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Demographic, Clinical Guideline Criteria, Medicaid Expansion and State of Residency: A Multilevel Analysis of PrEP use on a Large US Sample

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3 **Demographic, Clinical Guideline Criteria, Medicaid Expansion and State of Residency: A**
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5 **Multilevel Analysis of PrEP use on a Large US Sample**
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Abstract

Objective: To explore the association of clinical guideline-related variables, demographics and Medicaid expansion on PrEP uptake in one of the largest US sample of MSM and TGNB people ever analyzed.

Methods: We analyzed predictors of current PrEP use using demographic and HIV risk-related variables (level-1), as well as state-level variables (level-2) (i.e, Medicaid Expansion status). We further explored the role state of residence plays in PrEP uptake disparities across the US.

Results: We found that the odds of PrEP use were significantly greater in older age, white, cisgender men. Moreover, individuals who reported recent PEP use, a recent sexually transmitted infection diagnosis and recent drug use were significantly more likely to report PrEP use. Lastly, we found **that** the median odds of PrEP use between similar individuals from different states were 1.40 for the ones living in the Medicaid expansion states, compared to those not living in Medicaid expansion states. State of residence did not play a significant role in explaining PrEP disparities overall.

Conclusion: Our analysis showed that PrEP use is less common in communities standing to benefit the most from it – young MSM and TGNB of color. However, individuals meeting federal guidelines for PrEP were significantly more likely to use PrEP. Though we found a positive association between living in Medicaid expansion states and PrEP use; that variable, as well as one's state of residency, were not suitable to explain variations in PrEP use in the US.

Article summary

Strengths and limitations of this study

1. This study reports on patient-level risk factors of PrEP use in a sample of over 6,000 cisgender men and transgender people who have sex with men across the United States, representing all states.
2. This study uses multi-level modelling analysis to understand the role of state-level predictors alongside individual-level predictors of PrEP use.
3. This study includes the magnitude of clinical guidelines criteria predictors of PrEP use in a US national sample, and the role of Medicaid Expansion on PrEP use.
4. This study was conducted in 2017 and 2018, and the implementation of PrEP across the United States is ever growing and changing.
5. The study uses self-reported cross-sectional data, and causal inference cannot be drawn from the analysis

Introduction

In 2012, the US Food and Drug Administration (FDA) approved the first daily HIV preexposure prophylactic (PrEP) medication in the form of tenofovir disoproxil fumarate and emtricitabine (TDF/FTC).¹ The efficacy of PrEP is unmatched, providing near-universal (i.e., 99%) protection against HIV with proper adherence.²⁻⁴ Following its approval, the CDC estimated that as many as 1.2 million Americans would benefit from taking the regimen.⁶ In 2017, the first official analysis of PrEP data in the United States was published, identifying approximately 80,000 prescriptions filled by unique HIV-negative users by the end of 2016.⁷ The number represents one-fifth of all estimated candidates and about one-quarter of all eligible men who have sex with men (MSM)⁶ – these numbers haven't been updated since, and there is little indication they have significantly improved.

Recent estimations of PrEP use in the general population suggest that as many as 200,000 individuals have initiated PrEP since the 2012 FDA approval through 2020,⁸ a number still lower than expected.⁶ To add complexity to the issue, these numbers represent initiations-only and, for PrEP to be effective, users also need to stay engaged and persist. Researchers in the US have reported PrEP discontinuation rates of up to 60% following six-months of initiation.⁹⁻¹² An analysis of persistence (i.e., continuous use) data using prescription drug records in the US from 2012-2017 found that PrEP persistence was only 14-months on average, and significantly differed by race, age group and insurance status.¹³ Understanding this issue is critical for communities at-risk for HIV, especially Black and Latinx MSM communities. Racial disparities in HIV outcomes are alarming in magnitude in the US with a recent report from the CDC estimating that Black MSM have a 1 in 2 chance of lifetime seroconversion, while Latinos have a 1 in 4.¹⁶ There is an immediate need to develop solutions to mitigate both issues - the overall

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3 uptake and persistence in PrEP, and the observed racial disparity in communities standing to
4 benefit the most from it.
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8 A prominent issue impacting PrEP uptake in the US is coverage, both financial coverage
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10 in the form of health insurance, and geographic coverage in the form of access to a provider who
11 is competent and accepts your medical coverage. Issues related to having health insurance
12 coverage or being able to afford costs associated with medical care are widely reported
13
14 throughout the PrEP literature,¹⁷⁻²⁰ and they relate to an individual inability to pay for costs
15 associated with taking PrEP. However, financial coverage is also managed at the state-level,
16
17 through state-run Medicaid programs and drug assistance programs (DAP), which grant some
18 access and affordability to PrEP. Patients enrolled in Medicaid have mixed levels of PrEP access,
19
20 with enrollees with incomes under 150% of the federal poverty level (FPL) receiving PrEP for
21 nearly free due to federal laws limiting costs.²¹ In 2010, the affordable care act (ACA) provided
22 states with the ability to expand Medicaid programs to adults aged 65 and younger with incomes
23
24 138% of the FPL (about \$17,000 a year) and below.²¹ Several states have chosen to expand
25
26 Medicaid, and reports have linked increases in PrEP use to these expansions,²³⁻²⁵ suggesting that
27 state variation in PrEP use may explain some of the disparities observed in the population at-
28
29 large. Thus far, the issue of Medicaid expansion has only been explored on the aggregate level,
30
31 limiting studies to measures of association which only informs on effect size but not on the
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33 impact of the variable on the distribution of PrEP across communities. Understanding the impact
34
35 of Medicaid expansion on a population-level can support a better understanding of the
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37 complexities in regional disparities in PrEP use, for example, by exploring the association of
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39 Medicaid expansion and racial disparities in PrEP uptake. Furthermore, it seems imperative to
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3 understand whether the state of residency of a particular individual is significant to explain PrEP
4 uptake.
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8 Another limitation of current PrEP use reports in the US is their reliance on pharmacy
9 claims data,⁷ or multiple different sources to obtain estimates,⁸ limiting one's ability to account
10 for confounding variables, like HIV-related risk factors. They also limit a deeper exploration of
11 complex questions by limiting the study unit to a prescription claim, for example, rather than one
12 individual. Though an objective clinical guidance is in place to assess PrEP eligibility, the units
13 of analysis used thus far have been unable to be used to explore the association of these and PrEP
14 uptake. Using the combined the screening/enrollment data from two similar-in-scope U.S.
15 national cohorts, we created one of the largest national samples of MSM and transgender and
16 gender non-binary (TGNB) individuals who have sex with men. Using a mixed-effect multilevel
17 logistic analysis (MLA) approach, we analyzed predictors of current PrEP use using
18 demographic and HIV risk-related variables (level-1), as well as state-level variables (level-2)
19 (i.e, Medicaid Expansion status).
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35 **Methods**

36 **About the studies**

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38 The *Together 5,000* and *UNITE* studies are both U.S. national cohorts longitudinally
39 following sexual and gender minorities at-risk for HIV. Both cohorts are similar in scope,
40 exploring sexual behavior and PrEP uptake. Details on both studies have been described
41 elsewhere.^{26, 27} Briefly, each used advertisements on geospatial sexual networking apps to recruit
42 MSM and TGNB people who have sex with men across the U.S. to enroll in longitudinal
43 assessments. During each study's enrollment phase, app-users were presented with an ad for the
44 study. Those interested were directed to a brief screening (i.e., eligibility) survey on their devices
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3 browser. The present analysis utilizes the reconciled screening data from each study dataset (i.e.,
4 all variables that were identical across both screening surveys). Both studies enrolled samples in
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6 2017 and 2018.
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10 The sample's composition, which was not designed to be nationally representative, is
11 nonetheless one of the largest national surveys of sexual minorities, consisting of 157,035
12 responses, with 27% of the responses being from the *Together 5,000* study and the remainder
13 from *UNITE*. Our current analysis, exploring individual- and state-level predictors of current
14 PrEP use, was limited to individuals not living with HIV, and those residing in one of the 50
15 states, Washington, DC, or Puerto Rico – hereby referred to as “states.” Our decision to limit the
16 analytical sample to these states was based on state-level data availability. Our final sample was
17 inclusive of 123,905 (79%) cisgender men and TGNB people who have sex with men.
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20 21 22 **Individual-level variables (level-1)** 23

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25 **Demographics.** Participants were grouped according to their age (under 18 years old, 18-
26 24 years old, 25-29 years old, 30-49 years old, 50+ years old), gender identity (male, female
27 (assigned male at birth), transgender person, something else), and race/ethnicity (Black, Latinx,
28 white, multiracial, other).
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31 **Current PrEP use.** Participants were asked about their PrEP status and current users
32 were identified based on their self-reported status (current use/not).
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36 **Clinical criteria guideline variables.** In both studies, participants were asked about post-
37 exposure prophylaxis (PEP) use in the prior 12 months, drug use in the past three months (i.e.,
38 cannabis, cocaine, stimulants, methamphetamine, inhalants, sedatives, GHB, MDMA,
39 hallucinogen), and whether they received a sexually transmitted infection (STI) diagnosis (i.e.,
40 syphilis, chlamydia or gonorrhea) in the past 12 months. Based on their answers, we developed
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3 three dichotomous (yes/no) variables indicating their PEP, drug use, and STI experiences within
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5 the timeframes noted.
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7 8 **State-level variables (level-2)**

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10 **Medicaid expansion status.** We created a three-level variable to indicate the state's
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12 Medicaid expansion status as of 2020. We categorized as fully expanded, not expanded, or
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14 conditionally expanded. Conditional expansion includes any alternative Medicaid expansion
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16 model differing from the Affordable Care Act (ACA) format and one state that started expansion
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18 in 2020 (i.e., Nebraska).²⁸
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21 **Patient and Public Involvement**

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24 Patients were not involved in the development of this study
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26 **Ethics Approval Statement**

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28 Procedures for each of the cohort studies, as well as those to merge de-identified datasets
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30 were reviewed and approved by the CUNY Internal Review Board (Protocol number: 2019-
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32 0334).
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37 **Analysis**

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39 Our analysis included a descriptive assessment of our sample's demographics and HIV-
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41 clinical guideline-related variables, as well as a description of state-level variables. Next, we
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43 built a multilevel logistic multivariable mixed-effects regression model predicting current PrEP
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45 use (yes/no), using individual- (level-1) and state-level (level-2) predictors. We calculated the
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47 fixed effects odds ratio and 95% confidence interval of our fixed-effect variables, as well as the
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49 random effect intraclass correlation coefficients (ICC), the median odds ratios (MOR) of each of
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51 our models, and the interval odds ratio (IOR-80) of our fixed-effect level-2 variables – random
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3 effect components were calculated via previously reported equations and methods.^{29, 30} Our
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5 model-building approach was the following, first, we constructed a null model (model 1) in order
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7 to calculate the ICC and determine the variance in PrEP use accounted by an individual's state of
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9 residency. After, we built a model with level-1 variables (model 2) to explore the fixed effects of
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11 individual-level factors on current PrEP use. Finally, we built a full mixed effect multilevel
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13 logistic model (model 3) with all variables in both levels. Our analysis was conducted using the
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15 PROC GLIMMIX procedure with one random effect at the intercept, a binary distribution and a
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17 logit link on SAS 9.4. We used Satterthwaite degrees of freedom. Random effects components
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19 were calculated manually.^{29, 30} Given our large sample size, we analyzed our intervals of
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21 confidence and effect sizes when discussing statistical significance.
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25 26 **Results**

