



CQUIN 5th Annual Meeting

Virtual: November 16-19, 2021

Estimating the size of the population of men who have sex
with men

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16 November 2021

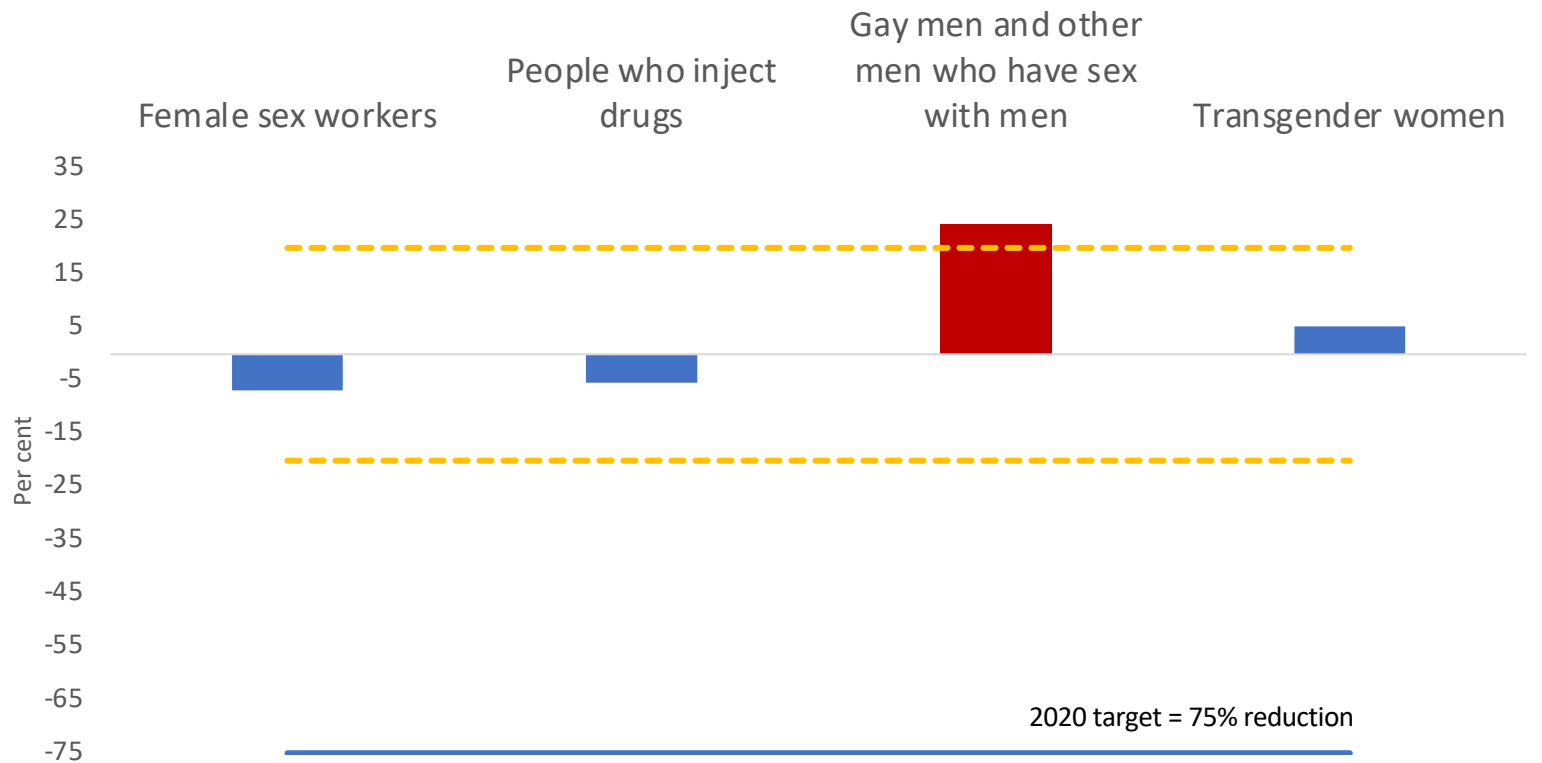
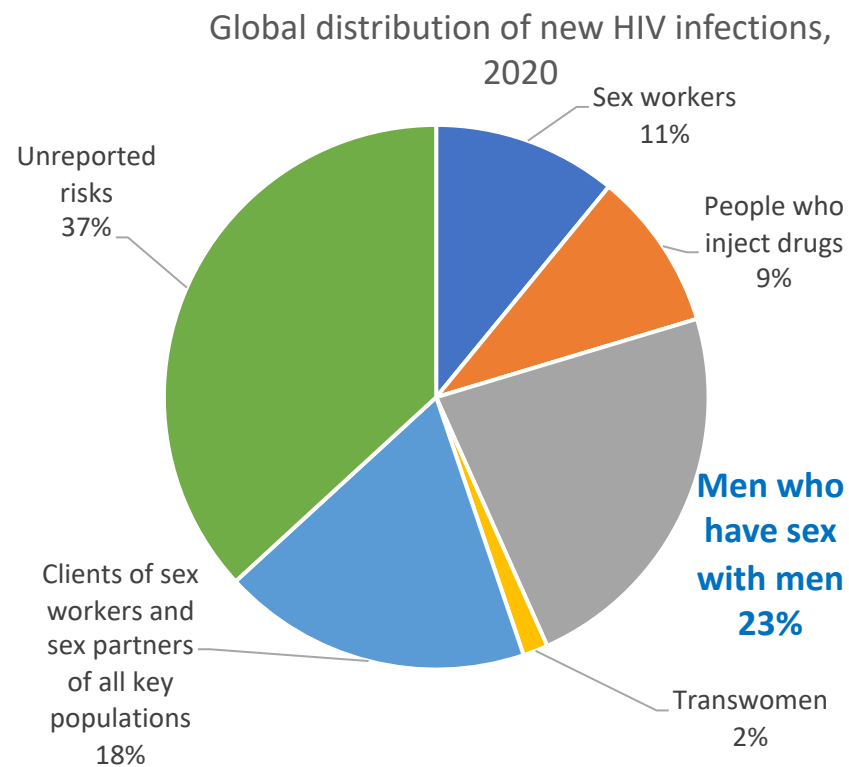


HIV Learning Network
The CQUIN Project for Differentiated Service Delivery

Why are population size estimates important?

