Global Epidemiology of Stroke with Special Reference to Sub-Saharan Africa

Rufus O. Akinyemi  MBBS, MSc, PhD, MWACP, FMCP.
Institute for Advanced Medical Research and Training
College of Medicine
University of Ibadan, Ibadan, Nigeria.
Learning Objectives

• In this session we will:

  - **Remind** ourselves of the recent definition of stroke.

  - **Appreciate** the trend of global and African epidemiology of stroke

  - **Understand the drivers** of the changing stroke epidemiology

  - **Be inspired** to identify where/how we can fit in, to tackle the growing burden of stroke in Africa.
Outline

• Stroke - definitions
• Epidemiology of Stroke _ Global
• Epidemiology of Stroke _ Africa
• Risk factors for Stroke
• Drivers of Changing Stroke Epidemiology
• Is Genetics important to Stroke in Africa ?
• Tackling the growing Stroke burden in Africa
• Conclusion
**Stroke Definition**

(Before Now)

- Global or focal disturbance of cerebral function resulting only from a vascular cause with dysfunction lasting more than 24 hours or resulting in death.

- Included in this definition are: cerebral infarction, intracerebral haemorrhage, subarachnoid haemorrhage

Revised Definition

- Stroke is defined as a sudden global or focal neurological deficit resulting from spontaneous hemorrhage or infarction of the central nervous system with objective evidence of infarction/hemorrhage irrespective of duration of clinical symptoms. AHA/ASA 2009.

- CT/MRI necessary to increase diagnostic accuracy.

Current concepts

- **TIA**: New definition classifies TIA as a transient episode of neurologic dysfunction caused by focal brain, spinal cord, or retinal ischemia, without evidence of acute infarction. No objective evidence of acute infarction in the affected region of brain or retina. *Sorensen et al Neuroimaging Clin N Am. 2011; 21(2): 303–313.*

- **Stroke**: Stemming from the new tissue-based definition of transient ischemic attacks (TIA), stroke can be defined as a sudden global or focal neurological deficit resulting from spontaneous hemorrhage or infarction of the central nervous system with objective evidence of infarction irrespective of duration of clinical symptoms. CT/MRI necessary to increase diagnostic accuracy. *Sacco RL et al Stroke. 2013;44:00-00. (cf Angina pectoris vs Myocardial infarction).*
Major Stroke Types

Ischaemic stroke

Haemorrhagic stroke

Subarachnoid haemorrhage
Trends in Global Stroke Epidemiology
• 17 million strokes per year
• 1 stroke every 2 seconds
• 6.5 million deaths per year
• 26 million stroke survivors
The burden of stroke in population
Stroke incidence rates over four decades (1970-2010), with a 42% ↓ in HIC and ↑ 100% LMIC. In 2000–08, overall stroke incidence rates in LMIC, for the first time, exceeded HIC by 20%.

- Feign et al, 2009
Global trends in stroke incidence rates per 100,000 person-years (1990-2015)

- Feigin et al, 2016
The global burden of disease used multi-state models implemented in the software program DisMod III. *Neuroepidemiology* 2012;38:30–40, Mathers CD British Medical Bulletin 2009; 92: 7–32
Age standardized Incidence of Ischemic Stroke 1990
Krishnamurthi RV Lancet Glob Health 2013;1: e259–81
Age standardized Incidence of Ischemic Stroke 2010
Krishnamurthi RV Lancet Glob Health 2013;1: e259–81
Age standardized Incidence of Hemorrhagic Stroke 1990

Krishnamurthi RV Lancet Glob Health 2013;1: e259–81
Age standardized Incidence of Hemorrhagic Stroke 2010

Krishnamurthi RV Lancet Glob Health 2013;1: e259–81
Global stroke deaths 1990-2020

Proportional contribution of deaths from stroke to all causes of deaths in the world (1990-2015)
Figure 2: Age-standardised stroke mortality per 100,000 people for 2010

Geographical variations in stroke mortality rates in 2015
Worldwide burden of all stroke deaths

Size of country proportional to the proportion of worldwide stroke deaths in that country
The reality of health care in areas of stroke burden
Prevalence

Feigin et al, 2015
Global trends in stroke DALYs rates per 100,000 person-years (1990-2015)
Absolute number of DALYs from stroke in the world (1990-2015)
Proportional contribution of DALYs from stroke to DALYs from all causes in the world (1990-2015)

In 2015, DALYs from stroke are the 2\textsuperscript{nd} leading cause of DALYs worldwide.
Estimated number of disability-adjusted life-years (DALYs) lost to stroke in 2020

- Developed world: 10 million
- Developing world: 52 million

Total 62 million

Source: Murray and Lopez, Lancet 1997
Epidemiology of Stroke in SSA
CLINICAL INVESTIGATIONS

Contributions of Noncommunicable Diseases to Medical Admissions of Elderly Adults in Africa: A Prospective, Cross-Sectional Study in Nigeria, Sudan, and Tanzania

Rufus O. Akinyemi, PhD,*† Isameldin M. H. Izzeldin, MBBS,*‡ Catherine Dotchin, MD,*‡ William K. Gray, PhD,*§ Olaleye Adeniji, MBBS,* Osheik A. Seidi, MBBS,* Josephine J. Mwakisambwe, MD,* Carl J. Mbina, MD,* Florence Mutesi, MD,* Helen Z. Msechu, MD,* Kien A. Mteta, MD,* Mayada A. M. Ahmed, MBBS,*§ Shahd H. M. Hamid, MBBS,*§ Nazik A. A. Abuelgasim, MBBS,* Sumia A. A. Mohamed, MBBS,* Ashraf Y. O. Mohamed, MBBS,* Fidelis Adesina, MBChB,* Mohammed Hamzat, MBBS,* Taiwo Olumuga, MBChB,* Venance P. Maro, MMed,* and Richard Walker, MD*‡§

