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UNAIDS Reference Group and HIV/AIDS countries in SSA

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United Nations Expert Group Meeting on Methods for the World Population Prospects 2021 and Beyond

Population Division, Department of Economic and Social Affairs

6–8 April 2020

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Outline

1. Use of WPP in global HIV estimates.

2. Experience with population data in country estimates work.

3. Priority areas for UNAIDS Reference Group relevant to WPP population estimates.

4. A never-ending (slowly iterating) circle: HIV and all-cause mortality in SSA

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UNAIDS Reference Group

- Open cohort of experts in epidemiology, demography, statistics, surveillance, public health…
  - Coordinated by secretariat at Imperial College London, University of Cape Town, and Stanford University.

- Purpose: Provide scientific guidance to UNAIDS, countries, and partner organizations on the methods, data, and tools underpinning global HIV epidemic estimates.
  - Provide timely and independent expert review on contemporary issues and topics.
  - Develop new methods and tools responsive to policy needs, emerging data.
  - Coordinate and conduct data analyses to support national and global HIV response.

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Stanford University

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Global estimates for adults and children | 2018

People living with HIV	**37.9 million** [32.7 million–44.0 million]
New HIV infections in 2018	**1.7 million** [1.4 million–2.3 million]
AIDS-related deaths in 2018	**770 000** [570 000–1.1 million]

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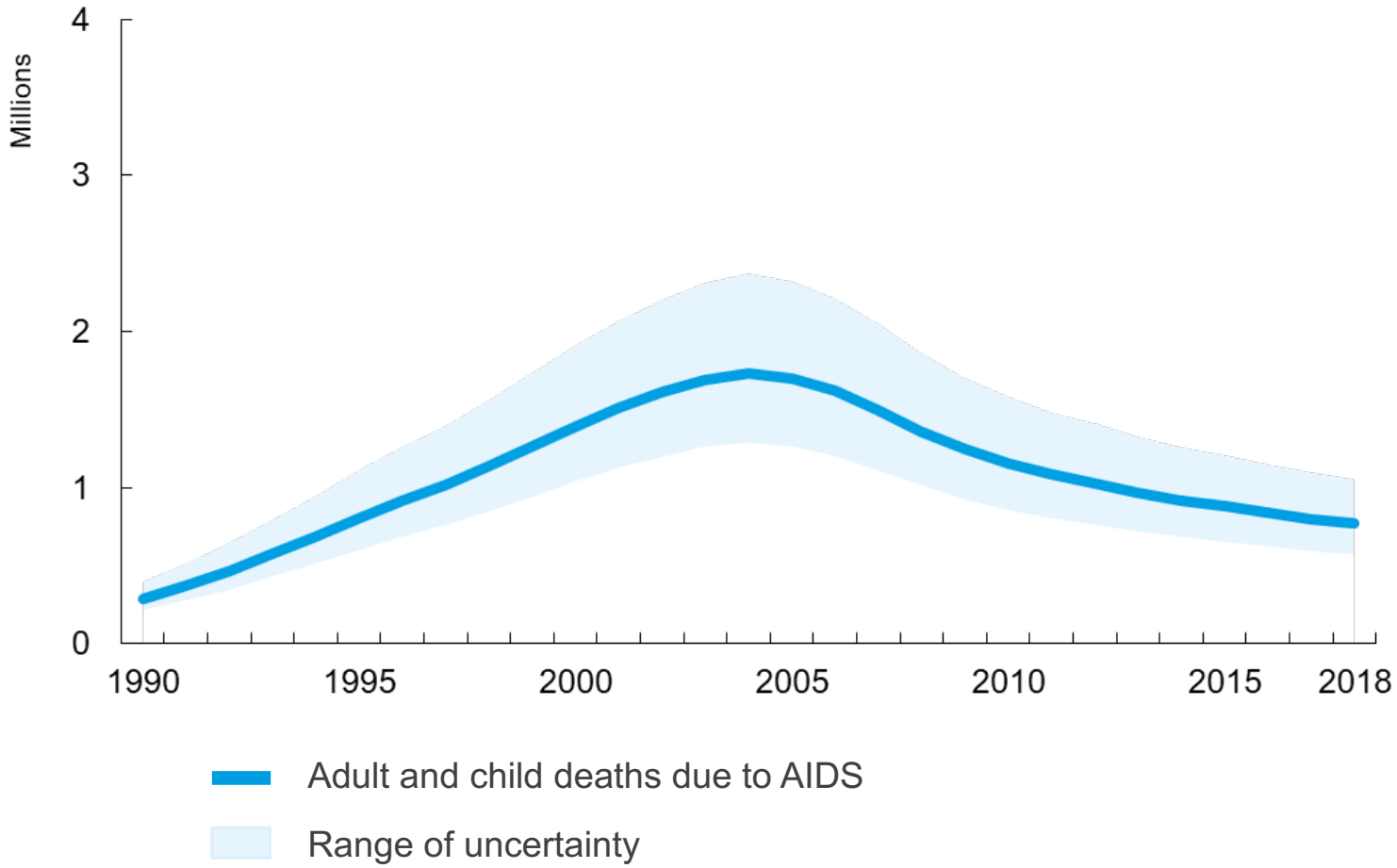
Adult and child deaths due to AIDS | 1990–2018



