Key population stratified estimates across all HIV epidemic settings

Report and recommendations from a meeting of the UNAIDS Reference Group on Estimates, Modelling, and Projections
19-22nd April 2021

REPORT & RECOMMENDATIONS

Abbreviations

ANC	Antenatal clinic
ART	Antiretroviral therapy
BBS	Biobehavioural survey
CDC	US Centers for Disease Control and Prevention
CFSW	Clients of female sex workers
ECDC	European Centre for Disease Control
EPP	Estimation and Projection Package
FSW	Female sex workers
GAM	Global AIDS Monitoring
IHME	Institute for Health Metrics and Evaluation
IPM	Incidence Patterns Model
MENA	Middle East and North Africa
MoT	Modes of transmission model
MSM	Men who have sex with men
MTCT	Mother to child transmission
PEPFAR	President's Emergency Plan For AIDS Relief
PLHIV	People living with HIV
PSE	Population size estimates
PWID	People who inject drugs
SSA	sub-Saharan Africa
TG	Transgender
TGM	Transgender men
TGSW	Transgender sex workers
TGW	Transgender women
tPAF	Transmission population attributable fraciton
UNAIDS	Joint United Nations Programme on HIV/AIDS
WHO	World Health Organization

The meeting of the UNAIDS Reference Group on Estimates, Modelling, and Projections was organised for UNAIDS by the Secretariat of the Reference Group (www.epidem.org), managed at Imperial College London, the University of Cape Town, and Stanford University. Participants of the meeting are listed at the end of this document.

Oli Stevens, April 2021

Background

UNAIDS Reference Group on Estimates, Modelling, and Projections

The Joint United Nations Programme on HIV/AIDS (UNAIDS) relies on impartial scientific advice from international experts in relevant subject areas to provide guidance on how to best calculate estimates and projections of the prevalence, incidence, and impact of HIV/AIDS globally. The UNAIDS Reference Group on Estimates, Modelling, and Projections acts as an 'open cohort' of epidemiologists, demographers, statisticians, and public health experts to provide scientific guidance to UNAIDS and partner organisations on the development and use of the tools used by countries to generate annual HIV estimates, which are the source for UNAIDS Global HIV epidemic estimates. The group is coordinated by a secretariat hosted at Imperial College London, the University of Cape Town, and Stanford University.

Meeting Overview

The UNAIDS Reference Group held its virtual thematic meeting on *Key population stratified estimates across all HIV epidemic settings* from 19-22nd April 2021. The meeting featured presentations and group discussion to generate consensus recommendations. The programme was divided into the following sessions:

1. Incidence Patterns Model
2. Discussants on the Incidence Patterns Model
3. Consolidating key population input data
4. Working groups for the 2022 UNAIDS estimates
5. Synthesis and implementation
6. Estimates of key population transmission
7. Key population estimates in CSAVR
8. Middle East and North Africa

This report presents a summary of the meeting presentations and discussions. The presentations are available to meeting participants at www.epidem.org (others, please contact the Secretariat via epidem@imperial.ac.uk). The final recommendations can be found at the end of this report.

The recommendations drafted at these meetings provide UNAIDS with guidance on generating HIV estimates, review current approaches, and identify required data to further improve HIV estimates. Previous meeting reports are available at www.epidem.org. This transparent process aims to allow the statistics and reports published by UNAIDS and partners to be informed by impartial, scientific peer-review.

The list of participants and meeting agenda are included in Appendix I and Appendix II, respectively.

Background

Ensuring equitable progress towards reducing new HIV infections and AIDS deaths across all population groups, including key population groups that are particularly vulnerable to HIV, is essential for ending AIDS as a public health threat by 2030, and a central component of the Global AIDS Strategy 2021-2026 [1].

Tools for annual estimates of HIV epidemic indicators, including HIV prevalence, incidence, mortality and the treatment cascade, have become increasingly granular with respect to age, sex, and geographic strata to ensure populations are not missed as coverage reaches high levels. However, while UNAIDS publish global estimates of HIV indicators by population groups based on internal modelling, key population stratified estimates are not produced as part of country-led HIV estimates process for most countries. These data are required for implementing effective national HIV responses and monitoring progress towards global goals and targets.

The Spring 2021 meeting will focus on developing a work plan towards four outcomes:

1. Develop an appropriate modelling tool and workflow for key population stratified estimates for as part of 2022 estimates in sub-Saharan Africa.
2. Review key population data sources and analytical methods in sub-Saharan Africa and develop a consensus guidance and checklist for key population data and assumptions into key population-stratified estimates.
3. Reach recommendations about indicator definitions and programmatic use cases to guide model develop priorities for key population stratified estimation models.
4. Implement a population risk group stratified extension of the Case Surveillance and Vital Registration (CSAVR) model for settings with case surveillance data stratified by mode of transmission.

Meeting objectives

<u>High prevalence settings in sub-Saharan Africa</u>

- Review available data on key population size, HIV prevalence, HIV incidence, and ART coverage for the four key population groups (MSM, PWID, FSW, and TG);
- Review analytical approaches for synthesising key population data for model inputs, for example:
    - Integrating multiple observations or sources of data about the same outcome;
    - Extrapolating subnationally representative data for national estimates;
    - Assumptions or model extraploations for required indicators in settings with no data;
- Develop criteria and processes for triangulating, prioritising, or including / excluding key population data into models.

<u>Low prevalence settings with case surveillance data</u>

- Availability and interpretation of case surveillance data stratified by transmission mode;
- Extension of the CSAVR model to model case surveillance data stratified by mode of transmission; and
- Model developments to incorporate key population prevalence surveillance previously input to EPP, enabling further integration of EPP and CSAVR for concentrated epidemic settings.

Meeting overview

For the 2022 estimates process, UNAIDS guided the UNAIDS Reference Group on Estimates, Modelling, and Projections to advance the development of models that produce key population estimates in both high and low HIV prevalence settings. The Reference Group sought to recommend a data and modelling workflow such that all countries in sub-Saharan Africa are able to review available key population data and produce estimates for:

- Population size;
- People living with HIV; and
- New infections

for key population groups:

- Men who have sex with men (MSM);
- Female sex workers (FSW);
- People who inject drugs (PWID);
- Transgender people (TG).

The Reference Group identified the Incidence Patterns Model (IPM) as a candidate approach for furnishing key population estimates in sub-Saharan Africa. The IPM produces estimates of new infections by 21 demographic and risk stratified groups, informed by nationally representative household survey data and programme data. The model and its applications are detailed in Session 1. The Reference Group invited three discussants to:

- Evaluate and review IPM parameterisation and implementation;
- Make recommendations on its suitability for achieving the above UNAIDS objectives;
- Identify further model development work for its specific application to key populations

The consolidated summary of discussants' commentary can be found in Session 2. An overview of key population data, its limitations, and discussion on how to consolidate diverse and disparate data into consolidated model inputs can be found in Session 3. Meeting participants were then invited to make recommendations in working groups (Session 4) on:

- Developing an appropriate modelling tool and workflow for key population stratified estimates for as part of 2022 estimates in sub-Saharan Africa.
- Reviewing key population data sources and analytical methods in sub-Saharan Africa and develop a consensus guidance and checklist for key population data and assumptions into key population-stratified estimates.
- Reaching recommendations about indicator definitions and programmatic use cases to guide model develop priorities for key population stratified estimation models.