- **Human Rights - right to highest level of health achievable**
 - Uncounted people are invisible and ignored
- **Epidemic response**
 - Cannot control epidemic without addressing epidemiologically key and vulnerable communities
 - Setting and measuring meaningful targets
- **HIV estimates from Spectrum**
 - New models in development will require key population data (HIV prevalence and size estimates)
 - As epidemics among wider population come under control, focus will need to shift

Persistent challenges to reduce HIV among men who have sex with men



Percent change in estimated incidence, 2010-2020, Global

Criminalization impacts size estimates

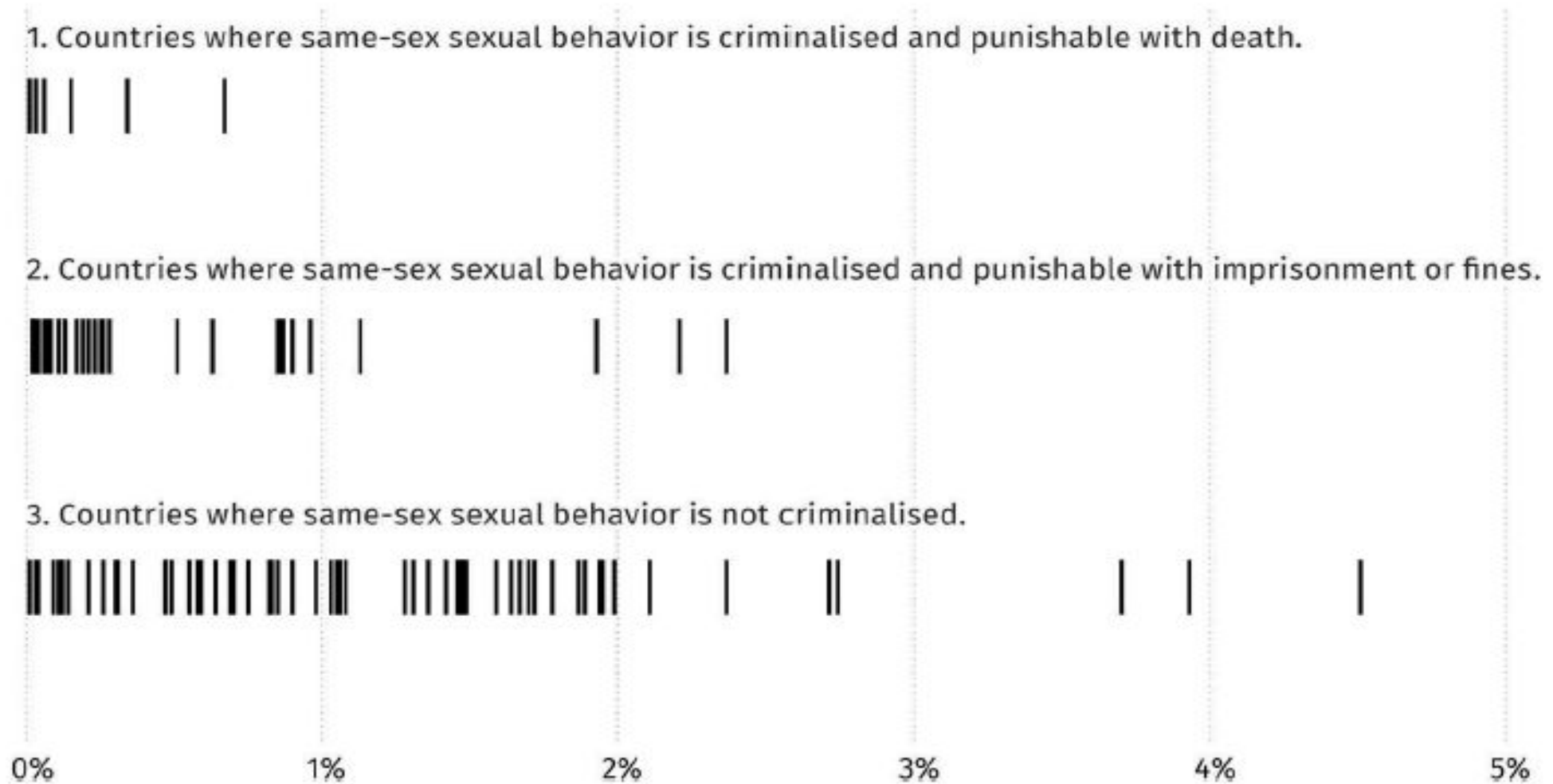


Figure 1. Relation between criminalization of same-sex sexuality and country-reported population size estimates for men who have sex with men (2007–14).

Criminalization affects coverage reporting

Table 2. Relation between laws criminalizing same-sex sexuality and country-reported HIV testing coverage of men who have sex with men (2007–14)

Country-reported HIV testing coverage among MSM	Countries where same-sex sexuality was legal	Countries where same-sex sexual behaviour was criminalized, punished with imprisonment/fines	Countries where same-sex sexual behaviour was criminalized, punished with death penalty
Less than 25·0% reported HIV testing coverage among MSM	16·3%	13·3%	66·7%
25·0–49·9% reported HIV testing coverage among MSM	54·3%	54·2%	16·7%
50·0–79·9% reported HIV testing coverage among MSM	22·8%	26·7%	16·7%
80·0% or greater reported HIV testing coverage among MSM	6·5%	17·8%	

$\chi^2(6) = 15.904, p = .014.$

KEY POPULATIONS STRATEGIC INFORMATION

RECOMMENDED POPULATION SIZE ESTIMATES OF MEN WHO HAVE SEX WITH MEN

NOVEMBER 2020



KEY MESSAGE

Countries using population size estimates for men who have sex with men that are less than 1% of the total adult male population should revise their estimates.

WHO/UNAIDS: RECOMMENDED POPULATION SIZE ESTIMATES OF MEN WHO HAVE SEX WITH MEN
<https://apps.who.int/iris/rest/bitstreams/1321427/retrieve>

Guidance for setting size estimates of men who have sex with men

- Global AIDS Monitoring system collects size estimates reported by countries for men who have sex with men
- UNAIDS, WHO and Global Fund review estimates to determine their best use.
 - Most estimates are best for local use where the underlying data are collected
 - Some estimates use robust methods for extrapolation to a “national estimate.”
 - Only “national estimates” are displayed in global reports.
- “National estimates” were divided by the adult male population, aged 15-49, to give a population prevalence of men who have sex with men

Categorizations

- **Nationally adequate estimates are:**
 - empirically-derived using one of the following methods:
 1. multiplier;
 2. capture-recapture;
 3. mapping/enumeration;
 4. network scale up method (NSUM);
 5. RDS-SS.
 - Estimates had to be national or a combination of multiple sites with a clear approach to extrapolating to a national estimate;

Correct population proportions to use?

