

Spectrum of heart disease and risk factors in a black urban population in South Africa (the Heart of Soweto Study): a cohort study

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Summary

Background The Heart of Soweto Study aims to increase our understanding of the characteristics and burden imposed by heart disease in an urban African community in probable epidemiological transition. We aimed to investigate the clinical range of disorders related to cardiovascular disease in patients presenting for the first time to a tertiary-care centre.

Methods From Jan 1 to Dec 31, 2006, we recorded data for 4162 patients with confirmed cases of cardiovascular disease (1593 newly diagnosed and 2569 previously diagnosed and under treatment) who attended the cardiology unit at the Chris Hani Baragwanath Hospital in Soweto, South Africa. We developed a prospectively designed registry and gathered detailed clinical data relating to the presentation, investigations, and treatment of all 1593 patients with newly diagnosed cardiovascular disease.

Findings Most patients were black Africans (n=1359 [85%]), and the study population contained more women (n=939 [59%]) than men. Women were slightly younger than were men (mean 53 [SD 16] years vs 55 [15] years; $p=0.031$), with 399 (25%) patients younger than 40 years. Heart failure was the most common primary diagnosis (704 cases, 44% of total). Moderate to severe systolic dysfunction was evident in 415 (53%) of 844 identified cases of heart failure, 577 (68%) of which were attributable to dilated cardiomyopathy or hypertensive heart disease, or both. Black Africans were more likely to be diagnosed with heart failure than were the rest of the cohort (739 [54%] vs 105 [45%]; odds ratio [OR] 1.46, 95% CI 1.11–1.94; $p=0.009$) but were less likely to be diagnosed with coronary artery disease (77 [6%] vs 88 [38%]; OR 0.10, 0.07–0.14; $p<0.0001$). Prevalence of cardiovascular risk factors was very high, with 897 (56%) patients diagnosed with hypertension (190 [44%] of whom were also obese). Only 209 (13%) patients had no identifiable risk factors, whereas 933 (59%) had several risk factors.

Interpretation We noted many threats to the present and future cardiac health of Soweto, including a high prevalence of modifiable risk factors for atherosclerotic disease and a combination of infectious and non-communicable forms of heart disease, with late clinical presentations. Overall, our findings provide strong evidence that epidemiological transition in Soweto, South Africa has broadened the complexity and spectrum of heart disease in this community. This registry will enable continued monitoring of the range of heart disease.

Introduction

The causes and consequences of an epidemic of cardiovascular disease and its major component, heart disease, in developed countries have been well documented. Conversely, few data exist in low-income and middle-income countries to describe the effect of cardiovascular disease emerging as a threat in addition to malnourishment and infectious disease,^{1–3} especially in vulnerable populations for whom modifiable risk factors have previously been rare⁴ and health-care resources already overburdened. The potential effect of different stages of epidemiological transition is especially evident in South Africa; this country of great diversity extends from highly industrialised cities with an urban advanced-economy lifestyle to remote rural regions with more traditional lifestyles. Although the sustained epidemic of HIV/AIDS causes 41% and 64% of deaths in men and women aged 15–44 years, respectively, coronary artery disease, hypertensive heart disease, and stroke already account for more than a third of deaths in people older than 65 years.^{5,6}

We therefore established the Heart of Soweto Study⁷ to monitor, describe, and respond to the evolving burden of heart disease within the largest urban concentration of black Africans in South Africa. We investigated the clinical spectrum of disorders related to cardiovascular disease (with a particular focus on heart disease) in people presenting for the first time to a tertiary-care centre.

Methods

Study setting and design

The Heart of Soweto Study is a large-scale study of emergent heart disease and its antecedents in the geographically compact townships that comprise Soweto (estimated population of 1.1 million).⁷ This internationally renowned community has one of the largest urban populations of black Africans on the African continent.⁷ We investigated people presenting between Jan 1, 2006, and Dec 31, 2006, for the first time to a tertiary-care centre (the Chris Hani Baragwanath

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Panel: Sociodemographic and clinical data obtained for every new case of cardiovascular disease

