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State Health Policies and Interest in PrEP: Evidence from Google Trends

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Abstract

This study investigated the association between interest in Pre-exposure Prophylaxis (PrEP) in the US using Google Health Trends as a source of big data and state policy variables of Medicaid expansions under the Affordable Care Act (ACA) and initiation of PrEP Assistance Programs (PrEP-AP). As of December 2019, thirty-three states and the District of Columbia have accepted federal Medicaid funding provided through the ACA to expand eligibility to low-income adults. Among these expansion states, eight states also implemented PrEP-AP, a program that finances PrEP. A difference-in-differences approach estimated how changes in Google search for PrEP before and after the expansion differed across expansion and non-expansion states. Analyses also gauged whether the magnitude of the correlation between Medicaid expansions and Google searches was higher in states that also initiated PrEP-AP. Findings indicated that the Medicaid expansions were associated with a higher share of Google searches for PrEP keywords ($\beta = 1.536$, S.E. =.36, $p < .001$). Moreover, the magnitude of correlation for some keywords was higher in states that also implemented PrEP-APs.

Keywords

HIV; Pre-exposure Prophylaxis (PrEP); HIV Prevention; Google Trends; Medicaid Expansion

Introduction

Although Pre-exposure Prophylaxis (PrEP) is one of the pillars to end the HIV pandemic, levels of adoption have been disappointing (Finlayson et al., 2019). PrEP is prescribed for individuals who are HIV-negative and who are at risk of exposure to HIV and has established efficacy in preventing infection (Grant et al., 2014). Although PrEP adoption increased from 8,768 when introduced in 2012 to 100,282 in 2018 (Sullivan et al., 2018), it is still remarkably underutilized among 1.23 million people who could benefit from it (Smith et al., 2015). The lack of adoption may be due in part to PrEP's high cost and lack of health insurance in populations that need PrEP (Patel et al., 2017). Although programs such as Gilead's Advancing Access Program (NASTAD, 2020) were launched to provide free

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PrEP to uninsured individuals (Kay & Pinto, 2020), recent evidence suggest that insurance expansions were associated with higher use of PrEP (FayazFarkhad et al., 2021; Siegler et al., 2020). In this light, are PrEP assistance programs effective in improving interest in PrEP when they are combined with broader insurance access? Do they increase interest in obtaining information about PrEP above and beyond the effects of having health insurance? To answer these questions, we used Google searches, one source of big data used as a proxy for interest in information about PrEP, to examine whether the increase in search queries for PrEP varied across states that expanded Medicaid and/or initiated PrEP Assistance Programs (PrEP-AP) versus other states.

Although interest (i.e., the motivation to know about a subject matter) in PrEP is not sufficient for PrEP uptake, interest is a necessary step to awareness. Awareness has been emphasized as a first step in the PrEP continuum (Pérez-Figueroa et al., 2015), and seeking information about behavior is a key to implementing that behavior (Middlestadt et al., 1995; Noguchi et al., 2007), particularly for new products. For example, individuals who engage in unprotected sex and want to find information about PrEP may search for “HIV prevention pill”, “Truvada”, and “PrEP” on the Google search engine. After finding positive information online, they may visit their health care providers and obtain a prescription. Often, however, the availability of health care may be a *prerequisite* to searching for information about PrEP. First, individuals may become aware of PrEP during a visit to their providers. After all, primary care physicians are advised to screen their patients for HIV infection and to provide behavioral counseling for persons at risk (AHRQ, 2014). Second, individuals may search for information if and only if they believe that they will have access to PrEP should they be interested. In this sense, the availability of health insurance may facilitate learning about PrEP altogether, leading to Medicaid expansions and PrEP-APs to ultimately increase interest in PrEP.

Medicaid access may increase interest in PrEP because health insurance reduces out-of-pocket costs and increases contact with healthcare providers. Because federal laws limit copayments to nominal amounts, PrEP is nearly free for low-income individuals (KFF, 2020a; Kay & Pinto, 2020). Traditionally, however, only a limited group of low-income individuals (i.e., pregnant women, adults with disabilities, and very low-income parents) were covered by Medicaid. A provision of the ACA (Affordable Care Act) expanded Medicaid eligibility to all individuals with income less than 138% of the federal poverty line. Even though the original legislation of ACA was planned for all states, the states’ eligibility expansion became optional. Hence, as of December 2019, 33 states and the District of Columbia expanded their Medicaid, and 16 states did not.

Although Medicaid facilitates access to PrEP by covering the associated costs, its benefits are limited to low-income individuals. Therefore, several states have created PrEP-APs to assist with at least one of the following costs: medication costs, copay costs, clinical visits, and laboratory testing costs (NASTAD, 2020). Among the expansion states, 8 also implemented PrEP-AP between 2014 and 2019. In contrast, none of the non-expansion states had implemented PrEP-AP by the end of our study period. Figure 1 shows the timeline of the expansions and PrEP-APs and suggests this variation across states and over time may help to assess the correlation between state policies and interest in PrEP.

Prior studies have mostly used surveys to measure people's interest in PrEP (Kuehn, 2019; Petroll et al., 2017; Yusuf et al., 2020). However, this approach requires a vast amount of resources and is infeasible for collecting data about a long reporting period retrospectively (Krosnick et al., 2005, 2019). Importantly, given the stigma surrounding PrEP (Cahill et al., 2017; Calabrese & Underhill, 2015), self-report measures can be biased by social desirability concerns. A novel way to circumvent these concerns is to examine interest in PrEP through Google Trends, a source of the search volume of different queries by anonymous users via Google search engine.

Google Trends was first available in 2009 with the demonstration of a strong correlation of influenza-related searches with physician visits for influenza (Ginsberg et al., 2009). Google Trends is increasingly representative of the public mind as more than 83 percent of internet users use Google engine primarily (Purcell et al., 2012; Statista, 2021), which has increased its use in population health care research (FayazFarkhad & Albarracín, 2021; Kapitány-Fövény et al., 2019; Morsy et al., 2018; Young et al., 2018; Young & Zhang, 2018). In addition to being a useful tool to obtain a snapshot of the public mind in an area, previous research has also demonstrated the utility of Google Trends for understanding opinions on sensitive and/or culturally stigmatized topics (Markey & Markey, 2013; Moors, 2017).

We thus capitalized on Google Trends to assess variations in Google searches as indicative of interest in PrEP in three groups of states: (a) with expansion and PrEP-AP; (b) with expansion only; and (c) with neither expansion nor PrEP-AP. Analyses were conducted over time using a differences-in-differences (DiD) framework to determine if increases in interest in PrEP were higher in expansion than in non-expansion states and whether PrEP-AP contributed over and above the expansions.

Data

The information about the states' Medicaid expansion was collected from the Kaiser Family Foundation (KFF, 2020b). We collected the implementation date of the PrEP-APs from multiple sources (see Appendix A). Table A1 presents the list of states that implemented the Medicaid expansion and/or PrEP-AP by the end of 2019.