- Nationally adequate sizes yields much higher population proportions

Table 1. Regional estimates for low- and middle-income countries of the proportion of the population of adult (15–49 years old) men who have sex with men using only nationally adequate estimates

Region	Number of countries	Median %	Interquartile range: 25% and 75% of the submitted estimates
Asia and the Pacific	12	1.63	0.26–3.10
Caribbean	4	5.7	0.29–0.10
Eastern and Southern Africa	2	1.45	1.9–1.9
Eastern Europe and Central Asia	6	2.11	0.9–2.68
Latin America	3	3.22	1.5–12
Middle East and North Africa	3	1.02	0.005–1.03
Western and Central Africa	8	1.44	1.0–6.27

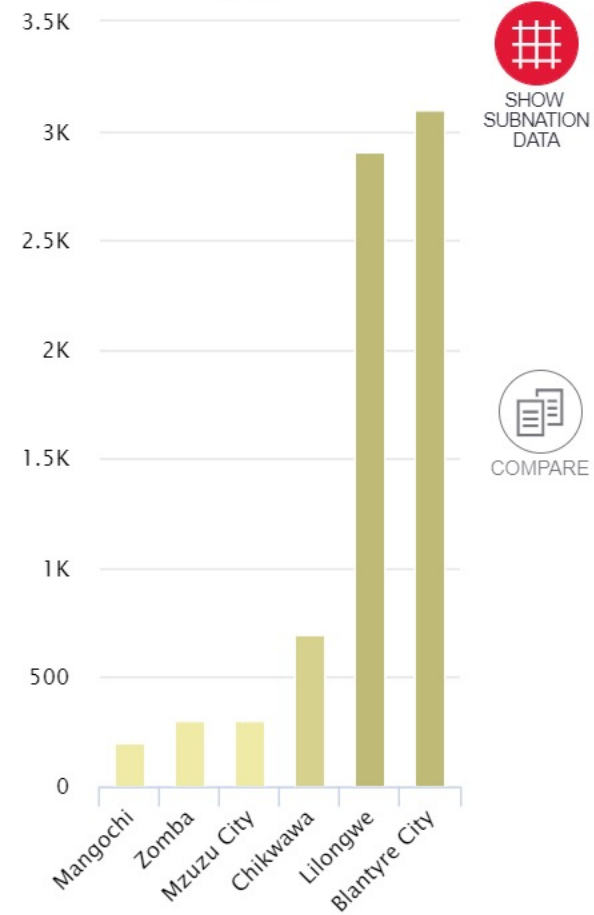
Source: [AIDSInfo.unaids.org](https://aidsinfo.unaids.org); Underlying data available in aidsinfo.unaids.org and WPP 2019.

