



A Review of Approaches Used to Increase Awareness of Pre-exposure Prophylaxis (PrEP) in the United States

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Published online: 10 October 2018
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Abstract

PrEP is an important and useful HIV prevention strategy, yet awareness remains low among at-risk populations in the United States and elsewhere in the world. As previous studies have shown PrEP awareness to be important to PrEP uptake, understanding approaches to increase PrEP awareness is imperative. The current systematic review provides an overview of published articles and on-going research on PrEP awareness. Using PRISMA guidelines, two published articles and seven on-going research studies were identified that use different approaches to increase PrEP awareness. Findings highlight the need for research to target other at-risk populations and geographic areas. Future research should consider the use of technology and network approaches to assess whether they lead to increased awareness, accurate knowledge, and uptake of PrEP, along with examining which messaging works best for specific targeted, at-risk population(s).

Keywords Pre-exposure prophylaxis (PrEP) · Awareness · HIV prevention

Resumen

PrEP es una estrategia importante y útil, sin embargo, la concientización dentro de las poblaciones de riesgo en Estados Unidos y en el Mundo, son bajas. Como lo han demostrado estudios anteriores, la concientización del PrEP es importante para el consumo del PrEP, por lo tanto, entender los enfoques para incrementar la concientización del PrEP, es imperativo. El actual sistema de revisión provee algunos artículos publicados e investigación continua sobre la concientización del PrEP. Usando las guías PRISMA, dos artículos publicados y siete estudios de investigación continua, fueron identificados que utilizan diferentes métodos para incrementar la concientización del PrEP. Resultados resaltan la necesidad de investigaciones en poblaciones de riesgo y en áreas geográficas. Futuras investigaciones deberían considerar el uso de tecnología y redes para evaluar si se incremento de la concientización, conocimiento y consume del PrEP, en conjunto con examinar mensajes que funcionan para el objetivo específico, para una población o poblaciones en riesgo.

Introduction

In the United States (U.S.), nearly 40,000 people were newly diagnosed with HIV in 2016 [1]. Individuals who were Black/African American (43.6%) or Hispanic/Latino (17.0%), between the ages of 20–29 (34.8%), and/or living

in the southern region of the U.S. (16.8 per 100,000) had the highest rates of HIV infection [1]. According to the Centers for Disease Control and Prevention (CDC), the most common ways to acquire HIV are engagement in sexual behaviors, such as condomless intercourse (e.g., anal or vaginal) with a person living with HIV or of an unknown serostatus, and/or sharing needles, syringes, or other equipment for injection drug use [2]. Moreover, the top three transmission categories for HIV diagnoses in 2016 were male-to-male sexual contact (i.e., men who have sex with men (MSM); n = 26,569), injection drug use (i.e., people who inject drugs (PWID); n = 3425), and heterosexual contact (i.e., vaginal and/or anal intercourse; n = 9578) [1]. Despite growing efforts to decrease new HIV infections, these at-risk groups are still disproportionately

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s10461-018-2305-0>) contains supplementary material, which is available to authorized users.

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affected by HIV [1]. One novel HIV prevention method with the potential to decrease infections rates for all at-risk groups is the medication known as Pre-Exposure Prophylaxis (PrEP).

What is PrEP?

PrEP is a pill taken daily to decrease the likelihood that exposure to HIV will result in an infection among individuals who are currently HIV-negative [3]. Efficacy trials have demonstrated that when used in combination with safer sex practices (e.g., using condoms and reducing the number of sex partners), PrEP can greatly reduce the risk of acquiring HIV [4–12]. Additionally, these trials demonstrated the effectiveness of PrEP in the reduction of HIV transmission among individuals who represent the top three transmission categories. Since these findings, the U.S. Food and Drug Administration approved Truvada™, a combination of two medications (tenofovir and emtricitabine), to be prescribed for PrEP [13]. To determine who would best benefit from taking PrEP, the CDC established eligibility guidelines [13]. Individuals who are HIV-negative and at high-risk for acquiring HIV through risky sexual behaviors (e.g., unprotected sex, having multiple sex partners, or having sex with persons living with HIV), and/or are injection drug users are eligible for PrEP [14]. Eligible individuals will need to test negative for the HIV antibody before starting PrEP medication, and have routine visits with their primary care provider to conduct and repeat HIV testing every 3 months once on PrEP [14].

In 2015, the CDC estimated more than 1.2 million adults in the U.S. could potentially benefit from taking PrEP [15]. This included 813,970 gay, bisexual or other MSM, 72,510 PWID and 258,080 sexually active heterosexuals [15]. By 2016, in recognition of the role PrEP could play in HIV prevention, the National HIV/AIDS Strategy (NHAS) added a PrEP indicator to monitor PrEP uptake [16]. NHAS is a five-year plan that details the principles, priorities, and actions needed to aid in the national response to the HIV epidemic [16]. One important feature of NHAS are the 17 indicators used to measure progress on meeting the plan's goals. The PrEP indicator established numerical targets for increasing PrEP use by 2020 ($n = 47,832$), which was reached in 2017 [16]. Although PrEP use has increased since 2014, uptake is far below the projected 1.2 million individuals who could benefit from taking PrEP. Moreover, consumer awareness of PrEP is at an inadequate level, thereby limiting its potential to help toward reducing HIV incidence among known at-risk populations. Low PrEP awareness has been recently documented among MSM and transgender women [17],

transgender men [18], heterosexual women [19, 20] and PWID [21].

PrEP Awareness Versus PrEP Knowledge

PrEP awareness is one of the initial steps to PrEP uptake [22, 23]. However, the meaning of 'awareness' is unclear. Often, the terms 'awareness' and 'knowledge' are used interchangeably, yet represent two different levels of understanding. Even when these terms are intended to be different, the difference is not clarified or made explicit [24]. In a recent conference abstract, knowledge of PrEP was measured using the following question: "Have you ever heard of PrEP for HIV prevention?" [25]. Interestingly, other studies have used similar variations of this question to assess PrEP awareness, such as "Before today, have you ever heard of people who do not have HIV taking PrEP, the antiretroviral medicine taken every day for months or years to reduce the risk of getting HIV?" [21, 26–28]. Understanding the distinction between what is meant by awareness and knowledge regarding PrEP can help provide clarity not only through their individual meanings, but in conceptual and empirical contexts [24].

Trevethan [24] assessed the use of these terms in public health research and found that there are two domains in which awareness is used, the "knowledge domain" and the "awareness domain." The knowledge domain implies that knowledge and awareness are not qualitatively different yet exist on two opposite ends of the knowledge continuum. Thus, the knowledge domain includes *general awareness knowledge* (having little or no knowledge about a specific topic) represented at the lower end of the domain, where *detailed and specific knowledge* (having the specificity and accuracy of information about a topic) is at the higher end. While the knowledge domain specifies that awareness and knowledge are not qualitatively different, the awareness domain "spans the extent of personal engagement or concern" and has a strong personal element [24]. This domain implies that awareness is a continuum on a single domain, where *low personal awareness* is on one end, with *higher personal awareness* on the other. Overall, these two domains imply that awareness can be conceptualized as the lowest level of understanding for a specific topic.

Therefore, to be PrEP 'aware', an individual must have at least heard of PrEP, but may not necessarily understand what it is, or the accurate guidelines to use it. In contrast, to be knowledgeable of PrEP requires a substantive understanding of PrEP, including how effective it is, eligibility and adherence requirements, and how to access it. Prior research has shown that once PrEP aware, individuals may then seek the knowledge needed to better understand PrEP, which may lead to increased willingness to use it [19, 21–23]. Thus, increasing research efforts regarding the lowest level of understanding for PrEP (i.e., awareness) may help increase

our efforts to improve PrEP uptake. For these reasons, the current review focuses on ‘PrEP awareness.’