RESULTS: In Africa, noncommunicable diseases (NCDs) accounted for 80.4% (n = 703) of admissions (n = 874), and tuberculosis, malaria, and the human immunodeficiency virus and acquired immunodeficiency syndrome accounted for 4.5% (n = 39). Stroke (n = 213, 24.4%) was the most common reason for admission, followed by cardiac or circulatory dysfunction (n = 155, 17.7%). Rates of hypertension were remarkably similar in the United Kingdom (45.8%) and Africa (40.0%).
About 30% of workers in an hospital (majorly non–clinical) could not identify the brain as the organ affected in stroke. 90% correctly identified hypertension as a risk factor. 14% considered evil spirit/witchcraft as cause of stroke. Spiritual healing was most preferred by 13%.
The burden of stroke in Africa: a glance at the present and a glimpse into the future

Mayowa O Owolabi, Sally Akarolo-Anthony, Rufus Akinyemi, Donna Arnett, Mulugeta Gebregziabher, Carolyn Jenkins, Hemant Tiwari, Oyedunni Arulogun, Albert Akpalu, Fred Stephen Sarfo, Reginald Obiako, Lukman Owolabi, Kwamena Sagoe, Sylvia Melikam, Abiodun M Adeoye, Daniel Lackland, Bruce Ovbiagele, as members of the H3Africa Consortium

Abstract

Objective: Information on the current burden of stroke in Africa is limited. The aim of this review was to comprehensively examine the current and projected burden of stroke in Africa.

Methods: We systematically reviewed the available literature (PubMed and AJOL) from January 1960 and June 2014 on stroke in Africa. Percentage change in age-adjusted incidence velocity, ischaemic stroke proportion, mean age and case fatality compared to high-income countries remain unknown.

Conclusions: While the available study data and evidence are limited, the burden of stroke in Africa appears to be increasing.
Stroke Incidence in Africa

- Hospital-based may show trends but not representative
- Community-based, door-to-door, multiple case ascertainment methods, including verbal autopsies, over 3 years, age-standardized preferred. *Owolabi MO West Indian Medical Journal. 2011; 60:412-421*

- **315.9 per 100 000 (281.6–352.3) in Dar-es-Salaam (urban) Tanzania in 2006** *Walker R Lancet Neurol 2010; 9: 786–92*

- **108.6 per 100 000 (95% CI 89.0–130.9) in Hai (rural) Tanzania in 2006**

- **58.0 per 100 000 in Lagos, 2007. Under-reporting** (surveillance for 1 year, verbal autopsies not utilized, prehospitalization deaths not captured, patients who presented in hospitals outside the community not captured). *Danesi MA J Neurol Sci. 2013;331:43-7.*
<table>
<thead>
<tr>
<th>Year</th>
<th>Country/location/setting</th>
<th>Author</th>
<th>Crude incidence per 100 000 per year</th>
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<tr>
<td></td>
<td>Hospital-based</td>
<td></td>
<td>Overall</td>
</tr>
<tr>
<td>1984</td>
<td>Libya, Benghazi, urban</td>
<td>Ashok</td>
<td>63</td>
</tr>
<tr>
<td>1985</td>
<td>South Africa: Atteridgeville and Mamelodi, suburban areas of Pretoria, urban</td>
<td>Rosman</td>
<td>101</td>
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<td>1991</td>
<td>Zimbabwe, Harare, urban</td>
<td>Matenga</td>
<td>31</td>
</tr>
<tr>
<td>1993</td>
<td>Libya, Benghazi, urban</td>
<td>El Zunni</td>
<td>48</td>
</tr>
<tr>
<td>2006</td>
<td>Mozambique, Maputo, urban</td>
<td>Damasceno</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td>Population/community-based</td>
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<td></td>
</tr>
<tr>
<td>1975</td>
<td>Nigeria, Ibadan, urban</td>
<td>Osuntokun</td>
<td>26</td>
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<tr>
<td>1993</td>
<td>Egypt, Sohag, mixed*</td>
<td>Kandil</td>
<td>180</td>
</tr>
<tr>
<td>1993</td>
<td>Egypt, Sohag, urban</td>
<td>Kandil</td>
<td>150</td>
</tr>
<tr>
<td>1993</td>
<td>Egypt, Sohag, rural</td>
<td>Kandil</td>
<td>210</td>
</tr>
<tr>
<td>2006</td>
<td>Tanzania, Hai, rural</td>
<td>Walker</td>
<td>95</td>
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<tr>
<td>2006</td>
<td>Tanzania, Dares Salaam, urban</td>
<td>Walker</td>
<td>108</td>
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<tr>
<td>2007</td>
<td>Nigeria, Lagos, urban</td>
<td>Danesi</td>
<td>25</td>
</tr>
<tr>
<td>2007</td>
<td>Egypt, Al-Kharga, mixed*</td>
<td>Farghaly</td>
<td>250</td>
</tr>
<tr>
<td>2007</td>
<td>Egypt, Al-Kharga, rural</td>
<td>Farghaly</td>
<td>230</td>
</tr>
<tr>
<td>2007</td>
<td>Egypt, Al-Kharga, urban</td>
<td>Farghaly</td>
<td>260</td>
</tr>
<tr>
<td>2012</td>
<td>Egypt, Al Quseir, urban</td>
<td>El Tallawy</td>
<td>181</td>
</tr>
</tbody>
</table>

*Combined rates including both rural and urban communities.
Stroke mortality in SSA

• In hospital – based studies, 1- month case fatality rate of up 50% (ICH – 72%, CI- 27%) were reported by Damasceno et al. Stroke 2010.

• In the INTERSTROKE Study, 1 – month CFR was 22% in Africa (compared to 4% in HIC)

• In the Tanzanian Incident Stroke Study, case fatality rate was 28.7% at 1 month and 84.3% at 3 years (Walker et al, 2010)
Stroke Prevalence in Africa

- Southern Africa Stroke Prevention Initiative (SASPI), demographic surveillance in 2001, a stroke prevalence study in Agincourt, rural South Africa, with diagnosis of stroke based on the WHO definition of stroke, yielded an age-standardized (Segi world population) stroke prevalence of **290 per 100,000 people** over the age of 15 years.

- In men, the prevalence was **281 per 100,000** and in women, **315 per 100,000** [Connor MD, *Lancet Neurol* 2007; 6: 269–78].