Subnational estimates are useful locally

MALAWI

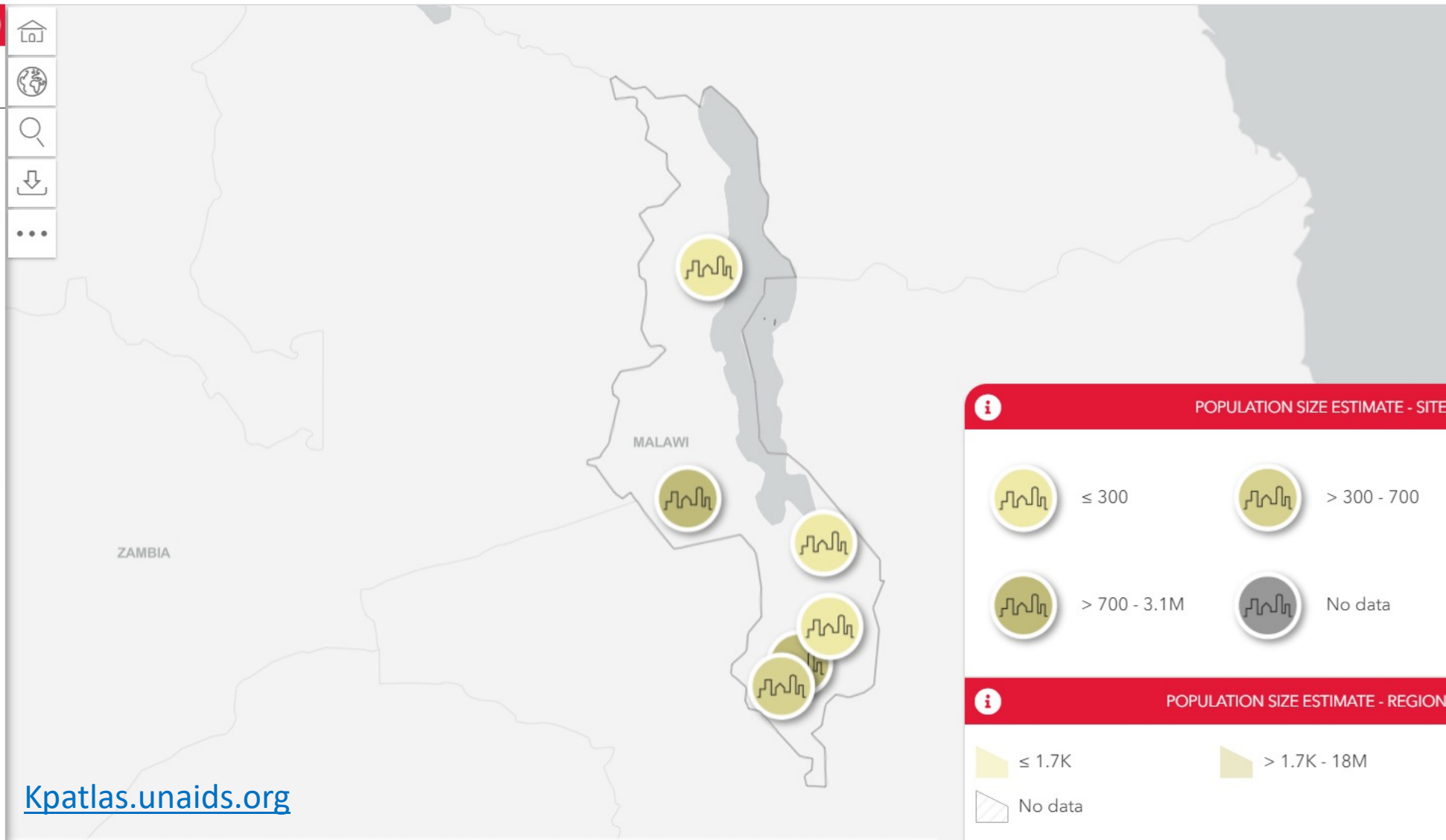
POPULATION SIZE ESTIMATE

Sites



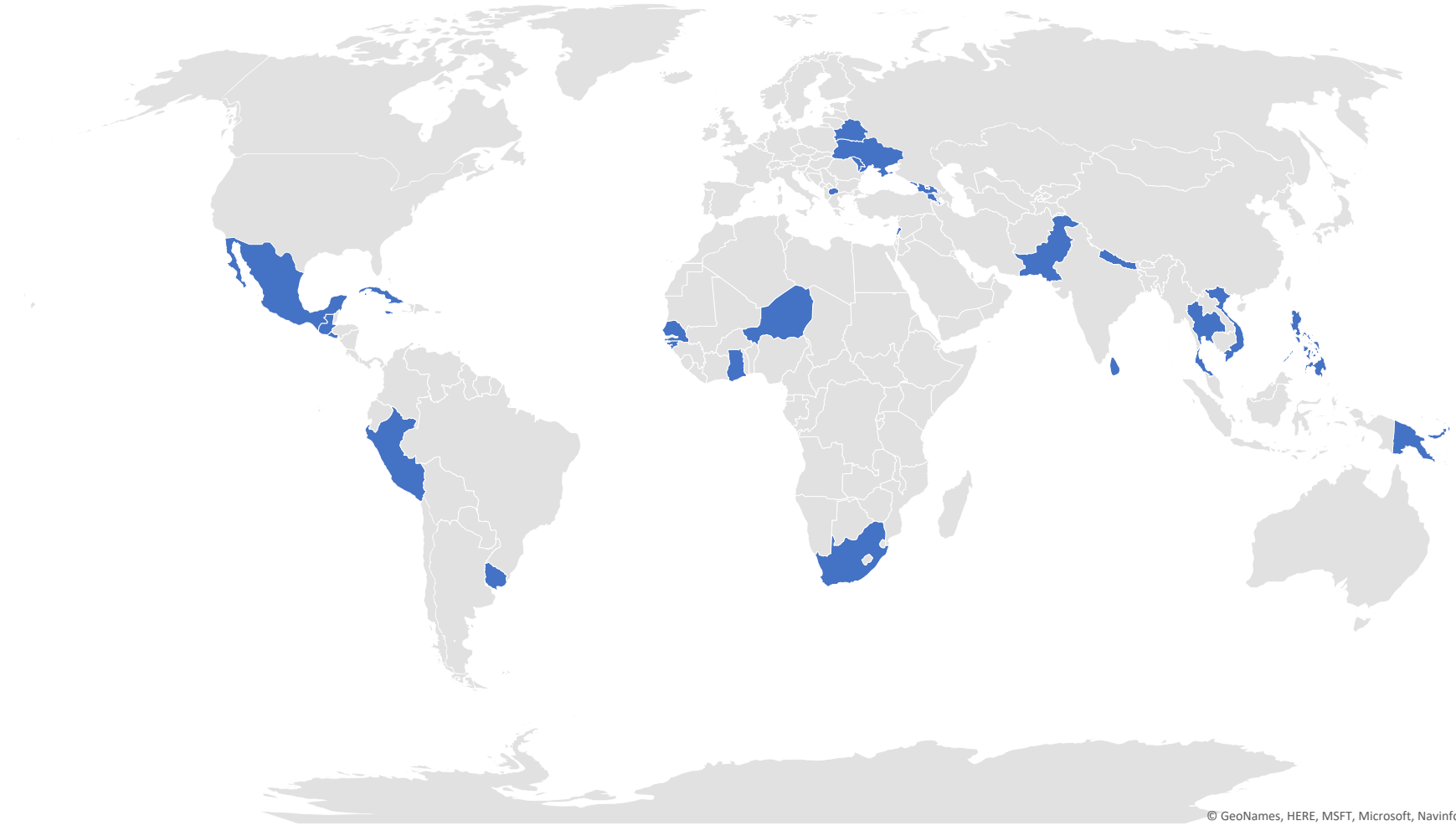
SHOW SUBNATION DATA

COMPARE



Kpatlas.unaids.org

Nationally adequate size estimates for men who have sex with men are needed for estimates and national planning



Extrapolations to national population size estimates: methods 2010–2014

Approaches for extrapolations	FSW	MSM	PWID	Transgender women
Proportion of adult population	21	30	10	4
Based-on one selected estimate	4	2	4	
Summed up from site-specific results	8	7	4	1
Regression or models	9	13	6	4
Delphi/consensus	6	5	5	1
Total number of countries with extrapolations	58	57	29	10

doi:10.1371/journal.pone.0155150.t005

Sabin K, Zhao J, Garcia Calleja JM, Sheng Y, Arias Garcia S, et al. (2016) Availability and Quality of Size Estimations of Female Sex Workers, Men Who Have Sex with Men, People Who Inject Drugs and Transgender Women in Low- and Middle-Income Countries. PLOS ONE 11(5): e0155150.

doi:10.1371/journal.pone.0155150

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155150>

Geographic coverage of estimates with known estimation methods, 2010–2014

Geographic coverage	FSW	MSM	PWID	Transgender women
National or national representative sample	41	43	31	8
More than 50% of first subnational administrative divisions	10	6	3	1
Less than 50% of first subnational administrative divisions	10	7	3	3
Major cities	9	17	7	2
Capital city	6	8		1
Not reported	2	1	3	
Total number of countries	78	82	47	15

doi:10.1371/journal.pone.0155150.t004

Sabin K, Zhao J, Garcia Calleja JM, Sheng Y, Arias Garcia S, et al. (2016) Availability and Quality of Size Estimations of Female Sex Workers, Men Who Have Sex with Men, People Who Inject Drugs and Transgender Women in Low- and Middle-Income Countries. PLOS ONE 11(5): e0155150.

doi:10.1371/journal.pone.0155150

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155150>

Methods in estimating population size estimates, 2010–2014.

Methods	FSW	MSM	PWID	Transgender women
Multiplier	29	31	23	2
Capture re-capture	19	17	11	2
Census & enumeration	19	10	3	1
Programmatic mapping	27	23	12	9
Network scale up method or population-based survey	4	11	9	
RDS-SS successive sampling	2	3	2	
Administrative registry/programmatic results	2	1	1	1
Regional benchmark	3	7	2	1
Population-based survey	1	5	4	
Expert opinion (wisdom of crowds/literature/ Delphi/key informants)	13	10	7	2
Wisdom of crowds	6	10	3	
Not Reported	9	6	6	2
Total number of countries	87	88	53	17

doi:10.1371/journal.pone.0155150.t002

Sabin K, Zhao J, Garcia Calleja JM, Sheng Y, Arias Garcia S, et al. (2016) Availability and Quality of Size Estimations of Female Sex Workers, Men Who Have Sex with Men, People Who Inject Drugs and Transgender Women in Low- and Middle-Income Countries. PLOS ONE 11(5): e0155150.

doi:10.1371/journal.pone.0155150

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155150>

Use of social media-based size estimates?

- Only relevant to men who have sex with men
- Recent study in Kenya suggested that previous estimates undercounted by 25%
- How to incorporate with other methods/estimates?
- How to use data from multiple sources without surveys?
(Avoid double counting)

Table 3. Number of estimates used in countries with known estimation methods for female sex workers (FSW), men who have sex with men (MSM), people who inject drug (PWID) and transgender women in low- and middle-income countries, 2010–2014.

Number of estimates	FSW	MSM	PWID	Transgender women
Five or more	2	4	5	
Four	4	2		
Three	12	6	7	1
Two	15	16	8	1
One	45	54	27	13
Total number of countries	78	82	47	15

doi:10.1371/journal.pone.0155150.t003

Sabin K, Zhao J, Garcia Calleja JM, Sheng Y, Arias Garcia S, et al. (2016) Availability and Quality of Size Estimations of Female Sex Workers, Men Who Have Sex with Men, People Who Inject Drugs and Transgender Women in Low- and Middle-Income Countries. PLOS ONE 11(5): e0155150.

doi:10.1371/journal.pone.0155150

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155150>

Table 1. Number of countries with available estimates for female sex workers (FSW), men who have sex with men (MSM), people who inject drug (PWID) and transgender women by groups over the year 2010–2014 in low- and middle-income countries.

