

Public Insurance and the Spread of Infectious Disease*

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We investigate the effect of broadened public health insurance access on the spread of HIV. Using a difference-in-differences strategy, we exploit variation in states’ decisions to expand their Medicaid programs. We estimate a 6.8% reduction in annual HIV incidence among men in states which expanded Medicaid relative to those in states that did not. We find that our reductions are primarily driven by young men aged 25 to 34 and men who have sex with men (MSM), who make up the largest proportion of annual HIV incidence in the United States. We estimate differential reductions in HIV incidence across subpopulations and explore three potential mechanisms for these effects: knowledge of HIV status, HIV susceptibility, and HIV transmission. Our results demonstrate that increased public health insurance access reduced the rate of new HIV incidence and a back of the envelope calculation suggests the ACA Medicaid expansions led to cost savings in terms of net HIV prevention and treatment.

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1 Introduction

One in five Americans live with a sexually transmitted infection (STI) and the 26 million new STI diagnoses in 2018 (Kreisel et al., 2021) represent an incurred lifetime medical cost of nearly \$16 billion dollars (Chesson et al., 2021).¹ Of this, treatment of sexually acquired HIV accounted for 13.8 billion or 86% of all incurred costs.

HIV is an enduring public health epidemic. Nearly one million people aged 13 and older were estimated to be living with HIV in 2019, with over 35,000 new HIV diagnoses estimated in the same year. The dynamics of HIV incidence and prevalence vary across group and disproportionately affects racial minorities and men who have sex with men (MSM). The relative risk for contracting HIV is also greater for those with less than a high school degree, low income individuals, and those living in poverty. Although both prevention and treatment options exist for HIV, their prohibitive costs without health insurance coverage diminish potential benefits to these groups with disproportionate HIV risk and burden.

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¹STIs in this valuation include chlamydia, genital herpes, gonorrhea, hepatitis B, Human Immunodeficiency Virus (HIV), Human Papillomavirus (HPV), syphilis, and trichomoniasis.

In 2010, roughly 67% of non-elderly adults had private insurance. Contrastingly, only 17% of adults living with HIV or AIDS had private insurance coverage. Health insurance can facilitate prevention, screening, and treatment ([Lee et al., 2018](#)) which all serve a meaningful role in moderating the spread of HIV. Prior to the Affordable Care Act (ACA), low income childless adults were largely ineligible to enroll in state Medicaid programs.² In 2014 – following passage of the Affordable Care Act (ACA) – states which opted to expand their Medicaid programs broadened their eligibility to individuals earning up to 133 percent of the federal poverty level (FPL),³ regardless of disability or parental status. Notably, these expansions targeted low-income, childless, non-elderly adults: a demographic group at higher risk for HIV infection.

A key provision of the ACA mandated all state Medicaid programs expand their eligibility to low-income families and childless adults who earned up to 133% of the FPL by January 1, 2014.⁴ However, the ACA was – and continues to be – beset with legal challenges. The most consequential of these was the 2012 ruling in *National Federation of Independent Business (NFIB) v. Sebelius*, where the Supreme Court asserted that states retained the right to choose their own eligibility thresholds and could not be coerced into expansion under the ACA (567 U.S. 519). Therein, states were given the option to expand or retain their Medicaid programs' eligibility threshold, with the incentive of accessing federal dollars for expansions. As of June 2022, 38 states and the District of Columbia have chosen to expand Medicaid; however, the timing of these decisions was not uniform and varied across states.

In this paper, we examine the impact of state-level decisions to expand public health insurance eligibility on the incidence of HIV. We use case surveillance data from the Centers for Disease Control and Prevention (CDC) to document large disparities in the incidence of HIV across age, sex, and race. A vast majority of HIV incidence – 81.1% of all new diagnoses in 2019 – were among men, particularly young men aged 25 to 34 (30.6%) and men who have sex with men (68.0%). We document large racial disparities in the distribution of HIV incidence (before and after Medicaid expansions) and offer descriptive evidence that national increases in HIV incidence rates among young men are driven by incidence in non-expansion states while states which expanded their Medicaid program saw reductions in the same groups.

²Medicaid is a joint state and federal insurance program for low-income people, and while each state program must comply with federal regulations under Title XIX of the Social Security Act, individual states both administer and determine eligibility for their respective state Medicaid programs.

³FPL is a measure of income issued by the Department of Health and Human Services (HHS) which governs eligibility for Medicaid, the Children's Health Insurance Program (CHIP), and savings on ACA Marketplace health insurance options. In 2022, the FPL for an individual is 12,880 USD.

⁴While expansion by 2014 was mandated, expansions began as early as September 2010 when three states and the District of Columbia began limited expansions using funding options provided by the ACA, see [Sommers et al. \(2014\)](#).

Next, we focus on isolating the causal effect of public insurance expansions on the incidence of HIV. We leverage variation in state-level Medicaid expansions and address the challenge of staggered treatment timing with a stacked difference-in-differences strategy following [Cengiz et al. \(2019\)](#).

We find that, following Medicaid eligibility expansions, the rate of HIV incidence decreased by 6.8% among all men in states that expanded their Medicaid programs relative to those that did not. Our estimates suggest that these reductions in the rate of HIV incidence were driven primarily by young men, aged 25 to 34 and men who have sex with men (MSM) who experienced a 9.6% and 6.8% reduction, respectively. Finally, we identify a 8.4% reduction in HIV incidence among young, Black men aged 25 to 34 who accounted for over 10% of new HIV infections in 2019.

