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_____ _____

Aditi Ramakrishnan, M.D. Date

Enhancing HIV Pre-Exposure Prophylaxis Training in Publicly Funded Family Planning Clinics in the Southern United States using an Implementation Science Framework

By

Aditi Ramakrishnan, M.D.

Master of Science

Clinical Research

_____

Anandi N. Sheth, M.D., M.Sc.
Advisor

_____

Matthew Magee, Ph.D.
Committee Member

_____

Jessica Sales, Ph.D.
Committee Member

Accepted:

_____

Kimberly Jacob Arriola, Ph.D., M.P.H.
Dean of the James T. Laney School of Graduate Studies

_____

Date

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By

Aditi Ramakrishnan, M.D.

B.A., Yale University, 2009

M.D., University of Michigan Medical School, 2015

Advisor: Anandi N. Sheth, M.D., M.Sc.

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Abstract

Enhancing HIV Pre-Exposure Prophylaxis Training in Publicly Funded Family Planning Clinics in the Southern United States using an Implementation Science Framework

By Aditi Ramakrishnan

Background:

Among women affected by HIV in the United States (US), women in the South are disproportionately affected, but despite this HIV pre-exposure prophylaxis (PrEP) use is markedly low in this population. Training healthcare providers to deliver PrEP and increasing PrEP access are key components of the Ending the HIV Epidemic (EHE) initiative. However, provider training is often not "one size fits all" and may require customization to facilitate successful PrEP implementation in different contexts. Title X-funded family planning (FP) clinics serve as an important safety net source and are ideal sites for expanding PrEP services. In this study, we analyzed associations between PrEP knowledge, attitudes, and self-efficacy (i.e., confidence in conducting the steps of PrEP care) and provider-, clinic-, and county-level variables among providers from Title X-funded FP clinics in the South to inform future customization of provider training.

Methods:

We conducted a secondary analysis of a web-based survey of providers and administrators in Title X FP clinics in 18 Southern states administered February–June 2018. This analysis included providers (clinical staff who could screen, counsel, or prescribe PrEP) from clinics that did not currently provide PrEP. Survey items were designed using the Consolidated Framework for Implementation Research (CFIR). We developed linear mixed models to evaluate the associations between provider-, clinic-, and county-level variables with the CFIR-guided outcomes of provider knowledge, attitudes, and self-efficacy in PrEP care.

Results:

Among 351 providers from 193 unique clinics, 194 (55%) were non-prescribing providers and 157 (45%) were prescribing providers. Provider ability to prescribe medications was associated PrEP knowledge, attitudes, and self-efficacy when adjusting for other provider-, clinic-, and county-level covariates. Self-efficacy was lowest in the PrEP initiation step of overall PrEP care and when stratified by prescriber status. Among all providers, self-efficacy was additionally associated with attitudes, knowledge, contraception self-efficacy, and county Hispanic population, when adjusting for other covariates.

Conclusion:

Our findings suggest that provider PrEP training can be enhanced by customizing training to prescriber status, addressing provider concerns about PrEP, integrating PrEP and existing FP training, and focusing on the initiation steps of PrEP care.

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Introduction

The epicenter of the HIV epidemic in the United States (US) has shifted in recent years to the South, which faces the highest burden of HIV compared to other regions of the US[1]. Women comprise 20% of the 40,000 annual new diagnoses, the majority of whom live in the South[1,2]. HIV pre-exposure prophylaxis (PrEP) is a safe, effective, individual-controlled, and scalable HIV prevention strategy that was recently identified as a key initiative in the Department of Health and Human Services "Ending the HIV Epidemic: A Plan for America"[3,4]. However, despite national efforts for widespread dissemination of PrEP, uptake remains disproportionately low in in the South,[1] including among women, who account for less than 5% of PrEP users nationally[5-7]. In order to address this challenge, "Ending the HIV Epidemic" emphasizes a core goal of optimizing the HIV workforce through partnerships with diverse organizations, which requires customized provider training[4]. Few US PrEP implementation studies have focused on healthcare provider training needs[8] or included cis-gender women[9]. One potential avenue to expand provider training and PrEP access for women are clinics funded by the Title X Family Planning Program, as these clinics serve as safety net sources of healthcare for women, particularly in areas without Medicaid expansion[10]. However, effective strategies to improve provider delivery of PrEP, particularly in the women's health setting, are not known.

Providers face key challenges to bring PrEP to scale in the US. Structural barriers include low awareness of PrEP and risk-perception among women[11-14], and scarcity of PrEP-providing clinics and insurance support for PrEP, particularly in the South[7,10,15]. Specific to provider-level barriers, studies have demonstrated variable knowledge and attitudes towards PrEP among primary care providers, HIV clinicians, and family planning (FP) providers[16-19]. Knowledge about PrEP and likelihood of PrEP prescribing has also been found to be lower among providers

in the South compared to providers in other regions[8,16,17,20]. Another challenge for providers is that the models of PrEP care can vary between organizations, including among Title X clinics[21]. The steps of PrEP care encompass screening eligible patients, initiating PrEP, and subsequently monitoring patients[21,22]. While these steps are universal, given differences in PrEP care models, a wide spectrum of provider knowledge and attitudes about PrEP, and varying financial assistance programs available by state for PrEP, customized provider training is critical[8,23].

Implementation science is the study of strategies to facilitate the systematic adoption of evidence-based practices, such as PrEP, into routine practice[15]. Provider training is a necessary pre-implementation step. The Consolidated Framework for Implementation Research (CFIR)[24] can be applied to assess factors that may influence effective provider training in PrEP. Three key CFIR constructs relevant to PrEP training are knowledge about PrEP, attitudes towards PrEP, and self-efficacy in PrEP care (i.e. confidence in conducting the steps of PrEP care). Given the diversity of regions and clinic types within Title X clinic network, customization of trainings based on assessment of these CFIR constructs may be particularly relevant for PrEP scale-up in this setting.

Our group recently conducted a CFIR-guided survey of providers and administrators from Title X clinics in the South to systematically study facilitators and barriers to implementation of PrEP in this setting [25]. For the current analysis, our objective was to use data from this parent survey to analyze the associations between provider-, clinic-, and county-level covariates, with CFIR constructs relevant to provider training: provider knowledge, attitudes, and self-efficacy in PrEP care (Figure 1). Given the potential heterogeneity in training for prescribing (e.g. physicians, nurse practitioners) vs. non-prescribing providers (e.g. nurses, health educators), the primary provider-level exposure variable of interest was prescriber status. We hypothesized

that there is a positive, linear association between medication prescribing ability and provider knowledge, attitudes, and self-efficacy in PrEP care. Understanding this relationship will facilitate the development of customized PrEP training for providers and inform resource allocation for PrEP scale-up in Title X clinics in the South.

Background

Women in the Southern US are disproportionately affected by HIV, but have low awareness and use of HIV prevention strategies. Women account for 20% new HIV infections nationally and are disproportionately affected in the South[1,2]. Racial disparities persist in that black women comprise two thirds of new HIV infections in US women[15]. Black women in the South also face nearly 20 times the risk of being diagnosed with HIV compared to white women[26]. PrEP is an effective, female-controlled HIV prevention strategy that urgently needs to be optimized for women at risk for HIV in the South. Unfortunately, PrEP use among US women remains low, with only 2% of the estimated 176,670 women eligible for PrEP in the US having used PrEP in 2015[6,27]. Furthermore, women and residents of the South have lower levels of PrEP use relative to new HIV diagnoses based on national prescription data[7]. Strategies to improve awareness and accessibility of PrEP have focused largely on the men who have sex with men (MSM) community in the US, with limited studies published on PrEP utilization among women[28].

Challenges in PrEP uptake among women include individual gaps in knowledge and awareness, provider-level factors, and health system variables. Numerous studies have reported low PrEP knowledge and awareness among US women[13,29], even though PrEP awareness has steadily increased among men who have sex with men[30]. Another study found that though both men and women were equally likely to express interest in PrEP, women were less

likely to begin taking PrEP and experienced higher rates of discontinuation[31]. Lack of perception of risk for HIV acquisition has also been cited as a barrier to PrEP uptake among women[32]. Regarding provider-level barriers, a large-scale survey of primary care providers and HIV specialists conducted in 2014-2015 revealed significant variability in provider awareness of and willingness to integrate PrEP with their practice[16]. A 2015 national survey of US FP providers identified low PrEP knowledge and use among a majority of providers, which was even lower among providers in the South.[17] In this study, most providers cited lack of training as the main barrier to PrEP implementation, and 87% were interested in more PrEP training and education. In another survey, women highlighted the concern that medical providers who are unaware of PrEP use in women would be less willing to offer PrEP[19]. Health system factors which have contributed to low PrEP uptake include structural inequities, variable insurance coverage of PrEP, limited state-level PrEP assistance programs, lack of Medicaid expansion in many southern states, and low density of PrEP-providing clinics in the South[7,15,33].

To increase PrEP uptake, access to PrEP must be enhanced for women. Given low PrEP utilization among women at risk for HIV and numerous identified barriers, research is needed to improve PrEP delivery for this population. Adoption of evidence-based practices into clinical care can be a multi-step and tedious process that can be accelerated and optimized using implementation science[15,34]. PrEP implementation literature is limited, but demonstration projects have revealed potential models for PrEP delivery including PrEP implementation in sexually transmitted infections (STI) clinics, pharmacies, community health centers, and primary care clinics, with varying levels of adoption[15,35-37]. *However, women's health settings have not been prioritized for PrEP delivery programs or implementation studies*, and few women have been included in the evaluation of PrEP delivery programs in clinic- and community-based

settings. Nonetheless, integrating PrEP delivery with health services that women trust and routinely access for their sexual health offers potential for high impact PrEP dissemination. The Title X National Family Planning Program provides grants to health department or county hospital-based programs and non-profit stand-alone clinics to ensure access to contraception and preventive health services, particularly for low-income and uninsured individuals[38,39]. The program supports a network of approximately 4,000 sites that serves over 4 million clients, 90% of whom are women[38,39]. In a study conducted by our group, a single PrEP training session conducted in four safety net FP clinics located in high HIV burden areas in Atlanta resulted in improved provider PrEP knowledge and confidence, subsequent integration of PrEP counseling with FP visits, and patient interest in on-site PrEP provision. This study provides proof-of-concept supporting PrEP capacity building within FP clinics in high HIV burden areas[12].