Background literature, including a literature summary, provided to meeting participants for reference may be found here.

Meeting introduction – Global AIDS Strategy 2021-2026 and key population estimate requirements

Peter Ghys presented the recently approved Global AIDS Strategy 2021-2026 focused on reducing the inequalities that drive the HIV/AIDS epidemic in order to end the AIDS epidemic by 2030 [1]. The 95-95-95 targets in 2025 have expanded beyond knowledge of status, ART treatment, and viral suppression to also include coverage targets for services for eliminating mother-to-child transmission (MTCT), access to sexual and reproduction health services, and coverage of combination prevention. HIV prevention and treatment cascade targets are stratified by key population and risk prioritisation, requiring more detailed strategic information about these populations to set programme targets and monitor progress. Further

targets on integration and societal enablers that must be met to end HIV/AIDS by 2030 look to address the broader determinants of health and HIV outcomes that key populations experience when trying to engage with HIV services.

Mary Mahy presented an overview of how HIV estimation can be used to close the inequality gap for key populations. Estimates are required to guide prevention and treatment services, requiring estimates of key population size, HIV prevalence, and distribution of new infections by mode of transmission. Key population data are recognised to be sparse and inconsistent over time, and it is important to ensure that estimates provide additional value beyond the raw data themselves. For the 2022 estimates, the distribution of new infections by key population group (female sex workers (FSW), men who have sex with men (MSM), people who inject drugs (PWID), and transgender people (TG)) is required for all countries in sub-Saharan Africa.

Key points from discussion

- The Important to ensure uncertainty is communicated through the estimates (Josh Salomon)
- Three tests may be put forward to a key population model:
    - Does the uncertainty shrink as more data are added?
    - Does uncertainty sum across population and geographic strata? and
    - Does the model structure provide constraints for plausible estimates? (i.e. the model is better than raw data alone)

Session 1 – The Incidence Patterns Model

Sessions 1 and 2 focused on reviewing the Incidence Patterns Model (IPM) and its suitability as a modelling tool and framework to synthesise key population data and produce estimates of the distribution of HIV infections by key population group.

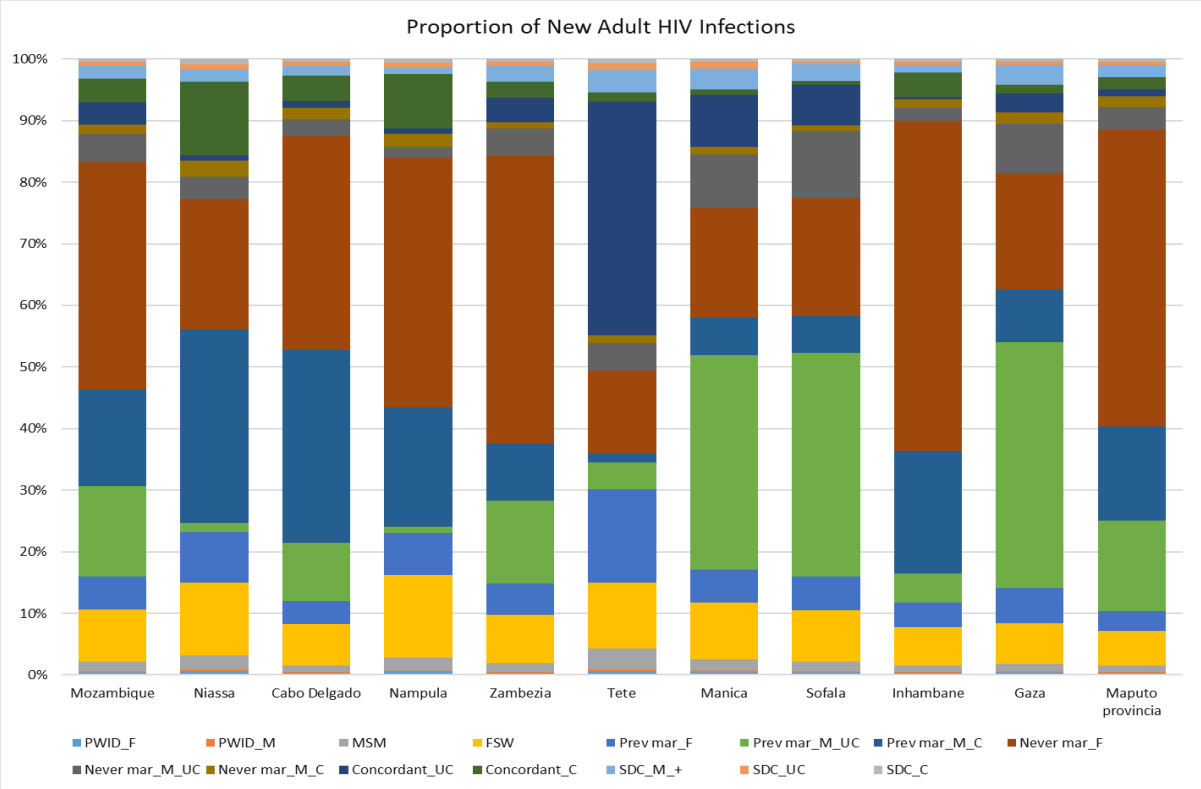
Annick Bórquez presented the Incidence Patterns Model (IPM) [2], which produces estimates for new HIV infections disaggregated by 21 subpopulations. The model was developed as successor to the Modes of Transmission model (MoT) [3]. The MoT is a cross-sectional spreadsheet model developed in the early 2000s to estimate the distribution of HIV infections occurring between population groups and by mode of transmission, and was applied by many national HIV programmes to support the UNAIDS *Know Your Epidemic, Know Your Response* initiative.

The IPM was developed to address some of the MoT's limitations, including statistical calibration to epidemiological data and formally representing uncertainty in estimates. It produces estimates of the distribution of infections by subpopulation and first administrative region (e.g. province) over a single year time step. The population is stratified into groups defined by marital union status, HIV serodiscordancy, antiretroviral treatment and male circumcision status within partnerships, and key populations.

Data inputs are derived from Demographic Health Surveys for the general population inputs and Biobehavioural Surveys or local studies for the key population inputs. The model outputs were validated using ALPHA network cohort data and performed well in these settings, though key population validation was restricted to FSW estimates. The distribution of HIV transmission can be back calculated from the distribution of acquired HIV infection, population prevalence, and population mixing and transmissibility matrices.

Incidence in key population is modelled as the HIV prevalence among the key population divided by the mean duration of risk practice.

