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Imperial College
London

Estimating the impact of improvements in the HIV care cascade on HIV incidence among men who have sex with men in the US: mathematical modelling for HPTN 078

Kate M Mitchell

Imperial College London
London, UK
25th July 2017

Enhancing Recruitment, Linkage to Care and Treatment for HIV-Infected Men Who Have Sex with Men (MSM) in the United States

Trial sites: Atlanta GA, Baltimore MD, Birmingham AL, Boston MA

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The HPTN 078 trial

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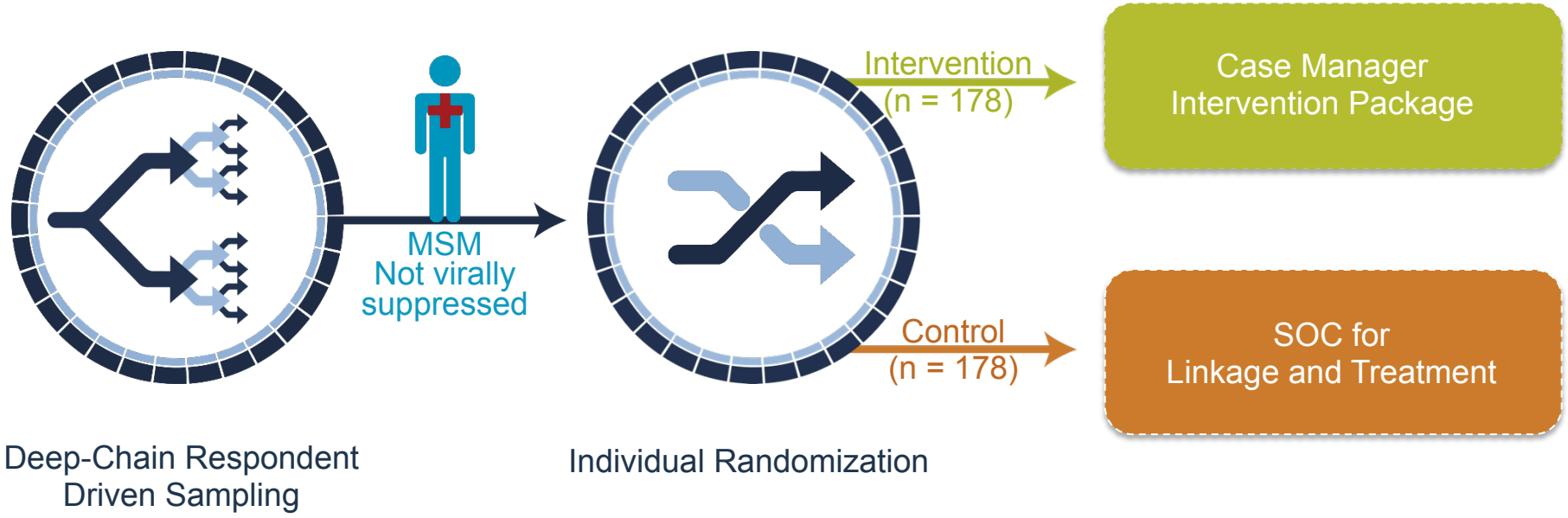

Mathematical modelling in HPTN 078

1. **Before/during the trial** - to estimate levels of viral suppression that must be reached to attain HIV incidence reduction targets
2. **After the trial** - to estimate reduction in HIV incidence achieved by trial interventions

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HIV epidemic among MSM in Baltimore

- **HIV prevalence:** 30% in 2014 (NHBS*)
- **Virally suppressed:** 40% of diagnosed in 2015 (Maryland DHMH)
- **PrEP use:** 2.4% in 2014 (NHBS*)

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Research Questions

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1. How much does the level of viral suppression need to be increased by to **reduce HIV incidence** among Baltimore MSM by 10, 20, 30 or 50% after 2, 5 and 10 years?

2. By how much could HIV incidence be reduced if **US National HIV/AIDS strategy (NHAS) targets** met by 2020:
   - 90% diagnosed
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Mathematical model

- Deterministic compartmental model
- Sexual HIV transmission

Model structure

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- **Risk groups:** age (<25, 25+) x race (black, white)
- **Care cascade:**