We measured interest in PrEP by obtaining monthly, geo-located search data using Google Trends. Google Trends quantifies search patterns from all web queries on the Google search engine, even those made in incognito browser mode (i.e., a browsing mode with cookies and local history deleted when users close the browser; Google LLC, 2020), and the data can be collected through the Google Trends website and Google Health Trends API (Stocking & Matsa, 2017; Zepecki et al., 2020). The Google Trends website provides a scaled result from 0 representing the least popularity to 100 being the most popular based on a topic's search proportion in a given region and time period. The main limitation with this scaled measure is that the data are not on the same scale for all regions, as a result of which the numbers do not show whether a particular area has a higher interest in a specific query compared to another. To resolve this shortcoming, we used the Google Health Trends API, which returns *query share* defined as:

$$query\ share = \frac{number\ of \text{ query in region and time interval}}{number\ of\ all\ searches\ in \text{ region and time interval}} \times 10^7. \quad (1)$$

Because these shares are not scaled to the highest result as the Google Trends website is, the Health Trends API data allows for comparison of searches performed across regions. Hence, the Google Health Trends API data is more appropriate for our differential analysis that compares within state changes over time across states with different policy environments (Ginsberg et al., 2009; Kapitány-Fövény et al., 2019; Morsy et al., 2018; Young et al., 2018; Young & Zhang, 2018).

For selecting the search keywords, we consulted with two specialists and kept the most frequently searched ones in our final list. On May 27, 2020, we collected monthly trends data from January 2010 to December 2019 for a set of PrEP-related search phrases: "PrEP HIV", "Truvada PrEP", "Descovy PrEP", "Truvada Cost", "Truvada Coupon", and "Truvada Side Effects". As Google Trends are case insensitive, we included a combination of words to include relevant queries. For example, Google does not distinguish "PrEP" from "prep" which is an abbreviation for *preparation*. Likewise, we combined Truvada and Descovy (licensed brands for PrEP) with PrEP, to distinguish searches for preventive medication from those for treatment. We also constructed a *combined index*, which is the summation of searches for all PrEP keywords. In addition to state-level data, Google Health Trends provides query shares in smaller regions known as designated market areas (DMA). Each DMA is a combination of a few metropolitan areas and their suburbs (Nielsen, 2020). Hence, we collected monthly data for 2010-2019 at the DMA level. The correlation between annual Google searches and the rate of PrEP users (see Appendix B) showed that searches for PrEP were positively correlated with PrEP use (AIDSVu, 2021), which supports the validity of Google Trends in this domain.

To account for area-level attributes, we controlled for several variables that could correlate with both state policies and interest in PrEP (Courtemanche et al., 2017; Lee & Porell, 2020; Meinhofer & Witman, 2018). These include the percentage of the population that is male, aged 25-44 years, aged 45-64 years, aged 65 and older, adults 25 years and older with a high school diploma (AHRF, 2019). We also included the number of primary care physicians and health educators and community health workers per 1000 residents (*BLS*, 2019).

Analytical Procedures

To identify the impact of the Medicaid expansions on Google searches for PrEP, we estimated difference-in-differences (DiD) models with different outcomes, including the combined index and search shares of each search phrase. In the context of the DiD model, the treatment group was DMAs in Medicaid expansion states, and the control group was DMAs in non-expansion states. The pre-expansion period was state-specific and dependent on the month and year of Medicaid expansion; all months before Medicaid expansion were considered to be pre-expansion periods. The interaction between state Medicaid expansion and the post-expansion period determined whether the expansion impacted each of the Google searches. We also included an interaction between Medicaid expansion and PrEP-

AP to estimate the effect of the implementation of PrEP-APs among expansion states. In particular, the results are based on OLS models of the following form:

$$Y_{dst} = \beta\, Expansion_{st} + \gamma\, Expansion_{st} \times \mathrm{PrEPAP}_{\mathrm{st}} + \lambda\, X_{\mathrm{st}} + \delta_s + \delta_t + \epsilon_{dst}, \quad (2)$$

where Y_{dst} is the share of Google searches in DMA d, state s, and time t. The variable $Expansion_{st}$ is an indicator variable that takes a value of one for DMAs in a state that opted to expand Medicaid and after the policy implementation, and zero otherwise. $\mathrm{PrEPAP}_{\mathrm{st}}$ is an indicator variable that takes a value of one for states that implemented PrEP-AP. X_{st} is a matrix of state characteristics such as demographics and healthcare resources. Finally, δ_s and δ_t are state and year fixed effects, respectively, and ϵ_{dst} is a random error term.

The validity of the DiD model depends on the parallel trends assumption. Under this assumption, the trends in the treatment group in the absence of treatment must be similar to that of the control group. The analyses in Appendix C verified the validity of this assumption. To determine whether trends in Google searches for PrEP keywords are unique, we estimated our models using a secondary set of HIV keywords (unrelated to PrEP) in Appendix D.

Results

Summary Statistics

Table 1 shows descriptive statistics for the main variables. Our sample includes 24,720 observations (206DMAs×10years×12months). We classified DMAs considering their status regarding Medicaid expansion as well as PrEP-AP. As of December 2019, 125 DMAs are in states that expanded Medicaid, 81 DMAs are in states that did not expand. Among the DMAs in expansion states, 47 DMAs are in states that also implemented PrEP-AP. None of the non-expansion states had implemented PrEP-AP by the end of our study period. As shown in Table 1, DMAs with either Medicaid expansion only or both Medicaid expansion and PrEP-AP had a higher share of PrEP-related searches than did non-expansion states.

Trends in PrEP Searches

Figure 2 presents the average share of Google searches for PrEP keywords over time separately for the three groups of DMAs. Figure 2a shows that although the share of Google searches for “PrEP HIV” increased over time for all the three groups of DMAs, the increase in DMAs in states with both expansion and PrEP-AP was visually larger than the increase in non-expansion and expansion only states. A similar pattern was present for searches for “Truvada PrEP” (Figure 2b). Figure 2c shows that “Descovy PrEP” (Descovy was approved for use as PrEP by the FDA in 2019) had a higher search share in the states that had both expansion and PrEP-AP relative to expansion-only states. In contrast, the search score in DMAs with neither expansion nor PrEP-AP was 0, which indicates either no volume or suppression of data due to insufficient numbers of searches. Likewise, Figures 2d-2f show higher shares of searches for “Truvada Cost”, “Truvada Coupon”, and “Truvada Side Effects” in expansion states than in non-expansion states.