Awareness of and Willingness to Use PrEP

Findings from prior studies have illustrated the need to increase awareness of PrEP among at-risk populations [29–32]. For instance, Koechlin and colleagues [29] conducted a systematic review of values and preferences among populations that may benefit from PrEP, specifically women, heterosexual men, young women and adolescent girls, female sex workers, sero-discordant couples, transgender people, PWIDs, and healthcare providers who may prescribe PrEP. Their search identified 76 peer-reviewed articles and 28 conference abstracts that met their inclusion criteria. Findings identified a strong interest in PrEP among at-risk populations; however, research among heterosexual men, transgender people, young women and adolescent girls, and PWIDs were limited. Though many potential PrEP users lacked basic PrEP knowledge, the authors found that once an at-risk population becomes aware of PrEP as a potential method to help decrease their risk for HIV, their willingness to use this method increased [29].

This same trend has been found in international countries. For instance, Zhang and colleagues [33] evaluated attitudes towards PrEP use among 1407 HIV-negative or unknown serostatus MSM in China. Of the 1407 participants included in the study, 22% (n = 310) had heard of PrEP, with 12 participants reporting having used PrEP. If proven safe and effective, 64% (n = 891) of participants reported that they were willing to use PrEP [33]. Specifically, they would be willing to use PrEP if it were free (71%), free and used by others (77%), had to be taken once a day (30%), or had to be taken once a week (37%). Multivariable analyses revealed being aware of PrEP (OR 1.33; 95% CI 1.01–1.75) and believing PrEP was effective in preventing HIV (OR 1.46, 95% CI 1.16–1.83) increased the odds of a participant being willing to use it. Moreover, Rester and colleagues [34] conducted semi-structured qualitative interviews among 21 female and 23 male HIV-negative sex workers in Mombasa, Kenya to examine their perspectives on PrEP and post-exposure prophylaxis (PEP). Focusing on their findings regarding PrEP, only 16 participants were PrEP aware, with more male sex workers having heard of PrEP (n = 5) than female sex workers (n = 0). Moreover, no sex workers had reported ever using PrEP. Despite never having heard of PrEP, once PrEP aware, most participants (male sex workers: n = 16, female sex workers: n = 19) reported being interested in using PrEP if it were available. Although prior research has indicated that by increasing one’s PrEP awareness it can lead to an increase in one’s willingness to use PrEP [19, 29], literature has identified a gap between actual use and reported willingness to use PrEP [35].

Willingness Versus Intention to Use PrEP

Willingness to use PrEP is notably different from real-world PrEP initiation. Existing research on real-world PrEP uptake has been limited to demonstration projects, and rarely touches on all at-risk populations [36–43]. Additionally, the questions used to obtain PrEP willingness are hypothetical and often do not consider the steps needed to acquire PrEP [19, 44–46]. For instance, simply asking, “If the possibility of taking a daily pill to prevent HIV existed, would you be interested in taking it?” does not accurately obtain information on intention to use PrEP, or provide information on how qualified individuals can initiate PrEP. For instance, Rendina and colleagues [35] examined the structural, demographic, behavioral, and psychological factors that differentiate PrEP willingness from behavioral intentions to initiate PrEP among 880 PrEP naïve, HIV-negative, gay and bisexually men (GBM) from the *One Thousand Strong* study: a longitudinal study that prospectively followed a national cohort for 3 years. Of the 880 GBM included in the study, 42.6% were unwilling to initiate PrEP, 41.4% were willing but not intending to initiate PrEP, and 15.9% intended to initiate PrEP. Their findings revealed that while intending to initiate PrEP was most common among GBM who were identified as at-risk for HIV, men intending to initiate PrEP had limited access to it.

Low PrEP Uptake

As research efforts continue to provide information on intentions to use PrEP among at-risk populations, prior research has noted a variety of reasons for apprehension towards PrEP use, ranging from concerns about side effects and lack of access to discomfort or perceived discrimination in discussing PrEP with health workers [47, 48]. One particular concern regarding PrEP uptake has been cost [49–53], whereas having insurance has been noted to be a facilitator of PrEP uptake since it could help cover costs of it [54]. For instance, Wang and colleagues [49] investigated willingness to use PrEP using two cost scenarios among 403 MSM of HIV-negative or unknown serostatus in Hong Kong, China. The authors found that the prevalence of MSM willing to use daily oral PrEP was 7.7% if participants could purchase PrEP at market rate (HK\$8,000 (US\$1,032)/month) by private hospitals/clinics; but was 45.2% if PrEP was provided for free by public hospitals/clinics in Hong Kong [49]. To address this barrier, Norway [55] and Scotland [56] have opted to provide PrEP for free. Interestingly, in the U.S., some private insurance companies reimburse for PrEP use. There are also a variety of organizations that are now providing PrEP for free [57–59].

Gilead, the biopharmaceutical company who branded Truvada for PrEP medication, has committed to reimbursing HIV

testing for individuals to initiate PrEP [57]. Gilead also provides PrEP for free through their Gilead Advancing Access Program and the Patient Assistance Program, both of which can help individuals cover costs of copay, find an insurance plan that currently covers PrEP, and help to appeal denial of PrEP coverage by insurance companies. Moreover, both Medicaid and Medicare cover PrEP at varying copays. As we continue to make strides in eliminating barriers to PrEP uptake (e.g., decreasing cost), increasing the number of people who are aware of this HIV prevention strategy is imperative. Despite these findings, potential PrEP users lack basic knowledge about PrEP, with many ignorant to the existence of PrEP. To fully integrate PrEP as a viable HIV prevention option among all at-risk populations, it is crucial for all individuals, including those at-risk for acquiring HIV, to become aware about this prevention method.

Approaches to Increase PrEP Awareness Among At-Risk Groups

While prior studies have looked at the awareness and willingness of at-risk groups to use PrEP as a HIV prevention method [19, 29, 32, 44, 60–62], few studies have examined the specific approaches that could be used to affectively increase PrEP awareness. Approaches to increase PrEP awareness may include, but are not limited to, mass media campaigns, digital media (such as social media), ehealth, mhealth, and education interventions. Ehealth is a form of electronic communication providing accessible healthcare delivered through the Internet and other forms of technology [63]. mHealth is the use of mobile cellular technology (i.e., smartphone applications or SMS text messages) to access health information and services [64]. These approaches, if tested and found promising, may be useful for increasing PrEP awareness among at-risk populations and lead to their potential uptake of PrEP. Some of these approaches have been found beneficial to increase awareness and use of non-PrEP HIV prevention methods, such as telephone-based counseling [27], computer-based HIV prevention sessions [65], and mass-media campaigns [66].

Research is limited as to whether these approaches, and others, increase PrEP awareness, and are appropriate for specific at-risk populations. Given this limitation, we conducted a systematic literature review to summarize published and ongoing research to examine what approaches have been and are currently being used to increase PrEP awareness among at-risk populations.

