Cardiovascular Disease in Africa
Impact of Socioeconomic factors, ethnicity and urbanization on risk factors and essential care

Karen Sliwa, MD, PhD, DTM&H, FESC, FACC

Homage celebrating life!
OVERVIEW

1. Understanding Heart Disease in Africa
   - Epidemiology, Socioeconomic & Political Context
   - The Heart of Soweto Studies
   - Heart of Africa: Multi-centre cohort studies
   - Heart Disease in Maternity in Africa

2. Complexities for Essential Care in Africa
AFRICA

2nd most populous continent
1 billion or...

16% of the world’s population

54 countries but before colonial rule

Africa comprises up to 10 000 autonomous groups with distinct languages and customs.
## Impact of Socioeconomic Status, Ethnicity, and Urbanization on Risk Factor Profiles of Cardiovascular Disease in Africa

Karen Sliwa, MD, PhD, FESC, FACC; Letitia Acquah, MD, MSc; Bernard J. Gersh, MB, ChB, DPhil, MACC, FRCP; Ana Olga Mocumbi, MD, PhD, FESC

*(Circulation. 2016;133)*

<table>
<thead>
<tr>
<th>Low Gini (&lt;0.38)</th>
<th>Medium Gini (0.38–0.55)</th>
<th>High Gini (&gt;0.55)</th>
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<tr>
<td>Australia</td>
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<td>Austria</td>
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<td>Romania</td>
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<td>Spain</td>
<td>Trinidad and Tobago</td>
<td>Swaziland</td>
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<td>Sweden</td>
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<td>Thailand</td>
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<tr>
<td>Switzerland</td>
<td>Uganda</td>
<td>United Republic of Tanzania</td>
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</table>
Multi-centre cohort study and meta-analysis of 48 independent prospective cohort studies with information on socioeconomic data and 25X25 risk factors (hypertension, current smoking, physical inactivity, high alcohol intake, diabetes, obesity)

- Estimated the association of socioeconomic data on all cause and cause-specific mortality in 7 high-income WHO member countries

- Participants from low socioeconomic status had a greater mortality compared to those with high socioeconomic status (HR 1.42). Association remained significant in adjusted models that include the 25 x 25 factors.

- Population attributable fraction was highest for smoking, followed by physical inactivity than socioeconomic status.

- Low socioeconomic status was associated with a 2.1 year reduction in life expectancy between 40-85 years compared to 0.5 years for obesity, 1.6 years for hypertension, 2.4 years for physical inactivity, 4.8 years for current smoking
Heterogeneity in key socio-demographic parameters in Africa

Keates AK, Mocumbi AO, Ntsekhe M, Sliwa K, Stewart S. Cardiovascular Disease in Africa: Epidemiologic Profile and Challenges; Nature Review Cardiology; 2016
Figure 3C. Prevalence rates of estimated mean cholesterol (mmol/L total cholesterol) in Africa (2010), as reported by the WHO InfoBase, International Federation of Diabetes, and World Bank. Combined estimated mean cholesterol prevalence rates (%) for males and females indicated by color code in the legend. Adapted from the WHO Global Comparable Estimates.

(Sliwa K et al. Circulation. 2016;133)

Figure 3D. Combined estimated prevalence rates (percent) for age- and sex-standardized cigarette smoking, as reported by the World Health Organization (WHO) InfoBase, International Federation of Diabetes, and World Bank. Combined age-standardized prevalence estimates of males and females who are currently smoking cigarettes are color-coded in the legend.
Urbanisation
Urbanization

South Africa’s population is more urbanised than rural

- 64.3% urbanised: 34.17 million people
- 35.7% rural: 18.9 million people

*mid-year 2016 (UN Data)*
The Heart of Soweto Studies
Soweto and not Framingham: The Heart of Soweto Studies


- more than 25 publications to date

- Soweto comprises a series of townships (SW Johannesburg)
- One of the largest urban concentration of Black Africans
- Official census (2001) estimated population of 2.1m
- Steady influx of migrants
- Economic transition: increased affluence
- Serviced by Baragwanath Hospital (3,500 beds)

An international collaboration
The primary goal of the “Heart of Soweto Studies” is to systematically examine and respond to the epidemiologic transition in risk behaviors and clinical presentations of heart disease in the community of Soweto.

