Demography, Epidemiology, and Statistics
What's Next?

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Zoom

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Outline
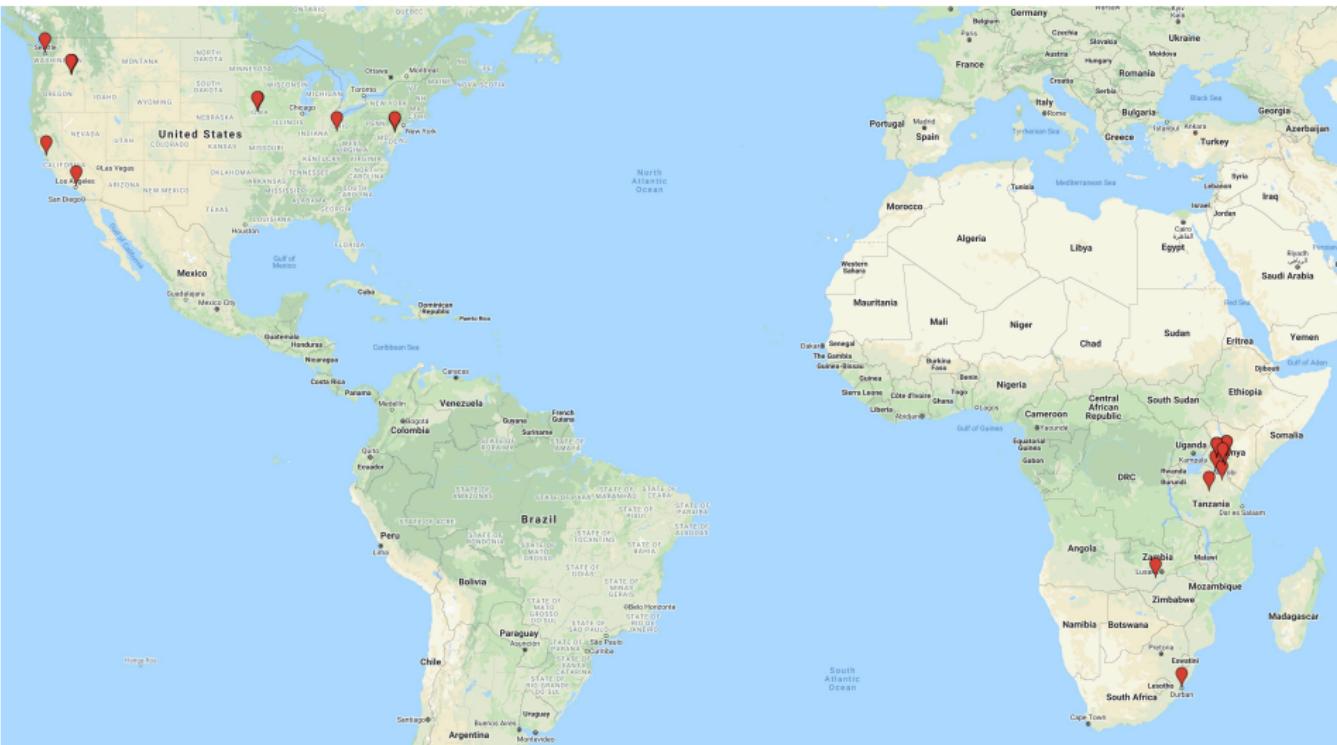
About me

Biographical summary:

- Professor at The Ohio State University, Columbus, Ohio, USA
- Demographer/Epidemiologist/[Statistician] → multidisciplinary
- Education in biology, engineering/computer science, and demography
- Born in Kenya, grew up in East Africa, parents American → mixed identity
- Most of my career working on topics affecting Africa
- Current work mostly on
  - statistical/computational methods for characterizing burden of disease in areas where traditional vital statistics systems do not function
  - mathematical models of age-specific mortality
  - methods to improve coverage and accuracy of mortality estimates

More information and PDFs of all publications: samclark.net, CV.

