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Behavioral Interventions to Enhance PrEP Uptake Among Black Men Who Have Sex With Men: A Review

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Abstract

In the United States, nearly 500,000 men who have sex with men (MSM) are at risk of contracting HIV. Men who have sex with men constitute 70% of all new cases of HIV in the United States; within this population, the incidence of HIV infection is the highest among Black MSM. Our integrated review synthesized published behavioral interventions designed to enhance the uptake of and adherence to pre-exposure prophylaxis (PrEP) for the prevention of HIV in the Black MSM population. A search of 4 electronic databases revealed only 7 studies whose samples included Black MSM. Adherence to PrEP medication declined overtime across all studies. No statistically significant changes in safer sexual behaviors were reported. Few studies described theory-driven interventions. Effective interventions are needed to enhance the uptake of PrEP and to reinforce behaviors that prevent HIV transmission among Black MSM.

Keywords

biomedical; Black men; HIV pre-exposure prophylaxis; intervention; men who have sex with men; prevention

HIV infection represents a challenging global health problem (World Health Organization, 2016). Men who have sex with men (MSM) have experienced a particularly significant HIV-related disease burden. Although MSM made up only 2% of the U.S. population in 2015, they constituted 70% of all new HIV infections in the United States (Fisher et al, 2011; U.S. Department of Health and Human Services, 2018). More than 600,000 MSM in the United States were living with HIV in 2014, and nearly 500,000 MSM were at risk of contracting HIV (Centers for Disease Control and Prevention, 2018b); however, stigma, discrimination, and homophobia continue to hinder the implementation of HIV prevention strategies (Abbott & Williams, 2015; Centers for Disease Control and Prevention, 2018b).

Black MSM have the highest risk of acquiring HIV. From 2010 to 2014, the rate of new HIV diagnoses in Black MSM was approximately 10,000 per year, 26% of the total new

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infections every year (Centers for Disease Control and Prevention, 2018b). Several factors contributed to this population's high risk of acquiring HIV, including (a) socioeconomic factors limiting treatment and preventative care, (b) lack of awareness regarding HIV status, (c) increased number of sexual partners, and (d) more exclusive sexual networks (Department of Health and Human Service, 2018). In addition, Black MSM have been found to be more likely to engage in receptive anal sex, which is considered the riskiest behavior for contracting HIV (Downing, 2014; Department of Health and Human Service, 2018). Moreover, factors such as race, socioeconomic status, and sexual orientation further stigmatize Black MSM and thereby limit their access to necessary treatment and prevention care (Centers for Disease Control and Prevention, 2018b).

Currently, the Centers for Disease Control and Prevention (CDC) recommends a multifaceted approach to HIV prevention, including the implementation of safer sexual practices and the use of biomedical interventions for high-risk groups. These high-risk groups include persons who use injection drugs, knowingly have sex with people living with HIV (PLWH), have condomless intercourse, or have multiple sexual partners (Centers for Disease Control and Prevention, 2018a; World Health Organization, 2016). The Department of Health and Human Services (2018) has recommended the use of condoms for MSM to decrease the overall risk of acquiring HIV. In 2012, the U.S. Food and Drug Administration approved a once-daily, oral, fixed-dose combination antiretroviral (ARV) medication—emtricitabine and tenofovir disoproxil fumarate—for pre-exposure prophylaxis (PrEP; Gilead Sciences, 2012), following the publication of three randomized controlled trials, which showed that the medication greatly reduced the risk of acquiring HIV (Baeten et al., 2012; Grant et al., 2010; Thigpen et al., 2012). Since then, studies have demonstrated PrEP's effectiveness when the medication is taken as prescribed (Grant et al., 2014; Liu et al., 2016; McCormack et al., 2016).

The uptake of PrEP in Black MSM has been slow, despite strong evidence regarding the efficacy of HIV prevention medication (Kirby & Thornber-Dunwell, 2014; Parisi et al., 2018). Communication efforts designed to highlight the success of HIV chemoprophylaxis have originated primarily from grassroots organizations (Amico & Stirratt, 2014; Kirby & Thornber-Dunwell, 2014). Health care providers' hesitancy to prescribe medication to prevent HIV infection, due to concerns about side effects reported in open-label clinical trials (Baeten et al., 2012; Grant et al., 2010; Parisi et al., 2018), has compounded the public's lack of knowledge about PrEP. Moreover, stigma, homophobia, negative attitude, and lack of access to health care hinder Black MSM from seeking prescriptions for HIV prevention medications (Kirby & Thornber-Dunwell, 2014; Department of Health and Human Service, 2018).

Our integrative review examined the available literature describing behavioral interventions designed to enhance the uptake of and adherence to HIV PrEP medication in the Black MSM population. The aim of our review was to identify best practices with regard to behavioral interventions to enhance the use of PrEP in Black MSM. The review focused on medication adherence and intervention characteristics, as well as on recommendations for future studies.