- **Community Surveillance**

- **Tertiary Care Registry**

- **Primary Care Registry**
  - > 1300 patients subject to CV risk & clinical profiling (EHJ 2011)

- **Interventional Trials**
  - RCT of heart failure management (submitted 2016)

- **IT-based Education Projects**
  - Cardiac Disease in Maternity Educational Program www.hedu-africa.org
Fig 2: Pattern of “new” and historically prevalent heart disease in Soweto versus “migrant” black Africans
Primary Care Screening Soweto
Elevated risk factors but low burden of heart disease in urban African primary care patients


Major diagnostic groups in male (n = 449) and female (n = 862) case presentations
Impact of HIV/AIDS in the de novo presentation of heart disease

- Overall, 506 of 5328 de novo cases of heart disease were diagnosed as HIV-positive (9.5%).
- Women (62%), significantly younger than men 38 ± 14 vs. 42 ± 13 years (p = 0.002)
- Only 13 (2.6%) cases of HIV/AIDS presented with newly diagnosed coronary artery disease
HIV and the Heart: The Impact of Antiretroviral Therapy. A Global Perspective

Thienemann F, Sliwa K, Rockstroh J. Eur Heart J 2013
Incidence and characteristics of newly diagnosed rheumatic heart disease in urban African adults: Insights from the Heart of Soweto


- 60% of cases were women
- 20% presented with symptoms & signs of heart failure and EF <45%
- 25% needed surgery within a year
Figure 1a: Patient with rheumatic mitral valve disease imaged with a top-of-the range cardiac ultrasound machine
US Dollar: approx. 60 000

Figure 1b: Patient with rheumatic mitral valve disease imaged with a hand held cardiac ultrasound machine
US Dollar: approx. 6000
Heart of Africa: Multi-centre cohort studies
Heart of Africa Research Team
1006 patients prospective cohort study presenting with acute heart failure

Mean age: 52.3 ± 18.3 years  
Gender: 50.8% were women  
Ethnicity: Black Africans (98.5%)  
LV function: Mean LVEF 39.5% ± 16%  
Mortality: 17.9% in 6 months

Hypertension = 396 (40.4%)  
Rheumatic Heart Disease = 140 (15.4%)  
Idiopathic dilated Cardiomyopathy = 136 (13.9%)  
Ischemic Heart Disease = 77 (7.9%)  
Peripartum Cardiomyopathy = 75 (7.6%)  
Pericardial Effusion/Tamponade = 47 (4.8%)  
Other: Endemic = 39 (4.0%)  
Other: Emerging = 34 (3.5%)  
HIV Cardiomyopathy = 23 (2.4%)  
Endomyocardial Fibrosis = 13 (1.3%)

Dakar, Senegal 15  
Abeokuta, Nigeria 200  
Abuja, Nigeria 25  
Kano, Nigeria 205  
Douala, Cameroon 90  
Cape Town, South Africa 50  
Johannesburg, South Africa 62

Khartoum, Sudan 72  
Addis Ababa, Ethiopia 10  
Nairobi, Kenya 32  
Kampala, Uganda 154  
Maputo, Mozambique 76

Features of Patients with Acute Decompensated Heart Failure in the ADHERE (United States), EHFS II (Europe) and THESUS-HF (sub-Saharan Africa) Registries

*Sliwa K & Stewart S. Heart Failure in the Developing Word; D. Mann- HF companion to Braunwald’s Cardiology Textbook, 2015*

<table>
<thead>
<tr>
<th>Feature</th>
<th>ADHERE REGISTRY (n = 105,388)</th>
<th>ADHERE—AP (n = 10,171)</th>
<th>EHFS II REGISTRY (n = 3580)</th>
<th>THESUS-HF REGISTRY (n = 1006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, %</td>
<td>48</td>
<td>57</td>
<td>61</td>
<td>49</td>
</tr>
<tr>
<td>Mean age, years</td>
<td>72</td>
<td>66</td>
<td>70</td>
<td>52</td>
</tr>
<tr>
<td>Hypertension</td>
<td>73</td>
<td>64</td>
<td>63</td>
<td>45</td>
</tr>
<tr>
<td>Coronary artery disease, %</td>
<td>57</td>
<td>50</td>
<td>54</td>
<td>7</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>44</td>
<td>45</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Atrial fibrillation, %</td>
<td>31</td>
<td>24</td>
<td>39</td>
<td>18</td>
</tr>
<tr>
<td>Anemia, %</td>
<td>NA</td>
<td>NA</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Renal insufficiency, %</td>
<td>30</td>
<td>NA</td>
<td>17</td>
<td>8</td>
</tr>
</tbody>
</table>

