QUANTIFYING INDIRECT BENEFITS OF PREP: MODELING ANALYSIS OF ORAL PREP IN ZIMBABWE

[1] Zindoga Mukandavire, [2]Daniel J. Klein, [1]Graham F. Medley, [2]Anna Bershteyn, [3]Katharine Kripke, [4]Delivette Castor, [5]Definate Nhamo, [5]Joseph Murungu, [6]Taurai Bhatasara, [6]Lawrance Nyazema, [6]Kudakwashe Takarinda, [7]Kristine Torjesen, for the OPTIONS Consortium

[1] London School of Hygiene & Tropical Medicine, London, UK, [2]Institute for Disease Modeling, Bellevue, WA, USA, [3]Avenir Health, Washington, DC, USA, [4]United States Agency for International Development, Washington, DC, USA, [5]Pangaea Zimbabwe Aids Trust, Harare, Zimbabwe, [6]Zimbabwe Ministry of Health and Child Care, Harare, Zimbabwe, [7]FHI 360, Durham, NC, USA

EMAIL: Zindoga.Mukandavire@lshtm.ac.uk

BACKGROUND

- HIV prevalence remains high in Zimbabwe despite notable declines over the years [1]. Recent studies showed that HIV incidence is higher among adolescent girls and young women (AGYW) than males of the same age group [2].
- For effective control of HIV among women at risk in Zimbabwe, existing HIV prevention and control programs could be complemented with other new HIV prevention technologies such as tenofovir-based oral pre-exposure prophylaxis (PrEP).
- Oral PrEP can prevent individual infection, but population level impact and disaggregation of the direct (primary) and indirect (secondary/onward) preventive effects remain unexplored. We assessed potential population-level benefits of oral PrEP use among female sex workers (FSW) and AGYW, and parse direct from indirect effects.
- Assessment of the potential population level impact of oral PrEP, including both direct and indirect protective effects, can be explored using mathematical modeling.

METHODS

An individual-based HIV network model, EMOD-HIV v2.5, was parameterized for Zimbabwe to simulate provincial-level epidemics. The model was fit to age/gender/province-specific data on HIV prevalence, antiretroviral treatment (ART) and voluntary medical male circumcision (VMMC) coverages. We used data from Zimbabwe Ministry of Health and Child Care (MoHCC) reports and Zimbabwe Demographic Health Survey (ZDHS) reports and other published literature. In the simulation, oral PrEP was provided to AGYW (18-24 years) with multiple partners and/or FSW(18-24 years) at 40% coverage beginning in 2017 with a 5-year regimen of 73% effectiveness, which represents 90% efficacy with 81% adherence [3]. We developed a methodology of differentiating direct and indirect (and tertiary, etc.) infections prevented by oral PrEP. Direct and indirect infections averted by oral PrEP were estimated by simulating a randomized trial (RT) in which 40% of the target population received oral PrEP and 40% received placebo drug. Direct prevention was computed from the incidence rate ratio between the two arms. Indirect prevention was computed as the difference between the number of HIV infections in the RT simulation and the number of HIV infections in a separate PrEP-free counterfactual simulation. Results from year 2017-2022 and 2017-2037, with no ART and VMMC scale-up, were averaged over 1000 replicates.

RESULTS

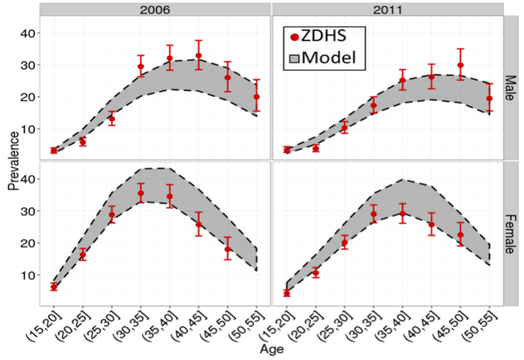

Figure 1: EMOD-HIV fits showing HIV prevalence 15-49 age group by sex.

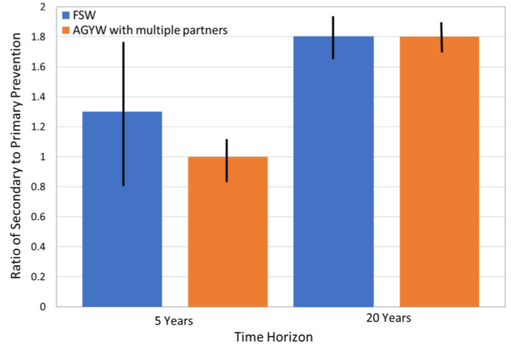

Figure 3: Ratios of indirect to direct infections averted by providing oral PrEP to FSW and AGYW with multiple partners for 5 and 20 years.

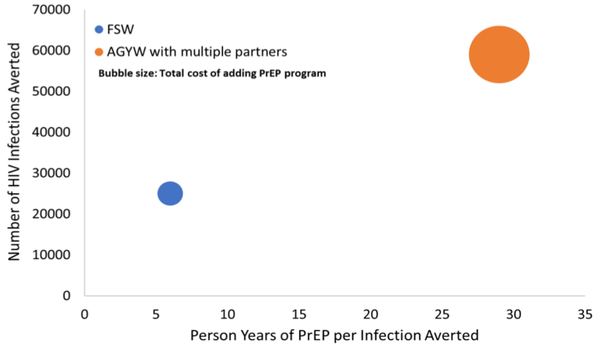

Figure 2: Cost-effectiveness of oral PrEP for FSW and AGYW from year 2017-2037.

Fitting and cost-effectiveness

Figure 1 shows EMOD-HIV model fitting to national age-specific HIV prevalence by sex for Zimbabwe. In general the model predicted higher HIV prevalence in women, with HIV prevalence higher in women aged 30-40 years (~40%) compared to men of the same age (~30%). In our case, the flexible age-structure of the model makes it suitable for modeling age-targeted HIV programs. The model also projected that national HIV prevalence has been on the decline in Zimbabwe since 1998 and HIV incidence is also declining and plateauing at low levels (<1%) in both men and women.

Model analysis results in Figure 2 show that FSW had 25,000 HIV infections averted and 6 person-years (PY) of oral PrEP per HIV infection averted compared to 59,000 HIV infections averted and 27 PY of oral PrEP per HIV infection averted among AGYW in 20 years. The results demonstrate that providing oral PrEP to FSW is more cost-effective but may result in a lower overall impact.

RESULTS

Indirect impact of oral PrEP

For every HIV infection directly averted by providing oral PrEP to FSW, 1.3 additional infections were indirectly averted in the community over 5 years and 1.8 additional infections were prevented in 20 years (Figure 3). However, there was substantial uncertainty in estimating prevention ratios for FSW in a 5-year time horizon due to their smaller population size.

The ratios were 1 and 1.8 when providing oral PrEP to AGYW with multiple partners over the same horizons. Figure 3 shows that oral PrEP has the potential to prevent more indirect HIV infections in a longer (20 year) time horizon compared with a shorter (5 year) horizon. On average, FSW resulted in more indirect prevented infections in the shorter time horizon (Figure 3).

CONCLUSION

Our results suggest that providing oral PrEP to FSW is more cost-effective and is likely to produce more indirect benefits. Despite this, a greater population level benefit can be achieved by providing oral PrEP to AGYW. Indirect benefit of oral PrEP may outweigh direct individual-level benefit. Both indirect benefit and total impact should be considered when prioritizing populations for oral PrEP service provision. Properly targeted PrEP can be an important component of epidemic control of HIV, as well as protecting individuals at greatest risk.

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