Guy Mahiane presented the implementation of the IPM used for thirteen country modelling exercises in sub-Saharan Africa. Survey data are processed into an excel workbook, to which key population and Spectrum inputs are added. Estimates are produced at the provincial level. Across all countries, the large majority of new infections are found within the general population (Fig 1).



Key points from discussion

- The number of new infections from Spectrum is treated as a data point in IPM model calibration (Annick Borquez)
- The priors for the mean duration in key population are out of date and may have an outsized effect on key population estimates (Annick Borquez)
- The transmission model requires further development work, and is sensitive to the accuracy of the mixing and transmissibility matrices (Tim Brown, Annick Borquez). The transmission model was not used within the country modelling exercises (Guy Mahiane).
- Clients of FSW (CSFW) are not a separate population within the model, which limits the ability of the model to represent transmission dynamics between FSW to CFSW and from CFSW to non-FSW sexual partners (Peter Vickerman).
- All key population compartments and infections are independent of the general population compartments, suggesting that the KP estimation component operates somewhat independently (Jeff Eaton).
- It would be challenging to separate the KP compartments from the model because the number of new infections would be unconstrained without the general population data (Annick Borquez)
- Mean duration reflects several things (turnover, death, ART coverage) and relies on an equilibrium assumption – this is challenging as ART coverage rates have risen rapidly in recent years. Turnover of HIV^+ key population members does not represent the end of HIV infectivity and this is not reflected within the model (Josh Salomon)

- Validation should be done for all key populations where available (Le Bao) but this is challenging given the sparsity of cohort data for other KPs (Annick Borquez)

Session 2 – Discussants on the Incidence Patterns Model

Joseph Larmarange, Tim Brown, and Kennedy Mutai were invited to provide comments the IPM's suitability for the UNAIDS objectives of producing estimates of new infections by key population group. The key thematic areas of their discussion were:

1) Design and structure of the key population analysis
    a. **Definition and choice of groups**
        - Clients of female sex workers (CFSW) are not represented in the IPM;
        - The Modes of Transmission (MoT) model offered greater stratification than the IPM, including female partners of MSM, partners of PWID, and partners of CFSW; and
    b. **Heterogeneity within groups** – Key populations may be further stratified e.g. FSW by client frequency and the difference between transactional and commercial sex work.
    c. **Interaction between population size and prevalence** – Prevalence is an insufficient measure by which to assess HIV burden, prevalence and PSE must be viewed in conjunction.
    d. **Former members of key populations remain important for onward transmission for longer estimation horizons**

2) Model parameterisation and implementation
    a. Validity for equilibrium model for key population estimation
    b. **Model outputs and their use for programming** – the IPM produces highly stratified estimates for the general population which may not be of use to country teams.
    c. **Strengths and weaknesses of behavioural vs epidemiological approaches**
        - The IPM's Bayesian framework and fitting to prevalence/incidence data is an improvement over the MoT, but omits behavioural inputs such as frequency of sex acts, prevention coverage within KP groups, and transmission probabilities.
        - A data framework for the collection of behavioural data should be constructed to inform the future development of behavioural-based models
    d. **Validation** – Model validation included The model should be validated in other key population groups beyond FSW.

3) Data
    a. Availability
        - Nineteen nationally representative household surveys have been published since the publication of the IPM
        - High uncertainty remains around estimates of risk activity duration
        - Data are widely available for FSW and MSM, but sparse for PWID and TG
    b. Biases
        - The distinction between gender expression, identity, and sexual orientation differs from person to person and may be poorly captured by surveillance instruments

4) Reporting

a. **The transmission model -** As the IPM estimates a small number of acquired infections within key populations, the transmission model must be included within future implemented versions of the model to communicate that key populations sustain the HIV epidemic

Key points from discussion

- Key population estimates are required by UNAIDS for denominators to assess equity in HIV response. Allocation needs require PSE and new infections. These are adequately produced by a static model (John Stover)
- Introducing a "client" stratification, akin to the currently implementation of ART and circumcision status would be the best way to integrate clients into the general population unions (Annick Borquez)
- Both the acquisition and transmission model should be implemented alongside to give a fuller picture of KP transmission (Annick Borquez, Peter Vickerman, Joseph Larmarange)
- Survey data on clients are sparse and impacted by social desirability bias (Guy Mahiane, Michel Alary), though other analyses suggest that they are of acceptable quality (Mathieu Maheu-Giroux)
- Stratifying by transactional or commercial sex is not required – the focus should be on client number and overlap between partners (Katharine Kripke, Lucy Platt)

Session 3: Key population input data

Keith Sabin presented an overview of key population data collected by UNAIDS through Global AIDS Monitoring (GAM). Data are collected on MSM, PWID, SW, TG, and prisoners, though data are not collected for CFSW. HIV prevalence, ART coverage, and population size are available within GAM, disaggregated by gender, age, and geography as available. It is noted that UNAIDS does not mandate the reporting of key population definitions. The majority of countries in SSA have size estimates for FSW and MSM. However, many MSM size estimates lie beneath the 1% threshold that is deemed to be credible [4], and few size estimates are deemed to be of sufficient quality to be nationally representative [5]. Little data are available for PWID and TG populations.

Oli Stevens presented a consolidated analysis of stakeholder organisation KP data (GAM, Global Fund, Key Population Atlas, Centres for Disease Control and prevention, Goals, and Optima). Audit trails tracing back from modelled or stakeholder datasets to surveillance data were generally of good quality, though methodological details relating to national extrapolations were sparse. PSE data were frequently replicated within datasets, whilst unique HIV prevalence data were found between datasets.

Louisa Degenhardt presented a summary of global systematic reviews on injecting drug use conducted in 2007 and 2017 [6]. The proportion of SSA countries with evidence of injecting drug use has increased sharply from 2007-2017, though the proportion of countries with PSE estimates for PWID remains low in the region. Globally, 21% of PWID are estimated to be women, and 28% are under 25 years old, though little data are available to inform these estimates in SSA. ART coverage data in PWID are limited globally, and in-country consultations are key to fill data gaps where published data are sparse.

Peter Vickerman presented the process for collating PWID data in Tanzania, Kenya, and South Africa to inform modelling efforts, representing the best available PWID data in SSA. HIV prevalence data are of the best quality, though limited to five or fewer sites in each country and may not be appropriate for extrapolation to national level. Size estimate data are of mixed quality, and rarely nationally representative. Finally, ART coverage are sparse and

derived from self-report data in BBS-style surveys. Women who inject drugs have a higher HIV prevalence than men who inject drugs when compared to sex-matched general population HIV prevalence, with high HIV prevalence at injection initiation. Many settings lack sufficient data to produce PWID estimates using national data alone, and regional data is likely to be required to support national modelling.

An overview of epidemiological data available for FSW was presented by Lydia Atuhaire. Twelve countries have recent surveillance or modelling studies that offer estimates of HIV prevalence. ART coverage data are older, and are often derived from a small number of sites within a country. Programmatic data stratified by mode of transmission offer a promising data source which which to triangulate BBS data, and have been used to calculate population size for transgender populations. Many countries rely on regional averages to support nationally available data.