- Self-reported cultural, sociodemographic, and risk-factor profile, which included ethnic origin, length of residence in Soweto, education status, and previous clinical history
- Averaged seated systolic and diastolic blood pressure (mm Hg) and heart rate (beats per min), with measurements via a calibrated Dynamap (Critikon [GE Medical Systems Information Technologies]; Johannesburg, South Africa) monitor
- Height and weight with calculation of body-mass index (kg/m²); data available for ambulatory patients only
- Results of an advanced cardiological assessment including heart and lung sounds and documentation of any other clinically relevant signs and symptoms on dedicated study forms
- Functional status according to the New York Heart Association (NYHA) classification of dyspnoea
- 12-lead electrocardiogram (ECG) subject to blinded coding according to published Minnesota criteria⁸ to document any clinical abnormalities relating to wave-form abnormalities (eg, changes indicative of left ventricular hypertrophy), conduction (eg, left bundle-branch block), or cardiac rhythm (eg, atrial fibrillation). Data were available in 1431 (90%) patients and final determination was made by SS
- Two-dimensional targeted M-mode echocardiography with doppler colour flow mapping with a Hewlett Packard (Johannesburg, South Africa) Sonos 5500 echocardiograph attached to a 2.5 or 3.5 MHz transducer. Left ventricular dimensions and parameters (average of more than three beats) were measured according to the American Society of Echocardiography guidelines.⁹ Diastolic mitral flow was assessed by pulsed-wave doppler echocardiography from the apical four-chamber view. If no abnormalities were detected during the initial echocardiographic assessment, no further specific measurements were recorded. In all other cases, echocardiographic assessment consisting of a detailed assessment of ventricular function, valvular integrity, and function and regional wall abnormalities was undertaken. For patients in atrial fibrillation, echocardiographic measures were taken at least three times and the average documented

Hospital), which provides specialist cardiac care to patients in Soweto and surrounding communities. Importantly, this 3500-bed hospital also provides referral services to individuals from a broad range of ethnic backgrounds including Europeans, Asians, and those of mixed ancestry (Khoi San European-African-Malay South Africans).

We developed a prospectively designed registry via dedicated facilities and staff (with a strong focus on local capacity building) that included all individuals presenting with confirmed or suspected cardiovascular disease to the cardiology unit. We gathered detailed clinical data relating to the presentation, investigations, and treatment of all patients with newly diagnosed cardiovascular disease. Patients with previously established cardiovascular disease were entered into a simpler version of the study's clinical registry. Data were collected for age, sex, ethnic group, and primary diagnosis for previously established cases.

The study was approved by the relevant local ethics committee and administrative bodies. The study conformed to the principles outlined in the Declaration of Helsinki. Every patient in the registry was assigned a unique identifying code (nine digits), and all documents

were labelled accordingly to maintain anonymity. All participating patients provided oral consent to become part of the clinical registry.

Participants

Since the population of Soweto and surrounding communities rely on the Chris Hani Baragwanath Hospital to provide all cardiac services and treatment via the cardiology unit, clinical data from the unit's activities are highly representative of the underlying spectrum of cardiovascular disease (mild to severe). In 2006, the hospital managed 129 633 inpatients (45 400 [35%] of whom were managed by the Department of Medicine). In 2006, the case load for the cardiology unit included an estimated 5000 patients with a total of 21 000 patient contacts.

The cardiology unit is staffed by internal medicine specialists (with a minimum of 4 years' specialist training) undergoing specialist cardiology training and supported by experienced cardiologists. With gold-standard cardiological expertise and advanced diagnostic technical capacity (eg, coronary angiography and nuclear imaging), the cardiology unit provides definitive diagnostic and treatment services to the region. These services include all patients being seen at the dedicated cardiology outpatient department in addition to the hospital's coronary-care unit. The cardiology outpatient department population includes all patients seen at 12 local Soweto primary-care clinics who were referred directly for a suspected cardiac disorder; all patients requiring more definitive investigation or treatment of suspected or confirmed cardiovascular disease, who were seen initially at the general medical outpatient facilities, the specialist medical registrar clinic, and the diabetic clinic; and patients being initially admitted to the general medical or any other ward at Chris Hani Baragwanath Hospital who need a cardiological consultation.

Study data

Data were collected on a consecutive patient basis that was designed to keep selection bias to a minimum, and collection was limited only by the volume of cases at peak clinical activity. Overall, less than 10% of the administrative listing of patient case load by the cardiac-clinic clerk could not be accounted for (mainly because patients left the clinic before assessment during busy clinic days). The panel shows the sociodemographic and clinical data that the registry obtained for every new patient with cardiovascular disease.