*ADHERE, Acute Decompensated Heart Failure National Registry; ADHERE-AP, ADHERE Asia Pacific; EHFS II, EuroHeart Failure Survey II; THESUS-HF, The Sub-Saharan Africa Survey of Heart Failure.*
Figure 1. Unadjusted mortality at 1 year, by region and cause
Further Research on Heart Failure in Africa

**Economic Burden of Heart Failure: Investigating Outpatient and Inpatient Costs in Abeokuta, Southwest Nigeria**

Dikechukwu S. Ogha, Simon Stewart, Obinna E. Onyejekwe, Oyedipe-O Fusekile, Olumide O. Adeyeye, Taiwo Olumuyiwa, Karen Sliwa

**A predominance of hypertensive heart failure in the Abuja Heart Study cohort of urban Nigerians: a prospective clinical registry of 1515 de novo cases**

Dike Ojjii, Simon Stewart, Samuel Ajayi, Manven Mannak, and Karen Sliwa

**Renal dysfunction in African patients with acute heart failure**

Mahmoud L. Sami, Beth A. Dawson, Gad Cotter, Karen Sliwa, Christopher Edwards, Libette Liu, Albertino Damasceno, Bongani M Mayosi, Okechukwu S. Ogha, Charles Mondo, Anastase Dzudie, Dike B. Ojii, and Adrian A. Voors

PhD students supervised by Prof Karen Sliwa
Heart Disease in Maternity in Africa
<table>
<thead>
<tr>
<th>Region</th>
<th>Maternal mortality ratio (per 100 000 live births)</th>
<th>Number of maternal deaths</th>
<th>Annualised rate of change 1990-2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>World-wide</td>
<td>1990: 283.2 (258.6 to 306.9) 2003: 273.4 (251.1 to 296.6) 2013: 209.1 (186.3 to 233.9)</td>
<td>1990: 376,034 (343,483 to 407,574) 2003: 361,706 (332,230 to 392,393) 2013: 292,982 (261,017 to 327,792)</td>
<td>-0.3% (~1.1 to 0.6)</td>
</tr>
<tr>
<td>Developed countries</td>
<td>1990: 24.5 (23.0 to 26.1) 2003: 16.0 (14.9 to 17.0) 2013: 12.1 (10.4 to 13.7)</td>
<td>1990: 3827 (3596 to 4076) 2003: 2341 (2178 to 2490) 2013: 1811 (1560 to 2053)</td>
<td>-3.3% (~3.8 to 2.8)</td>
</tr>
<tr>
<td>Southern sub-Saharan Africa</td>
<td>1990: 150.8 (115.9 to 182.6) 2003: 490.4 (367.8 to 626.1) 2013: 279.8 (202.6 to 381.5)</td>
<td>1990: 2455 (1886 to 2973) 2003: 8406 (6305 to 10,733) 2013: 4898 (3547 to 6679)</td>
<td>9.1% (~6.1 to 11.8)</td>
</tr>
<tr>
<td>Botswana</td>
<td>1990: 205.8 (101.3 to 325.6) 2003: 1061.1 (523.3 to 1793.6) 2013: 480.8 (211.8 to 828.4)</td>
<td>1990: 95 (47 to 151) 2003: 504 (249 to 852) 2013: 228 (100 to 393)</td>
<td>12.6% (~6.9 to 18.0)</td>
</tr>
<tr>
<td>Lesotho</td>
<td>1990: 189.5 (130.9 to 255.2) 2003: 606.5 (419.2 to 849.2) 2013: 510.6 (303.5 to 772.7)</td>
<td>1990: 107 (74 to 144) 2003: 343 (237 to 480) 2013: 295 (175 to 446)</td>
<td>8.9% (~5.3 to 12.5)</td>
</tr>
<tr>
<td>Namibia</td>
<td>1990: 165.2 (99.1 to 223.4) 2003: 307.5 (212.4 to 440.0) 2013: 149.6 (90.3 to 236.1)</td>
<td>1990: 89 (54 to 121) 2003: 184 (127 to 263) 2013: 89 (54 to 141)</td>
<td>4.8% (~1.1 to 8.5)</td>
</tr>
<tr>
<td>South Africa</td>
<td>1990: 134.0 (93.3 to 175.2) 2003: 341.8 (227.8 to 481.0) 2013: 174.1 (96.3 to 274.9)</td>
<td>1990: 1403 (977 to 1835) 2003: 3739 (2492 to 5262) 2013: 1925 (1065 to 3041)</td>
<td>7.2% (~3.0 to 11.4)</td>
</tr>
</tbody>
</table>