Le Bao presented model-based estimates of district-level PSE for FSW, consolidating 1263 estimates across 39 countries. Frequently encountered data quality issues and challenges included varying definition of sex work, reconciling PSE methods, and difficulty in identifying geographic catchments and associated population denominators. National FSW prevalence estimates vary from 0.32% in Malawi to 2.36% in Namibia. Biases within the data remain of concern, and few countries have FSW PSE across several years. It is noted that uncertainty within PSE should be formally incorporated within the final uncertainty of key population estimates.

Data on MSM were presented by James Stannah [7]. PSE estimates are sampled almost exclusively from urban sites and may not be nationally representative. National level estimates are frequently under the 1% threshold set out by WHO and UNAIDS, particularly in Western and Central Africa where estimates can be as low as 0.01%. HIV prevalence data are largely derived from West Africa, with fewer data from Central, East, and Southern Africa. Trends suggest decreasing HIV prevalence over time, but data quality can be poor and trends implausible. HIV prevalence in older MSM is higher, though most studies struggle to recruit older MSM and samples are small. ART coverage data is frequently self-reported, and are likely biased by face-to-face interview methods in countries where same-sex relations remain criminalised. Challenges in interpreting the data include generalisability from urban samples, convenience samples and unweighted RDS methods, and reporting biases surrounding illegal or stigmatised behaviour.

Keith Sabin presented data reported to UNAIDS GAM on transgender people, comprised of 8 PSE, 4 HIV prevalence estimates, and 4 ART coverage estimates. Accurately capturing data on transgender people is difficult as the language used by surveillance instruments can be inadequate for the local cultural setting. Defining risk populations is a further difficulty: transmen are often included with MSM, data are often derived from TGSW who will have a higher incidence risk than those not involved in sex work.

Demographics in key populations and challenges for modelled estimates were presented by Leigh Johnson. It is important to consider KP demography when understanding turnover rates, geospatial distribution of key populations, using multiplier methods, and assessing the confounding effect of age on estimates of HIV incidence and ART coverage in key populations. Studies considering female sex work use difference definitions of sex work and may mask risk heterogeneity within the population. FSWs tend to be younger than the general female population, and male and TGM sex workers remain understudied in SSA. MSM recruited by RDS methods have a much younger median age than the general population, which may be due to selection biases in referral chains, high mortality in older MSM, or age-related changes in sexual preference. Limited demographic data are available for transgender people, but a 2017 study found similar age distributions for MSM and TGW in 8 African countries [ref]. Models of KPs need to be age-stratified (and calibrated to age-

specific data where possible) if they are to correctly describe the disparities between KPs and ‘general population’ in terms of HIV incidence, prevalence and access to HIV testing and treatment.

John Stover presented a possible user interface for the IPM. Users would be able to upload Spectrum files, survey data, and key population specific data, review and evaluate model inputs, fit the model, and validate model outputs. The input data validation menus could be separated out into a separate tool that guides users through evaluating input data, extrapolating subnational estimates to the national level, and forming consensus estimates to be used in a subsequent modelling framework.

Key points from discussion

- Additional data may be sought for PWID from UNODC and WHO databases (Kamran Niaz) and programme data on transgender people from PEPFAR (Keith Sabin, Peter Nyasulu)
- Consider stratifying transgender populations by TGW and TGM
- It is unclear which populations are the partners of transgender people, though it is noted that the clients of FSW are not expected to be the clients or partners of TGSW (Tim Brown)
- Transgender PSE are small and definitions are strong drivers of responses and data quality (Keith Sabin, Joseph Larmarange)
- Women who enter sex work are often already HIV+ in South Africa, reflecting the vulnerable demographic of sex work initiates (Leigh Johnson), but in West Africa this is often not the case (Michel Alary)
- A hierarchical model for integrating regional and national data could supported within a tool for creating consensus inputs (Mary Mahy/John Stover)
- It would be beneficial for users to adjust inputs and see the effects on model outputs with as little delay as possible (Jeff Eaton). This could be done after model fitting of the IPM using the posterior estimates, providing changes to model inputs are relatively small (Annick Borquez, John Stover)

Session 4 – Working groups

Meeting participants were allocated to seven working groups and invited to address a set of questions on key objectives and specific features of the Incidence Patterns Model for use in the 2022 estimates process. A summary of the working group responses follows, with full responses at the end of this document.

1. **Framework / model: Enumerate three priority (a) areas for model development, (b) assumptions requiring validation, or (c) questions to be addressed for IPM or other suitable tool for KP estimates in 2022 UNAIDS estimates.**

    - A hybrid approach, combining both epidemiological fitting features of the IPM alongside behavioural features of the MoT model may be beneficial
    - Many general population union strata may not be required
    - The assumption that $Incidence = \frac{Prevalance}{Mean\ duration}$ may not be valid, and requires further model development
    - Clients of FSW should be included in the model
    - The transmission model should be a core function of the IPM
    - A hierarchical model to guide extrapolation, which need not be integrated into IPM, would be of use

2. **Data use checklist: Enumerate three items for each of the following sections of the checklist:**

<u>Compiling available data sources on key populations in your country</u>

- Have you:
    - Engaged appropriate stakeholders (govt, donors, community organizations, harm reduction networks)?
    - Searched grey literature as well as journal articles?
    - Searched existing KP databases/reviews (e.g. KP atlas, Johns Hopkins database, GAM submissions, published reviews)?
    - Identified the data sources used in recent planning exercises? (e.g. National Strategic Plans, Global Fund, PEPFAR Data Pack, Goals/Optima)
    - Identified covariate data that may be necessary in extrapolation (e.g. HIV data for general population)?
    - Abstracted the key information to judge the data (KP definition, year, catchment area, design, sample size, 95% CI)?
    - Considered programme data on KP services?

<u>Reviewing, evaluating, and assessing available data</u>

- Have you graded your data according to reliability of study type (e.g. RDS, venue-based, household-based, Delphi)?
- Have you considered the reliability of the survey instrument/questionnaire (e.g. self-report vs ARV testing)?
- How consistent are the different data in terms of the KP definitions that are used?
- How consistent are the data with “gold standard” estimates (locally & in the region)?
    - Is the MSM population size >1% of the adult male population?
- Are population size estimates consistent with programme data where available (e.g. PWID accessing harm reduction services)?
- Have national data been disaggregated by province/district?

Synthesising or extrapolating available data for model inputs

- What is the KP definition that will be used in synthesis?
- What is the year/period to be used in the synthesis?
- Have you weighted/excluded data based on quality criteria?
- Have you weighted/excluded data based on recency?
- What assumptions have you made in extrapolating to districts/regions for which there are no data?
- When extrapolating/converting proportions to absolute numbers, have you checked that the population denominators (age, sex, etc) are defined consistently?

