Disparities in Management of Cardiovascular Disease in Rural South Africa: Data from the HAALSI (Health and Aging in Africa: Longitudinal Studies of INDEPTH Communities) Study

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Abstract

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 sub-district of Mpumalanga province. Data collection included socioeconomic and clinical data, anthropometric measures, blood pressure, HIV 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. Out of 5,059 subjects, 592 (11.7%) met CVD

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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 five individual risk factors assessed were as follows: tobacco 92.9%; blood pressure 51.2%; BMI 33.8%; LDL 31.4%; and waist-to-hip ratio 29.7%. Only 4.4% had all five risk factors controlled and 42.4% had three or more risk factors controlled. Male sex (β-coefficient=0.44; 95%CI 0.25–0.63; p<0.001), absence of physical disability (β-coefficient=0.40; 95%CI 0.16–0.65; p=0.001) and socioeconomic status (SES) (β-coefficient=0.10; 95%CI 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, SES, and level of disability. Efforts to improve secondary prevention in this population should be focused on females, subjects from lower SES, and those with physical disabilities.

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 non-communicable diseases (NCDs) 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 approximately 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].

While 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].

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 regarding management of patients with established CVD in sub-Saharan Africa prompted us to investigate this topic in an appropriate population: the 'Health and Aging in Africa: Longitudinal Studies of INDEPTH Communities (HAALSI)' 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 Health and Demographics Surveillance System (HDSS) site, a sub-district of the rural Mpumalanga province, South Africa, comprising some 115 000 people living in 21 000 households and 31 villages in an area of ~450km^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 and older as of July 1, 2014 who had permanently resided in the Agincourt sub-district for at least one year prior to 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 and older (8,974 women and 3,901 men) who met the residency criteria were identified. A target sample size, assuming an 80% response rate, was approximately 5,000 completed interviews. We selected a total of 6,281 women and men for the main household study. Among these, 391 had moved outside of the study site or were deceased. Out of the remaining 5,890 eligible individuals, 5,059 (85.9%) participated in the baseline survey[13].

Ethics Approval

The study received ethical approvals from the Ethics Committees of three 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 22nd October 2014).

Recruitment and Follow Up

Prior to 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 2–3 hours were conducted in participants' homes. The visit included a questionnaire in two 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" (DBS). Data were captured on laptop computers using a Computer Assisted Personal Interview (CAPI) 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; 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, Indiana, USA) in point-of-care machines. The DBSs were collected via finger prick on Whatman 903 ™ paper (Whatman, Buckinghamshire, UK) and used to measure HIV-status and high sensitivity C-reactive protein (hsCRP). Three blood pressure readings (systolic and diastolic) were obtained with two 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 non-smokers were considered as having this risk factor controlled. LDL cholesterol was considered controlled with a value < 1.8mmol/L according to the South African Dyslipidaemia Guidelines[16]. Body mass index (BMI) in kg/m^2 was categorized using World Health Organization cutoffs[17] and values lower than 25 k/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 mmHg and diastolic blood pressure < 90 mmHg[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 a HIV-negative status, while positive results triggered a second (confirmatory) test using the Roche Elecys (Indianapolis, Indiana, USA) 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 (WHO) 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 (ADL) (excluding difficulty in dressing as an ADL)[22]. Socioeconomic status (SES) was measured using the wealth asset index which is a quintile ranking of scores constructed following the Demographic Health Surveys (DHS) 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, US). Continuous variables were compared using T test (expressed in mean values and standard deviations, since they were normally distributed) and categorical variables using Chi Square test (expressed in absolute numbers and percentiles). The distribution of modifiable risk factors under control was assessed by HIV and immigration status, since these two conditions were highly prevalent in this cohort, have been shown to impact on NCD 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%), HDL-cholesterol (16%), triglycerides (16%), and hs C-Reactive Protein (15%). Descriptive statistics in Table 1 reflect the results for all persons 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 LDL-cholesterol (16%).