Methods

Search Strategy

To thoroughly examine published literature regarding approaches aimed to increase PrEP awareness, and to search specializations both within and outside the realm of public health that include HIV prevention, the following electronic databases were searched Fall of 2017: PubMed, Cochrane Library, CINAHL, Web of Science, Academic Search Complete, Diffusion of Effective Behavioral Interventions (DEBI), Psych Info, EMBASE, and ERIC. The search strategy, utilizing MeSH terms as an approach to each database, used the following search query: social networking OR social network OR social media OR mass media OR digital media OR health education OR health promotion OR health communication OR messaging OR health knowledge AND pre-exposure prophylaxis AND awareness. The query was modified to fit specific requirements of each of the databases searched. For example, Web of Science included the following search query and refined search items: pre-exposure prophylaxis OR PrEP AND social network AND mass media AND digital media AND health education OR health knowledge AND awareness AND men who have sex with men AND transgender AND women AND injection drug users. Refined by: DOCUMENT TYPES: Articles; Web of Science Categories: Infectious Diseases OR Immunology OR Medicine General Internal OR Social Sciences Biomedical; Timespan: 2012-2017; Indexes: SCI-EXPANDED, SSCI, ESCI. A manual search was conducted through the references of the articles retrieved through the electronic search.

Criteria for Selecting Studies

Only literature published between 2012 and 2017 were included in the current review, as Truvada™ (a composite of tenofovir and emtricitabine) was not approved by the FDA for PrEP until 2012. International studies were included to provide a more comprehensive overview about what approaches have been and/or are currently being used to increase PrEP awareness. Currently, Truvada for PrEP has received approval in Australia, Brazil, Canada, Chile, the European Union, Hong Kong, Israel, Kenya, Malawi, New Zealand, Peru, South Africa, Taiwan, Tanzania, Thailand, Zambia, and Zimbabwe [57, 67]. Although the U.S. was the first country to start large-scale implementation of PrEP, international PrEP demonstration projects and/or research studies may provide different insights about approaches related to PrEP awareness. International studies were included based on the following criteria: (1)

examined or used an approach to increase PrEP awareness; (2) had an outcome measure or measures that addressed PrEP awareness; and/or (3) included steps to increasing PrEP awareness that could lead to an increase in PrEP knowledge. In addition to the academic databases initially searched for in this review, the following databases were also used to search for international studies that met the three inclusion criteria: the European Union clinical trials register, an online registry on interventional clinical trials and medicines conducted in Europe [68]; the Australia New Zealand Clinical Trial Registry (ANZCTR), an online registry of clinical trials being conducted in Australia, New Zealand, and elsewhere [69]; the AIDS Vaccine Advocacy Coalition (AVAC), a New York City-based international non-profit community- and consumer-based global advocacy organization working to accelerate ethical development and delivery of AIDS vaccines and other HIV prevention options to populations throughout the world [70]; and PrEPWatch, an external database created by AVAC that provides information on global PrEP data, research, cost, access, implementation and advocacy efforts [71].

As our initial literature search yielded a small number of articles that met our inclusion criteria, our search was expanded to include on-going studies. Inclusion of on-going studies allowed the authors to examine if there was a need for additional research regarding specific approaches to increase PrEP awareness by geographic area and at-risk population. On-going studies were included if they examined or used an approach to increase PrEP awareness, included PrEP awareness as a measured outcome, or increased PrEP awareness as a pre-requisite to PrEP knowledge. Federal RePORTER and Clinicaltrials.gov were used to search for on-going studies. Federal RePORTER is a searchable database of federally funded scientific awards from various granting agencies and is a reliable source to find federally funded, on-going research [72]. <https://ClinicalTrials.gov> is a web-based registry of federally and privately funded clinical trials that test the effectiveness of experimental drugs for serious or life-threatening diseases or conditions, maintained by the National Library of Medicine and the National Institute of Health [73]. Both databases were searched using a combination of the following search terms: pre-exposure prophylaxis, PrEP, awareness, knowledge, education, and approach. All relevant information was abstracted from each database. For on-going studies, the name, number or identifier, location, term of the study, approach, target population, study design, goal/objective, aim(s), process used to meet the aim(s), and outcome measure(s) or study hypothesis were put into an Excel spreadsheet. No authors were contacted for additional information.

Target Population

No specific target-population was used for the current review so not to exclude studies which examined more than one at-risk population. We included the following search terms to frame our study based on at-risk populations described by the CDC: men who have sex with men (MSM), heterosexual, women, people who inject drugs (PWID), and transgender individuals. These terms were included individually and separately within our initial search query. This strategy helped to provide more relevant articles during the database search. Studies whose main target populations were health care providers, primary care providers, physicians, or residents were excluded, as the aim of the current study was to provide a summary of strategies that can be used to increase PrEP awareness among at-risk populations, not health care providers.

Interventions and Studies

Interventions and studies that assessed any approach used to increase PrEP awareness (e.g., mass media campaigns, mhealth, digital media, education intervention, social marketing campaign) were included in the current review.

Comparison and Study Design

As the purpose of this review was to assess approaches used to increase PrEP awareness, studies were not excluded based on study design.

Outcomes

Any study that measured PrEP awareness was included, whether that was a part of the study's primary outcome(s) or not.

Data Extraction

Titles and abstracts were screened by the first author, and all irrelevant articles were excluded. For the remaining articles, full texts were obtained for review and screened by the first author and a second reviewer. Then the first author reviewed each article against a screening sheet detailing inclusion and exclusion criteria. This was checked by the second reviewer. For on-going studies, the same strategy was used to determine on-going research relevant to the current review.

A summary of all studies identified through our search were put into an Excel spreadsheet. The location of the study, sample, study aim/purpose, intervention/study description, study design, comparison group(s), outcomes specific to PrEP, findings specific to PrEP, and limitations were extracted from each study or intervention, including for

international studies. The spreadsheets combined created a database for all information included in this review.

Results

The findings from the current review were reported based on the PRISMA guidelines [74]. The following databases provided no information on the current topic: Cochrane, DEBI, Psych Info, EMBASE, ERIC, European Union Clinical Trials registry, and ANZCTR. However, the other databases yielded 625 potential articles, including two articles identified through searching reference lists (see Fig. 1). Of these 625 articles, 95 were from PubMed, 13 from CINHALL, 21 from Academic Search Complete, 489 from Web of Science, 2 from AVAC, 3 from PrEP Watch, and 2 were found searching through the reference section of other articles.

After deleting all duplicates ($n = 57$), preliminary screening of titles and abstracts led to the exclusion of 557 additional articles. Articles that were international and had not addressed PrEP or PrEP awareness ($n = 159$); assessed PrEP awareness, education, and/or knowledge, but not approaches to increasing PrEP awareness ($n = 26$); assessed aspects of PrEP, but not PrEP awareness ($n = 193$); were clinical studies ($n = 37$) or conference abstracts ($n = 1$); targeted primary care providers/physicians ($n = 22$); and were not about PrEP ($n = 119$) were excluded. Full text articles of the remaining 11 records were examined by the first author and a second reviewer. After review, nine additional published articles were excluded because they only analyzed the potential use of an approach to increase PrEP awareness but did not test it. Three of the 11 records were international studies, but did not have an outcome measure or measures that addressed PrEP awareness and were also excluded. Thus, no international studies were included in this review as none met our inclusion criteria. Overall, two published studies were included for review—one reporting findings from a test of a clinic-based educational intervention and the other from a test of a mobile app. Table 1 provides a brief description of the two published articles, including the study location, sample size, study purpose, a brief description of the intervention, study design, comparison group(s), outcome(s) specific to PrEP, key findings specific to PrEP, and study limitations.