Reviewing model outputs for consistency

- Do subnational KP estimates look consistent with subnational general population estimates? (e.g. correlated prevalence)
- Are prevalence levels in KPs higher than the 'general population' (controlling for age and sex where possible)?
- Have you conducted sensitivity analyses to assess the importance of the assumptions that you are most unsure of?
- Have you shared the results with stakeholders who can comment on their plausibility?
- Does the distribution of new infections/incidence look consistent with information on behaviours/prevention? (e.g. high levels of condom use should imply low incidence)

Validating model results for key population estimates with other data sources

- Have you compared the results against the results of previous models that have been applied in the country?
- Are there programme data that can be used to validate the model, e.g. numbers of KP on ART?
- (Are there case surveillance data that can be used to validate the model, e.g. new diagnoses stratified by KP?)
- In countries with multiple DHS/PHIA surveys, how sensitive are results to the use of a different survey data set in IPM?

3. **User interface / workflow: Please describe or sketch three tables, visualisations, or key features that will support users to interact with key population data and modelling results.**

- Comparison of input data with regional averages, previous GAM data/data used in other exercises (PEPFAR, National Strategic Plans, Global Fund);
- Visualisation of results for all KPs and general population together;
- Visualise the effect of adjusting parameter inputs in 'real-time';
- Need to represent uncertainty in outputs, but also need some way of visualise uncertainty in inputs (e.g. quality ranking based on study type);
- Flags to highlight abnormally high/low inputs; and
- Subnational maps/charts should indicate where estimates are based on extrapolation.

Session 5 – Estimates of onward KP transmission

Sharmistha Mishra presented an overview of the transmission population attributable fraction (tPAF) indicator and its use in programmatic settings. Cross-sectional estimates of HIV transmission or acquisition do not capture the onward contribution of a given population to the HIV epidemic over time. tPAF over time looks to quantify the proportion of cumulative HIV infections in a population that stem directly and indirectly from a risk factor and may be calculated by modelling a counterfactual scenario in which that risk factor is removed:

$$tPAF_t = 1 - \frac{\#\ new\ infections\ (no\ risk)}{\#\ new\ infections\ (risk)}$$

tPAFt is expected to increase over longer time horizons for key populations, reflecting the growing number of infections linked to initial key population infection. It may sum to greater than 100% across population groups as the metric is not independent across groups.

Ross Booton presented a model comparison study to assess the contribution of key populations to HIV epidemics in SSA. Fourteen transmission dynamic models in eight SSA countries provided estimates of:

- The distribution of incident and transmitted infections over 1 year (2020)
- tPAF over 1 and 10 years (2020 and 2010-2020 respectively)

Each of the fourteen models identified the same key population as the priority population when using the 1-year and 10-year tPAF, but the population identified by proportion of transmitted infections aligned with the tPAF metrics in only 50% of cases. This may be due to population size differences within the models.

Country/setting	Model	KP with greatest contribution to indicator			
		Indicator 1: % HIV infections acquired, 2020	Indicator 2: % HIV infections transmitted, 2020	Indicator 3: % tPAF over 1 year, 2020	Indicator 4: % tPAF over 10 years, 2010-2019
Eswatini	Optima	OW	OM	OW	OW
South Africa (KZ-N)	Silhol	OW	OM	OM	OM
SA, Eswatini and Lesotho	Mishra	CFSW	CFSW	CFSW	CFSW
South Africa	EMOD	OW	OM	OM	OM
South Africa	Goals	CFSW+FSW	*	CFSW+FSW	CFSW+FSW
South Africa	Optima	OW	OM	OW	OW
South Africa	THEMBISA	YW	CFSW+FSW †	CFSW	CFSW
South Africa	Vickerman	CFSW	CFSW	CFSW	CFSW
Zimbabwe	Optima	OW	OM	OW	OW
Mozambique	Optima	OW	OW	OW	OW
South Africa (WC)	Silhol	CFSW+FSW	CFSW+FSW	CFSW	CFSW
Malawi	Optima	OW	OM	OW	OW
Cameroon (Yaoundé)	Silhol	CFSW ‡	*	MSM	MSM
Cote d'Ivoire	Maheu-Giroux	OW	CFSW	CFSW	CFSW

The 10-year tPAF suggests that all KPs contribute more to overall transmission than their population size might suggest, but due to their population size the general population groups remain the largest contributors to overall HIV transmission.

Results from six SSA countries from the Optima model were presented by Sherrie Kelly. Model inputs for HIV prevalence and PSE are consolidated from a range of stakeholder databases and in country consultations. PSE inputs for MSM are frequently below the

minimum recommended 1% threshold. PSE are not directly available for CFSW and are assumed to be 10fold larger than the PSE for FSW. KPs only account for 0%-7% new HIV infections (except for 16% in FSW in Zimbabwe), with most new HIV infections occurring in the general population. Onwards transmission is least attributable to FSW. However, poorly informed HIV prevalence for CFSW which may lead to an underestimation of new HIV infections among clients. Where MSM have sex with females, onward transmission is highest compared with counties where sex with females was not reported for MSM. This can then guide optimized prevention spending to reduce the total number of new HIV infections.

Estimates of the contribution of KPs in South Africa were presented by Jack Stone [8]. The model, stratified by low risk men/women, FSW, CFSW, and young MSM, old MSM, was fit to South African household survey data. Projections for FSW and MSM are consistent with prevalence estimates from surveys. 10-year tPAF was largest in the low-risk population, followed by CFSW, and scaling up ART in these populations would avert the most infections. Expressing tPAF proportional to PSE produces a measure of efficiency – the number of HIV infections averted by 100 person years on ART – identifying FSW and MSM as the most efficient due to their small population size.

Leigh Johnson presented KP results from Thembisa and MicroCOSM. MicroCOSM permits extensive behavioural flexibility, including relationship heterogeneity in MSM, sexual mixing by age, risk, education, race, and location group, and role and same-sex preference for MSM. The model is fit to non-nationally representative survey prevalence data for MSM and FSW and random effects are used in model calibration when estimating national prevalence. MicroCOSM additionally fits to behavioural data for MSM and FSW where available. For MSM, data are adjusted for oversampling the 18-24 age group in RDS studies which increases the fitted HIV prevalence by 8%, reflecting the higher prevalence in older MSM.

The Goals model was presented by John Stover which fits to survey and surveillance data for the general population, and key population prevalence estimates often derived from the UNAIDS Key Population Atlas. Seventy seven countries used Goals for UNAIDS 2025 Target Setting, of which 37 were in SSA, where 10% of new infections occurred in KPs (omitting CFSW). Comparing estimates from the IPM and Goals in Nigeria, both models suggest that around 11-12% new infections are in key populations, and it is noted that the third largest source of new infections are vertical infections and this should not be lost sight of when identifying optimal prevention interventions.