We discuss and evaluate potential mechanisms for this reduction in the spread of HIV. Specifically, we examine how increases in insurance access affected HIV testing and the utilization of antiretroviral drugs, including pre-exposure prophylaxis (PrEP). PrEP dramatically reduces the likelihood of contracting HIV and the two drugs approved by the FDA for PrEP have an efficacy rate of over 90% in preventing new infections ([Underhill et al., 2016](#)). Though previous studies have evaluated this mechanism ([Fayaz Farkhad, Holtgrave and Albarraçin, 2021](#)), the staggered timing of Medicaid expansions introduced bias which those specifications failed to account for. We estimate that the reduction in incident HIV diagnoses was facilitated, in part, by a 39% increase in PrEP utilization following the implementation of Medicaid expansions. These effects are driven primarily by young men less than 34 – a population with low uptake of preventative health behaviors ([Karletsos and Stoecker, 2021](#)).

Our study contributes to three primary strands of literature. First, we add to the large body of research using quasi-experimental designs and population-based data which has documented that these Medicaid expansions have had substantial public health impacts. Notably, these eligibility expansions have increased health insurance coverage ([Frean, Gruber and Sommers, 2017](#)), lowered out-of-pocket spending ([Gotanda et al., 2020](#)), increased healthcare utilization ([Sommers et al., 2016](#)), and reduced financial burdens for those engaging in the health care system ([Hu et al., 2018](#)). These gains were particularly concentrated among adults living in rural areas, childless adults, and non-whites ([Courtemanche, Marton and Yelowitz, 2016](#)), and have narrowed existing disparities in healthcare access across the dimensions of race, ethnicity, sex, and sexual minority status ([Carpenter et al., 2020](#); [Wehby and Lyu, 2018](#)). We expand on this work and report heterogeneous effects for Medicaid expansions on the incidence of HIV among men, women, and racial minorities.

While economic theory suggests that government intervention in health insurance markets could increase social welfare – including reductions in infectious diseases – there is a lack of adequate research showing this

(Cawley and Ruhm, 2011). Whereas evidence from experimental and quasi-experimental settings suggests that health care consumption is sensitive to health insurance and cost (Einav and Finkelstein, 2018; Finkelstein et al., 2012), estimates do not exist on elasticities for infectious diseases related to preventive care. Additionally, rates of having no usual source of care, postponing care due to cost, and postponing or foregoing needed prescription drugs are higher among the uninsured relative to those with public or private insurance (Garfield, Orgera and Damico, 2019). Broadened health insurance eligibility increased engagement in preventative care following the ACA (Soni, 2020) and reduced unmet medical needs due to financial burdens following the ACA's Dependent Coverage Mandate (Barbaresco, Courtemanche and Qi, 2015).⁵ We contribute to this body of work and examine the relationship between broadened access to preventative care and the incidence of STIs.

Finally, while health insurance reduces the financial burden associated with preventive care, it also reduces the incurred cost of engaging in risky health behaviors since treatment is more affordable. PrEP decreases the cost of engaging in risky sex, such as sex without condom use, because it is effective in reducing HIV infections. However, PrEP use does not reduce the risk of infection from other STIs. Much of the research on risky health behaviors and sex relates to laws and policies that increased the cost of risky sex. Abortion laws and minimum drinking ages have been found to reduce the demand for risky sex (Chesson et al., 2021) and biomedical research advances such as the introduction of highly active anti-retroviral treatment (HAART) have led to reductions in HIV infection rates; but, the lower cost of risky sex could increase demand for such behaviors (Chan, Hamilton and Papageorge, 2016). Willage (2020) examines unintended consequences of reduced health care costs and finds that while the zero-cost sharing mandate of the ACA decreased prescription contraception prices, it also decreased condom use and increased sexually transmitted infections. Contrastingly, while condoms do not require a prescription, Ahituv, Hotz and Philipson (1996) find increased demand for condoms in response to local AIDS prevalence.

We extend this literature with novel estimates for the impact of broadened public insurance eligibility on the utilization of PrEP and the incidence of STIs with a lower financial cost to treat than HIV. While a prior study finds that the Medicaid expansions increased the use of PrEP, the authors also estimate that Medicaid expansions were associated with an 13.9% increase in county-level HIV incidence rates (Fayaz Farkhad, Holtgrave and Albarracín, 2021). We find opposite effects on HIV incidence, attributable to several differences in our empirical strategies including an estimation method robust to the staggered timing of ACA-facilitated Medicaid

⁵The Affordable Care Act requires all plans and issuers in the individual and employer sponsored insurance market to make dependent child coverage available until a child reaches the age of 26, invariant of the child's marital status. This policy was enacted prior to Medicaid expansions, in 2010 (Depew and Bailey, 2015).

expansions. Additionally, for some populations we estimate significant but descriptively small changes in STI incidence which align with reported changes (particularly in syphilis and chlamydia) following other public insurance expansions (Oney, 2018).

Our results highlight the importance of health care access and availability on the spread of infectious disease. For policymakers, our findings identify the benefits of broadening access to HIV treatment and prevention and support the need for structural interventions which reduce barriers to such medications (Sharpe et al., 2022). We offer evidence that our estimates – particularly for young, Black men – are being driven, in part, by increases in HIV incidence in states which opted not to expand their Medicaid program’s eligibility threshold. A back-of-the-envelope calculation suggests that these states’ decisions led to 5,000 excess HIV diagnoses among men relative to expansion states from 2015 to 2019 and represent an incurred treatment cost of 2.8 billion USD (Schackman et al., 2015).

2 Data

Our main outcomes are drawn from state-level surveillance data from the Centers for Disease Control and Prevention (CDC) which detail new cases – or incidence – of sexually transmitted infections (STIs) and offer stratification by sex, race, and age group. We augment these data with information on utilization of prescription drugs used to treat and prevent HIV from quarterly, state-level administrative Medicaid reports. Finally, we include state-level economic and demographic variables for controls from varied sources. We discuss these data and their sources below.

2.1 STI Incidence Data

Our primary incidence measure for sexually transmitted infections (STIs) relies on surveillance data produced by the CDC from 2008-2019. Surveillance data are drawn from reports from state health departments and reflect the incidence of STI diagnoses in a given state and year. We identify 4 STIs – chlamydia, gonorrhea, syphilis, and HIV – and obtain incidence counts at the state-year level for each. Surveillance data are compiled by the CDC from state health departments and report the number incident cases for a set of “notifiable” diseases for which reporting is mandatory.