Dependent on the clinical diagnosis and subsequent routine management of the patient, additional clinical variables that were entered into the clinical registry included: serum glucose concentration and haemoglobin A_{1c} ratio, lipid profile, full blood count (eg, platelet and white cell counts and haemoglobin), renal function (creatinine and urea concentrations), cardiac enzymes (eg, cardiac troponin concentrations), and results of HIV

testing if consent was given. In addition to the prescribed treatments, the registry also captured all advanced clinical investigative procedures (eg, coronary angiography, which was undertaken in all people diagnosed with coronary artery disease) and therapeutic procedures (eg, valve repair surgery).

All clinical diagnoses were independently reviewed by KS and SS following contemporary guidelines published online by the European Society of Cardiology¹⁰ to finalise each individual's list of diagnoses within the clinical registry by consensus.

Statistical analysis

All study data were documented on specific study forms and then entered into a dedicated database (Microsoft Access) by the same designated data coordinator, who was a cardiac nurse with extensive clinical experience. Data were then verified (with resolution of data queries) and transferred to SAS version 9.1 for all analyses. Normally distributed continuous data are presented as the mean (SD), and variables with non-Gaussian distribution as the median (IQR). Categorical data are presented as percentages with 95% CIs when appropriate. To compare groups of patients according to demographic and clinical profile, we used χ^2 analysis with calculation of odds ratios (OR) and 95% CI for discrete variables, Student's *t* test, and analysis of variance for normally distributed continuous variables. *p* values were two sided.

Role of the funding source

The sponsors of the study had no role in the design of the study, data collection, data analysis, data interpretation, or the writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit the report for publication.

Results

Figure 1 shows the clinical profile of the study population. Of the 4506 patients who were assessed and entered into the registry, 344 (8%) did not have underlying cardiovascular disease: these patients had a similar sex and racial profile to those with cardiac disease, but were, on average, a decade younger (data not shown). Thus the study population consisted of 4162 confirmed patients with cardiovascular disease, 1593 (38%) of whom were newly diagnosed and 2569 (62%) were previously diagnosed and under treatment (figure 1). On average, patients with established disease were 1.7 (95% CI 0.7–2.7) years older than were those with newly diagnosed disease ($p=0.0012$).

The table shows the demographic and clinical profile of the 1593 patients with newly diagnosed cardiovascular disease according to their primary diagnosis. Most patients were black Africans and the study population included more women than men (table). The age profile of women was slightly younger than that for men (mean

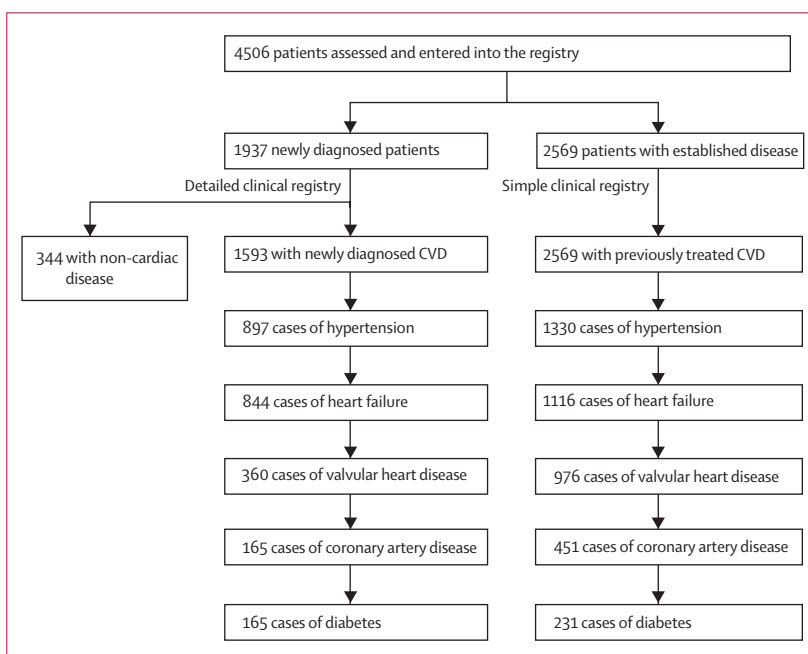


Figure 1: Clinical profile of the study cohort
CVD=cardiovascular disease.

age 53 [SD 16] years vs 55 [15] years; $p=0.031$), with 862 (54%) patients younger than 55 years and 399 (25%) younger than 40 years. Just over half of patients reported living in Soweto itself (table), with only 42 (5%) indicating they had lived there for less than 5 years. Black Africans were significantly more likely to report low education levels than were other races combined (381 [28%] vs 35 [15%]; $p<0.0001$).

