Identification of priority populations for HIV epidemic response: a combined analysis of 15 mathematical models from 10 African countries

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Presentation Highlights

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1. Important problem: different indicators can measure the contributions of vulnerable population subgroups (e.g., FSW, GBMSM) to new HIV infections (due to prevention/treatment gaps)
2. Most common indicator (fraction of all new infections acquired) is insufficient to identify the most important population subgroups when designing a prevention intervention
3. UNAIDS and modelling teams should also use indicators measuring the long-term effects of preventing transmission from different subgroups

Context

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- HIV prevention programs can be improved by better understanding the contribution of vulnerable population subgroups to new HIV infections (due to their prevention/treatment gaps)
- Estimates of the importance of subgroups vary across studies and settings, partly due to the indicator used
- Most common indicator in the literature: fraction of all new infections acquired in one year by each subgroup (e.g., UNAIDS annual estimates)
  - Underestimates the contribution of key populations and the importance of addressing their needs to reduce all new infections

Objectives

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Model comparison study evaluating the contributions of different population subgroups to new infections from different indicators

Purpose: making recommendations to UNAIDS and other modelling teams

Collaboration & contributors

- HPTN Modelling Centre
- UNAIDS Reference Group on Estimates, Modelling and Projections
- Key Populations Program at Johns Hopkins University, University of Toronto, and Penn State University

Contributors

- **Lead:** Romain Silhol, Ross D. Booton, Kate M. Mitchell, James Stannah, Oliver Stevens, Dobromir Dimitrov, Deborah Donnell, Stefan Baral, Jeffrey W. Imai-Eaton, Marie-Claude Boily
- **Modeling groups:** Anna Bershteyn, Leigh Johnson, Sherrie L. Kelly, Hae-Young Kim, Mathieu Maheu-Giroux, Rowan Martin-Hughes, Sharmistha Mishra, Romain Silhol, Jack Stone, John Stover, Robyn Stuart, Peter Vickerman, David P. Wilson

Study process

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- Identified 4 common HIV indicators in the literature
- Mini surveys (Epidemiologists, Modelers, Public health) to elicit feedback on the 4 proposed indicators
- Invited modelling teams with an HIV model calibrated to a SSA setting
- Data provided in standard spreadsheet:
  - Estimates of the 4 indicators for 7 different population subgroups (based on precise indicator definitions).
  - No directive on parameter values
- Research questions:

1. Do HIV indicators identify the same most important subgroup?
2. What is the magnitude of the difference between different HIV indicators for the same model and subgroup?

Modelled subgroups

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Population aged 15+ years ("Younger" = 15-24 years, "Older" = 25+ years)

Key populations (KP)

- Female sex workers
- Clients of female sex workers
- GBMSM*

HPTN 075, 083, …

Non-key populations

- Younger non-KP women
- Older non-KP women
- Younger non-KP men
- Older non-KP men

HPTN 081, 082, 084, ...

HPTN 111, 112, …

* Gay, bisexual, and other men who have sex with men

Indicators

1. **Acquisition indicator:** fraction of all new infections in 2020 (N) acquired by a specific subgroup

By far the most used indicator (e.g. UNAIDS annual reports)

Infections acquired by:		Acquisition indicator:
Female sex workers	a	a / N
Clients of female sex workers	b	b / N
GBMSM	c	c / N
Younger non-KP women	d	d / N
Older non-KP women	e	e / N
Younger non-KP men	f	f / N
Older non-KP men	g	g / N

Total number of new infections in 2020:
N=a+b+c+d+e+f+g

Indicators

1. *Acquisition indicator: fraction of all new infections in 2020 (N) acquired by a specific subgroup*
2. **Direct transmission indicator:** fraction of all new infections in 2020 (N) directly transmitted by a specific subgroup

Infections directly transmitted by:		Direct transmission indicator:
Female sex workers	a'	a’ / N
Clients of female sex workers	b'	b’ / N
GBMSM	c'	c’ / N
Younger non-KP women	d'	d’ / N
Older non-KP women	e'	e’ / N
Younger non-KP men	f'	f’ / N
Older non-KP men	g'	g’ / N