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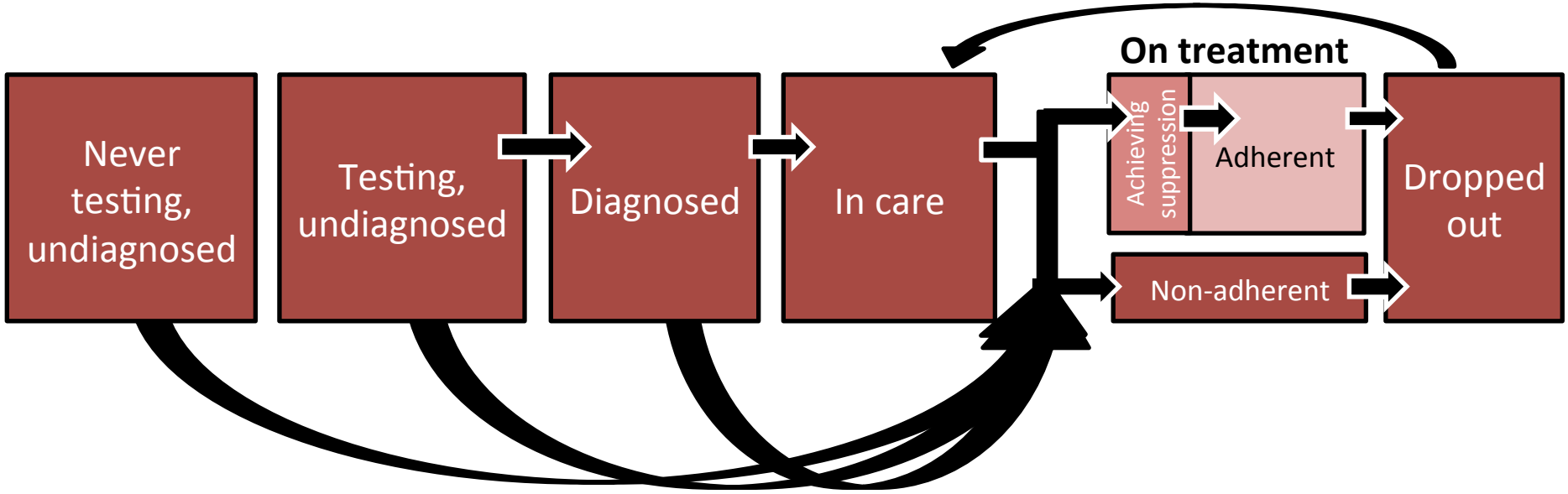

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Model parameters

Domain	Examples	Data source
Disease progression	• Initial CD4 and viral load distribution • HIV-related mortality • CD4 progression rates	Published studies: cohorts in North America and Europe
Infection probabilities	• Per-sex-act transmission probability • Relative infectiousness different disease stages	Published studies: meta analyses, study of Australian MSM
Intervention efficacy	• Reduction in per-sex-act HIV transmission risk: condoms, ART	Published studies: clinical trials, meta-analyses
Sexual risk behaviour	• Number and type of partners • Condom use • Age and race of partners	NHBS surveillance data, (eventually 078 trial) **Baltimore**
Intervention behaviour	• HIV testing • Linkage/dropout from HIV care • ART initiation, adherence and dropout	NHBS surveillance data, clinical cohorts, state health department data, (eventually 078 trial) **Baltimore**

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Model calibration outcomes

- Observed Baltimore data:
  - **HIV prevalence -** by age and race (NHBS)
  - **MSM demography** - age and race (NHBS, census)
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Model Fits:
HIV prevalence by age and race

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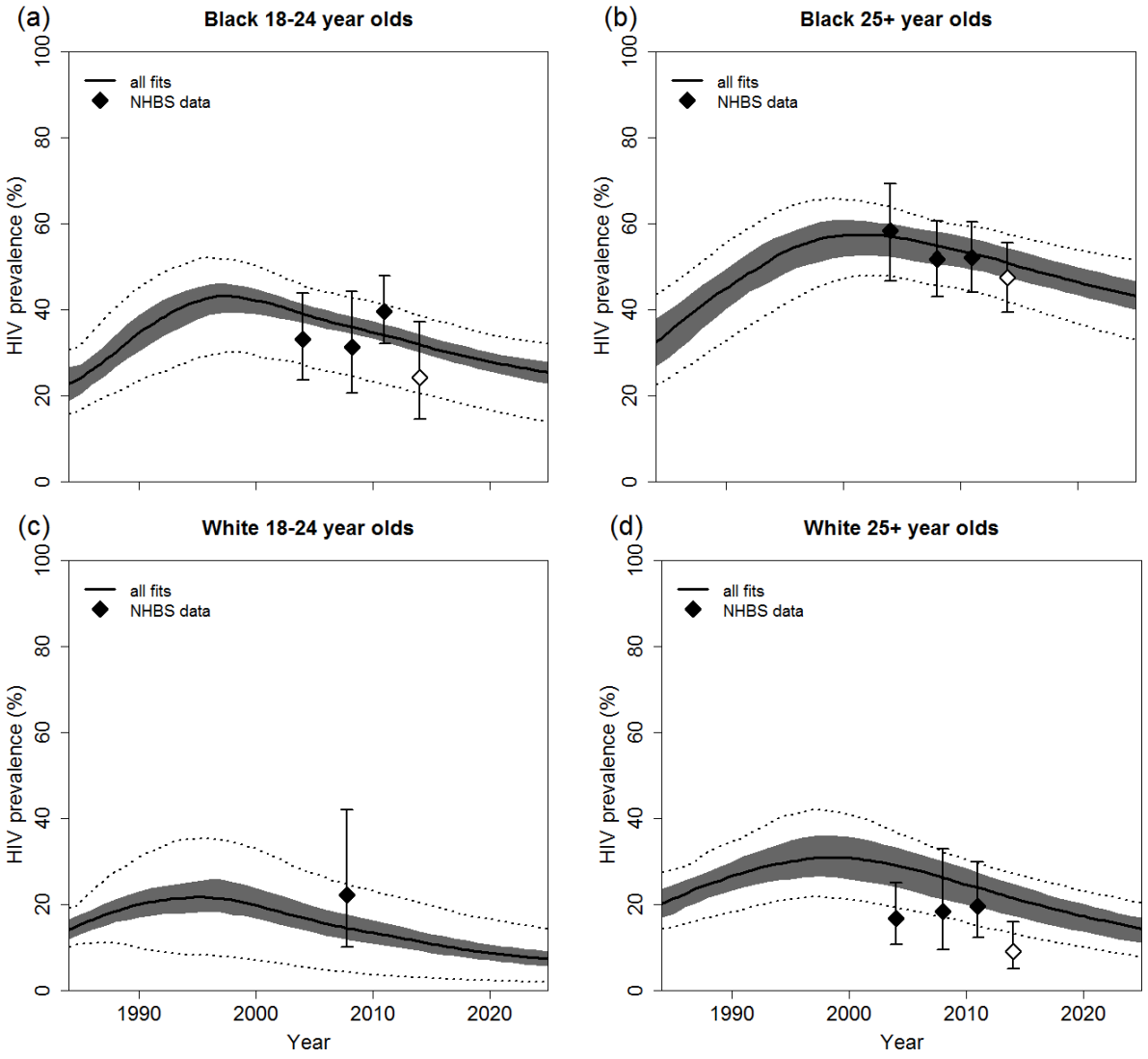
N=299