*Kassebaum NJ, Bertozzi-Villa A, Sliwa K et al. [www.thelancet.com](http://www.thelancet.com) Published online May 2, 2014*
152 consecutive pregnant women assessed at cardiac maternity clinic over a period of 24 months

*Sliwa et al. Heart 2014*
Findings

- Disease patterns were markedly different to that seen in the developed world.

- However, joint obstetric–cardiac care in the low-resource cohort was associated with excellent survival outcome rates of pregnant mothers (even with complex diseases) and their offspring and was similar to that seen in the western world.

- Mortality typically occurred in the postpartum period, beyond the standard date of recording maternal death (9 out of 152 patients died, 8 post partum > 42 days)
Fig. 3. Cardiovascular conditions contributing to cardiac death ($n = 118$).

PPCM (34%) and complications of RHD (25.3%) were the most important causes of heart failure and maternal death.

### Factors contributing to death for the 2 major disease groups

<table>
<thead>
<tr>
<th>Avoidable factors</th>
<th>Whole group</th>
<th>Peripartum cardiomyopathy</th>
<th>Rheumatic heart disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient delay in seeking help</td>
<td>49 (41.5%)</td>
<td>16 (39.0%)</td>
<td>16 (45.7%)</td>
</tr>
<tr>
<td>Lack of expertise by medical staff managing case</td>
<td>35 (29.7%)</td>
<td>16 (39.0%)</td>
<td>12 (34.3%)</td>
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<tr>
<td>Delay in referral to appropriate level of care</td>
<td>31 (26.3%)</td>
<td>13 (31.7%)</td>
<td>8 (22.9%)</td>
</tr>
<tr>
<td>Delay in appropriate action</td>
<td>43 (36.4%)</td>
<td>15 (36.6%)</td>
<td>15 (42.9%)</td>
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Late maternal deaths: a neglected responsibility

Sliwa K, Anthony A. The Lancet 2016; 387: 2072-2073

Maternal mortality, no matter when and where it occurs, results in sequelae that extend beyond the loss of the life of a single woman.

Most countries record maternal death only up to 42 days postpartum because of the assumption that avoidable death in pregnant women occurs during pregnancy or shortly thereafter.

Globally, there are more postpartum and late maternal deaths from direct and indirect obstetric causes than maternal deaths during pregnancy.

Postpartum and late maternal deaths have not declined in the past decade, whereas deaths in the peripartum period have.

The International Classification of Diseases Code (ICD10) makes it obligatory to document the occurrence of pregnancy within a year of the death of any woman.

What is known is that late maternal deaths fall into the main categories: cardiovascular causes, thromboembolism, and suicide (likely linked to postpartum depression).
Prof. Karen Sliwa (World Heart Federation President-Elect, University of Cape Town), Prof. John Anthony (Head Maternity, Groote Schuur Hospital, UCT) and Dr. Liesl Zühlke (Saheart President, UCT) met with Dr. Aaron Motsoaledi, Minister of Health and Prof Melvyn Freeman, Cluster Manager: Non-communicable Diseases, National Department of Health, at their offices at the Department of Health, Pretoria to discuss the issues of poor reporting of late maternal death, the shortage of training of cardiovascular specialists and the importance of the South African academics and the Ministry joining forces.
OVERVIEW

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2. Complexities for Essential Care in Africa
Figure: Factors contributing to the epidemic of cardiovascular disease in low- and middle income countries (Sliwa et al. Circulation 2016)
Multiple challenges dealing with patients suffering from hypertension & cardiac disease in Africa

- Lack of awareness of CVD has impact on life expectancy.
- Poor access to health care is leading to late diagnosis of the precursors of CVD.
- Shortage of physicians and health care workers in Africa affects management.
- Lack of specialised centres and delays in referral.
- Lack of researchers and epidemiological data has impact of poor health care planning.