While a prior study used aggregate, county-level incidence, we opt to use state-level counts and stratify our incidence measures by age, sex, and race using definitions provided by the CDC. County-level HIV incidence

data pose three significant limitations when attempting to isolate the causal effects of state-level policy actions. First, county-level incidence data do not offer stratification by race or age groups. Estimates drawn from aggregate – albeit granular – surveillance data mask heterogeneity across sub-populations disproportionately burdened with HIV. Secondly, county-level surveillance data is subject to suppression when publicly released by the CDC. This privacy-oriented suppression impacts any county-year observation with less than five incident HIV diagnoses; for county-level incidence by sex, all county values are suppressed if there are fewer than 5 incident diagnoses among men or women in a given year. Therein, dropping these suppressed counties – particularly when stratifying by sex – drastically reduces statistical power and geographic data coverage.⁶

Finally, methods used to account for CDC data suppression often impute a fixed value for missing observations (Siegler et al., 2020) and the existing estimates are drawn from data which impute zero for suppressed counts (Fayaz Farkhad, Holtgrave and Albarracín, 2021). This zero-imputation produces large and meaningful differences between aggregated state-level incidence from imputed county-level data and ‘true’ state-level counts. We visualize the differences in Appendix Figure A5 and show that 22% of state-level incidence is ignored using this imputation method.

Our study instead leverages state-level incidence data – which is not subject to suppression. We estimate our main specification for sub-populations by sex, race, and age groups, in addition to aggregate measures of state-level incidence.

2.2 Medicaid State Drug Utilization Data

We obtain information on prescription drug from the Medicaid State Drug Utilization Data (SDUD). This data, compiled by the Centers for Medicare and Medicaid Services (CMS), contains the universe of prescription drugs used in outpatient, non-specialty settings: telemedicine, retail, and online pharmacies. Medicaid covers these drugs as a third party under the Medicaid Drug Rebate Program (*Social Security Act of 1935, 1992*). This data is compiled by the federal government quarterly and plays a role in determining state and federal rebates from nearly 600 distinct pharmaceutical companies that participate in the program.

We consider prescriptions drawn from both fee-for-service and managed care reimbursement schemes. Since these data directly influence the rebates collected from manufacturers and whether states receive Medicaid drug funds from CMS, both are incentivized to ensure these data are of high quality. We identify prescription drug data from 2009-2019. We weight these observations by total Medicaid enrollment (both fee-

⁶See Appendix Figure A4 for geographic data coverage issues associated with county-level surveillance data.

for-service and managed care reimbursement schemes) in our main specification, as states have shifted toward managed care plans over time (Hurley and Somers, 2003). Additionally, the vast majority of expansion states' newly-eligible population will be enrolled in managed care plans (Paradise, 2017).

We identify drugs used to treat and prevent HIV by their national drug code (NDC) in the Medicaid data and create a state-year panel of PrEP utilization in the Medicaid population. The NDCs used to identify these drugs and a list of their brand names are provided in our appendix. While CMS suppresses data for counts of fewer than eleven (11) prescriptions, few states in our sample suppress prescription counts for our primary drugs of interest. Suppressed counts are imputed as zeroes in our sample, though we only observe three state-year observations subject to such suppression.⁷ We construct our outcome variables as the number of prescriptions written per 100,000 Medicaid enrollees – the prescribing rate – using Medicaid enrollment data provided by CMS.

2.3 Additional Data Sources

We create a state-year panel and augment our primary outcomes data on STI incidence and prescription drug utilization with covariate measures from four sources. First, we link data on policies that could impact the rate of injecting drug use from RAND-University of Southern California's Schaeffer Opioid Policy Tools and Information Center (OPTIC) database at the state-year level including must-access prescription drug monitoring programs (PDMPs), good samaritan laws, and naloxone access laws. Second, we link data on annual state-level unemployment rates from the Bureau of Labor Statistics (BLS) Local Area Unemployment (LAU) estimates. Third, we link data on the number of practicing physicians and healthcare availability from the Area Health Resource File (AHRF) at the state-year level.

To construct our primary outcome measures, we retrieve counts of incident diagnoses and create annual sub-population incidence rates using estimates provided by the Surveillance, Epidemiology, and End Results (SEER) Program (NCI-SEER, 2021). We additionally use racial composition estimates from these data as covariates in our primary specification; these four measures represent the the proportion of the state population that is Black, Hispanic, Male, and male aged 25 to 44. Finally, we create our primary measure of variation and create a Medicaid expansion indicator variable following Carey, Miller and Wherry (2020).

⁷When excluding states that ever have a suppressed observation for these data and re-estimating our main specification, our results are descriptively similar in sign and magnitude. These estimates are available on request.

3 Results

In this and subsequent sections, we present evidence of the effect of Medicaid expansions under the ACA on a variety of sexual health-related outcomes. We begin by presenting descriptive statistics and unadjusted trends in aggregated new HIV diagnoses among men (who account for most new HIV infections). Next, we turn to event study and difference-in-difference models that compare changes in new HIV diagnoses between states that expanded Medicaid and those that did not.

We estimate statistically significant reductions in HIV incidence rates following Medicaid expansions for men, men who have sex with men, and young Black men; we do not find any sustained reduction in HIV incidence rates among women. This leads us to discuss a series of plausible mechanisms that could explain these differential effects. We offer estimates for the effect of Medicaid expansions on the use of preventative and therapeutic antiretroviral drugs which aid in reducing HIV transmission.

Finally, we present the results from numerous sensitivity tests, which demonstrate the robustness of our results. We demonstrate that our results are robust to the inclusion of state-specific linear time trends, the use of linear and nonlinear estimation models, and the exclusion of early and late expansion states.