Total number of new infections in 2020:
N=a’+b’+c’+d’+e’+f’+g’

Indicators

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1. *Acquisition indicator: fraction of all new infections in 2020 (N) acquired by a specific subgroup*
2. *Direct transmission indicator: fraction of all new infections in 2020 (N) directly transmitted by a specific subgroup*
3. **1-year tPAF*:** fraction of new infections directly or indirectly transmitted by a specific subgroup over 2020

Subgroup:	1-year tPAF:
Female sex workers (a)	M_a/N
Clients of female sex workers (b)	M_b/N
GBMSM (c)	M_c/N
Younger non-KP women (d)	M_d/N
Older non-KP women (e)	M_e/N
Younger non-KP men (f)	M_f/N
Older non-KP men (g)	M_g/N

Mx is calculated by blocking all transmissions from a subgroup: also averts future transmissions to their partners' partners

N = total number of new infections over 2020 if all subgroups can transmit HIV

M_x = total number of new infections over 2020 attributable to subgroup x

*transmission Population-Attributable Fraction

Indicators

1. *Acquisition indicator: fraction of all new infections in 2020 (N) acquired by a specific subgroup*
2. *Direct transmission indicator: fraction of all new infections in 2020 (N) directly transmitted by a specific subgroup*
3. *1-year tPAF: fraction of new infections directly or indirectly transmitted by a specific subgroup over 2020*
4. **10-year tPAF*:** fraction of new infections directly or indirectly transmitted by a specific subgroup over 2020-2029

*transmission **P**opulation-**A**ttributable **F**raction

Subgroup:	10-year tPAF:
Female sex workers (a)	M_a/N
Clients of female sex workers (b)	M_b/N
GBMSM (c)	M_c/N
Younger non-KP women (d)	M_d/N
Older non-KP women (e)	M_e/N
Younger non-KP men (f)	M_f/N
Older non-KP men (g)	M_g/N

N = total number of new infections over 2020-2029 if all subgroups can transmit HIV

Mx = total number of new infections over 2020-2029 attributable to subgroup x

15 mathematical models

Western and Central Africa (n=5)

- Mali (Silhol)
- Senegal (Silhol)
- Côte d'Ivoire (Silhol, Maheu-Giroux)
- Cameroon (Silhol)

Eastern and Southern Africa (n=10)

- South Africa (Emod, Goals, Optima, Stone, Thembisa)
- South Africa, Lesotho and Eswatini combined (Mishra)
- Eswatini (Optima)
- Zimbabwe (Optima)
- Mozambique (Optima)
- Malawi (Optima)

10/15 models provided indicator estimates for each subgroup

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Q1: Do HIV indicators identify the same most important subgroup?

Which subgroup contributes the most? (Eastern and Southern Africa; 6 models)