- Crude prevalence rate of stroke in urban Nigeria 2005/2006 was **114/100,000** [Danesi MA *Neuroepidemiology* 2007;28:216–23].
<table>
<thead>
<tr>
<th>Year</th>
<th>Country/location/setting</th>
<th>Author</th>
<th>Crude prevalence per 100,000</th>
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<tr>
<td></td>
<td></td>
<td>Overall</td>
<td>Male</td>
</tr>
<tr>
<td>1982</td>
<td>Nigeria, Igbo-Ora, rural</td>
<td>Osuntokun³⁷</td>
<td>58</td>
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<tr>
<td>1985</td>
<td>Tunisia Kelibia, mixed*</td>
<td>Atia-Romdhane⁴¹</td>
<td>42</td>
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<tr>
<td>1988</td>
<td>Ethiopia, central Ethiopia, rural</td>
<td>Tekle Haimanot³⁴</td>
<td>15</td>
</tr>
<tr>
<td>1993</td>
<td>Egypt, Sohag, mixed*</td>
<td>Kandil³¹</td>
<td>508</td>
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<tr>
<td>1993</td>
<td>Egypt, Sohag, urban</td>
<td>Kandil³¹</td>
<td>410</td>
</tr>
<tr>
<td>1993</td>
<td>Egypt, Sohag, rural</td>
<td>Kandil³¹</td>
<td>540</td>
</tr>
<tr>
<td>1994</td>
<td>Tanzania, Hai, rural</td>
<td>Walker³²</td>
<td>127</td>
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<tr>
<td>2002</td>
<td>South Africa: Agincourt Health and Population Unit, Limpopo province, rural</td>
<td>Connor³³</td>
<td>243</td>
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<tr>
<td>2006</td>
<td>Nigeria, Lagos, urban</td>
<td>Danesi³⁸</td>
<td>114</td>
</tr>
<tr>
<td>2009</td>
<td>Benin, Cotonou, urban</td>
<td>Cossi³⁴</td>
<td>460</td>
</tr>
<tr>
<td>2009</td>
<td>Egypt, Al-Kharga, mixed*</td>
<td>Farghaly²²</td>
<td>560</td>
</tr>
<tr>
<td>2009</td>
<td>Egypt, Al-Kharga, urban</td>
<td>Farghaly²²</td>
<td>580</td>
</tr>
<tr>
<td>2009</td>
<td>Egypt, Al-Kharga, rural</td>
<td>Farghaly²²</td>
<td>520</td>
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<tr>
<td>2010</td>
<td>Tanzania, Hai district, rural</td>
<td>Dewhurst³⁹</td>
<td>2300</td>
</tr>
<tr>
<td>2010</td>
<td>Egypt, Assuit, urban</td>
<td>Khedr³⁵</td>
<td>963</td>
</tr>
<tr>
<td>2013</td>
<td>Egypt, Qena, mixed*</td>
<td>Khedr³⁰</td>
<td>922</td>
</tr>
</tbody>
</table>

*Combined rates including both rural and urban communities.
Stroke Types in SSA – Data from the INTERSTROKE Study


<table>
<thead>
<tr>
<th>Stroke Type</th>
<th>Overall (n=13,447)</th>
<th>Western Europe, North America, Australia (n=1917)</th>
<th>Eastern and central Europe, Middle East (n=13,947)</th>
<th>South America (n=1,471)</th>
<th>China (n=3,987)</th>
<th>South Asia (n=2,850)</th>
<th>Southeast Asia (n=855)</th>
<th>Africa (n=973)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>62.2 (13.6)</td>
<td>66.7 (13.4)</td>
<td>63.9 (14.3)</td>
<td>65.8 (12.5)</td>
<td>61.9 (12.9)</td>
<td>59.6 (13.0)</td>
<td>56.6 (13.0)</td>
<td>58.7 (15.2)</td>
</tr>
<tr>
<td>Age ≤45 years</td>
<td>1582 (11.8%)</td>
<td>141 (7.4%)</td>
<td>143 (10.3%)</td>
<td>123 (8.4%)</td>
<td>364 (9.1%)</td>
<td>451 (15.8%)</td>
<td>156 (18.3%)</td>
<td>204 (21.0%)</td>
</tr>
<tr>
<td>Women</td>
<td>5434 (40.4%)</td>
<td>781 (40.7%)</td>
<td>556 (39.9%)</td>
<td>652 (44.3%)</td>
<td>1606 (40.3%)</td>
<td>1017 (35.7%)</td>
<td>352 (41.2%)</td>
<td>470 (48.3%)</td>
</tr>
<tr>
<td>Intracerebral haemorrhage</td>
<td>3059 (22.7%)</td>
<td>128 (6.7%)</td>
<td>117 (8.4%)</td>
<td>348 (23.7%)</td>
<td>1102 (27.6%)</td>
<td>785 (27.5%)</td>
<td>285 (33.3%)</td>
<td>294 (30.2%)</td>
</tr>
<tr>
<td>Ischaemic stroke</td>
<td>10,388 (77.3%)</td>
<td>1,789 (93.3%)</td>
<td>1,277 (91.6%)</td>
<td>1,123 (76.3%)</td>
<td>2,885 (72.4%)</td>
<td>2,065 (72.5%)</td>
<td>570 (66.7%)</td>
<td>679 (69.7%)</td>
</tr>
<tr>
<td>OCSP classification*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total anterior circulation infarct</td>
<td>673/10,388 (6.5%)</td>
<td>71/1,789 (4.0%)</td>
<td>72/12,777 (5.6%)</td>
<td>176/11,223 (15.7%)</td>
<td>127/2,885 (4.4%)</td>
<td>105/2,065 (5.1%)</td>
<td>33/570 (5.8%)</td>
<td>89/679 (13.1%)</td>
</tr>
<tr>
<td>Partial anterior circulation infarct</td>
<td>487/10,388 (4.6%)</td>
<td>809/1,789 (45.2%)</td>
<td>631/12,727 (49.4%)</td>
<td>404/1,123 (36.0%)</td>
<td>1306/2,885 (45.3%)</td>
<td>945/2,065 (45.8%)</td>
<td>383/570 (67.2%)</td>
<td>394/679 (58.0%)</td>
</tr>
<tr>
<td>Posterior circulation infarct</td>
<td>1,509/10,388 (14.5%)</td>
<td>353/1,789 (19.7%)</td>
<td>265/12,777 (20.8%)</td>
<td>146/1,123 (13.0%)</td>
<td>372/2,885 (12.9%)</td>
<td>258/2,065 (12.5%)</td>
<td>63/570 (11.1%)</td>
<td>52/679 (7.7%)</td>
</tr>
<tr>
<td>Lacunar infarction</td>
<td>2,789/10,388 (26.9%)</td>
<td>536/1,789 (30.0%)</td>
<td>267/12,777 (20.9%)</td>
<td>212/1,123 (18.9%)</td>
<td>1051/2,885 (36.4%)</td>
<td>549/2,065 (26.6%)</td>
<td>79/570 (13.9%)</td>
<td>95/679 (14.0%)</td>
</tr>
<tr>
<td>Undetermined</td>
<td>545/10,388 (5.3%)</td>
<td>20/1,789 (1.1%)</td>
<td>42/12,777 (3.3%)</td>
<td>185/1,123 (16.5%)</td>
<td>29/2,885 (1.0%)</td>
<td>208/2,065 (10.1%)</td>
<td>12/570 (2.1%)</td>
<td>49/679 (7.22%)</td>
</tr>
</tbody>
</table>
Why is the burden of stroke increasing in low to middle income countries?


