

Standing at the crossroads between new and historically prevalent heart disease: effects of migration and socio-economic factors in the Heart of Soweto cohort study

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Aims

Migration, urbanization, and change in socio-economic factors have potentially profound effects on heart disease in low-to-middle income countries.

Methods and results

Chris Hani Baragwanath Hospital in Soweto, South Africa, provides health care to >1 million Africans. We systematically captured data from all *de novo* presentations of suspected heart disease (focusing on 'new' vs. historically prevalent forms) during 2006–2008. There were 3168 female (52 ± 18 years) vs. 2160 male (53 ± 17 years) cases. Overall, 999 (19%) presented with uncomplicated hypertension ($n = 988$) or type II diabetes, 1862 cases (35%) 'new' heart disease (1146 and 581 cases of hypertensive heart failure and coronary artery disease), and 2092 cases (39%) of historically prevalent heart disease (including 724 with primary valve disease and 502 idiopathic dilated cardiomyopathies). Level of education and non-communicable risk factors were important correlates of advanced disease. The rate of historically prevalent cases was higher in those aged 20–49 years (19–60 cases/100 000 population/annum) whilst being higher for "new" heart disease in those aged >50 years (155–343 cases/population/annum). Historically prevalent heart disease cases were younger [adjusted odds ratio (OR) 0.98, 95% 0.97–0.99 per year], more likely to be African (OR 4.59, 95% 2.76–7.60) while being less likely to originate from Soweto (OR 0.87, 95% 0.75–1.00) and be female (OR 0.67, 95% 0.49–0.92).

Conclusion

Dynamic socio-economic and lifestyle factors characteristic of epidemiological transition appear to have positioned the urban, mainly African community of Soweto at the crossroads between historically prevalent and 'new' forms of heart disease.

Keywords

Africa • Cardiovascular disease • Heart disease • Spectrum of disease • Epidemiological transition

Introduction

Although the burden of cardiovascular disease (CVD) states, such as heart disease, is stabilizing in high-income countries, in low-to-middle-income countries (LMIC) it continues to rise.¹ With scarce health-care resources, LMIC are typically ill-equipped to cope with new challenges² when already over-burdened by

illness related to malnourishment and infection.³ There is little scope to tackle new prototypes of heart disease arising from changing risk behaviours due to epidemiological transition.⁴ Contemporary studies demonstrate high levels of non-communicable antecedents of heart disease (except dyslipidaemia) in Sub-Saharan Africa; particularly urban communities.^{5–7} Preliminary data from

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the Heart of Soweto Study⁸ suggest that epidemiological transition has broadened the spectrum of advanced forms of heart disease in one of Africa's largest urban concentrations of Africans. We found a high burden of complex cases in young individuals and women (a pattern rarely seen in high-income countries).⁹

The contemporary balance between historically prevalent and emergent (new) forms of heart disease in Sub-Saharan Africa is unknown. This tension between the 'old and the new' is largely reflected in the balance between communicable vs. non-communicable disease states.¹⁰ Historically, rheumatic heart disease (RHD),¹¹ the dilated cardiomyopathies (CMO),¹² pulmonary heart disease, arrhythmias, and infectious forms of heart disease are predominant in Sub-Saharan Africa.¹³ With high levels of rural migration and extreme poverty counterbalanced by sufficient consumer demand for new, state-of-the-art shopping precincts, Soweto is an ideal community to study epidemiological transition. We postulated that in Soweto (>1 million people of African descent) the balance between largely communicable (historically prevalent) vs. non-communicable (newer) forms of heart disease¹⁴ has irrevocably changed. Specifically, we hypothesized that (i) the burden of new forms of heart disease is equal to historically prevalent forms, (ii) socio-demographic gradients exist in case presentations and, (iii) lifestyle risk factors are both common and contribute to more advanced presentations in those with historically prevalent heart disease.

Methods

Study setting and design

As described previously,⁹ the 3500-bed Chris Hani Baragwanath Hospital (case load of >125 000 inpatients per annum) services the tertiary care needs of Soweto and surrounding communities. With no other major facilities and limited private health care, it represents a key barometer of the overall health of Soweto. All cases of suspected heart disease are referred to the Cardiology Unit for advanced diagnostic testing and gold-standard treatments. A prospective clinical registry of all *de novo* presentations was established in 2006 as part of the Heart of Soweto Study; Sub-Saharan Africa's largest and most detailed study of advanced forms of heart disease to date.

Participants

During 2006–2008, we captured data on 6006 *de novo* presentations to the Cardiology Unit. Excluding those 678 cases (11%) found not to have significant disease or risk, the remainder ($n = 5328$) were referred on the following basis:

- emergency presentation ($n = 401$, 7.6% of total case-load);
- external referral from local primary care clinics for advanced assessment and definitive treatment ($n = 367$, 6.8%);
- internal referral of a patient as a current hospital inpatient ($n = 1992$, 37.4%);
- referral from another outpatient department ($n = 2568$, 48.2%).

The study was approved by the University of the Witwatersrand Ethics Committee and conforms to the principles outlined in the Declaration of Helsinki.