Effects of Medicaid Expansions and PrEP-APs

Table 2 presents the regression results from eq. (2) on DMA level shares of Google searches for PrEP. The first row contains DiD estimates of the effect of the Medicaid expansion and represents changes in searches among Medicaid expansion states relative to changes in searches among non-expansion states. These results suggest that relative to non-expansion states, states with Medicaid expansion had higher shares of Google searches for PrEP. For example, relative to non-expansion states, states with Medicaid expansions had higher searches for "PrEP HIV" ($\beta = .870$, $p < .001$) and "Truvada PrEP" ($\beta = .488$, $p < .05$). Likewise, results based on the combined index indicated that, relative to non-expansion states, states that expanded Medicaid had higher a share of Google searches for all of our PrEP related keywords ($\beta = 1.536$, $p < .001$). The second row contains estimates of the interaction between Medicaid expansion and PrEP-AP and represents changes in searches following the implementation of PrEP-APs among expansion states. These results suggest that states with both Medicaid expansion and PrEP-AP had the highest shares of Google searches for "Descovy PrEP" ($\beta = .247$, $p < .001$), "Truvada Cost" ($\beta = .124$, $p < .05$), and "Truvada Coupon" ($\beta = .125$, $p < .001$).

Additional analyses in Appendix D demonstrated that this pattern of results was unique for PrEP-related phrases. The unique pattern of correlation indicates that people residing in states with more generous health policies had a higher interest in searching for information about PrEP.

Discussion

Clinical trials of PrEP have shown that its use reduces HIV infection. However, despite the availability of assistance programs, such as Gilead's Advancing Access Program, PrEP use remains surprisingly low (Kay & Pinto, 2020). Therefore, the present study attempted to understand internet users' interest in seeking out information about PrEP (i.e., a critical milestone in use continuum) by assessing trends in the share of Google searches among three groups of states, namely expansion and PrEP-APs, expansion-only, and neither expansion nor PrEP-AP.

Our results indicated that the share of searches for PrEP was higher in states that expanded Medicaid relative to non-expansion states. Although uninsured individuals may receive PrEP for free through manufacturer assistance programs, higher Google searches in expansion states suggest that not having insurance poses barriers beyond cost. One interpretation is that individuals with limited access to care might be less likely to be aware of PrEP, and awareness is a prerequisite to searching information about PrEP. In addition, drug payment assistance options available for the uninsured do not cover medical visits and are therefore insufficient to close the gap between uninsured and insured populations.

Although Medicaid is an important mechanism in improving access to PrEP, only adults with annual income below 138% of the FPL are eligible. Adults with higher income may be covered by subsidized private health insurance. Although private insurance certainly facilitates PrEP use, out-of-pocket costs might still be prohibitive for some users, leading to

some states implementing PrEP-AP. We found that states with both Medicaid expansion and PrEP-AP exhibited the highest share of PrEP searches.

Our study has limitations. First, our data sources did not allow us to investigate the effects across population characteristics. This limitation is important because evidence suggests that PrEP awareness is not uniform across different populations (Finlayson et al., 2019). Second, Google searches are prone to bias as i) they aggregate the searches without distinguishing how many queries each user has made and who performed the searches, ii) certain groups have lower access to the internet, iii) users may restrict their location access in privacy settings, iv) they represent only searches done using the Google engine, v) searches may be associated with inaccurate geolocations due to using virtual private networks, and vi) they include neither misspelling nor typographical errors. Although the Google searches may not be representative of the entire population, changes in search behavior may still track changes in the general population, an idea that prior research has supported (Mellon, 2014). Third, despite controlling the number of men who have sex with men deems desirable, this omission is unlikely to bias our results as differences across states are captured by the inclusion of fixed effects. Finally, this is an ecological study that may not fully control for time-varying differences across states. Since state policy decisions are not random, our findings may not imply causality. However, supplementary analysis suggests that the same pattern was not present for control keywords, which suggests that our findings are unlikely to be driven by unobserved confounders.

Despite these limitations, this study provides evidence that suggests internet search data can be used as an additional tool for understanding public opinion about sensitive and/or stigmatizing topics and PrEP use. These approaches are not meant to replace traditional methods of data collection such as surveys but may provide an additional scalable tool to facilitate HIV prevention efforts.

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Appendix A: Supplementary Table

Table A1.

Status of States' Medicaid Expansion and PrEP Assistance Programs as of December 2019

All Expansion	All Non-expansion	All PrEP-AP
Alaska	Alabama	California[a] [06/2018]
Arizona	Florida	Colorado[b] [04/2015]
Arkansas	Georgia	District of Columbia[c] [06/2018]
California	Idaho	Illinois[d] [10/2016]
Colorado	Kansas	Massachusetts[e] [02/2017]

All Expansion	All Non-expansion	All PrEP-AP
Connecticut	Mississippi	New York[f] [04/2015]
Delaware	Missouri	Ohio[g] [10/2019]
District of Columbia	Nebraska	Washington[h] [04/2014]
Hawaii	North Carolina	
Illinois	Oklahoma	
Indiana	South Carolina	
Iowa	South Dakota	
Kentucky	Tennessee	
Louisiana	Texas	
Maine	Utah	
Maryland	Wyoming	
Massachusetts		
Michigan		
Minnesota		
Montana		
Nevada		
New Hampshire		
New Jersey		
New Mexico		
New York		
North Dakota		
Ohio		
Oregon		
Pennsylvania		
Rhode Island		
Vermont		
Virginia		
Washington		
West Virginia		
Wisconsin[1]		

Notes: The status of the states' Medicaid expansion program was gathered from the Kaiser Family Foundation (KFF, 2020b). Authors gathered the implementation dates of PrEP-APs from the following resources and contacted with state health officials to verify those, if necessary.

[1]Although Wisconsin was not an ACA expansion state, the state received federal approval to offer Medicaid to childless adults below 100 percent FPL through the BadgerCare program. We therefore include it in our treatment group.

[a](Koester et al., 2017)

[b](Colorado Public Health Intervention Program PrEP, 2015)

[c](Pre Exposure Prophylaxis Drug Assistance Program, 2018)

[d](IDPH Launches PrEP 4 Illinois, 2016)

[e](Massachusetts PrEP Drug Assistance Program Now Open Statewide, 2017)

[f](Program Reimburses Health Care Providers for Services, 2015)

[g](Prevention Assistance Program Interventions (PAPI), 2019)

[h](Aleshire, 2017)

Appendix B: Validation of Google Health Trends Data

Table B1.

Pearson Correlation Coefficients (r) between Annual Google Searches for PrEP-Related Search Phrases and Rate of PrEP Users ($p < .001$)

Search phrase	Pearson-r
"PrEP HIV"	0.8898**
"Truvada PrEP"	0.8668*
"Descovy PrEP"	0.9069**
"Truvada Cost"	0.8928**
"Truvada Coupon"	0.8899**
"Truvada Side Effects"	0.5537
Combined index	0.9055**

Significance levels:
* p < 0.05
** p < 0.01
*** p < 0.001.