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28 Our US sample varied demographically with over a quarter being under 24 years old,
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30 13% were over 50 years of age, about 1.7% were transgender people, and 40% were either
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32 Black, Latinx or Multiracial. About 8% used PEP in the past 12 months, 60% used drugs in the
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34 past 3 months, and 13% had a positive STI results in the past 12 months. In total, 15% of the
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36 sample were current PrEP users, and the proportion of PrEP use was significantly greater in older
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38 adults (68% v. 51%), white participants (59% v. 53%), people who recently used PEP (23% v
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40 5%), who recently used drugs (74% v. 58%), and those who reported a recent STI diagnosis
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42 (29% v. 10%). Table 1 provides further details about our sample individual-level (level-1)
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44 variables. States-level characteristics (level-2) also varied greatly with about 54% having fully
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46 expanded Medicaid, and 22% having conditionally expanded. We provided this list as an
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48 appendix.
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Table 1. Demographics and Clinical Guideline-related Characteristics of Sample (level-1)

Variables	<i>n</i>	%	<i>Not currently on PrEP</i>		<i>Current PrEP user</i>			
	123905		104330	84%	18126	15%		
Age group							2711	<0.0001
24 & under	32852	26.5%	30694	29%	2158	12%		
25-29	26347	21.3%	22471	22%	3876	21%		
30-49	48904	39.5%	39370	38%	9534	53%		
50+	15802	12.8%	13042	13%	2760	15%		
Gender identity (<i>n</i>=123453)							69.81	<0.0001
Male	105514	85.2%	102827	99%	18034	99%		
Female (Trans woman)	348	0.3%	367	0.4%	21	0.1%		
Transgender Person	1706	1.4%	1759	2%	200	1.1%		
Something else	215	0.2%	225	0.2%	20	0.1%		
Race							280.9	<0.0001
Black	14237	11.5%	12524	12%	1713	9%		
Latinx	23999	19.4%	20894	20%	3105	17%		
White	65941	53.2%	55210	53%	10731	59%		
Multiracial	11845	9.6%	10240	10%	1605	9%		
Other	7883	6.4%	6709	6%	1174	6%		
PEP in past 12 months (<i>n</i>= 123552)							6616	<0.0001
Yes	9713	7.8%	5542	5%	4171	23%		
No	113839	91.9%	99717	96%	14122	78%		
Drug use in past 3 months (<i>n</i>= 122456)							1615	<0.0001
Yes	73837	59.6%	60464	58%	13373	74%		
No	48619	39.2%	43866	42%	4753	26%		
STI diagnosis in past 12 months (<i>n</i> = 122734)							5296	<0.0001
Yes	15605	12.6%	10280	10%	5325	29%		
No	107129	86.5%	94292	90%	12837	71%		

Our regression model results are presented on Table 2, we report here the findings of our model

3. The odds of current PrEP use for all age groups were significantly higher when compared to people 24 years old and younger, with individuals 25-29 having 2.2 greater odds (aOR = 2.21, 95% CI: 2.15 - 2.28), 30-39 having 3.2 greater odds (aOR = 3.20, 95% CI: 3.12 - 3.29) and those 50 years old and older having 2.9 greater odds (aOR = 2.91, 95% CI: 2.82 - 3.01) of current PrEP use. All races had significantly lower odds current PrEP use when compared to white participants, with Black participants having 27% lower odds (aOR = 0.73, 95% CI: 0.71 – 0.76), 26% lower for Latinx (aOR = 0.74, 95% CI: 0.73 – 0.76), and 21% lower for multiracial individuals (aOR = 0.79, 95% CI: 0.76 – 0.81). Those who identified as female (aOR = 0.44, 95% CI: 0.35 – 0.56) or as a transgender person (aOR = 0.71, 95% CI: 0.66 – 0.77) had 66% and 29% significantly lower odds of being current PrEP users than those identifying as male.

Individuals who reported PEP use in the past 12 months (aOR = 3.94, 95% CI: 3.85 – 4.04), drug use in the past 3 months (aOR = 1.73, 95% CI: 1.70 – 1.76) or were diagnosed with an STI in the previous 12 months (aOR = 3.34, 95% CI: 3.27 – 3.42) had significantly greater odds of being current PrEP users. On the state level, individuals living in states with no Medicaid expansion had 31% lower odds of being current PrEP users (aOR = 0.69, 95% CI: 0.54 – 0.88), and those living in conditional Medicaid expansion state had 27% lower odds of being current PrEP users than individuals living in states with full expansion (aOR = 0.73, 95% CI: 0.56 – 0.95). For the states with no expansion (aOR= 0.69) the IOR-80 was between 0.37 – 1.30, and for those conditional expansion (aOR=0.73) it was between 0.39 – 1.38. The median odds of PrEP use between individuals with identical individual characteristics but from different states were 1.40 for the ones living in the Medicaid expansion states, compared to those not living in Medicaid expansion states. Overall, the state of residency accounted for about 6% in the variance of PrEP

use overall, and after accounting for fixed-effects of individuals and Medicaid expansion, it accounts for only 4% of the remaining variance.

Table 2. Multilevel mixed-effects regression predicting current PrEP use

Fixed-Effects Variables	Model 1 (Null)	Model 2	95% CI	Model 3	95% CI
Demographics					
Age group (24 & Under)					
25-29		2.21	(2.09, 2.35)	2.21	(2.15, 2.28)
30-49		3.20	(3.04, 3.37)	3.19	(3.04, 3.37)
50+		2.91	(2.73, 3.1)	2.9	(2.82, 3.01)
Race/Ethnicity (White)					
Black		0.73	(0.69, 0.78)	0.73	(0.71, 0.76)
Latinx		0.75	(0.71, 0.78)	0.74	(0.73, 0.76)
Multiracial		0.79	(0.74, 0.84)	0.79	(0.76, 0.81)
Other		0.82	(0.76, 0.88)	0.82	(0.79, 0.85)
Gender Identity (Male)					
Female (Trans woman)		0.44	(0.28, 0.7)	0.44	(0.35, 0.56)
Something else		0.44	(0.26, 0.73)	0.42	(0.33, 0.56)
Transgender person		0.71	(0.61, 0.84)	0.71	(0.66, 0.77)
Risk Variables					
PEP use in past 12 months (ref: No)		3.94	(3.76, 4.14)	3.94	(3.85, 4.04)
STI diagnosis in past 12 months (ref: No)		3.34	(3.21, 3.48)	3.34	(3.27, 3.42)
Drug use in past 3 months (ref: No)		1.73	(1.67, 1.8)	1.73	(1.7, 1.76)
State-level Variable					
Medicaid Expansion status					
No Expansion				0.69	(0.54, 0.88)
Conditional Expansion				0.73	(0.56, 0.95)
Random Effect Components					
Interval Odds Ratio (IOR-80)					
Medicaid Expansion status					
No Expansion				(0.37 - 1.30)	
Conditional Expansion				(0.39 - 1.38)	
Intercept Variance	0.21	0.15		0.12	
Interclass Correlation Coefficient (ICC)	0.06	0.04		0.04	
Median Odds Ratio (MOR)	1.54	1.45		1.40	

Discussion

In this US national survey with over 120,000 responses, we found that older age, white race, cisgender male identity, and meeting objective criteria per current guidelines were positive predictors of current PrEP use. Previous epidemiologic surveillance reports exploring PrEP uptake in the US using prescription drug data have found similar demographic outcomes.⁷ Furthermore, though a state's Medicaid expansion status significantly predicted the likelihood an individual is currently taking PrEP, these effects were weak across states and did not explain variation in PrEP use in our analysis. Our study represents one of the largest U.S. national samples to explore multilevel predictors of current PrEP use, using individual and risk-related variables, and state-level variables.

Our findings affirmed the demographic disconnect between HIV and PrEP epidemiology in the US. While HIV incidence is disproportionately distributed in Black and Brown MSM and TGNB youth communities,¹⁵ PrEP was most commonly used by older white cisgender men.⁷ These effects persisted without change in effect size after controlling for Medicaid expansion. This contrast cannot be overlooked for the racial inequities in HIV outcomes in the US are historic and enduring. Aside from denying protection to communities who stand to benefit the most from PrEP, demographic inequities in access to HIV prevention interventions can significantly increase the magnitude of this racial inequity. Nevertheless, PrEP use was much more common among those who would have otherwise benefited from its protection most, such as those who had taken PEP, been recently treated for an STI, or reported drug use. This scenario presents a critical consideration to the successes, and possible limitations, of current PrEP guidelines in the US.³¹ The guidelines, set forth by the CDC, have a strong focus on objective risk (i.e., recent bacterial STI, history of inconsistent or no condom use, sharing injection

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3 equipment).³² To that extent, our results demonstrated that guidelines can be successful in
4 translating theory to practice: participants who reported any recent guideline criteria had as much
5 as 3 times the odds of PrEP use than otherwise. However, the persistent demographic disconnect
6 between *who gets HIV* and *who takes PrEP* requires discussing the limitations of recommending
7 PrEP solely based on objective risk. Researchers in the US have previously speculated about the
8 role an extension of guidelines would have in impacting PrEP uptake.³³ Using the premise of
9 determining “good fit” of PrEP for a given patient’s goals, instead of “eligibility” for PrEP they
10 suggest PrEP may be used to reduce HIV-related anxiety during sex and increase inter-partner
11 intimacy.³³ The CDC and other agencies overseeing clinical guidelines should immediately
12 consider heeding such advice. Australia, for example, is considered a model-jurisdiction for
13 PrEP implementation, with several reports associating community PrEP uptake to substantial
14 declines in HIV incidence.^{34, 35} The guidelines for offering PrEP in Australia are much broader
15 and comprehensive than those of the CDC, including reasons for offering PrEP such as “*when a*
16 *person plans to travel during which time they anticipate that they will be having condomless sex*
17 *with casual partners,*” and “*when a person reports being so anxious about HIV infection that it*
18 *may prevent them from having regular HIV testing, or engaging in any form of anal sex.*”³⁶ A
19 more inclusive set of clinical recommendations may have a much greater impact on PrEP uptake
20 than traditional community outreach strategies; agencies and organizations with jurisdiction over
21 these guidelines should consider doing so.