Study data

A complete list of study data captured by the registry, comprising basic socio-demographic (including self-reported years of education, origin and history of any form of CVD) and advanced clinical profiling, has been described previously.^{9,11,15} Those of African descent were typically of Zulu or Xhosa origin. Migrants were defined as individuals who were not born in Soweto with a differential of >10 years between calculated age and reported years of living in the area. Anthropometric measurements were available for calculation of body mass index (BMI— kg/m^2) in 3844 (72%) ambulatory cases, and renal function assessed in 4348 (82%) cases. Despite echocardiography being performed in every case (according to gold-standard criteria¹⁶), not all values were quantified (e.g. due to poor visualization); left ventricular ejection fraction (LVEF) was recorded in 4597 cases (86%). Similarly, 12-lead ECG (blinded Minnesota coding¹⁷) was available in 4782 (90%) cases. We also adhered to the STROBE guidelines for this type of study.¹⁸

Data classification and analyses

All data and diagnoses were independently reviewed and adjudicated (consensus approach) by K.S. and S.S. using European Society of Cardiology guidelines.¹⁹ For these analyses, we prospectively classified cases into six clinical groups (using the primary diagnosis)—see *Table 1*.

Table 1

Study classification	Primary diagnoses	General characteristics	Communicable component
Hypertension/type II diabetes (without evidence of established heart disease or another form of CVD)	Hypertension	Increasingly prevalent risk factor in urban communities, primary diagnosis only when no evidence of cardiac dysfunction	None/strongly linked to lifestyle risk factors
Historically prevalent heart disease	Type II diabetes RHD and other valve disorders, non-ischaemic CMOs, pericardial disease, and pulmonary heart disease ¹⁰	Low prevalence relative to other LMIC Historically, the main (reported) contributors to heart disease in Sub-Saharan Africa	Streptococcal infection, tuberculosis, other pulmonary infections, and now HIV infection
New/non-communicable heart disease	Hypertensive heart failure (HF) and (atherosclerotic) coronary artery disease (CAD)	Hypertensive HF is a well-described phenomenon in Sub-Saharan Africa but in historically low numbers	Strongly linked to lifestyle risk factors.

Continued

Table 1 Continued

Study classification	Primary diagnoses	General characteristics	Communicable component
Congenital heart disease	Congenital heart disease (including septal defects) and cardiac trauma	Relatively rare	None
Other heart disease (<i>other than those listed above</i>)	Miscellaneous diagnoses including cardiac trauma or cases without a definitive diagnosis	Relatively rare	None/undetermined
Other CVD (<i>no evidence of underlying heart disease</i>)	Peripheral arterial and cerebrovascular disease	Haemorrhagic stroke is a common form of CVD (particularly in rural regions). Increasing contribution from modifiable risk factors	Almost exclusively linked to lifestyle risk factors

Study data were documented on standardized forms and entered into a database (Microsoft Access) at the Soweto Cardiovascular Research Unit. Data were then verified and transferred to SPSS Statistics 17.0 for independent analyses at Baker IDI. Normally distributed continuous data are presented as the mean \pm standard deviation and non-Gaussian distributed variables as the median plus inter-quartile range. Categorical data are presented as percentages with 95% confidence intervals (CIs) presented where appropriate. For patient group comparisons, we initially used χ^2 analysis with calculation of odds ratios (ORs) and 95% CI (where appropriate) for discrete variables, Student's *t*-test and analysis of variance for normally distributed continuous variables. Multiple logistic regression analyses (entry model) were performed on demographic and baseline risk factor profile (all variables listed in Table 3) to derive adjusted ORs for the risk of presenting with historically prevalent vs. 'new' forms of heart disease. Mantel-Haenszel tests were also performed to examine the interaction between gender, age (age-groups), and type of case presentation. In order to address the third hypothesis amongst those with historically prevalent heart disease, the risk of presenting with more advanced heart disease (as evidenced by secondary valve disease and/or left ventricular systolic dysfunction) was assessed. Rate of case presentations per annum was calculated on an age- and sex-specific basis using contemporary Census data²⁰ for the Baragwanath Hospital catchment area. Significance was accepted at the level of 0.05 (two-sided).

Results

Study cohort

Table 2 shows the broad socio-demographic and clinical profile of this cohort comparing men to women (60% of the cohort) and African (87%) vs. other ethnicities. The latter comprised 292 Caucasian (5.5%), 219 Indian (4.1%), and 191 (3.6%) of mixed descent. There were proportionately more African women (54% of total) than men (33%). Although more men smoked tobacco, their mean BMI was markedly lower than women ($P < 0.0001$ for both comparisons). Men were also more likely to present with left ventricular systolic dysfunction (OR 1.71, 95% CI 1.50–1.95; $P < 0.001$) but numerically more women [1418 (45%) vs. 975 (45%)] presented with any form of HF. In addition to being collectively younger, the overall risk factor profile of Africans (less family history, less smokers, and lower cholesterol levels) was more favourable than other ethnicities ($P < 0.001$ for all sex-based comparisons).

Figure 1 shows the spectrum of 5328 *de novo* cases highlighting key differentials according to sex, ethnicity, and level of education in the pre-specified clinical groupings. The two largest groups were historically prevalent heart disease (39% of the total cohort) comprising 60% women and 93% Africans, and 'new' forms of heart disease (35%) comprising 56% women and 79% Africans ($P < 0.001$ for both comparisons). A similar proportion of men and women were diagnosed with a non-heart disease form of CVD including 87 cases of stroke/cerebrovascular disease (46 co-morbid cases of stroke were identified) and 57 cases of peripheral arterial disease (28 co-morbid cases). A further 999 cases, predominantly those with uncomplicated hypertension (primary diagnosis with no evidence of end-organ damage, $n = 988$) and 11 cases of type II diabetes (315 co-morbid cases—not shown), had a major risk factor without established heart disease. The proportion of cases with < 6 years (low) education ranged from 29% (other forms of CVD) to 48% ('new' heart disease).