Methods

Searches in four electronic databases, PubMed, CINAHL (EBSCO), MEDLINE (Ovid), and Google Scholar, were used to locate articles published from September 2007 to October 2017. Our review was performed using PRISMA guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). MeSH terms used to conduct searches included “medication adherence OR compliance,” “intervention OR methods,” “HIV,” and “men who have sex with men OR gay.” All databases were searched using the same strategy. The terms “PrEP” and “pre-exposure prophylaxis” were intentionally excluded to ensure that studies that used drug names were included in the search. Eligible studies focused on behavioral interventions that were published in peer-reviewed journals in English in the past 10 years. A 10-year timeframe was used to include studies conducted prior to Food and Drug Administration approval of PrEP in 2012 (Gilead Sciences, 2012). Studies were included if any part of the study population was Black MSM. Feasibility studies were included if they described a behavioral intervention. Articles that focused on open-label trials of PrEP or other ARV medications were excluded, as were articles that did not include Black MSM in the study sample. Methods papers and qualitative studies that described a phenomenon or provided narratives were also excluded. Ancestry searches were conducted to identify additional eligible studies. After removing duplicates, a total of 236 articles were identified. Of these, 193 were excluded following a review of titles/abstracts, leaving 43 articles for full-text review. Of these 43 articles, 14 were excluded because the interventions were not behavioral in nature, 13 were excluded because the study sample did not include MSM, and 9 were excluded due to the method followed (i.e., survey, interview, or nonintervention). Hence, seven behavioral intervention studies were included in our review (Figure 1). Intervention effectiveness included impact on medication adherence to PrEP and safer sexual health behaviors.

Data Extraction and Synthesis

The first author abstracted the data for each study included in the review. The first and second authors reviewed the abstracts and full-text articles, interpreted the extracted data, and synthesized the findings. The following data were extracted from each study: journal characteristics, theory use, intervention description, study findings, methods, setting, population, sample size, follow-up, medication adherence data, attrition, limitations, adverse outcomes, and author recommendations. All studies were published between 2013 and 2018 in peer-reviewed journals. Behavioral interventions included group-based sessions, individual sessions, cognitive counseling, risk reduction techniques, medication adherence support, and peer-based support. All studies were conducted in large urban settings. Only two studies described a theoretical framework (Hosek, Green, et al., 2013; Mayer et al., 2017), and two studies used a randomized controlled design (Hosek, Siberry, et al., 2013; Mayer et al., 2017). Postintervention follow-up was generally brief, with the longest follow-up occurring 12 months after the final study visit (Parisi et al., 2018). Information about individual studies is given in Table 1.

Results

We found only a few published behavioral studies that focused on PrEP uptake exclusively in the priority population of Black MSM. While all studies with Black MSM in the sample, regardless of how small, were included in this review, only seven studies met the inclusion criteria. While the type of recruitment site varied, all studies were conducted in urban cities located across the United States. Study cities included Philadelphia, Los Angeles, Denver, Chicago, New Orleans, Boston, Baltimore, Detroit, Houston, Memphis, Miami, New York, and Tampa. The recruitment sites included community health clinics, primary care clinics, and hospital settings (Daughtridge, 2015; Hosek, Siberry, et al., 2013; Hosek, Rudy, et al., 2017; Mayer et al., 2017). Recruitment of participants occurred at primary health care locations, community health clinics, local school presentations, and street venues and via online venues (Daughtridge et al., 2015; Hosek, Siberry, et al., 2013; Hosek, Landovitz, et al., 2017; Hosek, Rudy, et al., 2017; Mayer et al., 2017). Daughtridge et al. (2015) used social media to remind participants of upcoming appointments in a youth empowerment intervention program study. The social media strategy was shown to be reliable in the adolescent population, compared to using cell phones (Daughtridge et al., 2015). Hosek, Landovitz, et al. (2017) and Mayer et al. (2017) also used social media to recruit participants, while Parisi et al. (2018) partnered with existing community-based organizations to recruit eligible MSM.

Population characteristics and sample sizes varied between studies. Although our review targeted behavioral interventions to enhance PrEP uptake among Black MSM, studies that included White MSM as part of the study population were also included (Mayer et al., 2017; Parisi et al., 2018). The racial and ethnic distribution across studies included persons who identified predominantly as Black. Age ranges varied widely between studies, with three studies specifically targeting adolescents and youth (Daughtridge et al., 2017; Hosek, Siberry, et al., 2013; Hosek, Landovitz, et al., 2017) and another including participants with ages greater than 55 (Parisi et al., 2018). The broadest age range in any study was 18 to older than 55 years of age (Parisi et al., 2018).