- The average age of the populations increases
- Exposure to cardiovascular risk factors increases:
  - Smoking
  - Raised blood pressure
  - Raised blood glucose concentrations
  - Westernised diets
    - Low in fruit and vegetables
    - High in fat and salt
  - Physical inactivity
Risk Factors
10 risk factors are associated with 90% population attributable risk (PAR) risk of stroke

- history of hypertension (OR 2.64)
- current smoking (OR 2.09)
- waist-to-hip ratio (OR 1.65 for highest vs lowest tertile)
- diet risk score (OR 1.35) for highest vs lowest tertile;
- regular physical activity (OR 0.69)
- diabetes mellitus (OR 1.36)
- alcohol intake (OR 1.51) for more than 30 drinks per month or binge drinking
- psychosocial stress (OR 1.30)
- depression (OR 1.35)
- cardiac causes (OR 2.38)
- ratio of apolipoproteins B to A1 (OR 1.89) highest vs lowest tertile
• Globally, 90% of the burden of stroke are attributable to modifiable risk factors
  - Clusters of behavioural, metabolic and environmental risk factors:
    - Behavioural (smoking, poor diet, low physical activity)
    - Metabolic (↑SBP, ↑BMI, ↑FPG, ↑TC, ↓GFR)
    - Environmental (household air pollution from solid fuels, ambient particulate matter pollution, lead exposure)
Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013

Walter Leo Feigin, Gregory A Roth, Mohsen Naghavi, Priya Parmar, Rita Krishnamurthi, Sumeet Chugh, George A Mensah, Bo Norrvig, Ivy Shiue, Marie Ng, Kara Estep, Kelly Cerce, Christopher J L Murray, Mohammad H Forouzanfar, for the Global Burden of Diseases, Injuries, and Risk Factors Study 2013 and Stroke Experts Writing Group

### Summary

**Background** The contribution of modifiable risk factors to the increasing global and regional burden of stroke is... *Lancet Neurol 2016*

| Risk factor                                | Global | High-income Asia Pacific | Western Europe | High-income North America | Central Europe | Eastern Europe | South Asia | East Asia | South Central Asia | Andean Latin America | Central Latin America | Latin America | North Africa and Middle East | Central Asia | Middle East and North Africa | South Africa | Western sub-Saharan Africa | Eastern sub-Saharan Africa | West Africa | Central sub-Saharan Africa | Eastern sub-Saharan Africa |
|--------------------------------------------|--------|--------------------------|----------------|---------------------------|----------------|----------------|------------|----------|---------------------|------------------------|------------------------|---------------|-----------------------------|--------------|--------------------------|----------------------|-----------|--------------------------|--------------------------|
| High systolic blood pressure               | 1      | 1                        | 1             | 1                         | 1              | 1              | 1          | 1        | 1                   | 1                      | 1                      | 1             | 1                           | 1          | 1                        | 1                    | 1         | 1                        | 1                      |
| Diet low in fruits                         | 2      | 2                        | 4             | 4                         | 4              | 4              | 3          | 2        | 2                   | 2                      | 2                      | 2             | 2                           | 2          | 2                        | 2                    | 2         | 2                        | 2                      |
| High body-mass index                       | 3      | 6                        | 2             | 2                         | 2              | 2              | 3          | 2        | 2                   | 2                      | 2                      | 2             | 2                           | 2          | 2                        | 2                    | 2         | 2                        | 2                      |
| Diet high in sodium                        | 4      | 4                        | 6             | 10                        | 6              | 3              | 8          | 6        | 3                   | 4                      | 8                      | 4             | 7                           | 4          | 12                      | 5                    | 13        | 7                        | 9                      |
| Smoking                                    | 5      | 5                        | 5             | 5                         | 5              | 4              | 3          | 6        | 6                   | 6                      | 4                      | 6             | 6                           | 6          | 5                        | 5                    | 8         | 10                       | 12                     |
| Diet low in vegetables                     | 6      | 5                        | 5             | 5                         | 4              | 5              | 3          | 11       | 3                   | 5                      | 12                     | 14            | 6                           | 12         | 7                        | 14                   | 12        | 3                        | 3                      |
| Ambient particulate matter (2.5 μm)       | 7      | 8                        | 11            | 14                        | 12             | 10             | 9          | 10       | 10                  | 14                     | 8                      | 12            | 12                           | 9          | 12                      | 14                   | 12        | 3                        | 3                      |
| Household air pollution from solid fuels  | 8      | 7                        | 11            | 10                        | 12             | 7              | 10         | 7        | 12                  | 14                     | 11                     | 14            | 6                           | 7          | 12                      | 14                   | 12        | 6                        | 6                      |
| Diet low in whole grains                   | 9      | 7                        | 9             | 8                         | 9              | 7              | 8          | 7        | 5                   | 7                      | 5                      | 7             | 5                           | 7          | 6                        | 10                     | 7        | 12                       | 10                     |
| High fasting plasma glucose               | 10     | 10                       | 10            | 9                         | 7              | 11             | 9          | 10       | 9                   | 10                     | 9                      | 10            | 9                           | 10         | 9                        | 11                     | 8         | 11                       | 11                     |
| Low physical activity                      | 11     | 11                       | 8             | 6                         | 8              | 10             | 11         | 13       | 11                  | 13                     | 12                     | 14            | 10                           | 12         | 14                      | 12                     | 12        | 10                       | 10                     |
| Low glomerular filtration rate            | 12     | 12                       | 7             | 7                         | 13             | 9              | 12         | 14       | 10                  | 14                     | 10                     | 12            | 10                           | 9          | 11                      | 14                     | 12        | 6                        | 7                      |
| Alcohol use                                | 13     | 11                       | 12            | 11                        | 10             | 12             | 9          | 12       | 12                  | 11                     | 15                     | 14            | 16                           | 15         | 11                      | 13                     | 14        | 14                       | 14                     |
| Lead exposure                              | 14     | 14                       | 14            | 13                        | 14             | 16             | 15         | 10       | 16                  | 12                     | 14                     | 15            | 13                           | 14         | 16                      | 16                     | 15        | 15                       | 15                     |
| High total cholesterol                     | 15     | 13                       | 12            | 11                        | 13             | 12             | 11         | 13       | 13                  | 14                     | 15                     | 16            | 14                           | 14         | 10                      | 14                     | 16        | 15                       | 15                     |
| Second-hand smoke                          | 16     | 15                       | 15            | 15                        | 15             | 14             | 15         | 16       | 16                  | 16                     | 15                     | 16            | 16                           | 16         | 16                      | 16                     | 16        | 16                       | 16                     |
| Diet high in sugar-sweetened beverages     | 17     | 16                       | 16            | 16                        | 16             | 16             | 16         | 17       | 17                  | 17                     | 17                     | 17            | 16                           | 16         | 16                      | 16                     | 16        | 16                       | 16                     |