Historically prevalent vs. 'new' forms of heart disease

The proportion of historically prevalent (1.8 ± 0.9 diagnoses overall) and new forms of heart disease cases (2.4 ± 0.8 diagnoses) was evenly poised. Table 3 demonstrates a number of socio-demographic and modifiable risk factors were potentially important in determining the type of presentation. On an adjusted basis, historically prevalent heart disease cases were more likely to be younger, African and be male. Conversely, they were less likely to originate from Soweto in addition to having a positive family history of CVD, elevated total cholesterol level, hypertension, and/or be obese.

We specifically examined age and sex trends according to whether an individual originated from Soweto or had 'migrated' to the area in the most prevalent racial group in the cohort—those of African descent ($n = 3308$). As shown in Figure 2 there were marked differences in the pattern of presentation on this basis. Overall, there were more cases of historically prevalent than new heart disease up to 49 years for women and 59 years for men, before this pattern reversed in older age groups. For female Soweetans, new heart disease case presentations continuously increased across all age groups compared with historically prevalent cases

Table 2 Demographic and clinical presentation (n = 5328)

	All (n = 5328)	Men (n = 2160)	Women (n = 3168)	African (n = 4626)	Other (n = 702)
Socio-demographic profile					
Mean age (years)	52.0 ± 17.4	52.8 ± 16.5	51.5 ± 17.9	51.5 ± 17.7	56.7 ± 14.1
African descent	4626 (87%)	1763 (82%)	2863 (90%)	4626 (100%)	—
Female	3168 (60%)	—	3168 (100%)	2863 (62%)	305 (43%)
<6 years education	2264 (43%)	933 (43%)	1331 (42%)	2018 (44%)	246 (35%)
Originally from Soweto	2835 (53%)	1079 (50%)	1756 (55%)	2807 (61%)	28 (4.0%)
Mean years living in Soweto	39.4 ± 17.9	38.2 ± 17.7	39.2 ± 18.1	38.8 ± 18.0	38.6 ± 15.8
Risk factor profile					
Family history of CVD	2157 (41%)	727 (34%)	1430 (45%)	1800 (39%)	357 (51%)
Total cholesterol (mmol/L)	4.2 ± 1.3	4.1 ± 1.3	4.4 ± 1.3	4.2 ± 1.3	4.8 ± 1.3
History of smoking (%)	2425 (46%)	1454 (67%)	971 (31%)	2000 (43%)	425 (61%)
Body mass index (kg/m ²)	28.2 ± 7.3	25.7 ± 6.0	29.8 ± 7.6	28.2 ± 7.2	28.0 ± 7.5
Clinical presentation					
NYHA II, III, or IV	3645 (68%)	1371 (63%)	2274 (72%)	3214 (69%)	431 (61%)
Systolic blood pressure (mmHg)	132 ± 27	132 ± 28	133 ± 27	133 ± 27	132 ± 26
Diastolic blood pressure (mmHg)	76 ± 15	76 ± 16	75 ± 16	76 ± 15	74 ± 14
Angina pectoris/chest pain	626 (12%)	241 (11%)	385 (12%)	505 (11%)	121 (17%)
Peripheral oedema	1702 (32%)	648 (30%)	1054 (33%)	1579 (34%)	123 (18%)
Mean LVEF (%)	54.4 ± 16.4	51.7 ± 16.7	56.3 ± 15.8	54.2 ± 16.5	55.8 ± 14.7
LV systolic dysfunction	1189 (26%)	592 (32%)	597 (22%)	1074 (26%)	115 (21%)
Diastolic dysfunction	759 (17%)	290 (16%)	469 (17%)	676 (16%)	83 (15%)
Primary diagnosis (%)					
Hypertensive heart failure	1146 (22)	414 (19)	732 (23)	1050 (23)	96 (14)
Hypertension	988 (19)	343 (16)	645 (20)	854 (19)	134 (19)
Valve disease	724 (14)	233 (11)	491 (16)	660 (14)	64 (9.1)
Coronary artery disease	581 (11)	342 (16)	239 (7.5)	271 (5.9)	310 (44)
Idiopathic dilated CMO	502 (9.4)	268 (12)	234 (7.4)	470 (10)	32 (4.6)
RHF/pulmonary hypertension	345 (6.5)	160 (7.4)	185 (5.8)	311 (6.7)	34 (4.8)
HIV-related heart disease	518 (9.7)	197 (9.1)	321 (10)	500 (11)	18 (2.6)

NYHA, New York Heart Association Class; LVEF, left ventricular ejection fraction; LV systolic dysfunction, LVEF <45%; CMO, cardiomyopathy; RHF, right heart failure; Diastolic dysfunction, based on E/A ratio and deceleration time according to generally accepted criteria.¹⁶

which peaked in 30–39 year olds and then declined slowly thereafter. Alternatively, for male Sowetans, new heart disease cases peaked between 50–69 years and then decreased thereafter while historically prevalent cases peaked in 50–59 year age group before decreasing. This pattern was very similar for male migrant Africans. For female migrants however, new heart disease case presentations peaked in 50–59 year olds before declining compared with historically prevalent cases which decreased across all age groups. Although there was no interaction between age, sex, and presentation in ‘migrants’, there was a borderline association in native Sowetans ($P = 0.059$); the probability of a women aged 20–29 years presenting with historically prevalent heart disease being 1.25-fold greater, but 0.67-fold less likely in the 70+ years age group relative to age-matched males.