Results

Out of the 5,890 eligible persons, 85.9% (5,059) 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 BMI, larger waist circumference and higher total cholesterol and less likely to be smokers when compared to the non-CVD population. The

overall population characteristics, as well as results of those with CVD compared to the non-CVD population are summarized in table 1.

Among the subjects with angina 6.1% (28/456) were receiving treatment. In the group with stroke 65.8% (98/149) were being treated and in the subset with previous myocardial infarction 86.4% (19/22) reported treatment of their disease. Collectively, 24% (142/592) 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% (85/456) of those who were HIV-positive had angina compared to 22.9% (1,048/4,576) 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 persons was 16.3% (24/147) and 9.1% (2/22), respectively, compared to 22.7% (1,110/4,894) and 22.5% (1,132/5,020) for HIV-negative persons. 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 five 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 non-smokers. Lower levels of control were attained for adiposity, as indicated by 29.7% of patients with waist-hip ratio below the cut-off 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 BP were found in the HIV positive patients and fewer smokers were observed in the immigrant population (see 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 two or fewer risk factors controlled and less than 5% had all five risk factors under control. When the number of risk factors controlled was assessed by sex 55.8% of the male subjects had three or more risk factors controlled compared to 34.2% of the females (p<0.001). In contrast, 28.3% of the females had only 1 risk factor controlled compared to 13.0% of the males (p<0.001).

An additional analysis was conducted to address the individual impact of each of the five 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 to those with stroke (31.4% versus 22.8%; p=0.045). All other comparisons for the remaining risk factors were not statistically significantly different (see 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 physical disability and higher SES.

Discussion

Many different aspects of CVD have been studied in sub-Saharan Africa, particularly the prevalence of cardiovascular risk factors and primary prevention strategies[1, 6, 10–12, 30–32]. 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 sub-Saharan Africa, 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 five risk factors that were assessed under control, and the majority of the group had two or fewer risk factors controlled. In addition to that, gender, SES and physical disability were identified as associated to CVD management in this setting.

The prevalence of CVD in our population was 13% and is similar to the 10% for combined angina, stroke, and MI reported in the adult US population from the 2010 American Heart Association (AHA) estimates[33]. According to SANHANES, the South African National Health Survey from 2013, the self-reported prevalence of heart disease (2.2%) and stroke (1.8%) were lower than was found in our cohort (10.7% and 3%, respectively)[34]. However, it should be noted that in both the AHA and SANHANES studies the CVD prevalence was estimated for the adult population (>18 years), whilst for HAALSI, only subjects older than forty 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%)[35], 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 stablished that human immunodeficiency virus-infected individuals are at increased risk for CVD, due to, among other factors, the high prevalence of cardiovascular risk factors in HIV-infected individuals[36]. Despite the fact that prevalence of HIV positivity was higher in the non-CVD population (23.1%) when compared to 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[37]. 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 to 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 and hypertension[38], which ultimately can lead to fewer cardiovascular events.

In the CLARIFY registry[39] that included 33,283 outpatients (77% male, mean age: 64 years) with proven stable CAD 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 LDL 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%). Since we only investigated currently smoking this lower smoking rates in the CVD group may be attributable to smoking cessation after a cardiovascular event[40].

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 (NHANES) 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[41]. Considering that having all risk factors under control is the most effective action in secondary prevention of CVD[5, 42], 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 to men[43, 44].

Since each risk factor assessed in this population has a different impact as a secondary prevention strategy on angina, myocardial infarction and stroke[45, 46], we assessed the proportion of control for each the five risk factors individually. Once again, this stratification is of particular interest when dealing with stroke, since it is already known that hypertension is the most dominant risk factor for cerebrovascular events[45], and additionally a focus on blood pressure and excess weight control would yield best preventive results for stroke in this populaion[46]. 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[46]. 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, physical disability and SES. Male sex, absence of physical disability and SES were positively associated with the number of risk factors controlled. Higher SES has been consistently associated with better risk factor control[47] 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 physical disability results might be related to a better adherence to treatment in these two groups, when compared to females and individuals with co-morbidities[48, 49].