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47 In exploring the role of a state’s Medicaid expansion in predicting current PrEP use, we
48 found mixed results. The median OR (MOR = 1.40) suggests that at least 50% of the odds of
49 PrEP use between multiple pairs of identical individuals living in different states are 40% greater
50 or higher, on average, for individuals living in states with Medicaid expansion. This finding is in
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3 line with previously reported effect estimates of PrEP use in relation to Medicaid expansion.²³⁻²⁵
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5 However, our final model ICC indicated that the state of residency of a given participant
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7 accounted for only 4% of the variance of PrEP use in our analysis, and the IOR-80 for our
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9 Medicaid expansion variables measure of association (i.e., odds ratio) included the null value - 1.
10
11 In MLA, the inclusion of the null value on the IOR-80 indicates that the variable was not
12
13 relevant to understanding the state-level variation in an individual predisposition to use PrEP.³⁰
14
15 Furthermore, the positive MOR observed in our analysis must be understood in light of the small
16
17 ICC presented in our model, though there may have been strong differences between two
18
19 individuals from different states tendency to use PrEP, there was not enough variation between
20
21 states for Medicaid expansion to impact PrEP use. In MLA, the estimate of the ICC is highly
22
23 dependent on the area-level variable variance (e.g, state-level),²⁹ which suggests that perhaps a
24
25 smaller area-level analysis, like zip code or county-level, may be better suited to understand the
26
27 impact of Medicaid expansion on PrEP uptake. Previously reported regional disparities in PrEP
28
29 use seems to suggest this as well. For example, though Medicaid expansion has been associated
30
31 with increased PrEP use, a majority of states have been found to have less than one PrEP-
32
33 providing clinic per 100,000 people.³⁷ A narrower area of analysis, using MLA, may be
34
35 advisable to explore how much geographic region explains disparities in PrEP use, and to
36
37 explore the question about Medicaid expansion more effectively.

44 **Limitations:**

45
46 Our findings must be understood in light of several limitations. First, our data were
47
48 collected via self-report and may be subjected to social desirability bias. Several demographic
49
50 variables that could further influence PrEP use were not measured such as health insurance
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52 status, income, and other social determinants of health. In our analysis we did not control from
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3 insurance type, for example, rather we explored the population-level effect of living in a
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5 Medicaid expansion state. It may be relevant to oversample patients receiving Medicaid and
6
7 control for insurance information in future analysis.
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10 Lastly, the parent studies of our dataset recruited participants using similar strategies that
11
12 may have resulted in the same participants responding to both surveys. We note that we treated
13
14 each individual response as independent. Although we cannot ascertain precisely the amount of
15
16 overlap of participants across surveys, the studies' recruitment strategies utilized multiple
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18 applications platforms, each of which has millions of daily users. Therefore, the relative pool of
19
20 available participants is several times the magnitude of those who actually took our surveys.
21
22

23 **Conclusion:**

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26 Our analysis showed that PrEP use is less common in communities standing to benefit the
27
28 most from it – young MSM and TGNB of color. However, individuals meeting federal
29
30 guidelines for PrEP were significantly more likely to use PrEP. Updating guidelines may provide
31
32 a strong avenue to improve uptake and reduce racial disparities. Additionally, individuals living
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34 in states where Medicaid was expanded were similarly more likely to use PrEP, however we did
35
36 not find that this variable was significant to explain state-level differences in PrEP use.
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5
6

7
8 **Authorship contribution statement**
9

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11 multiples drafts and contributed to each section of the paper. CM performed the initial bivariate
12 analysis, extracted the data, and provided valuable data analysis and variable development
13 feedback. SJ Developed the dataset, conceptualized the variables, and reviewed multiple drafts
14 of the manuscript. JR provided key methodology feedback, and analytical guidance.
15
16

17
18
19 Additionally, JR helped with the interpretation of results.
20
21

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23
24 **Data Sharing Statement**
25

26 No additional data available
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28

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Appendix. State-level (level-2) Medicaid Expansion Status

State	Sample population	Medicaid Expansion Status 2020
Alabama	1,461	Not expanded
Alaska	204	Fully expanded
Arizona	2,791	Conditionally Expanded
Arkansas	830	Conditionally Expanded
California	16,723	Fully expanded
Colorado	2,413	Fully expanded
Connecticut	1,137	Fully expanded
Delaware	340	Fully expanded
District of Columbia	1,072	Fully expanded
Florida	9,654	Not expanded
Georgia	4,311	Not expanded
Hawaii	511	Fully expanded
Idaho	497	Fully expanded
Illinois	5,079	Fully expanded
Indiana	2,098	Conditionally Expanded
Iowa	912	Conditionally Expanded
Kansas	776	Not expanded
Kentucky	1,432	Conditionally Expanded
Louisiana	1,600	Fully expanded
Maine	371	Fully expanded
Maryland	1,944	Fully expanded
Massachusetts	2,816	Fully expanded
Michigan	2,745	Conditionally Expanded
Minnesota	1,739	Fully expanded
Mississippi	744	Not expanded
Missouri	1,807	Not expanded
Montana	308	Fully expanded
Nebraska	594	Conditionally Expanded
Nevada	1,412	Fully expanded
New Hampshire	413	Conditionally Expanded
New Jersey	2,741	Fully expanded
New Mexico	822	Conditionally Expanded
New York	11,010	Fully expanded
North Carolina	3,367	Not expanded
North Dakota	199	Fully expanded
Ohio	3,652	Conditionally Expanded
Oklahoma	1,163	Not expanded
Oregon	1,659	Fully expanded
Pennsylvania	4,192	Fully expanded
Puerto Rico	1,119	Fully expanded
Rhode Island	432	Fully expanded
South Carolina	1,504	Not expanded

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2	South Dakota	192	Not expanded
3	Tennessee	2,005	Not expanded
4	Texas	11,750	Not expanded
5	Utah	1,285	Conditionally Expanded
6	Vermont	193	Fully expanded
7	Virginia	2,757	Fully expanded
8	Washington	2,812	Fully expanded
9	West Virginia	511	Fully expanded
10	Wisconsin	1,641	Not expanded
11	Wyoming	165	Not expanded
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BMJ Open

Demographic, Clinical Guideline Criteria, Medicaid Expansion and State of Residency: A Multilevel Analysis of PrEP use on a Large US Sample

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3 **Demographic, Clinical Guideline Criteria, Medicaid Expansion and State of Residency: A**
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5 **Multilevel Analysis of PrEP use on a Large US Sample**
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Abstract

Objective: To explore the association of clinical guideline-related variables, demographics and Medicaid expansion on PrEP uptake in one of the largest US sample of MSM and TGNB people ever analyzed.

Methods: We analyzed predictors of current PrEP use using demographic and HIV risk-related variables (level-1), as well as state-level variables (level-2) (i.e, Medicaid Expansion status). We further explored the role state of residence plays in PrEP uptake disparities across the US.

Results: We found that the odds of PrEP use were significantly greater in older age, white, cisgender men. Moreover, individuals who reported recent PEP use, a recent sexually transmitted infection diagnosis and recent drug use were significantly more likely to report PrEP use. Lastly, we found **that** the median odds of PrEP use between similar individuals from different states were 1.40 for the ones living in the Medicaid expansion states, compared to those not living in Medicaid expansion states. State of residence did not play a significant role in explaining PrEP disparities overall.

Conclusion: Our analysis showed that PrEP use is less common in communities standing to benefit the most from it – young MSM and TGNB of color. However, individuals meeting federal guidelines for PrEP were significantly more likely to use PrEP. Though we found a positive association between living in Medicaid expansion states and PrEP use; that variable, as well as one's state of residency, were not suitable to explain variations in PrEP use in the US.

Article summary

Strengths and limitations of this study

1. This study reports on patient-level risk factors of PrEP use in a sample of over 6,000 cisgender men and transgender people who have sex with men across the United States, representing all states.
2. This study uses multi-level modelling analysis to understand the role of state-level predictors alongside individual-level predictors of PrEP use.
3. This study includes the magnitude of clinical guidelines criteria predictors of PrEP use in a US national sample, and the role of Medicaid Expansion on PrEP use.
4. This study was conducted in 2017 and 2018, and the implementation of PrEP across the United States is ever growing and changing.
5. The study uses self-reported cross-sectional data, and causal inference cannot be drawn from the analysis

Introduction

In 2012, the US Food and Drug Administration (FDA) approved the first daily HIV preexposure prophylactic (PrEP) medication in the form of tenofovir disoproxil fumarate and emtricitabine (TDF/FTC).¹ Following its approval, the CDC estimated that as many as 1.2 million Americans would benefit from taking the regimen.² By 2017, only approximately 80,000 prescriptions were filled by unique HIV-negative users.³

Recent estimations of PrEP use in the general population suggest that as many as 200,000 individuals have initiated or persisted in PrEP year-over-year since the 2012 FDA approval through 2020,⁴ a number still lower than expected.² Researchers in the US have reported PrEP discontinuation rates of up to 60% following six-months of initiation.⁵⁻⁸ An analysis of persistence (i.e., continuous use) data using prescription drug records in the US from 2012-2017 found that PrEP persistence was only 14-months on average, and significantly differed by race, age group and insurance status.⁹ Understanding this issue is critical for communities at-risk for HIV, especially Black and Latinx MSM communities.¹⁰ A limitation of current PrEP use reports in the US is their reliance on pharmacy claims data,³ or multiple different sources to obtain estimates,⁴ limiting one's ability to account for confounding variables, like HIV-related risk factors. They also limit a deeper exploration of complex questions by limiting the study unit to a prescription claim, for example, rather than one individual. There is an immediate need to develop solutions to mitigate both issues - the overall uptake and persistence in PrEP, and the observed racial disparity in communities standing to benefit the most from it.

A prominent issue impacting PrEP uptake in the US is coverage, both financial coverage in the form of health insurance, and geographic coverage in the form of access to a provider who is competent and accepts your medical coverage. Issues related to having health insurance

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2
3 coverage or being able to afford costs associated with medical care are widely reported
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5 throughout the PrEP literature,¹¹⁻¹⁴ and they relate to an individual inability to pay for costs
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7 associated with taking PrEP. However, financial coverage is also managed at the state-level,
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9 through state-run Medicaid programs and drug assistance programs (DAP), which grant some
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11 access and affordability to PrEP. Patients enrolled in Medicaid have mixed levels of PrEP access,
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13 with enrollees with incomes under 150% of the federal poverty level (FPL) receiving PrEP for
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15 nearly free due to federal laws limiting costs.¹⁵ In 2010, the affordable care act (ACA) provided
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17 states with the ability to expand Medicaid programs to adults aged 65 and younger with incomes
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19 138% of the FPL (about \$17,000 a year) and below.¹⁵ Several states have chosen to expand
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21 Medicaid, and reports have linked increases in PrEP use to these expansions,¹⁶⁻¹⁸ suggesting that
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23 state variation in PrEP use may explain some of the disparities observed in the population at-
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25 large. Thus far, the issue of Medicaid expansion has only been explored on the aggregate level,
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27 limiting studies to measures of association which only informs on effect size but not on the
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29 impact of the variable on the distribution of PrEP across communities. Understanding the impact
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31 of Medicaid expansion on a population-level can support a better understanding of the
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33 complexities in regional disparities in PrEP use, for example, by exploring the association of
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35 Medicaid expansion and racial disparities in PrEP uptake. Furthermore, it seems imperative to
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37 understand whether the state of residency of a particular individual is significant to explain PrEP
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39 uptake.