Lived/worked in East/Southern Africa and USA

23 places where Sam has lived

Outline

Research and applications

Research themes

- ▶ Africa-related demography and epidemiology
- ▶ Orphan mortality
- ▶ Methods
- ▶ Data methods
- ▶ Interviewer effects
- ▶ Small-area estimates
- ▶ *Indirect estimates of mortality*
- ▶ COVID-19 in Ohio
- ▶ Verbal autopsy

Software

Applications

In the following project summary slides, the paper titles are clickable links to the papers themselves

Africa: demography and epidemiology (selected publications)

HIV

- Returning home to die: Circular labour migration and mortality in South Africa
- Prevalence of HIV among those 15 and older in rural South Africa
- HIV Incidence Among Older Adults in a Rural South African Setting: 2010–2015

Epidemographic transition

- The Evolving Demographic and Health Transition in Four Low- and Middle-Income Countries: Evidence from Four Sites in the INDEPTH Network of Longitudinal Health and Demographic Surveillance Systems
- The Unfolding Counter-Transition in Rural Southa Africa: Mortality and Cause of Death, 1994–2009
- Socioeconomic differences in mortality in the antiretroviral therapy era in Agincourt, rural South Africa, 2001–13: a population surveillance analysis

Africa: demography and epidemiology (selected publications)

Household composition and mortality

- ▶ Household context and child mortality in rural South Africa: the effects of birth spacing, shared mortality, household composition and socio-economic status

- ▶ Assessing Changes in Household Socioeconomic Status in Rural South Africa, 2001–2013: A Distributional Analysis Using Household Asset Indicators

- ▶ Childhood mortality among former Mozambican refugees and their hosts in rural South Africa

Orphan mortality

Childrens' risk of dying related to their mother's death

- Young Children's Probability of Dying Before and After Their Mother's Death: A Rural South African Population- Based Surveillance Study

- The impacts of maternal mortality and cause of death on children's risk of dying in rural South Africa: evidence from a population based surveillance study (1992-2013)

- *Forthcoming:* Linking The Timing Of A Mother's And Child's Death: Comparative Evidence From Two Rural South African Population-based Surveillance Studies, 2000 - 2015

Methods

Various methods development publications

- ▶ A General Age-Specific Mortality Model With an Example Indexed by Child Mortality or Both Child and Adult Mortality

- ▶ The age pattern of increases in mortality affected by HIV: Bayesian fit of the Heligman-Pollard Model to data from the Agincourt HDSS field site in rural northeast South Africa

- ▶ Probabilistic population projections for countries with generalized HIV/AIDS epidemics

- ▶ Estimates of age-specific reductions in HIV prevalence in Uganda: Bayesian melding estimation and probabilistic population forecast with an HIV-enabled cohort component projection model

- ▶ Modeling Age-Specific Mortality for Countries with Generalized HIV Epidemics

- ▶ A parsimonious characterization of change in global age-specific and total fertility rates

Data methods

Tools for longitudinal data management

- ▶ Toward a Unified Timestamp with explicit precision
- ▶ A general temporal data model and the structured population event history register

Interviewer effects

Interviewers affect the data they collect

- ▶ Let's Talk about Sex, Maybe: Interviewers, Respondents, and Sexual Behavior Reporting in Rural South Africa
- ▶ Fieldworker effects on substance use reporting in a rural South African setting
- ▶ Validation, Replication, and Sensitivity Testing of Heckman-Type Selection Models to Adjust Estimates of HIV Prevalence

Small-area estimates and Hyak

Small-area estimation for child mortality

- ▶ Space–time Smoothing of Complex Survey Data: Small Area Estimation for Child Mortality
- ▶ Changes in the spatial distribution of the under-five mortality rate: Small-area analysis of 122 DHS surveys in 262 subregions of 35 countries in Africa

UNICEF small-area estimates of child mortality

- ▶ Subnational Under-five Mortality Estimates, 1990–2019

Hyak – merging health and demographic surveillance and sample surveys

- ▶ HYAK mortality monitoring system: innovative sampling and estimation methods – proof of concept by simulation

COVID-19

Partnership with Ohio Department of Health

- ▶ CV19 prevalence survey: Estimating Seroprevalence of SARS-CoV-2 in Ohio: A Bayesian Multilevel Poststratification Approach with Multiple Diagnostic Tests
- ▶ Excess deaths study
- ▶ Lessons: Monitoring epidemics: Lessons from measuring population prevalence of the coronavirus

Verbal autopsy – burden of disease

Verbal autopsy methods

- ▶ Probabilistic Cause-of-Death Assignment Using Verbal Autopsies
- ▶ Using Bayesian Latent Gaussian Graphical Models to Infer Symptom Associations in Verbal Autopsies
- ▶ Bayesian Factor Models for Probabilistic Cause of Death Assessment with Verbal Autopsies

Research

- ▶ An integrated approach to processing WHO-2016 verbal autopsy data: the InterVA-5 model
- ▶ Direct maternal deaths attributable to HIV in the era of antiretroviral therapy: evidence from three population-based HIV cohorts with verbal autopsy