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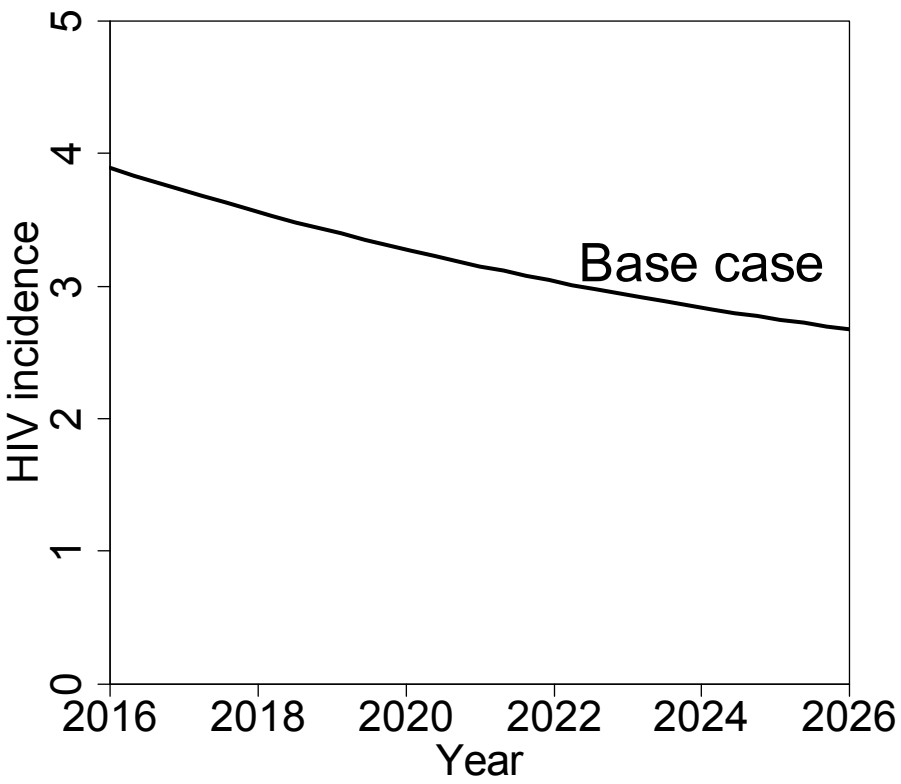

