

PrEP Targeting Strategies for US Adolescent Sexual Minority Males: A Modeling Study

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BACKGROUND

- Pre-exposure prophylaxis (PrEP) is an effective and safe intervention to prevent HIV transmission in men who have sex with men (MSM).
- Current CDC guidelines indicate use for sexually-active adult MSM at substantial HIV risk.¹
- Adolescent sexual minority males (ASMM)—ie, males under 18 who identify as gay or bisexual, or are sexually active with other males—also have significant HIV risk, as evidenced by studies of multiple types.²⁻⁶
- A recent demonstration project and safety study of PrEP in US ASMM aged 15–17 (ATN 113) shows strong promise, but lower adherence than among adult MSM.⁷
- There is currently little guidance on how best to prioritize or target PrEP among adolescent ASMM; models can inform this process.

OBJECTIVE

To estimate population impact and intervention efficiency of PrEP for adolescent sexual minority males (ASMM) in higher prevalence areas of the US, under various:

- implementation strategies
- coverage levels
- adherence levels
- levels of background HIV incidence

METHODS

- Model adapted from previously published adult model, with new age-specific parameters and features.
- Network-based mathematical modeling based in separable, temporal exponential random graph models (STERGMs).⁸
- Characteristics of sexual acts, HIV transmission, and HIV disease progression were simulated on top of dynamic sexual networks using EpiModel (www.epimodel.org).
- Adolescents could enter population of interest via male-male anal sexual debut at any age 13-18; or via development of gay/bisexual identity at any age 13-18, with subsequent anal sexual debut.
- We included an additional constant hazard of infection from non-ASMM, which **increased with age and varied with an individual's overall relational propensity.**
- Adolescent-specific sexual behavior parameters were drawn from the published literature,⁹⁻¹¹ and from new analyses of the **American Men's Internet Survey** (adolescent subsample),¹² InvolveMENT Study,¹³ and MAN Project.¹⁴
- We calibrated our model to 7% observed HIV prevalence among 18-year-old ASMM in the InvolveMENT cohort (Atlanta).¹⁵ This corresponded in our model to 2.90% prevalence across the 13-18 year-old age group.
- Retention and adherence to PrEP regimens were derived from ATN 113 (with adherence averaged across study visits).

METHODS (CONT.)

- Table of scenarios, showing 9 sets of eligibility criteria, and sensitivity analyses on coverage, adherence, and background prevalence. (Optimistic and pessimistic adherence distributions were taken from the first and last ATN 113 study visit).

Scenario name	Background ASMM HIV prev.	PrEP eligibility criteria	Timing of PrEP initiation	PrEP coverage among eligible pop.	Cohort distribution by adherence level (none, low, med., high)
No PrEP (comparison scenario)		N/A	N/A	N/A	N/A
16+ / 6 mos. (base scenario)		Ages 16-18 and AI experienced	6 months after eligibility at point of eligibility		
16+ / immed.					
13+ / 6 mos.		Ages 13-18 and AI experienced	6 months after eligibility at point of eligibility		
13+ / immed.					
13+ / pre-AI		Ages 13-18	when seeking first sexual partnership	40%	(20.9%, 24.4%, 13.1%, 41.6%)
16+ / CAI10	2.90%	Ages 16-18, ≥ 10 acts of CAI in the prior 6 mos.			
16+ / CAI5		Ages 16-18, ≥ 5 acts of CAI in the prior 6 mos.			
13+ / CAI10		13-18, ≥ 10 acts of CAI in the prior 6 mos.	at point of eligibility		
13+ / CAI5		13-18, ≥ 5 acts of CAI in the prior 6 mos.			
C20				20%	
C30				30%	(20.9%, 24.4%, 13.1%, 41.6%)
C50	2.90%	16-18 and AI experienced	6 months after eligibility	50%	
C60				60%	
C20 + Hi Adh				20%	
C30 + Hi Adh				30%	(4.6%, 18.5%, 16.9%, 60.0%)
C40 + Hi Adh	2.90%	16-18 and AI experienced	6 months after eligibility	40%	
C50 + Hi Adh				50%	
C60 + Hi Adh				60%	
C20 + Low Adh				20%	
C30 + Low Adh				30%	(46.2%, 20.5%, 5.1%, 28.2%)
C40 + Low Adh	2.90%	16-18 and AI experienced	6 months after eligibility	40%	
C50 + Low Adh				50%	
C60 + Low Adh				60%	
Med prev + no PrEP *		N/A	N/A		
Med prev / 16+ / 6 mos.	1.50%	16-18 and AI experienced	6 months after eligibility		
Med prev / 16+ / CAI10		16-18, ≥ 10 acts of CAI in the prior 6 months	at point of eligibility	40%	(20.9%, 24.4%, 13.1%, 41.6%)
Low prev + no PrEP *		N/A	N/A		
Low prev / 16+ / 6 mos.	0.90%	16-18 and AI experienced	6 months after eligibility		
Low prev / 16+ / CAI10		16-18, ≥ 10 acts of CAI in the prior 6 months	at point of eligibility		