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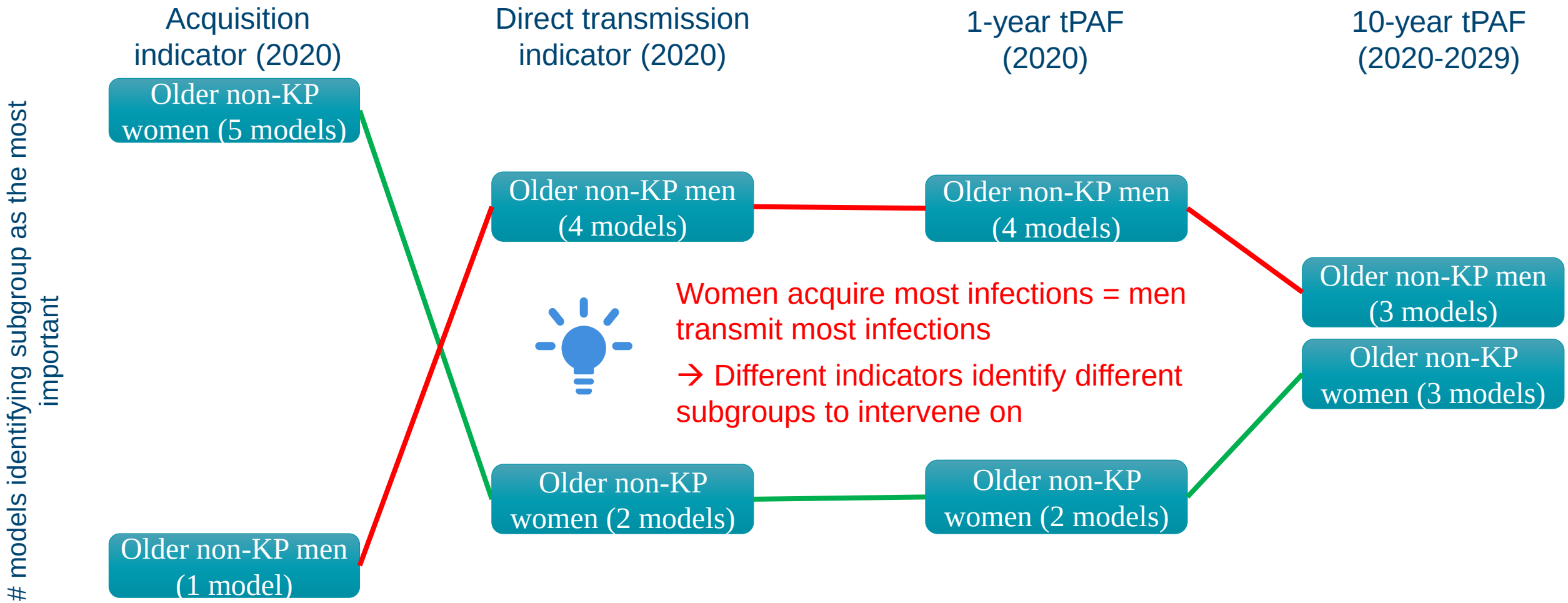
Number of models identifying a specific subgroup as the greatest contributor



Which subgroup contributes the most? (Western and Central Africa; 4 models)