A potential limitation of this particular study is the fact that the sub-district from which the cohort was recruited has been part of a HDSS since 1992. This may create a specific environment of improved health care surveillance that might increase the level of risk factor control among patients with CVD, when compared to 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 suggests 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, beta-blockers, blockers of the renin–angiotensin system, and statins was not obtained, limiting these specific comparisons with other epidemiological studies[50]. 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%)[51], reinforcing the hypothesis of better healthcare associated to 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 to 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[52]. 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[53]. 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 sub-Saharan Africa is low (ischemic heart disease 4.7%, stroke 5.0%) but South Africa's are slightly higher (7.6% and 6.3%, respectively)[54, 55]. Our data shows that one of the reasons for these high levels of mortality from cardiovascular events may be due to 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, like population-wide screening for hypertension and diabetes, 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[56] and some of these interventions are currently under investigation[57].

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 physical disabilities.

Acknowledgments

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What is Known

- The burden of non-communicable diseases (NCDs) such as cardiovascular disease (CVD) has become an increasing challenge for health systems in sub-Saharan Africa.

- For CVD 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 CVD in sub-Saharan Africa.

What the Study Adds

- Despite the growing prevalence of CVD 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 five cardiovascular risk factors under control, and the majority of the group had two or fewer risk factors controlled.

- In addition, there were differences in the rates of optimal risk factor management by gender, socioeconomic status, and physical disability, suggesting potential disparities in care.

	No risk factors	One risk factor	Two risk factors	Three risk factors	Four risk factors	All risk factors
■ Overall	1.0	22.5	34.1	25.7	12.3	4.4
■ Females	0.3	28.3	37.2	21.7	9.0	3.5
■ Males	2.2	13.0	29.0	32.1	17.9	5.8

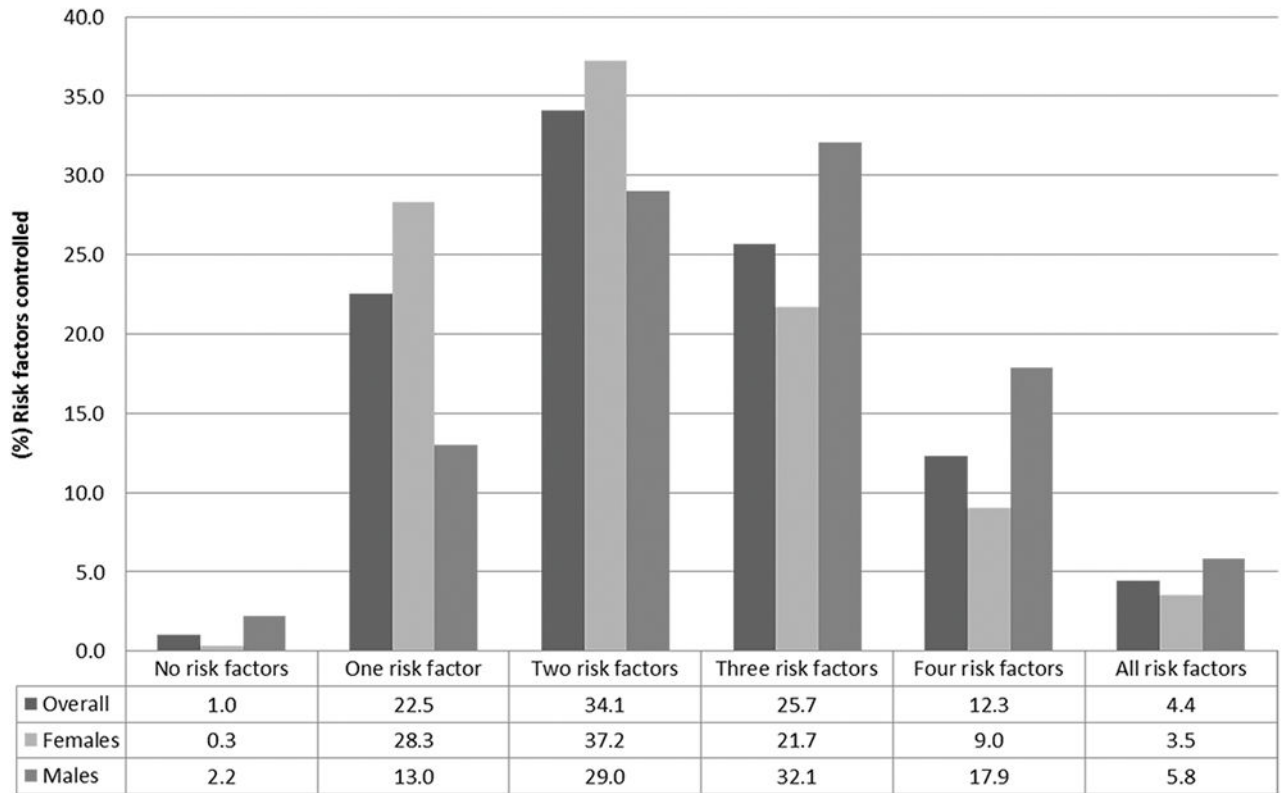**Figure 1. Number of risk factors[*] controlled among subjects with CVD[†] stratified by sex, Agincourt sub-district, South Africa 2015 (n=592)**