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42 Using the combined the screening/enrollment data from two similar-in-scope U.S.
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44 national cohorts, we created one of the largest national samples of MSM and transgender and
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46 gender non-binary (TGNB) individuals who have sex with men. Using a mixed-effect multilevel
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48 logistic analysis (MLA) approach, we analyzed predictors of current PrEP use using
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3 demographic and HIV risk-related variables (level-1), as well as state-level variables (level-2)
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5 (i.e, Medicaid Expansion status).
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7 **Methods**

8 **About the studies**

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12 The *Together 5,000* and *UNITE* studies are both U.S. national cohorts longitudinally
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14 following sexual and gender minorities at-risk for HIV. Both cohorts are similar in scope,
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16 exploring sexual behavior and PrEP uptake. Details on both studies have been described
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18 elsewhere.^{19,20} Briefly, each used advertisements on geospatial sexual networking apps to recruit
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20 MSM and TGNB people who have sex with men across the U.S. to enroll in longitudinal
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22 assessments. During each study's enrollment phase, app-users were presented with an ad for the
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24 study. Those interested were directed to a brief screening (i.e., eligibility) survey on their devices
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26 browser. The present analysis utilizes the reconciled screening data from each study dataset (i.e.,
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28 all variables that were identical across both screening surveys). Both studies enrolled samples in
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30 2017 and 2018.
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35 The sample's composition, which was not designed to be nationally representative, is
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37 nonetheless one of the largest national surveys of sexual minorities, consisting of 157,035
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39 responses, with 27% of the responses being from the *Together 5,000* study and the remainder
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41 from *UNITE*. Our current analysis, exploring individual- and state-level predictors of current
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43 PrEP use, was limited to individuals not living with HIV, and those residing in one of the 50
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45 states, Washington, DC, or Puerto Rico – hereby referred to as “states.” Our decision to limit the
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47 analytical sample to these states was based on state-level data availability. Our final sample was
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49 inclusive of 123,905 (79%) cisgender men and TGNB people who have sex with men.
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53 **Individual-level variables (level-1)**

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3 **Demographics.** Participants were grouped according to their age (under 24 years old, 25-
4 29 years old, 30-49 years old, 50+ years old), gender identity (male, female (assigned male at
5 birth), transgender person, something else), and race/ethnicity (Black, Latinx, white, multiracial,
6 other).
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12 **Current PrEP use.** Participants were asked about their PrEP status and current users
13 were identified based on their self-reported status (current use/not).
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16 **Clinical criteria guideline variables.** In both studies, participants were asked about post-
17 exposure prophylaxis (PEP) use in the prior 12 months, drug use in the past three months (i.e.,
18 cannabis, cocaine, stimulants, methamphetamine, inhalants, sedatives, GHB, MDMA,
19 hallucinogen), and whether they received a sexually transmitted infection (STI) diagnosis (i.e.,
20 syphilis, chlamydia or gonorrhea) in the past 12 months. Based on their answers, we developed
21 three dichotomous (yes/no) variables indicating their PEP, drug use, and STI experiences within
22 the timeframes noted.
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33 **State-level variables (level-2)**

34 **Medicaid expansion status.** We created a three-level variable to indicate the state's
35 Medicaid expansion status as of 2020. We categorized as fully expanded, not expanded, or
36 conditionally expanded. Conditional expansion includes any alternative Medicaid expansion
37 model differing from the Affordable Care Act (ACA) format and one state that started expansion
38 in 2020 (i.e., Nebraska).²¹
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46 **Patient and Public Involvement**

47 Patients were not involved in the development of this study
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51 **Ethics Approval Statement**

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3 Procedures for each of the cohort studies, as well as those to merge de-identified datasets
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5 were reviewed and approved by the CUNY Internal Review Board (Protocol number: 2019-
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7 0334).
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10 11 12 **Analysis** 13

14 Our analysis included a descriptive assessment of our sample's demographics and HIV-
15 clinical guideline-related variables, as well as a description of state-level variables. Next, we
16 built a multilevel logistic multivariable mixed-effects regression model predicting current PrEP
17 use (yes/no), using individual- (level-1) and state-level (level-2) predictors. We calculated the
18 fixed effects odds ratio and 95% confidence interval of our fixed-effect variables, as well as the
19 random effect intraclass correlation coefficients (ICC), the median odds ratios (MOR) of each of
20 our models, and the interval odds ratio (IOR-80) of our fixed-effect level-2 variables – random
21 effect components were calculated via previously reported equations and methods.^{22,23} Our
22 model-building approach was the following, first, we constructed a null model (model 1) in order
23 to calculate the ICC and determine the variance in PrEP use accounted by an individual's state of
24 residency. After, we built a model with level-1 variables (model 2) to explore the fixed effects of
25 individual-level factors on current PrEP use. Finally, we built a full mixed effect multilevel
26 logistic model (model 3) with all variables in both levels. Our analysis was conducted using the
27 PROC GLIMMIX procedure with one random effect at the intercept, a binary distribution and a
28 logit link on SAS 9.4. We used Satterthwaite degrees of freedom. Random effects components
29 were calculated manually.^{22,23} Given our large sample size, we analyzed our intervals of
30 confidence and effect sizes when discussing statistical significance.
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53 54 **Results** 55 56 57 58 59 60

Our US sample varied demographically with over a quarter being under 24 years old, 13% were over 50 years of age, about 1.7% were transgender people, and 40% were either Black, Latinx or Multiracial. About 8% used PEP in the past 12 months, 60% used drugs in the past 3 months, and 13% had a positive STI results in the past 12 months. In total, 15% of the sample were current PrEP users, and the proportion of PrEP use was significantly greater in adults older than 29 y.o. (68% v. 51%), white participants (59% v. 53%), people who recently used PEP (23% v 5%), who recently used drugs (74% v. 58%), and those who reported a recent STI diagnosis (29% v. 10%). Table 1 provides further details about our sample individual-level (level-1) variables. States-level characteristics (level-2) also varied greatly with about 54% having fully expanded Medicaid, and 22% having conditionally expanded. We provided this list as an appendix.

Table 1. Demographics and Clinical Guideline-related Characteristics of National Sample of Cisgender Men and Transgender People who have Sex with Men (level-1)

Variables	<i>n</i>	%	<i>Not currently on PrEP</i>		<i>Current PrEP user</i>			
	123905		104330	84%	18126	15%		
Age group							2711	<0.0001
24 & under	32852	26.5%	30694	29%	2158	12%		
25-29	26347	21.3%	22471	22%	3876	21%		
30-49	48904	39.5%	39370	38%	9534	53%		
50+	15802	12.8%	13042	13%	2760	15%		
Gender identity (<i>n</i>=123453)							69.81	<0.0001
Male	120861	97.9%	102827	99%	18034	99%		
Female (Trans woman)	388	0.3%	367	0.4%	21	0.1%		
Transgender Person	1959	1.6%	1759	2%	200	1.1%		
Something else	245	0.2%	225	0.2%	20	0.1%		
Race							280.9	<0.0001
Black	14237	11.5%	12524	12%	1713	9%		

Latinx	23999	19.4%	20894	20%	3105	17%	
White	65941	53.2%	55210	53%	10731	59%	
Multiracial	11845	9.6%	10240	10%	1605	9%	
Other	7883	6.4%	6709	6%	1174	6%	
PEP in past 12 months (n= 123552)							6616 <0.0001
Yes	9713	7.8%	5542	5%	4171	23%	
No	113839	91.9%	99717	96%	14122	78%	
Drug use in past 3 months (n= 122456)							1615 <0.0001
Yes	73837	59.6%	60464	58%	13373	74%	
No	48619	39.2%	43866	42%	4753	26%	
STI diagnosis in past 12 months (n = 122734)							5296 <0.0001
Yes	15605	12.6%	10280	10%	5325	29%	
No	107129	86.5%	94292	90%	12837	71%	

Our regression model results are presented on Table 2, we report here the findings of our model

3. The odds of current PrEP use for all age groups were significantly higher when compared to people 24 years old and younger, with individuals 25-29 having 2.2 greater odds (aOR = 2.21, 95% CI: 2.15 - 2.28), 30-39 having 3.2 greater odds (aOR = 3.20, 95% CI: 3.12 - 3.29) and those 50 years old and older having 2.9 greater odds (aOR = 2.91, 95% CI: 2.82 - 3.01) of current PrEP use. All races had significantly lower odds current PrEP use when compared to white participants, with Black participants having 27% lower odds (aOR = 0.73, 95% CI: 0.71 – 0.76), 26% lower for Latinx (aOR = 0.74, 95% CI: 0.73 – 0.76), and 21% lower for multiracial individuals (aOR = 0.79, 95% CI: 0.76 – 0.81). Those who identified as female (aOR = 0.44, 95% CI: 0.35 – 0.56) or as a transgender person (aOR = 0.71, 95% CI: 0.66 – 0.77) had 66% and 29% significantly lower odds of being current PrEP users than those identifying as male.

Individuals who reported PEP use in the past 12 months (aOR = 3.94, 95% CI: 3.85 – 4.04), drug use in the past 3 months (aOR = 1.73, 95% CI: 1.70 – 1.76) or were diagnosed with an STI in the previous 12 months (aOR = 3.34, 95% CI: 3.27 – 3.42) had significantly greater odds of being current PrEP users. On the state level, individuals living in states with no Medicaid expansion had 31% lower odds of being current PrEP users (aOR = 0.69, 95% CI: 0.54 – 0.88), and those living in conditional Medicaid expansion state had 27% lower odds of being current PrEP users than individuals living in states with full expansion (aOR = 0.73, 95% CI: 0.56 – 0.95). For the states with no expansion (aOR= 0.69) the IOR-80 was between 0.37 – 1.30, and for those conditional expansion (aOR=0.73) it was between 0.39 – 1.38. The median odds of PrEP use between individuals with identical individual characteristics but from different states were 1.40 for the ones living in the Medicaid expansion states, compared to those not living in Medicaid expansion states. Overall, the state of residency accounted for about 6% in the variance of PrEP

use overall, and after accounting for fixed-effects of individuals and Medicaid expansion, it accounts for only 4% of the remaining variance.