Appendix C: Additional Details on the Validity of Model Assumptions

C1. Changes in Insurance Coverage as a Function of Medicaid Expansion

We assessed changes in insurance coverage over time to verify the coverage was affected by the Medicaid expansions. Figure C1 presents the variation over time in the average insurance coverage among low income adults aged 19-64 (with income under 200% FPL) separately for DMAs in the following three categories of states: expansion and PrEP-AP, expansion only, and neither expansion nor PrEP-AP from 2010-2018 (KFF, 2018). Two findings are noteworthy. First, among the three groups of states, states with neither expansion nor PrEP-AP generally had the lowest rate of insurance coverage. In 2010, insurance coverage varied from 56% in non-expansion states to 65% in expansion states. The range widened in 2014 (in the first year of Medicaid expansion), when insurance coverage varied from 64% in non-expansion states to 75% in expansion states. This finding suggests that the expansion had the expected effect of increasing insurance coverage in expanded states.

Second, as shown in Figure C1, changes in insurance coverage were not affected by the implementation of PrEP-AP. Specifically, the rates of insurance coverage among low-income adults living in expansion only states were similar to those living in states that implemented both Medicaid and PrEP-APs. This result is important in verifying that any differential effect of PrEP-APs on Google searches can be properly attributed to the implementation of PrEP-APs rather than insurance coverage differences.

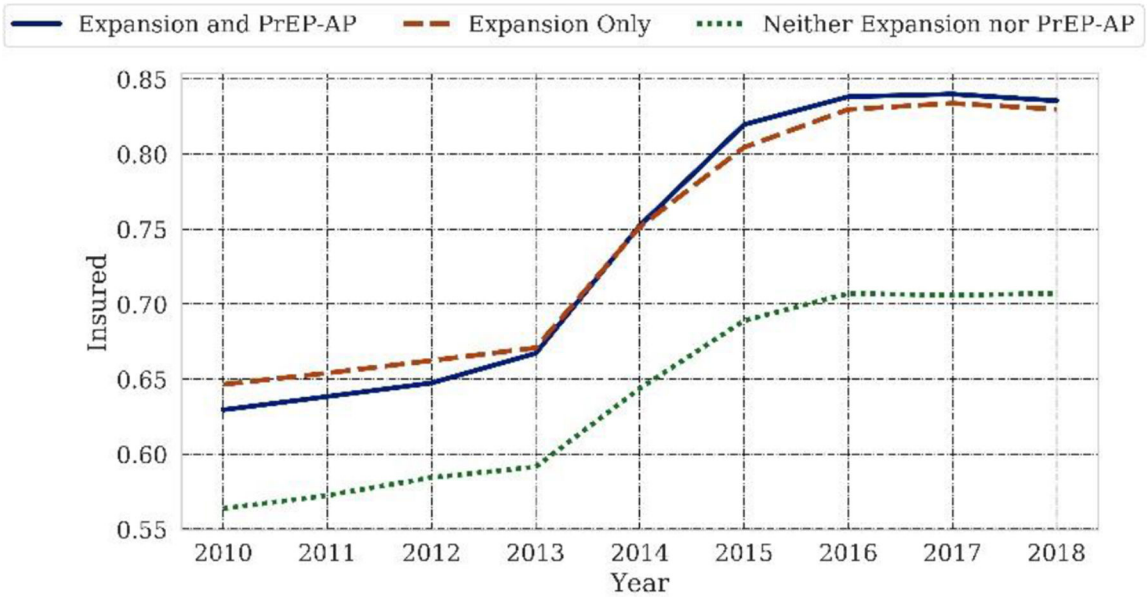


Figure C1.
Trends in Health Insurance Rates of Low-Income Adults Aged 19-64 (under 200% FPL)
Notes: Source is KFF from 2010 to 2018. See Appendix Table A1 for the list of states that expanded Medicaid and the list of states that implemented PrEP-APs.

C2. Validation of Parallel Trends Assumption

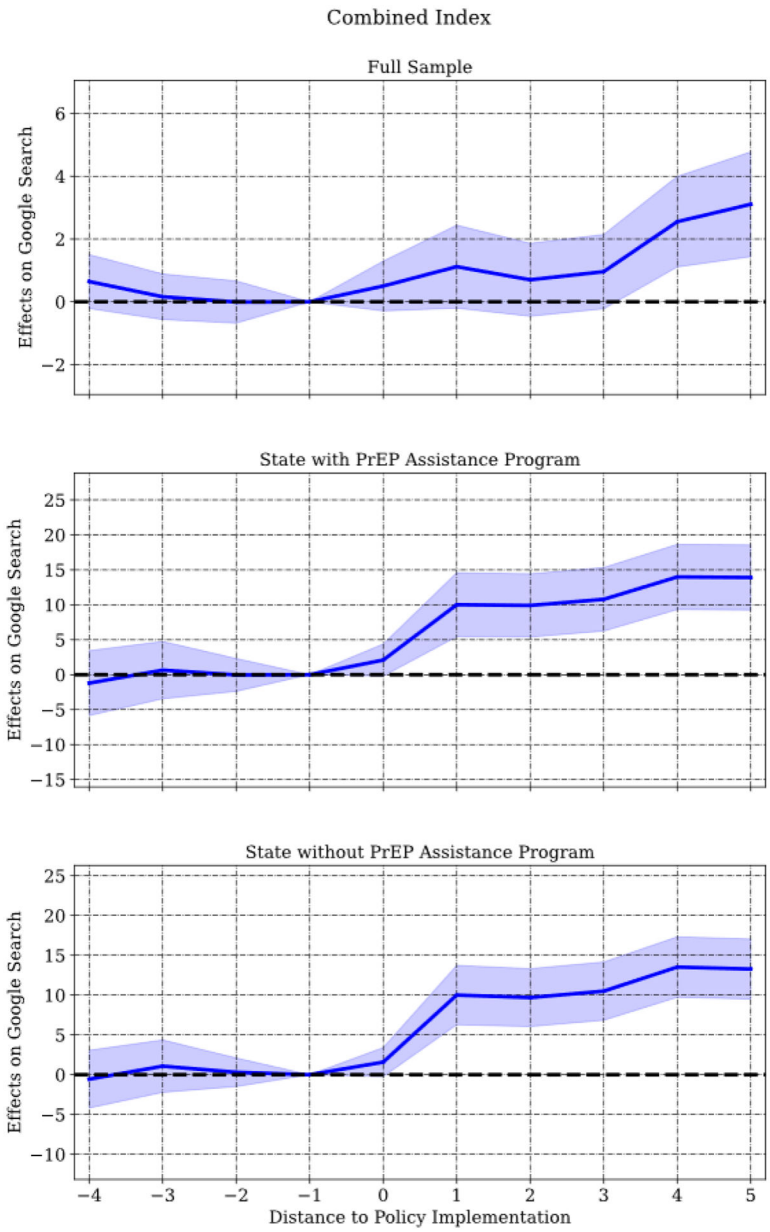
The standard identification of DiD models relies on the assumption of parallel trends that, in the absence of the policy, outcomes in the "treated" states would have evolved as in the "untreated" states. We assessed the plausibility of this assumption using an event study model specifying a full set of policy leads. In particular, we replaced each single Medicaid expansion indicator variable with a series of indicator variables representing the number of years relative to state Medicaid expansion. In particular, we estimated the following model using OLS:

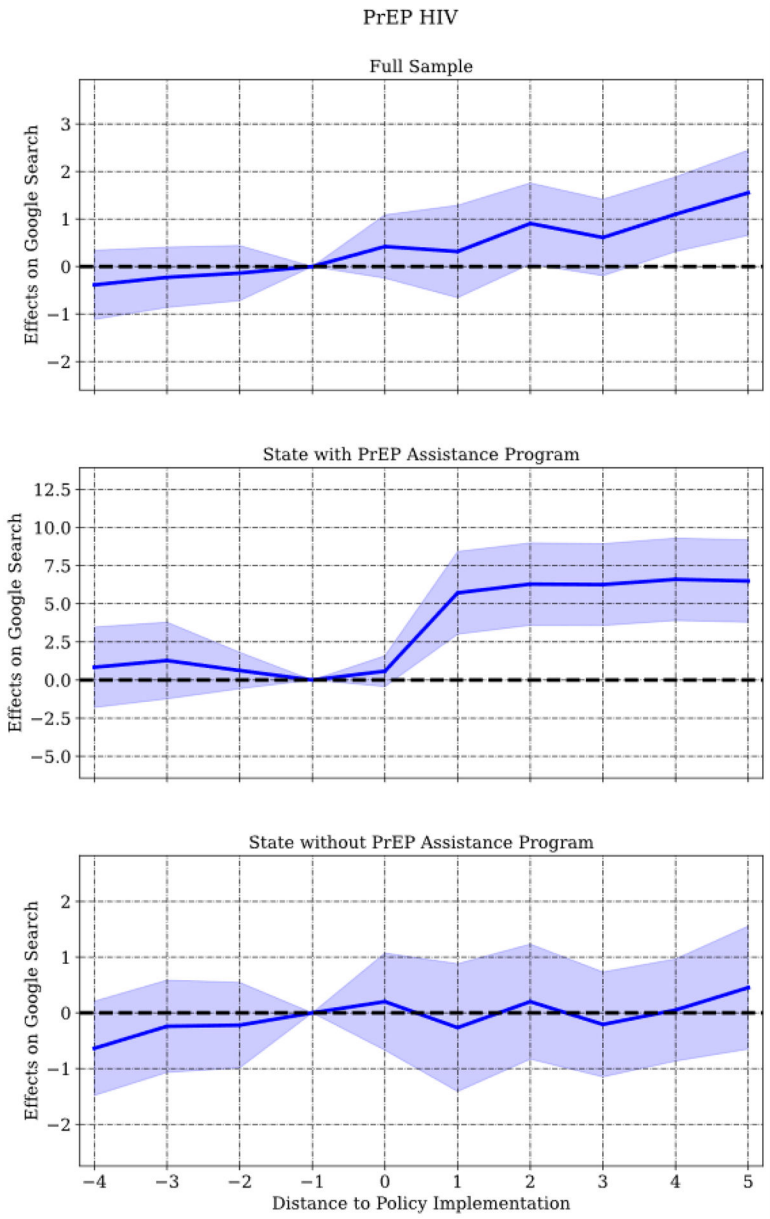
$$Y_{dst} = \sum_{\substack{y=-4 \\ y \neq -1}}^{5} \beta^{y} \, Expansion_{st}^{y} + \lambda X_{st} + \delta_t + \delta_s + \epsilon_{dst}, \tag{C}$$

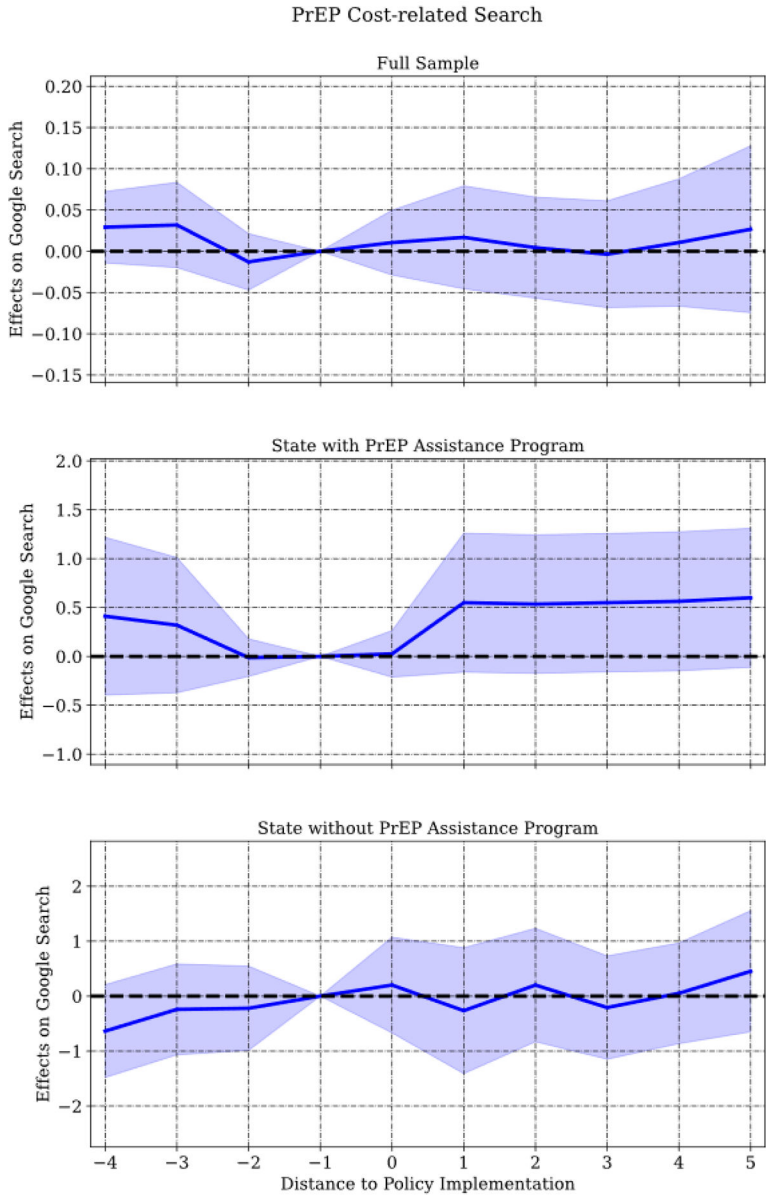
in which $Expansion_{st}^{y}$ is a dummy variable equal to 1 if the state has expanded Medicaid for y periods, or is zero otherwise, with the year before the implementation of the expansion ($y = -1$) as the omitted category. If expansion and non-expansion states had similar trends prior to the Medicaid expansion, the estimated coefficients associated with event times y = −4 to y = −2 would be small and not statistically significant.