Innovative implementation science-based approaches are needed to bring PrEP to scale for women. Given limited data about PrEP effectiveness and implementation among US women, research applying formal implementation science is integral to advancing knowledge in this understudied area[25]. To improve PrEP utilization among women in the South, our group conducted a mixed-methods implementation science study of PrEP delivery in Title X-funded FP clinics in the South between February and June 2018[10,25]. Data consisted of 519 geographically-targeted surveys and 38 key informant interviews of Title X FP clinic provider and administrators in 18 Southern US states and the District of Columbia, which overlap with high HIV-burden areas. The survey assessed critical elements of internal and external contextual characteristics important for integrating PrEP with FP services, guided by CFIR[24].

This framework provides a comprehensive set of constructs that can serve as a practical guide for systematically evaluating potential facilitators and barriers in preparation for

implementing an evidence-based practice in a novel setting (i.e. integration of PrEP services with Title X FP clinics)[24,25]. It is comprised of 39 constructs organized into 5 domains (*intervention characteristics, inner and outer setting, characteristics of individuals,* and *process*) (Figure 2). Key findings from this survey revealed that only one-fifth of the 283 Title X clinics provided PrEP, clinic- and county-level variables influenced PrEP provision, and that readiness to provide PrEP was positively associated with a climate supportive of HIV prevention, leadership engagement, and availability of resources[10].

PrEP training may require customization to facilitate effective and sustained change in practice. Existing PrEP literature has identified gaps in provider knowledge and the need for provider training[16,17,40-44]. Effective provider training is a necessary pre-implementation step required for successfully adoption of a new practice in a clinical setting, such as PrEP integration in Title X FP clinics. Furthermore, findings from our survey suggest key constructs that may be successfully addressed by training, such as supportive climate, leadership support, and individual attitudes. Another salient factor, availability of resources, would in turn influence provider training. However, aside from individual assessments of provider knowledge, literature identifying other necessary elements of PrEP provider training and how these elements may need to be customized depending on provider, clinic, or regional factors such as provider role, clinic type, or local HIV prevalence is limited. In fact, the literature examining clinic-level barriers to PrEP, mostly from non-women's health settings, indicate that though provider training is crucial, training is not easily generalized across all settings, but rather needs to be customized to specific contexts[16,17,40-44].

Provider knowledge, attitudes, and self-efficacy towards PrEP care and implementation. *Characteristics of Individuals* is the CFIR domain that encompasses the constructs of individual

knowledge related to the intervention, attitudes towards the intervention, and self-efficacy regarding the intervention. Understanding these provider-related CFIR constructs is integral to developing effective, customized PrEP training. To advance knowledge regarding provider-level barriers to PrEP implementation and to shape optimal PrEP provider training, this study investigates the associations between provider-, clinic-, and county-level characteristics and provider knowledge about PrEP, attitudes towards PrEP, and self-efficacy in PrEP care.

Methods

Hypothesis & Aims

This analysis was conducted with the following three specific aims:

(1) To determine the association between the ability to prescribe medication, and other provider-, clinic-, and county-level covariates, with provider knowledge about PrEP.

(2) To determine the association between the ability to prescribe medication, and other provider-, clinic-, and county-level covariates, with provider attitudes towards PrEP.

(3) To determine the association between the ability to prescribe medication, and other provider-, clinic-, and county-level covariates, with provider self-efficacy in PrEP care.

Our hypothesis is that there is a positive, linear association between ability to prescribe medication and provider knowledge, attitudes, and self-efficacy in PrEP care.

Study Design

We conducted a secondary analysis of a previously collected survey from a sequential, mixed-methods research study investigating readiness for PrEP implementation among Title X clinics in the South[10]. A comprehensive overview of the parent study's protocol, data collection instruments, and statistical analysis methods has been previously described by our group[25]. Briefly, our group conducted a web-based, geographically-targeted survey of providers and

administrators from Title X clinics in 18 southern states between February – June 2018. As part of the overall evaluation of clinic readiness to implement PrEP, the survey addressed the CFIR constructs of provider knowledge, attitudes, and self-efficacy in PrEP care. Providers were defined as any clinical staff who could screen, counsel, or prescribe PrEP. In order to inform methods of improving provider training to optimize PrEP delivery, we analyzed responses only among providers from Title X clinics that did not provide PrEP (Figure 3). Approval was obtained from the Emory University and University of North Carolina Institutional Review Boards.

Study Population and Recruitment

Healthcare providers and clinic administrators from Title X clinics in the Department of Health and Human Services (DHHS) regions III (Mid-Atlantic states), IV (Southeastern states), and VI (Southwestern states) were invited to complete the web-based quantitative survey. Participants were primarily recruited online through the National Clinical Training Center for Family Planning (NCTCFP) website advertisement and listserv e-mails, in-person at the NCTCFP meeting, and through engagement with state Title X grantees. This secondary analysis restricted the study population to providers from clinics that did not provide PrEP.

Survey Development

This survey referenced a similar survey addressing provider knowledge and attitudes that was also conducted among FP providers[17]. Survey items were developed using CFIR-specific tools or from existing, validated measures of CFIR constructs to evaluate constructs relevant to PrEP implementation[17,45-47]. The 93-item survey included 11 CFIR implementation-focused constructs from review of US-based PrEP implementation literature. Most CFIR-related survey

items were evaluated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Survey items of knowledge about PrEP were presented in the format of multiple choice.

Measures

a. Outcomes

The primary outcomes of this analysis were the 3 CFIR constructs of knowledge, attitudes, and self-efficacy regarding PrEP (Figure 4). Outcome measures were derived as semi-continuous composite scores based on collections of related survey items. Survey items had high internal consistency based on Cronbach's Alpha[10].

Survey questions assessing knowledge consisted of five multiple choice questions addressing PrEP medication identification, PrEP efficacy in clinical trials, tests to determine HIV status, frequency of monitoring patients taking PrEP, and frequency of monitoring side-effects and labs for patients taking PrEP (Figure 4). The outcome of knowledge was derived as the mean sum of correct responses to these questions (range 0-5).

Questions addressing attitudes towards PrEP were divided topically into the following subcategories: *Acceptability of PrEP Integration in Family Planning Settings* and *Clinical and Sociological Attitudes towards PrEP*. The outcome of attitudes was calculated as the average of the survey items within the overall category (range 0-5). Higher Likert-scale scores for positively-worded questions indicated more favorable attitudes towards PrEP, and for negatively-worded questions indicated more unfavorable attitudes towards PrEP. Certain survey items were re-coded for the same directionality when deriving the overall score.

Self-efficacy was evaluated through survey questions addressing the steps of PrEP care: *PrEP Screening* (comprising Patient Engagement and Initial Clinical Evaluation*), PrEP*

Initiation, and *PrEP Follow-up* (Figure 5)[22]. The outcome was calculated as the average of all self-efficacy survey items and subdivided by these steps of PrEP care.

b. Covariates

Provider-, clinic-, and county-level characteristics were selected as covariates (Figure 6) *a priori* based on review of the relevant PrEP and FP implementation literature. Provider-level covariates included age, gender (female vs. other), self-reported race (White vs. non-White), ethnicity (Latinx vs. non-Latinx), years worked in primary role at the clinic, ability to prescribe medication (yes with or without a supervisor vs. no), and contraception self-efficacy (range 1-5).

Clinic-level covariates included clinic type (health department, federally qualified health center (FQHC), or other), on-site insurance support (yes vs. no), on-site pharmacy (yes vs. no), and offering primary care services (yes vs. no).

County-level covariates for the population of the clinic catchment area included HIV prevalence, percent uninsured, percent living in poverty, percent with a high school degree, percent Hispanic/Latinx, percent of females aged 15 to 44 years, Medicaid expansion (yes vs. no), and DHHS Title X region (Mid-Atlantic, Southeast, or Southwest) based on county-level AIDSVu and Census data using the self-reported zip code of the provider's clinic[48,49]. Since data from counties with a small number of HIV cases and/or a small population size are suppressed in AIDSVu, for analysis we recoded suppressed values to the smallest positive HIV prevalence rate across the dataset. Using the 2013 NCHS urban-rural classification scheme, clinics were classified as metropolitan (i.e., urban, including large central or fringe metro, medium metro, and small metro areas) and non-metropolitan (i.e., rural, including micropolitan and noncore counties)[50].

Sample size justification

As a similar approach was applied in a national survey of FP providers regarding PrEP care by Seidman et al. (2016), a sample size goal of 600 respondents (400 providers and 200 administrators) was established by the parent study[17]. We included 351 respondents, consisting of 194 non-prescribing and 157 prescribing providers, of the original 519 respondents from primary analysis (Figure 3). This results in 85% power to detect a minimum difference of 15% using a two-sided two-sample pooled *t* test (alph=0.05).

Statistical Analyses

Statistical analyses were performed using SAS version 9.4 (Cary, NC). Descriptive statistics were applied to provider-, clinic-, and county-level covariates (means (SD) or counts (%) for all providers and/or clinics where appropriate). We then applied chi-square tests and unpaired *t* tests, where appropriate, to compare scores in the CFIR outcomes of knowledge, attitudes, and self-efficacy between prescribing and non-prescribing providers. For self-efficacy, paired *t* tests were applied to compare mean scores between the steps of PrEP care. Statistical tests were performed using a significance level of 0.05.

Next, simple linear regression models were utilized to evaluate the unadjusted associations between each provider-, clinic-, and county- level covariate and each CFIR outcome among all providers. All provider-, clinic-, and county-level covariates in Figure 6 were considered in the final linear mixed models, except for provider race, ethnicity, and gender, as the relationship between these characteristics and PrEP delivery are not supported in the literature. The following simple linear regression model was applied:

$$Y = ß_0 + ß_1X + E$$

Y = mean score of knowledge, attitudes, or self-efficacy survey items*
X = provider-, clinic-, or county-level covariate

E = random error, assumed ~ N (0, σ^2)

**Knowledge outcome: mean sum of correct response*

All provider-, clinic-, or county-level covariates with $p < 0.2$ in the simple linear regression models were included as covariates in the linear mixed models. Purposeful selection of covariates included in all multivariable models was based on observed bivariate associations between covariates and CFIR outcomes, suspected confounders according to previous published literature, and directed acyclic graph theory (Figure 1a-c)[51]. For the model of knowledge, prescribing ability and years in primary role at clinic were included *a priori*. In the model of attitudes, prescribing ability and Medicaid expansion were included *a priori*. In the model of self-efficacy, prescribing ability and contraception self-efficacy were included *a priori*.