3.1 Trends of HIV Incidence

HIV incidence in the United States decreased, on average, across our study period. There were 10,000 fewer incident HIV diagnoses in 2019 compared to 2008: the start of our study window. A majority (68.7%) of incident HIV cases in 2019 were among men who have sex with men (MSM); young men aged 25 to 34, whose average incidence rate is 34.6 per 100,000 during our study period (Appendix Table A1), made up 35.8% of HIV incidence in the same year. There exist significant racial disparities in HIV incidence. The HIV incidence rate for Black individuals was seven times higher than that of their white counterparts; Hispanic HIV incidence was nearly four times higher relative to whites. Nearly half (42%) of all HIV incidence in 2019 was among Black men and women who made up less than 13% of the US population in the same year. These racial disparities persist and intensify for young men and Hispanic populations. Compared to white men aged 25 to 34, the HIV incidence rate is three times higher for Hispanic men of the same age and five times higher for Black men.

We are interested in how incidence changed in response to the expansion of public health insurance eligibility following implementation of Medicaid expansions in 2014. To isolate this effect, we first focus on the groups with the highest annual rates of HIV incidence. Figure 1 illustrates the percent change in HIV incidence rates

among these sub-populations before and after 2014. We plot this change separately for states which expanded their Medicaid program eligibility and those that did not for each sub-population. While overall HIV incidence reduced across our study window in the United States, incidence rates for certain sub-populations – including those presented in Figure 1 – increased, on average, in non-expansion states. Appendix Figure A2 plots trends in these diagnoses and illustrates that while aggregate HIV incidence has been declining reducing, incidence rates for young men have risen steadily across our study window.

We document consistent declines in population-level HIV incidence in both expansion and non-expansion states relative to pre-2014 incidence rates. Average HIV incidence rates among all men, men who have sex with men (MSM), and resulting from injecting drug use (IDU) reduced by 22.6% to 39.4% for expansion states and reduced by 4.0% to 25.7% for non-expansion states. Average HIV incidence rates among persons aged 25 to 34, specifically white and Black men, increased in non-expansion states relative to pre-2014 rates by 5.8% to 17.7%. Among young, Hispanic men aged 25 to 34, average HIV incidence rose by 8.6% and 31.4% in non-expansion states. Contrastingly, these same sub-populations saw an 5.3% to 10.3% reduction in average incidence rates in expansion states with one notable exception: young, Black men. Average HIV incidence rates among Black men aged 25 to 34 increased across the United States (5.4%) relative to pre-2014 and while seemingly driven by a 5.8% increase in non-expansion states, expansion states also experienced a 1.9% increase in average incidence rates.

3.2 *Impacts of Medicaid Expansions on HIV*

Our goal is to identify the causal impact of broadened public health insurance eligibility on the incidence of HIV. We compare sub-population rates of HIV incidence in states which opted to expand their Medicaid program eligibility threshold relative to those that did not expand their programs using a state-year panel.

3.2.1 *Empirical Strategy*

We exploit variation in state-level Medicaid expansions and employ a difference-in-differences design to evaluate the impact of expanded access to public health insurance on the spread of sexually transmitted infections (STIs). Our baseline specification takes the following form:

$$E[y_{st}] = \exp(\beta_1 \text{MedicaidExpansion}_{st} + \beta_n X_{st} + \mu_s + \tau_t)$$

Where y_{st} is our outcome in state s and year t and $MedicaidExpansion_{st}$ is an indicator variable equal to one if a state has expanded Medicaid and 0 otherwise. We include a vector of covariates X_{st} which includes the unemployment rate, the presence of prescription drug monitoring programs (PDMPs), and the percentage of the population that is Black, Hispanic, male, or aged 25 to 44, indexed at the state-year level. We include state and year fixed effects – μ_s and τ_t – to adjust for time invariant geographic shocks and time-specific shocks, respectively. We estimate Poisson regressions and weight our observations by outcomes’ sub-group population.⁸

There are two primary considerations for estimation in a two-way fixed effects setting. First, ACA-facilitated Medicaid expansions were staggered across five distinct cohorts. This staggered treatment timing creates the potential for bias in our two-way fixed effects (TWFE) estimator due to comparisons between early and later treated units (Goodman-Bacon, 2021). To adjust for the bias introduced by this staggered timing, we estimate a ‘stacked’ difference-in-difference model to attempt to adjust for the bias introduced by staggered timing in our sample (Baker, Larcker and Wang, 2022; Cengiz et al., 2019). In the stacked specification, we identify cohorts which expanded Medicaid in the same year and construct a comparison group of only untreated states (those which did not expand Medicaid) and isolate them for four years before and after expansion. Our primary difference-in-difference specification takes the form

$$E[y_{gst}] = \exp(\beta_1 MedicaidExpansion_{st} + \beta_n X_{st} + \mu_{gs} + \tau_{gt})$$

where all parameters are analogous to our baseline model. The primary difference in this specification is an interaction of the state and year fixed effects with an indicator for the treatment ‘stack’ the observation is drawn from. The validity of a TWFE estimate additionally relies on the presence of parallel pre-trends between treated and non-treated groups, asserting that – in the absence of Medicaid expansion – these trends would not have been statistically different. To evaluate the presence of parallel pre-trends, we employ a stacked event study model which takes the following form:

$$E[y_{gst}] = \exp\left(\sum_{j=-4; j \neq -1}^4 \beta_t MedicaidExpansion_{st}(t = k + j) + \beta_n X_{st} + \mu_{gs} + \tau_{gt}\right)$$

⁸A Poisson distribution is well adapted to continuous outcomes and can be estimated for rate outcomes when the rate denominator is used as observations’ weights. Estimation in this setting with robust standard errors is shown to be much less sensitive to misspecification for continuous dependent variables when compared to OLS models (Wooldridge, 2010). Our results are descriptively similar in an OLS setting.