*Note: The table ranks risk factors based on their contribution to the burden of stroke. The highest risk factors are ranked 1, and the lowest are ranked 17.*
Figure 1: Stroke-related DALYs attributable to all modifiable risk factors combined for both sexes in 2013
DALY = disability-adjusted life-year.

Feigin et al, 2016
Feigin et al, 2016
Feigin et al, 2016
Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study

Martin J O’Donnell, Siu Lim Chin, Sumathy Rangarajan, Denis Xavier, Lisheng Liu, Hongye Zhang, Purnima Rao-Melacini, Xiaohai Zhang, Prem Pais, Steven Agapay, Patricia Lopez-Jaramillo, Albertino Damasceno, Peter Langhorne, Matthew J McQueen, Annika Rosengren, Mahshid Dehghan, Graeme J Hankey, Antonio L Dans, Ahmed Elsayed, Alvaro Avezum, Charles Mondo, Hans-Christoph Diener, Danuta Ryglewicz, Anna Czlonkowska, Nana Pogosova, Christian Weimar, Romina Iqbal, Rafael Diaz, Khalid Yusoff, Afzalhussein Yusufali, Aytekin Ogru, Xingyu Wang, Ernesto Penaherera, Fernando Lanas, Okechukwu S Ogah, Adesola Ogguniyi, Helle K Iversen, German Malaga, Zvonko Rumboldt, Shahram Oveisgharan, Fawaz Al Hussain, Daliwongwa Magazi, Yongchai Nilanont, John Ferguson, Guillaume Pare, Salim Yusuf; on behalf of the INTERSTROKE investigators

Summary
Background Stroke is a leading cause of death and disability, especially in low-income and middle-income countries. We sought to quantify the importance of potentially modifiable risk factors for stroke in different regions of the world.
O’Donnell, 2016

- Data confirm regional/geographic variation of PAR of stroke risk factors
- Implications for region- and country-specific primary and secondary prevention
Drivers of changing stroke epidemiology

- Demographic transition (population growth and ageing)
- Urbanization and changing environments
- Changing risk factor pattern
- Racial (? Genetic factors, gene – gene, gene – environment interactions)
Is Genetics important for Stroke in Africa?
Stroke Disparities and African ancestry

- Significant racial (ethnic) and geographical (environmental) disparities occur in stroke.
- African Americans have a higher predisposition, worse severity and often poorer outcomes compared to Caucasian Americans (US Studies).
- Black stroke survivors had poorer cognitive outcome compared to other racial groups (South London Stroke Register Study).
- Inherited genetic variations offer a possible explanation for the observed peculiarities of stroke in populations of African ancestry.
Genetic diversity of African populations

- The African population exhibits great genetic diversity.

- This contributes to variations in disease pattern eg Hbs and malaria.

Campbell and Tishkoff; Annu Rev Genomics
Genetic diversity of African populations

- The import of this on the pathobiology, phenomics and pharmacogenomics of cerebrovascular disorders are largely unexplored.

- Exploring genomics of diseases has great potentials for deeper insight, new therapeutics, neuro-protective agents and personalized medicine.