Multivariable regression was then applied to evaluate the associations between covariates and each outcome. Linear mixed models that included a clinic-specific random effect were developed in order to account for confounding due to possible correlation in survey answers from providers of the same clinic. Covariates were checked for multicollinearity and excluded if found to be highly collinear ($r > 0.8$). Log transformation was applied to covariates that did not have a normal distribution. Models met the four assumptions of linear modeling (linearity, homoscedasticity, independence, and normality). The following linear mixed model was applied:

$$Y_{ij} = \beta_0 + u_{0j} + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \beta_3 X_{3ij} + \beta_4 X_{4ij} + \beta_5 X_{5ij} + \beta_6 X_{6ij} + \beta_7 X_{7ij} + E_{ij}$$

where i=number of respondents within a given clinic, j=number of unique clinics,
Y_{ij} = mean score of knowledge*, attitudes, or self-efficacy survey items,
β_0=fixed intercept, u_{0j}=random intercept (clinic-specific random effect),
β_p=fixed effect parameter estimate for p covariates, X_{pij}=covariate value for p covariates,
E_{ij} =random error assuming ~ N (0, σ^2)

**Knowledge outcome: mean sum of correct responses*

Given potential heterogeneity in previous provider training and experience based on prescribing ability and in line with the goal of developing customized provider training in PrEP,

models were then stratified by prescriber status for the outcomes of knowledge, attitudes, and self-efficacy. For the self-efficacy model, "contraception self-efficacy," referring to self-efficacy in the steps of FP, was included as a covariate in this model. As we hypothesized that knowledge and attitudes were associated with provider self-efficacy[52,53], we included knowledge and attitudes as covariates in this model.

After purposeful covariate selection as described above for the full linear mixed models, reduced linear mixed models were also developed using backward selection (threshold $p < 0.2$) and assessed for consistency. Model fitness was evaluated through reviewing the Akaike information criterion (AIC). Adjusted associations between the outcome and covariates were deemed to be significant if $p < 0.05$.

Missing data was uncommon and observations were dropped from the models if data was incomplete. Analyses were restricted to respondents who responded to at least one survey item pertaining to that outcome.

Results

Survey Response

Of 742 respondents from eligible DHHS Title X regions who agreed to participate, 519 (69.9%) from 283 unique clinics completed the survey. This secondary analysis restricted the study population to providers from clinics that did not provide PrEP, resulting in 351 respondents representing 193 unique clinics (Figure 3).

Provider-, Clinic-, and County-level Characteristics

Among the 351 providers included in this study, 194 (55%) were non-prescribers the mean age was 45 years, 310 (88%) were female, and 228 (65%) were white (Table 1). Providers had worked in their respective clinics for a mean (SD) duration of 8 (8) years. 157 (45%) could

prescribe medications with or without supervision. Non-prescribing providers consisted of 131 (63%) nurses and 65 (31%) clinical staff such as health educators, counselors, medical assistants, or patient navigators.

Regarding clinic-level characteristics, 346 (70%) survey respondents were from the Southeast Title X region. 244 (70%) respondents were from clinics located in metropolitan areas and 279 (79%) from clinics classified as health departments. 123 (35%) respondents noted that their clinics provided primary care services, 227 (65%) endorsed that their clinics had staff to assist patients enrolling in Medicaid and insurance programs, and 158 (45%) reported that their clinics had a pharmacy on-site.

Regarding county-level characteristics, 113 (32%) respondents were from clinics located in catchment areas of Medicaid expansion. County HIV prevalence was a median 290 per 100,000 population.

Knowledge about PrEP

Overall, the mean sum of correct responses for knowledge survey items was 2.62 (standard deviation [SD] 1.72, Table 2). Prescribing providers had higher odds of correct responses on all individual knowledge questions and significantly higher mean sum of correct responses than non-prescribing providers ($p < 0.0001$).

Based on unadjusted models, selected covariates for the multivariable model included, at the provider-level, ability to prescribe medications and years in clinic role; at the clinic-level, clinic location in metropolitan region and on-site primary care; and at the county-level, HIV prevalence, reproductive-age women, and high-school education (Supplemental Table 1).

The overall adjusted model of knowledge revealed a significant positive association with prescribing ability (0.851 (95% CI 0.493, 1.209)) and a significant negative association with

years in primary clinic role (-0.031 (95% CI -0.053, -0.010), Table 3, Figure 7). Among non-prescribing providers, there was a significant negative association with years in primary clinic role (-0.038 (95% CI -0.0777, - 0.0099). Among prescribing providers, there were no significant covariate associations.

Attitudes towards PrEP

Overall, the mean attitudes score was 3.52 (SD 0.55), and was 3.66 for prescribing prescribers and 3.40 for non-prescribing providers (p-value < 0.0001, Table 4). However, scores on the attitudes subcategory of "Acceptability of PrEP Integration in FP Settings" did not differ by prescriber status. For the attitudes subcategory of "Clinical and Socio-behavioral Attitudes towards PrEP," prescribing providers had more favorable attitudes than non-prescribing providers ($p < 0.0001$).

Based on unadjusted models, selected covariates for the multivariable model included, at the provider-level, age, ability to prescribe medications; at the clinic-level, Metropolitan location, on-site insurance support, and on-site pharmacy; at the county-level, Medicaid expansion, HIV prevalence, reproductive-age women, uninsured, and high-school education (Supplemental Table 2).

The overall adjusted model of attitudes revealed a significant positive association with prescribing ability (0.192 (95% CI 0.071, 0.313), Table 5, Figure 8). Among non-prescribing providers, there were significant positive associations with on-site insurance support (0.180 (95% CI 0.021, 0.340)) and county HIV prevalence (0.095 (95% CI 0.004, 0.186)). Among prescribing providers, there was significant positive association with county percent high school education (0.022 (95% CI 0.003, 0.040)).

Self-efficacy in PrEP Care

Overall, the mean self-efficacy score was 3.35 (SD 0.78), and was 3.71 for prescribing providers and 3.05 for non-prescribing providers (p-value < 0.0001, Table 6). When self-efficacy survey items were grouped by the steps of PrEP care, scores were higher among prescribing providers regarding each step (p < 0.0001). Comparison of scores between steps indicated prescribing and non-prescribing providers were most confident in PrEP screening, less confident regarding PrEP follow-up, and least confident regarding PrEP initiation (p < 0.0001).

Based on unadjusted models, selected covariates for the multivariable model included, at the provider-level, ability to prescribe medications, knowledge, attitudes, and contraception self-efficacy; at the clinic-level, on-site insurance support; and at the county-level, Medicaid expansion, HIV prevalence, Hispanic/Latinx, uninsured, and high school education (Supplemental Table 3).

The overall adjusted model of self-efficacy demonstrated significant associations with prescribing ability (0.424 (95% CI 0.290, 0.559)), attitudes towards PrEP (0.213 (95% CI 0.094, 0.332)), contraception self-efficacy (0.439 (95% CI 0.367, 0.511)), and county percent Hispanic/Latinx in the population (-0.089 (95% CI -0.162, -0.017), Table 7, Figure 9). Among prescribing providers, there were significant associations with knowledge (0.064 (95% CI 0.007, 0.122)), contraception self-efficacy (0.459 (95% CI 0.328, 0.589)), county percent uninsured (0.038 (95% CI 0.011, 0.065)), and county percent Hispanic/Latinx (-0.136 (95% CI -0.236, -0.037)). Among non-prescribing providers, there were significant associations with attitudes towards PrEP (0.276 (95% CI 0.097, 0.455)) and contraception self-efficacy (0.435 (95% CI 0.346, 0.524)).

Discussion

We characterized associations between provider-, clinic-, and county characteristics and knowledge, attitudes, and self-efficacy in PrEP care among providers in Title X-funded FP clinics that do not provide PrEP in the Southern US and found that provider ability to prescribe medications is associated with higher scores. This analysis also reveals gaps in provider confidence in certain steps of PrEP care and elucidates potential avenues to customize provider training or develop models of care to bridge these gaps.

Our finding that provider PrEP knowledge was higher among prescribing providers was expected due to differences in background training and experience for these groups. PrEP knowledge was also negatively associated with provider years in primary role at the clinic, indicating that providers further out from clinical training may benefit from continuing medical education covering PrEP. Among prescribing providers, there were no additional covariates associated with PrEP knowledge, further emphasizing that the clinical content of PrEP training should be tailored by prescriber status, but may not need customization beyond this.

Similarly, attitudes toward PrEP were more favorable among prescribing providers. However, when PrEP attitudes were subcategorized, there was more nuance. While both prescribing and non-prescribing providers had favorable attitudes regarding integration of PrEP in FP settings, non-prescribing providers had significantly less favorable attitudes regarding the clinical and sociological aspects of PrEP, such as higher concerns about PrEP efficacy, drug resistance, and risk compensation. These findings suggest that PrEP training for non-prescribing providers should provide education directed to overcome unfavorable perceptions of PrEP, particularly as more favorable attitudes regarding an intervention can strengthen self-efficacy[54].

While prescribing providers had significantly higher self-efficacy scores compared to non-prescribing providers, both groups had the least confidence in the PrEP initiation steps compared to the other steps of PrEP care. This finding aligns with previous literature describing low PrEP prescription rates despite a high-level of provider awareness and support for PrEP in the US[8,23,55]. Furthermore, other studies have suggested that decreased knowledge about insurance navigation stymies providers' ability to prescribe PrEP[23,56]. Lack of on-site primary care services and Medicaid expansion may add insurance navigation challenges and contribute to lack of provider confidence in the PrEP initiation step[23,56,57].

Analysis of self-efficacy by prescriber status revealed that higher PrEP knowledge was associated with increased confidence in PrEP care among prescribing providers, but favorable attitudes about PrEP was associated among non-prescribing providers. Coupled with our findings that non-prescribing providers had less favorable attitudes toward PrEP, especially in its clinical and sociological aspects, training for non-prescribing providers that improves PrEP attitudes may concomitantly improve self-efficacy, in line with the literature[54,58]. The observed association between contraception and PrEP self-efficacy suggests that contraception self-efficacy may be a proxy measure of overall clinical confidence among FP providers. However, this finding also suggests that an important goal of training may be to integrate PrEP training with general FP training.

Our findings support that provider training can be customized to address provider knowledge, attitudes, and self-efficacy in PrEP care[8,23]. This effect of customized training has been demonstrated in other areas of healthcare. One narrative review revealed that tailored strategies addressing providers' self-efficacy and knowledge may improve negative attitudes towards buprenorphine prescription for opioid use disorder[54]. Another study found that training

leading to improved self-efficacy and knowledge served as a facilitator for effective implementation of evidence-based tobacco use treatment in health centers[53]. Emerging PrEP literature also supports customized training in PrEP; one recent study suggests that providers have varying preferences in PrEP training content and format depending on their level of PrEP experience along four stages – awareness of PrEP, willingness to prescribe PrEP, discussion of PrEP with patients, and actual prescription of PrEP [8,23]. While various PrEP training formats exist, ranging from targeted on-site trainings to online modules, our findings support utilizing provider, clinical setting, and geographic characteristics to shape existing trainings for specific audiences[23,59].