Study Characteristics of Published Research

Two published studies were found that tested an approach to increase PrEP awareness. Both studies were conducted in the U.S., used similar study designs, and targeted the same at-risk population. Raifman et al. [75] created an

education-based intervention to increase PrEP awareness among a sample of 316 MSM who attended a STD clinic in Rhode Island using a separate-sample, pre-test post-test, historical-control-group design [75]. Specifically, MSM of HIV-negative and unknown HIV-status, whose first visit to the clinic was after the intervention began, were put into the treatment group ($n = 234$) and received the PrEP education intervention. MSM of HIV-negative and unknown HIV-status, whose first visit to the clinic was before the intervention, comprised the control group ($n = 82$), and did not receive the PrEP education intervention. For a validity check, individuals who identified as men who only had sex with women were put into a negative control group and did not receive the PrEP education intervention. Sullivan et al. [76] tested the usability and acceptability of a theory-based Android mobile phone app for HIV prevention, HealthMindr. The app was tested among 121 self-reported HIV-negative MSM from Atlanta ($n = 72$) and Seattle ($n = 49$). Though PrEP awareness was not the main outcome of this approach, the app included features to increase PrEP awareness, of which, was also a reported outcome. HealthMindr was created using the social cognitive theory of behavior [77], and included various features specific to HIV prevention, such as a screener for PrEP and non-occupational post-exposure prophylaxis (nPEP) eligibility and the ability to order at-home HIV test kits, condoms, and lubricants (screenshots of HealthMindr app can be found here: <http://mhealth.jmir.org/article/download/SuppFile/7199/46439>).

Method of Approach Used to Increase PrEP Awareness

The methods used to increase PrEP awareness differed by approach and duration of participant use of each approach. Raifman et al. [75] provided PrEP education via a 5-minute education session to all MSM regardless of risk behaviors. In each brief education session, individuals gained additional PrEP knowledge, specifically about PrEP effectiveness, eligibility requirements, dosing, follow-up, and side effects. Individuals also received a one-page flyer with PrEP information. Although all MSM received PrEP information, this intervention was limited in the information they were able to provide in the 5-minute time span. Sullivan et al. [76] gave study participants control of which HIV prevention information and methods they could learn about (e.g., PrEP). Specifically, study participants were able to explore the HealthMindr app for 4 months. During this time, participants had full access to all app features, including PrEP information and a PrEP screener. Although MSM had access to all app features, only MSM who had Android mobile phones were included in their study.

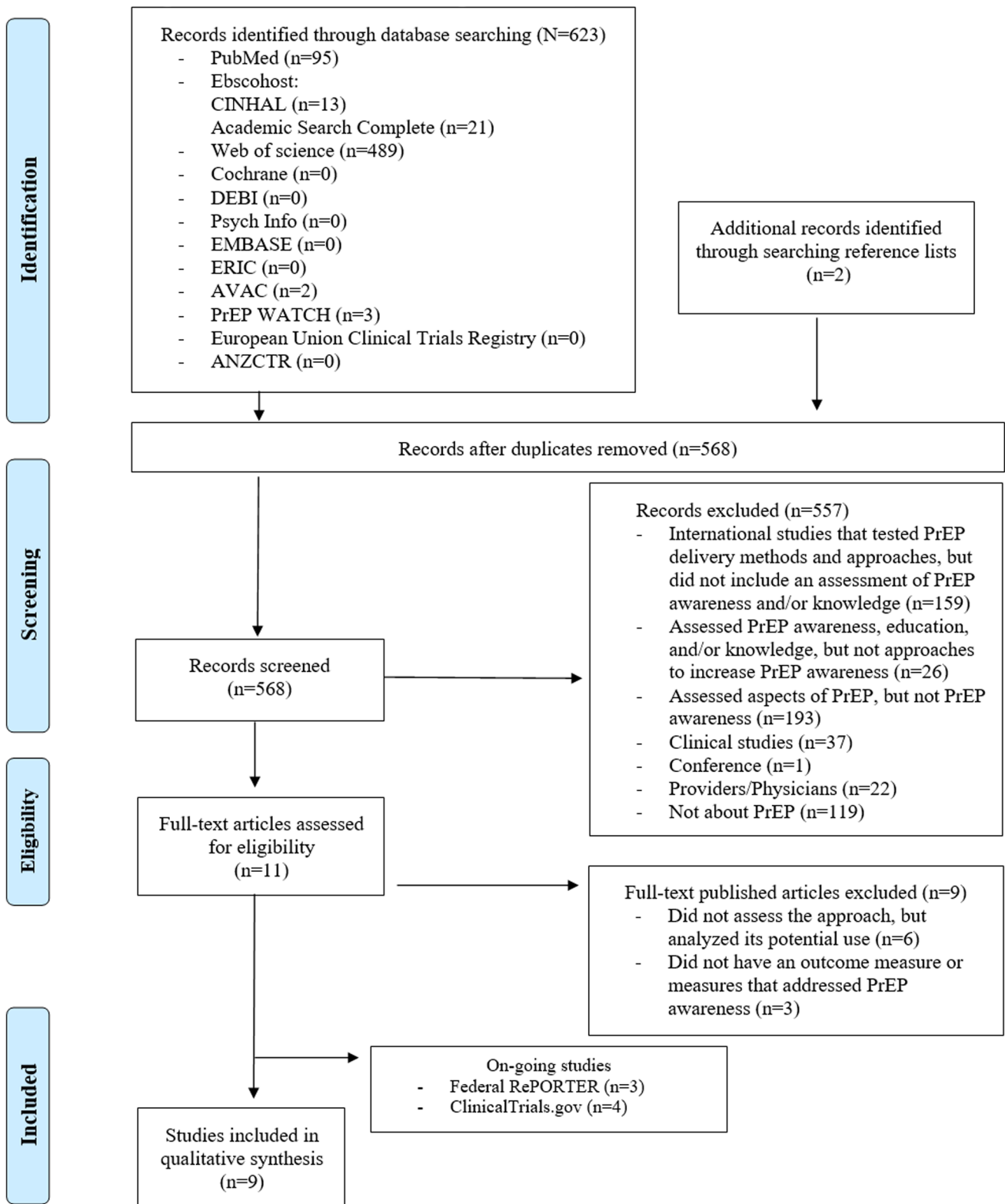


Fig. 1 PRISMA flow diagram

Table 1 Summary of published studies testing approaches to increase PrEP awareness

Approach (author)	Location	Sample	Study purpose	Intervention/ study description	Study design	Comparison groups (n)	Outcome(s) specific to PrEP	Findings specific to PrEP	Limitations
Education-based PrEP Intervention Raifman et al. [75]	Rhode Island STD Clinic	316 MSM patients	Evaluate the impact of a PrEP education intervention among MSM attending a STD clinic	Five-minute education session given to clients by STD clinic staff members	Separate sample pre-test post-test historical control group design (quasi-experimental design)	Treatment group: MSM whose first clinic visit was after the intervention started (n = 234) Control group: MSM whose first clinic visit was before the intervention started (n = 82) Negative Control group: HIV-negative MSW who visited the clinic only twice	Increase PrEP awareness ^a and use	<i>PrEP Awareness</i> Treatment group 49.6–76.8% Control group: 34.5–48.2% <i>PrEP Use</i> Treatment group: 2.8–9.9%. Control group: 1.1–3.5%	Social desirability Limit in detailed information regarding extent of PrEP awareness Intervention fidelity Limited generalizability
Comprehensive mobile HIV prevention app: HealthMindr App Sullivan et al. [76]	Atlanta and Seattle	121 HIV-negative MSM	Assess usability and acceptability of app	Men installed HealthMindr app on their mobile phone for 4 months and completed an evaluation survey at the end of the study period	Pre-test post-test design	49 HIV-negative MSM from Seattle 72 HIV-negative MSM from Atlanta	Examine participant decision to start PrEP or not, and how the app influenced their decision-making process	<i>Pre-app engagement</i> PrEP Use - ever: Seattle (n = 8), Atlanta (n = 7) PrEP awareness: 25% had not heard of PrEP <i>Post-App Engagement</i> Viewed PrEP info: 40% Used PrEP eligibility screener: 25% Viewed PrEP provider locations: 15% First time started PrEP: n = 8	Selection bias Limited only to MSM who had phones with Android operating systems Did not include all at-risk MSM (e.g., Hispanic MSM) Limited generalizability