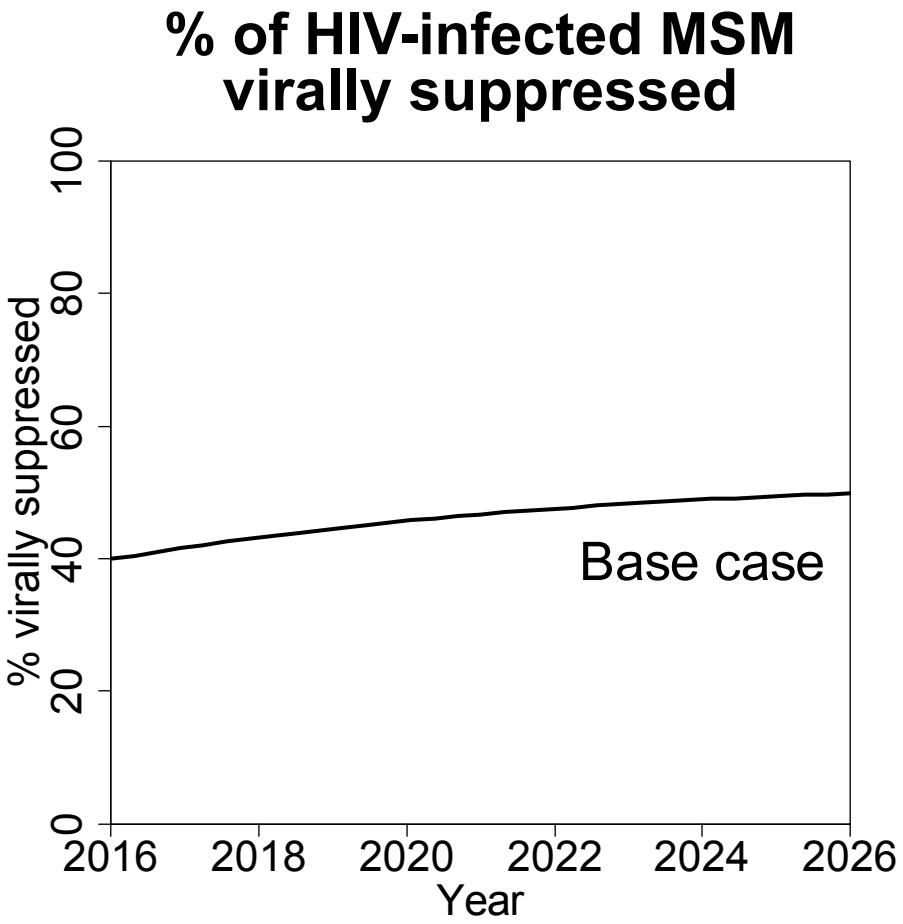

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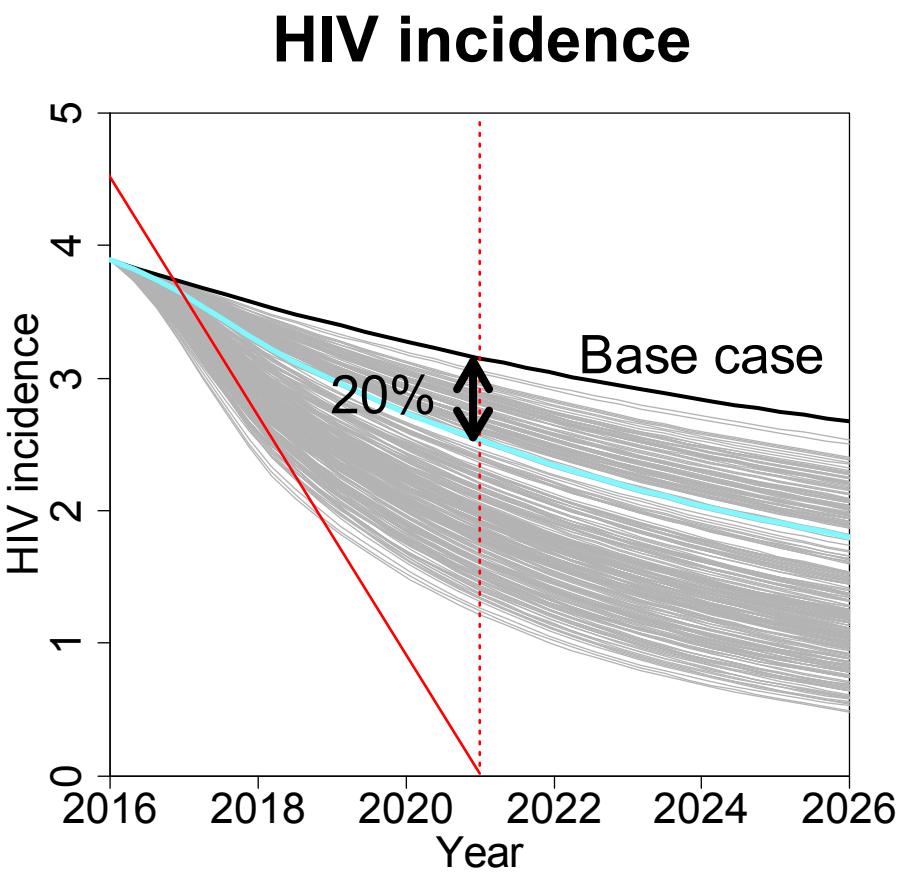