*Campbell and Tishkoff; Annu Rev Genomics Hum Genet. 2008; 9: 403–433*
## Genomics and health disparities

<table>
<thead>
<tr>
<th>Adapted Gene</th>
<th>Beneficial Trait</th>
<th>Negative Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBB</td>
<td>Confers incomplete resistance to lethal forms of malaria</td>
<td>Sickle Cell Trait Sickle Cell Disease</td>
</tr>
<tr>
<td>Regulatory Deficiencies of HBA and HBB</td>
<td>Confers incomplete resistance to lethal forms of malaria</td>
<td>α and β thalassemia</td>
</tr>
<tr>
<td>APOL1</td>
<td>Protection against Human African Trypanosomiasis</td>
<td>Kidney disease</td>
</tr>
<tr>
<td>ATP1A1, AQP2, CSK</td>
<td>Climate adaptation</td>
<td>Hypertension and Osmoregulation</td>
</tr>
<tr>
<td>DMD</td>
<td>Confers protection against Lassa fever</td>
<td>Duchenne Muscular Dystrophy</td>
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</tbody>
</table>

Rotimi et al, 2016
The burden of stroke in Africa: a glance at the present and a glimpse into the future

Mayowa O Owolabi, Sally Akarolo-Anthony, Rufus Akinyemi, Donna Arnett, Mulugeta Gebregziabher, Carolyn Jenkins, Hemant Tiwari, Oyedunni Arulogun, Albert Akpalu, Fred Stephen Sarfo, Reginald Obiaku, Lukman Owolabi, Kwamena Sagoe, Sylvia Melikam, Abiodun M Adeoye, Daniel Lackland, Bruce Ovbiagele, as members of the H3Africa Consortium

Stroke genomics in people of African ancestry: charting new paths

RO Akinyemi, B Ovbiagele, A Akpalu, C Jenkins, K Sagoe, L Owolabi, F Sarfo, R Obiaku, M Gebreziabher, E Melikam, S Warth, O Arulogun, D Lackland, A Oggunniyi, H Tiwari, RN Kalaria, D Arnett, MO Owolabi, for the SIREN investigators as members of the H3Africa Consortium

Review article

Neurogenomics in Africa: Perspectives, progress, possibilities and priorities

Rufus O. Akinyemi a,b,*, Mayowa O. Owolabi c, Tolulope Oyeniyi d, Bruce Ovbiagele e, Donna K. Arnett f, Hemant K. Tiwari f, Richard Walker g, Adesola Oggunniyi c, Raj N. Kalaria b,** and SIREN group of H3Africa Consortium
Stroke Investigative Research and Education Network (SIREN)
SIREN: Central Hypothesis and Objective

To develop suitable interventions, the stroke epidemic in Africa needs accurate epidemiologic, phenotypic and genomic characterization (first pillar of Stroke Quadrangle).

✓ **Aim**: To evaluate the *genomic and environmental risk factors for stroke in sub-Saharan Africa*, while simultaneously **building sustainable capacities** in phenomics, biobanking, genomics, biostatistics and bioinformatics.

✓ **Hypothesis**: Distribution of unique and novel genomic and environmental factors will account for the peculiar and hitherto unreported pattern, incidence, type, subtype and outcome of stroke among individuals of African ancestry.
• Unravel genomic and environmental risk factors for stroke in Africans.
• **CADET core**: Training and Capacity building for sustainability in all cores
• > 3000 case – control pairs

---

**SIBS – Phenomics and Comm. Eng.**

**SIBS - Genomics**

**SIBS – Biostatistics & Bioinformatics**

---

**Discovery Phase**

- Candidate gene . 25 SNPs
- GWAS African custom chip 2.5M SNPs
- WES/WGS; Pathway /Network analysis

**Replication Phase**

- Validate new SNPs and CNVs +/- InDels in REGARDS black sub-cohort, ISGC

---

**Genomic banking for future analysis**

- Further analysis with next nextGenSeq, functional genomics, emerging tech.

---

**Accurate phenotyping**

- **Cases**: ACCESS software-patent
- **Controls**: pictogram QVSFS created
- CVD screening of >7,000 subjects during comm. outreaches (>63).
- Task-shifting stroke training -model of translational genomics
AIM on ClearCanvas Enriched Stroke phenotyping
Software: ACCESS

- For standard/uniform reporting templates across multiple sites in multicenter studies.
- **USER-FRIENDLY**
  
  Facilitates…
  - concordant and reproducible classification of all stroke subtypes by multiple investigators
  - Multi-level adjudication/quality control of image report
  - Export of image data to other formats - XML map to Excel and merges easily with REDCap database
  - Archiving, backup & security
Preliminary Results
Risk factors for Ischemic stroke (64 %)

- Hypertension
- Dyslipidaemia
- Diabetes Mellitus
- Stress
- Cardiac diseases
- Raised Waist-Hip ratio
- High meat consumption
- Monthly income>$100
- Regular physical activity
- Regular vegetable intake
- Alcohol consumption

Risk factors for hemorrhagic stroke (36 %)

- Hypertension
- Dyslipidaemia
- Diabetes Mellitus
- Stress
- Cardiac diseases
- Raised Waist-Hip ratio
- High meat consumption
- Monthly income>$100
- Regular physical activity
- Regular vegetable intake
Comparison with REGARDS
(African Americans and European Americans)

• We compared stroke type and contributions of vascular risk factors among indigenous Africans (IA), African Americans (AA) and European Americans (EA)

• Using harmonized assessments and standard definitions, we compared data on stroke type and established risk factors for stroke in acute stroke cases age > 55 years in SIREN and REGARDS

• There were 811 IA, 452 AA and 665 EA stroke subjects, with mean age of 68.0±9.3, 73.0±8.3 and 76.0±8.3 years respectively (p<0.0001).

• Hemorrhagic stroke was higher in IA (27%) compared to AA (8%) and EA (5.4%; p < 0.001). Lacunar strokes were highest in IA (47.1%), followed by AA (35.1%), and then EA (21.0%; p < 0.0001).
Proportion of primary stroke types

- Indigenous Africans
- African Americans
- Indigenous Africans + African America
- European Americans

Ischemic
Hemorrhagic
Hypertension

- Indigenous Africans
- African Americans
- Indigenous Africans + African Americans