Figure 3 shows the estimated rate of case presentations per 100 000 within the hospital’s catchment area (estimated at 1.45 million people aged ≥ 20 years) according to historically prevalent vs. ‘new’ heart disease. Case presentation in the former was

higher in those aged up to 49 years (rising from 19 to 60 cases/100 000 per annum), rising to a peak in those aged >60 years (211 cases/100 000 per annum). Case presentation with predominantly hypertensive HF and CAD was extremely low in those aged 20 to 39 years before rising dramatically thereafter to 343 cases/100 000 per annum in the oldest age group. Overall, the estimated rate of case presentation of historically prevalent vs. ‘new’ heart disease in adults living within the hospital’s catchment area was 45 and 42 cases/100 000 per annum, respectively.

Impact of modifiable risk factors in historically prevalent heart disease

Although modifiable/lifestyle risk factors were not abundant in those with historically prevalent heart disease ($n = 2092$), multivariate analyses indicated they may (along with socio-economic factors) still play an important role in determining the acuity of presentation. Secondary valve dysfunction in the setting of a

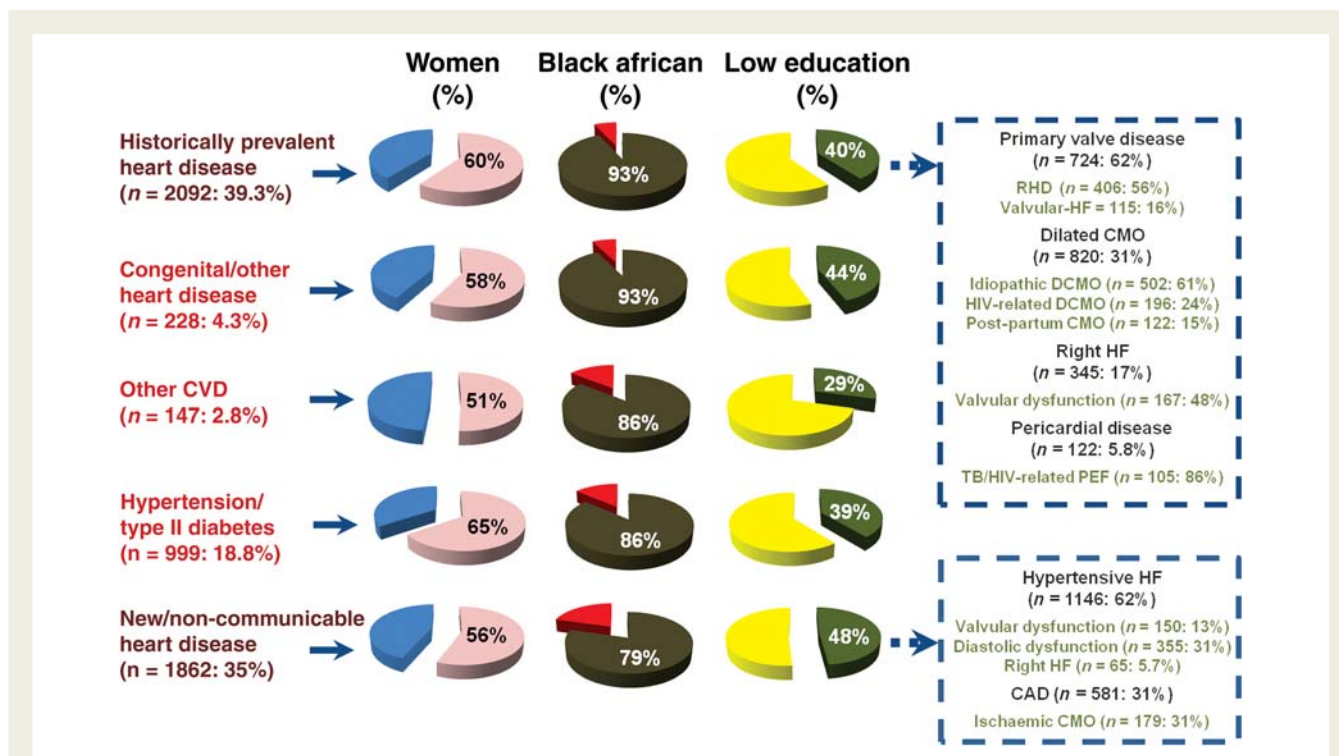


Figure 1 Spectrum of *de novo* case presentations (*n* = 5328).