Gersh BJ, Sliwa K, Mayosi B, Yusuf S Eur Heart J 2010
**Challenge:** Lack of awareness of hypertension and cardiovascular disease

**Response:** Consider regional cultural, logistic, and economic factors upon the development of preventive and management strategies.
**Challenge:** Lack of awareness of hypertension and cardiovascular disease

**Response:** Preventing and Tackling CVD through Awareness Creation

Targeting pregnant women

www.hedu-africa.org/
www.hatter.uct.ac.za
Challenge: Poor access to health care is leading to late diagnosis of the precursors of CVD

Response: Point of care testing facilities access to health
**Challenge:** Despite the potential benefits of polypill, widespread availability and uptake have not yet occurred. Barriers exist at the physician, patient, and pharmaceutical manufacturing level.

**Response:** Obtaining the full public benefit of polypills will require education, advocacy, endorsement, and implementation of key global agencies such as WHO and national clinical bodies, as well as endorsement from government.
**Challenge:** Shortage of physicians and health care workers in Africa affects management

**Response:** Increase appropriate training for Africa and seek private partnerships

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**Cardiology–cardiothoracic subspeciality training in South Africa: a position paper of the South Africa Heart Association**

Karen Siliva, Lielal Zuhlke, Robert Kleinloog, Anton Doubell, Iltikar Ebrahim, Mohammed Essop, Dave Kettle, David Jankelow, Sojaidh Khan, Eric Klag, Sandrine Lecouur, David Mirela, Martin Mpe, Mpoko Ntselha, Les Osim, Francis Smit, Adriann Snyders, Jean Paul Theron, Andrew Thornton, Ashley Chin, Nico van der Merwe, Erika Deu, Andrew Sarkin

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**Training in South Africa**

**Cardiovascular Practitioners in South Africa**

- **Number per million**
  - Adult Cardiologists: 55.7
  - Paediatric Cardiologists: 30%
  - Adult Surgeons: 50%

- **Needed per million**
  - Brazil: 6.8
  - South Africa: 2

Cardiologists, Paediatric Cardiologists and Cardio-Thoracic surgeons qualified per annum
**Challenge:** Lack of researchers and epidemiological data has impact of poor health care planning

**Response:** NIH Fogarty Non-communicable disease leadership programs and funding of cohort-studies

- Prof Karen Sliwa
- Prof Michele Ramsay
- Prof Kerstin Klipstein-Grobusch
- Prof Nigel Crowther
- Thandiswa Ngcungcu
- Nadia Carstens
- Sandra Pretorius
- Soter Ameh
- Alex Kasembeli
- Angela Hobbs
- Venesa Pillay
- Kim Lamont
**Objective:** to develop skilled researchers who engage in meaningful integrated research to address the burden of disease of specific NCDs in African populations

- Genetic & genomic contributions to NCDs and risk factors
- Obesity
- Hypertension
- Kidney disease
- Describe the patterns of health and health care utilisation (urban & rural)
- Dietary intake and micronutrient status
- Burden of disease due to stroke, ischemic heart disease & hypertension
- School-based nutrition intervention in Soweto
- Preventing cardiovascular diseases in rural SA
- Evaluate Integrated Chronic Disease Management (ICDM) model
www.world-heart-federation.org

The Emerging Leaders Programme

The Emerging Leaders Programme has been created by the World Heart Federation to train and develop a long-term cadre of experts who collaborate, research, and act to reduce premature mortality from cardiovascular disease (CVD) globally by at least 25% by 2025 as targeted by the World Heart Federation and World Health Organization (“25 x 25”).

Cohorts (20 people per year) of Emerging Leaders are formed each year, with 2010-2016 marking the third year of the programme. The World Heart Federation aims to reach as many potential candidates as possible on a global basis. Candidates from academia, civil service, private industry and cardiovascular medicine are encouraged to apply. Candidates may be affiliated with a member organization of the World Heart Federation, but this is not mandatory.

This year’s programme is focusing on tobacco control and prevention and included a think-tank in Bangalore, India.

To learn more about the programme we invite you to read former Emerging Leader Benn Grover’s story and visit the website.