In addition to the need for customized training, the "train-the-trainer" model can be applied to improve PrEP training. This model has succeeded in disseminating HPV vaccine education with subsequent increased delivery and uptake of the vaccine[60]. A core aspect of this model is to train providers and staff who commit to conducting trainings in their workplace, thus creating enhanced credibility. This model may work well in the world of PrEP education, particularly targeting prescribing and non-prescribing providers involved in the steps of PrEP care. Training clinicians and staff has been noted to be integral to improving PrEP delivery, particularly PrEP initiation[56].

Findings from this study elucidate potential paths for optimizing provider PrEP training. Our analyses suggest tailoring training based on an initial survey assessment of PrEP knowledge, attitudes, and self-efficacy, along with by prescribing ability, are first steps to customize PrEP training. In addition, our findings support development of trainings that focus on addressing unfavorable clinical and sociological attitudes towards PrEP across clinic staff and integrating PrEP training with FP training. Finally, our findings demonstrate that confidence in the steps of

PrEP care correlates with knowledge and attitudes about PrEP, supporting addressing all three components to improve provider confidence across PrEP care steps. Previous literature has indicated that training targeting provider knowledge and self-efficacy can simultaneously enhance provider attitudes, suggesting that these three constructs are inter-connected[61].

This study not only informs how to tailor PrEP training, but also informs models of care that can expand PrEP delivery (Figure 7). Given that providers were least confident in the PrEP initiation step of PrEP care, alternative PrEP delivery strategies, such as employing telehealth with PrEP providers or referring out to PrEP-specific clinics for PrEP initiation may allow providers in clinical settings that are new to PrEP to more easily move from PrEP awareness and willingness to PrEP prescription while maintaining longitudinal care with their patients. This model of care delivery may be used as a "bridge program" for clinics until providers gain the necessary resources and comfort to conduct PrEP initiation.

On-site insurance assistance and Medicaid expansion were associated with more favorable PrEP attitudes, though findings were not statistically significant in all models. Our previous findings demonstrated that on-site insurance assistance was associated with PrEP implementation readiness among clinics that did not provide PrEP[10]. Extending these results to customized training, provider training should include training about insurance navigation, especially for providers practicing in areas without Medicaid expansion or with limited financial assistance programs for PrEP.

We acknowledge several limitations. This study was based on a convenience sample of providers, thus introducing potential selection bias. As this was an exploratory analysis of a survey in which the number of covariates measured is limited, there is potential for unmeasured confounders. For example, the level of provider education was not measured in this survey but

could affect PrEP knowledge. County-level factors investigated may be subject to unmeasured confounders or be interrelated. For example, the county-level covariate measuring percent Hispanic/Latinx was a significant covariate in certain models; this finding may result from an unmeasured confounder. While collinear covariates were excluded from our multivariable analysis, assessment of collinearity does not account for all potential interaction between measured and unmeasured covariates.

In conclusion, optimizing provider knowledge, attitudes, and self-efficacy in PrEP is an important first step to develop effective PrEP delivery in FP settings and other clinical care settings in high HIV burden areas. Our results indicate that training focused on PrEP initiation for all providers in the clinical care team (or alternative care models to support PrEP initiation) may be a key strategy to move FP providers from PrEP awareness to prescription. Our analysis also suggests that addressing provider lack of knowledge and concerns about PrEP may improve confidence across the steps of PrEP care. Future implementation studies should focus on tailoring provider trainings and models of care to strengthen the ability of clinics to prescribe and start PrEP in order to improve PrEP delivery and uptake for women in the South.

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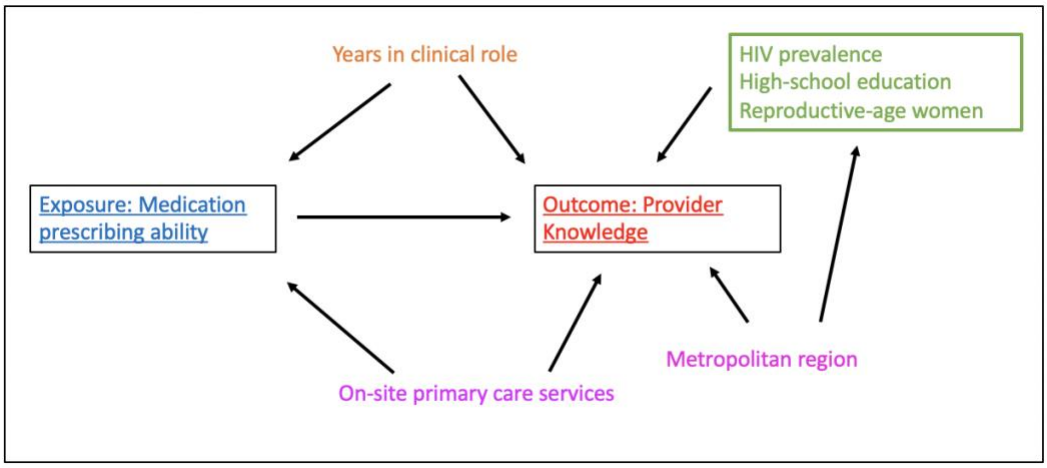
Tables and Figures



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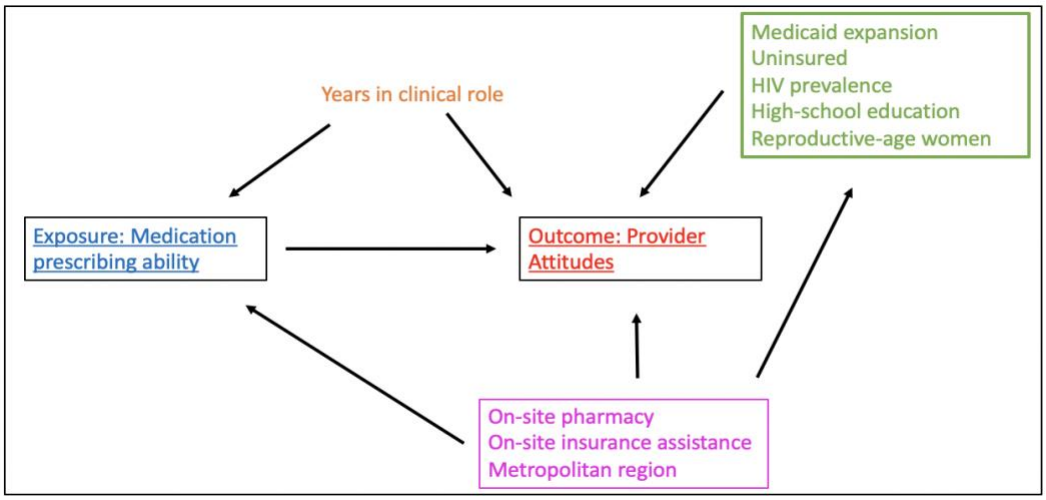

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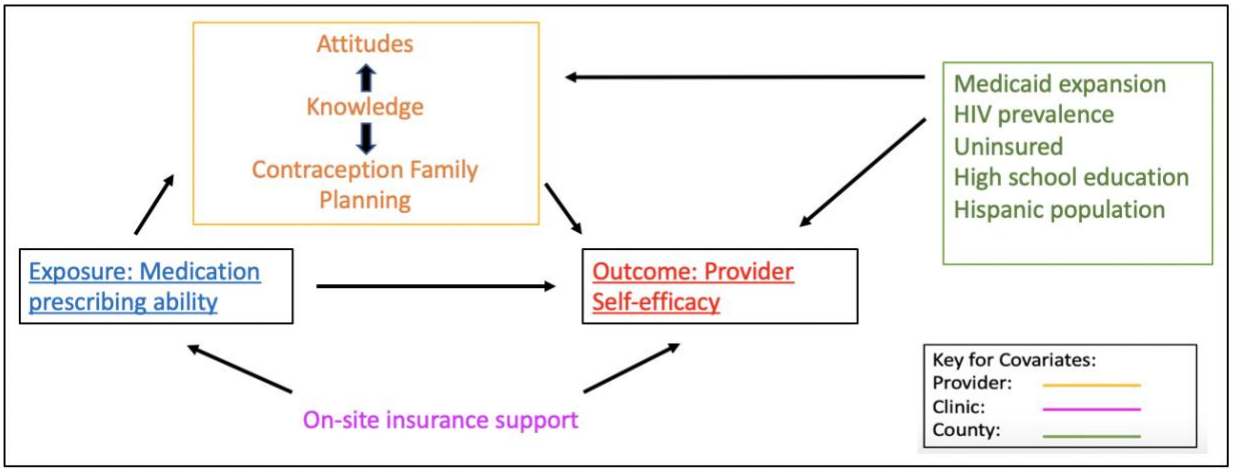

1c.

Figure 1a-c. Direct acyclic graphs describing the hypothesized relationship between the exposure of interest (provider ability to prescribe medications) and the outcome of interest (Provider Knowledge, Attitudes, and Self-efficacy).

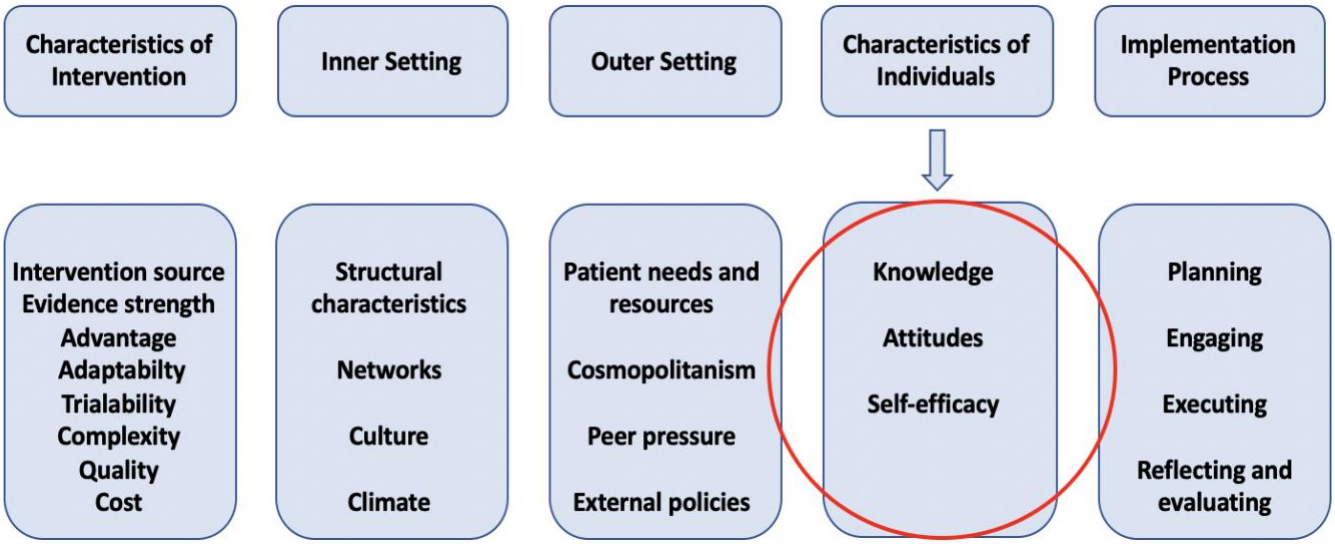

Figure 2. Overview of the Consolidated Framework for Implementation Research (CFIR), highlighting the study outcomes of Knowledge, Attitudes, and Self-efficacy in PrEP care[24,62].