Here, the summation term $\sum_{j=-4}^4 \beta_t MedicaidExpansion_{st}(t = k + j)$, j indexes the year relative to Medicaid expansion in expansion states – expansion occurs at $j = 0$ – and k represents the year in which a state expands their Medicaid program. We specify the reference period in these event study models at $j = -1$. We are interested in the estimate for β_t which represents the difference in a given outcome between treated and untreated states in period t . In this stacked specification, we must isolate our data to a balanced panel – here, four years before and after Medicaid expansion. As such, we only estimate our primary specification for 2014 and 2015 Medicaid expansion states.⁹ We perform additional analysis inclusive of late Medicaid expanders.

3.2.2 Primary Results

We present our main results from equation (1) in Table 1 for sub-populations with the highest annual rates of HIV incidence, aligning with Figure 1. Column (1) presents results from our primary specification without the inclusion of covariates and column (2) shows our main estimates. Columns (3) and (4) present estimates from a series of sensitivity analyses, described in Section 3.2.4. All coefficient estimates presented in Table 1 represent the difference in the rate of HIV incidence between expansion and non-expansion states following ACA-facilitated changes in Medicaid eligibility. We present estimates for all subgroups in Appendix Table A4.

Our estimates suggest that broadened public insurance eligibility following the ACA led to large and significant reductions in HIV among men, but not women. We find a 6.8% reduction in HIV incidence among all men, relative to states that did not expand their eligibility threshold. In the total population, we estimate a 7.6% reduction among persons aged 25 to 34 and a 6.8% reduction among men who have sex with men (MSM). We then turn our focus to young men, aged 25 to 34, who seemingly drive these reductions in the total population. We estimate a 9.6% reduction in the rate of HIV incidence among all men aged 25 to 34 following Medicaid expansions and a 8.4% reduction among Black men in the same age group. We do not estimate statistically significant reductions in the rate of HIV incidence among white men, though estimates are descriptively similar to other groups.¹⁰

Our results suggest heterogeneous effects of Medicaid expansions on the rate of HIV incidence. The reductions we estimate are isolated to groups with the highest rates of HIV incidence across our study window who

⁹We exclude states that expanded in 2006, 2016, and 2017 from the primary specification. Massachusetts (2006) is the largest of these states and experienced a broadened Medicaid eligibility criteria well before our study window. Alaska (2016), Montana (2016), and Louisiana (2017) are late Medicaid expanders in our sample.

¹⁰We estimate statistically significant reductions for MSM incidence rates, a group that made up a majority of HIV incidence across our study window. Surveillance data from the CDC does not provide further disaggregations among MSM, thereby preventing any evaluation of this particular effect by age or race among MSM

– on average – comprise over 80% of annual HIV incidence. Medicaid expansion status does not directly determine healthcare engagement, but these groups additionally experienced the largest gains in insurance coverage following the ACA (Garrett and Gangopadhyay, 2016). While we are unable to identify the transmission type among these groups, these analyses bolster our confidence that the reductions estimated for the total population are primarily driven by young, Black men aged 25 to 34.

3.2.3 Potential Mechanisms

To explore potential mechanisms which could produce the heterogeneous reductions we estimate for the rate of HIV incidence, we estimate regressions on a set of auxiliary outcomes. Our goal is to isolate potential mechanisms which are (1) affected by Medicaid expansions and (2) utilized primarily by young men and men who have sex with men (MSM). We argue that new HIV incidence is a function of three primary factors: knowledge of HIV status, HIV susceptibility, and community-level HIV viral suppression. Table 2 presents estimates for these outcomes.

Knowledge of HIV status is based primarily on rates of HIV testing. Prior work using data from the Behavioural Risk Factor Surveillance System (BRFSS) found public insurance expansions were associated with a higher probability of HIV testing for low-income, nonelderly adults – a group with disproportionately high rates of HIV incidence. Specifically, ACA-facilitated Medicaid expansions increased the probability of HIV testing among Black men by 4.8 percentage points, Hispanic men by 1.9 percentage points, and white women¹¹ by 4.5 percentage points; expansions had no statistically significant impact on testing among Black and Hispanic women, when compared to white men (Menon et al., 2021). Importantly, these authors identify no significant association between Medicaid expansion and HIV testing for individuals without a primary care physician (PCP).

HIV susceptibility is driven by two factors: the frequency of risky sero-discordant sexual encounters¹² and regimented use of pre-exposure prophylaxis (PrEP). While we are unable to directly capture changes to sexual behaviors, increases in HIV testing following Medicaid expansions would increase knowledge of HIV status and ideally reduce the frequency of such interactions, among people living with HIV. PrEP is a daily, regimented

¹¹We estimate a 15% reduction (95% CI = -0.28 to -0.02) in the rate of HIV incidence among white women aged 35 to 44, driven by a statistically significant reduction in (only) the first year after Medicaid expansion. See Appendix Table A6 for details and Appendix Figure A5 for event study estimates.

¹²Sero-discordant sexual encounters refer to any sexual interaction between an HIV-positive and an HIV-negative individual. Risky encounters are intended to describe those which additionally expose the HIV-negative individual to risk of HIV infection, e.g. condomless sex.

antiretroviral therapy approved by the FDA to reduce the likelihood of HIV infection conditional on exposure. PrEP is also costly; the wholesale price of a month's supply of PrEP in 2012 – the year it was approved by the FDA – was 2,000 USD. Medicaid wholly covers the cost of PrEP with no co-pay and additionally requires a negative HIV test before prescribed. Medicaid expansion was associated with statistically significant increases in PrEP utilization among those aged 25 to 34 (Karletsos and Stoecker, 2021) but we are the first to investigate the effect on PrEP utilization within the Medicaid population. We estimate, using our primary specification, the effect of Medicaid expansions on the utilization of PrEP using administrative data described in Section 2.2. The results are presented in Table 2 Panel B and show Medicaid expansions led to a 39% increase in the rate of PrEP utilization: the number of prescriptions written for PrEP per 100,000 Medicaid enrollees¹³.