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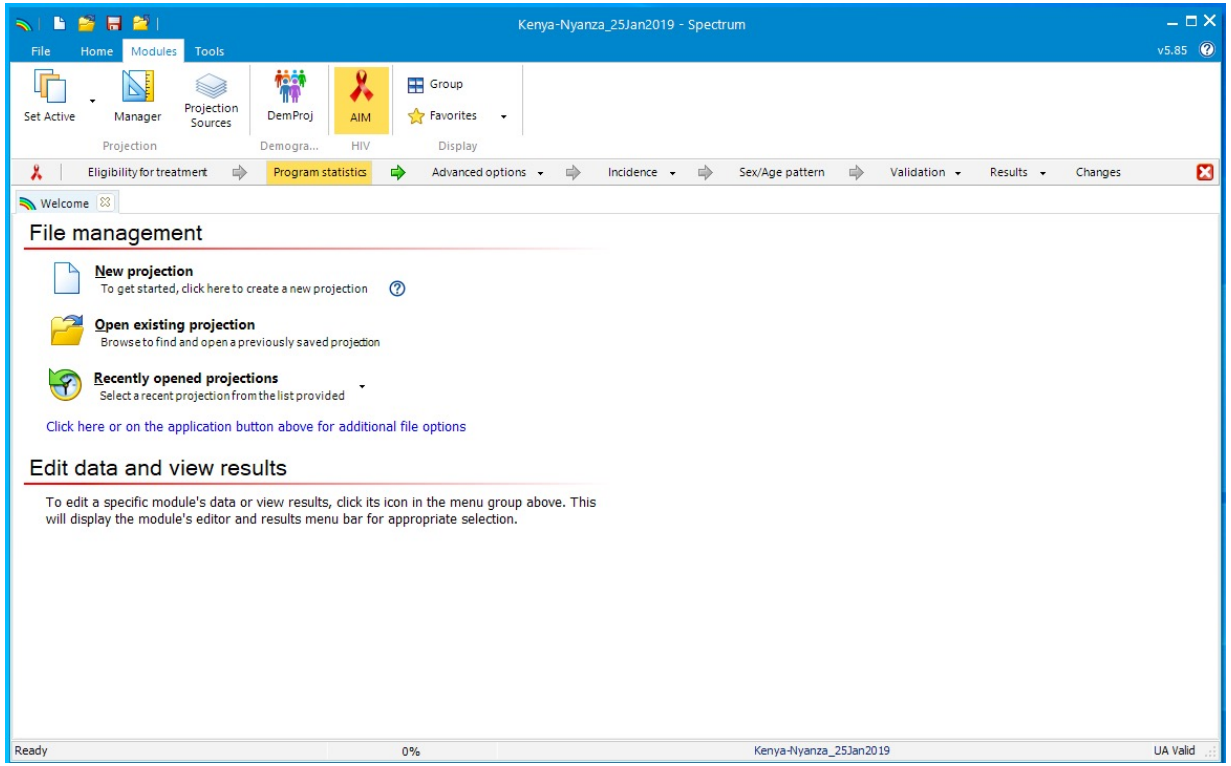
Spectrum model

- Multistate cohort component population projection model.
  - 1x1 population projection 1970-2025.
  - HIV infection, progression through stages of HIV infection, treatment.
- Requires all demographic inputs for CCMPP model.
  - Base population (1970), **non-HIV** mortality rates, age-specific fertility, net migration
- Total mortality = non-HIV mortality + AIDS mortality
  - Non-HIV life-table (CD or UN families)
  - AIDS deaths outcome of epidemic model fit to HIV surveillance data.
- Applied at national or admin 1 (province) level.



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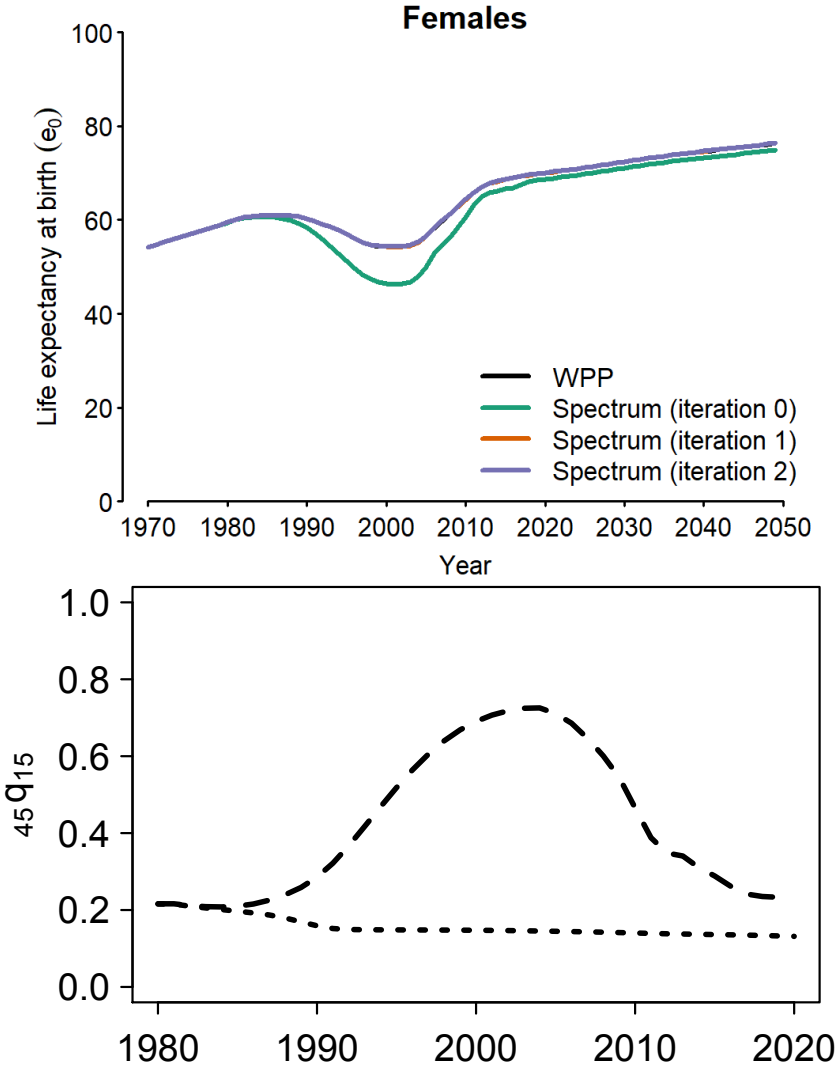
WPP in UNAIDS Spectrum estimates