*LDL cholesterol < 1.8mmol/L; blood pressure < 140 × 90 mmHg; not smoking; waist-hip ratio: 0.90 (men) or 0.85 (women); body mass index < 25 kg/m^2. †CVD – cardiovascular disease (self-report of Stroke/Myocardial Infarction or Angina by Rose criteria).

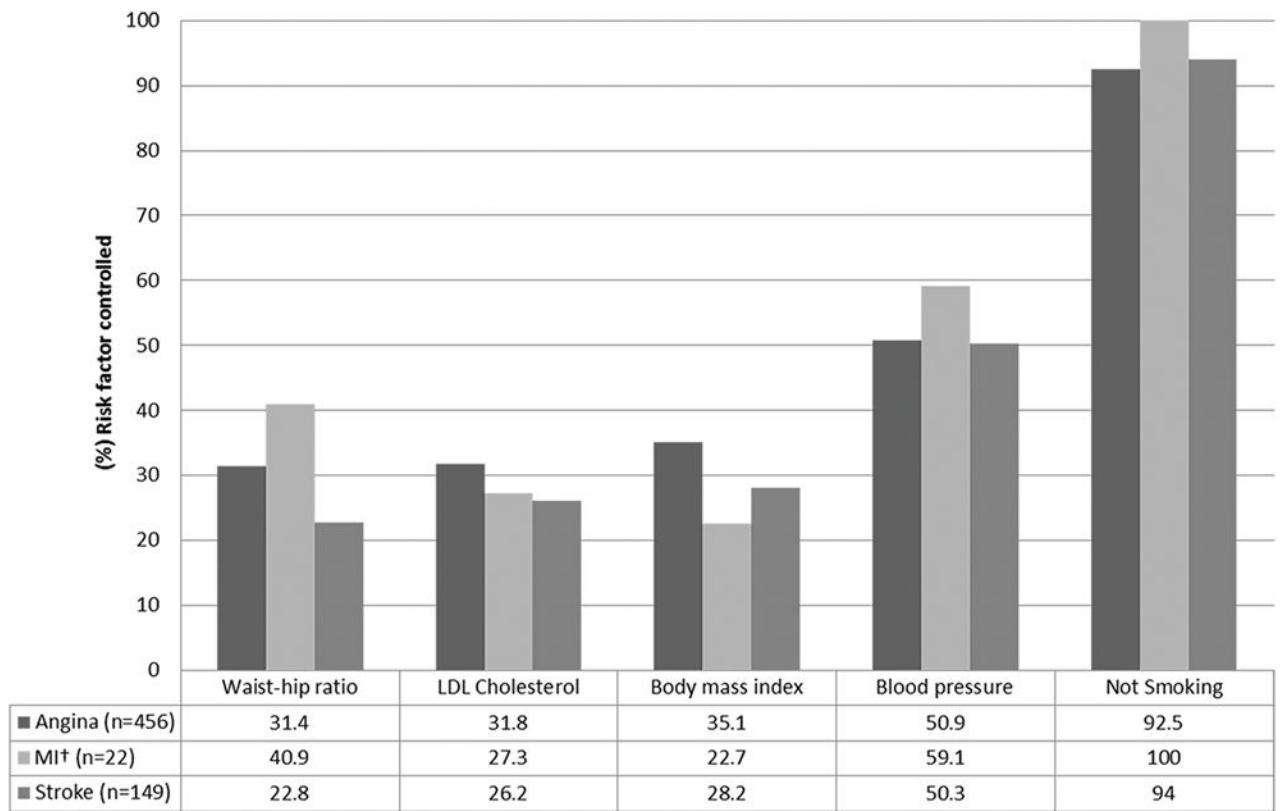|	Waist-hip ratio	LDL Cholesterol	Body mass index	Blood pressure	Not Smoking
■ Angina (n=456)	31.4	31.8	35.1	50.9	92.5
■ MI† (n=22)	40.9	27.3	22.7	59.1	100
■ Stroke (n=149)	22.8	26.2	28.2	50.3	94