Applications

- ▶ Member of WHO Verbal Autopsy Reference Group: standards, lots of work on new instrument, etc.
- ▶ Data for Health Initiative integrating verbal autopsy into CRVS
- ▶ ALPHA Network verbal autopsy

Software, applications, & reproducibility

Software and applications
- Github site
- openVA
- Data for health initiative: verbal autopsy in CRVS

Reproducibility
- *Open science*
- Data available
- All replication code available
- Preprint
- Open source tools
- If method, open source software that implements the method, e.g. R package or Python module
- Example: SVD-Comp

Outline

Possible contributions to LSHTM

Academia

- *Multidisciplinary*
- *International*
- Research
- Mentoring/teaching
- Funding

Community

- Engagement
- Impact and application

Vision

Academia

Multidisciplinary – all my work in the overlap between:

- Demography
- Epidemiology
- Statistics
- Data Science

International

- Africa: INDEPTH and ALPHA Networks of HDSS sites
- South African HDSS sites
- Developing work in Latin America: Brazil and Colombia
- Recently, CV19 work in Ohio

Academia

Research

- Verbal autopsy project with prominent partners: WHO, CDC, D4H, countries
- Mortality modeling project with UN Population Division
- CV19 surveillance in Brazil, Colombia
- Pandemic preparedness: pre-configured surveillance capabilities
- UNICEF/small-area estimates of child mortality collaboration
- Variety of smaller projects and new things developing: MITS Alliance/Gates, individual HDSS sites

Mentoring/teaching

- Masters and PhD students moved on to employment both in academia and industry
- Lots of co-publication with graduate students
- Experience teaching both graduate and undergraduate students – demographic methods, statistics, global health

Academia

Funding

- ▶ NIH
- ▶ Gates
- ▶ Wellcome
- ▶ Variety of contracts, mainly D4H through Vital Strategies and CDC Foundation

Community

Engagement

- ▶ SAC for INDEPTH and ALPHA Networks
- ▶ WHO Reference Group participation – Verbal Autopsy and previously Health Statistics
- ▶ UNICEF IGME contributor
- ▶ IUSSP Council
- ▶ PAA, various roles
- ▶ NIH review panels

Impact and application

- ▶ Open source software
- ▶ D4H openVA integration into CRVS – software development, implementation, and training

Outline

Critical issues

Looking forward a decade or two:

1. **Health**
   - ▶ Poor health results in wasted time, opportunities, and resources – can't address other challenges in poor health
   - ▶ Existing health issues: NCDs/aging, malaria, HIV, etc.
   - ▶ **Future zoonotic transmission-related epidemics**
   - ▶ **Bringing missing people – roughly half of global population – into the general accounting of health**
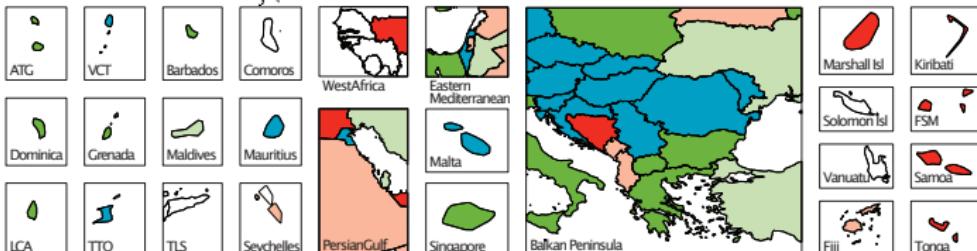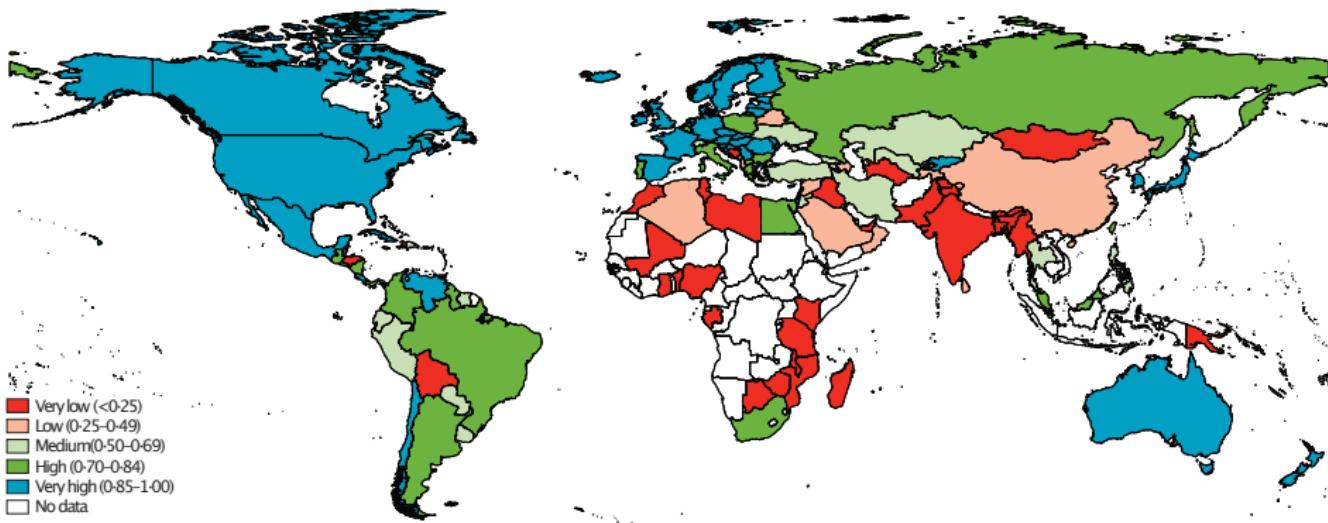
2. **Climate change**
   - ▶ Agriculture
   - ▶ Habitability, flooding, etc.
   - ▶ Extreme weather
   - ▶ Lots of unforeseen feedbacks and effects . . .
   - ▶ **Human activity creates this**