- Most recent WPP iteration incorporated in Spectrum as default demographic inputs.
  - Updated every 2 years.

- Complex process:
  - Interpolation of quinquennial WPP outputs to annual.
  - Iterative adjustment of non-HIV life table.
  - Match WPP e0 when current estimates of AIDS deaths by age/sex added back.



Rob Glaubius; UNAIDS Reference Group, October 2019

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Country-led HIV Estimates Process

- Countries to produce their *own* HIV estimates using the Spectrum software, supported by UNAIDS.

- National estimates updated annually (Dec – March).
- Published in July via AIDSinfo.org.

- 2019: 151 countries produced national HIV estimates and shared with UNAIDS.
  - Twelve regional workshops
  - 450 national HIV programme, UN and bilateral organization SI officers

Mahy et al. AIDS 2019

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UNAIDS Estimates Regional Workshop; January 2019

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Experience with population data in country estimates work

- Requests by several countries to change default populations to match national sources.
  - New data not yet incorporated in WPP-based default inputs (e.g. new census).
  - Discrepancies / perceived deficiencies with WPP estimates.
  - Consistency of national populations with district population estimates.
  - Political imperative to reflect official NSO population estimates.
    - Irrespective of methodological considerations.
    - Including cases where 'official' estimates of population / fertility / mortality inconsistent.
    - Children under 5; adult men.
- Inconsistency of WPP estimates with data used for survey sampling frames / weighting (typically NSO).
- Recommendations:
  - WPP2021 focus on visualization, transparency, and reproducibility will substantially help adoption.
  - Alignment of WPP methods and tools with training and TA for NSOs.

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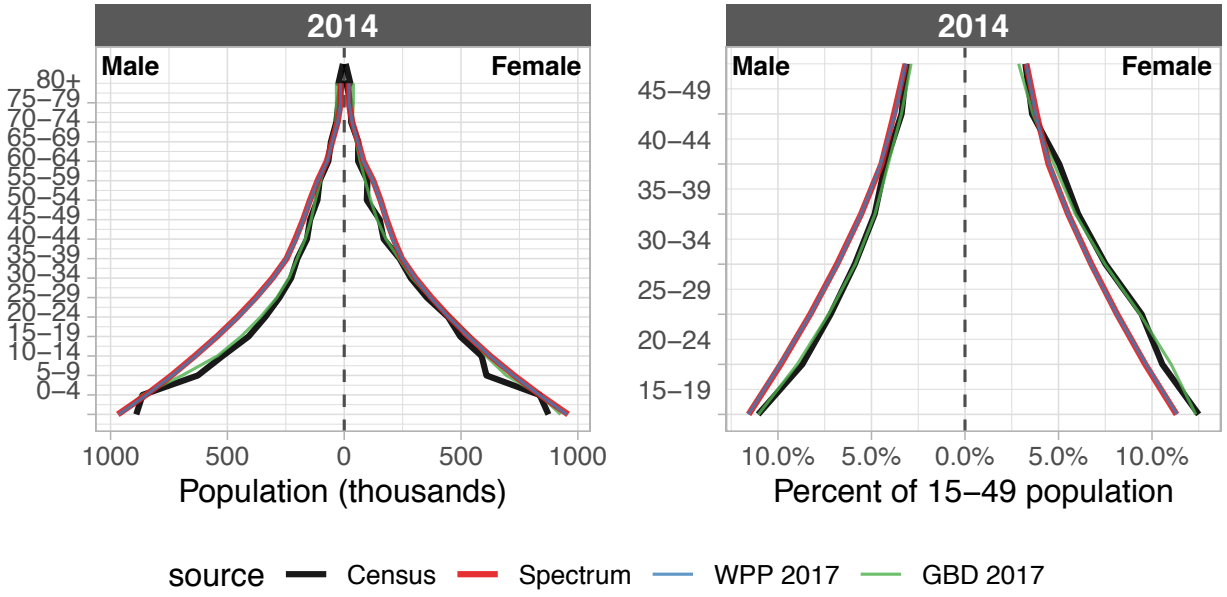
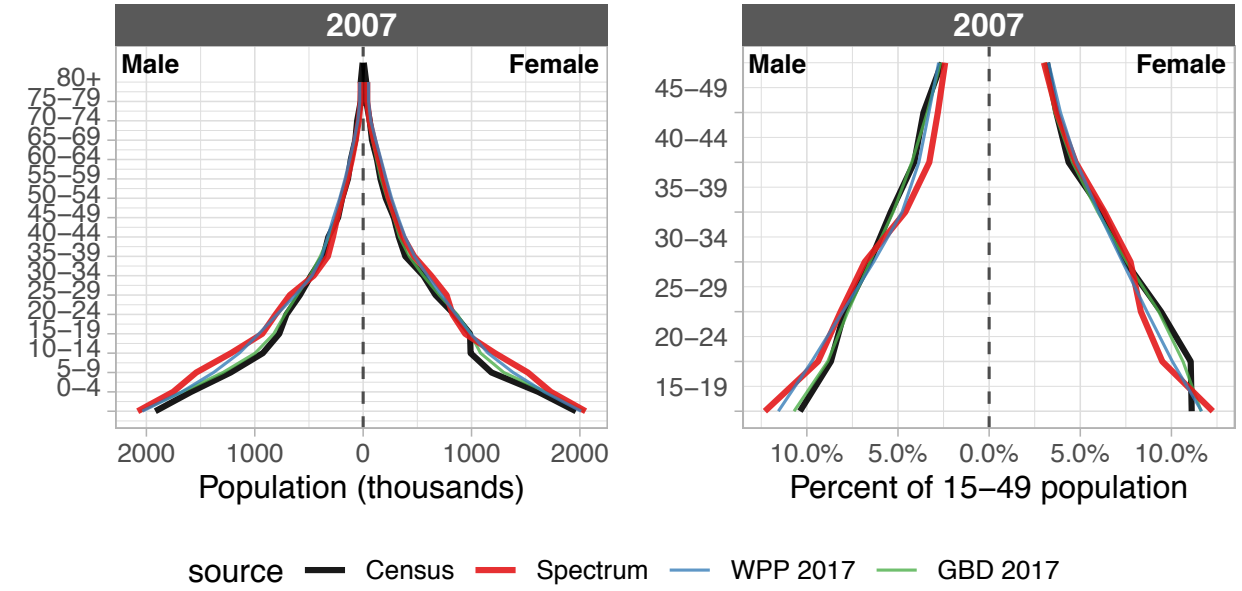
Female-to-male sex ratio among adults