Table 2. Multilevel Mixed-Effects Regression Models Predicting Current PrEP Use

Fixed-Effects Variables	Model 1 (Null)	Model 2	95% CI	Model 3	95% CI
Demographics					
Age group (24 & Under)					
25-29		2.21	(2.09, 2.35)	2.21	(2.15, 2.28)
30-49		3.20	(3.04, 3.37)	3.19	(3.04, 3.37)
50+		2.91	(2.73, 3.1)	2.9	(2.82, 3.01)
Race/Ethnicity (White)					
Black		0.73	(0.69, 0.78)	0.73	(0.71, 0.76)
Latinx		0.75	(0.71, 0.78)	0.74	(0.73, 0.76)
Multiracial		0.79	(0.74, 0.84)	0.79	(0.76, 0.81)
Other		0.82	(0.76, 0.88)	0.82	(0.79, 0.85)
Gender Identity (Male)					
Female (Trans woman)		0.44	(0.28, 0.7)	0.44	(0.35, 0.56)
Something else		0.44	(0.26, 0.73)	0.42	(0.33, 0.56)
Transgender person		0.71	(0.61, 0.84)	0.71	(0.66, 0.77)
Risk Variables					
PEP use in past 12 months (ref: No)		3.94	(3.76, 4.14)	3.94	(3.85, 4.04)
STI diagnosis in past 12 months (ref: No)		3.34	(3.21, 3.48)	3.34	(3.27, 3.42)
Drug use in past 3 months (ref: No)		1.73	(1.67, 1.8)	1.73	(1.7, 1.76)
State-level Variable					
Medicaid Expansion status					
No Expansion				0.69	(0.54, 0.88)
Conditional Expansion				0.73	(0.56, 0.95)
Random Effect Components					
Interval Odds Ratio (IOR-80)					
Medicaid Expansion status					
No Expansion				(0.37 - 1.30)	
Conditional Expansion				(0.39 - 1.38)	
Intercept Variance	0.21	0.15		0.12	
Interclass Correlation Coefficient (ICC)	0.06	0.04		0.04	
Median Odds Ratio (MOR)	1.54	1.45		1.40	

Discussion

In this US national survey with over 120,000 responses, we found that older age, white race, cisgender male identity, and meeting objective criteria per current guidelines were positive predictors of current PrEP use. Previous epidemiologic surveillance reports exploring PrEP uptake in the US using prescription drug data have found similar demographic outcomes.³ Furthermore, though a state's Medicaid expansion status significantly predicted the likelihood an individual is currently taking PrEP, these effects were weak across states and did not explain variation in PrEP use in our analysis. Our study represents one of the largest U.S. national samples to explore multilevel predictors of current PrEP use, using individual and risk-related variables, and state-level variables.

Our findings affirmed the demographic disconnect between HIV and PrEP epidemiology in the US. While HIV incidence is disproportionately distributed in Black and Brown MSM and TGNB youth communities,²⁴ PrEP was most commonly used by older white cisgender men.³ These effects persisted without change in effect size after controlling for Medicaid expansion. This contrast cannot be overlooked for the racial inequities in HIV outcomes in the US are historic and enduring. Aside from denying protection to communities who stand to benefit the most from PrEP, demographic inequities in access to HIV prevention interventions can significantly increase the magnitude of this racial inequity. Nevertheless, PrEP use was much more common among those who would have otherwise benefited from its protection most, such as those who had taken PEP, been recently treated for an STI, or reported drug use. This scenario presents a critical consideration to the successes, and possible limitations, of current PrEP guidelines in the US.²⁵ The guidelines, set forth by the CDC, have a strong focus on objective risk (i.e., recent bacterial STI, history of inconsistent or no condom use, sharing injection

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3 equipment).²⁶ To that extent, our results demonstrated that guidelines can be successful in
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5 translating theory to practice: participants who reported any recent guideline criteria had as much
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7 as 3 times the odds of PrEP use than otherwise. However, the persistent demographic disconnect
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9 between *who gets HIV* and *who takes PrEP* requires discussing the limitations of recommending
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11 PrEP solely based on objective risk. Researchers in the US have previously speculated about the
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13 role an extension of guidelines would have in impacting PrEP uptake.²⁷ Using the premise of
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15 determining “good fit” of PrEP for a given patient’s goals, instead of “eligibility” for PrEP they
16
17 suggest PrEP may be used to reduce HIV-related anxiety during sex and increase inter-partner
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19 intimacy.²⁷ The CDC and other agencies overseeing clinical guidelines should immediately
20
21 consider heeding such advice. Australia, for example, is considered a model-jurisdiction for
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23 PrEP implementation, with several reports associating community PrEP uptake to substantial
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25 declines in HIV incidence.^{28,29} The guidelines for offering PrEP in Australia are much broader
26
27 and comprehensive than those of the CDC, including reasons for offering PrEP such as “*when a*
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29 *person plans to travel during which time they anticipate that they will be having condomless sex*
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31 *with casual partners,”* and “*when a person reports being so anxious about HIV infection that it*
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33 *may prevent them from having regular HIV testing, or engaging in any form of anal sex.*”³⁰ A
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35 more inclusive set of clinical recommendations may have a much greater impact on PrEP uptake
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37 than traditional community outreach strategies; agencies and organizations with jurisdiction over
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39 these guidelines should consider doing so.

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42 In exploring the role of a state’s Medicaid expansion in predicting current PrEP use, we
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44 found mixed results. The median OR (MOR = 1.40) suggests that at least 50% of the odds of
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46 PrEP use between multiple pairs of identical individuals living in different states are 40% greater
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48 or higher, on average, for individuals living in states with Medicaid expansion. This finding is in
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3 line with previously reported effect estimates of PrEP use in relation to Medicaid expansion.¹⁶⁻¹⁸
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5 However, our final model ICC indicated that the state of residency of a given participant
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7 accounted for only 4% of the variance of PrEP use in our analysis, and the IOR-80 for our
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9 Medicaid expansion variables measure of association (i.e., odds ratio) included the null value - 1.
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11 In MLA, the inclusion of the null value on the IOR-80 indicates that the variable was not
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13 relevant to understanding the state-level variation in an individual predisposition to use PrEP.²³
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15 Furthermore, the positive MOR observed in our analysis must be understood in light of the small
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17 ICC presented in our model, though there may have been strong differences between two
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19 individuals from different states tendency to use PrEP, there was not enough variation between
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21 states for Medicaid expansion to impact PrEP use. In MLA, the estimate of the ICC is highly
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23 dependent on the area-level variable variance (e.g, state-level),²² which suggests that perhaps a
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25 smaller area-level analysis, like zip code or county-level, may be better suited to understand the
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27 impact of Medicaid expansion on PrEP uptake. Previously reported regional disparities in PrEP
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29 use seems to suggest this as well. For example, though Medicaid expansion has been associated
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31 with increased PrEP use, a majority of states have been found to have less than one PrEP-
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33 providing clinic per 100,000 people.³¹ A narrower area of analysis, using MLA, may be
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35 advisable to explore how much geographic region explains disparities in PrEP use, and to
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37 explore the question about Medicaid expansion more effectively.
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44 **Limitations:**

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46 Our findings must be understood in light of several limitations. First, our data were
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48 collected via self-report and may be subjected to social desirability bias. Several demographic
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50 variables that could further influence PrEP use were not measured such as health insurance
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52 status, income, and other social determinants of health. Further, our outcome variable (current
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3 PrEP use) In our analysis we did not control from insurance type, for example, rather we
4 explored the population-level effect of living in a Medicaid expansion state. It may be relevant to
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6 oversample patients receiving Medicaid and control for insurance information in future analysis.
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10 The time our data was collected (2017-2018) is an additional limitation, and the relevance
11 of the findings to the field of PrEP uptake might seem none. We call the reader's attention to the
12 wholesome numbers of PrEP users reported in the United States – approximately 200,000 – a
13 stagnant number since then until now.⁸ We believe our findings provide some value to the
14 question as to whether Medicaid expansion, as a variable, has an impact on an individual
15 decision to start PrEP.
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24 Lastly, the parent studies of our dataset recruited participants using similar strategies that
25 may have resulted in the same participants responding to both surveys. We note that we treated
26 each individual response as independent. Although we cannot ascertain precisely the amount of
27 overlap of participants across surveys, the studies' recruitment strategies utilized multiple
28 applications platforms, each of which has millions of daily users. Therefore, the relative pool of
29 available participants is several times the magnitude of those who actually took our surveys.
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38 **Conclusion:**

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40 Our analysis showed that PrEP use is less common in communities standing to benefit the
41 most from it – young MSM and TGNB of color. However, individuals meeting federal
42 guidelines for PrEP were significantly more likely to use PrEP. Updating guidelines may provide
43 a strong avenue to improve uptake and reduce racial disparities. Additionally, individuals living
44 in states where Medicaid was expanded were similarly more likely to use PrEP, however we did
45 not find that this variable was significant to explain state-level differences in PrEP use.
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For peer review only

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5
6

7
8 **Authorship contribution statement**
9

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11 multiples drafts and contributed to each section of the paper. CM performed the initial bivariate
12 analysis, extracted the data, and provided valuable data analysis and variable development
13 feedback. SJ Developed the dataset, conceptualized the variables, and reviewed multiple drafts
14 of the manuscript. JR provided key methodology feedback, and analytical guidance.
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19 Additionally, JR helped with the interpretation of results.
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24 **Data Sharing Statement**
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26 No additional data available
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29 **Author(s') disclosure statement(s)**
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31 All authors report no conflict of interest.
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Appendix. State-level (level-2) Medicaid Expansion Status

State	Sample population	Medicaid Expansion Status 2020
Alabama	1,461	Not expanded
Alaska	204	Fully expanded
Arizona	2,791	Conditionally Expanded
Arkansas	830	Conditionally Expanded
California	16,723	Fully expanded
Colorado	2,413	Fully expanded
Connecticut	1,137	Fully expanded
Delaware	340	Fully expanded
District of Columbia	1,072	Fully expanded
Florida	9,654	Not expanded
Georgia	4,311	Not expanded
Hawaii	511	Fully expanded
Idaho	497	Fully expanded
Illinois	5,079	Fully expanded
Indiana	2,098	Conditionally Expanded
Iowa	912	Conditionally Expanded
Kansas	776	Not expanded
Kentucky	1,432	Conditionally Expanded
Louisiana	1,600	Fully expanded
Maine	371	Fully expanded
Maryland	1,944	Fully expanded
Massachusetts	2,816	Fully expanded
Michigan	2,745	Conditionally Expanded
Minnesota	1,739	Fully expanded
Mississippi	744	Not expanded
Missouri	1,807	Not expanded
Montana	308	Fully expanded
Nebraska	594	Conditionally Expanded
Nevada	1,412	Fully expanded
New Hampshire	413	Conditionally Expanded
New Jersey	2,741	Fully expanded
New Mexico	822	Conditionally Expanded
New York	11,010	Fully expanded
North Carolina	3,367	Not expanded
North Dakota	199	Fully expanded
Ohio	3,652	Conditionally Expanded
Oklahoma	1,163	Not expanded
Oregon	1,659	Fully expanded
Pennsylvania	4,192	Fully expanded
Puerto Rico	1,119	Fully expanded
Rhode Island	432	Fully expanded
South Carolina	1,504	Not expanded

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2	South Dakota	192	Not expanded
3	Tennessee	2,005	Not expanded
4	Texas	11,750	Not expanded
5	Utah	1,285	Conditionally Expanded
6	Vermont	193	Fully expanded
7	Virginia	2,757	Fully expanded
8	Washington	2,812	Fully expanded
9	West Virginia	511	Fully expanded
10	Wisconsin	1,641	Not expanded
11	Wyoming	165	Not expanded
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Demographic, Clinical Guideline Criteria, Medicaid Expansion and State of Residency: A Multilevel Analysis of PrEP use on a Large US Sample

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1

1 **Demographic, Clinical Guideline Criteria, Medicaid Expansion and State of Residency: A**

2 **Multilevel Analysis of PrEP use on a Large US Sample**

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43 prevention

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Abstract

Objective: To explore the association of clinical guideline-related variables, demographics and Medicaid expansion on PrEP uptake in one of the largest US sample of MSM and TGNB people ever analyzed.

Methods: We cross-sectionally analyzed predictors of current PrEP use using demographic and HIV risk-related variables (level-1), as well as state-level variables (level-2) (i.e, Medicaid Expansion status). We further explored the role state of residence plays in PrEP uptake disparities across the US.

