Estimating the relative impact of VMMC and ART on HIV incidence in a declining epidemic: Results from Rakai, Uganda

Adam Akullian, Raphael Sauter, Kate Grabowski, Anna Bershteyn, Christophe Fraser and the Rakai Health Sciences Program

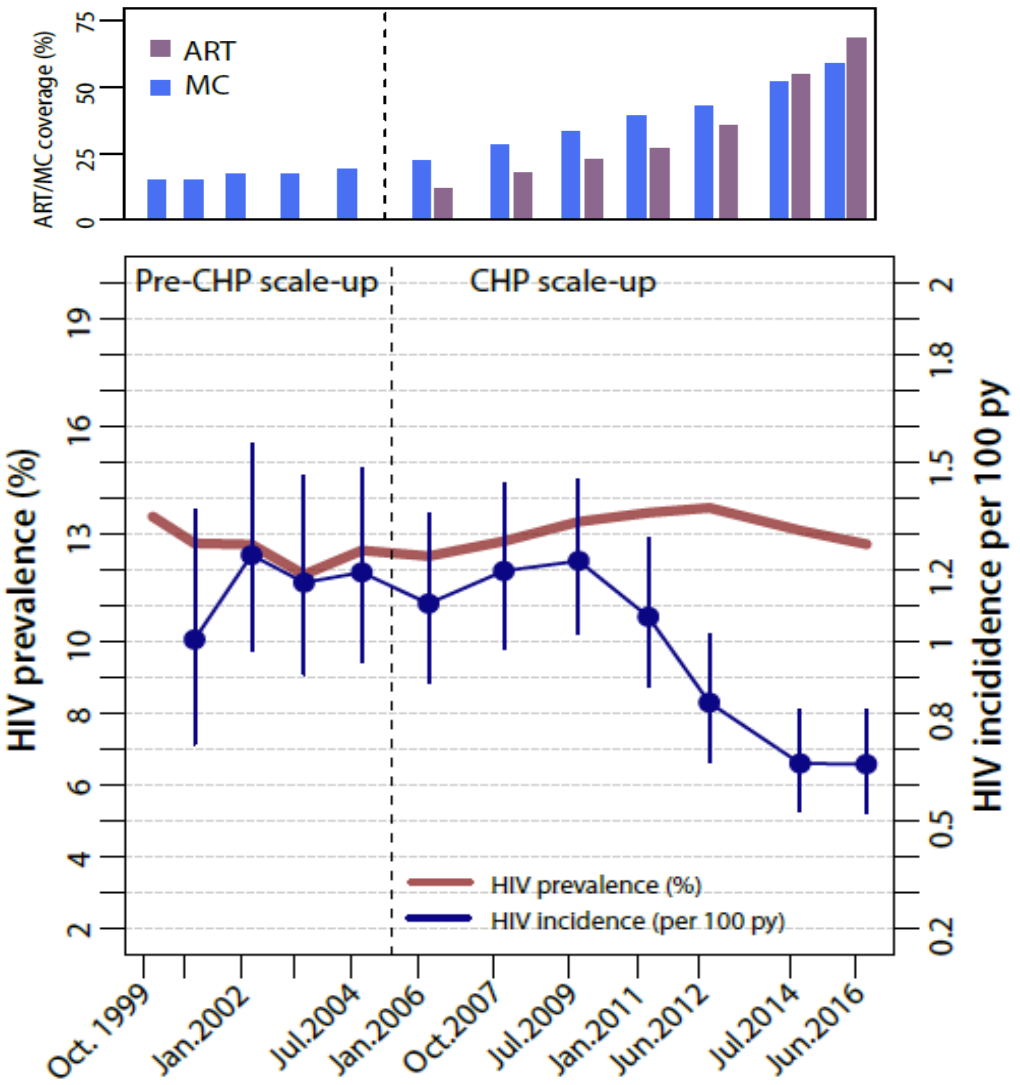
Rakai Health Sciences Program
Improved Health Through Research

JOHNS HOPKINS
BLOOMBERG SCHOOL of PUBLIC HEALTH

Background and motivation

- Significant HIV incidence declines observed in Rakai, Uganda with scale-up of ART and VMMC programs (Grabowski, NEJM, 2017).
  - ~60% VMMC coverage and 90-90-90 achieved by 2016 resulting in 42% decline in incidence.
  - Greater HIV incidence declines observed in men compared to women

- Relative impact of interventions unable to be determined using standard statistical approaches because they were scaled simultaneously.