- Systematically fewer working age men (25-44) in SSA censuses vs. population projections.

GIN: Guinea



MOZ: Mozambique



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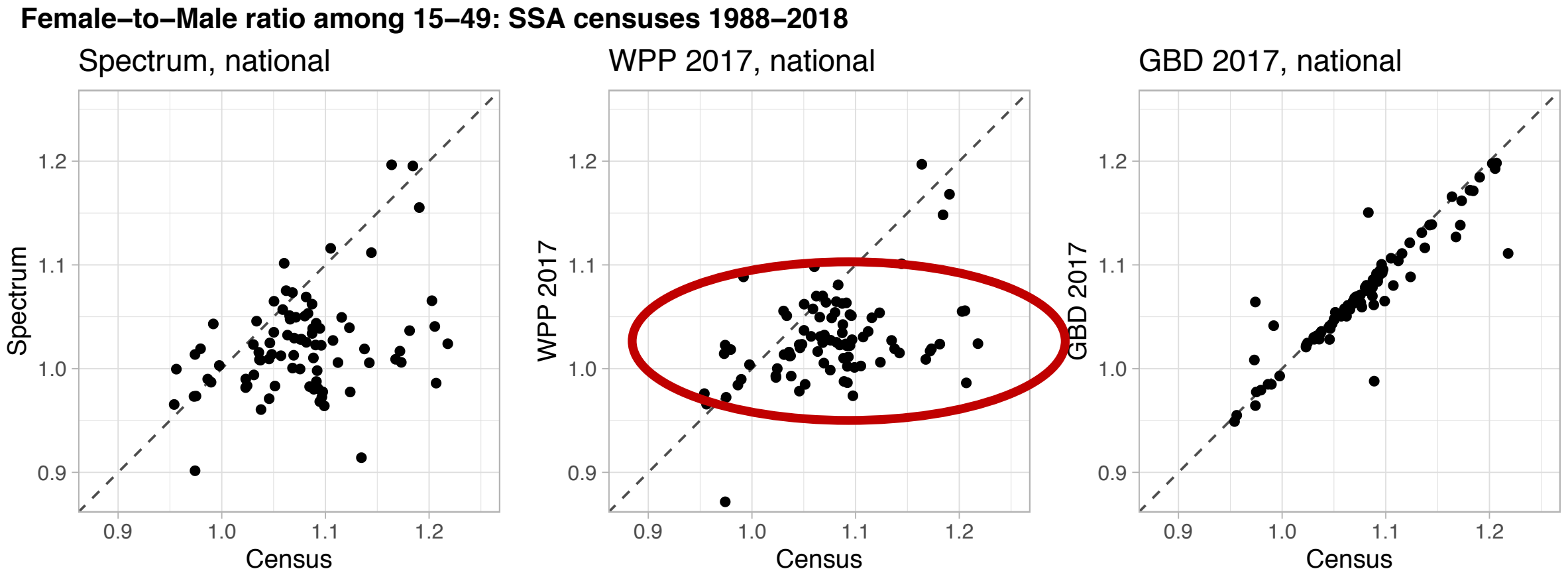
Female-to-male sex ratio 15-49



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UNAIDS Reference Group priorities

1. Harmonisation of model simulation code.
2. Harmonisation of data inputs.
3. Review of natural history parameters.
4. Routine review and revision of data about AIDS mortality.

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Spectrum simulation code harmonisation

AIM - Fit incidence to CSAVR

EPP3 2020_R2

Shiny 90

Spectrum

Multistate CCMPP +
HIV infection, progression, & treatment

UN WPP 2021?