Results: We found that the odds of PrEP use were significantly greater in older age, white, cisgender men. Moreover, individuals who reported recent PEP use, a recent sexually transmitted infection diagnosis and recent drug use were significantly more likely to report PrEP use. Lastly, we found **that** the median odds of PrEP use between similar individuals from different states were 1.40 for the ones living in the Medicaid expansion states, compared to those not living in Medicaid expansion states. State of residence did not play a significant role in explaining PrEP disparities overall.

Conclusion: Our analysis showed that PrEP use is less common in communities standing to benefit the most from it – young MSM and TGNB of color. However, individuals meeting federal guidelines for PrEP were significantly more likely to use PrEP. Though we found a positive association between living in Medicaid expansion states and PrEP use; that variable, as well as one's state of residency, were not suitable to explain variations in PrEP use in the US.

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Article summary

Strengths and limitations of this study

1. This study reports on patient-level risk factors of PrEP use in a sample of over 6,000 cisgender men and transgender people who have sex with men across the United States, representing all states.
2. This study uses multi-level modelling analysis to understand the role of state-level medicaid-expansion alongside individual-level predictors of PrEP use.
3. This study includes the magnitude of clinical guidelines criteria predictors of PrEP use in a US national sample, and the role of Medicaid expansion on PrEP use.
4. This study was conducted in 2017 and 2018, and the implementation of PrEP across the United States is ever growing and changing.
5. The study uses self-reported cross-sectional data, and causal inference cannot be drawn from the analysis

4

58 Introduction

59 In 2012, the US Food and Drug Administration (FDA) approved the first daily HIV
60 preexposure prophylactic (PrEP) medication in the form of tenofovir disoproxil fumarate and
61 emtricitabine (TDF/FTC).¹ Following its approval, the CDC estimated that as many as 1.2
62 million Americans would benefit from taking the regimen.² By 2017, only approximately 80,000
63 prescriptions were filled by unique HIV-negative users.³

64 Recent estimations of PrEP use in the general population suggest that as many as 200,000
65 individuals have initiated or persisted in PrEP year-over-year since the 2012 FDA approval
66 through 2020,⁴ a number still lower than expected.² Researchers in the US have reported PrEP
67 discontinuation rates of up to 60% following six-months of initiation.⁵⁻⁸ An analysis of
68 persistence (i.e., continuous use) data using prescription drug records in the US from 2012-2017
69 found that PrEP persistence was only 14-months on average, and significantly differed by race,
70 age group and insurance status.⁹ Understanding this issue is critical for communities at-risk for
71 HIV, especially Black and Latinx MSM communities.¹⁰ A limitation of current PrEP use reports
72 in the US is their reliance on pharmacy claims data,³ or multiple different sources to obtain
73 estimates,⁴ limiting one's ability to account for confounding variables, like HIV-related risk
74 factors. They also limit a deeper exploration of complex questions by limiting the study unit to a
75 prescription claim, for example, rather than one individual. There is an immediate need to
76 develop solutions to mitigate both issues - the overall uptake and persistence in PrEP, and the
77 observed racial disparity in communities standing to benefit the most from it.

78 A prominent issue impacting PrEP uptake in the US is coverage, both financial coverage
79 in the form of health insurance, and geographic coverage in the form of access to a provider who
80 is competent and accepts your medical coverage. Issues related to having health insurance

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3 81 coverage or being able to afford costs associated with medical care are widely reported
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5 82 throughout the PrEP literature,¹¹⁻¹⁴ and they relate to an individual inability to pay for costs
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8 83 associated with taking PrEP. However, financial coverage is also managed at the state-level,
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10 84 through state-run Medicaid programs and drug assistance programs (DAP), which grant some
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12 85 access and affordability to PrEP. Patients enrolled in Medicaid have mixed levels of PrEP access,
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14 86 with enrollees with incomes under 150% of the federal poverty level (FPL) receiving PrEP for
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16 87 nearly free due to federal laws limiting costs.¹⁵ In 2010, the affordable care act (ACA) provided
17
18 88 states with the ability to expand Medicaid programs to adults aged 65 and younger with incomes
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20 89 138% of the FPL (about \$17,000 a year) and below.¹⁵ Several states have chosen to expand
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22 90 Medicaid, and reports have linked increases in PrEP use to these expansions,¹⁶⁻¹⁸ suggesting that
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24 91 state variation in PrEP use may explain some of the disparities observed in the population at-
25
26 92 large. Thus far, the issue of Medicaid expansion has only been explored on the aggregate level,
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28 93 limiting studies to measures of association which only informs on effect size but not on the
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30 94 impact of the variable on the distribution of PrEP across communities. Understanding the impact
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32 95 of Medicaid expansion on a population-level can support a better understanding of the
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34 96 complexities in regional disparities in PrEP use, for example, by exploring the association of
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36 97 Medicaid expansion and racial disparities in PrEP uptake. Furthermore, it seems imperative to
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38 98 understand whether the state of residency of a particular individual is significant to explain PrEP
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40 99 uptake.

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47 100 Using the combined the screening/enrollment data from two similar-in-scope U.S.
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49 101 national cohorts, we created one of the largest national samples of MSM and transgender and
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51 102 gender non-binary (TGNB) individuals who have sex with men. Using a mixed-effect multilevel
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53 103 logistic analysis (MLA) approach, we analyzed predictors of current PrEP use using
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104 demographic and HIV risk-related variables (level-1), as well as state-level variables (level-2)
105 (i.e, Medicaid Expansion status).

106 **Methods**

107 **About the studies**

108 The *Together 5,000* and *UNITE* studies are both U.S. national cohorts longitudinally
109 following sexual and gender minorities at-risk for HIV. Both cohorts are similar in scope,
110 exploring sexual behavior and PrEP uptake. Details on both studies have been described
111 elsewhere.^{19,20} Briefly, each used advertisements on geospatial sexual networking apps to recruit
112 MSM and TGNB people who have sex with men across the U.S. to enroll in longitudinal
113 assessments. During each study's enrollment phase, app-users were presented with an ad for the
114 study. Those interested were directed to a brief screening (i.e., eligibility) survey on their devices
115 browser. The present analysis utilizes the reconciled screening data from each study dataset (i.e.,
116 all variables that were identical across both screening surveys). Both studies enrolled samples in
117 2017 and 2018.

118 The sample's composition, which was not designed to be nationally representative, is
119 nonetheless one of the largest national surveys of sexual minorities, consisting of 157,035
120 responses, with 27% of the responses being from the *Together 5,000* study and the remainder
121 from *UNITE*. Our current analysis, exploring individual- and state-level predictors of current
122 PrEP use, was limited to individuals not living with HIV, and those residing in one of the 50
123 states, Washington, DC, or Puerto Rico – hereby referred to as “states.” Our decision to limit the
124 analytical sample to these states was based on state-level data availability. Our final sample was
125 inclusive of 123,905 (79%) cisgender men and TGNB people who have sex with men.

126 **Individual-level variables (level-1)**

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3 127 **Demographics.** Participants were grouped according to their age (under 24 years old, 25-
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5 128 29 years old, 30-49 years old, 50+ years old), gender identity (male, female (assigned male at
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7 129 birth), transgender person, something else), and race/ethnicity (Black, Latinx, white, multiracial,
8
9 130 other).

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12 131 **Current PrEP use.** Participants were asked about their PrEP status and current users
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14 132 were identified based on their self-reported status (current use/not).

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17 133 **Clinical criteria guideline variables.** In both studies, participants were asked about post-
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19 134 exposure prophylaxis (PEP) use in the prior 12 months, drug use in the past three months (i.e.,
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21 135 cannabis, cocaine, stimulants, methamphetamine, inhalants, sedatives, GHB, MDMA,
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23 136 hallucinogen), and whether they received a sexually transmitted infection (STI) diagnosis (i.e.,
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25 137 syphilis, chlamydia or gonorrhea) in the past 12 months. Based on their answers, we developed
26
27 138 three dichotomous (yes/no) variables indicating their PEP, drug use, and STI experiences within
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29 139 the timeframes noted.

30 31 32 33 140 **State-level variables (level-2)**

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35 141 **Medicaid expansion status.** We created a three-level variable to indicate the state's
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37 142 Medicaid expansion status as of 2020. We categorized as fully expanded, not expanded, or
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39 143 conditionally expanded. Conditional expansion includes any alternative Medicaid expansion
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41 144 model differing from the Affordable Care Act (ACA) format and one state that started expansion
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43 145 in 2020 (i.e., Nebraska).²¹

44 45 46 47 146 **Patient and Public Involvement**

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49 147 Patients were not involved in the development of this study

50 51 148 **Ethics Approval Statement**

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3 149 Procedures for each of the cohort studies, as well as those to merge de-identified datasets
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5 150 were reviewed and approved by the CUNY Internal Review Board (Protocol number: 2019-
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153 **Analysis**

154 Our analysis included a descriptive assessment of our sample's demographics and HIV-
155 clinical guideline-related variables, as well as a description of state-level variables. Next, we
156 built a multilevel logistic multivariable mixed-effects regression model predicting current PrEP
157 use (yes/no), using individual- (level-1) and state-level (level-2) predictors. We calculated the
158 fixed effects odds ratio and 95% confidence interval of our fixed-effect variables, as well as the
159 random effect intraclass correlation coefficients (ICC), the median odds ratios (MOR) of each of
160 our models, and the interval odds ratio (IOR-80) of our fixed-effect level-2 variables – random
161 effect components were calculated via previously reported equations and methods.^{22,23} Our
162 model-building approach was the following, first, we constructed a null model (model 1) in order
163 to calculate the ICC and determine the variance in PrEP use accounted by an individual's state of
164 residency. After, we built a model with level-1 variables (model 2) to explore the fixed effects of
165 individual-level factors on current PrEP use. Finally, we built a full mixed effect multilevel
166 logistic model (model 3) with all variables in both levels. Our analysis was conducted using the
167 PROC GLIMMIX procedure with one random effect at the intercept, a binary distribution and a
168 logit link on SAS 9.4. We used Satterthwaite degrees of freedom. Random effects components
169 were calculated manually.^{22,23} Given our large sample size, we analyzed our intervals of
170 confidence and effect sizes when discussing statistical significance.

171 **Results**

9

172 Our US sample varied demographically with over a quarter being under 24 years old,
 173 13% were over 50 years of age, about 1.7% were transgender people, and 40% were either
 174 Black, Latinx or Multiracial. About 8% used PEP in the past 12 months, 60% used drugs in the
 175 past 3 months, and 13% had a positive STI results in the past 12 months. In total, 15% of the
 176 sample were current PrEP users, and the proportion of PrEP use was significantly greater in
 177 adults older than 29 y.o. (68% v. 51%), white participants (59% v. 53%), people who recently
 178 used PEP (23% v 5%), who recently used drugs (74% v. 58%), and those who reported a recent
 179 STI diagnosis (29% v. 10%). Table 1 provides further details about our sample individual-level
 180 (level-1) variables. States-level characteristics (level-2) also varied greatly with about 54%
 181 having fully expanded Medicaid, and 22% having conditionally expanded. We provided this list
 182 as an appendix (See Supplement 1).