Table 3 Socio-demographic and risk factor profile according to historically prevalent vs. ‘new’ heart disease (*n* = 3954)

	Prevalent heart disease (<i>n</i> = 2092)		New heart disease (<i>n</i> = 1862)		Adjusted odds ratio for prevalent disease All cases
	Men	Women	Men	Women	
Socio-demographic profile (%)					
Mean age in years	49.9 ± 17.2	45.8 ± 18.2	57.3 ± 13.9	59.4 ± 14.3	OR 0.98; 95% CI 0.97–0.99 (<i>P</i> = 0.001)
African descent (<i>n</i> = 3426)	749 (90)	1197 (95)	591 (73)	889 (85)	OR 4.59; 95% CI 2.76–7.60 (<i>P</i> = 0.0001)
Female (<i>n</i> = 2307)	—	1260 (100)	—	1047 (100)	OR 0.67; 95% CI 0.49–0.92 (<i>P</i> < 0.012)
<6 years education (<i>n</i> = 1740)	353 (42)	485 (38)	376 (46)	526 (50)	0.427
Originally from Soweto (<i>n</i> = 2093)	307 (37)	429 (34)	952 (51)	416 (40)	OR 0.87; 95% CI 0.75–1.00 (<i>P</i> < 0.045)
Years living in Soweto	36.7 ± 17.2	34.9 ± 18.1	41.7 ± 17.5	43.8 ± 17.2	0.624
Risk factor profile (%)					
Family history of CVD (<i>n</i> = 1591)	239 (29)	506 (41)	846 (45)	846 (45)	OR 0.75; 95% CI 0.57–1.01 (<i>P</i> = 0.054)
Total cholesterol level (>5.0 mmol/L) (<i>n</i> = 385)	40 (15)	63 (18)	119 (28)	201 (37)	OR 0.51; 95% CI 0.37–0.72 (<i>P</i> < 0.0001)
Hypertension (<i>n</i> = 2106)	234 (28)	377 (24)	596 (73)	899 (86)	OR 0.15; 95% CI 0.11–0.21 (<i>P</i> < 0.0001)
History of smoking (<i>n</i> = 1858)	576 (69)	372 (30)	562 (69)	348 (33)	0.516
Type II diabetes (<i>n</i> = 220)	24 (2.9)	32 (2.5)	68 (8.3)	96 (9.2)	0.672
Obese (BMI >30 kg/m ²) (<i>n</i> = 939)	75 (13)	284 (30)	163 (28)	437 (55)	OR 0.61; 95% CI 0.45–0.82 (<i>P</i> = 0.001)

dilated CMO was more common in men (adjusted OR 1.35, 95% CI 1.01–1.79; *P* = 0.041), those originating from Soweto (OR 1.34, 95% CI 1.03–1.74; *P* = 0.030), those with a smoking history (OR 1.74, 95% CI 1.31–2.29; *P* < 0.001), and increased BMI (OR 1.02, 95% CI 1.00–1.04 per kg/m²; *P* = 0.032). Similarly, those presenting with associated LV systolic dysfunction were also more

likely to originate from Soweto (adjusted OR 1.49, 95% CI 0.97–2.27; *P* = 0.069), have <6 years education (OR 1.57, 95% CI 1.12–2.20; *P* = 0.009) and a lower total serum cholesterol level (adjusted OR 0.80, 95% CI 0.70–0.92; *P* = 0.032). There was also a gradient in total cholesterol levels according to educational experience; 3.6 ± 1.4, 3.7 ± 1.3, and 4.2 ± 1.5 mmol/L in

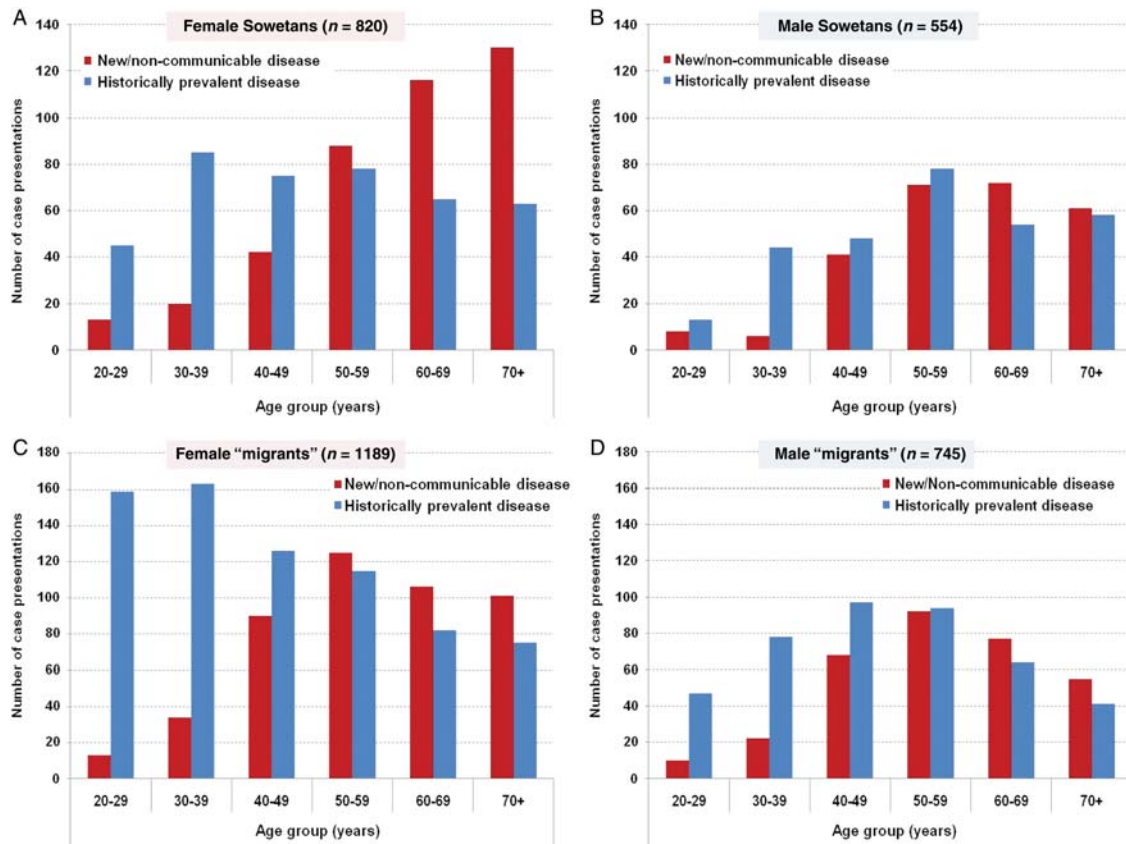


Figure 2 Pattern of 'new' and historically prevalent heart disease in Sowetan vs. 'migrant' Africans (n = 3308).