3. **Inequality, xenophobia, and bigotry of various kinds**
   - ▶ Holding us all back and a terrific waste of human capital
   - ▶ **Historical, structural situations – e.g. colonialism, slavery**
   - ▶ Lots of morally dubious structures and behaviors . . .

Health context - global VSPI (Mikkelsen et al., 2015)

Legend:
- Very low (<0·25)
- Low (0·25–0·49)
- Medium (0·50–0·69)
- High (0·70–0·84)
- Very high (0·85–1·00)
- No data

Caribbean

ATG, VCT, Barbados, Comoros, WestAfrica, Eastern Mediterranean, Marshall Isl, Kiribati

Dominica, Grenada, Maldives, Mauritius, Malta, Solomon Isl, FSM

LCA, TTO, TLS, Seychelles, PersianGulf, Singapore, Balkan Peninsula, Vanuatu, Samoa, Fiji, Tonga

Continue what I'm doing

- ▶ Verbal autopsy and burden of disease
- ▶ Mortality models
- ▶ Innovative data collection, monitoring, e.g. Hyak
- ▶ Epidemic monitoring
- ▶ New and updated methods, e.g. Bayes Brass indirect estimation for child mortality
- ▶ Variety of focused studies

Health

An alternative to IHME

- ▶ A global repository for health and population data, analysis, and forecasts is very useful

- ▶ IHME is one way of doing it – *located and operating in Global North with little involvement of Global South*

- ▶ *Areas of most interest for population and health change are in Global South*

- ▶ **Begin creating an alternative to IHME that is largely located in and focuses on the Global South**

- ▶ *Pragmatic approach* is to start with something comparatively small and focused and build from there:
  - ▶ Build on existing partnerships
  - ▶ Mutual partnerships with leadership and full participation from/in Global South
  - ▶ Integrated human capital development: for me, focusing on data science related to health
  - ▶ Mortality the COD in Africa and other developing regions
  - ▶ Population estimates and forecasts for some countries and subnational areas in Africa

Statistical Demography

Why?

- ▶ New data sources: digital exhaust, social media, remote sensing, administrative records, etc. – *many are unanchored and voluminous*

- ▶ Advances in computing and statistical methods – *computing power, storage, networking, and Bayesian statistics (efficient posterior sampling)*

- ▶ Traditional demographic methods are mostly deterministic and cannot handle new data sources → probabilistic methods – Bayes

- ▶ Need innovative approaches to data amalgamation and synthesized data collection/amalgamation and analysis, i.e. *real-time*, adaptive monitoring

Statistical Demography:

- **Generally probabilistic approach** – flexible quantification of uncertainty from variety of sources, not just sampling – often a Bayesian framework
- Flexible and amenable to data amalgamation
- Incorporates modern data science and open source software approaches and workflows
- Explore how machine learning can be used
- Embraces open science and reproducibility
- Not just methods – *integrated data collection and methods*
- *Training in demography/epidemiology, statistics, and computer science*
- Develop career opportunities and credit for people who primarily collect data

Demography in climate change research

Why?

- Human activities driving climate change
- Scale and growth of human population are key drivers
- Population dynamics potentially affected by climate change
- Economics links human activities and climate effects – markets and policy
- **Climate, population, and economic models largely function independently**
- **Need integrated model to fully understand how the three affect each other**
- Complex, non-linear system with lots of feedbacks!