* comparison scenario. AI = anal intercourse; CAI = condomless anal intercourse

- We conducted 100 runs of each scenario, run for 10 years. Key outcomes included:
 - percent of infections averted (impact)
 - # needed to treat = # of person-years on PrEP per infection averted (efficiency)

RESULTS

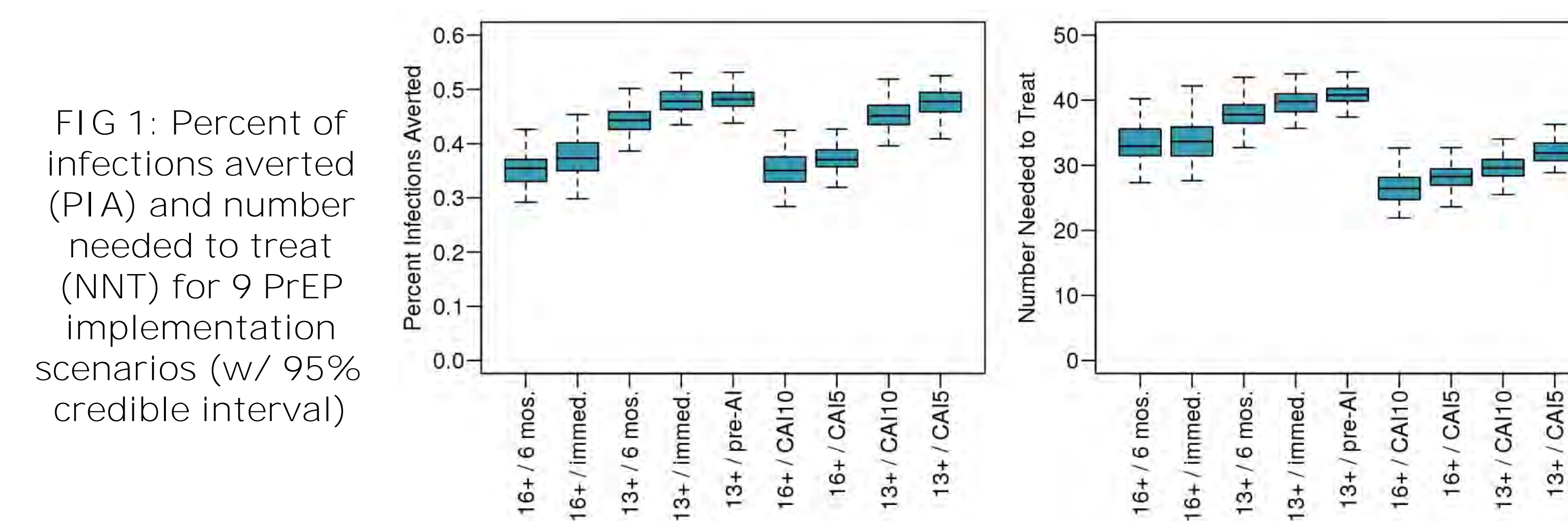
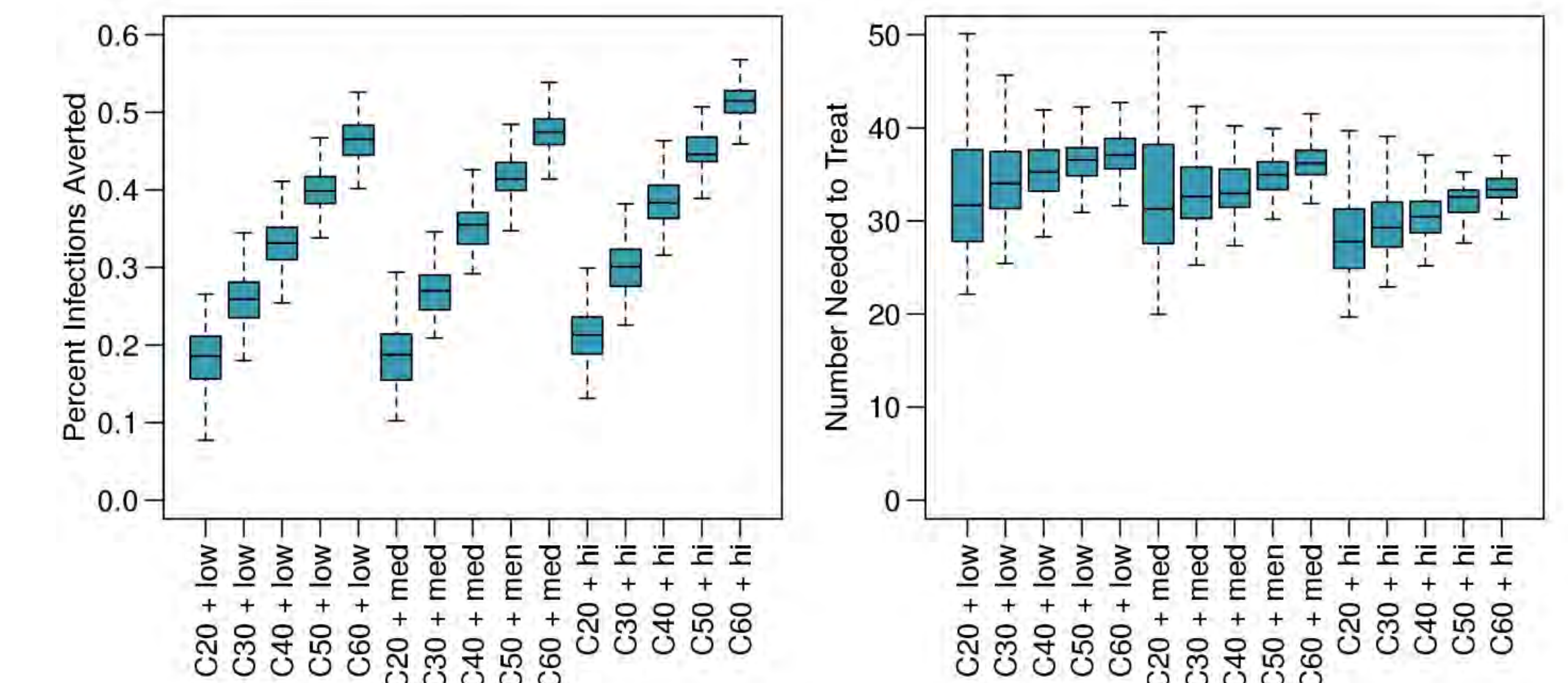