Key points from discussion

- Differences exist between Goals and KP Atlas PSE, in some cases KP Atlas PSE were too low (John Stover)
- Goals and Optima estimates of 10-year tPAF were the lowest in the model comparison study, which may be due to low PSE in these two models (Marie-Claude Boily)
- Optima uses PSE with uncertainty in model calibration, and there should be a move towards using consolidated model inputs between models (Sherrie Kelly)
- There is no single source of consolidated data and in-country review is essential. Data review workshops are required before the 2022 estimates process (John Stover, Tim Brown, Mary Mahy, Sherrie Kelly)

Estimates of onward KP transmission – working groups

Participants were allocated into seven working groups. Each working group was tasked to :

1. Propose one priority annually collected indicator to ensure that HIV prevention programme priorities are appropriately aligned to local epidemiology
2. Evaluate the indicator against the five standards defined in the UNAIDS MERG indicator guidelines.

Working group summary

- The utility of tPAF and the limitation of cross-sectional measures to capture onward key population-related transmission was recognised by most groups
- Three groups recommended tPAF as an annual indicator to be used by programmes
- tPAF was felt to be of limited utility to programmes if calculated as an annual indicator, with little novel data available on an annual basis.
- Several groups recommended calculating either a 3- or 5-year tPAF, or calculating a 10-year tPAF every 3-5 years.
- tPAF was seen as difficult to interpret by those unfamiliar with it, and its reliance on a modelled counterfactual scenario would not facilitate country team buy-in. One group recommended less modelled indicators which would be more easily used by programme teams.
- Combining metrics to create a comprehensive picture was viewed as useful by several groups, allowing short-term, non-counterfactual based metrics, in addition to medium-term counterfactual-based metrics to be used. These may include:
    - Number and proportion of infections acquired and transmitted over 1 year
    - Per capita tPAF

Key points from discussion

- The existing 'donut' visualisations produced as part of the UNAIDS Global AIDS Report to show distribution of new infections by mode of transmission are cross-sectional measures. These should not be replaced by estimates of tPAF because they are easily interpretable, unlike tPAF (John Stover)
- The graphics in the Global AIDS Report should be expanded or amended:
    - Number of new infections, source of transmission, tPAF, mosaic plots to show who infected whom
    - Sankey diagrammes to visualise infection flow
    - tPAF to population size ratio

Session 7 – Key population estimates in CSAVR

Ard van Sighem presented a summary of key population stratified data in the TESSy database and estimates from the Netherlands and Norway. Mode of transmission is recorded in 80% of case reports and CD4 count at diagnosis in 65%. Missing data are imputed, first gender, and then transmission group, migrant status, and CD4 count at diagnosis by gender group. New infections and the number with undiagnosed HIV in the Netherlands were estimated using the ECDC model, stratified by MSM, other men, and women. Each population was estimated individually and when aggregated overall estimates produced close matches to models fitting to the total population. The ECDC model was also used to make estimates in Norway stratified by PWID, MSM, migrants, and heterosexual populations from Norway and SSA and overall estimates were similar to CSAVR fits in Norway.

Guy Mahiane presented a methodological extension to CSAVR to produce estimates stratified by key population – see working paper here. The model can now calibrate to survey prevalence estimates, in addition to case report and vital registration data. Incidence in key populations is proportional to sex-matched incidence in the general population and is permitted to change over time. The diagnosis rate is also proportional to sex-matched

general population trends, but the proportional difference is fixed over time. The prevalence of key populations is fixed over time, with priors derived from a literature review. The model fits to:

- New diagnoses – both overall and stratified by mode of transmission (ECDC)
- AIDS deaths (IHME)
- HIV prevalence in key populations (survey estimates or literature)
- Population prevalence (literature)
- Turnover rates (literature)

Key population size is not a fixed input to the model, and posterior estimates of population size may differ from prior inputs to reconcile the number of new diagnoses and HIV prevalence.

Richard Gray, Nikos Pantazis, and Deepa Jahagirdar were invited to review and discuss a working paper detailing the key population stratified implementation of CSAVR. The key areas from their discussion is as follows:

1. **Model specification**
    - Assumed relationships between key populations and general populations may not be valid
        - Diagnosis rates in key populations are unlikely to be constant over time and will respond to programmatic targeting and additional flexibility should be considered;
        - Age distributions in key populations can change relatively quickly over time (e.g. drug use trends can change the median age for PWID rapidly); and
        - The best incidence option for the total population may not be the best fitting incidence option for each nested key population
    - Key population prevalence
        - Prevalence may not be constant over time; and
        - In cases where MSM and MWID prior population sizes were high, posterior estimates of population size were much lower
    - Model flexibility
        - The incidence model be too inflexible to capture PWID outbreaks (e.g. Greece, Romania); but conversely
        - IRR trends may be too flexible, causing model artefacts in the early epidemic and inflection points in cases where the data suggest smooth trends
        - Tighter priors may be useful in data limited settings
    - The model may overestimate knowledge of status and mean CD4 at diagnosis when compared to ECDC and TESSy data
    - How should the model categorise and calibrate to former members of key populations?

2. **Key population surveillance data**
    - Uncertainty in diagnosis data and vital registration is not represented in the model and are treated as fixed inputs;
    - Many countries had missing or limited data for certain key populations which may mask diverging epidemics in different key populations and aligning too heavily with the overall incidence trends;
    - Sex work as a mode of transmission is not recorded in TESSy. There is also significant overlap between FSW and FWID in Europe, and determining a mode of transmission is challenging; and

- The expected proportion of HIV transmission for each key population could be used either as validation or calibration data

Key points in discussion

- Under-reporting of mode of transmission in the TESSy database will be country specific. Anecdotal reports suggest underreporting of MSM is significant in Poland, and likely across Eastern Europe for injecting drug use (Ard van Sighem)
- Overestimates of CD4 count at diagnosis have negative implications for good programming, encouraging the belief that all diagnoses are caught early, and sits contrary to literature detailing the proportions of late diagnosis in ECDC countries (Nikos Pantazis)
- Stronger priors on incidence and diagnosis trends fail to capture country-specific trends (Guy Mahiane)
- Case reports missing mode of transmission are treated as “general population”. Future testing could use imputed datasets as calculated by ECDC or data may be redistributed before modelling (Guy Mahiane, Jeff Eaton, Richard Gray)
- Minimum thresholds for MSM population size estimates could be considered, and may prevent the model overadjusting population prevalence in the case of underreported mode of transmission (Oli Stevens)
- Population size estimates are dated and should be revised where available (Peter Ghys)
- Testing prevalence fitting is difficult in WCENA with few surveys. Testing countries could include Brazil, Thailand, and China (Peter Ghys).

Session 8 – Middle East and North Africa

Ali Feizzadeh and Tobi Saidel presented an overview of HIV surveillance data and estimation methods used in the Middle East and North Africa (MENA). KP PSE are often held constant or near constant over time though prevalence differs across the region, with the exception of PWID in Morocco and Iran where prevalence has been decreasing since 1990. Trend data are available, but the number of points informing trends is small. Iran, Morocco, Tunisia have multi-site HIV prevalence data over time for key populations from 2000, with data availability increasing after 2010. Morocco has PSE and HIV prevalence estimates for CFSW. HIV prevalence is available from both survey and programme data, but biases within programme data need to understood as including it can have large effects on EPP prevalence curves. 15 countries now use CSAVR within MENA as population size and prevalence estimates are not required for its use. Mortality data are sourced from either from IHME or from domestic vital registration and case surveillance systems. There is concern surrounding the use of IHME estimates for countries placed within IHME’s 2C mortality classification. IHME estimates for these countries are based on regional averages and sourced from Spectrum, and are not based on true data.