Demography in climate change research

Population, climate, and economics modeling

- ▶ Construct modeling framework that links
  - ▶ population size and dynamics,
  - ▶ climate, and
  - ▶ markets and economic policy
- ▶ Use the model to
  - ▶ explore scenarios and gain heuristic understanding of joint system
  - ▶ discover as-yet unknown synergies in the joint system – positive and negative
  - ▶ characterize alternative interventions – effects, costs, timescales
  - ▶ produce joint forecasts of all three systems together
- ▶ Requires interdisciplinary team of demographers, statisticians, economists, atmospheric and other earth scientists, epidemiologists, and others

Hopefully, encourage some hope that we can do things to have a positive effect on climate change, population dynamics, and health

# Support and contribute to South-based human capital development
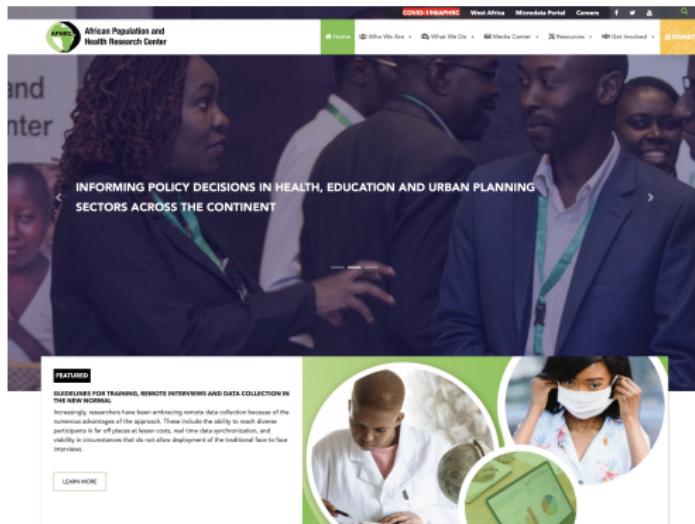
Examples

- ▶ The African Population and Health Research Center – APHRC (APHRC, 2021)

- ▶ The Consortium for Advanced Research and Training in Africa – CARTA (CARTA, 2021)

African Population and Health Research Center – APHRC

APHRC

- **Africa-led**
- Nairobi, Kenya
- Dakar, Senegal
- population & health research
- research capacity strengthening – *training*
- policy engagement and communications
- high impact, growing quickly
- URL: aphrc.org
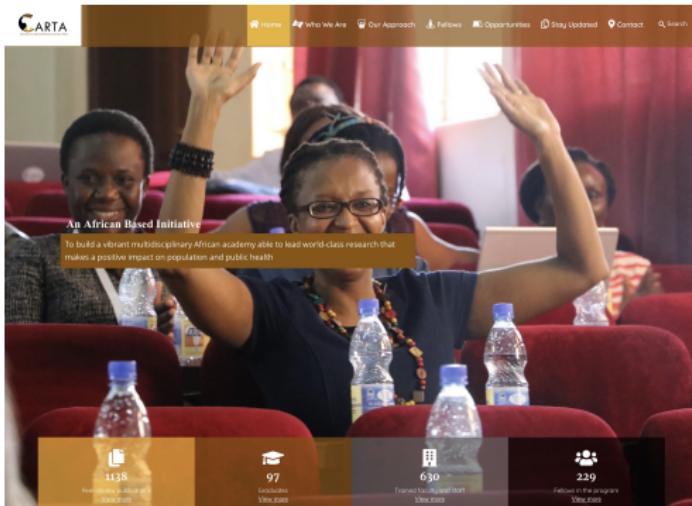
Consortium for Advanced Research Training in Africa – CARTA

Mission: Build high-level capacity for population and public health-related research in Africa

CARTA

- ▶ **wholly within Africa and Africa-led**
- ▶ consortium of African universities
- ▶ PhD training across consortium
- ▶ support young researchers: PhD, postdoc, faculty
- ▶ build critical mass of locally-trained and highly effective researchers
- ▶ URL: cartafrica.org

★

References

APHRC (Accessed March 23, 2021). APHRC – African Population and Health Research Center. https://aphrc.org.

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Mikkelsen, L., D. E. Phillips, C. AbouZahr, P. W. Setel, D. De Savigny, R. Lozano, and A. D. Lopez (2015). A global assessment of civil registration and vital statistics systems: monitoring data quality and progress. *The Lancet 386*(10001), 1395–1406.