Groups	2010	2011	2012	2013	2014
FSW	8	8	17	23	31
MSM	9	11	19	23	26
PWID	3	8	12	19	11
Transgender women	1	2	3	5	6

doi:10.1371/journal.pone.0155150.t001

Sabin K, Zhao J, Garcia Calleja JM, Sheng Y, Arias Garcia S, et al. (2016) Availability and Quality of Size Estimations of Female Sex Workers, Men Who Have Sex with Men, People Who Inject Drugs and Transgender Women in Low- and Middle-Income Countries. PLOS ONE 11(5): e0155150.

doi:10.1371/journal.pone.0155150

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155150>

Shiny Applications for Epidemiology

<https://www.epiapps.com/>

Consensus Estimation

- This tool assists in synthesizing multiple independent estimates of a quantity (e.g. population size or prevalence). Stakeholders may add additional information regarding the methodological quality of the studies and prior knowledge of the metric.

[Launch Application](#)

Consensus Estimate Calculator

Enter Estimates

Define Prior Beliefs

Synthesis

	Estimate	Standard Error	Design Confidence
1	10444	4396	100
2	5699	946	50
3	10315	7153	100
4	7182	5679	100
5	8900	7974	100
6			100
7			100
8			100
9			100
10			100

Estimate : An estimate from a study

Standard Error : The standard error of the estimate. Standard error can be calculated from a 95% confidence interval as $(\text{upper} - \text{lower}) / (2 * 1.96)$.

Design Confidence : Expert confidence in the design / implementation of the study. This scales the standard error such that a value of 50 will double the standard error.

Consensus Estimate Calculator

Enter Estimates

Define Prior Beliefs

Synthesis

Distribution

Log-Normal

Median

18000

Standard Deviation

5000

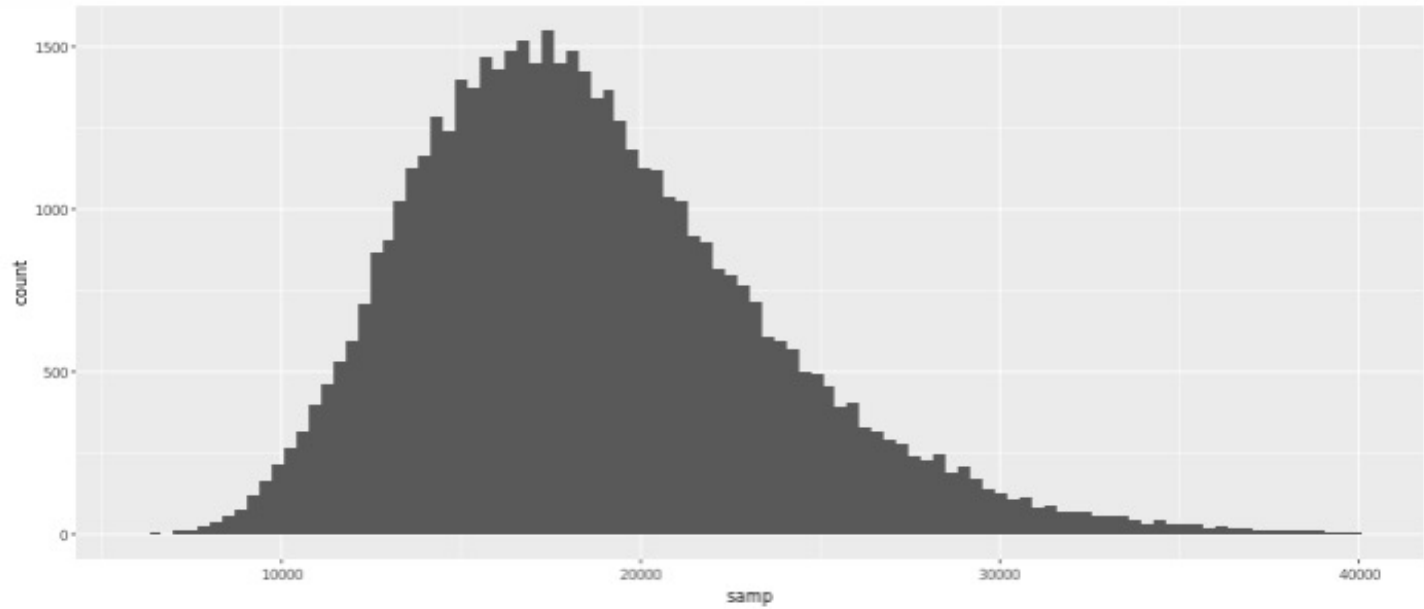
Lower Bound

2000

Upper Bound

40000

Enter prior beliefs
about population size



Summaries

Median	Mean	Standard.Deviation
17967.21	18583.63	4915.83

Quantiles:

5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%
11672.73	12848.89	14398.27	15664.23	16813.78	17967.21	19176.96	20607.84	22423.24	25192.20	27712.94