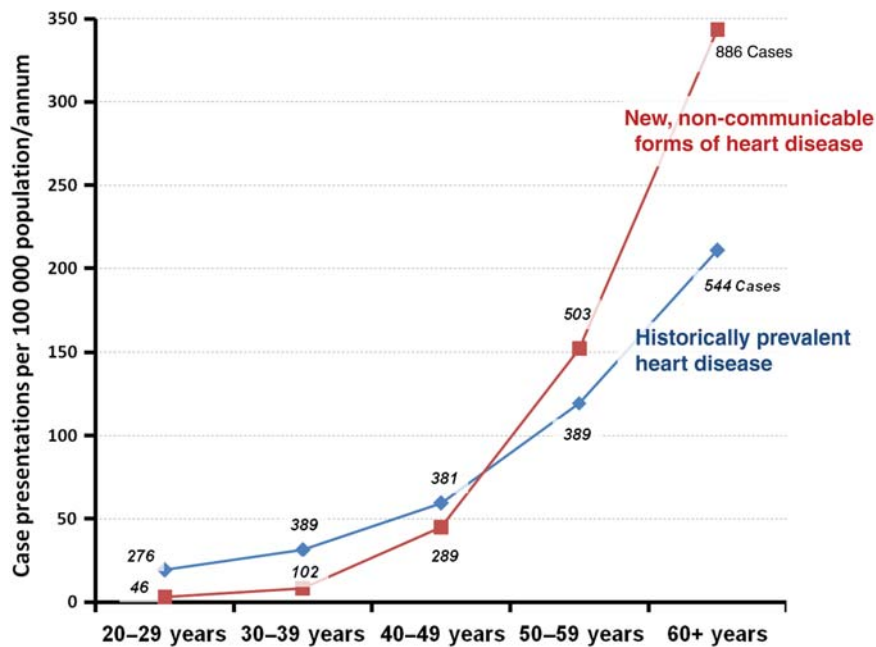


Figure 3 Rate of case presentation of historically prevalent vs. new forms of heart disease according to age group in all racial groups (n = 3805).

those with <6, 6–10 years and >10 years education, respectively ($P < 0.0001$).

Discussion

We present data from Sub-Saharan Africa's largest and most comprehensive cohort study of advanced forms of heart disease.^{21,22} As a likely barometer for other Sub-Saharan communities in epidemiological transition,^{21,22} the mostly African residents of Soweto are subject to dynamic and complex factors. This includes economic development, erosion of traditional lifestyles, rural migration, and global influences likely to adversely impact the health of vulnerable communities. A growing local appetite for products historically absent from the region (e.g. processed foods) will almost inevitably 'feed' new forms of disease. As a consequence of high levels of risk but poor awareness of healthy lifestyle choices, it appears that Soweto already stands at the crossroads between historically prevalent and newer forms of heart disease due to epidemiological transition. In particular, older African women (particularly those originating from Soweto) appear to be the greatest contributors to this phenomenon.

Specifically, we captured clinical data from 5328 *de novo* cases of hypertension and heart disease (the latter comprising almost 4000 cases). Contrary to contemporary reports,¹³ the single most prevalent form of heart disease was hypertensive HF (>1100 cases). When combined with 581 cases of CAD (47% of whom were African), the ratio of these 'new' vs. historically prevalent forms of heart disease was almost 1:1 (both numerically and population rate of presentation). Significantly, we also found a large pool of hypertensive cases at high risk of developing advanced heart disease.²³ Ominously, these data suggest that if South Africa continues to improve life expectancy through positive socio-economic changes and tackling of the HIV epidemic, the number of older adults (particularly women) paradoxically affected by non-communicable forms of heart disease will soon surpass the number of relatively younger adults affected by historically more prevalent disease states.

With the notable exception of hospital-based studies focusing on a single condition such as HF,²⁴ we are unaware of comparable reports from the region. When compared with the population-based studies across the spectrum of CVD,^{25–26} this study highlights a significant gap in our knowledge about advanced forms of heart disease in the region requiring more research capacity as the burden rises.¹⁴ Unfortunately, research funding is almost exclusively directed to towards combating communicable disease in Sub-Saharan Africa.²⁷ There is potential for a rise in heart disease linked directly to HIV and anti-retroviral therapy²⁸ (including CAD in individuals without significant atherosclerosis²⁹ and HIV-related CMO). However, the greatest threat appears to emanate from a complex set of socio-economic circumstances and the rise of non-communicable heart disease. In contrast to high-income countries, the most striking features of these data are the relatively young age of affected individuals and the predominance of women. However, there were clearly identifiable and predictable differences in the pattern of clinical presentations according to socio-demographic profile. It is interesting to note the expected pattern of increasing non-communicable heart

disease with advancing age overall but with a significant contribution from older African women (most notably Sowetans) and, by weight of numbers, migrants. Significantly, the prevalence of lifestyle risk factors (excepting dyslipidaemia and diabetes) was still relatively high in those with historically prevalent heart disease. As hypothesized, this influenced the acuity of such cases. Although there was a notable difference in the absolute proportion (93 vs. 79%) and adjusted risk of Africans presenting with historically prevalent vs. 'new' heart disease, it is important to note that almost 500 individuals of African descent per annum still presented with the latter.