- Single open-source simulation code base across HIV estimation models.
- Compiled as DLL to be used by multiple software and user interfaces.
- R interface for scripted and reproducible analysis

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Harmonisation of data inputs

Demographic and epidemiologic analysis	Household surveys	National HMIS
• Demographic inputs • HIV natural history • Mortality on treatment • Mother to child transmission • Effectiveness of prophylaxis • Eligibility for treatment	• HIV prevalence • HIV testing history • Treatment coverage • Fertility by HIV status • Breastfeeding • Sexual activity • Child mortality	• ANC attendees • Antiretroviral treatment • HIV testing • Circumcision

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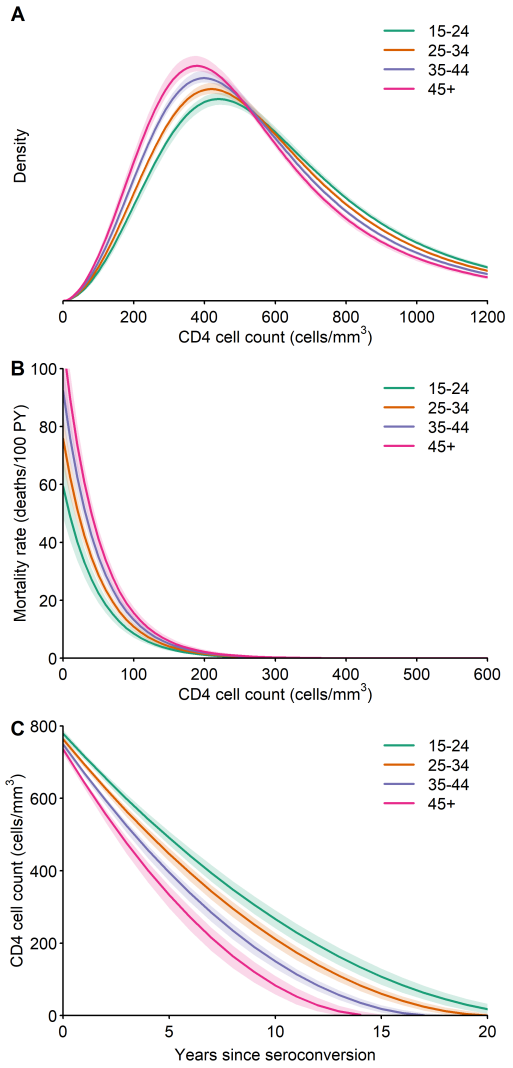
Important analytical work streams

- Review of untreated disease progression and mortality parameters.
  - Based on new evidence about CD4 distributions from household surveys.
  - May affect current and historical estimates of AIDS deaths and age/sex patterns.

- Updated analysis of mortality PLHIV on ART (IeDEA network)
  - Paediatric mortality 2020
  - Adult mortality 2021
- Review of evidence of HIV mortality among untreated adults.



