Impact of TasP, PrEP and condoms on the HIV Epidemic among MSM in British Columbia

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Background and Objectives

- Gay, bisexual and other men who have sex with men (MSM) are disproportionally affected by the HIV epidemic
- In British Columbia (BC), the HIV epidemic has decreased among people who inject drugs. However, the same trend has not been observed among MSM
- Today, condoms, Treatment as Prevention (TasP), and Pre-Exposure Prophylaxis (PrEP) are highly efficacious HIV prevention strategies that can prevent HIV transmission in MSM
- We conducted this study to assess how condoms, TasP and PrEP can be used in combination to prevent further HIV infections among the MSM population in BC

Methods

- We designed a mathematical model of HIV transmission and progression among MSM, sub-divided by risk of acquiring/transmitting HIV, based on the United States Centre for Disease Control HIV Incidence Risk Index for MSM (HIRI-MSM) (Fig. 1)
- The transmission parameters for each risk group were calibrated on incidence data from HIRI-MSM-specified sub-populations from an MSM cohort in Vancouver, BC
- We assessed the effect of increasing condom use, PrEP access, and optimizing TasP. For PrEP, we evaluated targeted access based on four HIRI-MSM based risk thresholds. For TasP, we studied the effect of decreasing the time to HIV diagnosis, to antiretroviral treatment (ART) initiation, and increasing the time retained on ART
- The measures of intervention impact at the end of 10 years (from 2017 until 2026) included: (1) HIV incident cases; (2) All-cause mortality cases among HIV-positive MSM; (3) HIV point prevalence (Fig. 2). Additionally, we calculated the effect of different interventions on the Control Reproduction Number R_c, and we assessed the scenarios in which we obtained an $\mathrm{R}_c < 1$ (Tab. 1)
- We estimated the univariate sensitivity coefficients for the incidence change under three PrEP uptake scenarios at the end of 2026. Additionally we estimated the percent change in cumulative HIV incident cases with respect to the Status Quo scenario from 2017 to 2026 (Fig. 4)

Figure 1. Risk-stratified deterministic compartmental model of HIV transmission and progression

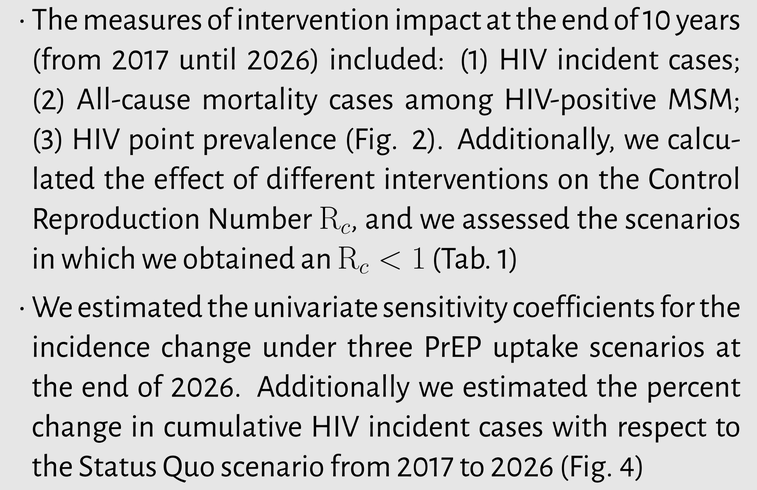


Figure 2. Reduction in HIV point prevalence, incident cases, and all-cause mortality cases among HIV-positive MSM after 10 years of TasP, PrEP and condom interventions