Salim Yusuf. MD (Bangalore), DPhil (Oxford), MRCP
World Heart Federation
President 2014-2016
Pan-African Society of Cardiology

www.pascar.org

The Heart of Africa
Profile of an evolving burden of communicable & non-communicable heart disease

Editors:
Simon Stewart, Karen Sliwa, Albertino Damasceno & Ana Mocumbi

PASCAR Governing Council
“passionate, knowledgeable, influential”

Published by Wiley Blackwell, West Sussex, United Kingdom, 2016

Online: www.pascar.org
## Summary of our recommendations based on the WHO ‘Best Buys” the way forward

*Sliwa et al. Circulation. 2016 10.1161/CIRCULATIONAHA.114.008730*

<table>
<thead>
<tr>
<th>Gaps in Knowledge &amp; Resources</th>
<th>Suggested next steps</th>
</tr>
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</table>
| **Reduced pool of trained health workers**  
  - Low rates of graduates from health professional schools  
  - Internal and External brain drain |  
  - Use of non-physician technicians, medical officers for service provision for most prevalent CVD  
  - Train community health workers for primary prevention, early detection of risk factors in the communities  
  - Involve community health workers in support for follow up of cardiovascular conditions and improvement of adherence to medication  
  - Improve salaries for health professionals and academics, promote career development and other incentives for teaching roles |

| Health system weaknesses in CVD area  
  - Clinicians apathy and lack of continuous training  
  - Lack of routine collection of CVD data  
  - Low and inconsistent drug availability and affordability  
  - Lack of education and strategies for increasing acceptance and adherence to chronic therapy  
  - Insufficient epidemiological data on NCD and risk factors  
  - Reduced operational research and low scientific output |  
  - Invest in equitable and high-quality primary care to better detect and manage risk factors such as high blood pressure, alcohol abuse and diabetes  
  - Implement continuous training of clinicians and non-physician health providers on prevention and management of cardiovascular diseases  
  - Develop context specific guidelines and algorithms for risk stratification and medical management of high risk individuals at primary level  
  - Make lower-cost tests available in low-income settings  
  - Increase access to essential medicines for CVD, by defining the minimum package for primary health care level and promoting simplified regimens, generic drugs and combination tablets  
  - Promote systems for cost recovery tailored to the setting and the local communities mode of living  
  - Strengthen the routine health information system imposing compulsory notification of CVD |
**Table 2: continued**

<table>
<thead>
<tr>
<th>Gaps in Knowledge &amp; Resources</th>
<th>Suggested next steps</th>
</tr>
</thead>
</table>
| Lack of comprehensive agenda for CVD prevention and control                                | - Incorporate strategies for health education and integrate risk factors control and initial management of CVD into primary health care  
- Regulate towards reduction of caloric intake, use of polyunsaturated fats, reduction of alcohol consumption  
- Apply the FCTC provisions aimed at reducing the supply of, and demand for, tobacco products (e.g. ban public smoking and increase price of tobacco)  
- Establish limits on salt for the more commonly used packaged foods and staples such as flour and bread  
- Promote healthy food choices by taxation of unhealthy food choices, improving access to fresh fruits and vegetables  
- Educate the public and health professionals for regular physical activity in urban populations, and introduce screening for high blood pressure at community level  
- Impose better planning of cities creating common open spaces for exercise and active leisure  
- Promote financial risk protection and universal health coverage |
| Lack of regulatory tools for risk factor control                                             | - Health policy decision makers inertia to legislate towards access to healthy diet and good lifestyle  
- Lack of population-level strategies for blood pressure control  
- Unhealthy patient behavior and knowledge of prevention of NCD  |
| Inadequate infrastructure for research and innovation                                       | - Small pool of scientists  
- Low investment in R&D infrastructure  
- Lack of S&T culture  
- Lack of recognition of the scientist’s role  |
| Inadequate infrastructure for research and innovation                                       | - Improve S&T infrastructure as part of poverty alleviation strategies  
- Implement Africa’s S&T Consolidated Plan of Action  
- Progressive increase in the % of GDP allocated to R&D  
- Reduce reliance on external financial support, which often targets short-term goals  
- Invest in regulation that promotes public-private partnerships on research  
- Incentives to students for engineering and new technologies |

CVD indicates cardiovascular disease; FCTC, Framework Convention for Tobacco Control; GDP, gross domestic product; NCD, noncommunicable disease; R&D, research and development; S&T, science and technology; and WHO, World Health Organization.
Conclusions and way forward

Africa faces many challenges in the detection and management of heart disease which includes:

- Cardiovascular disease prevention and management
- Detection and management of rheumatic heart disease
- Detection and management of cardiovascular disease in pregnancy

This needs to go hand-in-hand with research training and funding of projects.

The continent needs innovative approaches to close those gaps by dealing with inequality of education, access to health care and the profound shortage of health care providers.

*However, Africa is on the right track!*
Thank you