Finally, HIV incidence is a product of prevalent HIV cases. Viral suppression refers to sustained, undetectable levels of HIV for an HIV-positive individual and can only be attained by a regimen of highly active antiretroviral therapy (HAART). Regimented use of HAART for the goal of viral suppression can produce HIV that is not only undetectable by HIV tests but also untransmissible to HIV-negative individuals (Jiang, Su and Borné, 2020). Table 2 Panel B presents estimates for the effect of Medicaid expansions on the rate of HAART utilization among Medicaid enrollees. We estimate an 18% increase in the utilization of HAART among Medicaid enrollees following expansions, representing an increase in Medicaid coverage of HIV-positive individuals and increased engagement in HAART regimens which facilitate viral suppression.

3.2.4 Additional Analyses

We consider a series of additional analyses to validate the assumptions of our main specification and the robustness of our results. Causal interpretation of a two-way fixed effects (TWFE) estimate relies on parallel trends for a given outcome before Medicaid expansion between expansion and non-expansion states. Figures 2 and 3 visually illustrate estimates from our event study specification. For both the full population and our sub-populations of interest, Figure 2 demonstrates that, prior to Medicaid expansion in both expansion and non-expansion states, HIV incidence rates did not significantly differ. In the post period, we identify significant reductions in HIV incidence. Coefficients in the post-policy period are always negative and in some cases remain statistically significant for the full four years after Medicaid expansion which we capture in our event study specification.

¹³PrEP is written as 12 monthly prescriptions. When dividing the prescribing rate by 12 and re-estimating our main specification, we retrieve descriptively similar results which suggests that this change is driven by new PrEP users in Medicaid rather than intensive margin effects.

To ensure that our results were not driven by changes in a single Medicaid expansion state, we conduct a leave-one-out analysis and iteratively exclude expansion states and re-estimate our primary specification (see Appendix Figure A5 details). Table 1 column (1) presents estimates without covariates, which change neither the magnitude nor direction of our estimates. Table 1 column (2) presents estimates from our main specification with the inclusion of covariates – we show that covariate inclusion yields descriptively similar results.

Our estimates are drawn from a specification following [Cengiz et al. \(2019\)](#) which accounts for the potential bias introduced by the staggered timing of Medicaid expansions. Table 1 columns (3) and (4) present descriptively similar results from the estimator proposed in [Gardner \(2021\)](#), which is designed to account for settings such as ours.

4 Conclusion

This study evaluates the impact of broadened public health insurance eligibility on the incidence of HIV in the United States by leveraging variation offered by state-level Medicaid expansions following the ACA. We find large and statistically significant reductions in the rate of HIV incidence in states which opted to expand their Medicaid program's eligibility criteria, and these reductions were most pronounced for groups with the highest rates of HIV incidence: young men. Reductions were larger among groups who experienced outsized gains in insurance coverage following the ACA – we offer evidence that our findings are driven by young Black men, aged 25 to 34.

Our findings serve as guidance for meaningful policy interventions which address the HIV epidemic in the United States. Eleven percent of adults with HIV remain uninsured as of 2018 with a fourteen percentage point difference between Medicaid expansion states and non-expansion states, where twenty percent are uninsured ([Dawson and Kates, 2020](#)). This alone underscores the important impacts that Medicaid expansion may have had. Medicaid expansions led to a large increase in the accessibility of life saving drugs for people living with HIV – this has considerable societal implications given that such therapies yield undetectable and untransmissible levels of HIV. Our paper demonstrates that, in addition to large increases in the insurance coverage of people living with HIV, the ACA-facilitated expansions of public insurance eligibility also prevented thousands of new HIV diagnoses, particularly among minorities such as men who have sex with men and young Black men – populations that already suffer from worse health outcomes, lower socioeconomic status, lower rates of health insurance coverage, and higher rates of both discrimination and stigmatization.

5 Main Exhibits

Table 1: DiD Estimates for HIV Incidence Relative to Medicaid Expansion

	Stacked Poisson		Gardner 2-Stage	
	No Controls	Controls	No Controls	Controls
	(1)	(2)	(3)	(4)
Panel A. Pooled HIV Incidence				
Injecting Drug Use	0.016 (0.082)	-0.111 (0.064)	0 (0)	0 (0)
All Aged 25 to 34	-0.11*** (0.027)	-0.084*** (0.024)	-0.085** (0.026)	-0.085** (0.026)
Among Women	-0.022 (0.049)	-0.032 (0.047)	0.048 (0.049)	0.048 (0.049)
Among Men	-0.083** (0.025)	-0.07* (0.03)	-0.067** (0.024)	-0.067** (0.024)
Among MSM	-0.084*** (0.023)	-0.068* (0.029)	0* (0)	0* (0)
Panel B. HIV Incidence Among Young Men				
Men Aged 25 to 34	-0.132*** (0.024)	-0.096*** (0.022)	-0.114*** (0.025)	-0.114*** (0.025)
White Men Aged 25 to 34	-0.122* (0.047)	-0.1* (0.045)	-0.152*** (0.042)	-0.152*** (0.042)
Black Men Aged 25 to 34	-0.114*** (0.032)	-0.081** (0.029)	-0.074* (0.034)	-0.074* (0.034)
Hispanic Men Aged 25 to 34	-0.16*** (0.041)	-0.103** (0.035)	-0.156*** (0.03)	-0.156*** (0.03)

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Columns (1) and (2) present estimates from stacked Poisson difference-in-differences specification. Columns (3) and (4) present estimates from 2-stage difference-in-differences specification following Gardner (2021). Even numbered columns include covariates, odd numbered columns do not. Observations are weighted by sub-population size with the exception of injecting drug use transmission and MSM transmission, which are weighted by total and total male population, respectively. The outcome for columns (1) and (2) is the sub-population HIV incidence rate per 100,000 and its inverse hyperbolic sine for columns (3) and (4). Estimates are nonlinear and have been exponentiated, standard errors have been transformed using the delta method. Robust standard errors are clustered at the state level.*