Figure 2 shows the broad spectrum of cardiovascular disease and risk factors identified within the study cohort. Apart from patients with a primary diagnosis of hypertension, most cases represented late clinical presentations with established heart disease of more than one cause. Overall, the four most common diagnoses were hypertension, heart failure, valvular heart disease (figure 2). Patients diagnosed with valvular heart disease were on average more than a decade younger than were those with heart failure or hypertension (table). Concurrent diabetes (predominantly type 2), renal disease, and anaemia were also diagnosed in some patients (table), and 74 (5%) were confirmed as HIV positive (previous diagnosis or specifically tested for the virus).

In the 146 miscellaneous cases (9% of all cases), the most common diagnosis was pericardial effusion (figure 2) as a complication due to tuberculosis, HIV/AIDS, or a combination of both diseases ($n=80$ [5% of all cases]). Overall, rheumatic valvular heart disease, the cardiomyopathies, and tuberculous pericardial effusion combined, accounted for 639 (40%) of these newly diagnosed cases. A clinically important but

	All (n=1593)	Hypertension (n=310)	Heart failure (n=704)	Valve disease (n=268)	CAD (n=165)	Other (n=146)
Sociodemographic profile						
Age (years)	52.8 (17.1)	58.3 (15.3)	55.1 (16.2)	45.7 (18.2)	56.7 (12.4)	38.8 (16.6)
Black African	1359 (85%)	265 (86%)	640 (91%)	243 (91%)	77 (47%)	134 (92%)
Women	939 (59%)	199 (64%)	409 (58%)	179 (67%)	68 (41%)	84 (58%)
No or standard education	416 (26%)	76 (26%)	204 (31%)	69 (27%)	29 (21%)	38 (27%)
Live in Soweto	842 (53%)	169 (55%)	418 (59%)	126 (47%)	42 (25%)	87 (60%)
Years living in Soweto	41 (27–50)	46 (35–54)	43 (30–52)	36 (20–50)	44 (40–55)	28 (17–39)
Risk factor profile						
Positive family history	405 (25%)	67 (22%)	168 (24%)	75 (28%)	60 (36%)	35 (24%)
Hypercholesterolaemia*	159 (22%)	54 (38%)	45 (17%)	16 (21%)	37 (35%)	7 (20%)
History of smoking	661 (41%)	112 (36%)	327 (46%)	84 (31%)	84 (51%)	54 (37%)
Risk factors						
None	209 (13%)	0	71 (10%)	78 (29%)	8 (5%)	52 (36%)
One	451 (28%)	72 (23%)	203 (29%)	77 (29%)	40 (24%)	59 (40%)
More than one	933 (59%)	238 (77%)	430 (61%)	113 (42%)	117 (71%)	35 (24%)
Clinical presentation						
NYHA class III or IV	486 (31%)	84 (27%)	255 (36%)	63 (24%)	32 (19%)	52 (36%)
Heart rate (min)	86 (21.5)	82 (19.2)	90 (20.3)	83 (18.3)	77 (19.2)	97 (37.6)
Systolic BP (mm Hg)	130 (27.1)	144 (29.0)	129 (26.1)	123 (24.4)	124 (27.1)	120 (23.4)
Diastolic BP (mm Hg)	73 (16.6)	78 (16.8)	75 (16.7)	68 (15.0)	70 (13.5)	71 (17.3)
Angina pectoris/chest pain	451 (28%)	89 (29%)	182 (26%)	70 (26%)	82 (50%)	28 (19%)
Oedema (pulmonary/peripheral)	494 (31%)	78 (25%)	275 (39%)	75 (28%)	35 (21%)	31 (21%)
Co-morbidity						
Renal dysfunction†	115 (10%)	23 (10%)	51 (10%)	20 (8%)	16 (11%)	5 (5%)
Anaemia‡	156 (13%)	30 (12%)	64 (11%)	22 (12%)	7 (6%)	33 (28%)
Diabetes	165 (10%)	41 (13%)	66 (9%)	13 (5%)	35 (21%)	10 (7%)
HIV positive	74 (5%)	4 (1%)	35 (5%)	10 (4%)	2 (1%)	23 (16%)
ECG profile§						
Sinus rhythm	1321 (92%)	267 (98%)	574 (90%)	222 (90%)	140 (98%)	118 (93%)
Atrial fibrillation	102 (7%)	12 (4%)	48 (8%)	32 (13%)	4 (3%)	6 (5%)
Arrhythmia	487 (34%)	79 (29%)	252 (40%)	74 (30%)	31 (22%)	51 (40%)
Bundle block	127 (9%)	11 (4%)	76 (12%)	23 (9%)	11 (8%)	6 (4%)
Echocardiographic profile§						
Mean LVEF	53.0 (17.4)	65.0 (10.8)	45.7 (18.3)	57.1 (13.4)	51.6 (15.9)	61.8 (8.8)
Systolic heart failure¶	415 (29%)	0	341 (52%)	37 (14%)	37 (31%)	0
Preserved heart failure¶	373 (26%)	0	316 (48%)	35 (13%)	22 (18%)	0