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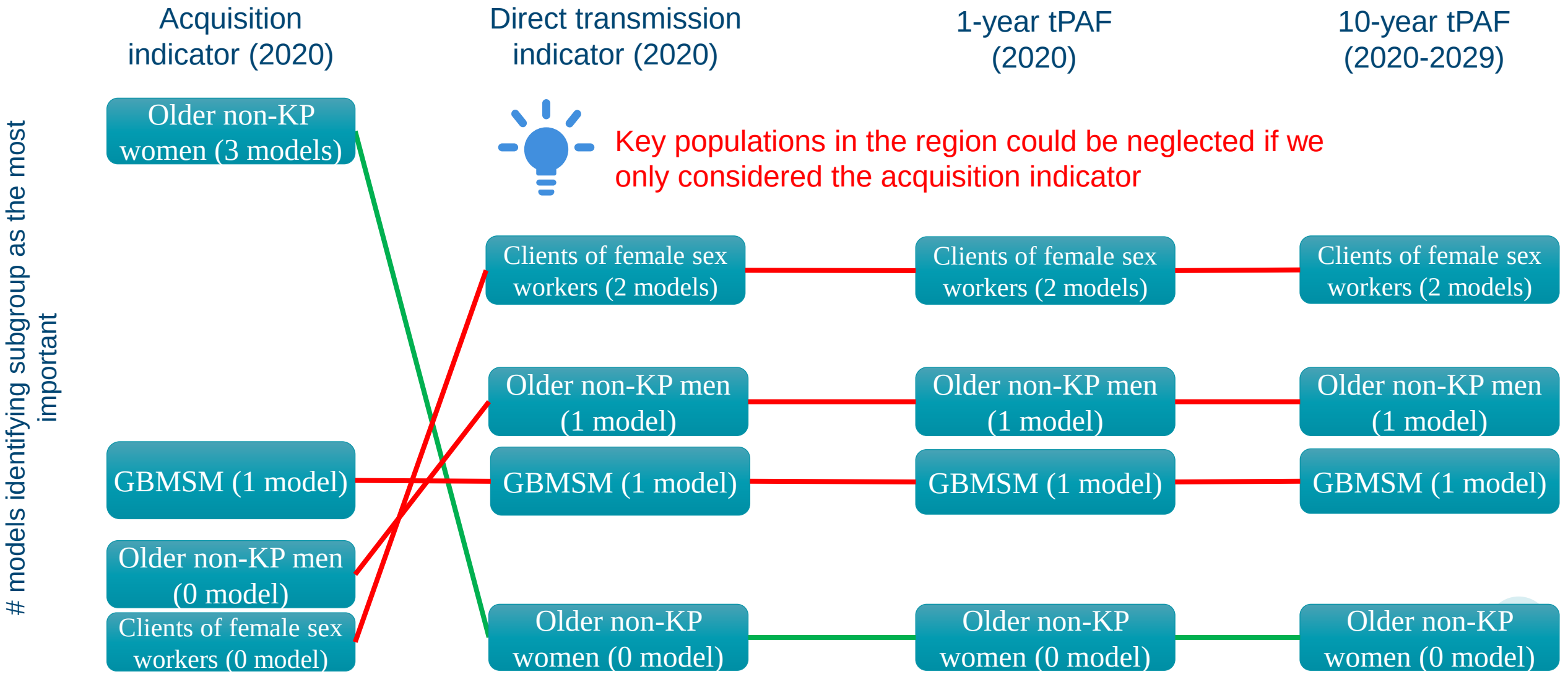
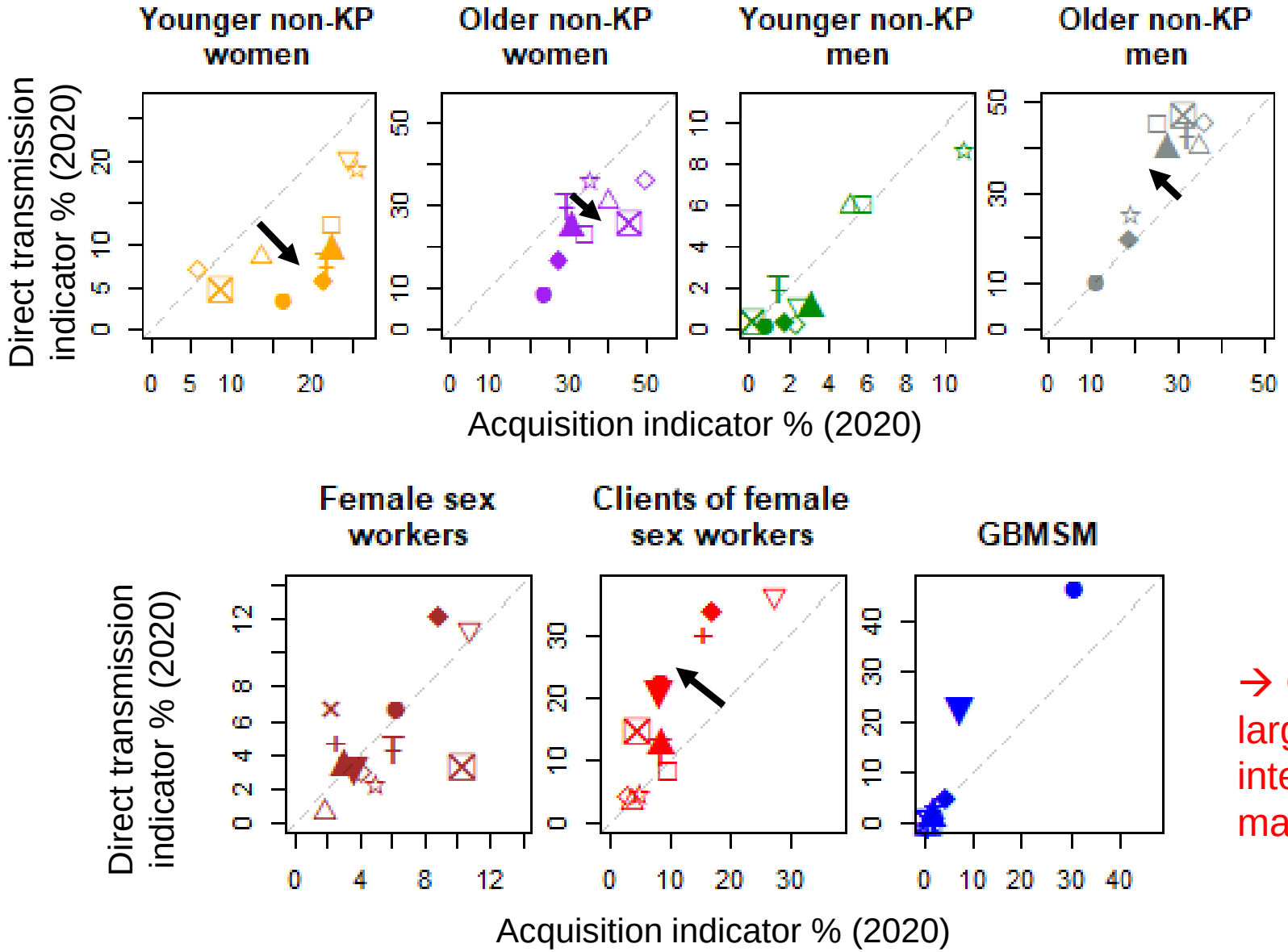
Number of models identifying a specific subgroup as the greatest contributor