Table 2: DiD Estimates for Potential Mechanisms

	Stacked Poisson		Gardner 2-Stage	
	No Controls	Controls	No Controls	Controls
	(1)	(2)	(3)	(4)
Panel A. Medicaid Drug Utilization				
PrEP Prescriptions	0.412* (0.204)	0.33** (0.123)	0.53** (0.195)	0.321* (0.136)
HAART Prescriptions	0.181 (0.15)	0.171 (0.089)	0.28* (0.14)	0.28* (0.14)
Panel B. AIDSvu PrEP Utilization				
PrEP Users	0.044 (0.062)	0.071 (0.053)	0* (0)	0* (0)
Male PrEP Users	-0.004 (0.077)	0.069 (0.047)	0* (0)	0* (0)
Female PrEP Users	0.177* (0.082)	0.174* (0.082)	0 (0)	0 (0)
Aged 13 to 24 PrEP Users	0.018 (0.068)	0.031 (0.071)	0** (0)	0** (0)
Aged 25 to 34 PrEP Users	0.04 (0.068)	0.065 (0.061)	0* (0)	0* (0)
Aged 35 to 44 PrEP Users	0.041 (0.086)	0.116* (0.051)	0* (0)	0* (0)
Aged 45 to 54 PrEP Users	0.03 (0.093)	0.078 (0.072)	0 (0)	0 (0)

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Columns (1) and (2) present estimates from stacked Poisson difference-in-differences specification. Columns (3) and (4) present estimates from 2-stage difference-in-differences specification following Gardner (2021). Even numbered columns include covariates, odd numbered columns do not. Observations are weighted by sub-population size with the exception of Medicaid drug utilization outcomes, which are weighted by state Medicaid enrollment. The outcome for columns (1) and (2) is the outcome rate per 100k and its inverse hyperbolic sine for columns (3) and (4). Estimates are nonlinear and have been exponentiated, standard errors have been transformed using the delta method. Robust standard errors are clustered at the state level.*