Data are number (%), mean (SD), or median (IQR). CAD=coronary artery disease. NYHA=New York Heart Association. BP=blood pressure. LVEF=left ventricular ejection fraction. ECG=electrocardiogram. *Hypercholesterolaemia defined as fasting total cholesterol serum concentration greater than 5.5 mmol/L (clinical data collected in 728 cases). †Renal dysfunction defined as a serum creatinine concentration greater than 160 µmol/L (clinical data in 1182 cases). ‡Anaemia defined as haemoglobin concentration less than 110 g/L in men and less than 100 g/L in women (clinical data in 1185 cases). §Echocardiographic data were available in 1431 and 1433 cases, respectively. ¶Systolic or preserved (diastolic) heart failure defined by the presence or absence of a left ventricular ejection fraction of 45% or less (measured on presentation to the cardiology unit) when clinical symptoms or signs of heart failure were present.

Table: Sociodemographic and clinical profile according to primary diagnosis

rare diagnosis was stroke. Overall, 145 (9%) patients reported a family history of stroke but only 64 (4%) were diagnosed with an acute stroke (16 cases) or as a secondary contributor to their presentation.

Black Africans accounted for most cases in all major diagnostic groups—eg, 739 of 844 (88%) cases of heart failure were in black African patients. Black Africans were significantly more likely to be diagnosed with heart failure than were the rest of the cohort (739 [54%] vs

105 [45%]; OR 1.46, 95% CI 1.11–1.94; p=0.009). However, they were far less likely to be diagnosed with coronary artery disease than were all other racial groups (77 [6%] vs 88 [38%]; OR 0.10, 0.07–0.14; p<0.0001). Although the overall proportions of men and women diagnosed with hypertension and diabetes were much the same, proportionately more women were diagnosed with valvular heart disease than were men (240 [26%] vs 120 [18%]; OR 1.30, 1.11–1.52; p=0.001). By contrast,

proportionately fewer women were diagnosed with heart failure (478 [51%] vs 366 [56%]; OR 0·89, 0·79–0·99; $p=0\cdot047$) or coronary artery disease (68 [7%] vs 97 [15%]; OR 0·66, 0·58–0·77; $p<0\cdot0001$); in absolute terms, however, 112 more women than men were diagnosed with heart failure.