These results are presented in Figure C2. Each figure plots the DiD estimates and their corresponding 95% confidence intervals, comparing query shares in expansion states with those in non-expansion states relative to the year before treatment. First, we estimated the eq. (C) for all DMAs. In addition, we separately estimated this equation on the sample

of states that implemented PrEP-AP by the end of our study period as well as on the sample of states that have not implemented the PrEP-AP. Prior to the Medicaid expansion, Google searches trended similarly across the two groups: the pre-expansion differences in Google searches between expansion and non-expansion DMAs are close to zero and not statistically significant. We additionally tested the assumption that all indicators for pre-expansion differences are jointly equal to zero. For all the keywords, we cannot reject the null hypothesis of F-test. Thus, these results provide evidence that the key assumption of the DiD design is valid.







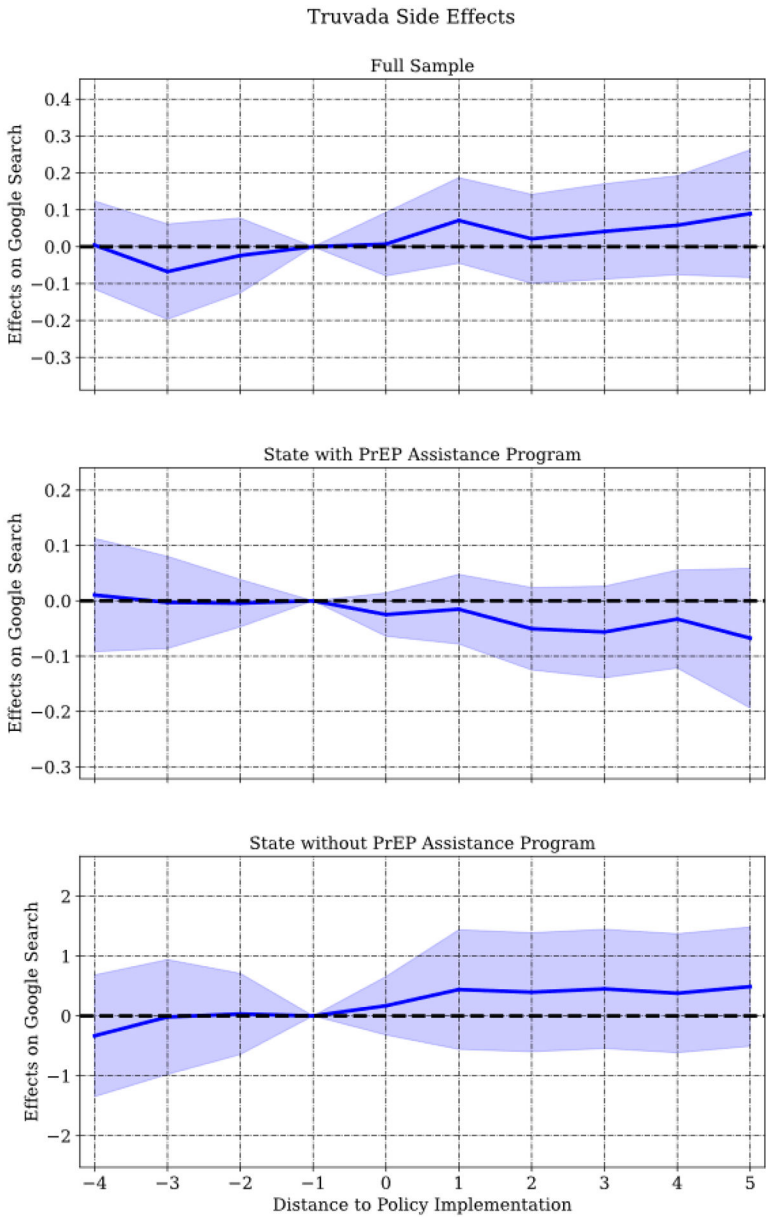


Figure C2.
Event Study of Medicaid Expansion on Shares of Google Searches for PrEP

Appendix D: Falsification Test

We attempted to ensure that our results were not due to the presence of unobserved population differences. For example, states that implement such HIV prevention policies as PrEP-AP may also have a higher risk of HIV transmission, which may result in higher Google searches for both PrEP and HIV. Hence, we conducted a series of analyses of different HIV-related keywords to rule out this possibility. The set included “HIV”, “HIV Symptoms”, “Ryan White Program”, “Syphilis”, “Chlamydia”, and “Hepatitis”. We estimated our DiD models using this secondary set of HIV-related keywords and examined

to what extent Medicaid expansion, and the combination of Medicaid expansion and PrEP-AP increased those Google searches. As shown in Table D1, these policies virtually had no positive associations (one exception is the association between expansion and "Hepatitis"). Therefore, these results suggest that the higher searches for PrEP are unlikely to be due to differential trends in omitted variables.

Table D1.

The Effects of Medicaid Expansions and PrEP-APs on Monthly Google Searches

	"HIV"	"HIV symptoms"	"Ryan white program"	"Syphilis"	"Chlamydia"	"Hepatitis"
Expansion	2.401 (21.02)	1.574 (5.46)	0.061 (0.05)	8.989 (12.76)	4.651 (15.99)	67.779** (22.61)
Expansion×PrEP-AP	-6.009 (18.36)	-7.687 (5.64)	0.018 (0.02)	6.712 (11.88)	23.411 (13.94)	-45.850* (19.16)
Male	125.258 (194.10)	73.493* (33.20)	0.198 (0.20)	-149.81 (132.45)	-223.361 (167.39)	410.869* (181.78)
Age 20-44	-143.413 (78.73)	19.015 (16.27)	0.031 (0.04)	88.109* (44.53)	45.306 (57.63)	-109.701 (81.07)
Age 45-64	81.631 (51.81)	-11.054 (9.18)	0.033 (0.05)	10.671 (32.42)	10.683 (38.23)	-15.717 (56.04)
Age 65 and older	-5.885 (54.63)	14.724 (10.25)	0.001 (0.03)	2.804 (42.15)	-55.172 (52.67)	84.901 (64.18)
Age 25 and older with HS degree	-63.865* (30.50)	-11.95 (6.53)	0.056 (0.03)	5.037 (16.17)	27.529 (20.99)	35.47 (30.59)
Physicians per 1000 residents	300.915 (382.22)	-78.14 (73.78)	0.272 (0.26)	-176.457 (266.91)	-360.8 (343.96)	-432.837 (381.32)
Education workers per 1000 residents	-48964.16** (15444.37)	2352.25 (2848.48)	-11.59 (16.01)	9099.53 (10370.78)	22240.90 (13397.03)	2449.50 (14764.64)
Observations	24,720	24,720	24,720	24,720	24,720	24,720