Figure 2. Cardiovascular risk factors controlled* stratified by angina, myocardial infarction and stroke, Agincourt sub-district, South Africa 2015

*LDL cholesterol < 1.8mmol/L; blood pressure < 140 × 90 mmHg; not smoking; waist-hip ratio 0.90 (men) or 0.85 (women); body mass index < 25 kg/m^2. †MI – myocardial infarction.

Table 1

Overall and CVD[*] population characteristics, Agincourt sub-district, 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 (years)	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-Hip Ratio	0.91 (±0.08)	0.91 (±0.08)	0.91 (±0.09)	0.070
Average SBP (mmHg)	137.99 (±23.34)	137.88 (±23.23)	138.79 (±24.13)	0.380
Average DBP (mmHg)	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

[*] CVD – cardiovascular disease (self-report of Stroke/Myocardial Infarction or Angina by Rose criteria)

[†] 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%), HDL-cholesterol (16%), triglycerides (16%), LDL-cholesterol (16%), and C-Reactive Protein (15%).

[‡] hs - high-sensitivity c-reactive protein

[§] p-value for comparison between Non CVD and CVD individuals.

Statistically significant at α = 0.05; Data given as mean ± SD or n (%)

Table 2

Distribution of modifiable risk factors under control among the subjects with CVD[*] by HIV and migration status, Agincourt sub-district, South Africa 2015.

	Overall	HIV positive	HIV negative	p-value	Immigrant	Non Immigrant	p-value
	(%)	(%)	(%)		(%)	(%)	
Waist-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 – cardiovascular disease (self-report of Stroke/Myocardial Infarction or Angina by Rose criteria).

[†]Waist-Hip Ratio: 0.90 (men) or 0.85 (women).

[‡]LDL cholesterol < 1.8mmol/L.

[§]Body mass index < 25kg/m^2

[||]Blood pressure < 140×90 mmHg.

[#]Statistically significant at $\alpha = 0.05$

Table 3

Linear regression coefficients for the number of risk factors controlled among subjects with CVD[*], Agincourt sub-district, South Africa 2015

Variables	β-coefficient	[95% CI]	p-value
Male sex	0.44	0.25 – 0.63	<0.001[§]
Absence of PD[†]	0.40	0.16 – 0.65	0.001[§]
SES[‡]	0.10	0.01 – 0.19	0.035[§]
Age	0.00	−0.01 – 0.00	0.687
HIV positive	0.20	−0.04 – 0.44	0.106
Immigrant	−0.05	−0.26 – 0.15	0.582
Illiterate	−0.04	−0.24 – 0.16	0.675

[*] CVD – cardiovascular disease (self-report of Stroke/Myocardial Infarction or Angina by Rose criteria).

[†] Physical disability - self-reported presence or absence of limitations in activities of daily living

[‡] SES – socioeconomic status (measured using the wealth asset index)

[§] Statistically significant at $\alpha = 0.05$