On presentation, many patients had evidence of advanced disease with significant dyspnoea (New York Heart Association class III or IV), chest pain or angina pectoris, and peripheral oedema as common presenting symptoms across all diagnostic groups (table). Electrocardiographic (ECG) and echocardiographic findings were indicative of a cohort with predominantly advanced and complex disease, with 487 (34%) patients having tachycardia, or underlying cardiac dysfunction or structural disease. Of the 844 cases of heart failure, 203 (24%) had a mixed underlying aetiology, 332 (39%) had developed valvular dysfunction (eg, secondary to mitral regurgitation), and 67 (8%) had a primary diagnosis of valve disease (eg, predominantly rheumatic heart disease or degenerative valve disease) (figure 2). The three most common forms of heart failure were the dilated cardiomyopathies (35% [95% CI 32–38]), which included peri-partum cardiomyopathy, heart failure second to hypertensive heart disease (33% [30–36]), and right heart failure (27% [24–30]), which was commonly associated with underlying cor pulmonale (99 [44%] patients) (figure 2). Overall, 415 (53%) of patients with heart failure had moderate to severe systolic dysfunction and 225 (27%) had impaired diastolic function; mean left ventricular ejection fraction being 34% (SD 13) in those with dilated cardiomyopathy and 39% (SD 15) in those with ischaemic cardiomyopathy. Patients with heart failure related to underlying hypertensive heart disease (157 [56%] of 281 cases) and valvular disease (24 [36%] of 67 cases) were most likely to have impaired diastolic function. Similarly, 733 (97%) of 756 12-lead ECGs in patients diagnosed with heart failure had some form of abnormality, with 115 (16%) patients having ECG evidence of left ventricular hypertrophy.

In all diagnostic groups, the rate of common risk factors for cardiovascular disease was very high; overall, only 209 (13%) had no risk factors, whereas 933 (59%) had several risk factors. For example, 70 (47%) patients with a primary diagnosis of hypertension were also obese and 84 (51%) with coronary artery disease had a history of smoking. In those for whom we recorded body-mass index (BMI) data (ambulatory cases), women were significantly heavier than were men (mean BMI 29·6 [SD 7·7] kg/m^2 vs 25·2 [5·9] kg/m^2 ; $p<0\cdot0001$).

Discussion

Consistent with a call for the development of high quality, contemporaneous data to combat the global effect of cardiovascular disease,¹¹ this first report from the Heart of Soweto Study provides a detailed perspective on the spectrum of heart disease arising from a large urban

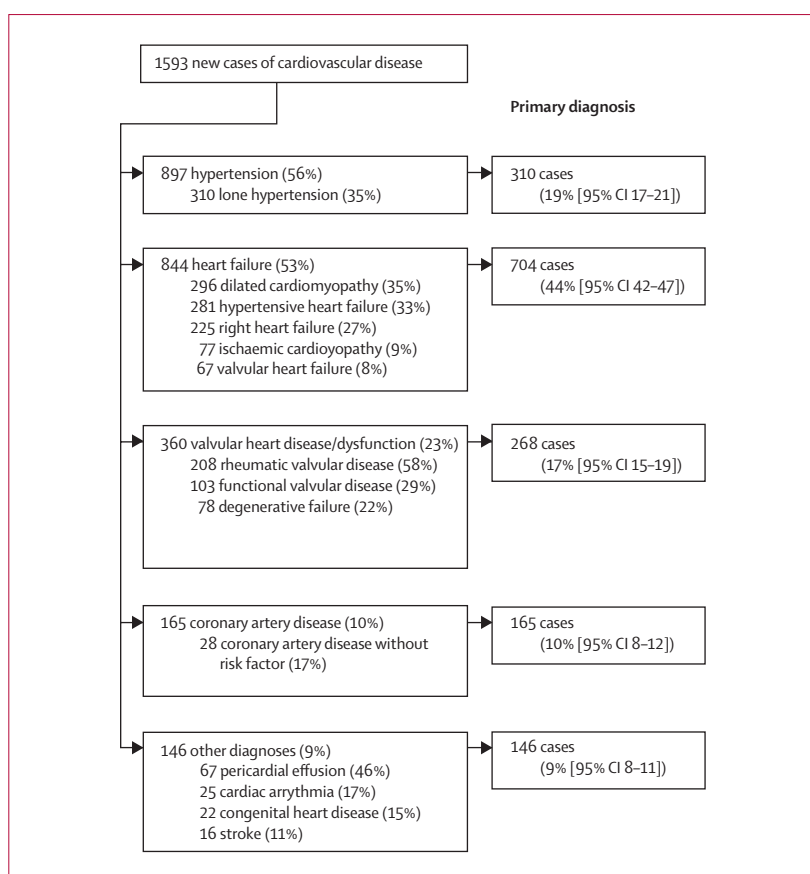


Figure 2: Clinical spectrum of disease

African community. We noted that heart failure was the most common primary diagnosis in this population, with moderate to severe systolic dysfunction evident in around half the cases. Black Africans were more likely to be diagnosed with heart failure than were others, but far less likely to be diagnosed with coronary artery disease. Almost two-thirds of patients had multiple risk factors for cardiovascular disease.