Consensus Estimate Calculator

Enter Estimates

Define Prior Beliefs

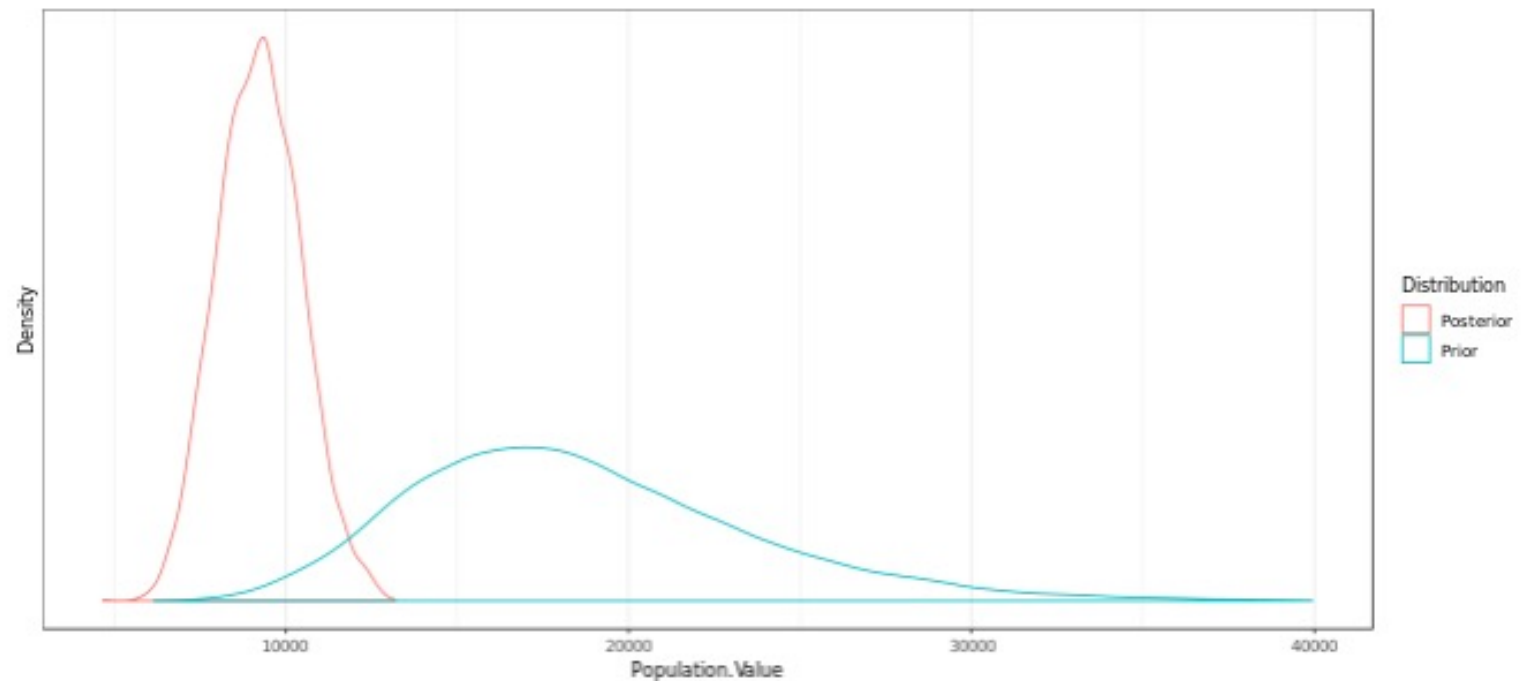
Synthesis

Run

Consensus Estimate:

Median	Mean	Standard Deviation	95% CI	90% CI
9234.72	9242.15	1205.64	(6995, 11676)	(7296, 11249)

Posterior:



Posterior Quantiles:

5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%
7296.13	7677.06	8201.94	8567.69	8913.76	9234.72	9528.31	9886.98	10272.04	10807.84	11249.23

Multiple Source Capture Recapture

- Implements user interfaces for log-linear models, Bayesian model averaging and Bayesian Dirichlet process mixture models.

[Launch Application](#)

Video tutorial:

- <https://www.youtube.com/watch?v=PgmyUnFlo5Y&feature=youtu.be>

Manual:

- <https://fellstat.github.io/shinyrecap/>

GitHub:

- <https://github.com/fellstat/shinyrecap>

Capture results



Note: 77 refusals in capture 1 and 41 refusals in capture 2

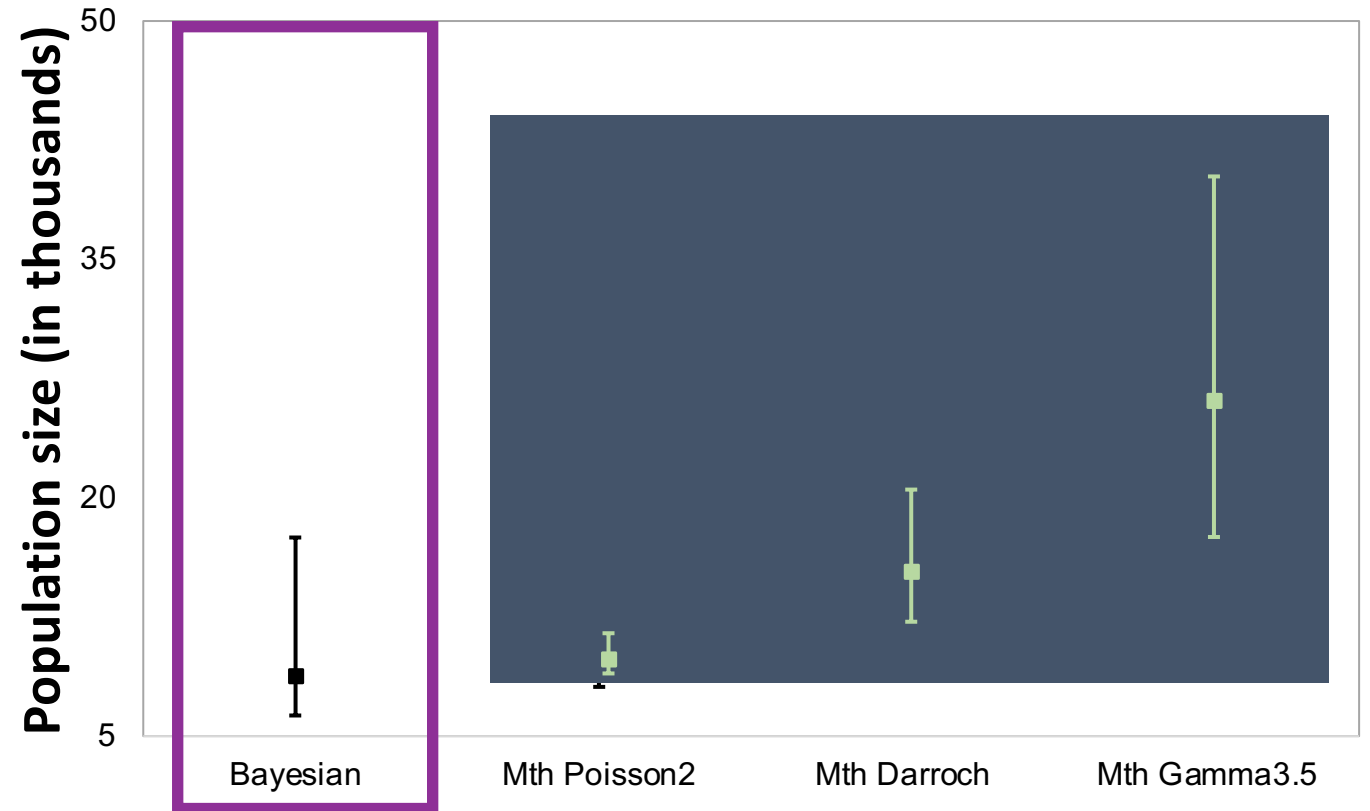
Population size of FSW in Kampala

8,848

95% Credible Interval:
6,337-17,470

2.1%

of Kampala adult women
1.5-4.2%



┌ 95% credible interval (Bayesian)
└ 95% confidence interval

Overview

Capture recapture analysis was originally developed to estimate the size of wild animal populations using observed counts. However, the method has been generalized for use in estimating the size of hard-to-reach populations such as Female Sex Workers (FSWs), Men having Sex with Men (MSM) and People Who Inject Drugs (PWID). It starts with "capturing and tagging" of individuals in a series of sampling occasions. This could be offering unique and easily identifiable gifts in each capture occasion and collecting as much information as the study protocol allows to be able to identify recaptures without identifying individuals.