FIG 1: Percent of infections averted (PIA) and number needed to treat (NNT) for 9 PrEP implementation scenarios (w/ 95% credible interval)

- Our base scenario (16+/6 mos.) prevented 35.1% of infections (95% credible interval 29.9–41.1%), with NNT of 33, and demonstrated strong indirect effects (secondary infections averted among those not on PrEP).
- Expanding eligibility generated higher PIA but less efficient NNT.
- Focusing on highest risk ASMM improved NNT considerably, but would require more detailed sexual behavioral data.

RESULTS (CONT.)

FIG 2: Percent of infections averted (PIA) and number needed to treat (NNT) for sensitivity analyses on adherence and coverage (w/ 95% credible interval)



- PIA increases roughly linearly with coverage, while NNT is lowest with low coverage.
- More pessimistic adherence only changes PIA and NNT modestly.
- In settings with lower background prevalence (results not shown in figs), NNT increases dramatically, to 73 and 59 (in a moderate prevalence area with broad targeting and risk-based targeting, respectively), or to 121 and 100 (for the same scenarios in the low prevalence setting).

DISCUSSION

- Our models suggest that PrEP has the potential to reduce population-level HIV incidence significantly among communities of adolescent sexual minority males (ASMM).
- In high prevalence settings, intervention efficiency is comparable to adult MSM, despite overall poorer adherence.
- Focusing on ASMM with the highest sexual risk behaviors decreases NNT considerably, with the added challenge of ascertaining elements of sexual history beyond sexual identity.
- Targeting 16–18 year-olds has almost as large an impact as 13–18, and more efficiency, and likely has higher feasibility and acceptability.
- A 6-month delay in initiating PrEP after debut affects results marginally relative to immediate initiation, so a system of annual evaluations should represent a good balance of effectiveness with feasibility and acceptability.
- Our results provide a guide for jurisdictions to weigh their own estimates of ASMM HIV prevalence with their tolerance for levels of intervention impact and efficiency, in determining the value of scaling up ASMM PrEP.