Our data have important public-health and clinical implications for the prevention and treatment of heart disease both within this internationally renowned community and possibly for other urban communities on the African continent that are undergoing epidemiological transition. Specifically, we note that the present spectrum of heart disease in Soweto ranges from the so-called traditional forms of infectious diseases that are usually expected in African populations^{12–14} to newer non-communicable diseases (predominantly associated with advanced clinical presentations) that are often reported in high-income countries.^{15,16}

These baseline data now provide us with the opportunity to establish whether epidemiological transition in Soweto has broadened the spectrum of clinical cardiovascular disease beyond the traditional threats of rheumatic valvular heart disease, the cardiomyopathies, and

tuberculous pericardial effusion (affecting 40% of patients in 2006).¹² The presence of a large component of non-communicable cardiovascular disease (eg, hypertensive heart disease and coronary artery disease) and its common antecedent, type II diabetes, is consistent with a broadening spectrum of cardiovascular disease in this urban population.¹⁷ In view of its near historical absence in black Africans,^{7,18} the number of documented cases of atherosclerotic disease (14% overall including stroke cases) is consistent with our recent community-based survey that showed a high prevalence of modifiable risk factors in black African adults living in Soweto.¹⁹ The clinical spectrum of heart disease within this population is further broadened by cardiac complications relating to tuberculosis and HIV/AIDS (eg, tuberculous pericardial effusion, HIV-cardiomyopathy, and diseases related to highly active antiretroviral therapy). The burden of patients presenting for the first time with symptoms of chronic rheumatic heart disease and idiopathic cardiomyopathy still exceeds the number of patients presenting with coronary artery disease. Importantly, these data also show that many patients had developed significant clinical disease before their first presentation (suggesting little awareness of heart disease and difficulty in accessing appropriate health care). Almost half of people being treated for hypertension in the absence of clinical heart disease were obese. That black African women were most likely to be obese both in this hospital cohort and the general community,¹⁹ and that they are also the predominant sex within this ethnic cohort, is especially noteworthy in view of the typical male dominance seen in cohorts from developed countries.^{15,16} Similarly, the fairly young age of the cohort also contrasts substantially with reports from high-income countries.

For decision-making and planning processes in health care, a consistent and comparative description of the spectrum and burden of diseases and their associated risk factors is essential. All broad indications, whether specific to the region^{6,20} or derived from a range of developing countries,²¹ indicate an increasing burden imposed by cardiovascular disease. For example, a South African survey of 10 000 households has identified a worsening risk profile for cardiovascular disease in the country.⁶ Similarly, a report from Columbia University's Earth Institute showed that cardiovascular mortality rates in working-age people in South Africa were 1.5 times higher than were those of working-age people in the USA, and 41% of cases occurred in those aged 35–64 years.²⁰ However, probable error rates relating to estimates of all-cause mortality (range 15–20%) and prevalence of ischaemic heart disease (25–35%) for sub-Saharan Africa are substantial.²² Few data for the spectrum and characteristics of heart disease and other major forms of cardiovascular disease in Africa exist.^{11–13,23} Many studies were undertaken before echocardiography was

used as standard, or many cases did not use this technique. By contrast with our report, studies usually focus on a particular disease and only seldom investigate the entire spectrum of cardiovascular disease.¹³ Overall, comprehensive clinical data supported by results of appropriate investigations (ECG, echocardiography, and biochemical studies) are not available from sub-Saharan African, and our study addresses this important gap.