MSM represents men who have sex with men, MSW represents men who have sex with women only, PrEP represents pre-exposure prophylaxis, STD represents sexually transmitted disease
^aPrEP awareness was defined as whether patients answered “yes” or “no” to the question, “Have you heard of taking HIV medications to prevent infection in people who are HIV-negative? (Pre-exposure prophylaxis, PrEP)”

Research Findings Specific to PrEP Awareness

Both study approaches increased PrEP awareness, and lead to an increase in PrEP use. Analyses of PrEP awareness in the education-based intervention identified an increase in PrEP awareness in the treatment group from 49.6 to 76.8%, and PrEP use increased by 7.1% [75]. Among participants in their control group, PrEP awareness increased from 34.5 to 48.2%, and PrEP use increased by 2.4%. There was no difference in PrEP awareness or use among men who only had sex with women [75]. Regarding HealthMindr [76], of the 121 MSM included in the study, 109 used app features. Specific to PrEP, the authors reported less than a quarter of the sample had initially heard of PrEP (24%). Of the 86 individuals who were found eligible for PrEP using the app's PrEP eligibility screener, eight individuals (not currently taking PrEP) were found to be eligible. The app's PrEP eligibility screener contained seven questions developed by the CDC to assess one's PrEP eligibility. After becoming eligible for PrEP, all eight individuals began using PrEP [76].

Study Characteristics of On-Going Research Studies

On-going studies were included in the current review if they: (1) examined or used an approach to increase PrEP awareness, (2) included PrEP awareness as a measured outcome, and/or (3) increased PrEP awareness as a prerequisite to PrEP knowledge or provided PrEP education. These studies also helped to provide information regarding current or future research aimed at increasing PrEP awareness.

The current review identified seven on-going research studies that met the inclusion criteria. No authors were contacted for additional information regarding on-going studies. Three on-going research studies that met the inclusion criteria were identified through Federal RePORTER. Four studies were identified through <https://ClinicalTrials.gov>. Table 2 provides a summary of these on-going studies, including their study name and number/identifier, study location and term of the study, approach used to increase PrEP awareness, target population, study design, goal/objective of the study, aim(s), process used to meet the aim(s), and measured outcome(s) or hypothesis used for the study. To provide additional data regarding these on-going studies, information from all articles currently published from these studies, or published to provide preliminary data about these studies, were also obtained and included the author's names, publication year, article title, and full abstract (see Online Appendix A).

Geographic Location and Study Population

The majority of on-going studies are being conducted in states that reported the highest number of HIV diagnoses in 2016 [1, 78, 79], including New York [80, 81], Illinois [82, 83], Florida [83], Texas [84], and Georgia [84]. Two studies are being conducted in states that do not have high incidence rates. Specifically, one study is being conducted in Milwaukee, Wisconsin and Cleveland, Ohio [85]. The second chose to conduct their study in one of three cities noting a state with high HIV prevalence, Philadelphia, Pennsylvania [84]. One study has yet to provide information regarding the specific location other than the study will be conducted in two metropolitan areas with local HIV rates that exceed the national average [86]. Regarding the target populations, most studies are targeting MSM [80, 82–85], whereas only two are targeting women [81, 86].

Type of Approach Used to Increase PrEP Awareness

Of the seven on-going studies included in the current review, two studies will use an mhealth approach [83, 84] and one will use an in-person intervention [86]. Based on our findings, four of the included on-going studies will use some type of network approach. Due to the specificity of each approach, we have categorized the type of network approach for studies as follows:

- *Social network approach* In-person intervention not led by a peer; n = 1 [85].
- *Peer-led network approach* In-person intervention training participants to deliver PrEP information to their peers; n = 2 [81, 82].
- *Online peer network approach* Use of networks (e.g., followers) created/obtained via social media to provide PrEP information; n = 1 [80].

The methods used to deliver each approach differed, even among studies that stated they would be using the same type of approach. For instance, of the two studies using an mhealth approach [83, 84], one study chose to deliver web-based content based on the demographic characteristics and sociocultural context of each study participant [84]. The second study plans to provide multiple options for HIV prevention for all participants through their app, including PrEP information and videos, online PrEP navigation, and a geospatial-based locator that includes PrEP clinics [83]. Regarding the studies using network approaches, two studies plan to use individuals or peer leaders to provide PrEP information to others in their community. Specifically, one study will promote HIV PrEP uptake by using a peer representative from a community-based organization that will be delivering PrEP education and counseling during

Table 2 Summary of on-going studies to test approaches to increase PrEP awareness (n = 7)

Study name (PI)	Study number/ identifier	Study location (term of study)	Approach	Target population	Study design	Study goal/objective	Study aim(s)	Process used to meet study aim(s)	Outcome measure(s)/study hypotheses
Social media based peer-led intervention to facilitate PrEP in YMCSM (Patel, V.V. [80])	5K23MH102118-05	NYC (2014–2019)	Social media based peer-led intervention (E-PrEP)	YMCSM of color (YMCSM), 13–29 years old	Community based participatory research approach that includes a mixed methods and diffusion of innovation framework	Develop and pilot-test a social media-based peer-led intervention to promote PrEP uptake in YMCSM	<ol style="list-style-type: none"> Determine factors associated with interest in and adoption of PrEP among YMCSM Develop Empowering with PrEP (E-PrEP), a social media-based peer-led intervention to increase PrEP uptake in YMCSM Pilot-test the feasibility and preliminary efficacy of E-PrEP for increasing intention to use and adoption of PrEP by YMCSM 	<p>Conduct in-person qualitative interviews with users and non-adopters of PrEP to identify current facilitators of and barriers to its uptake</p> <p>Interpret findings using diffusion of innovation framework</p> <p>Partner with YMCSM peer leaders to develop a social media-based intervention to provide education on PrEP, increase interest in PrEP use, and facilitate access to PrEP</p> <p>Conduct a randomized trial to pilot test E-PrEP to assess its feasibility and preliminary efficacy for increasing self-reported intention in and uptake of PrEP among YMCSM</p>	<p>The author hypothesizes that compared to a control group exposed to non-overlapping online contents focused on general health topics, participants randomized to E-PrEP will be more likely to express intention to use, and PrEP to use, PrEP</p>

Table 2 (continued)