REFERENCES

- Centers for Disease Control and Prevention. Preexposure prophylaxis for the prevention of HIV infection in the United States—2014: a clinical practice guideline. Atlanta, U.S. Public Health Service 2014. <http://www.cdc.gov/hiv/pdf/guidelines/PrEPguidelines2014.pdf>.
- Kann L, Olsen EO, McManus T, et al. Sexual Identity, Sex of Sexual Contacts, and Health-Related Behaviors Among Students in Grades 9–12—United States and Selected Sites, 2015. *MMWR Surveill Summ* 2016;65(No. SS-9):1–202. DOI: <http://dx.doi.org/10.15585/mmwr.ss6509a1>
- Garofalo R, Hottel AL, Kuhns LM, Gratz B, Mustanski B. Incidence of HIV infection and Sexually Transmitted Infections and Related Risk Factors among Very Young Men Who Have Sex with Men. *Journal of acquired immune deficiency syndromes* (1999). 2016.
- Division of HIV/AIDS Prevention. Diagnoses of HIV Infection in the United States and Dependent Areas, 2014. <http://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-report-us.pdf>. Atlanta: Centers for Disease Control; 2015.
- Wejnert C, Lo B, Rose CE, et al. HIV infection and awareness among men who have sex with men—20 cities, United States, 2008 and 2011. *PLoS One*. 2013;8(10):e76878.
- Wejnert C, Hess KL, Rose CE, et al. Age-Specific Race and Ethnicity Disparities in HIV Infection and Awareness Among Men Who Have Sex With Men—20 US Cities, 2008–2014. *The Journal of infectious diseases*. 2016;213(5):776–783.
- Hosek S, G, Rudy B, Landovitz R, Kapogiannis B, Sibery G, Rutledge B, ... & Lally M. (2017). An HIV Preexposure Prophylaxis Demonstration Project and Safety Study for Young MSM. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 74(1), 21–29.
- Krivitsky PN, Handcock MS. A separable model for dynamic networks. *J R Stat Soc B*. 2014;76(1):29–46.
- Rotheram-Borus MJ, Reid H, Rosario M. Factors mediating changes in sexual HIV risk behaviors among gay and bisexual male adolescents. *Am J Public Health*. 1994;84(12):1938–1946.
- Halkitis PN, Kapadia F, Siconolfi DE, et al. Individual, psychosocial, and social correlates of unprotected anal intercourse in a new generation of young men who have sex with men in New York City. *Am J Public Health*. 2013; 103(5):889–895.
- Hidalgo MA, Kuhns LM, Hottel AL, Johnson AK, Mustanski B, Garofalo R. The MyPEEPS randomized controlled trial: a pilot of preliminary efficacy, feasibility, and acceptability of a group-level, HIV risk reduction intervention for young men who have sex with men. *Arch Sex Behav*. 2015;44(2):475–485.
- Sanchez T, Zlotorzynska M, Sineath C, Kahle E, Sullivan P. The Annual American Men's Internet Survey of Behaviors of Men Who Have Sex with Men in the United States: 2014 Key Indicators Report. *JMIR Public Health Surveill*. 2016;2(1):e23.
- Sullivan PS, Rosenberg ES, Sanchez TH, et al. Explaining racial disparities in HIV incidence in black and white men who have sex with men in Atlanta, GA: a prospective observational cohort study. *Annals of epidemiology*. 2015; 25(6):445–454.
- Hernandez-Romieu AC, Sullivan PS, Rothenberg R, et al. Heterogeneity of HIV Prevalence Among the Sexual Networks of Black and White Men Who Have Sex With Men in Atlanta: Illuminating a Mechanism for Increased HIV Risk for Young Black Men Who Have Sex With Men. *Sexually transmitted diseases*. 2015; 42(9):505–512.
- Sullivan PS, Peterson J, Rosenberg ES, et al. Understanding racial HIV/STI disparities in black and white men who have sex with men: a multilevel approach. *PLoS One*. 2014;9(3):e90514.



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