Q2: How different can the indicators be for the same model and subgroup?

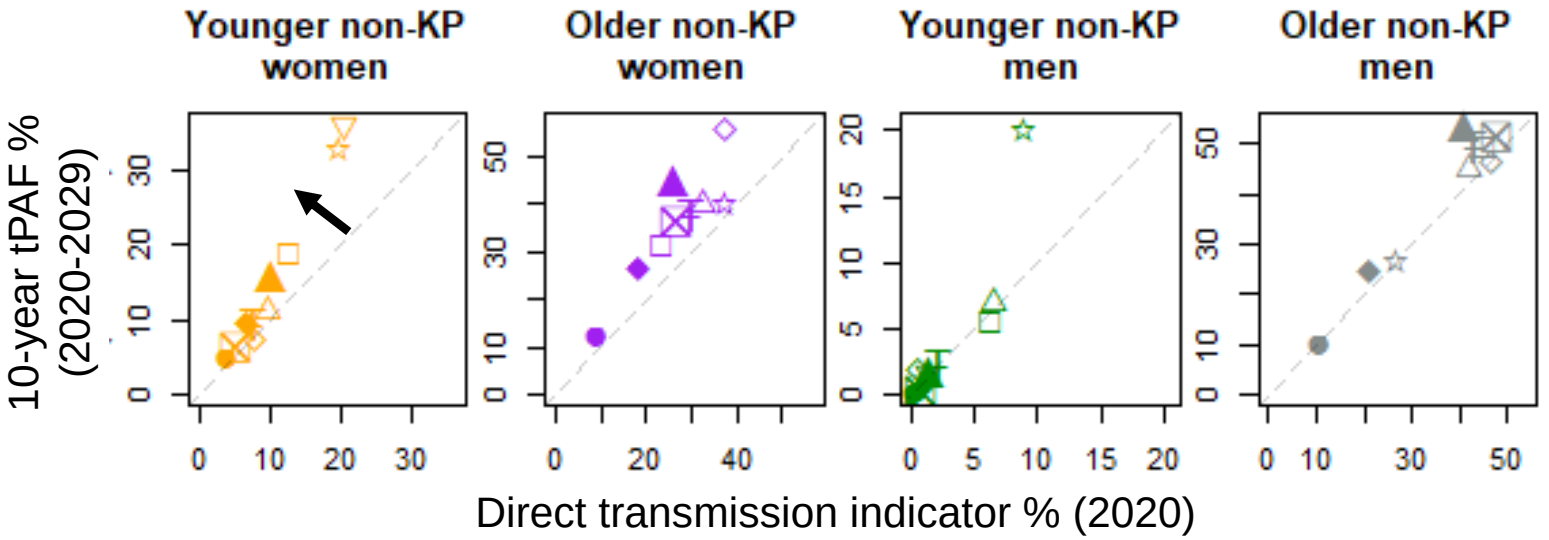
Direct transmission vs acquisition indicators