Study name (PI)	Study number/ identifier	Study location (term of study)	Approach	Target popula- tion	Study design	Study goal/ objective	Study aim(s)	Process used to meet study aim(s)	Outcome measure(s)/study hypotheses
Developing a women- focused PrEP intervention for HIV prevention (Teitelman, A.M. [86])	1R34MH108437-01A1	Two large metropolitan areas with local HIV rates that greatly exceed the national average but with different PrEP public policy and access landscapes (2016–2019)	PrEP intervention	Women (no specified age)	Formative research	Develop and evaluate an intervention to promote PrEP uptake	<p>1. Conduct in-depth interviews and surveys to identify the association of social-cognitive characteristics (e.g. PrEP knowledge, attitudes, norms, self-efficacy, and beliefs, perceived access to care, HIV, risk, and risk compensation, and PrEP uptake and adherence) and assess how these factors are influenced by relevant background factors (e.g., socio-demographics, resources, vulnerability factors)</p> <p>2. Using findings from Aim 1, develop an individually-tailored intervention for women to promote PrEP uptake behaviors and adherence</p> <p>3. Evaluate the feasibility and acceptability of the intervention in a pilot trial</p>	Use a theory-based, contextually relevant behavioral intervention combined with linkage to health care and social services to improve PrEP uptake among high risk women	<p>Secondary outcomes include:</p> <p>(a) examine PrEP uptake intention and behavior;</p> <p>(b) evaluate satisfaction in accessing health care for PrEP, comparing the two sites, and in using a text-message reminder system to support PrEP adherence</p>

Table 2 (continued)

Study name (PI)	Study number/identifier	Study location (term of study)	Approach	Target population	Study design	Study goal/objective	Study aim(s)	Process used to meet study aim(s)	Outcome measure(s)/study hypotheses
Advanced HIV Prevention, <i>PrEP Chicago</i> (Schneider, J. [82])	NCT02896699	South side of Chicago, Illinois (2016–2019)	Network intervention	Black MSM, 18–39 years old	Randomized control trial network intervention using crossover assignment	Evaluate the feasibility of a network intervention to train individuals to disseminate PrEP information and motivate PrEP interest and knowledge of PrEP in their social networks	<p>1. Train participants as peer change agents (randomized to cross-over groups) to disseminate PrEP information and motivate PrEP interest and knowledge of PrEP in their local networks</p> <p>2. Evaluate feasibility of the program over 2 years of participant follow-up through: (1) peer change agent exit survey; (2) peer change agent booster sessions; (3) peer change agent communication with University of Chicago PrEP program social media; (4) referrals into the project; and (5) calls into the PrEP hotline</p>	<p>Recruit participants in Chicago, Illinois and train them to be peer change agents</p> <p>Randomly assign participants to one of two treatment sequences: (a) intervention treatment in year 1, attention control in year 2; or (b) attention control in year 1, treatment in year 2</p> <p>Treatment includes PrEP/peer change agent training workshop followed by 12 months of booster calls</p> <p>Attention control includes sex diary activity to help participants assess sexual risk</p>	<p>Primary outcome is to have network members call into the PrEPline</p> <p>Secondary outcomes include assessing PrEP attitudes, completion of peer change agent booster sessions, the number of Facebook posts with respect to PrEP and sexual health, and the number of referrals enrolled into the study</p>

Table 2 (continued)

Study name (PI)	Study number/ identifier	Study location (term of study)	Approach	Target population	Study design	Study goal/objective	Study aim(s)	Process used to meet study aim(s)	Outcome measure(s)/study hypotheses
PrEP-UP: Peer Outreach and Navigation Intervention to Increase PrEP Uptake Among Women at High Risk for HIV (Blackstock, O.J., and Norton, B. [81])	NCT03226873	East Harlem, NY (2017–March 2018)	Peer outreach and navigation intervention	Women (18 years and older) who engage in exchange sex	Randomized control trial using single group assignment	Assess the feasibility and acceptability of a peer outreach and navigation intervention designed to increase access and promote HIV PrEP uptake among women at high risk for HIV through a Peer delivering PrEP education and counseling during street-based outreach followed by an offer of a PrEP care appointment along with peer navigation	Assess the feasibility and acceptability of a peer outreach and navigation intervention designed to increase access and promote HIV PrEP uptake among women at high risk for HIV through a Peer delivering PrEP education and counseling during street-based outreach followed by an offer of a PrEP care appointment along with peer navigation	The investigators will collaborate with an established CBO in East Harlem, NY that uses street-based peer outreach and navigation to connect individuals to needed health and social services. Medical and pharmacy records will be reviewed to assess PrEP initiation. Self-report surveys will be conducted at baseline and at a week 4–12 follow-up visit. Acceptability of the intervention will be assessed via individual interviews conducted post-intervention with a subset of the women, and the CBO staff and leadership	Primary outcomes include having a PrEP prescription filled within 4–12 weeks. Secondary outcomes include HIV risk behaviors, perception of HIV risk, interest in PrEP, PrEP acceptance, scheduling and attending a PrEP appointment, PrEP-related attitudes, knowledge, and self-efficacy

Table 2 (continued)

Study name (PI)	Study number/identifier	Study location (term of study)	Approach	Target population	Study design	Study goal/objective	Study aim(s)	Process used to meet study aim(s)	Outcome measure(s)/study hypotheses
LYNX: A Novel Mobile App to Support Linkage to HIV/STI Testing PrEP for Young Men Who Have Sex With Men (Liu, A. and Hyman, S. [83])	NCT03177512	Tampa or Chicago area (2018–June 2019)	mhealth: Mobile App	YMSM, 15–24 years old	Randomized control trial with parallel assignment	Test the acceptability and feasibility of a highly interactive mobile app to promote HIV/STI testing and uptake of PrEP among YMSM	1. Access acceptability through the system usability scale 2. Access feasibility through frequency of logins and use of LYNX app	Phase 1: Conduct open technical pilot to optimize usability via qualitative formative work Phase 2: Pilot test LYNX via RCT to evaluate preliminary acceptability, feasibility and preliminary efficacy Participants in treatment arm will have access to the LYNX mobile app which include Sex Pro (a personalized HIV risk score), a sex diary to facilitate accurate data collection; HIV/STI testing information and reminders; access to home HIV/STI testing options; a geospatial-based locator of HIV/STI testing sites and PrEP clinics; PrEP information and videos; and online PrEP navigation Participants in control arm will receive standard care for linkage to PrEP and HIV/STI testing	The primary outcomes include the acceptability and feasibility of LYNX app components and the overall system of the app Secondary outcomes include the frequency and duration of app use, app content functionality, number of requested HIV/STI testing kits, condoms, and lube, HIV/STI testing frequency, PrEP interest and uptake and its constructs, sexual and drug use behaviors, health care utilization, and IMB constructs for HIV/STI testing and PrEP uptake (including PrEP knowledge, motivation, and behavioral skills)

Table 2 (continued)

Study name (PI)	Study number/ identifier	Study location (term of study)	Approach	Target popula- tion	Study design	Study goal/ objective	Study aim(s)	Process used to meet study aim(s)	Outcome measure(s)/study hypotheses
Get Connected (GC): Link- ing YMSM to Adequate Care Through a Multilevel, Tailored WebApp Intervention (Bauer- meister, J. and Stephenson, R. [84])	NCT03132415	Houston, Philadelphia, and Atlanta (2017–2020)	mhealth: Web App brief inter- vention	YMSM, 15–24 years old	Two arm randomized control trial using paral- lel assign- ment	Test the effi- cacy of GC for increasing YMSM's successful engagement in locally appropriate HIV preven- tion and care	1: Examine the quality of HIV test coun- seling and PrEP- related referrals to YMSM within local HIV/STI testing sites in 3 cities 2: Test the efficacy of GC for increas- ing HIV-negative or HIV-unknown YMSM's success- ful uptake of HIV prevention services and PrEP awareness and willingness, as compared to the attention-control condition over a 12-month period 3: Qualitatively assess sites' satisfaction with performance assessments and their improvements in service delivery when working with YMSM across the three regions	Compare GC to an existing online HIV test locator Assessments will be col- lected at 30 days and at 3, 6, 9- and 12-month follow-up	The primary out- come includes change in HIV testing behavior Secondary out- comes include examining the uptake of PrEP, change in motivations to engage in HIV preven- tion behaviors, change in PrEP motivations (including change in PrEP awareness and willingness over time), and changes in STI testing behavior