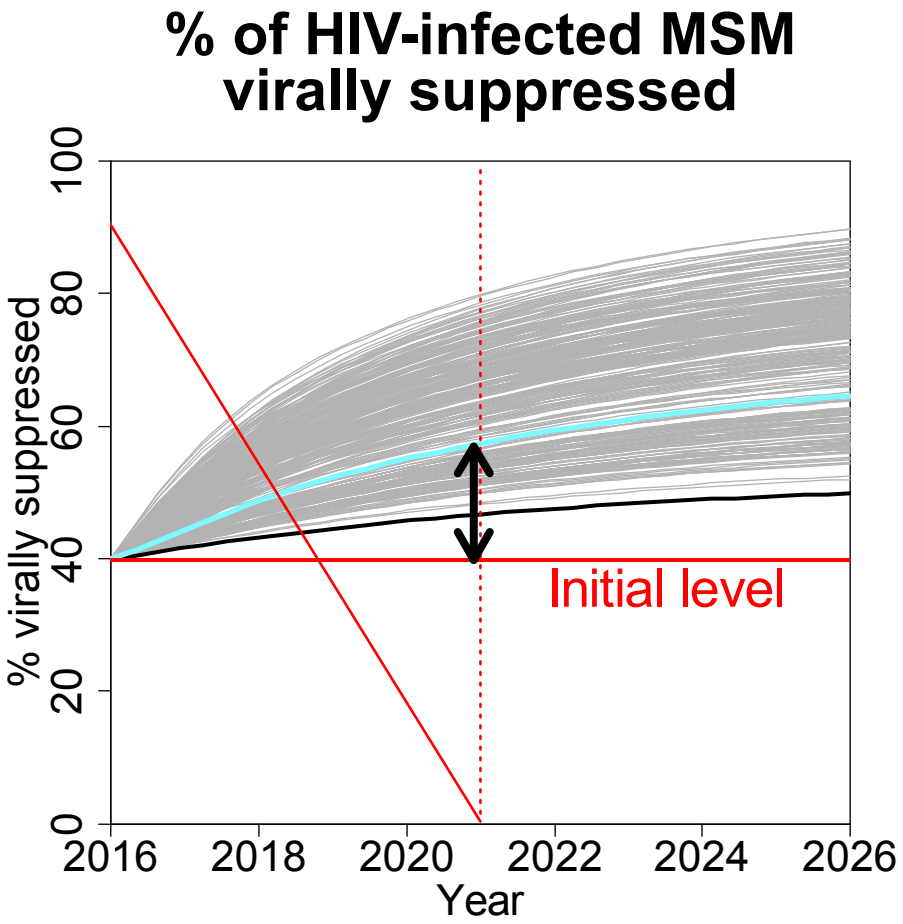

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Increase in viral suppression needed to reach incidence reduction targets

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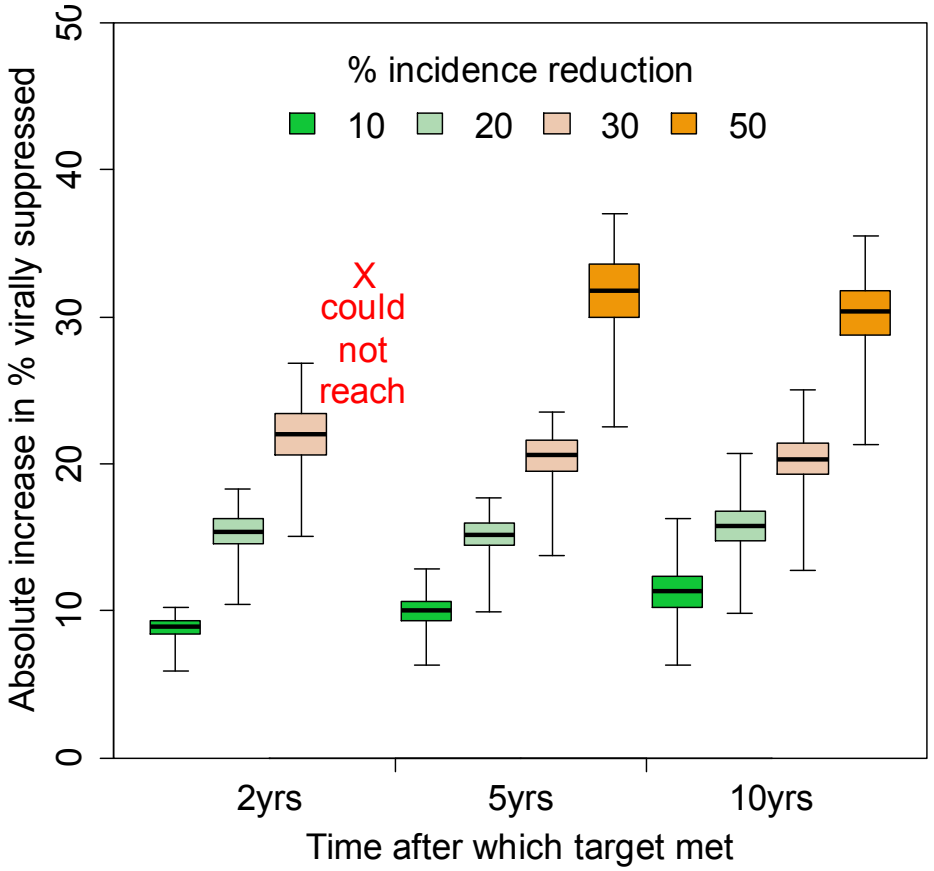
Target: reduce HIV incidence by 10, 20, 30, 50%