This tool is designed to estimate key population size using multiple source capture recapture data implementing loglinear models. It uses the **Rcapture** package in R. Please view [Rcapture:Loglinear Models for Capture-Recapture in R](#) for full documentation.

Data Preparation

Please carefully read the instruction below on how to prepare your dataset before importing it in to this tool

In the current version of the app, either aggregate or individual capture history of two or more capture occasions can be used for estimating the population size. For an aggregate format, prepare your dataset in such a way that the first $n-1$ columns (where n is the number of capture occasions) represent capture histories (0=not captured, 1=captured) whereas the last column (n^{th} column) represent capture frequency for the row. The individual capture history data are simply records of three columns each representing the capture occasion and rows representing individual capture history records. Columns can have any names

Upload Your Data

Browse...

No file selected

Select the data parameters below

 Header**Data Type** Aggregate Individual**Separator** Comma Semicolon Tab Space

Log Linear Models

Bayesian Model Averaging

Bayesian Latent Class

Pairwise

Log-linear Abundance Analysis

Model Comparison

Model Selection

Descriptives

Population Size Estimates by Model:

M_0 : All captures have the same probability and individuals are uniform.

M_t : Captures may have different probabilities and individuals are uniform.

M_h : All captures have the same probability and individuals may be heterogeneous.

M_{th} : Captures may have different probabilities and individuals may be heterogeneous.

Population Size Estimation Using Multiple Data Sources

- Implements a user interface for an algorithm for presenting a Bayesian hierarchical model for estimating the sizes of local and national populations. The model incorporates multiple commonly used data sources including mapping data, surveys, interventions, capture-recapture data, estimates or guesstimates from organizations, and expert opinion.

[Launch Application](#)

Reference: Bao, L., Raftery, A. E., & Reddy, A. (2015). Estimating the sizes of populations at risk of HIV infection from multiple data sources using a Bayesian hierarchical model. *Statistics and its Interface*, 8(2), 125-136.

Size Estimation Shiny App

Number of MCMC Iterations

Number Burn-In Iterations

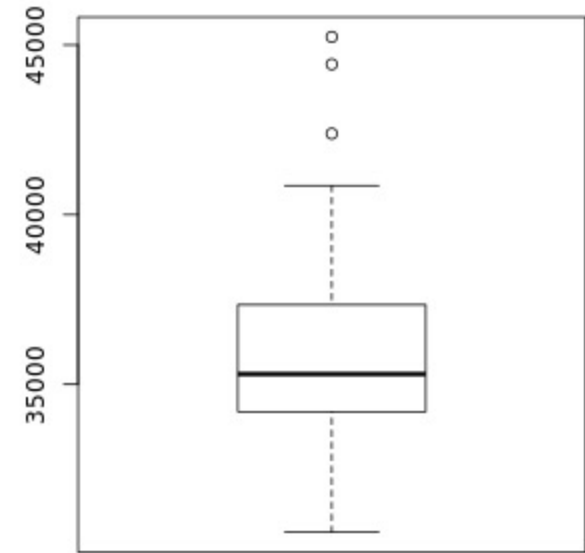
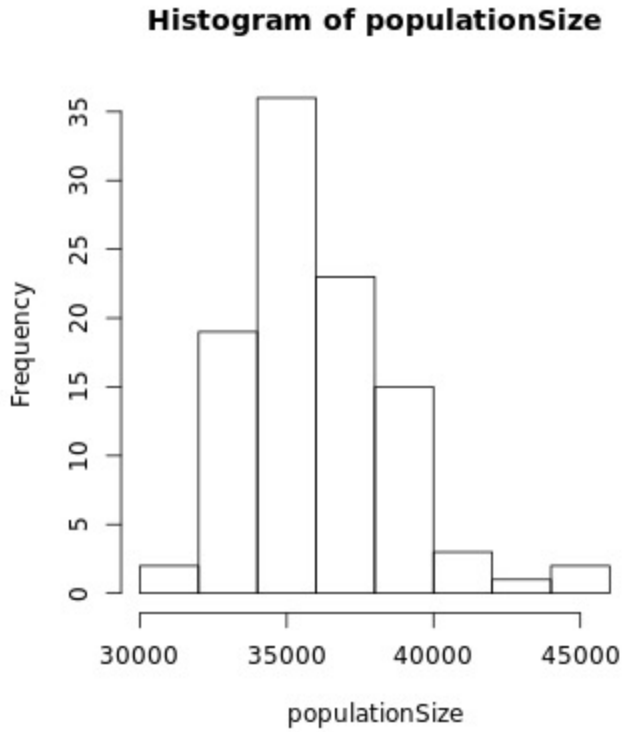
Keep Every _th Sample

Upload Dataset
 No file selected

Plots [Tables](#) [Help](#) [References](#)