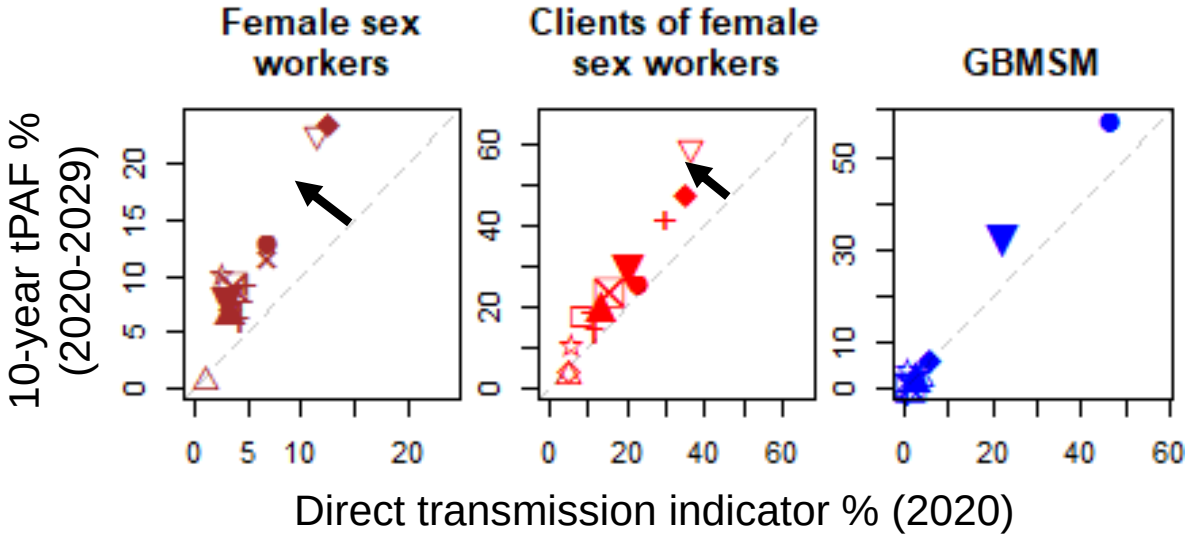


- 1 symbol = 1 model
- All models agreed that younger non-KP women (yellow) directly transmitted less infections (up to 3-fold) than they acquired
- Older non-KP men and clients of FSW (red) always directly transmitted more than they acquired (up to 3-fold)
- Largest differences in Western and Central Africa (plain symbols)

→ Only using the acquisition indicator could largely underestimate the potential impact of interventions preventing transmissions from male PLHIV

Importance of indirect transmissions





- Substantial fractions of indirect transmissions (measured using tPAFs) from younger non-KP women, female sex workers, and their clients
- There will be additional long-term benefits of addressing the needs of these subgroups

Conclusions

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1. Substantial differences between the different indicators used to quantify the contribution of population subgroups informing prevention programmes
   - Largest differences in Western and Central Africa
2. The acquisition indicator does not reflect the potential impact of preventing transmissions from male populations in SSA because of higher transmission risk and larger treatment gaps
3. UNAIDS and future modelling studies should systematically estimate and report indicators accounting for long-term (i.e., indirect) contribution of subgroups to new infections (tPAF)

Thank you

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