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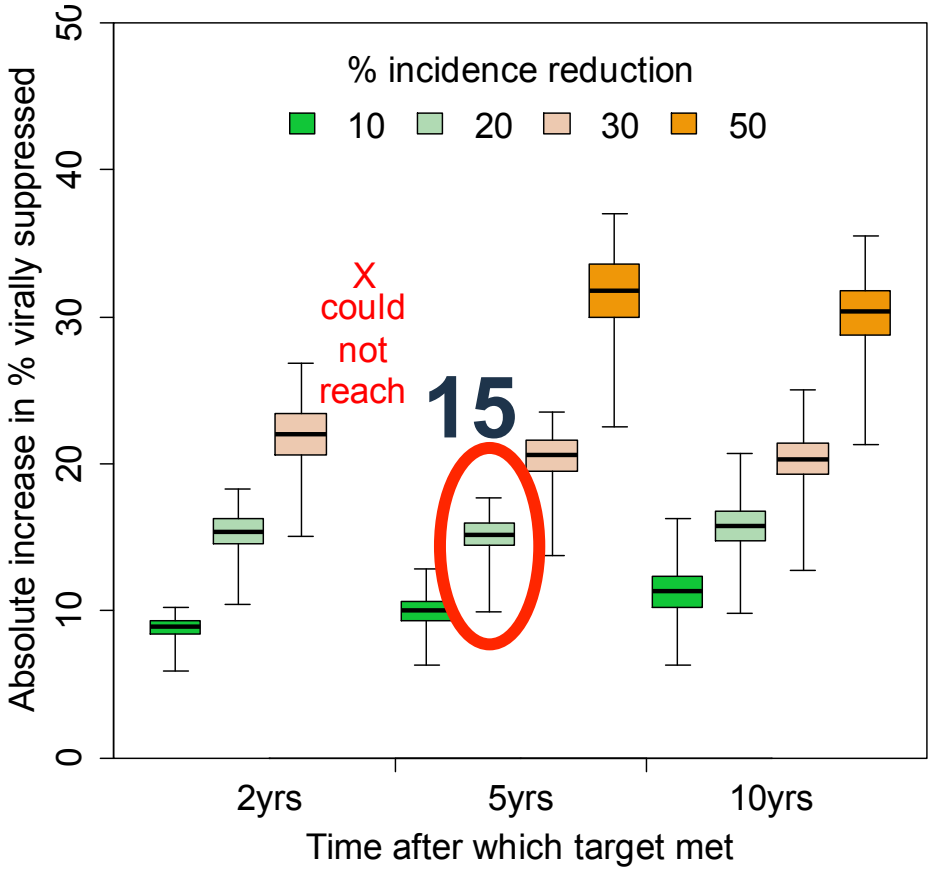

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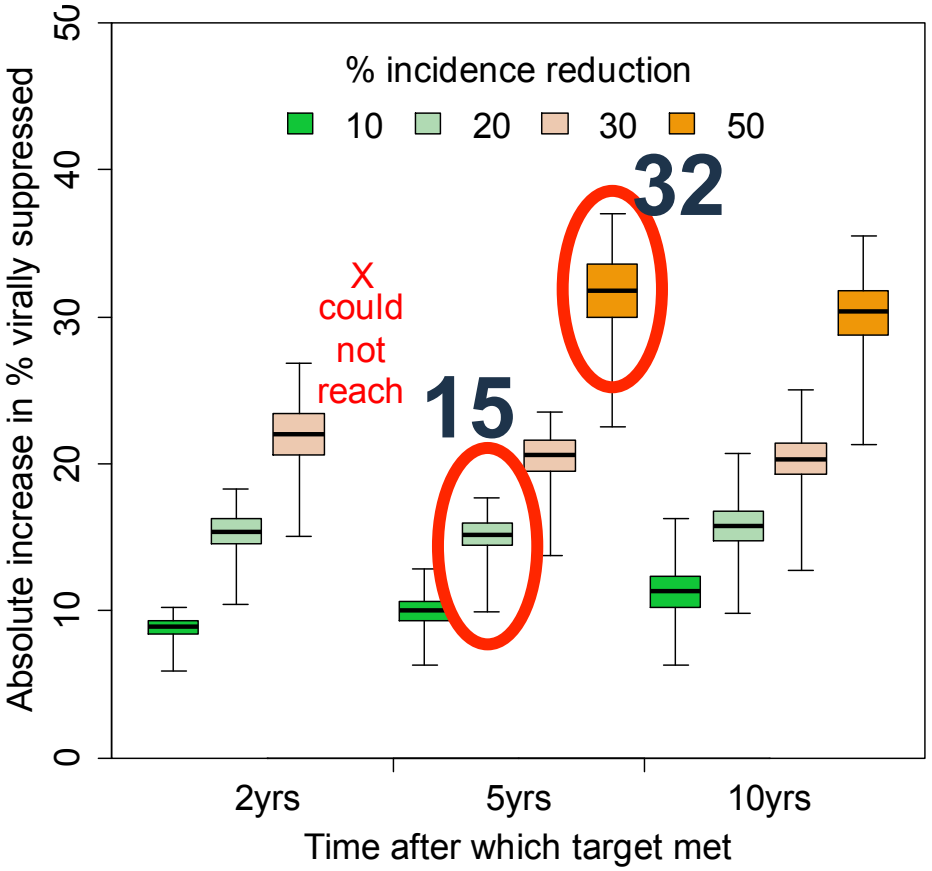