Laith Abu Raddad presented systematic reviews and modelling studies for KPs in MENA [9]–[11]. Half of MENA countries have expanding epidemics in MSM, emerging from 2003 onwards. Few MSM PSE are available in the region, and are small compared to other regions. PWID epidemics are also emerging and expanding since 2000, with average HIV prevalence around 12% in the region. PWID PSE are in line with global estimates, with highest prevalence in eastern MENA. Finally, the FSW-related HIV epidemic is also expanding by 15% per annum, with PSE for FSW and clients of 0.6% and 5.7% respectively. Sex work is estimated to be driving the majority of HIV incidence in Djibouti, Somalia, and South Sudan. Mode of Transmission models have been useful in understanding the epidemic in Morocco, and the process of collating and interrogating key population data, regardless of the model, is a key step in understanding key population estimates.

Underutilised data sources in the region include the large volume of HIV testing data and HIV case notification data.

Key points in discussion

- Regional averages underpin mortality estimates in IHME 2C countries and should not be used as CSAVR inputs (Deepa Jahagirdar/Jeff Eaton)
- IHME 2B countries mortality estimates can be used in CSAVR for the subset of years where data are available and underpin the estimates (Jeff Eaton)
- What will constrain CSAVR fits in the absence of mortality data in 2C countries? (Rob Glaubius)
    - Consider regional constraints be used, reflecting shared epidemic trajectories highlighted in Laith Abu Raddad's systematic reviews (Jeff Eaton), though this may be based on mortality data from domestic databases of varying quality (Rob Glaubius)
    - Fix the diagnosis rate at a regional average
- Significant levels of migration in Gulf states, all of whom are HIV tested upon arrival. Annual HIV testing is mandatory in specific professions, and may be able to be used as quasi-cohort data to estimate incidence (Laith Abu Raddad)
    - Approximating the diagnosis rate from the testing rate may assist in constraining CSAVR in 2C countries (Leigh Johnson)
    - Need to consider who the testing data represent if the mandatory testing is targeted at professions and may not represent the wider population (Tobi Saidel/Mary Mahy)
- Using both BBS and programme data in EPP could be addressed with a random effects model or bias adjustment (Jeff Eaton), and the data should be fully understood before considering model based approaches (Tim Brown)
- UNAIDS MENA estimates should be validated with MENA systematic reviews, and model comparison studies comparing EPP, CSAVR, and Laith Abu Raddad's incidence estimates

UNAIDS Reference Group on Estimates, Modelling, and Projections Recommendations | Spring 2021

Recommendation	Lead person(s)	Timeline
Session 1-5: Key populations in sub-Saharan Africa		
<u>Representation of uncertainty in modelled estimates</u> • Modelled uncertainty around key population estimates should reduce as more data are added • Uncertainty should sum over population and geographic strata • The model should provide constraint ranges of plausible estimates such that modelled estimates are better than raw data alone	Reference Group	2022 estimates process
<u>Model structure and outputs</u> • In addition to MSM, FSW, PWID, and TG, clients of female sex workers should be included as a key population	Reference Group	
• Country estimates teams should be engaged to ascertain key model outputs and stratifications	UNAIDS	
<u>Incidence Patterns Model</u> • The transmission model should be implemented alongside the acquisition model to give a full picture of key population-related transmission	Reference Group	October 2021
• Review and model development are recommended for: o Mixing and transmission matrices; o Mean duration of risk activity; o Equilibrium assumption for incidence estimation; and o Representation of former members of key populations		
• Validation of key population estimates should be extended beyond FSW to include PWID, MSM, and TG populations		
<u>Key population input data</u> • Additional data on PWID should be sought from UNODC and WHO databases		Summer 2021
• Programme data, particularly on transgender populations, should be considered for inclusion within size estimates		Summer 2021
<u>Implementation for the 2022 estimates process</u> • Country estimates teams will be supported to create estimates of new infections by key population from one of a range of estimation tools, including IPM, Goals, Optima, EPP, the Modes of Transmission Model	UNAIDS	2022 estimates process

• Spectrum will be updated to include:
  ○ An input editor for users to upload estimates of key population size, PLHIV, and new infections
  ○ Validation plots to show distribution of new infections by group, and comparisons to general population epidemic indicators
	Avenir Health	October 2021

• Guidance will be provided to countries for collating, reviewing, extrapolating, and documenting consensus key population size and prevalence estimates	Reference Group	October 2021
• A tool will be created to assist countries in visualising all key population input data	Reference Group	October 2021
• The development of a hierarchical modelling tool should be considered so that countries may utilise regional and national data in national modelling exercises	Reference Group	October 2021
• Data review workshops will be held to assist countries in consolidating key population data	UNAIDS	Summer 2021
Session 6 – Estimating onward key population transmission		

• Estimates that reflect key population transmission over time should be included alongside estimates of new infections by key population, but should not replace them. These may include:
  ○ tPAF
  ○ tPAF per capita
  ○ Number and proportion of infections acquired and transmitted over 1 year
• Long-time horizon tPAF estimates are not recommended to be introduced as an annual indicator
	Reference Group	October 2021

Session 7 – CSAVR		
• Review data on key population size estimates and allow population prevalence to vary over time • Consider the implementation of minimum size thresholds for MSM • Review flexibility of incidence and diagnosis models • Consider adjusting for incomplete or unavailable mode of transmission data • Countries with both HIV prevalence surveys and case report data should be considered for model testing e.g. China, Thailand, Brazil	Guy Mahiane	October 2021
Session 8 - MENA		

• Mortality estimates from IHME 2C classification countries should not be used as CSAVR mortality inputs	Reference Group

• Countries will require additional constraints to use CSAVR in the absence of mortality data. These may include:
  • Fixing the diagnosis rate at a regional average
  • Informing the diagnosis rate with HIV testing data
	Guy Mahiane

• UNAIDS estimates in MENA should be validated with systematic reviews in the region	Ali Feizzadeh/Tobi Saidel
• A review of programmatic data in MENA should be conducted, including a comparison against BBS survey data	UNAIDS