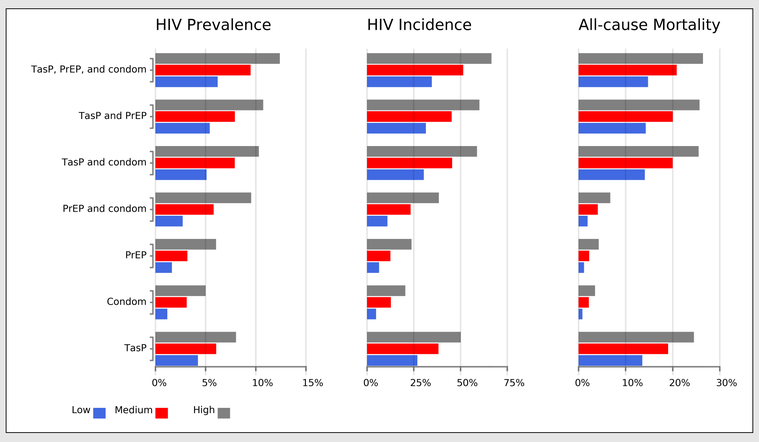


Table 1: R_c dependence on TasP and targeted PrEP

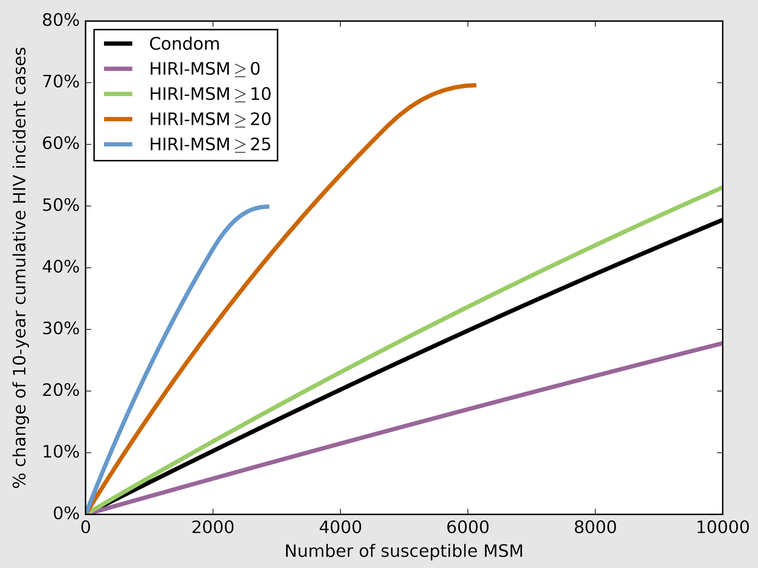
(HIRI-MSM ≥10)

PrEP Scenarios	TasP Scenarios			
	Status Quo	Low	Medium	High
Status Quo	2.79	2.30	2.05	1.73
1,000	2.68	2.20	1.96	1.66
2,000	2.57	2.11	1.88	1.59
3,000	2.45	2.02	1.80	1.52
4,000	2.34	1.93	1.71	1.45
5,000	2.23	1.83	1.63	1.38
Number on PrEP for R_c<1	-	-	-	-

(HIRI-MSM ≥25)

PrEP Scenarios	TasP Scenarios			
	Status Quo	Low	Medium	High
Status Quo	2.79	2.30	2.05	1.73
1,000	2.38	1.96	1.74	1.47
2,000	1.97	1.62	1.45	1.22
3,000	1.59	1.31	1.16	0.98
4,000	1.26	1.04	0.92	0.78
5,000	1.08	0.89	0.79	0.67
Number on PrEP for R_c<1	-	4188	3649	2920

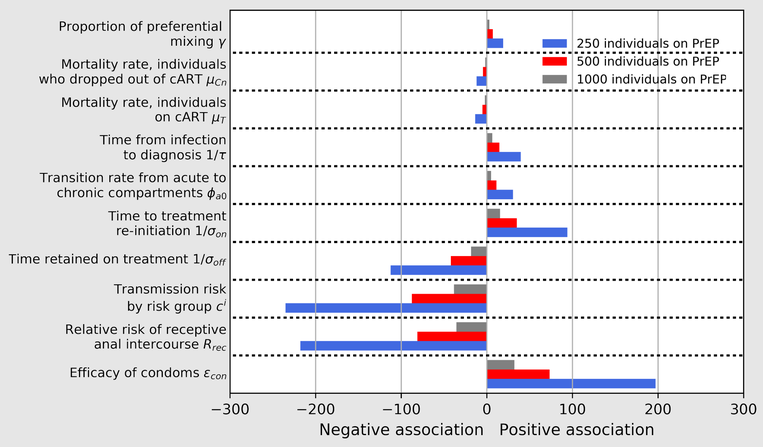
Figure 3: Effectiveness in incidence reduction of different PrEP and condom strategies

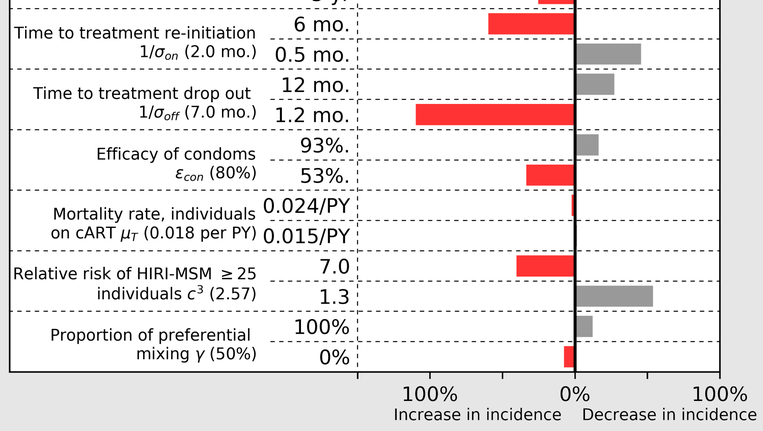


Results

- Optimizing all aspects of TasP and increased provision of PrEP to the highest-risk MSM sub-population results in a 67% reduction in incidence (Fig. 2), and R_c as low as 0.67 (Tab. 1)
- TasP was the only intervention that significantly decreased mortality (Fig. 2)
- Achieving control of the MSM epidemic $(\mathrm{R}_c < 1)$ would be possible with significant coverage of PrEP to the MSM at population at highest risk (Fig. 3 and Tab. 1)

Figure 4. Univariate Sensitivity Analysis on incidence for various PrEP strategies (top), and for the parameters with the most uncertainty (bottom)





Conclusions

- The optimization of TasP, by promoting timely HIV diagnosis, treatment initiation and higher retention, combined with the distribution of PrEP to MSM at high risk of HIV infection was the most successful strategy to control the HIV epidemic among MSM
- Consistent use of condoms should continue to be actively promoted to reduce HIV transmission by all MSM, regardless of their risk of HIV acquisition/transmission, especially among those who may not be eligible to receive PrEP

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