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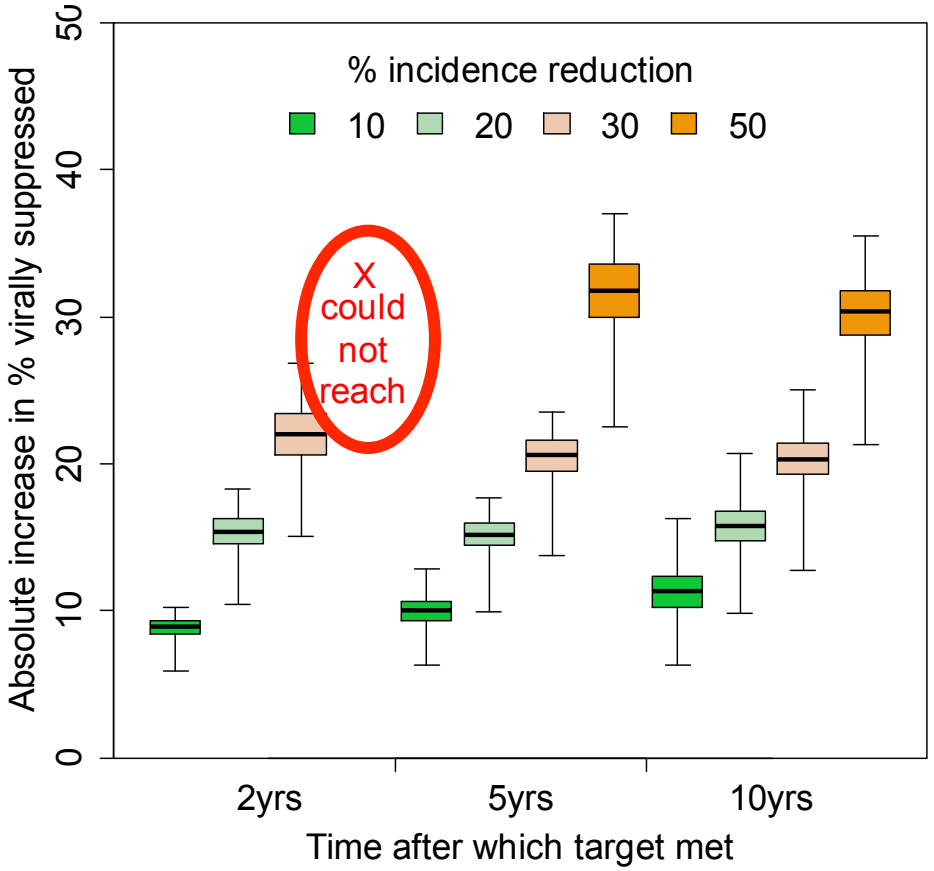

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Impact of meeting NHAS targets

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If NHAS targets all met in 2020:

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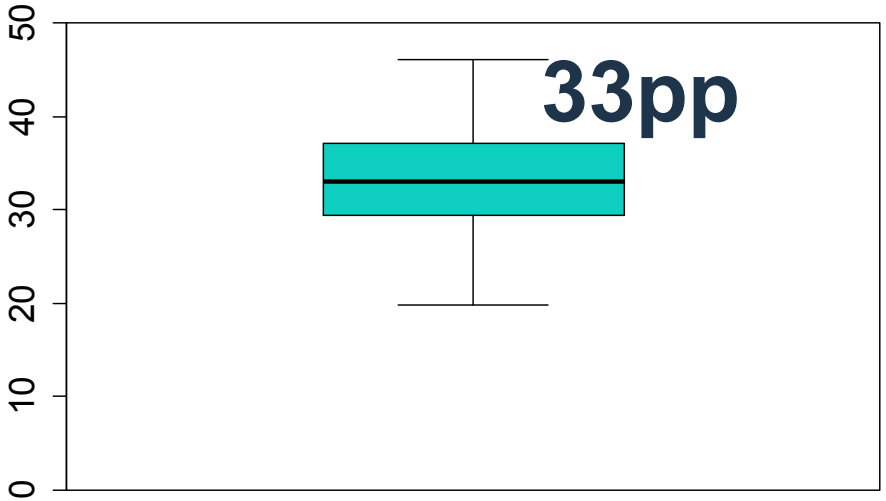