Total Population Size ▼

National estimate



Size Estimation Shiny App

Number of MCMC Iterations
100

Number Burn-In Iterations
1

Keep Every _th Sample
1

Upload Dataset
Browse... No file selected

Sample Posterior

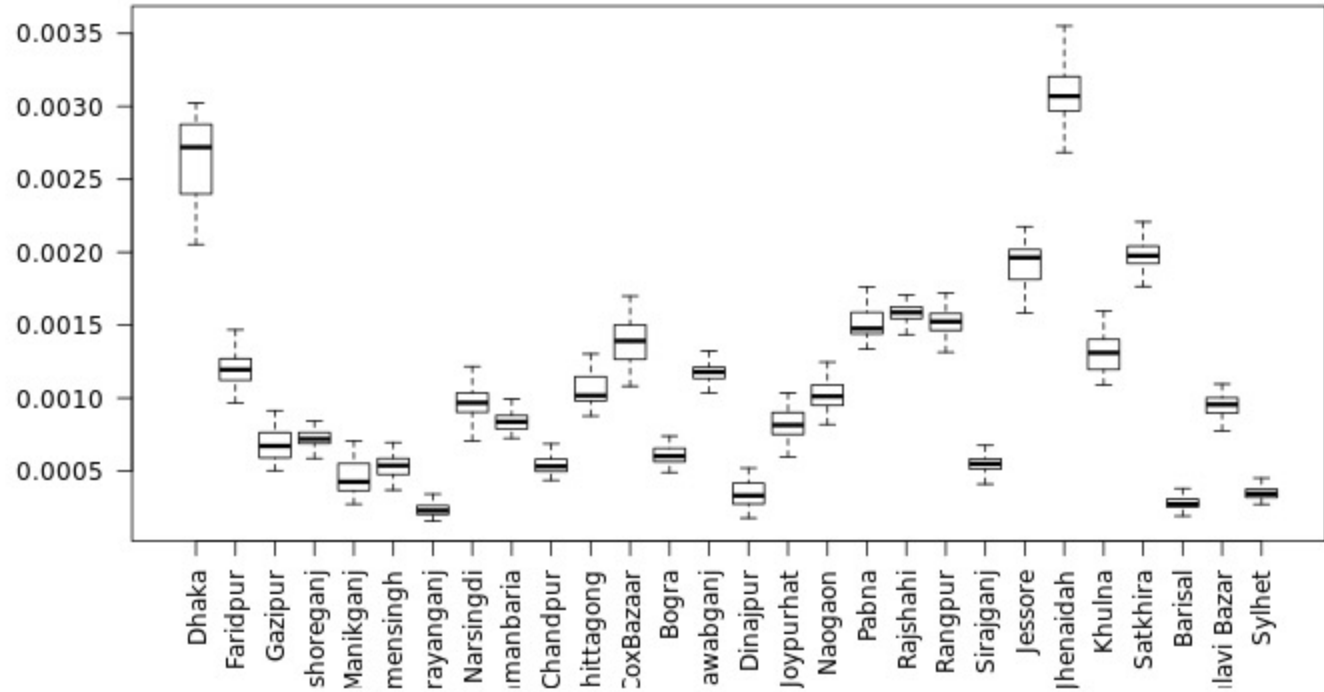
Download Data Template

Download Posterior Sample

Plots Tables Help References

Prevalence by District

Population size as a proportion of the male population



Size Estimation Shiny App

Number of MCMC Iterations

Number Burn-In Iterations

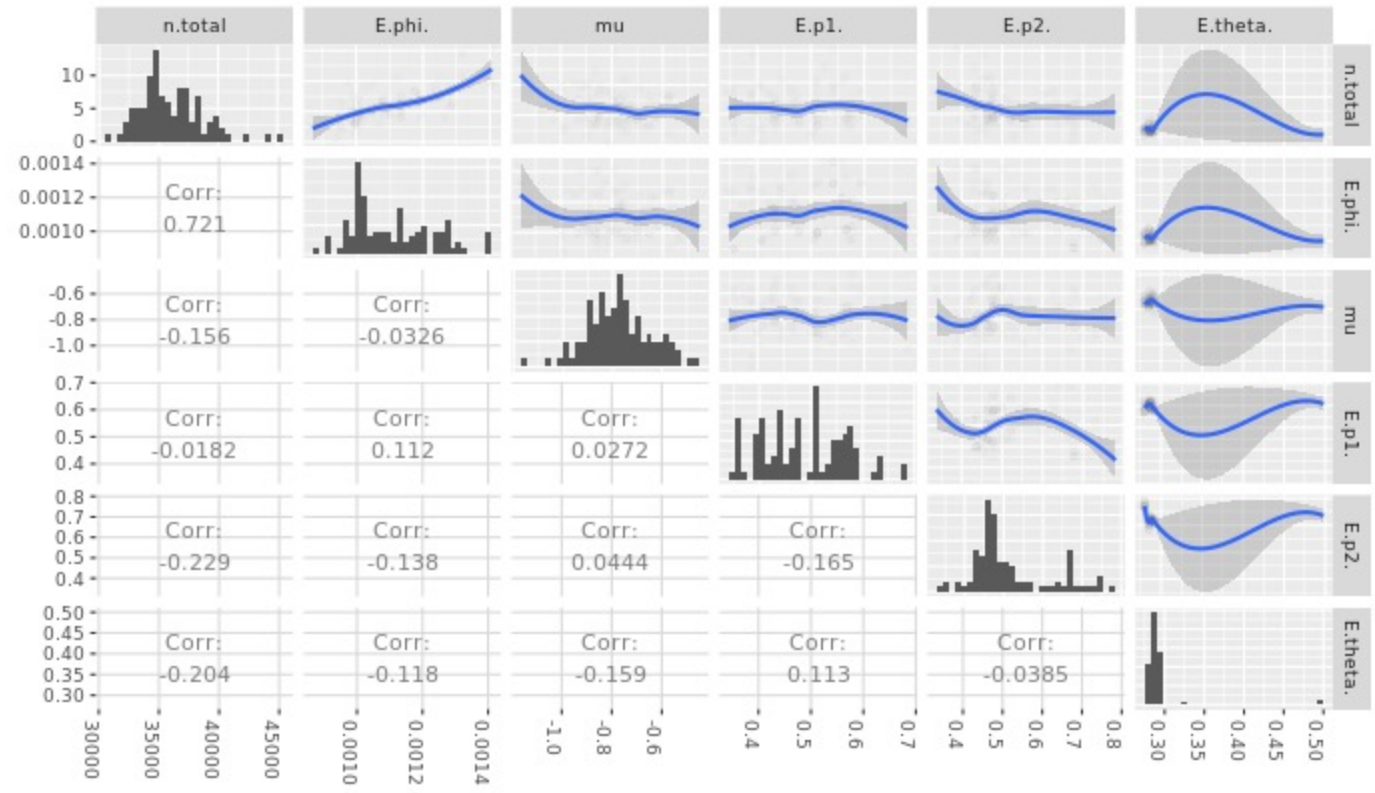
Keep Every _th Sample

Upload Dataset
 No file selected

Plots [Tables](#) [Help](#) [References](#)

Matrix Plot of Key Parameters

Diagnostic plots



Programmatic mapping?

- Mapping results need to be adjusted for extrapolation

	Temeke	Mbeya	Njombe	Shinyanga	Iringa	Total
Females aged 15–49 years in 2016	528,797	761,840	181,614	382,217	241,090	2,095,558
FSW estimate adjusted for Double Counting (DC)						
Range in absolute numbers	3758; 7947	16,192; 20,463	5052; 5971	3849; 7386	8190; 8985	37,041; 50,752
% of FSWs aged 15–49 years	0.7%; 1.5%	2.1%; 2.7%	2.8%; 3.3%	1.0%; 1.9%	3.4%; 3.7%	1.8%; 2.4%
FSW estimate adjusted for DC and Frequency						
Range in absolute numbers	7598; 9512	34,965; 41,026	8270; 11,062	9832; 13678	11844; 15103	72,509; 90,381
% of FSWs aged 15–49 years	1.4%; 1.8%	4.6%; 5.4%	4.6%; 6.1%	2.6%; 3.6%	4.9%; 6.3%	3.5%; 4.3%
FSW estimate adjusted for DC, Frequency and invisibility						
Range in absolute numbers	10,124; 12,493	48,457; 54,995	12,142; 17,333	20,766; 22,665	16780; 20359	108,269; 127,845
% of FSWs aged 15–49 years	1.9%; 2.4%	6.4%; 7.2%	6.7%; 9.5%	5.4%; 5.9%	7.0%; 8.4%	5.2%; 6.1%

<https://doi.org/10.1371/journal.pone.0228618.t003>

Guidelines are available at UNAIDS.org

- [Guidelines on Estimating the Size of Populations Most at Risk to HIV \(unaid.org\)](http://unaid.org)