Rob Glaubius; UNAIDS Reference Group, October 2019

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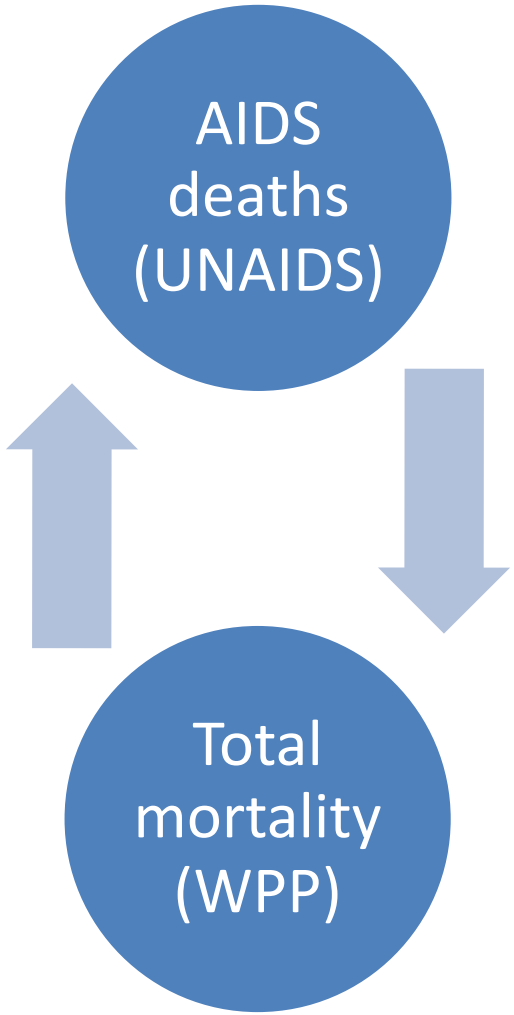
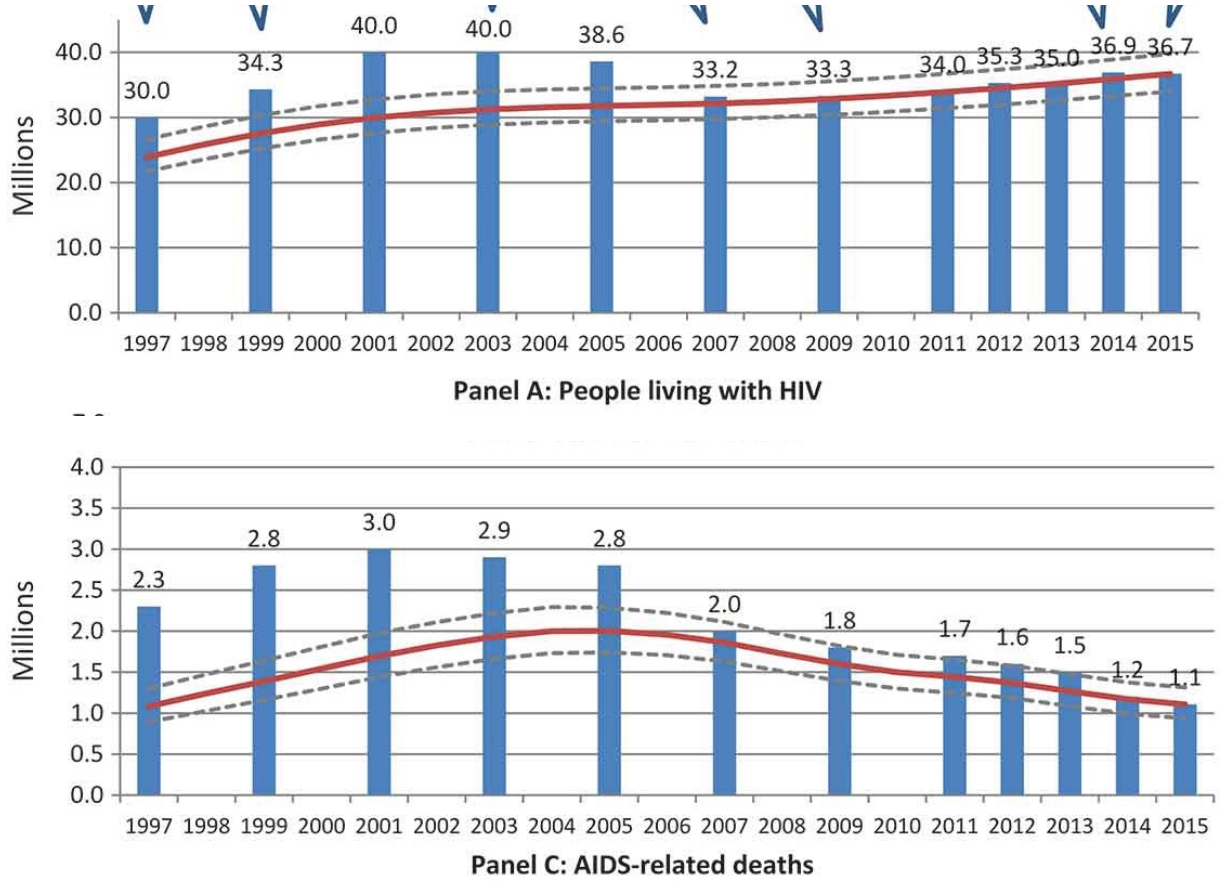
Slowly iterative updates: a complicated circle





Mahy et al. Glob Health Action 2017; 10

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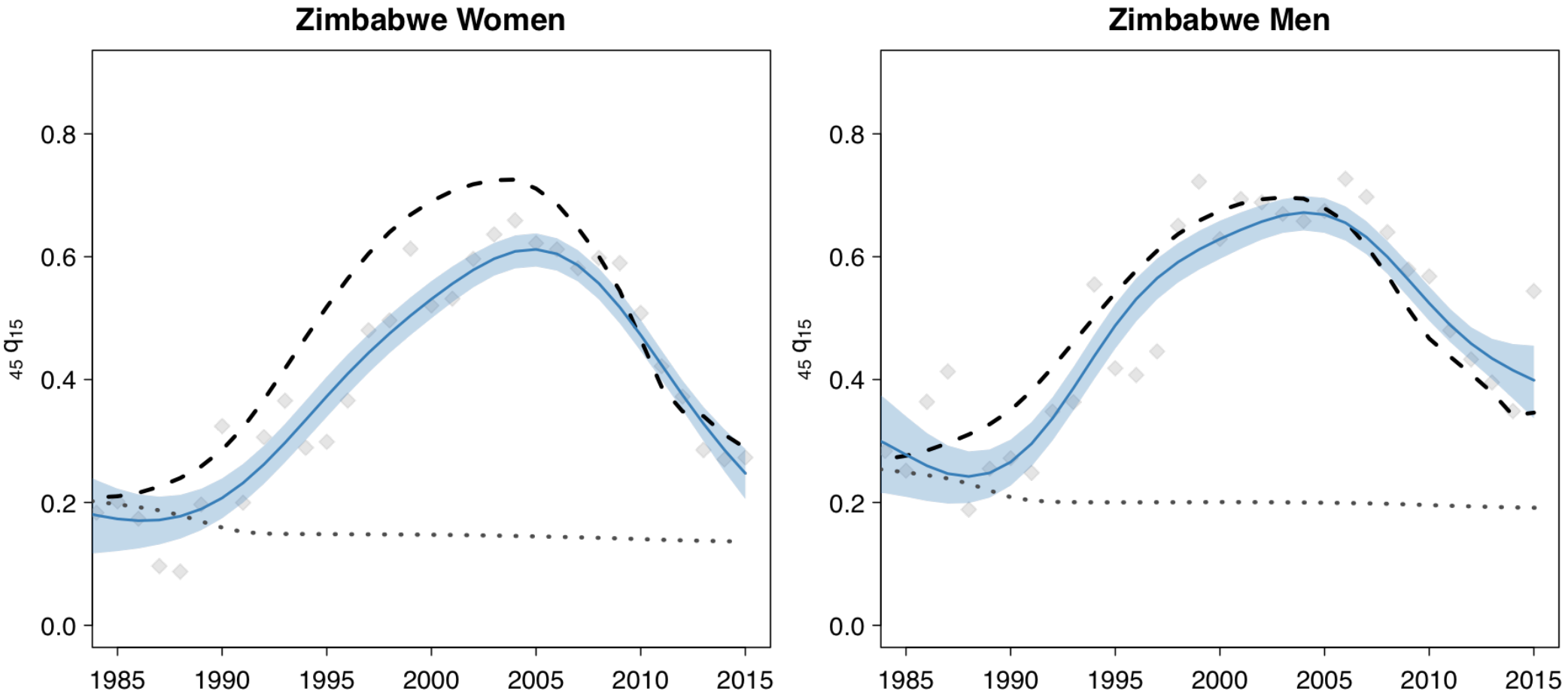
Sibling history vs Spectrum estimates