Table 2 (continued)

Study name (PI)	Study number/ identifier	Study location (term of study)	Approach	Target population	Study design	Study goal/objective	Study aim(s)	Process used to meet study aim(s)	Outcome measure(s)/study hypotheses
Increasing PrEP Use in High-Risk Social Networks of African American MSM in Underserved Low-Uptake Cities (Kelly, J. and Amirkhanian, Y. [85])	IR01NR017574-01	Milwaukee, WI and Cleveland, OH (2017–2022)	Network intervention using a social network approach	MSM (no age specified)	Mixed-methods and formative research	Test a novel approach for increasing PrEP use among neglected racial minority MSM through their social network connections	<ol style="list-style-type: none"> 1. Intervention mapping and refinement 2. Recruit social networks of young Black MSM at high risk for HIV infection 3. Randomize social networks to intervention or control arms; intervention arm will provide a PrEP training to network leaders 4. Compare outcomes (PrEP use) at 6 and 15 months and model impact on HIV incidence 	<p>Conduct in-depth interviews with African American MSM, PrEP providers, and key informants to identify understandings, concerns, barriers, and facilitators of PrEP use</p> <p>36 networks will be randomized in equal numbers to intervention and comparison conditions</p> <p>Network leaders from each network will attend an intervention that educates and provides training and guidance in diffusing messages to friends to encourage PrEP uptake, correcting PrEP misconceptions and stigma, and instilling positive PrEP norms and benefit perceptions</p> <p>At baseline and 6- and 15-month follow-up points, participants will complete measures of PrEP use verified by the testing of dried blood spot specimens for tenofovir; measures of PrEP related knowledge, attitudes, perceived norms, and stage of change readiness; sexual risk practices; and substance use</p>	<p>The authors hypothesize that the network intervention will produce greater PrEP adoption by HIV- participants than that found in comparison networks</p> <p>PrEP knowledge, attitudes, peer intentions, norms, and stage of change readiness will be explored as both mediators and as secondary outcomes</p>

On-going research studies were included if they examined or used an approach to increase PrEP awareness, included PrEP awareness as a measured outcome, or increased PrEP awareness as a pre-requisite to PrEP knowledge; thus, PrEP awareness did not have to be a primary outcome to be included in the current review

BMSM represent Black men who have sex with men, CBO represents community-based organization, IMB represents Information, Motivation, Behavior model, MSM represents men who have sex with men, PrEP represents pre-exposure prophylaxis, RCT represents randomized control trial, STI represents sexually transmitted infection, YMCSM represents young men who have sex with men, YMCSM represents young men who have sex with men of color

street-based outreach [81]. The second study will train participants to be peer change agents to deliver PrEP information [82]. Another study using a network approach will recruit network leaders to provide them with training and guidance to encourage PrEP uptake and correct misconceptions regarding PrEP within their social network connections [85]. Of the remaining two studies, one plans to use a behavioral intervention [86].

Study Aims and Outcome Measures Specific to PrEP

Few on-going studies had a study aim that was specific to increasing PrEP awareness, and/or had implications of increasing PrEP awareness through providing PrEP education. One study will aim to train participants as peer change agents to disseminate PrEP information and to motivate PrEP interest and knowledge of PrEP [82]. A second study will use peer outreach to deliver PrEP education and counseling, as well as offer a PrEP care appointment and peer navigation [81]. Another study that will use mhealth to test the efficacy of their web app for increasing successful uptake of HIV prevention services, and PrEP awareness and willingness [84]. The remaining four studies will increase PrEP awareness (either by providing PrEP information or knowledge) through their process used to meet their specified study aims [80, 83, 86] and/or as a secondary outcome measure [85].

Discussion

We believe this is the first review to examine specific approaches that have been tested, or are currently being tested, to increase PrEP awareness in the U.S.—a crucial step toward helping to improve the potential to increase PrEP uptake among at-risk, vulnerable populations. Despite the effectiveness of PrEP in lowering HIV risk and the lack of awareness about PrEP among at-risk populations, findings suggest that research in this area is limited. Of the 625 articles initially identified in the search, only two published articles examined specific approaches to increase PrEP awareness. Moreover, only seven on-going research studies were identified that either aim to increase PrEP awareness, or have aspects of their study (i.e. methods used to address the specific aim(s) or the outcome measure(s)) that will increase awareness of PrEP among an at-risk population in the U.S. As there are currently 67 countries using PrEP (either through demonstration projects or legally), and 28 countries that have legalized PrEP, several factors should be highlighted regarding these findings [71].

First, it should be noted that both the educational intervention and mobile health app identified in this review target MSM, as well as five of the seven on-going studies.

Although MSM are disproportionately affected by HIV, they are not the only at-risk population for acquiring HIV who could benefit to learn about PrEP. Numerous interventions have been created for MSM to help decrease barriers, bias, and overall risk associated with HIV [87–90], yet fewer have been developed for women [91], and even fewer for transgender individuals [92, 93] and PWIDs [94–96]. Future interventions should consider examining specific approaches that may be more useful within certain populations compared to others, specifically transgender men and women, PWID, and heterosexual women. In regard to heterosexual women, there is a need to build the capacity of organizations to not only educate, but to screen and refer or provide PrEP services for women. In 2016, heterosexual women made up 19% of the 39,782 new HIV diagnoses in the U.S., with 87% (6541) of these diagnoses contributed to heterosexual contact [97]. As women are the second highest at-risk population for acquiring HIV in the U.S. [1, 98], there is a need to raise awareness about PrEP among women.

Second, zero published, and only two on-going studies [83, 84] included in this review conducted research in the southern region of the U.S.. This is interesting as the CDC [78] and prior research [99] have identified individuals living in the southern states of the U.S. as at highest risk of acquiring HIV likely due to poor health of the population, high poverty rates, HIV-related stigma, cultural factors, and social barriers [99, 100]. To address the burden at-risk individuals may face in the South, research is needed to identify ways to provide PrEP messaging to hard-to-reach populations in this area. As prior researchers have identified lack of awareness and knowledge of PrEP as a barrier to PrEP uptake [22, 23], approaches that utilize health literate and culturally appropriate messaging are needed.

Next, the majority of on-going studies included in the current review target individuals between ages 18 and 24 [80, 82–84], an age group with one of the highest rates for HIV acquisition [1]. While NHAS 2020 has indicated individuals aging 13–24 as a target group for reducing new HIV infections [16], there has been an increase in HIV diagnoses among older adults. In particular, the CDC's HIV surveillance report noted individuals between ages 40–54 having high HIV incidence rates [1]. These rates varied by age group, with adults between ages 45–49 having a rate of 15.1 per 100,000; and adults between ages 50–54 having a rate of 13.5 per 100,000 [1]. According to the CDC, older adults have some of the same HIV risk factors as younger individuals, such as engaging in condomless sexual intercourse and lacking HIV prevention knowledge [101]. Older adults are also more likely to have late stage HIV infection at the time of diagnoses compared to younger individuals [101, 102]; are less likely to be assessed for STIs due to ageism [101] and/or misconceptions about the absence of STIs [103]; and are more likely to refuse discussing HIV due to fear of

stigma [102]. As PrEP is a viable HIV prevention option for all adults, approaches are needed to help increase PrEP awareness among older individuals. While there are concerns that older adults may be more susceptible to adverse outcomes from taking PrEP (i.e., decreased kidney function and bone disease) [103], efficacy trials have shown PrEP to be a safe option for HIV prevention. Using a multi-level approach that incorporates advertisements and flyers, as well persuasive health messaging [102] may be useful for increasing PrEP awareness and potential uptake among older adults in at-risk populations.