Table 1. Demographics and Clinical Guideline-related Characteristics of National Sample of Cisgender Men and Transgender People who have Sex with Men (level-1)

Variables	<i>n</i>	%	<i>Not currently on PrEP</i>		<i>Current PrEP user</i>			
	123905		104330	84%	18126	15%		
Age group							2711	<0.0001
24 & under	32852	26.5%	30694	29%	2158	12%		
25-29	26347	21.3%	22471	22%	3876	21%		
30-49	48904	39.5%	39370	38%	9534	53%		
50+	15802	12.8%	13042	13%	2760	15%		
Gender identity (<i>n</i>=123453)							69.81	<0.0001
Male	120861	97.9%	102827	99%	18034	99%		
Female (Trans woman)	388	0.3%	367	0.4%	21	0.1%		
Transgender Person	1959	1.6%	1759	2%	200	1.1%		
Something else	245	0.2%	225	0.2%	20	0.1%		
Race							280.9	<0.0001
Black	14237	11.5%	12524	12%	1713	9%		

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Latinx	23999	19.4%	20894	20%	3105	17%	
White	65941	53.2%	55210	53%	10731	59%	
Multiracial	11845	9.6%	10240	10%	1605	9%	
Other	7883	6.4%	6709	6%	1174	6%	
PEP in past 12 months (n= 123552)							6616 <0.0001
Yes	9713	7.8%	5542	5%	4171	23%	
No	113839	91.9%	99717	96%	14122	78%	
Drug use in past 3 months (n= 122456)							1615 <0.0001
Yes	73837	59.6%	60464	58%	13373	74%	
No	48619	39.2%	43866	42%	4753	26%	
STI diagnosis in past 12 months (n = 122734)							5296 <0.0001
Yes	15605	12.6%	10280	10%	5325	29%	
No	107129	86.5%	94292	90%	12837	71%	

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3 185 Our regression model results are presented on Table 2, we report here the findings of our model
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5 186 3. The odds of current PrEP use for all age groups were significantly higher when compared to
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7 187 people 24 years old and younger, with individuals 25-29 having 2.2 greater odds (aOR = 2.21,
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9 188 95% CI: 2.15 - 2.28), 30-39 having 3.2 greater odds (aOR = 3.20, 95% CI: 3.12 - 3.29) and those
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11 189 50 years old and older having 2.9 greater odds (aOR = 2.91, 95% CI: 2.82 - 3.01) of current PrEP
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13 190 use. All races had significantly lower odds current PrEP use when compared to white
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15 191 participants, with Black participants having 27% lower odds (aOR = 0.73, 95% CI: 0.71 – 0.76),
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17 192 26% lower for Latinx (aOR = 0.74, 95% CI: 0.73 – 0.76), and 21% lower for multiracial
18
19 193 individuals (aOR = 0.79, 95% CI: 0.76 – 0.81). Those who identified as female (aOR = 0.44,
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21 194 95% CI: 0.35 – 0.56) or as a transgender person (aOR = 0.71, 95% CI: 0.66 – 0.77) had 66% and
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23 195 29% significantly lower odds of being current PrEP users than those identifying as male.
24
25 196 Individuals who reported PEP use in the past 12 months (aOR = 3.94, 95% CI: 3.85 – 4.04), drug
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27 197 use in the past 3 months (aOR = 1.73, 95% CI: 1.70 – 1.76) or were diagnosed with an STI in the
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29 198 previous 12 months (aOR = 3.34, 95% CI: 3.27 – 3.42) had significantly greater odds of being
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31 199 current PrEP users. On the state level, individuals living in states with no Medicaid expansion
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33 200 had 31% lower odds of being current PrEP users (aOR = 0.69, 95% CI: 0.54 – 0.88), and those
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35 201 living in conditional Medicaid expansion state had 27% lower odds of being current PrEP users
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37 202 than individuals living in states with full expansion (aOR = 0.73, 95% CI: 0.56 – 0.95). For the
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39 203 states with no expansion (aOR= 0.69) the IOR-80 was between 0.37 – 1.30, and for those
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41 204 conditional expansion (aOR=0.73) it was between 0.39 – 1.38. The median odds of PrEP use
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43 205 between individuals with identical individual characteristics but from different states were 1.40
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45 206 for the ones living in the Medicaid expansion states, compared to those not living in Medicaid
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47 207 expansion states. Overall, the state of residency accounted for about 6% in the variance of PrEP
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208 use overall, and after accounting for fixed-effects of individuals and Medicaid expansion, it
 209 accounts for only 4% of the remaining variance.

Table 2. Multilevel Mixed-Effects Regression Models Predicting Current PrEP Use

Fixed-Effects Variables	Model 1 (Null)	Model 2	95% CI	Model 3	95% CI
Demographics					
Age group (24 & Under)					
25-29		2.21	(2.09, 2.35)	2.21	(2.15, 2.28)
30-49		3.20	(3.04, 3.37)	3.19	(3.04, 3.37)
50+		2.91	(2.73, 3.1)	2.9	(2.82, 3.01)
Race/Ethnicity (White)					
Black		0.73	(0.69, 0.78)	0.73	(0.71, 0.76)
Latinx		0.75	(0.71, 0.78)	0.74	(0.73, 0.76)
Multiracial		0.79	(0.74, 0.84)	0.79	(0.76, 0.81)
Other		0.82	(0.76, 0.88)	0.82	(0.79, 0.85)
Gender Identity (Male)					
Female (Trans woman)		0.44	(0.28, 0.7)	0.44	(0.35, 0.56)
Something else		0.44	(0.26, 0.73)	0.42	(0.33, 0.56)
Transgender person		0.71	(0.61, 0.84)	0.71	(0.66, 0.77)
Risk Variables					
PEP use in past 12 months (ref: No)		3.94	(3.76, 4.14)	3.94	(3.85, 4.04)
STI diagnosis in past 12 months (ref: No)		3.34	(3.21, 3.48)	3.34	(3.27, 3.42)
Drug use in past 3 months (ref: No)		1.73	(1.67, 1.8)	1.73	(1.7, 1.76)
State-level Variable					
Medicaid Expansion status					
No Expansion				0.69	(0.54, 0.88)
Conditional Expansion				0.73	(0.56, 0.95)
Random Effect Components					
Interval Odds Ratio (IOR-80)					
Medicaid Expansion status					
No Expansion				(0.37 -	1.30)
Conditional Expansion				(0.39 -	1.38)
Intercept Variance	0.21	0.15		0.12	
Interclass Correlation Coefficient (ICC)	0.06	0.04		0.04	
Median Odds Ratio (MOR)	1.54	1.45		1.40	

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211 Discussion

212 In this US national survey with over 120,000 responses, we found that older age, white
213 race, cisgender male identity, and meeting objective criteria per current guidelines were positive
214 predictors of current PrEP use. Previous epidemiologic surveillance reports exploring PrEP
215 uptake in the US using prescription drug data have found similar demographic outcomes.³
216 Furthermore, though a state's Medicaid expansion status significantly predicted the likelihood an
217 individual is currently taking PrEP, these effects were weak across states and did not explain
218 variation in PrEP use in our analysis. Our study represents one of the largest U.S. national
219 samples to explore multilevel predictors of current PrEP use, using individual and risk-related
220 variables, and state-level variables.

221 Our findings affirmed the demographic disconnect between HIV and PrEP epidemiology
222 in the US. While HIV incidence is disproportionately distributed in Black and Brown MSM and
223 TGNB youth communities,²⁴ PrEP was most commonly used by older white cisgender men.³
224 These effects persisted without change in effect size after controlling for Medicaid expansion.
225 This contrast cannot be overlooked for the racial inequities in HIV outcomes in the US are
226 historic and enduring. Aside from denying protection to communities who stand to benefit the
227 most from PrEP, demographic inequities in access to HIV prevention interventions can
228 significantly increase the magnitude of this racial inequity. Nevertheless, PrEP use was much
229 more common among those who would have otherwise benefited from its protection most, such
230 as those who had taken PEP, been recently treated for an STI, or reported drug use. This scenario
231 presents a critical consideration to the successes, and possible limitations, of current PrEP
232 guidelines in the US.²⁵ The guidelines, set forth by the CDC, have a strong focus on objective
233 risk (i.e., recent bacterial STI, history of inconsistent or no condom use, sharing injection

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3 234 equipment).²⁶ To that extent, our results demonstrated that guidelines can be successful in
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5 235 translating theory to practice: participants who reported any recent guideline criteria had as much
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8 236 as 3 times the odds of PrEP use than otherwise. However, the persistent demographic disconnect
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10 237 between *who gets HIV* and *who takes PrEP* requires discussing the limitations of recommending
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12 238 PrEP solely based on objective risk. Researchers in the US have previously speculated about the
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14 239 role an extension of guidelines would have in impacting PrEP uptake.²⁷ Using the premise of
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16 240 determining “good fit” of PrEP for a given patient’s goals, instead of “eligibility” for PrEP they
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18 241 suggest PrEP may be used to reduce HIV-related anxiety during sex and increase inter-partner
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20 242 intimacy.²⁷ The CDC and other agencies overseeing clinical guidelines should immediately
21
22 243 consider heeding such advice. Australia, for example, is considered a model-jurisdiction for
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24 244 PrEP implementation, with several reports associating community PrEP uptake to substantial
25
26 245 declines in HIV incidence.^{28,29} The guidelines for offering PrEP in Australia are much broader
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28 246 and comprehensive than those of the CDC, including reasons for offering PrEP such as “*when a*
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30 247 *person plans to travel during which time they anticipate that they will be having condomless sex*
31
32 248 *with casual partners,*” and “*when a person reports being so anxious about HIV infection that it*
33
34 249 *may prevent them from having regular HIV testing, or engaging in any form of anal sex.*”³⁰ A
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36 250 more inclusive set of clinical recommendations may have a much greater impact on PrEP uptake
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38 251 than traditional community outreach strategies; agencies and organizations with jurisdiction over
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40 252 these guidelines should consider doing so.