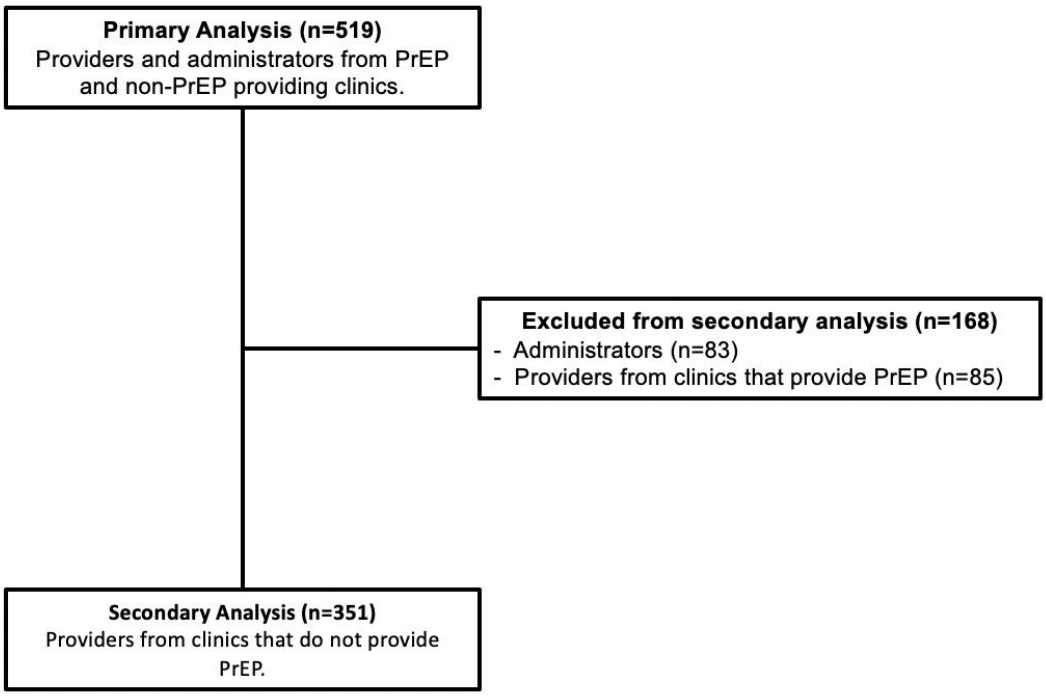

Figure 3. Flow diagram of participants eligible for secondary analysis of the Planning4PrEP survey.

Knowledge: Individuals' beliefs/ value placed on the intervention; familiarity with related facts, truths, and principles.
1. PrEP is an FDA-approved method for HIV prevention that involves: (blank) 2. In clinical trials of sexually active adults, among patients who took PrEP as prescribed, the efficacy of PrEP in preventing HIV was: (blank) 3. Which medication has been FDA-approved for PrEP use? 4. Your patient had a high-risk sexual exposure 3 weeks ago and wants to start PrEP. What is/are the best test(s) to determine HIV status? 5. How often should patients on PrEP be followed for medication side effects and lab toxicities after initial assessment?
Attitudes: Individuals' attitudes toward the intervention.
1. Do you think HIV prevention education is an essential part of family planning visits? 2. Do you think PrEP education is an essential part of HIV prevention education during family planning visits? 3. PrEP would have a visible and substantial impact on the health status of patients at my clinic. 4. It is more suitable to provide PrEP in STD clinics than in family planning clinics. 5. It is more suitable to provide PrEP in clinics that specialize in HIV care than in family planning clinics. 6. The use of PrEP will increase HIV drug resistance. 7. I am concerned that PrEP is not effective. 8. The use of PrEP will result in less federal funding for HIV treatment. 9. Non-biomedical (behavioral) HIV prevention interventions should be attempted before prescribing PrEP. 10. The use of PrEP will cause patients to engage in riskier behaviors. 11. For an HIV-negative patient in a relationship with an HIV-positive partner, treating the HIV-positive partner with antiretroviral therapy (ART) should be attempted instead of prescribing PrEP. 9. For an HIV-negative patient in a relationship with an HIV-positive partner, treating the HIV-positive partner with ART should be attempted before prescribing PrEP. 12. I am concerned about the potential side effects of PrEP.
Self-efficacy: Individual belief in own capabilities to execute courses of action to achieve implementation goals.
1. I can screen a patient for symptoms of acute HIV. 2. I can assess a patient's HIV risk using the CDC PrEP guidelines. 3. I can test a patient for HIV. 4. I can assess a patient's readiness for PrEP. 5. I can assess a patient's kidney function. 6. I can test a patient for active hepatitis B virus (HBV) infection and interpret results. 7. I can ensure a patient is not taking any concomitant medications that may affect their ability to take PrEP. 8. I can counsel a patient on the potential side effects of PrEP. 9. I can counsel a patient on PrEP adherence. 10. I can prescribe PrEP to a patient. 11. I can help patients navigate insurance payments regarding PrEP treatment. 12. I can refer patients to experts in PrEP and HIV when necessary. 13. I can conduct 3-month follow up visits for: Medication adherence counseling and side-effect assessment. 14. I can conduct 3-month follow up visits for: Laboratory testing (HIV, STI, kidney function, and pregnancy testing).

Figure 4. Characteristics of CFIR outcomes and corresponding survey questions.

Figure 5. The steps of PrEP care for providers: Screening of persons eligible for PrEP, initiation of PrEP, and follow-up of persons taking PrEP.

Provider-level	Clinic-level	County-level
• Age • Gender • Race/ethnicity • Clinic role • Years in clinic role • Ability to prescribe medications • Contraception self-efficacy	• Clinic type • On-site insurance assistance • On-site pharmacy • On-site primary care • Metropolitan • DHHS Region	• HIV prevalence • Poverty • Uninsured • High school education • Reproductive-age females • Medicaid expansion • Race/ethnicity

Figure 6. Definition of provider-, clinic-, and county-level covariates.

Table 1. Description of characteristics for providers of Title X family planning clinics in the Southern US that do not provide PrEP by prescriber status.

VARIABLE	ALL PROVIDERS (N = 351)	PRESCRIBING PROVIDERS* (N = 157)	NON-PRESCRIBING PROVIDERS (N = 194)
Provider-level characteristics			
Age (in years), mean (SD$^{\phi}$)	45.32 (11.93)	47.2 (12.78)	43.71 (10.94)
Gender, n (%)			
Male	3 (1.0)	0 (0)	3 (1.8)
Female	310 (98.7)	142 (99.3)	168 (98.2)
Genderqueer	1 (0.3)	1 (0.7)	0 (0)
Non-binary	0 (0)	0 (0)	0 (0)
Ethnicity, n (%)			
Latino/Latina/Latinx	12 (3.9)	3 (2.2)	9 (5.3)
Not Latino/Latina/Latinx	296 (96.1)	135 (97.8)	162 (94.7)
Race, n (%)			
Asian/Pacific Islander	6 (2.0)	4 (2.8)	2 (1.2)
Black/African-American	57 (18.6)	19 (13.5)	38 (22.5)
Native American/Alaskan Native	1 (0.3)	4 (2.8)	1 (0.6)
White	228 (74.5)	111 (78.7)	117 (69.2)
Other	3 (1.0)	0 (0)	3 (1.8)
More than one race	11 (3.6)	3 (1.6)	8 (4.7)
Primary role(s) at clinic** n (%)			
Clinical provider (NP, CNM, PA, MD, DO)	157 (44.7)	157 (80.10)	0 (0)
Nurse	157 (44.7)	26 (13.27)	131 (63.29)
Health Educator, Counselor, Health Care Associate, Medical Assistant, or Patient Navigator	69 (19.7)	4 (2.04)	65 (31.40)
Other provider	7 (2.0)	1 (0.52)	6 (2.90)
Other administrator	13 (3.7)	8 (4.08)	5 (2.42)
Years worked at the clinic, mean (SD)	8.37 (8.22)	8.64 (8.18)	8.16 (8.27)
Years worked at the clinic in primary role, mean (SD)	8.12 (8.33)	8.46 (7.88)	7.85 (8.70)
Years worked at the clinic in primary role, n (%)			
1-2	113 (32.4)	45 (28.7)	68 (35.4)
3-5	73 (20.9)	33 (21.0)	40 (20.8)
6+	163 (46.7)	79 (50.3)	84 (43.8)
Clinic-level characteristics			
Location, n (%)			
Metropolitan	244 (69.52)	116 (73.89)	128 (65.98)
Non-metropolitan	107 (30.48)	41 (26.11)	66 (34.02)
Services provided at clinic, n (%)			
Family Planning	223 (63.5)	105 (66.9)	118 (60.8)
Primary Care	2 (0.6)	2 (1.3)	0 (0)
Both	121 (34.5)	47 (29.9)	74 (38.1)
Other	5 (1.4)	3 (1.9)	2 (1.0)
Primary Care Services Provided at clinic, n (%)			
Yes	123 (35.04)	49 (31.21)	89 (45.88)