It is important to consider if a predicted rise in non-communicable forms of heart disease is justified. Many studies have now documented a rise in life style risk factors in Sub-Saharan Africa.^{6,22} Consistent with epidemiological transition, urban regions, where traditional lifestyles associated with a near historical absence of atherosclerotic disease, are being replaced by that typically seen in high-income countries (particularly obese women) are affected most. The predominance of uncomplicated hypertension and hypertensive HF confirms bleak predictions of a wave of such cases in urban Sub-Saharan Africa.³⁰ The estimated rate of case presentations of non-communicable heart disease in the region (by its very nature a very conservative indicator) of 42 cases/100 000 population per annum is not inconsistent with the WHO estimate of an age-adjusted mortality rate of 389 deaths per 100 000 population/annum in South Africa.³¹

These data highlight many complex and challenging health issues for Soweto and beyond. In addition to revisiting strategies to combat 'old' problems such as RHD,⁹ we need to better understand the nexus between heart disease and HIV infection and likely trends within a population that now has high levels of both underlying infection/inflammation and modifiable risk factors. Fundamentally, these data reconfirm the urgent need to establish cost-effective (region-specific) primary prevention strategies and secondary prevention programmes³² with early disease detection and chronic disease programmes being an obvious priority.² At the same time, there is a need to better understand the underlying dynamics and drivers of epidemiological transition in different communities. Consequently, we are now focusing on the primary care burden and management of heart disease in Soweto³³ and the Heart of Africa Study examining heart disease throughout Sub-Saharan Africa.

This study has a number of limitations. A small proportion of potential cases (<10%) were not captured by our registry without evidence of systematic bias in case selection. Despite the central importance of Baragwanath Hospital to managing advanced forms of heart disease in Soweto, it does not reflect the full spectrum of disease (from minor to fatal events) in the community. Impending results from the Heart of Soweto Primary Care Registry (involving >1000 cases) will be important in this context. Moreover, unlike a recent study in Maputo, Mozambique we did not specifically focus on capturing cerebrovascular disease.³⁴ Although we systematically applied echocardiography and 12-lead ECG, clinical data were obtained according to the nature of the presentation. We also acknowledge the often arbitrary nature of case classifications given the complexity of case presentations and our decision to designate historically prevalent vs.

new heart disease based on previous reports. Estimate rates of case presentations (like those of the WHO) are complicated by a lack of reliable population data for a dynamic region with large numbers of migrants and itinerant households. By necessity, we also did not collect detailed socio-economic data (e.g. household income). Finally, it is possible that our systematic approach to screening has revealed previously hidden levels of non-communicable heart disease.

Our unique data suggest that Soweto, like other urban regions in Sub-Saharan Africa where modifiable risk factors such as hypertension and obesity are becoming the norm, sits at the crossroads between historically prevalent and 'new' forms of heart disease. If current trends continue, it appears inevitable there will be more patients with non-communicable than communicable heart disease in the near future. The worst case scenario is a sustained burden of complex cases involving predominantly young African women in whom modifiable risk factors alter the natural history of already prevalent disease and an ever increasing burden of relatively older cases with advanced forms of non-communicable heart disease. Clearly, specific primary and secondary prevention strategies will need to be developed to facilitate earlier detection and optimal management of such cases within a resource-poor health-care environment. As such, appropriate funding to combat the evolving burden of heart disease in these vulnerable communities is urgently required.

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Conflict of interest: All authors had full access to all the data in the study. The corresponding author had final responsibility for the decision to submit the report for publication. There is no conflict of interest for any of the authors of this manuscript.