Note. Table shows unstandardized estimates and robust standard errors are in parentheses. The coefficients of state and year dummies are not reported. Significance levels:

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

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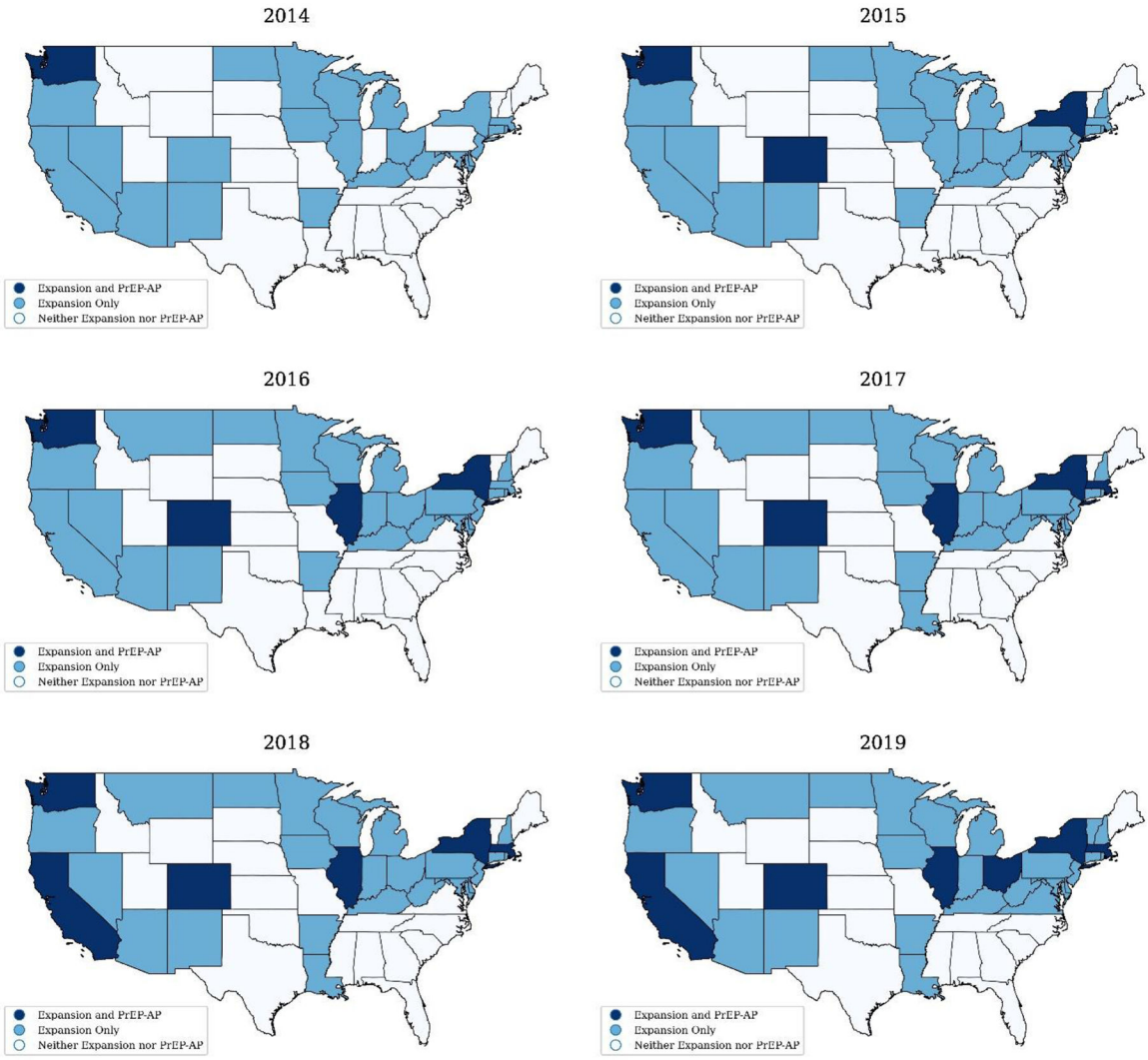

Figure 1: Implementation of Medicaid Expansion and PrEP-AP Over Time

Notes: The above figures display the timeline of Medicaid expansions and PrEP-APs across states. 26 states and District of Columbia expanded their Medicaid program in 2014 and an additional seven states followed over a period of six years. Although Wisconsin was not an ACA expansion state, the state received federal approval to offer Medicaid to childless adults below 100 percent FPL through the BadgerCare program. We therefore included it in our treatment group. PrEP-AP was initiated in Washington in 2014 and 7 more states (including District of Columbia) implemented similar programs until December 2019.