No	228 (64.96)	74 (38.14)	105 (54.12)
Staff to assist patients enrolling In Medicaid and insurance programs, n (%)			
Yes	227 (64.67)	107 (68.15)	120 (61.86)
No/Unknown	124 (35.33)	50 (31.85)	74 (38.14)
Respondent's clinic has a pharmacy on site, n (%)			
Yes	158 (45.3)	69 (44.5)	89 (45.9)
No/Unknown	191 (54.7)	86 (55.5)	105 (54.1)
Clinic Type, n (%)			
Family Planning	8 (2.3)	6 (3.8)	2 (1.0)
Health Department	279 (79.7)	114 (72.6)	165 (85.5)
Hospital	20 (5.7)	15 (9.6)	5 (2.6)
Planned Parenthood	2 (0.6)	2 (1.3)	0 (0)
Federally Qualified Health Center	27 (7.7)	12 (7.6)	15 (7.8)
Community	7 (2.0)	4 (2.5)	3 (1.6)
School	5 (1.4)	3 (1.9)	2 (1.0)
Other	2 (0.6)	1 (0.6)	1 (0.5)
Clinic Title X Region, n (%)			
Region III (Mid-Atlantic)	72 (20.5)	43 (27.4)	29 (15.0)
Region IV (Southeast)	246 (70.1)	97 (61.8)	149 (76.8)
Region VI (Southwest)	33 (9.4)	17 (10.8)	16 (8.3)
County-level characteristics			
Medicaid Expansion[#], n (%)			
Yes	113 (32.2)	61 (38.9)	52 (26.8)
No	238 (67.8)	96 (61.2)	142 (73.2)
HIV prevalence rate (per 100,000 population), median (IQR[Ω])	289.5 (351.0)	347.5 (397.5)	259.0 (365.0)
Reproductive-age women (15 - 44 years) (%), mean (SD)	20.18 (3.12)	20.73 (3.57)	19.73 (2.60)
Hispanic Or Latinx, median (IQR)	5.90 (6.10)	7.10 (5.60)	5.50 (4.60)
White Race (%), mean (SD)	68 (18.93)	69.68 (17.60)	66.66 (19.89)
Black Race (%), mean (SD)	23.36 (18.61)	20.94 (16.85)	25.32 (19.75)
Uninsured (%), mean (SD)	12.73 (3.42)	12.25 (3.62)	13.12 (3.20)
Living in Poverty (%), mean (SD)	18.56 (5.18)	17.62 (5.29)	19.32 (4.96)
High School Education (%), mean (SD)	84.63 (5.35)	85.91 (5.10)	83.60 (5.33)

ϕSD: Standard deviation.
*Prescribers included providers who could prescribe with and without physician supervision. 81 (51.6%) could prescribe independently and 76 (48.4%) could prescribe with physician supervision.
**Providers could select multiple roles.
ΩIQR: Interquartile range.
#In clinic catchment area.
1. N may vary slightly across characteristics due to some missing data.
2. Column percents may not total 100 due to rounding.

Table 2. Differences in Knowledge about PrEP between Prescribing and Non-prescribing Providers.

Knowledge about PrEP Question Text	**Number of correct respondents** N (% correct)	**Prescribing providers** N (% correct)	**Non-prescribing providers** N (% correct)	**OR (CI)**[ϕ]	***p*-value**[ϕ]
PrEP is an FDA-approved method for HIV prevention that involves: (blank)	204 (58.12)	114 (55.88)	90 (44.12)	3.06 (1.95 – 4.81)	<0.0001
In clinical trials of sexually active adults, among patients who took PrEP as prescribed, the efficacy of PrEP in preventing HIV was: (blank)	163 (46.44)	90 (55.21)	73 (44.79)	2.23 (1.45 – 3.42)	0.0002
Which medication has been FDA-approved for PrEP use?	198 (56.41)	108 (54.55)	90 (45.45)	2.55 (1.64 – 3.95)	<0.0001
Your patient had a high-risk sexual exposure 3 weeks ago and wants to start PrEP. What is/are the best test(s) to determine HIV status? (VL and/or Ag/Ab)	132 (37.61)	79 (59.85)	53 (40.15)	2.69 (1.73 – 4.20)	<0.0001
How often should patients on PrEP be followed for medication side effects and lab toxicities after initial assessment?	213 (60.68)	105 (49.30)	108 (50.70)	1.67 (1.07 – 2.60)	0.0234
Sum of correct responses* - Mean (SD)	2.62 (1.72)	3.21 (1.57)	2.17 (1.72)	----	<0.0001

Abbreviations: FDA = Food and Drug Administration; OR = odds ratio; CI = confidence interval; VL = viral load of HIV; Ag/Ab = Antigen-Antibody test for HIV; SD = standard deviation.

ϕ OR(CI) and *p*-value calculated by chi square except as noted.

* *p*-value calculated by t-test.

1. Range of sum of correct responses: 0 - 5

Table 3. Generalized Linear Mixed Models of Knowledge about PrEP among Providers[♦].

Covariate	Parameter estimate (β) (95% CI)	Standard error	*p*-value[b]
All Providers (n=351)			
Able to prescribe medications	0.851 (0.493, 1.209)	0.182	<0.0001
Years in primary role at clinic	-0.031 (-0.053, -0.010)	0.011	0.0044
Primary care services provided	-0.411 (-0.835, 0.014)	0.215	0.0580
HIV prevalence rate (log)	0.203 (-0.020, 0.427)	0.113	0.0739
Model Intercept	1.567 (0.276, 2.858)	0.654	0.0176
Non-prescribing Providers (n =194)			
Years in primary role at clinic	-0.033 (-0.061, 0.005)	0.014	0.0221
Reproductive-age women (%)	0.105 (-0.001, 0.211)	0.053	0.0523
Model Intercept	0.483 (-1.658, 2.624)	1.081	0.6557
Prescribing Providers (n=157)			
Years in primary role at clinic	-0.014 (-0.048, 0.020)	0.017	0.4269
Primary care services provided	-0.419 (-1.023, 0.185)	0.304	0.1712
HIV prevalence rate (log)	0.210 (-0.109, 0.529)	0.159	0.1926
High-school education (%)	0.043 (-0.012, 0.098)	0.028	0.1213
Model Intercept	-1.485 (-6.393, 3.424)	2.451	0.5472

[♦]All statistics calculated using a generalized linear mixed model.
1. All models represent reduced models.

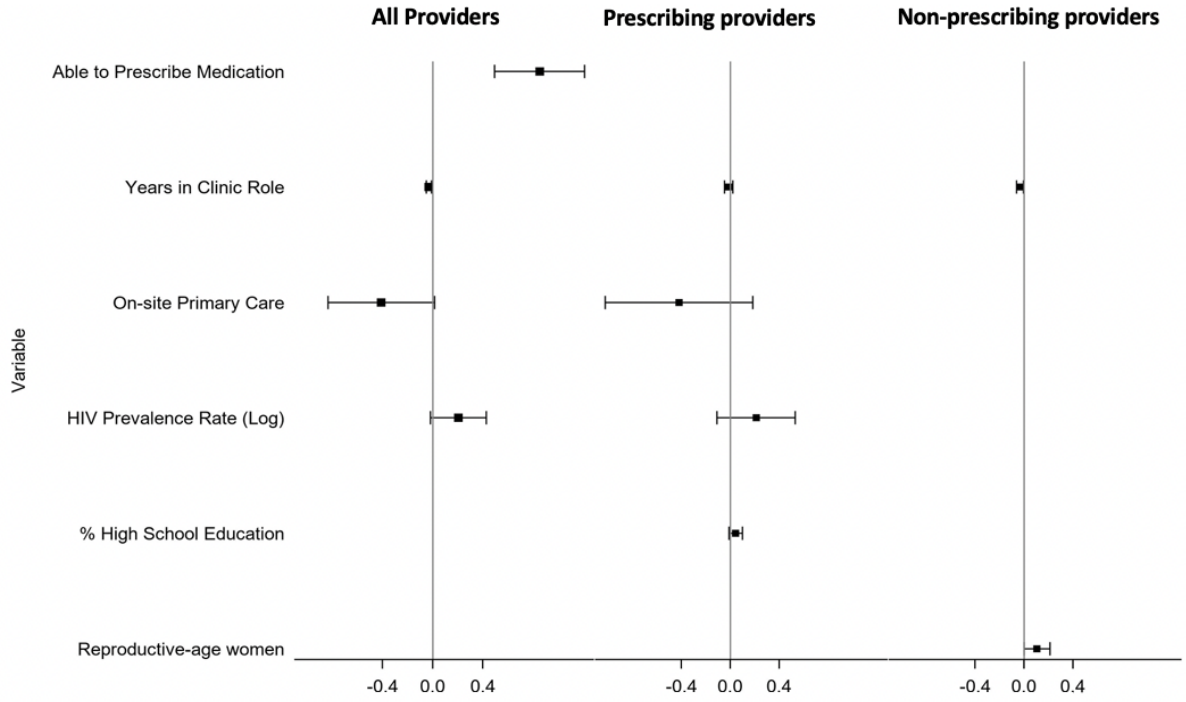

Figure 7. Linear Mixed Model Results for Knowledge about PrEP among all providers, prescribing providers, and non-prescribing providers. Variables were selected for inclusion in the reduced model using a backward selection approach. Variables missing in the model results were not selected. The percent and prevalence rate variables are the percents or log transformed percents or rate among the county population where the provider's clinic is located and based on data from the U.S. Census Bureau 2010 Census and AIDSVu. The points indicate linear mixed model estimates and whiskers indicate 95% confidence intervals.

Table 4. Differences in Attitudes towards PrEP between Prescribing and Non-prescribing Providers.

Individual Attitudes Question Text (Grouped by Topic)	**All Providers** Mean (SD) N = 351	**Prescribing providers** Mean (SD) N = 157	**Non-prescribing providers** Mean (SD) N = 194	***p*-value**
Acceptability of PrEP Integration in FP Settings				
Do you think HIV prevention education is an essential part of family planning visits*?	4.56 (0.94)	4.46 (1.0)	4.64 (0.88)	0.0688
Do you think PrEP education is an essential part of HIV prevention education during family planning visits*?	3.64 (1.28)	3.62 (1.30)	3.65 (1.28)	0.8191
It is more suitable to provide PrEP in STD clinics than in family planning clinics$^{\Omega}$.	2.93 (1.07)	2.96 (1.12)	2.91 (1.04)	0.6362
It is more suitable to provide PrEP in clinics that specialize in HIV care than in family planning clinic$^{\Omega}$.	2.92 (1.16)	2.87 (1.22)	2.06 (1.11)	0.4650
***Summary of Acceptability of PrEP Integration*[1]**	3.59 (0.80)	3.57 (0.82)	3.62 (0.79)	0.5717
Clinical and Sociological Attitudes towards PrEP				
The use of PrEP will increase HIV drug resistance$^{\Omega}$.	2.41(0.85)	2.16 (0.88)	2.61 (0.77)	<0.0001
I am concerned that PrEP is not effective$^{\Omega}$.	2.13 (0.90)	1.85 (0.85)	2.35 (0.87)	<0.0001
I am concerned about the potential side effects of PrEP$^{\Omega}$.	2.92 (0.91)	2.82 (1.03)	3.0 (0.81)	0.0755
The use of PrEP will cause patients to engage in riskier behaviors$^{\Omega}$.	2.53 (0.99)	2.31 (1.02)	2.71 (0.93)	0.0002
Non-biomedical (behavioral) HIV prevention interventions should be attempted before prescribing PrEP$^{\Omega}$.	2.92 (1.08)	2.69 (1.20)	3.10 (0.94)	0.0006
For an HIV-negative patient in a relationship with an HIV-positive partner, treating the HIV-positive partner with ART should be attempted *instead of* prescribing PrEP$^{\Omega}$.	2.35 (0.97)	2.0 (0.94)	2.64 (0.89)	<0.0001
For an HIV-negative patient in a relationship with an HIV-positive partner, treating the HIV-positive partner with ART should be attempted *before* prescribing PrEP$^{\Omega}$.	2.59 (1.01)	2.27 (1.05)	2.85 (0.91)	<0.0001

