Background: In areas highly endemic with HIV, discordancy is prevalent among couples affected by HIV, where a substantial proportion of infected individuals are in stable sexual relationships with non-infected individuals. Designing a package of interventions to reduce HIV incidence among discordant partnerships is critical. We assessed quantitatively the impact of four interventions (antiretroviral therapy (ART), pre-exposure prophylaxis (PrEP), condoms with and with no access to couple-based voluntary counseling and testing program (VCT), and male circumcision (MC)) on HIV incidence among a cohort of discordant couples at varying levels of efficacy, adherence, eligibility, and coverage.

Methods: A mathematical model was constructed to assess the impact of interventions and was parameterized by the best available evidence from clinical trials and observational studies. Uncertainty analyses were also conducted.

Results: Assuming full eligibility and coverage, ART, PrEP, condoms with (and with no) access to couple-based VCT, and MC reduced HIV incidence rate over three years by 69%, 37%, 36% (4.3%), and 19% respectively. Combining two interventions at a time led to a range of incidence rate reduction of 22%-82%; while combining three interventions led to a range of 76%-89%. Combining all four interventions reduced incidence rate by 92%. However, assuming realistic levels of eligibility, coverage, and adherence; ART, PrEP, condoms with (and with no) access to couple-based VCT, and MC reduced HIV incidence rate by 34%, 15%, 36% (2.3%), and 10%, respectively. An intervention package with two (three) interventions simultaneously reduced incidence rate between 12%-59% (24%-66%) depending on the eligibility and coverage conditions. Combining all 4 interventions reduced the incidence rate by 71%.

Conclusions: Despite substantial biological efficacy, the impact of each individual intervention is diluted at realistic levels because of eligibility, coverage, and adherence. However, combining multiple interventions can lead to large reductions in HIV incidence rate. ART is especially effective if combined with at least one other intervention and administered at intermediate to high levels of eligibility, coverage and adherence.