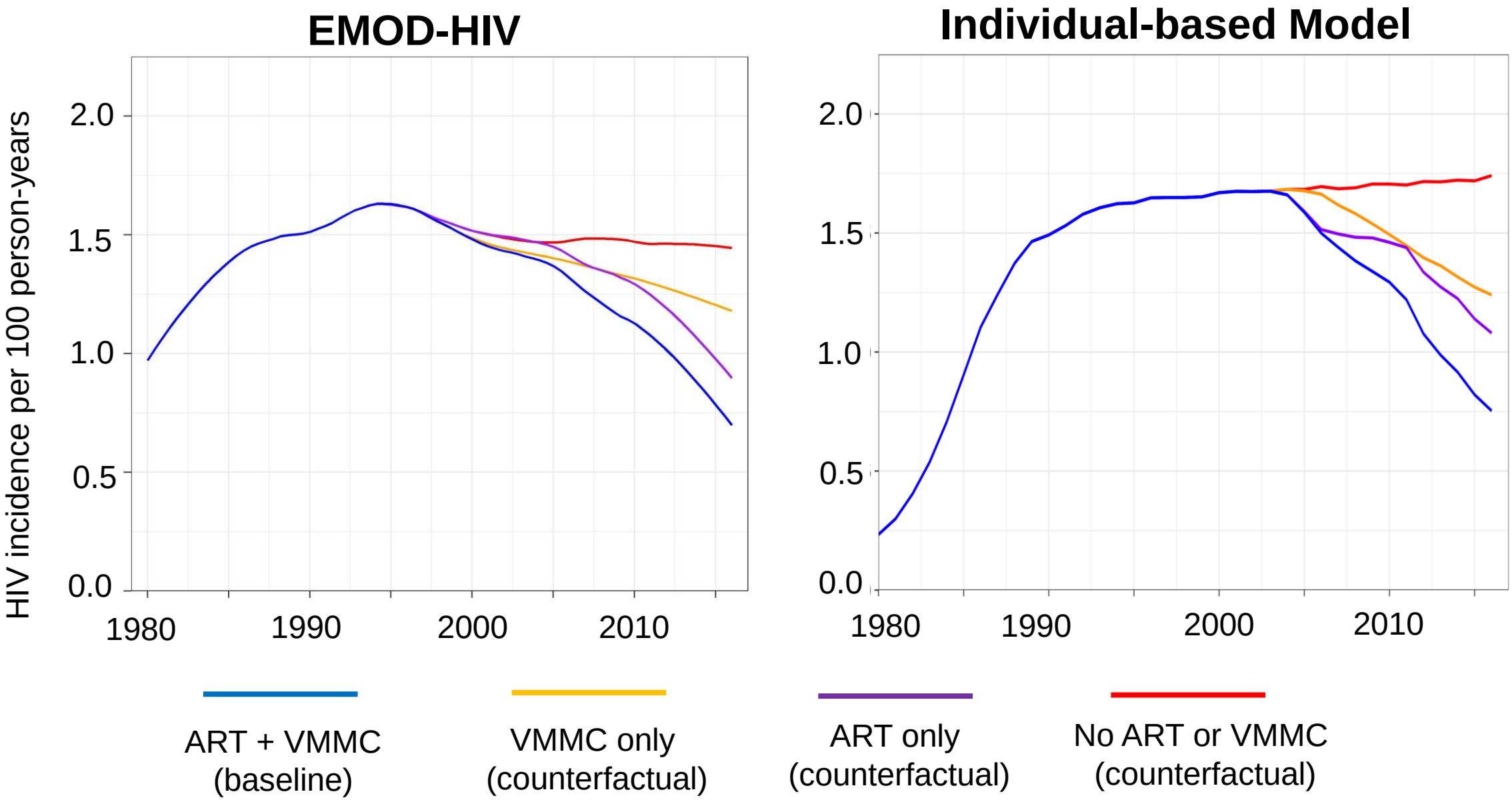
Grabowski, *NEJM*, 2017

Methods

- Two different model-based approaches fit to Rakai data (1999-2016) to estimate relative impact of ART and VMMC.
  1. **EMOD-HIV** (*Institute for Disease Modeling*): Microsimulation-model that models flow of individuals through configurable HIV care cascade
  2. **Individual-based Model** (*Oxford Big Data Institute*): Individual-based simulation model of HIV transmission developed for HPTN-071 and adapted to RCCS

- To estimate impact of ART vs. VMMC, baseline plus 3 alternative scenarios of HIV epidemic simulated.
  1. **Both interventions**: A baseline scenario to match historical scale-up ART and VMMC by age and gender
  2. **VMMC only**: A counterfactual scenario without ART
  3. **ART only**: A counterfactual scenario without VMMC scale-up
  4. **No interventions**: A counterfactual scenario without ART or VMMC

Results: Simulated HIV incidence trends



Results: Relative impact of interventions

AR% is the percent by which risk is reduced from each scenario relative to the counterfactual scenario without ART or VMMC

EMOD-HIV

	All		Women		Men	
Scenario	AR%	CI	AR%	CI	AR%	CI
ART + VMMC	49.3	(32.3 - 63.7)	44.5	(25.5 - 61.7)	54.1	(35.7 - 71.0)
VMMC only	18.4	(-5.7 - 34.1)	15.3	(-14.1 - 31.8)	23.3	(-15.5 - 47.0)
ART only	35.7	(16.2 - 51.5)	35.0	(9.4 - 50.3)	38.1	(7.9 - 56.5)

Individual-based Model

	All		Women		Men	
Scenario	AR%	CI	AR%	CI	AR%	CI
ART + VMMC	52.3	(39.6 - 63.1)	47.1	(32.7- 59.3)	59.1	(45.6 - 70.5)
VMMC only	26.0	(13.1- 35.7)	18.8	(4.1- 30.6)	35.0	(20.8- 48.5)
ART only	33.8	(20.0-46.5)	33.6	(18.9 – 46.8)	34.4	(17.6 - 48.4)

Conclusions

- **Two models, similar findings**: ART and VMMC had independent impact on observed HIV incidence declines.
  - Effects of interventions appeared to be additive.
  - VMMC and ART had ~equal impact in men.
  - ART had bigger impact in women

- Thus, **even in settings with high ART coverage (90-90-90), VMMC has significant impact** on population-level HIV incidence in both genders.

- **Important caveats**:
  - Both models overestimated HIV incidence among women compared to observed data.
  - Models were not fully parameterized to Rakai demographic/sexual behavior data.
  - Long term impact or cost effectiveness of interventions not estimated.
  - More analyses in progress, but preliminary results promising.