Source UNAIDS 2016 estimates



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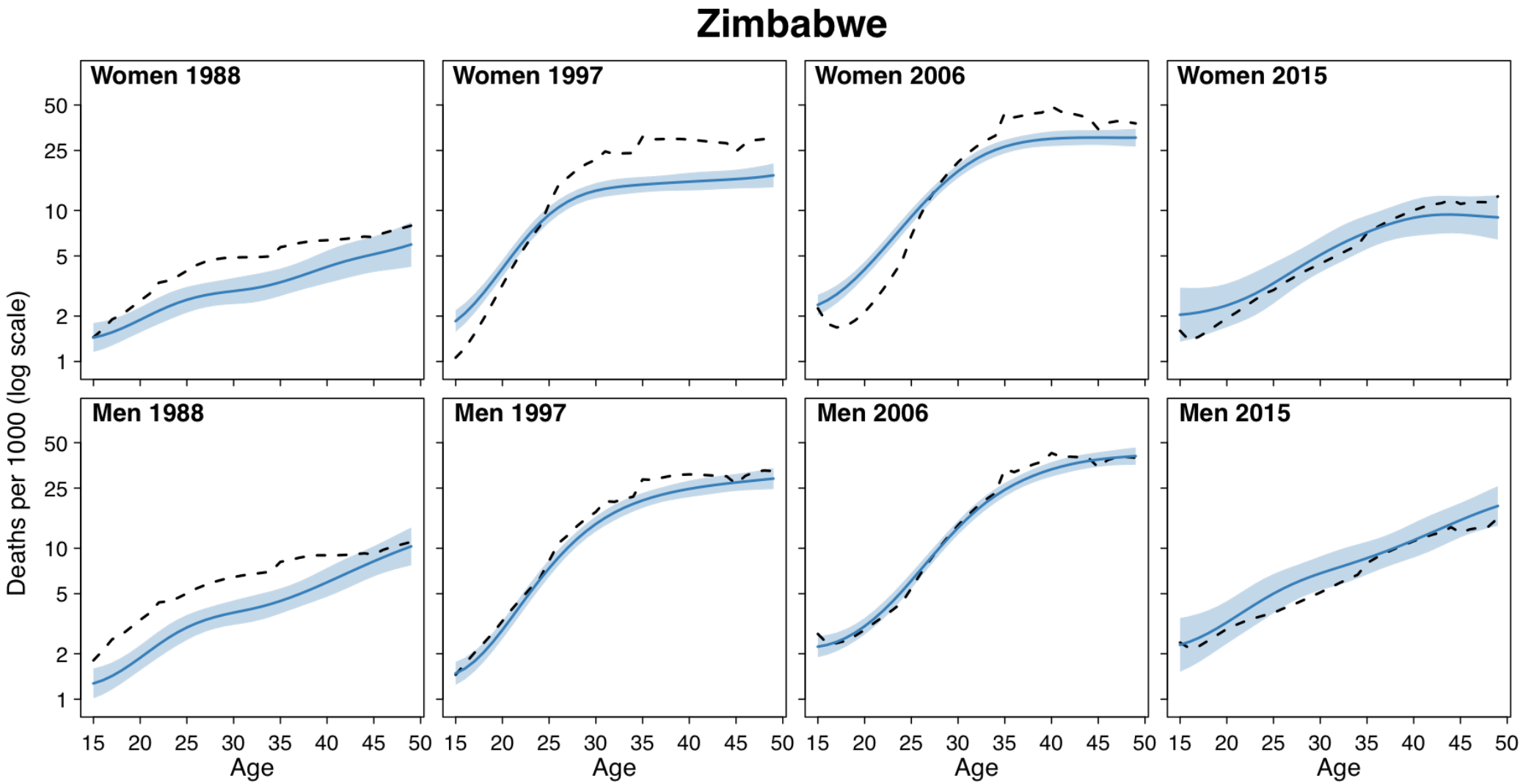
Sibling history vs Spectrum estimates



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Template Model Builder (TMB)

- R package, C library for automatic differentiation and probabilistic functions
  - http://tmb-project.org
- Model code written in templated C++
  - Fast
  - Portable
- Analytical gradient via automatic differentiation (AD).
  - Non-linear optimisation, Hamiltonian Monte Carlo, Laplace Approximation
- Approximate marginalisation of random effects via Laplace Approximation.

- Software for GBD implementation of population reconstruction.
- UNAIDS Naomi district HIV estimation model.

- Typical application: Empirical Bayes optimization of hyperparameters w/ marginalisation of latent field via Laplace approximation.