We noted that most patients presented with advanced disease and the most frequent primary diagnosis was heart failure. The likely reasons for these findings are complex. An absence of screening programmes for rheumatic or congenital heart disease in schoolchildren means that many individuals will present late with symptoms of heart failure in adulthood. This problem could be addressed with the emergence of portable technologies that provide cost-effective and pragmatic options for screening when resources are scarce. Similarly, underlying hypertension and diabetes are often identified only when significant end-organ damage has occurred. Little community awareness of the signs and symptoms of advanced heart disease undoubtedly contributes to a systematic delay in health seeking behaviours and patterns of referral. The disease profile is clearly different to the so-called traditional spectrum of disease; our data identified a large burden of newly diagnosed patients with rheumatic heart disease but not one case of acute rheumatic fever, which was previously a common disease.^{24,25} Although this finding potentially shows improved living circumstances and access to antibiotic therapy for throat infections in children living in Soweto, it could also indicate an underestimation of acute rheumatic fever by parents or first-line health-care workers. Moreover, our data might not be representative for rural regions or other sub-Saharan countries (eg, the prevalence of rheumatic heart disease in Mozambique was reported to be 2.3 cases per 1000 on the basis of clinical screening and 30.4 cases per 1000 on the basis of echocardiographic screening).²⁶

Consistent with data from other parts of Africa suggesting a broadening pattern of cardiovascular disease involving a component of greater burden imposed by atherosclerotic disease,^{27,28} we recorded a small but potentially significant number of cases of coronary artery disease. Our data need careful examination in view of a cost-effectiveness analysis on the application of multidrug regimens for the primary and secondary prevention of cardiovascular disease from the perspective of six developing World Bank geographical regions, which favoured populations with high absolute risk for future cardiovascular events.²⁹ Our data would lend support to the application of this form of strategy on a primary prevention basis in sub-Saharan Africa, but not (as of yet) on a secondary prevention basis. More applicable, perhaps, would be culturally adapted programmes for the management of chronic diseases, particularly in

relation to the management of heart failure.³⁰ Clearly, these issues need to be addressed via appropriately designed and powered clinical trials in addition to sustainable community programmes for screening and awareness.

Notwithstanding a range of issues (including few health-care resources, the complexity of disease states, and need to build local research capacity), we support a call for an appropriate research agenda to better understand and respond to the evolving burden of cardiovascular disease in Africa on the basis of our findings.¹³ Further to this study and other substantive attempts to investigate changes in the lifestyles and cardiovascular risk in African children,³¹ similar reports from other parts of Africa are needed. We plan to continue this registry to monitor potential changes in the spectrum of cardiovascular disease presentations over the next decade.

Our study has several limitations. First, since not all patients being managed by the cardiology unit were captured by our registry, selection bias might exist. Furthermore, our focus on patients being managed by a tertiary centre to describe the spectrum of disease within the region could also have been biased. We acknowledge that individuals with subclinical disease, milder forms of cardiovascular disease, or those suffering sudden fatal events (eg, fatal haemorrhagic stroke or myocardial infarction) would not be captured by our registry; the few cases of stroke could partly be explained by the fact that haemorrhagic strokes diagnosed via CT scans with an obvious non-cardiac origin are often not referred to a cardiology centre in South Africa. Alternative cardiac services for those living in Soweto and surrounding communities are few, and the use of private facilities in black South Africans is very low.³² Similarly, since the registry was based on routine clinical practice (albeit under the direction of trained cardiologists), we did not capture identical clinical data for all patients and have relied on clinical diagnoses. However, our ability to provide comprehensive 12-lead ECG and echocardiographic data for most patients is a major strength of our study, and wherever possible, we have adhered to the recently published STROBE guidelines relating to the reporting of this type of study.³³

Despite some important limitations, our data provide preliminary evidence to show the effect of epidemiological transition in this population who face many threats to their present and future cardiac health, including a high prevalence of modifiable risk factors for atherosclerotic disease, a combination of infectious and non-communicable forms of heart disease, and late clinical presentations. The combination of common preventable risk factors and late clinical presentations (especially heart failure) represents a particular challenge to improve primary and secondary prevention strategies to not only reduce the number of new cases of cardiovascular disease

but also improve health outcomes for those with pre-established disease. Long-term surveillance systems are also needed to monitor the success or failure of such initiatives.

Contributors

KS, DW, LN, KT, AB, and SS participated in the original design of the study. KS supervised the collection of data, and LN, KT, and AB assisted in the collection of data. KS led the writing of the report, which was co-led by DW and SS, and assisted by all other authors. CH coordinated data collection and data reports. All authors assisted in the interpretation of the study data and have seen and approved the final version of the report.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

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