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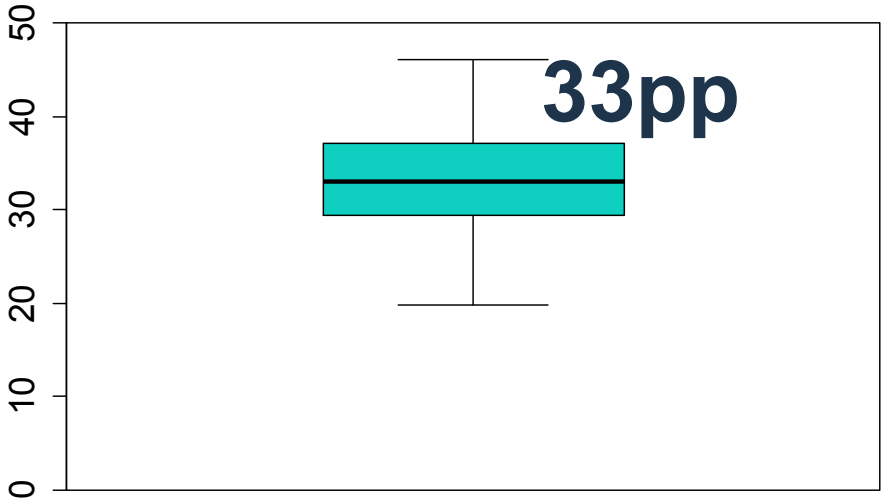
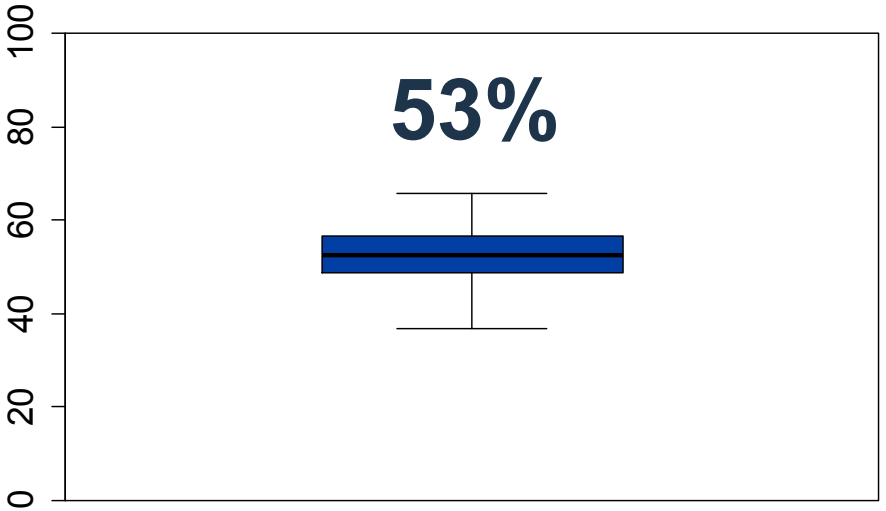


Incidence reduction in 2020



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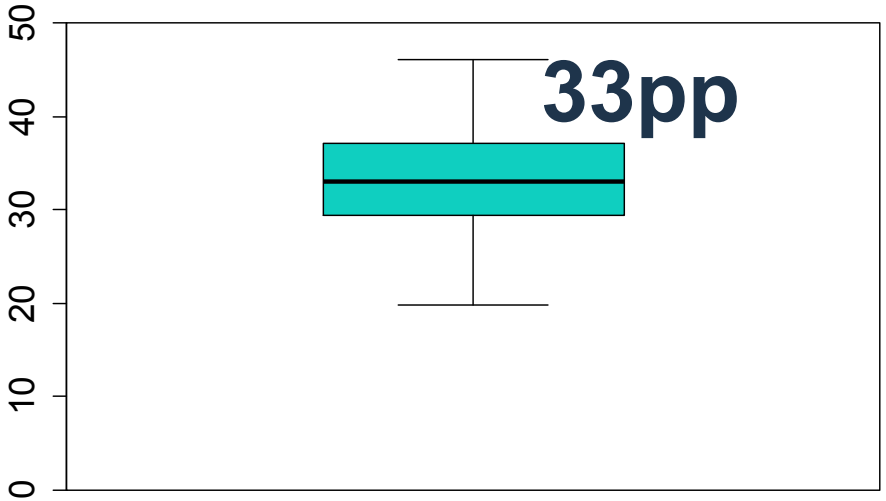

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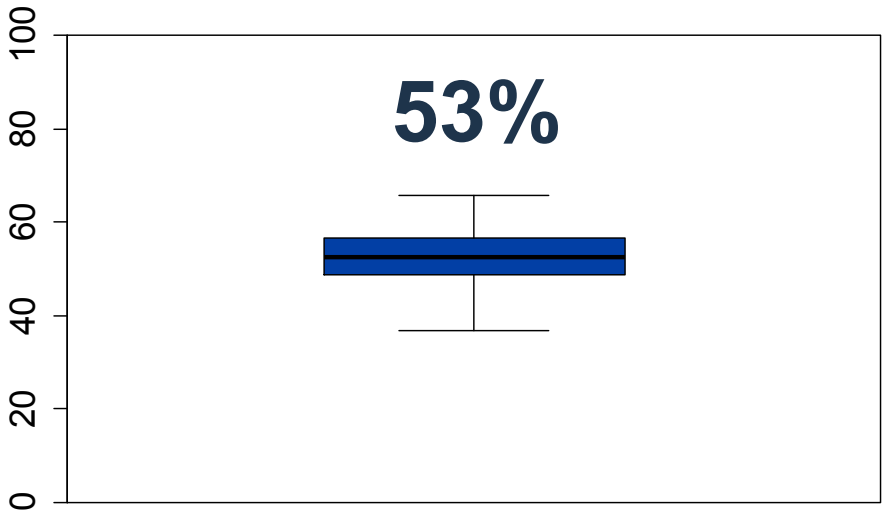

Meeting NHAS targets: very similar effect to reaching 50% incidence reduction target after 5 yrs

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Likelihood of HIV elimination

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Likelihood of HIV elimination (HIV incidence <0.1% per year) among MSM in Baltimore in the next 20 years:

- under current levels of care: 0
- when incidence reduction targets are met:

Incidence reduction target:	10%	20%	30%	50%
2 years	0	0	3.5%	-
5 years	0	0	0	0.02%
10 years	0	0	0	0

- when NHAS targets are met:

target:	90% of infected diagnosed	90% of diagnosed in care	80% of diagnosed virally suppressed	All 3 targets
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ACKNOWLEDGEMENTS

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