In regard to the types of approaches that were identified among the on-going studies that were included in this review, four studies will use a type of network approach to increase PrEP awareness (i.e., social network approach [85], peer-led network approach [81, 82], or an online peer network approach [80]). Due to the limited number of studies included in this review, the authors are limited in the interpretation of these findings. However, using a network approach may have the potential to help reach more individuals to provide information about HIV prevention. For instance, Patel [80] is using a mixed methods study design to develop and pilot-test a social media-based peer-led intervention (E-PrEP) to promote PrEP uptake among young MSM of color (YMCSM) in New York. E-PrEP will use online messaging and discussions to provide PrEP education, increase interest in PrEP use, and facilitate access to PrEP. The project aims to determine factors associated with PrEP interest and uptake among YMCSM, and test the feasibility and efficacy of E-PrEP to increase intention to use and adopt PrEP. There are currently published articles from this on-going study (see Online Appendix A). As more effort is made to increase awareness of PrEP, more research is needed to determine if using a network approach could be useful and provide an easier gateway to help increase PrEP awareness.

Technology-based approaches such as mhealth and ehealth, may also be a useful approach to help increase PrEP awareness. Technology can provide services beyond clinical settings, alleviating barriers to HIV prevention and treatment services. This type of approach has been used to provide information, conduct self-assessment of risk, remind individuals of recurring services, increase adherence, deliver prevention interventions, provide referral services, and decrease geographical barriers to HIV prevention efforts [65, 104, 105]. Among both published and on-going studies included in the current review, four used approaches that incorporated technology in some way [76, 83, 84, 86]. For instance, Sullivan et al. [76] used mhealth to increase PrEP awareness and knowledge, while Teitelman [86] plans to incorporate technology using a text-messaging reminder system to help women adhere to PrEP. In a previous study, Sullivan et al. [105] conducted a systematic inventory of Android and iOS mobile apps relevant to HIV prevention

to examine the role of technology for MSM. Using a web bot to examine the data dump of Google Play and Apple store apps, 147 apps from the Google Play Store and 138 apps from the Apple App Store were relevant to HIV or AIDS. Most of these apps were created by nonacademic or public health institutions ($n=202$), were free ($n=237$), and reported information about one or more HIV prevention qualities ($n=151$). Of the 20 apps that focused on MSM, two included information on treatment as prevention, three provided condom information, and eight provided information on HIV testing [105].

While technology-based approaches could be useful, they are limited only to those who have access to an intervention's technological aspects. If the purpose of HIV prevention research is to affectively provide information regarding HIV prevention to hard-to-reach populations, we must find ways to make technology-based approaches more accessible to these populations. As the use of technology increases among individuals in the U.S., future research should examine if technology-based HIV prevention interventions would be an ideal approach to help increase PrEP awareness.

Considering our findings, the accessibility of these approaches should also be mentioned. For instance, among the two published studies, the education-based intervention [68] was specifically created with the aim of increasing PrEP awareness among an at-risk population, though was limited in that it only included and targeted MSM who visited a specific STD clinic. HealthMindr [69] was created as a mobile health and wellness app that included PrEP information as one of its features, though was limited to only be used by Android users. Though these studies may provide information on the usefulness of a clinic-based and/or mhealth approach to increase PrEP awareness for MSM, future research should also consider how potential target populations can access services provided through these approaches. Moreover, while the generalizability of these approaches to increase PrEP awareness and/or uptake among all MSM in the U.S. is limited, the authors recommend future research examine the accessibility of any novel approaches chosen to increase efforts for PrEP scale up (e.g., PrEP awareness).

While no international studies were found for the current review, it should be noted that many demonstration projects in international countries are on-going and have yet to provide preliminary data. Thus, whether these projects are testing approaches to increase PrEP awareness is unknown. Furthermore, international studies that are examining ways to increase PrEP uptake may not be capturing PrEP awareness data, yet provide novel approaches that could be used to do so. For instance, Anand et al. [106] recently evaluated the effect of an Online-to-Offline (O2O) model to increase PrEP uptake among MSM and transgender individuals at two clinics and two community-based drop-in centers in Bangkok, Thailand (Adam's Love clinic, TRCARC Anonymous

clinic, Rainbow Sky Association of Thailand (RSAT), and Service Workers in Group (SWING) Foundation). Men were reached via tailored social media PrEP promotions through Adam's Love (www.adamslove.org), a HIV educational and counselling website. By contacting online staff at Adam's Love, men who were interested in free PrEP and/or HIV testing received real-time PrEP eCounseling, and completed free online bookings to receive services [106] (see Online Appendix B for detailed description of O2O model). Using these services via the O2O model, 168 of 316 (53.2%) HIV-negative MSM and transgender individuals initiated PrEP. The authors also demonstrated that a O2O model could reach high-risk, closeted MSM and transgender individuals, as well as connect online outreach efforts to offline uptake of PrEP and HIV testing services. Given the increase in international research to provide PrEP and assess the feasibility and acceptability of this prevention strategy among at-risk populations, approaches that have been tested, evaluated, and proven to be effective to increase PrEP awareness are needed.

Overall, greater efforts are needed to increase PrEP awareness. It is important that messages and information regarding PrEP are provided to everyone, not only at-risk individuals. While network or technology-based approaches (i.e., mhealth, ehealth) could be helpful to affectively target a larger number of individuals, future research should further examine and test these approaches to identify whether they lead to increased awareness, accurate knowledge, and actual uptake of PrEP. Moreover, the messaging used within these approaches should not only ensure that correct knowledge of PrEP is administered, but also work to eliminate misconceptions of PrEP and emphasize its importance and correct use in conjunction with other existing HIV prevention strategies, such as Treatment as Prevention (TasP), correct condom use, and various modalities for testing sexually transmitted infections and HIV.

Limitations

There are limitations to this review. First, studies that focused on increasing PrEP awareness and/or knowledge among providers and primary care givers were excluded from the current study. Since 22 of these studies were excluded, this method of PrEP dissemination may have an effective means of reaching at-risk populations compared to other approaches. More research is needed to gain a better understanding of the extent to which interventions that target providers lead to PrEP uptake. Second, while it is believed that the current review was exhaustive, the search terms used for each database may have excluded words that could have been useful in finding additional studies which examined specific approaches to increase PrEP awareness.

Next, due to the small number of studies found on this topic, generalizations cannot be made as to the effectiveness of these approaches to increase PrEP awareness among other at-risk populations. Despite these limitations, the current study identified two evaluated approaches that increased awareness of PrEP among their target populations and had led to PrEP uptake.

Conclusion

PrEP is an important and useful HIV prevention strategy, yet awareness of this novel prevention method is low. As previous studies have shown PrEP awareness to be important to PrEP uptake, understanding approaches to increase PrEP awareness is imperative. The current review identified approaches used to increase PrEP awareness, as well as approaches under development. These findings may help shape future prevention efforts by providing information about the potential approaches that could work for certain at-risk populations, as well as shed light on the gaps within current research relative to PrEP scale up, such as those pertaining to increasing PrEP awareness—the first step to PrEP uptake.

Funding There is no funding attached to this manuscript.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Research Involving Human and Animal Rights This article does not contain any studies with human participants or animals performed by any of the authors.

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