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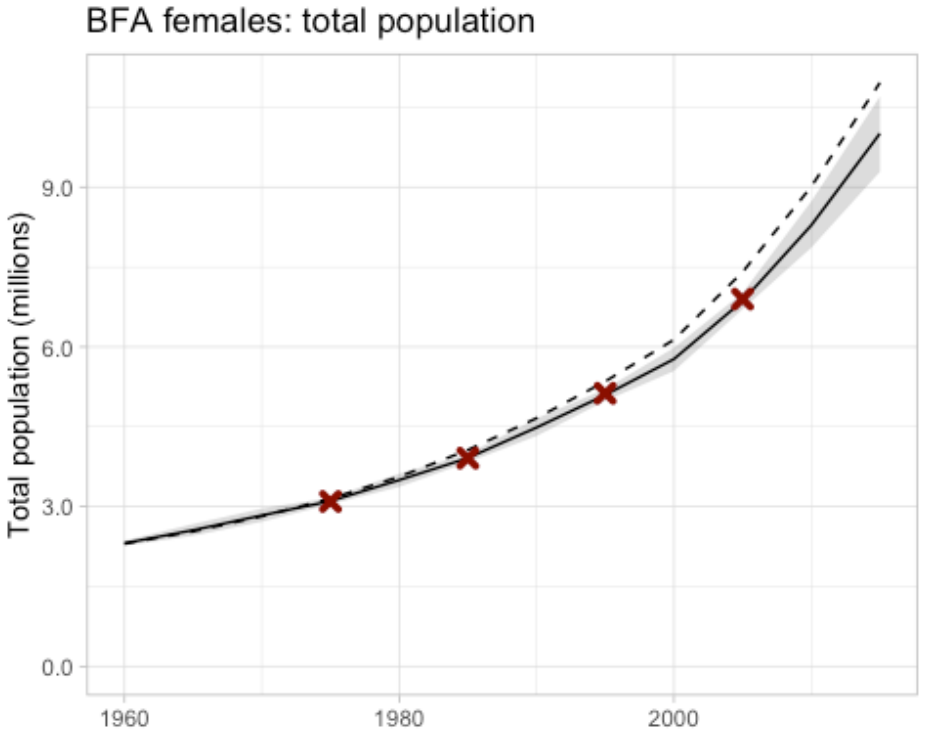
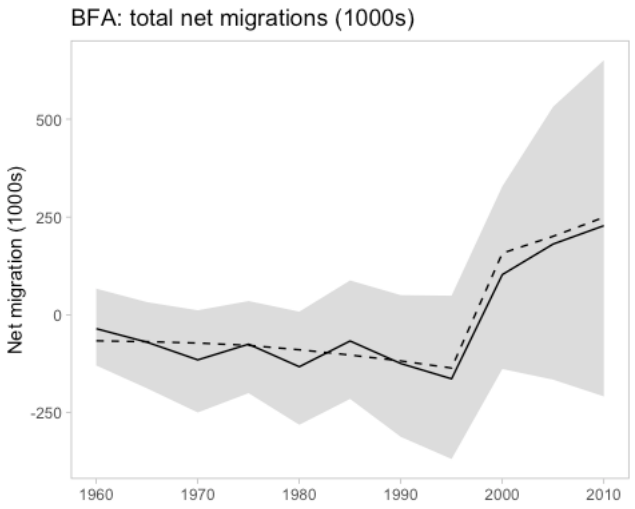
TMB Implementation of popReconstruct

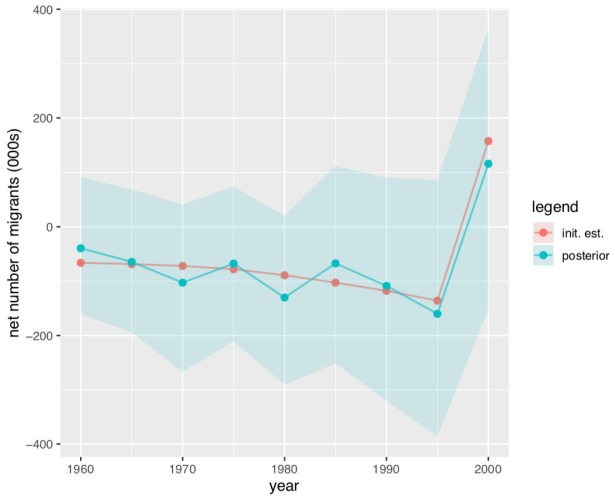
popReconstruct *Burkina Faso females example*



TMB implementation



Wheldon popReconstruct vignette



- Empirical bayes w/ Laplace approximation: 2 seconds.
- HMC via Stan: 15 seconds
  - *(But scaling to 1x1, multistate projection systems a concern!)*

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Considerations for WPP21 directions

- High enthusiasm to harmonize demographic inputs and calculations between HIV estimates and WPP
  - Single-year interval will improve consistency — highly endorsed.
  - Switch from mid-year to calendar would be large change, but potential substantial benefit for other HIV estimation .

- Bayesian population reconstruction—attention to census discrepancies among key age groups:
  - Working-age adult males in SSA.
  - Age 0-5 population.

- Consequences of potential change in WPP approach to high HIV countries needs consideration.
  - Should HIV estimates match to total mortality vs. back out non-HIV mortality?
  - What happens if discrepancies? A less transparent circle?

- Focus on transparency, visualisation, reproducibility will help adoption of estimates and analysis by countries.
  - Methods and tools alignment of WPP and training and technical assistance to NSOs (e.g. USCB) will also help