: the role of social cognitive factors. *Soc Personal Psychol Compass*. 2010;4:704–727. doi: 10.1111/j.1751-9004.2010.00295.x.
46. Shah NS, Huffman MD, Ning H, Lloyd-Jones DM. Trends in myocardial infarction secondary prevention: the National Health and Nutrition Examination Surveys (NHANES), 1999–2012. *J Am Heart Assoc*. 2015;4:e001709. doi: 10.1161/JAHA.114.001709.
47. Desai NR, Choudhry NK. Impediments to adherence to post myocardial infarction medications. *Curr Cardiol Rep*. 2013;15:322. doi: 10.1007/s11886-012-0322-6.
48. Yusuf S, Rangarajan S, Teo K, Islam S, Li W, Liu L, Bo J, Lou Q, Lu F, Liu T, Yu L, Zhang S, Mony P, Swaminathan S, Mohan V, Gupta R, Kumar R, Vijayakumar K, Lear S, Anand S, Wielgosz A, Diaz R, Avezum A, Lopez-Jaramillo P, Lanas F, Yusoff K, Ismail N, Iqbal R, Rahman O, Rosengren A, Yusufali A, Kelishadi R, Kruger A, Puoane T, Szuba A, Chifamba J, Oguz A, McQueen M, McKee M, Dagenais G; PURE Investigators. Cardiovascular risk and events in 17 low-, middle-, and high-income countries. *N Engl J Med*. 2014;371:818–827. doi: 10.1056/NEJMoa1311890.
49. Yusuf S, Islam S, Chow CK, Rangarajan S, Dagenais G, Diaz R, Gupta R, Kelishadi R, Iqbal R, Avezum A, Kruger A, Kutty R, Lanas F, Lisheng L, Wei L, Lopez-Jaramillo P, Oguz A, Rahman O, Swidan H, Yusoff K, Zatonski W, Rosengren A, Teo KK; Prospective Urban Rural Epidemiology (PURE) Study Investigators. Use of secondary prevention drugs for cardiovascular disease in the community in high-income, middle-income, and low-income countries (the PURE Study): a prospective epidemiological survey. *Lancet*. 2011;378:1231–1243. doi: 10.1016/S0140-6736(11)61215-4.
50. Tong E, Saito N, Tancredi DJ, Borges G, Kravitz RL, Hinton L, Aguilar-Gaxiola S, Medina-Mora ME, Breslau J. A transnational study of migration and smoking behavior in the Mexican-origin population. *Am J Public Health*. 2012;102:2116–2122. doi: 10.2105/AJPH.2012.300739.
51. Dillon DG, Gurdasani D, Riha J, Ekoru K, Asiki G, Mayanja BN, Levitt NS, Crowther NJ, Nyirenda M, Njelekela M, Ramaiya K, Nyan O, Adewole OO, Anastos K, Azzoni L, Boom WH, Compostella C, Dave JA, Dawood H, Erikstrup C, Fourie CM, Friis H, Kruger A, Idoko JA, Longenecker CT, Mbondi S, Mukaya JE, Mutimura E, Ndhlovu CE, Praygod G, Pefura Yone EW, Pujades-Rodriguez M, Range N, Sani MU, Schutte AE, Sliwa K, Tien PC, Vorster EH, Walsh C, Zinyama R, Mashili F, Sobngwi E, Adebamowo C, Kamali A, Seeley J, Young EH, Smeeth L, Motala AA, Kaleebu P, Sandhu MS; African Partnership for Chronic Disease Research (APCDR). Association of HIV and ART with cardiometabolic traits in sub-Saharan Africa: a systematic review and meta-analysis. *Int J Epidemiol*. 2013;42:1754–1771. doi: 10.1093/ije/dyt198.
52. Shepard D, VanderZanden A, Moran A, Naghavi M, Murray C, Roth G. Ischemic heart disease worldwide, 1990 to 2013: estimates from the global burden of disease study 2013. *Circ Cardiovasc Qual Outcomes*. 2015;8:455–456. doi: 10.1161/CIRCOUTCOMES.115.002007.
53. GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2015;385:117–171.
54. Vedanthan R, Kamano JH, Bloomfield GS, Manji I, Pastakia S, Kimaiyo SN. Engaging the entire care cascade in Western Kenya: a model to achieve the cardiovascular disease secondary prevention roadmap goals. *Glob Heart*. 2015;10:313–317. doi: 10.1016/j.gheart.2015.09.003.
55. Vedanthan R, Kamano JH, Lee H, Andama B, Bloomfield GS, DeLong AK, Edelman D, Finkelstein EA, Hogan JW, Horowitz CR, Manyara S, Menya D, Naanyu V, Pastakia SD, Valente TW, Wanyonyi CC, Fuster V. Bridging income generation with group integrated care for cardiovascular risk reduction: rationale and design of the BIGPIC study. *Am Heart J*. 2017;188:175–185. doi: 10.1016/j.ahj.2017.03.012.

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Disparities in Management of Cardiovascular Disease in Rural South Africa: Data From the HAALSI Study (Health and Aging in Africa: Longitudinal Studies of International Network for the Demographic Evaluation of Populations and Their Health Communities)

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