European Americans

$P<0.0001$ for all comparisons
• Hypertension was highest in IA (92.8%), followed by AA (82.5%) and then EA (64.2%; p<0.01).
• Diabetes mellitus (DM) was similar in IA (38.3%) and AA (36.8%) but lower in EA (21%; p<0.0001).
• Pre-morbid sedentary lifestyle was similar in AA (37.7%) and EA (34%) but lower in IA (8%).
• Behavioural factors such as sedentary lifestyle, alcohol and smoking may contribute to the higher proportion of ischemic stroke in AA compared to IA,
• **Inherited genetic variations offer a possible explanation for the higher proportion of hypertension and DM among stroke subjects of African ancestry as well as the proportion of risk that remains unexplained by traditional and emerging risk factors alone.**
Candidate gene studies
<table>
<thead>
<tr>
<th>CHR</th>
<th>Gene</th>
<th>SNP</th>
<th>Location Basepair</th>
<th>Minor Allele</th>
<th>OR</th>
<th>p-value</th>
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<td>7</td>
<td>IL6</td>
<td>rs1800796</td>
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<td>1.027</td>
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<td>16</td>
<td>ZFHX3</td>
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<td>G</td>
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<td>19039605</td>
<td>C</td>
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<td>0.9552</td>
</tr>
<tr>
<td>11</td>
<td>Sickle cell (HBB)</td>
<td>rs334</td>
<td>5248232</td>
<td>T</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
Next Steps...........
Genome-Wide Association Study using the H3Africa Consortium Chip

- Can probe for associations between a million (+?) genetic variants (SNP) and stroke phenotypes
- May identify novel genes - i.e., genes not previously suspected of playing a role in stroke
- Multiple testing can be problematic. Candidate genes identified here must be examined in replication studies
Tackling the growing Stroke burden in Africa
• The impact of stroke will grow into the future as populations age, and globalization grows with attendant lifestyle changes – especially in developing economies including Nigeria.

• To mark 40 years of the journal ‘Stroke’ Vladimir Hachinski, the WFN president led a synergium to advance the frontiers of stroke in all facets in all the regions of the world.
Stroke Neurologic Manpower in Africa

- No Stroke – specific postgraduate medical education programme in Africa (academic or professional)

- Most African strokologists are primarily neurologists with different levels of further training and research interest in stroke.

- Stroke units are springing up – Cape Town, Accra, Benin city, Ilorin, Cairo, with residents in Neurology, Internal Medicine and Geriatrics rotating through them.
“PROBLEMS CAN BECOME OPPORTUNITIES WHEN THE RIGHT PEOPLE COME TOGETHER.”

ROBERT SOUTH
Opportunities in stroke medicine in Africa

• Paucity of strokologists and allied health workers for effective MDT stroke research and practice.

• Neuroimaging challenges – availability and cost

• Lack of stroke rehab facilities

• Inequity of access to health care

• Stroke literacy and cultural beliefs

• Lack of stroke systems of care
Strategic keys to bridging the stroke training gap in Africa

- Global Health Perspective of Stroke Medicine
- African and North – South Networking and Collaborations
- Strong Leadership and Team work
- Creativity and Innovation: eg. Deploying IT
- Mentorship
- Tapping into the African Diaspora: Turning ‘Brain drain’ to ‘Brain gain’
- ‘Training – Service – Research’ Synergy
Strengthening capacity for health research in Africa

James A G Whitworth, Gilbert Kokwaro, Samson Kinyanjui, Valerie A Snein, Marcel Tanner, Mark Walport, Nelson Sewankambo

Kaddumukasa et al. Human Resources for Health 2014, 12:75
http://www.human-resources-health.com/content/12/1/75

Global medical education partnerships to expand specialty expertise: a case report on building neurology clinical and research capacity

Mark Kaddumukasa1, Elly Katabira1, Robert A Salata2, Marco A Costa3, Edward Ddumba4, Anthony Furlan5, Angelina Kakooza-Mwesige6, Moses R Kamya1, James Kayima1, Chris T Longenecker2, Harriet Mayanja-Kizza1, Charles Mondo1, Shirley Moore7, Svetlana Pundik8, Nelson Sewankambo9, Daniel I Simon2, Kathleen A Smyth10 and Martha Sajatovic11
The World Stroke Academy is a global online educational resource aimed at major stroke issues for CME of healthcare professionals.

Professional section:
- Case based adaptive e-Learning
- Interactive eLearning lectures
- Webcast/podcast past congresses
- Article reviews
- Guidelines
- CME certification

Patient/carers section:
Dear WSO Members,

This is a call for applicants for the WSO Clinical Exchange Programme for Young Stroke Professionals!

The WSO Brief Clinical Exchange Scholarships are designed to expose young stroke professionals from medical, nursing and allied health backgrounds to best practice clinical...
World Stroke Organization Global Stroke Services Guidelines and Action Plan

Patrice Lindsay\textsuperscript{1,2,*},\textsuperscript{†}, Karen L. Furie\textsuperscript{3,4,*},\textsuperscript{†}, Stephen M. Davis\textsuperscript{5,6,*},\textsuperscript{†}, Geoffrey A. Donnan\textsuperscript{6,7,*},\textsuperscript{†}, and Bo Norrving\textsuperscript{8,*}

Int J Stroke 2014;9:4-13
Fig. 1 Levels of health service capacity for stroke care.
<table>
<thead>
<tr>
<th>Advanced stroke services</th>
<th>Essential stroke services</th>
<th>Minimal healthcare services</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Access to advanced diagnostic services</td>
<td>☐ Access to basic diagnostic services – laboratory, ECG, CT scan, ultrasound</td>
<td>☐ Variable access to healthcare workers (nurses or lay workers)</td>
</tr>
<tr>
<td>☐ Access to physicians with stroke expertise</td>
<td>☐ Access to nurses</td>
<td>☐ Very limited access to physicians</td>
</tr>
<tr>
<td>☐ Access to advanced interventions in addition to tPA, such as interventional radiology and neurosurgery</td>
<td>☐ Access to physicians, although may not be stroke specialists</td>
<td>☐ No access to diagnostic services or hospital care</td>
</tr>
<tr>
<td>☐ Access to specialist rehabilitation therapists</td>
<td>☐ Access to acute thrombolysis with tPA</td>
<td>☐ Limited access to the most basic lifestyle preventative advice</td>
</tr>
<tr>
<td>☐ Access to community programs for recovery after stroke</td>
<td>☐ Access to elements of stroke unit care, including members of an interdisciplinary stroke team</td>
<td>☐ Care provided in local communities without coordination across defined geographic regions</td>
</tr>
<tr>
<td>☐ Fully coordinated stroke care provided across geographically discrete regions</td>
<td>☐ Access to rehabilitation services</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Access to stroke prevention therapies such as aspirin, lifestyle change recommendations, blood pressure management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Limited coordinated stroke care provided across geographically discrete regions</td>
<td></td>
</tr>
</tbody>
</table>

*These checklists should be used for self-assessment and for stroke services planning. The goal is to achieve as many checkmarks as possible and continually strive to provide the highest level of stroke services that is realistically and reasonably attainable, given local and regional resources and circumstances.