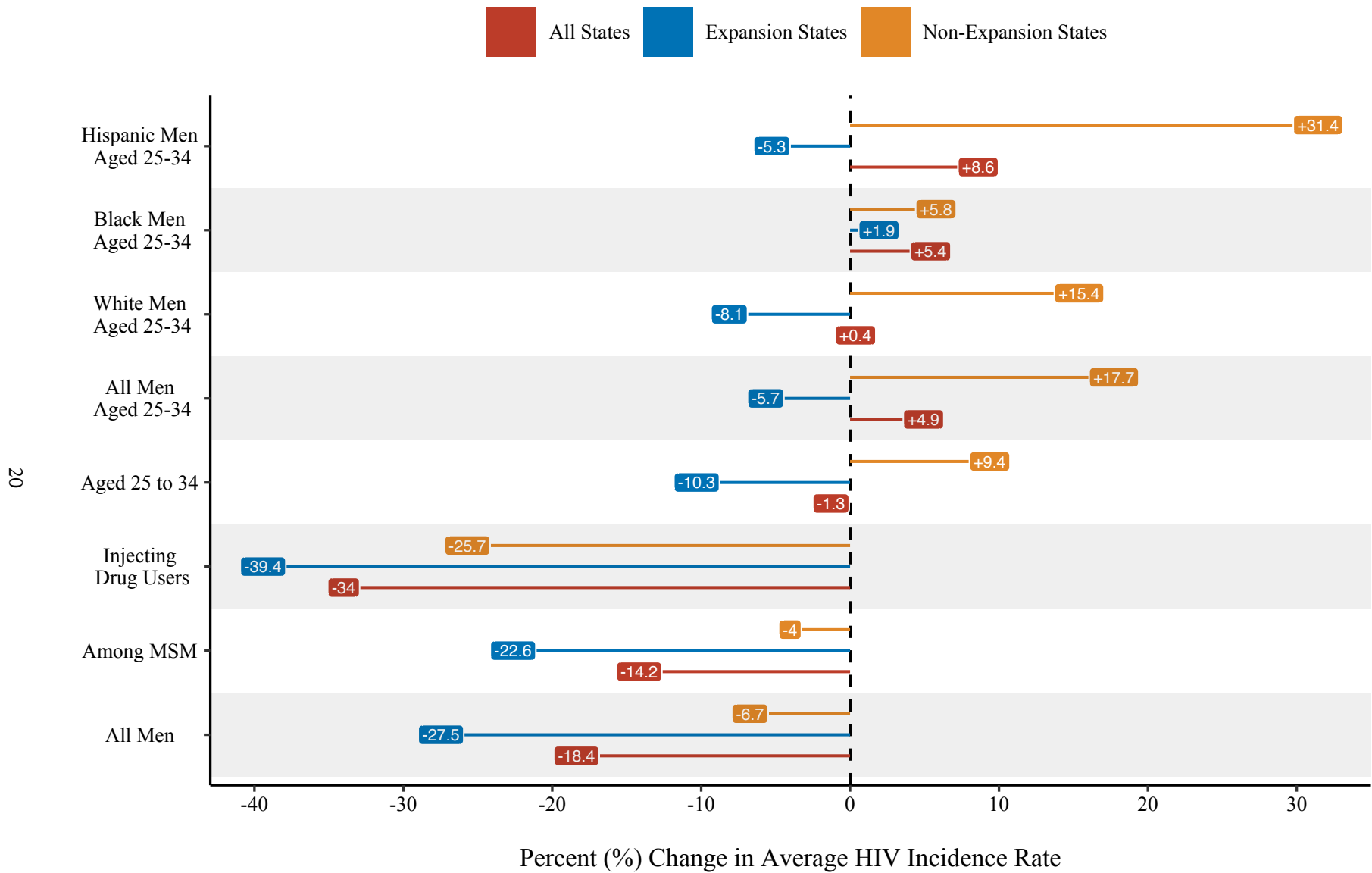


Figure 1: Change in Average HIV Incidence Relative to pre-ACA Rates

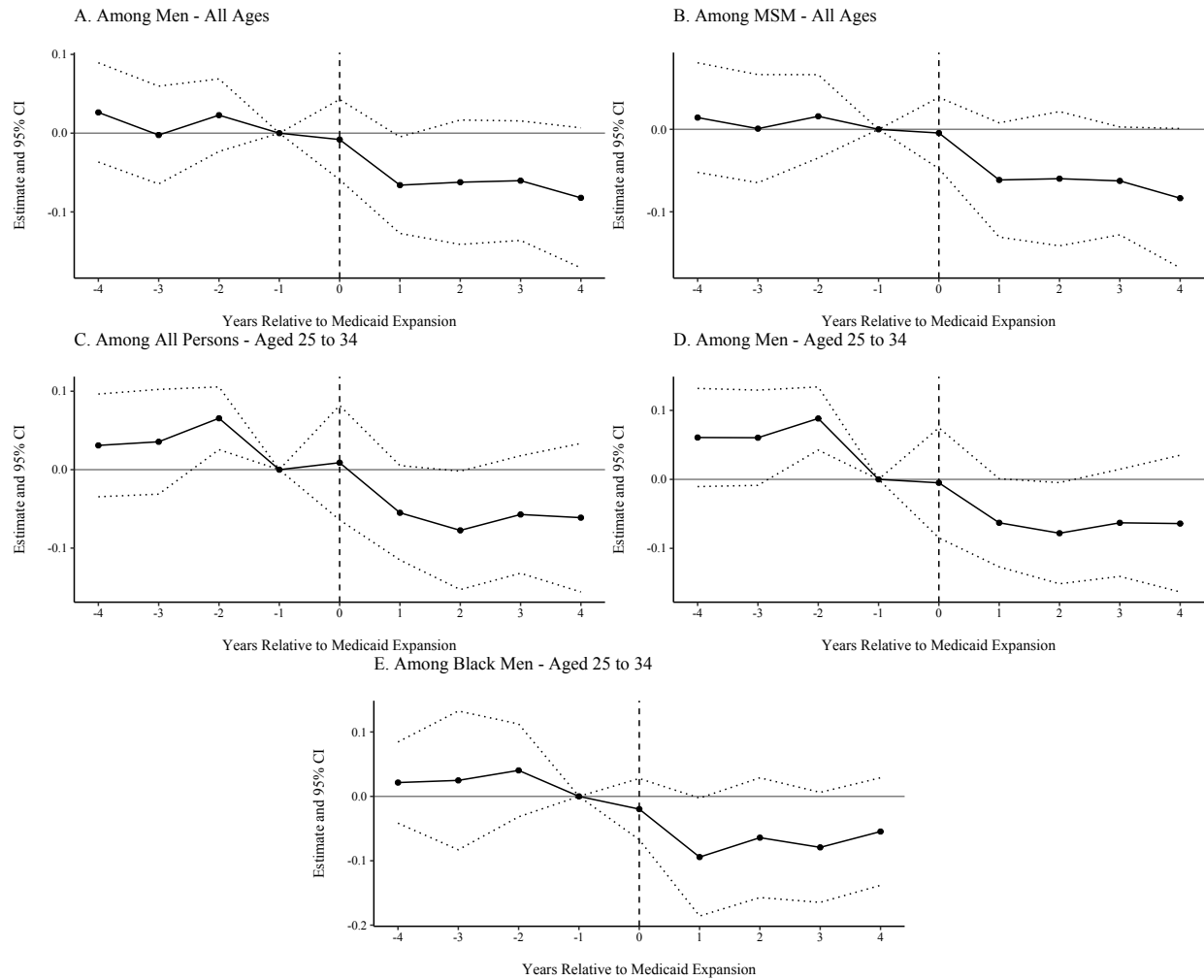


Figure 2: Stacked Event Study Estimates for HIV Incidence

Note: Estimates plotted from stacked event study specification.

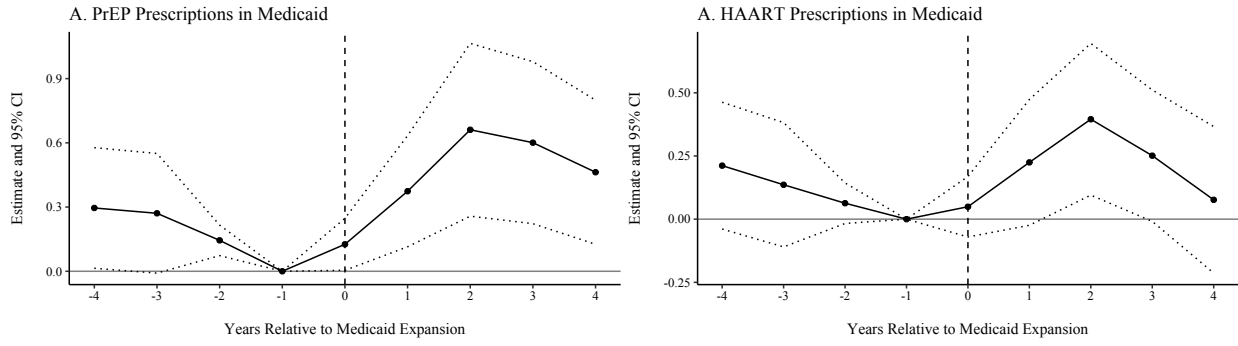


Figure 3: Stacked Event Study Estimates for HIV Incidence

Note: Estimates plotted from stacked event study specification.

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