The use of PrEP will result in less federal funding for HIV treatment$^{\Omega}$.	2.26 (0.88)	2.01 (0.87)	2.46 (0.84)	<0.0001
PrEP would have a visible and substantial impact on the health status of patients at my clinic*.	3.46 (0.82)	3.57 (0.84)	3.38 (0.79)	0.0310
Summary of Clinical and Sociological Attitudes towards PrEP[1]	3.48 (0.60)	3.71 (0.62)	3.30 (0.51)	<0.0001
Summary of Overall Attitudes towards PrEP[1]	3.52 (0.55)	3.66 (0.58)	3.40 (0.50)	<0.0001

Abbreviations: FP = family planning; STD = sexually transmitted disease/infection; ART = antiretroviral therapy; SD = standard deviation.
*Questions based on Likert scale of 1 (Strongly Disagree) – 5 (Strongly Agree) with higher scores representing more favorable attitudes.
$^{\Omega}$Questions based on Likert scale of 1 (Strongly Disagree) – 5 (Strongly Agree) with higher scores representing more unfavorable attitudes.
1. Means of groups of question scores were recoded such that Likert scales had the same directionality, with higher scores representing more favorable attitudes towards PrEP care and implementation.

Table 5. Generalized Linear Mixed Models of Attitudes towards PrEP among Providers[ɸ].

Reduced Model

Covariate	Parameter estimate (β) (95% CI)	Standard error	*p*-value
All Providers (n = 351)			
Able to prescribe medication	0.192 (0.071, 0.313)	0.061	0.0020
On-site Insurance support	0.106 (-0.017, 0.230)	0.063	0.0915
HIV prevalence rate (log)	0.065 (-0.010, 0.141)	0.038	0.0893
Medicaid expansion	0.137 (-0.007, 0.281)	0.073	0.0625
High-school education (%)	0.010 (-0.003, 0.023)	0.007	0.1334
Model Intercept	2.135 (1.062, 3.208)	0.542	0.0001
Non-prescribing providers (n = 194)			
Medicaid expansion	0.117 (-0.070, 0.303)	0.094	0.2164
On-site Insurance support	0.180 (0.021, 0.340)	0.081	0.0269
On-site Pharmacy	-0.137 (-0.297, 0.022)	0.080	0.0902
HIV prevalence rate (log)	0.095 (0.004, 0.186)	0.045	0.0411
Model Intercept	2.803 (2.283, 3.323)	0.258	<0.0001
Prescribing providers (n = 157)			
Medicaid expansion	0.123 (-0.074, 0.319)	0.988	0.2186
High-school education (%)	0.022 (0.003, 0.040)	0.009	0.0242
Model Intercept	1.750 (0.140, 3.361)	0.811	0.0335

[ɸ]All statistics calculated using a generalized linear mixed model.
1. All models represent reduced models.

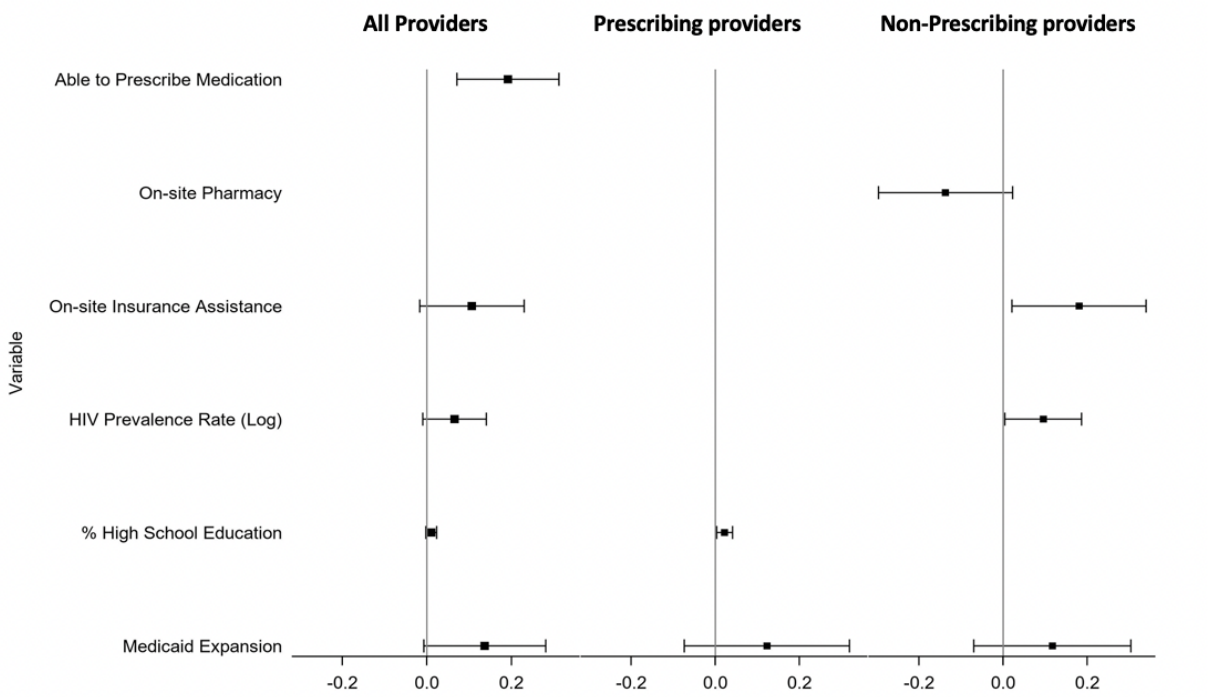

Figure 8. Linear Mixed Model Results for Attitudes towards PrEP among all providers, prescribing providers, and non-prescribing providers. Variables were selected for inclusion in the reduced model using a backward selection approach. Variables missing in the model results were not selected. The percent and prevalence rate variables are the percents or log transformed percents or rate among the county population where the provider's clinic is located and based on data from the U.S. Census Bureau 2010 Census and AIDSVu. The points indicate linear mixed model estimates and whiskers indicate 95% confidence intervals.

Table 6. Differences in Self-efficacy in PrEP care between Prescribing and Non-prescribing Providers.

Provider Self-Efficacy Survey Topics and Questions[ϕ]	All Providers N = 325 (mean, SD)	Prescribing providers N = 149 (mean, SD)	Non-prescribing providers N = 176 (mean, SD)	*P*-value[*]
PrEP Screening	3.57 (0.81)	3.94 (0.64)	3.25 (0.81)	<0.0001
A. Patient Engagement HIV risk assessment per CDC PrEP guidelines. PrEP readiness assessment. PrEP side-effects counseling. PrEP adherence counseling. Patient referral to subspecialists for PrEP/HIV.	3.67 (0.84)	4.02 (0.66)	3.38 (0.86)	<0.0001
B. Initial Clinical Evaluation Test for HIV. Screen for acute HIV. Kidney function assessment. Test for and interpret active hepatitis B virus results. PrEP medication interactions assessment.	3.46 (0.91)	3.86 (0.75)	3.12 (0.90)	<0.0001
PrEP Initiation PrEP prescription. PrEP insurance navigation.	2.33 (0.95) 2.34 (1.26) 2.31 (1.03)	2.70 (1.02) 3.07 (1.31) 2.32 (1.05)	2.01 (0.76) 1.73 (0.82) 2.30 (1.01)	<0.0001
PrEP Follow-up Medication adherence counseling and side-effect assessment. Appropriate interval laboratory testing.	3.29 (1.15)	3.55 (1.13)	3.07 (1.12)	<0.0001
Overall PrEP Self-Efficacy	3.35 (0.78)	3.71 (0.66)	3.05 (0.75)	<0.0001
Contraception Self-Efficacy Pregnancy intentions and contraceptive counseling initial assessment. Pregnancy intentions and contraceptive counseling follow-up.	4.03 (0.92)	4.28 (0.70)	3.82 (1.03)	<0.0001

1. Self-efficacy scores for each step of PrEP care represent the means of scores corresponding to questions within each step. 2. Overall PrEP Self-Efficacy represents the mean of all steps of PrEP care.[ϕ]Survey question text is abridged in this table to highlight question topic. [*]*P*-values comparing prescribing and non-prescribing provider self-efficacy scores were calculated using unpaired t-tests. *P*-values described in the manuscript text comparing self-efficacy scores between the steps of the PrEP care were calculated using paired t-tests.

Table 7. Generalized Linear Mixed Models of Self-efficacy in PrEP care among Providers[ϕ]

Covariate	Parameter estimate (β) (95% CI)	Standard error	*p*-value
All Providers (n = 351)			
Able to prescribe medication	0.424 (0.290, 0.559)	0.069	<0.0001
Contraception self-efficacy	0.439 (0.367, 0.511)	0.037	<0.0001
Attitudes towards PrEP	0.213 (0.094, 0.332)	0.061	0.0005
Hispanic or Latinx (log, %)	-0.089 (-0.162, -0.017)	0.037	0.0162
On-site Insurance support	0.104 (-0.029, 0.237)	0.067	0.1241
Model Intercept	0.726 (0.253, 1.198)	0.240	0.0027
Non-prescribing providers (n = 194)			
Contraception self-efficacy	0.435 (0.346, 0.524)	0.045	<0.0001
Attitudes towards PrEP	0.276 (0.097, 0.455)	0.091	0.0028
Hispanic or Latinx (log, %)	-0.093 (-0.208, 0.021)	0.058	0.1080
Model Intercept	0.604 (-0.125, 1.333)	0.369	0.1038
Prescribing providers (n = 157)			
Contraception self-efficacy	0.459 (0.328, 0.589)	0.066	<0.0001
Knowledge about PrEP	0.064 (0.007, 0.122)	0.029	0.0282
Attitudes towards PrEP	0.113 (-0.045, 0.271)	0.080	0.1606
On-site Insurance support	0.154 (-0.025, 0.333)	0.091	0.0918
Hispanic or Latinx (log, %)	-0.136 (-0.236, -0.037)	0.050	0.0078
Uninsured (%)	0.038 (0.011, 0.065)	0.014	0.0064
Model Intercept	0.847 (0.109, 1.585)	0.373	0.0248

[ϕ]All statistics calculated using a generalized linear mixed model.
1. All models represent reduced models.