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42 253 In exploring the role of a state’s Medicaid expansion in predicting current PrEP use, we
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44 254 found mixed results. Appendix 1 provides a detailed description of the state-level sample and
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46 255 some important demographic breakdown, as well as each state’s Medicaid expansion status at the
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48 256 time of the study. The median OR (MOR = 1.40) suggests that at least 50% of the odds of PrEP
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3 257 use between multiple pairs of identical individuals living in different states are 40% greater or
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6 258 higher, on average, for individuals living in states with Medicaid expansion. This finding is in
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8 259 line with previously reported effect estimates of PrEP use in relation to Medicaid expansion.¹⁶⁻¹⁸
9
10 260 However, our final model ICC indicated that the state of residency of a given participant
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12 261 accounted for only 4% of the variance of PrEP use in our analysis, and the IOR-80 for our
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14 262 Medicaid expansion variables measure of association (i.e., odds ratio) included the null value - 1.
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17 263 In MLA, the inclusion of the null value on the IOR-80 indicates that the variable was not
18
19 264 relevant to understanding the state-level variation in an individual predisposition to use PrEP.²³
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21 265 Furthermore, the positive MOR observed in our analysis must be understood in light of the small
22
23 266 ICC presented in our model, though there may have been strong differences between two
24
25 267 individuals from different states tendency to use PrEP, there was not enough variation between
26
27 268 states for Medicaid expansion to impact PrEP use. In MLA, the estimate of the ICC is highly
28
29 269 dependent on the area-level variable variance (e.g. state-level),²² which suggests that perhaps a
30
31 270 smaller area-level analysis, like zip code or county-level, may be better suited to understand the
32
33 271 impact of Medicaid expansion on PrEP uptake. Previously reported regional disparities in PrEP
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35 272 use seems to suggest this as well. For example, though Medicaid expansion has been associated
36
37 273 with increased PrEP use, a majority of states have been found to have less than one PrEP-
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39 274 providing clinic per 100,000 people.³¹ A narrower area of analysis, using MLA, may be
40
41 275 advisable to explore how much geographic region explains disparities in PrEP use, and to
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43 276 explore the question about Medicaid expansion more effectively. The latter analysis, in fact,
44
45 277 provides a better health equity framing to our question, because communities of color often live
46
47 278 in smaller enclaves, and using the entire of a state area may dissolve the true impact of the state's
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49 279 policy in these communities.
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280 Limitations:

281 Our findings must be understood in light of several limitations. First, our data were
282 collected via self-report and may be subjected to social desirability bias. Several demographic
283 variables that could further influence PrEP use were not measured such as health insurance
284 status, income, and other social determinants of health. Further, our outcome variable (current
285 PrEP use) In our analysis we did not control from insurance type, for example, rather we
286 explored the population-level effect of living in a Medicaid expansion state. It may be relevant to
287 oversample patients receiving Medicaid and control for insurance information in future analysis.

288 The time our data was collected (2017-2018) is an additional limitation, and the relevance
289 of the findings to the field of PrEP uptake might seem none. We call the reader's attention to the
290 wholesome numbers of PrEP users reported in the United States – approximately 200,000 – a
291 stagnant number since then until now.⁸ We believe our findings provide some value to the
292 question as to whether Medicaid expansion, as a variable, has an impact on an individual
293 decision to start PrEP.

294 Lastly, the parent studies of our dataset recruited participants using similar strategies that
295 may have resulted in the same participants responding to both surveys. We note that we treated
296 each individual response as independent. Although we cannot ascertain precisely the amount of
297 overlap of participants across surveys, the studies' recruitment strategies utilized multiple
298 applications platforms, each of which has millions of daily users. Therefore, the relative pool of
299 available participants is several times the magnitude of those who actually took our surveys.

300 Conclusion:

301 Our analysis showed that PrEP use is less common in communities standing to benefit the
302 most from it – young MSM and TGNB of color. However, individuals meeting federal

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3 303 guidelines for PrEP were significantly more likely to use PrEP. Updating guidelines may provide
4
5 304 a strong avenue to improve uptake and reduce racial disparities. Additionally, individuals living
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7 305 in states where Medicaid was expanded were similarly more likely to use PrEP, however we did
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9 306 not find that this variable was significant to explain state-level differences in PrEP use.
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3 318 **Acknowledgements:** We are thankful to participants for their time as well as other members of
4
5 319 the *Together 5000* study team. We gratefully acknowledge the contributions of all our
6
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10
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12
13 323 contributions of Dr. Mark Pandori and the Alameda County Public Health Laboratory. We would
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16
17 325 collection for this study was conducted at Hunter College of the City University of New York
18
19 326 (CUNY), and affiliations reflect authors' institutions at the time of the most recent manuscript
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21 327 submission, which were not directly involved in the human subjects' portion of the research.

22 328 **Authorship contribution statement**

23
24 329 PC, and CG conceptualized the paper, with PC performing the main analysis - both reviewed
25
26 330 multiples drafts and contributed to each section of the paper. CM performed the initial bivariate
27
28 331 analysis, extracted the data, and provided valuable data analysis and variable development
29
30 332 feedback. SJ Developed the dataset, conceptualized the variables, and reviewed multiple drafts
31
32 333 of the manuscript. JR provided key methodology feedback, and analytical guidance.
33
34 334 Additionally, JR helped with the interpretation of results.

35 335 **Data Sharing Statement**

36 336 No additional data available

37 337 **Author(s') disclosure statement(s)**

38 338 All authors report no conflict of interest.

39 339 **Funding statement**

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4
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6
7 343 Human Development, and National Institute on Drug Abuse (UG3/UH3-AI133674, PI: Rendina).
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Appendix. State-level (level-2) Medicaid Expansion Status

State	Sample population	Medicaid Expansion Status 2020
Alabama	1,461	Not expanded
Alaska	204	Fully expanded
Arizona	2,791	Conditionally Expanded
Arkansas	830	Conditionally Expanded
California	16,723	Fully expanded
Colorado	2,413	Fully expanded
Connecticut	1,137	Fully expanded
Delaware	340	Fully expanded
District of Columbia	1,072	Fully expanded
Florida	9,654	Not expanded
Georgia	4,311	Not expanded
Hawaii	511	Fully expanded
Idaho	497	Fully expanded
Illinois	5,079	Fully expanded
Indiana	2,098	Conditionally Expanded
Iowa	912	Conditionally Expanded
Kansas	776	Not expanded
Kentucky	1,432	Conditionally Expanded
Louisiana	1,600	Fully expanded
Maine	371	Fully expanded
Maryland	1,944	Fully expanded
Massachusetts	2,816	Fully expanded
Michigan	2,745	Conditionally Expanded
Minnesota	1,739	Fully expanded
Mississippi	744	Not expanded
Missouri	1,807	Not expanded
Montana	308	Fully expanded
Nebraska	594	Conditionally Expanded
Nevada	1,412	Fully expanded
New Hampshire	413	Conditionally Expanded
New Jersey	2,741	Fully expanded
New Mexico	822	Conditionally Expanded
New York	11,010	Fully expanded
North Carolina	3,367	Not expanded
North Dakota	199	Fully expanded
Ohio	3,652	Conditionally Expanded
Oklahoma	1,163	Not expanded
Oregon	1,659	Fully expanded
Pennsylvania	4,192	Fully expanded
Puerto Rico	1,119	Fully expanded
Rhode Island	432	Fully expanded
South Carolina	1,504	Not expanded
South Dakota	192	Not expanded

1			
2	Tennessee	2,005	Not expanded
3	Texas	11,750	Not expanded
4	Utah	1,285	Conditionally Expanded
5	Vermont	193	Fully expanded
6	Virginia	2,757	Fully expanded
7	Washington	2,812	Fully expanded
8	West Virginia	511	Fully expanded
9	Wisconsin	1,641	Not expanded
10	Wyoming	165	Not expanded
11			
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	Age group				Race/Ethnicity		
	24 and under	25-29	30-49	50+	Black	Latino	White
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3							
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5							
6	446	301	561	153	389	70	884
7	41	47	90	26	11	13	101
8	785	602	1,048	356	144	773	1,352
9	225	172	318	115	107	52	571
10							
11	4,454	3,662	6,605	2,002	1,181	5,435	5,912
12	575	566	995	277	140	468	1,407
13							
14	309	230	403	195	120	184	675
15	83	57	138	62	64	34	208
16	201	262	484	125	208	129	563
17							
18	2,439	1,867	3,746	1,602	1,089	2,658	4,746
19	1,116	956	1,713	526	1,233	380	2,193
20	92	91	230	98	12	45	140
21							
22	151	110	180	56	1	89	352
23	1,263	1,108	2,060	648	669	978	2,735
24	632	401	759	306	215	154	1,520
25							
26	247	66	367	132	46	65	707
27	242	173	276	85	59	87	519
28	399	303	562	168	132	62	1,129
29	435	352	667	173	357	132	954
30							
31	78	82	141	70	9	16	319
32	521	423	762	238	448	233	939
33							
34	724	612	1,052	428	214	407	1,671
35	745	531	1,095	374	325	179	1,920
36	450	349	717	223	91	140	1,206
37	203	168	267	106	222	15	461
38	509	340	703	255	183	90	1,367
39							
40	85	62	134	27	11	17	236
41	192	121	194	87	38	72	428
42	362	287	586	177	136	355	647
43							
44	88	62	172	91	15	25	339
45	730	496	1,044	471	330	521	1,423
46	221	173	345	83	17	381	223
47							
48	2,608	2,554	4,591	1,257	1,337	2,042	5,521
49	965	732	1,279	391	702	331	1,940
50	57	36	83	23	10	10	145
51	901	780	1,455	516	435	168	2,670
52							
53	314	205	505	139	91	98	697
54	356	345	750	208	60	226	108
55	1,153	899	1,574	566	437	355	2,909
56	285	219	492	123	26	49	292
57							
58	106	94	160	72	8	807	28
59	427	287	566	224	365	95	907
60	51	43	74	24	7	11	135

1							
2	514	465	788	238	267	120	1,434
3	3,600	2,567	4,438	1,145	1,464	4,383	4,291
4	363	280	532	110	27	182	888
5	57	29	77	30	6	16	153
6	814	601	1,005	337	483	308	1,539
7	644	623	1,203	342	122	354	170
8	127	99	211	74	28	11	441
9	421	349	643	228	145	1,453	1,179
10	46	36	64	20	1	21	121
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y	Multiracial	Other
6	69	49
7	40	39
8	366	156
9	61	39
11	2,343	1,852
12	289	109
13	98	60
15	19	15
16	80	92
17	817	344
18	295	210
20	123	191
21	44	11
22	396	301
24	140	69
25	51	43
26	71	40
27	77	32
29	107	50
30	12	15
32	194	130
33	277	247
34	199	122
35	147	155
37	27	19
38	104	63
39	19	25
41	43	13
42	167	107
43	26	8
45	241	223
46	118	83
47	1,192	918
48	232	162
50	14	20
51	266	113
52	124	153
53	196	96
55	294	197
56	40	25
58	262	14
59	90	47
60	21	18

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2	127	57
3	1,064	548
4	122	66
5	8	10
6		
7	248	179
8	355	261
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60STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page and line number
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Page 2 Line 25
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2 Line 21-40
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4-5 Lines 59-99
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 5 Lines 100 - 105
Methods			
Study design	4	Present key elements of study design early in the paper	Page 6 Lines 108-117
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 6 Lines 118-125
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	Page 6 Lines 121-124
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 7 Lines 127 - 145
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 7 Lines 127 - 145
Bias	9	Describe any efforts to address potential sources of bias	Page 8 Lines 161-165
Study size	10	Explain how the study size was arrived at	Page 6 Lines 119 -125
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 8 Lines 154 - 170
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page 8 Lines 154 - 170
		(b) Describe any methods used to examine subgroups and interactions	N/A
		(c) Explain how missing data were addressed	N/A
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(e) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-	Page 6 Lines 121-124 + Table 1

		up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 Page 9 Lines 172 - 182
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Table2
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 11 Lines 185- 209
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 13 Lines 212 -220
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 16 Lines 279 - 297
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 13,14,15 Lines 221 - 277
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 16 Lines 279 – 285
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 18 Line 329 - 332

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.