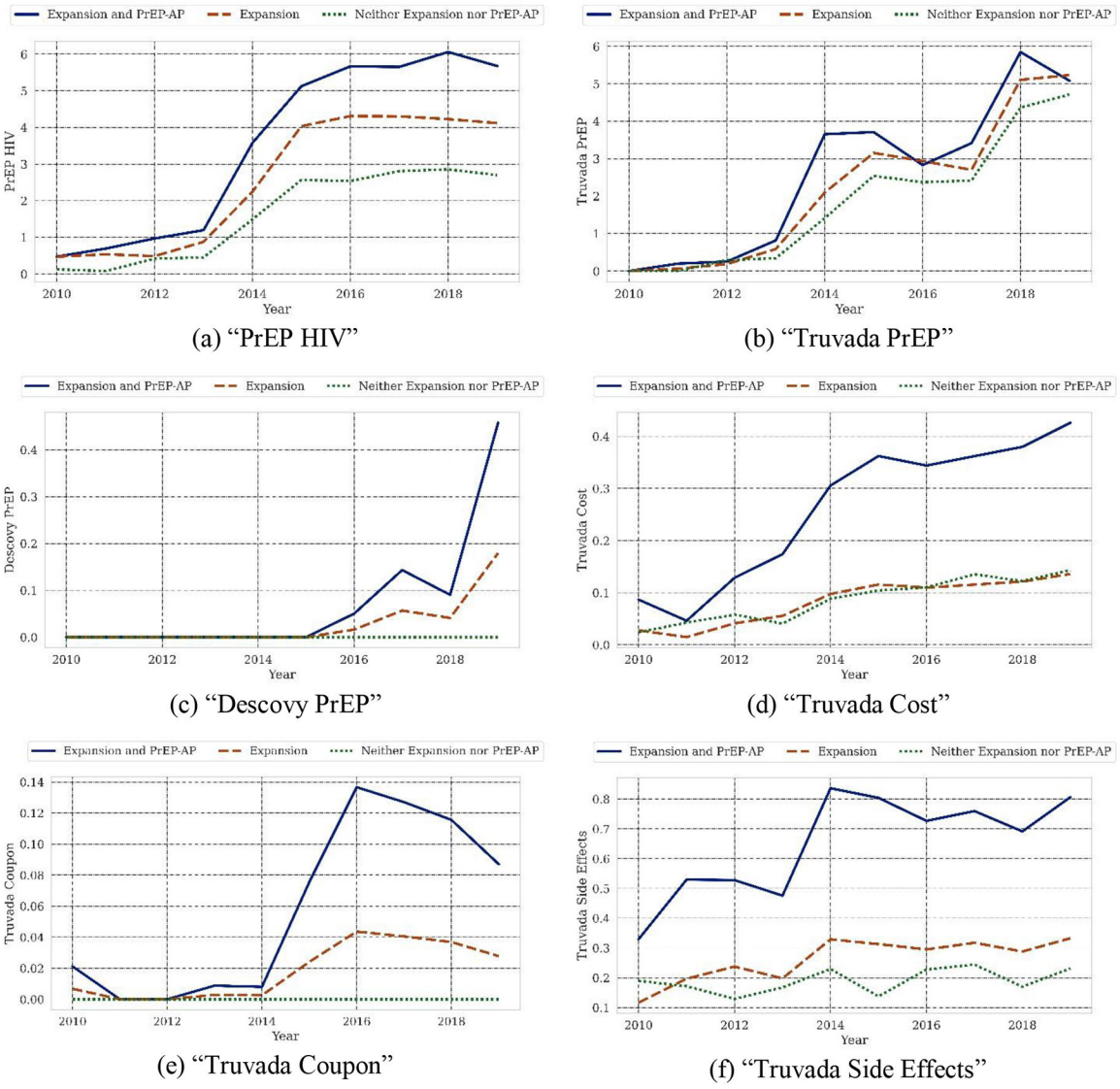

Figure 2. Trends in the Share of Google Searches for PrEP, by Medication Expansion and PrEP-AP Policies

Notes: Our sample includes 24,720 observations (206 DMAs*10 years*12 months). DMAs (designated market area) were classified into the following three groups considering their status regarding Medicaid expansion as well as PrEP-AP: (a) with expansion and PrEP-AP; (b) with expansion only; and (c) with neither expansion nor PrEP-AP.

Table 1.

Descriptive Statistics of Share of Google Searches for PrEP Keywords and State Characteristics

	Expansion and PrEP-AP		Expansion		Neither Expansion nor PrEP-AP	
	Mean (1)	S.D. (2)	Mean (3)	S.D. (4)	Mean (5)	S.D. (6)
PrEP Related Searches						
Combined Index	7.75***	17.6	5.03***	15.4	3.77	13.6
"PrEP HIV"	3.82***	9.4	2.50***	9.3	1.62	7.2
"Truvada PrEP"	2.73***	8.5	2.15*	8.8	1.87	8.8
"Descovy PrEP"	0.09***	0.8	0.03***	0.5	0.00	0.0
"Truvada Cost"	0.25***	1.4	0.08	0.8	0.08	1.0
"Truvada Coupon"	0.06***	0.6	0.02***	0.3	0.00	0.0
"Truvada Side Effects"	0.80***	2.7	0.26**	1.6	0.19	2.1
State Characteristics						
Male	49.20***	0.7	49.31***	0.6	49.20	0.6
Age 20-44	34.96***	1.9	33.01***	2.0	33.34	1.4
Age 45-64	25.99***	1.1	26.66***	1.3	25.55	1.3
Age 65 and older	13.81***	1.3	15.03***	1.7	14.34	2.4
Individuals aged 25 and over with HS degree	85.74***	3.3	87.46***	3.4	85.55	3.2
Physicians per 1000 residents	1.66***	0.2	1.57***	0.2	1.33	0.1
Education workers per 1000 residents	0.01***	0.0	0.02***	0.0	0.03	0.0
Observations (DMA-month)	4,560		14,280		10,440	

Notes: Our sample includes 24,720 observations (206 DMAs*10 years*12 months). DMAs (designated market area) were classified into the following three groups considering their status regarding Medicaid expansion as well as PrEP-AP: (a) with expansion and PrEP-AP; (b) with expansion; and (c) with neither expansion nor PrEP-AP.The asterisks in column (1) present significance levels from t-tests that examine whether the difference between columns (1) and (5) are equal to zero. The asterisks in column (3) present significance levels from t-tests that examine whether the difference between columns (3) and (5) are equal to zero. Significance levels:

* p < .05

** p < .01

*** p < .001.

Table 2.

The Effects of Medicaid Expansions and PrEP-APs on the Share of Google Searches for PrEP-Related Keywords

	"PrEP HIV"	**"Truvada PrEP"**	**"Descovy PrEP"**	**"Truvada Cost"**	**"Truvada Coupon"**	**"Truvada Side Effects"**	**Combined Index**
Expansion	0.870*** (0.26)	0.488* (0.20)	0.025*** (0.01)	0.119* (0.05)	0.008** (0.00)	0.121* (0.05)	1.536*** (0.36)
Expansion×PrEP-AP	0.494 (0.37)	−0.635 (0.37)	0.247*** (0.05)	0.124* (0.05)	0.125*** (0.02)	0.135 (0.08)	0.49 (0.69)
Male	−4.661*** (1.14)	−4.843*** (1.22)	−0.319** (0.10)	−0.068 (0.14)	0.013 (0.01)	−0.800** (0.31)	−10.678*** (1.99)
Age 20-44	3.493*** (0.53)	2.528*** (0.49)	0.041 (0.03)	−0.017 (0.05)	−0.062*** (0.01)	−0.033 (0.09)	5.950*** (0.84)
Age 45-64	2.785*** (0.36)	2.300*** (0.34)	−0.023 (0.04)	0.137*** (0.03)	−0.017** (0.01)	−0.085 (0.09)	5.098*** (0.61)
Age 65 and older	0.705 (0.38)	0.51 (0.42)	−0.097* (0.04)	−0.051 (0.03)	−0.031** (0.01)	−0.327** (0.10)	0.709 (0.69)
Age 25 and older with HS degree	−0.131 (0.14)	0.02 (0.15)	0.036*** (0.01)	−0.022 (0.01)	−0.016*** 0.00	0.047 (0.04)	−0.066 (0.24)
Physicians per 1000 residents	3.736 (2.55)	−8.597** (2.70)	0.642*** (0.14)	0.555** (0.21)	−0.199* (0.09)	−0.111 (0.49)	−3.974 (4.28)
Education workers per 1000 residents	−141.651 (115.70)	433.313*** (75.76)	16.042*** (4.73)	−7.587 (6.06)	−5.951*** (1.79)	30.892 (16.88)	325.058* (150.16)
Observations (DMA-month)	24,720	24,720	24,720	24,720	24,720	24,720	24,720

Notes: Analysis based on monthly Google Health Trends at DMA(designated market area) level from 2010-2019. Our sample includes 24,720 observations (206 DMAs*10 years*12 months). Table shows unstandardized estimates and robust standard errors are in parentheses. The coefficients of state and year dummies are not reported. Significance levels:

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$.