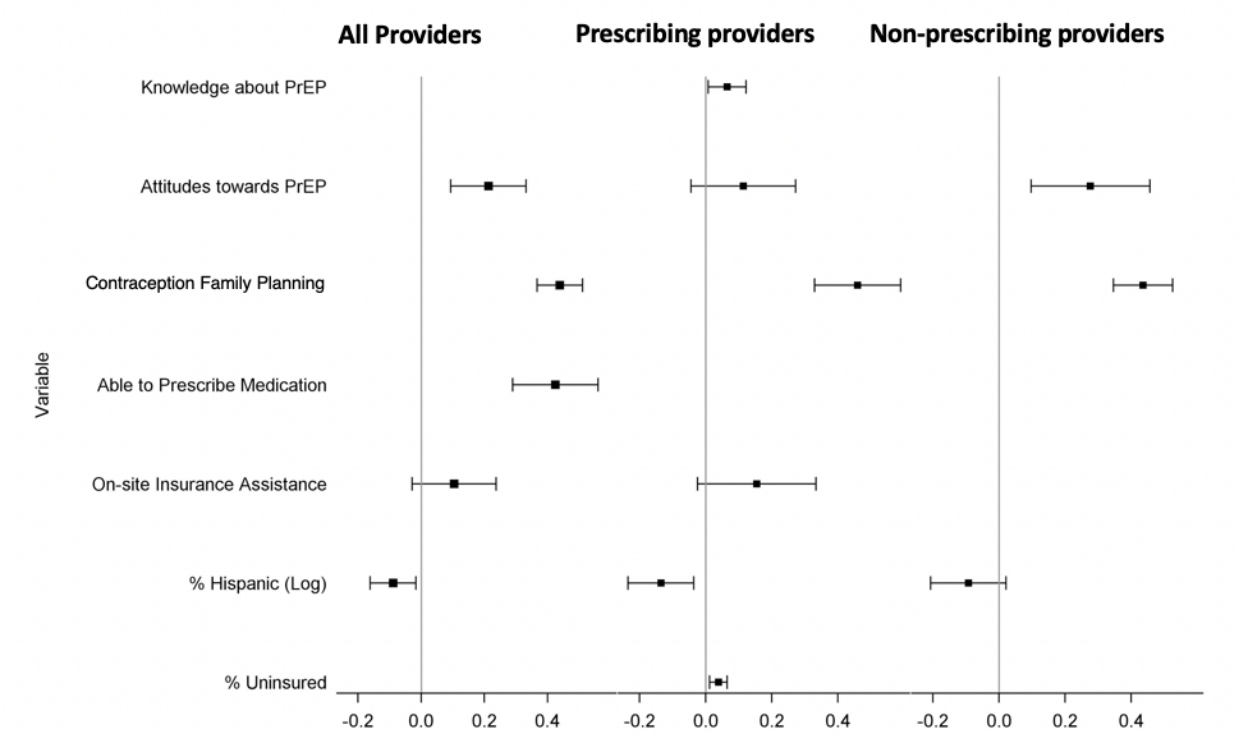

Figure 9. Linear Mixed Model Results for Self-efficacy in PrEP care among all providers, prescribing providers, and non-prescribing providers. Variables were selected for inclusion in the reduced model using a backward selection approach. Variables missing in the model results were not selected. The percent and prevalence rate variables are the percents or log transformed percents or rate among the county population where the provider's clinic is located and based on data from the U.S. Census Bureau 2010 Census and AIDSVu. The points indicate linear mixed model estimates and whiskers indicate 95% confidence intervals.

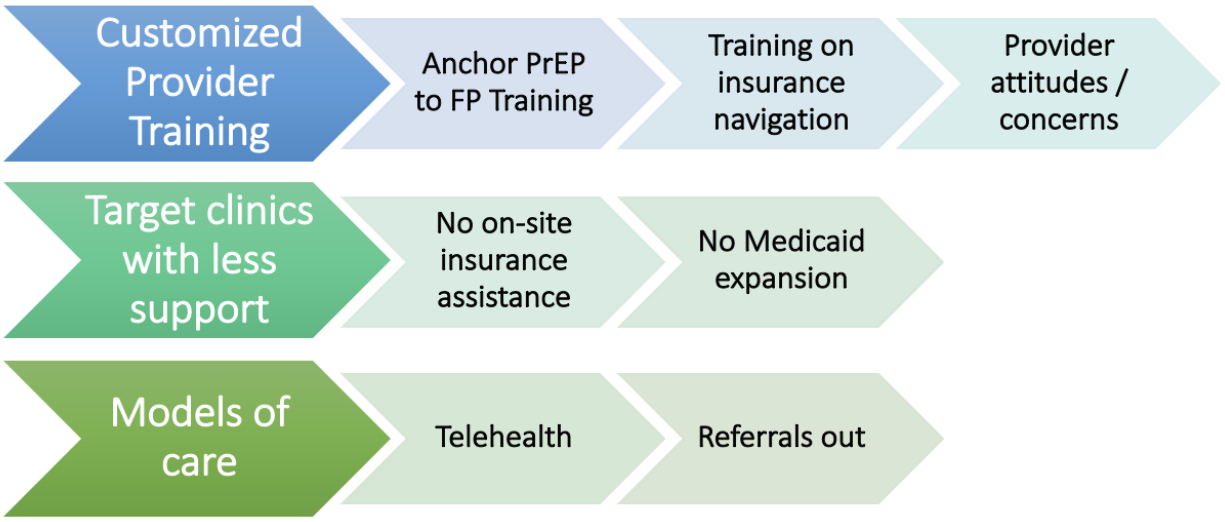

Figure 10. Implications from study findings to improve PrEP implementation in the US.

Supplemental Table 1. Univariate associations between Knowledge about PrEP and provider-, clinic-, and county-level characteristics among providers (n=351)ϕ.

Covariate	Parameter estimate (β) (95% CI)	Standard error	p-value*
Provider-level			
Age (in years)	0.001 (-0.016, 0.017)	0.008	0.9115
Years worked at the clinic in primary role	-0.024 (-0.046, -0.002)	0.011	0.0292
Ability to prescribe medications	1.062 (0.714, 1.410)	0.177	<0.0001
Clinic-level			
Metropolitan location	0.259 (-0.136, 0.654)	0.201	0.1976
On-site primary care	-0.487 (-0.864, -0.110)	0.192	0.0115
On-site insurance support	-0.045 (-0.425, 0.336)	0.194	0.8168
On-site pharmacy	0.004 (-0.363, 0.371)	0.187	0.9834
County-level			
Medicaid expansion	0.190 (-0.199, 0.579)	0.198	0.3367
HIV prevalence rate (log)	0.234 (0.043, 0.426)	0.097	0.0166
Reproductive-age women	0.109 (0.051, 0.166)	0.029	0.0002
Hispanic or Latinx population (log)	0.103 (-0.095, 0.300)	0.100	0.3002
Uninsured population	-0.028 (-0.081, 0.025)	0.027	0.3044
Living in poverty	-0.021 (-0.056, 0.014)	0.018	0.2449
High School Education	0.067 (0.033, 0.100)	0.017	0.0001

ϕAll statistics calculated using a simple linear regression model.

Supplemental Table 2. Univariate associations between Attitudes towards PrEP and provider-, clinic-, and county-level characteristics among providers (n=351)ϕ.

Covariate	Parameter estimate (β) (95% CI)	Standard error	p-value*
Provider-level			
Age (in years)	0.004 (-0.001, 0.010)	0.003	0.1152
Years worked at the clinic in primary role	-0.001 (-0.008, 0.006)	0.004	0.8690
Ability to prescribe medications	0.266 (0.153, 0.379)	0.058	<0.0001
Clinic-level			
Metropolitan location	0.093 (-0.032, 0.219)	0.064	0.1444
On-site primary care	-0.036 (-0.157, 0.085)	0.062	0.5603
On-site insurance support	0.153 (0.032, 0.273)	0.061	0.0130
On-site pharmacy	-0.093 (-0.210, 0.023)	0.059	0.1160
County-level			
Medicaid expansion	0.142 (0.019, 0.266)	0.063	0.0237
HIV prevalence rate (log)	0.082 (0.021, 0.143)	0.031	0.0088
Reproductive-age women	0.030 (0.011, 0.048)	0.009	0.0016
Hispanic or Latinx population (log)	-0.010 (-0.073, 0.052)	0.032	0.7434
Uninsured population	-0.014 (-0.031, 0.003)	0.009	0.1047
Living in poverty	-0.006 (-0.017, 0.005)	0.006	0.3132
High School Education	0.018 (0.007, 0.029)	0.005	0.0009

ϕAll statistics calculated using a simple linear regression model.

Supplemental Table 3. Univariate associations between Self-efficacy in PrEP care and provider-, clinic-, and county-level characteristics among providers (n=351)ϕ.

Covariate	Parameter estimate (β) (95% CI)	Standard error	p-value*
Provider-level			
Age (in years)	0.000 (-0.007, 0.008)	0.004	0.9153
Years worked at the clinic in primary role	-0.004 (-0.014, 0.006)	0.005	0.4389
Ability to prescribe medications	0.660 (0.504, 0.816)	0.079	<0.0001
Knowledge about PrEP	0.127 (0.078, 0.175)	0.024	<0.0001
Attitudes towards PrEP	0.511 (0.367, 0.654)	0.073	<0.0001
Contraception self-efficacy	0.527 (0.452, 0.601)	0.038	<0.0001
Clinic-level			
Metropolitan location	0.008 (-0.179, 0.195)	0.095	0.9347
On-site primary care	0.050 (-0.129, 0.230)	0.091	0.5796
On-site insurance support	0.126 (-0.052, 0.305)	0.091	0.1654
On-site pharmacy	-0.078 (-0.251, 0.094)	0.088	0.3728
County-level			
Medicaid expansion	0.148 (-0.036, 0.332)	0.093	0.1142
HIV prevalence rate (log)	0.092 (0.003, 0.182)	0.045	0.0436
Reproductive-age women	0.003 (-0.025, 0.030)	0.014	0.8506
Hispanic or Latinx population (log)	-0.066 (-0.158, 0.026)	0.047	0.1599
Uninsured population	-0.023 (-0.048, 0.002)	0.013	0.0683
Living in poverty	-0.007 (-0.024, 0.010)	0.009	0.3993
High School Education	0.013 (-0.003, 0.029)	0.008	0.1037

ϕAll statistics calculated using a simple linear regression model.