CT, computed tomography; ECG, electrocardiogram; tPA, tissue plasminogen activator.
Stroke medicine sub-specialty interest among young African neurologists and trainees

• 77 young African neurologists and trainees
  (IWGYNT – African group database)
• 10 African countries
• Sub-specialty interest (multiple choices)
  - Stroke medicine : 35 (45.5%)
  - Epileptology : 28 (36.4%)
  - Movement disorders : 21 (27.3%)
  - Neuroinfections : 17 (22.1%)
  - Cognitive Neurology : 10 (13.0%)
8th REGIONAL TEACHING COURSE IN SUB-SAHARAN AFRICA
MAPUTO, MOZAMBIQUE
10 – 12 NOVEMBER, 2016

Organised by EAN – European Academy of Neurology

In cooperation with:

African Academy of Neurology
American Academy of Neurology
International Brain Research Organisation
International PD and Movement Disorder Society
World Federation of Neurology

World Stroke Organisation

and

Eduardo Mondlane University of Maputo, Mozambique
A new alliance between the Florida Society of Neurology and the Nigerian Society of Neurological Sciences and Nigerian Stroke Society—the Nigeria-Florida Neuroscience Partnership—aims to develop neurology training and services in the West African country and eventually to expand to include research collaborations, exchange programs, mentoring, patient management, teleconferencing, and other collaborative efforts.

The Nigerian Stroke Society (NSS) is an affiliate of the Nigerian Society of Neurological Sciences (NSNS) and the World Stroke Organization. All NSNS members interested in stroke are NSS members. It was inaugurated in 2009. Prof. Yomi Ogun is president, Dr. Njide Okubadejo is vice president, and Dr. Babadele Oluwagbami is secretary-general.

The partnership was forged in response to recent study findings demonstrating that Nigeria’s high stroke and associated mortality rates, coupled with a shortage of trained neurologists and a lack of understanding of stroke in patients and health care providers alike, put the country at risk for further straining its already diminished resources.

The organizers also plan to focus on the development of clinical programs such as stroke units, independent subspecialty clinics, neurosurgical subspecialties, as well as the creation of guidelines for how neurological emergencies can be approached by neurologists and neurosurgeons, and by practitioners in pediatrics, internal medicine, emergency medicine, and general surgery when neurologists and neurosurgeons are not available.

The first Nigeria-Florida Neuroscience Partnership (NFPNP) conference was held Nov. 2-5 in Lagos, Nigeria. The Joint Steering Committee was co-chaired by Dr. Michael Pinski, representing the Florida Society of Neurology (FSN) and the World Neurology Foundation (WFN); Prof. Yomi Ogun of the NSNS, with the help of Dr. Njide Okubadejo, Dr. Rufus Akinwumi, and Dr. Bawani Ogunrin, all members of both the NSNS and NSS; and Dr. Hubert Fernandez, Dr. Ali Malek, and Dr. Susan Naselli, all of the FSN.

See Nigeria-Florida • page 3
What about allied stroke professionals?
Conclusion: An advanced practice nurse–centered discharge planning and home care intervention for at-risk hospitalized elders reduced readmissions, lengthened the time between discharge and readmission, and decreased the costs of providing health care.
Task-shifting training improves stroke knowledge among Nigerian non-neurologist health workers

Rufus O. Akinyemi a,g,*, Mayowa O. Owolabi b, Philip B. Adebayo c, Joshua O. Akinyemi d, Folajimi M. Otubogun a, Ezinne Uvere b, Olaleye Adeniji a, Osimhiarherhuo Adeleye a, Olumayowa Aridegbe a, Funmilola T. Taiwo f, Shamsideen A. Ogun e, Adesola Ogunniyi b

a Department of Medicine, University of Ibadan, Ibadan, Nigeria
b Department of Neurology, College of Medicine, University of Ibadan, Ibadan, Nigeria
c Department of Medicine, Federal Medical Centre, Owo, Ondo, Nigeria
d Department of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria
e Department of Neurology, University of Ibadan Teaching Hospital, Ibadan, Nigeria
f Department of Neurology, University College Hospital, Ibadan, Nigeria

Fig. 3. Association between respondents’ professional category and knowledge of thrombolysis before and after the training.
Final words..................

“With the trainees on the ground telling us what should happen, people are very positive about the future”
- Prof. Raj Kalaria.

“My African colleagues feel very optimistic about the future of neurological sciences in Africa”
- Prof. Alfred Njamnshi.

“I like the dreams of the future better than the history of the past”
- Thomas Jefferson.

“The future belongs to those who believe in the beauty of their dreams”
- Eleanor Roosevelt

Faculty at EAN RTC in Dakar, Senegal, July 2013
Summary

• An increase in global stroke burden with regional variations, LMIC being worst affected
• Growing burden of Stroke in Africa
• The current epidemiology is driven by certain modifiable and non-modifiable factors
• Capacity building, including task-shifting approaches and stroke services devp are needed to curtail the growing burden in Africa.
Acknowledgements
• **UK**
  Raj Kalaria
  Peter Sandercock (WSO)
  Janet Slade
  Peter Sandercock

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  Bruce Ovbiagele
  Donna Arnett
  Hemant Tiwari
  Mulugeta G.
  Samantha Hurst
  Philip Gorelick

• **Nigeria**
  Adesola Ogunniyi
  Mayowa Owolabi
  Joshua Akinyemi
  Godwin Ogbole
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