References

- Abegunde DO, Mathers CD, Adam T, Ortegón M, Strong K. The burden and costs of chronic diseases in low-income and middle-income countries. *Lancet* 2007;**370**:1929–1938.
- Stewart S, Sliwa K. Preventing CVD in resource-poor areas: perspectives from the 'real-world'. *Nat Rev Cardiol* 2009;**6**:489–492.
- Essop MR, Wisenbaugh T, Sareli P. Evidence against a myocardial factor as the cause of left ventricular dilation in active rheumatic carditis. *J Am Coll Cardiol* 1993;**22**:826–829.
- Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: Part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. *Circulation* 2001;**104**:2746–2753.
- Tollman SM, Kahn K, Sartorius B, Collinson MA, Clark SJ, Garenne ML. Implications of mortality transition for primary health care in rural South Africa: a population-based surveillance study. *Lancet* 2008;**372**:893–901.
- Steyn K, Fourie J, Temple N. *Chronic Diseases of Lifestyle in South Africa: 1995–2005*. Cape Town: South African Medical Research Council; 2006.
- Tibazarwa K, Ntyintyane L, Sliwa K, Gerntholtz T, Carrington M, Wilkinson D, Stewart S. A time bomb of cardiovascular risk factors in South Africa: results from the Heart of Soweto Study 'Heart Awareness Days'. *Int J Cardiol* 2009;**132**:233–239.
- Stewart S, Wilkinson D, Becker A, Askew D, Ntyintyane L, McMurray JJ, Sliwa K. Mapping the emergence of heart disease in a black, urban population in Africa: the Heart of Soweto Study. *Int J Cardiol* 2006;**108**:101–108.
- Sliwa K, Wilkinson D, Hansen C, Ntyintyane L, Tibazarwa K, Becker A, Stewart S. Spectrum of heart disease and risk factors in a black urban population in South Africa (the Heart of Soweto Study): a cohort study. *Lancet* 2008;**371**:915–922.
- Mayosi BM, Flisher AJ, Lalloo UG, Sitas F, Tollman SM, Bradshaw D. The burden of non-communicable diseases in South Africa. *Lancet* 2009;**374**:934–947.
- Sliwa K, Carrington M, Mayosi BM, Zigiriadis E, Mvungi R, Stewart S. Incidence and characteristics of newly diagnosed rheumatic heart disease in urban African adults: insights from the heart of Soweto study. *Eur Heart J* 2010;**31**:719–727.
- Sliwa K, Fett J, Elkayam U, Peripartum cardiomyopathy. *Lancet* 2006;**368**:687–693.
- Brink AJ, Aalbers J. Strategies for heart disease in sub-Saharan Africa. *Heart* 2009;**95**:1559–1560.
- Setel PW, Saker L, Unwin NC, Hemed Y, Whiting DR, Kitange H. Is it time to reassess the categorization of disease burdens in low-income countries? *Am J Public Health* 2004;**94**:384–388.
- Stewart S, Wilkinson D, Hansen C, Vaghela V, Mvungi R, McMurray J, Sliwa K. Prevalence of heart failure in the Heart of Soweto Study cohort: emerging challenges for urban African communities. *Circulation* 2008;**118**:2360–2367.
- Sahn DJ, DeMaria A, Kisslo J, Weyman A. Recommendations regarding quantitation in M-mode echocardiography: results of a survey of echocardiographic measurements. *Circulation* 1978;**58**:1072–1083.
- Prineas RJ, Crow RS, Blackburn H. *The Minnesota Code Manual of Electrocardiographic Findings: Standards and Procedures for Measurement and Classification*. Boston, MA: John Wright; 1982.
- von Elm E, Altman DG, Egger M, Pocock SJ, Gotsche PC, Vandenbroucke JP. The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007;**70**:1453–1457.
- European Society of Cardiology. ESC guidelines. <http://escardio.org/knowledge/guidelines/> Accessed August 2010.
- Statistics South Africa. Mid-year population estimates. 2009. Statistical Release P0302.
- Albert MA. Heart failure in the urban African enclave of Soweto: a case study of contemporary epidemiological transition in the developing world. *Circulation* 2008;**118**:2323–2325.
- Vedanthan R, Fuster V. Cardiovascular disease in Sub-Saharan Africa: a complex picture demanding a multifaceted response. *Nat Clin Pract Cardiovasc Med* 2008;**5**:516–517.
- Stewart S, Libhaber E, Carrington M, Damasceno A, Abbasi H, Hansen C, Wilkinson D, Sliwa K. The clinical consequences and challenges of hypertension in urban-dwelling black Africans: insights from the Heart of Soweto Study. *Int J Cardiol* 2009; June 25 [Epub ahead of print] PMID: 19560221.
- Damasceno A, Cotter G, Dzudie A, Sliwa K, Mayosi BM. Heart failure in sub-Saharan Africa: time for action. *J Am Coll Cardiol* 2007;**50**:1688–1693.
- Kruger R, Kruger HS, Macintyre UE. The determinants of overweight and obesity among 10- to 15-year-old schoolchildren in the North West Province, South Africa: the THUSA BANA (Transition and Health during Urbanisation of South Africans; BANA, children) study. *Public Health Nutr* 2006;**9**:351–358.
- Brainin M, Teuschl Y, Kalra L. Acute treatment and long-term management of stroke in developing countries. *Lancet Neurol* 2007;**6**:553–561.
- Sridhar D, Batniji R. Misfinancing global health: a case for transparency in disbursements and decision making. *Lancet* 2008;**372**:1185–1191.
- World Health Organization. *Sub-Saharan Africa AIDS Epidemic Update Regional Summary*. Geneva, Switzerland: World Health Organization; 2008.
- Becker AC, Sliwa K, Stewart S, Libhaber E, Essop AR, Zambakides CA, Essop MR. Acute coronary syndromes in treatment-naïve Black South Africans with human immunodeficiency virus infection. *J Interv Cardiol* 2009;**23**:70–77.
- Addo J, Smeeth L, Leon DA. Hypertension in sub-Saharan Africa: a systematic review. *Hypertension* 2007;**50**:1012–1018.
- World Health Organization. *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*. Geneva, Switzerland: World Health Organization; 2009.
- Gaziano TA. Cardiovascular disease in the developing world and its cost-effective management. *Circulation* 2005;**112**:3547–3553.
- World Health Organisation. The World Health Report 2008: primary health care (now more than ever). <http://www.who.int/whr/2008/en/index.html>. Accessed August 2010.
- Damasceno A, Gomes J, Azevedo A, Carrilho C, Lobo V, Lopes H, Madede T, Pravinrai P, Silva-Matos C, Jala C, Stewart S, Lunet N. An epidemiological study of stroke hospitalisations in Maputo, Mozambique: a high burden of disease in a resource poor country. *Stroke* 2010;**41**:2463–2469.