Session 4 Working Groups	Group 1	Group 2	Group 3	Group 4
Priority areas for model development	- Query whether IPM is appropriate model - Consider hybrid approach of behavioural and epidemiological approaches			
Assumptions requiring validation	- Validity of mean duration approach to calculating incidence	- Validity of mean duration approach to calculating incidence - Equilibrium assumption		
Questions to be addressed for 2022 model		- Are many non-KP strata required?		
Creating key population data guidance and checklist				
Compiling available data sources	- Stakeholder engagement - Academic & grey literature review - Investigating the relationship between data in the general population and KPs	- Data indicators (e.g. year of survey, design, geographic catchment) - Sample size/denominator for PSE - KP group definition	- Size estimates - Surveys on prevalence, incidence - Programme data	
Reviewing, evaluating, and assessing available data	- Difference in methods (particularly for PSE) - Self report limitations - Uncertainty in input data	- Consideration of biases - Sampling methods - Generalisability	- Are data within expected ranges - Age of data and geographic coverage - Uncertainty and sample size - Definitions of KPs	
Synthesising or extrapolating available data for model inputs	- Align KP definitions before pooling data - Uncertainty and dealing with missing data - Review against “gold standard” estimates	- Weighting estimate by design/recency of estimate - Extrapolation guidance - Transparent reporting of extrapolation method	- Nature of extrapolation - Note the absence of critical data - Using regional data for extrapolation	
Reviewing model outputs for consistency with epidemiologic understanding	- Sensitivity analyses - Comparison against general population indicators - Stakeholder review		- Review MSM population size if modelled	

Validating model results for key population estimates with other data sources	- Stakeholder review - Review against previous modelling efforts - Proportion of onward transmission pertaining to key populations		- Triangulate against KP programme data - Compare against general population estimates	
User interface	- Aggregate over general population categories - Visualise uncertainty in inputs and outputs - Data quality visualisations: flagging abnormal inputs, ranking of data inputs by method	- Highlighting uncertainty and which regions have least uncertainty - Indicate which areas are using extrapolated data		- Visualise quality of input data, including flagging abnormal inputs - Uncertainty of inputs - Visualise extrapolation methods - Sensitivity analysis graphics

	Group 5	Group 6	Group 7
Priority areas for model development			
Assumptions requiring validation		- Validation of behavioural vs epidemiological approaches - Validity of mean duration approach to calculating incidence	- Equilibrium assumption - Mean duration: mortality and its dependence on ART status is not formally included in time spent in KP groups
Questions to be addressed for 2022 model		- What determines admin-1 variation in results - Are admin-1 results programmatically useful?	- For model to be useful for informing prevention programs, should factor in mechanistic transmission components (e.g., condom use) and their trends
Creating key population data guidance and checklist			
Compiling available data sources	- Identify survey and non-survey sources - KP programme data - Literature review	- Reviewed all data in KP Atlas, JHU database, systematic review literature, GAM submissions - Recent surveillance data (IBBS, etc.): NAC, local unversities / research organisations, technical partners (CDC) - KP programme data - NSP, Global Fund, PEPFAR Data Pack, Goals / Optima modelling	- Collect PSE - Use IBBS data where available - Are case surveillance data available to inform estimates?
Reviewing, evaluating, and assessing available data	- Harmonise KP defintions - Review PSE methods - Data quality review of programme data - Geographical stratification	- Temporality of data - Extrapolation of PSE - Need to extrapolate or adjust prevalence/ART coverage	- Consider the plausibility of size estimates (provide basis for UNAIDS 1% MSM threshold to countries) - Consider whether HIV surveillance and size estimation data are using consistent key population definitions.
Synthesising or extrapolating available data for model inputs	- Creating national estimates for PSE and prevalence - Review extrapolation methods	- Relationship between key population prevalence and general population prevalence - Use of regional data to guide national extrapolation	- Triangulate/synthesize subnational estimates - Use of regional data to guide national extrapolation

Reviewing model outputs for consistency with epidemiologic understanding	- Compare model outputs of new infections to distribution of diagnoses - Check HIV incidence aligns with behavioural data expectations		- Does contribution of key populations to overall epidemic make sense? If not, what inputs might explain that (e.g., too few infections in KP because size estimate is too low)? - Validate against programme or case surveillance data as available
Validating model results for key population estimates with other data sources	- Stakeholder review - Sensitivity analysis using alternative surveys, if available.		
User interface		- Comparison of input data with regional averages, previous input/GAM data, other consolidated data - Visualisation of KP alongside general population data - Uncertainty - Adjust PSE or prevalence inputs and see the impact on output estimates	

Session 6 Working Group – full reporting

Group 1:

- Recommends the use of 10-year tPAF as it best captures the long term contribution of KPs to the epidemic
- Recognises that the indicator is difficult to estimate, requiring counterfactual modelled scenarios
- Feels that a single indicator cannot capture the complexity of the epidemic, and recommends a detailed panel of indicators gathered every 5 years rather than annually

Group 2:

- Recommends the use of a 5-year tPAF, with a 'best approximation' recommended for the 2022 estimates (e.g. approximation from the IPM transmission model)
- The strengths and limitations of input data need to be fully understood for tPAF to be a useful metric
- The indicator should be:
    - Collected annually
    - Produced as a standard output from models
    - Disaggregated subnationally
- tPAF is more comprehensive than existing indicators in capturing contributions of KP to overall transmission, but harder to explain and calculate, and there are issues surrounding long term projections and communicating what tPAF means and how it should be interpreted

Group 3:

- Recommends the use of a 3- or 5-year tPAF or per-capita tPAF
- Interpretation of the indicators could be presented as:
    - "Epidemiologic consequence of current prevention gaps across subgroups" or
    - "If we address this vulnerability, the maximum proportion of infections prevented over that time-period is.."
- Subnational estimates could be of use if appropriate heterogeneity exists
- The indicator could be used for funding, policies, design of national strategic planning, and advocacy for prioritisation/resources

Group 4:

- Difficult to choose a single indicator that covers all needs, but recommends tPAF as a first choice indicators
- Notes that tPAF is difficult to compare over time as it relies on modelled counterfactuals, particularly pertaining to scaling ART coverage over time
- There may not be national desire for a tPAF indicator at present, but demonstrating its usefulness in understanding transmission may lead to need
- The indicator could help:
    - Inform allocation across KP programmes
    - Target setting against HIV incidence in KPs
    - Measure progress against targets
- Annual reporting may not make sense as the inputs are likely to be collected infrequently

Group 5:

- One indicator is insufficient to capture KP epidemics
- Though recognising the utility of tPAF, it is not appropriate to be collected annually

- Recommend number and proportion of infection acquired and transmitted over 1 year as an annual indicator
    - Simple to calculate and easy to interpret
    - Query whether this indicator is likely to change year-on-year, and whether a more sophisticated indicator should be calculated less often
    - Not a good basis on which to allocate resources, and instead recommend 10 year tPAF for this – to be calculated less frequently
        - The difficulty in calculating and interpreting tPAF was noted

Group 6:

- Recommends a 10-year tPAF ratio indicator for each KP
- Query whether annual reporting would be necessary given infrequency of input data changes: suggest every 2 years
- Difficulties around tPAF interpretation and communication
    - Recommend clear visualisations

Group 7:

- Recognises the utility of tPAF but does not recommend as an annual indicator
    - Instead when new data emerge or when new planning cycle is initiated
- Sought a different indicator that communicated similar information with a less modelled indicator i.e. identifying a population with large fraction of transmission with limited resources assign to programming

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