Social media and community settings were used to deliver interventions that focused on personal cognitive counseling, group-based education and counseling sessions, and other individual counseling methods (Daughtridge et al., 2015; Hosek, Landovitz, et al., 2017). Behavioral interventions varied in length from a 2-day seminar (Hosek, Green, et al., 2013) to an ongoing 12-month intervention (Parisi et al., 2018). Interventions were delivered by infectious disease physicians (Daughtridge et al., 2015) and trained research staff (Hosek, Siberry, et al., 2013; Hosek, Landovitz, et al., 2017; Hosek, Rudy, et al., 2017; Mayer et al., 2017; Parisi et al., 2018).

Adapted Interventions

The benefits of theory-driven medication adherence interventions have been well documented in the literature (Conn, Enriquez, Ruppert, & Chan 2016; Prestwich, Webb, & Conner, 2015), yet only two studies in our review reported how their intervention utilized theory (Hosek, Green, et al., 2013; Mayer et al., 2017). Hosek, Siberry, et al. (2013) described the use of the Many Men, Many Voices (3MV) intervention founded on Social

Cognitive Theory (Bandura, 1986) and the Transtheoretical Model (Centers for Disease Control and Prevention, 2010; Sparakowski, Prochaska, & DiClemente, 1986). The authors described a behavioral intervention known as 3MV in which HIV risk is explored in the context of dual minority identities, where sessions focused on cultural and social norms and psychological influences on risky behaviors. Both intervention and control groups received the 3MV intervention before randomization (i.e., pill, placebo control, and no pill control). Many men, many voices was originally designed to reduce the risk of HIV and sexually transmitted infections (STIs) in Black MSM and has been recognized as a CDC Dissemination of Effective Interventions Evidence-Based HIV Behavioral Intervention (Centers for Disease Control and Prevention, 2010; Wilton et al., 2009). Many men, many voices is a group-based, seven-session behavioral intervention that encourages healthy behaviors and attempts to decrease STI and HIV risk behaviors. Many men, many voices addresses challenges related to dual identity, behaviors that put Black MSM at risk, homophobia, racism, and the connections between STIs and HIV (Centers for Disease Control and Prevention, 2010). However, the adapted 3MV intervention did not enhance PrEP medication adherence in any of the study's three arms (Hosek, Siberry, et al., 2013).

In a similar study conducted by Mayer et al. (2017) that aimed to increase adherence to PrEP, the researchers used the Life Steps intervention based on principles of Cognitive Behavioral Therapy, Problem Solving Therapy, and the Motivational Interviewing Model (Safren et al., 2001). Life Steps was originally designed to enhance medication adherence in PLWH and was adapted for the study. Life Steps used a single-session intervention created to increase motivation, understand adherence behaviors, and solve problems (Safren et al., 2001). Participants were given the adapted Life Steps intervention or supportive counseling to increase the uptake of and adherence to PrEP. The adapted intervention centered on identifying barriers and then problem solving to enhance medication adherence. The adapted Life Steps intervention allowed flexible visits that were designed to meet the needs of the participants and included adherence topics such as regimen schedules, barriers to adherence, and problem solving. No significant difference in medication adherence to PrEP or intention to use condoms was seen between the intervention and control groups (Mayer et al., 2017).

Measurement of Medication Adherence

Measurement of adherence varied between studies and included medication self-report, pickup rates, drug plasma levels, and electronic monitoring devices (Daughtridge et al., 2015; Hosek, Rudy, et al., 2017; Mayer et al., 2017; Parisi et al., 2018). Self-reported medication adherence data were consistently higher than drug plasma level measures of adherence (Hosek, Siberry, et al., 2013; Parisi et al., 2018). Only one study reported a significant or sustained increase in PrEP uptake and adherence (Parisi et al., 2018).

In a New York-based demonstration study, 96.6% of included participants self-reported taking four or more pills per week at the 6-month postintervention time point (Parisi et al., 2018). However, across the other six studies included in this review, medication adherence declined over time. In two controlled studies, there was no significant difference in medication adherence between groups at the end of the study (Hosek, Siberry, et al., 2013; Mayer et al., 2017). While Hosek, Landovitz, et al. (2017) found that 95% of participants

had detectable drug levels at Week 12 with a level of protection at 49%, the level of protection declined to 22% by Week 48. In another study by the same researchers, 81% of participants had detectable drug levels at Week 24, but only 34% had a drug level that was consistent with taking four or more pills per week (Hosek, Rudy, et al., 2017).

Two studies examined reasons for missing medication doses (Hosek, Landovitz, et al., 2017; Hosek, Rudy, et al., 2017) through the use of an adapted version of the AIDS Clinical Trials Group Adherence Follow-up Questionnaire (Chesney, Morin, & Sherr, 2000). The most common reasons reported by participants for missing medications were forgetting and being away from home (Hosek, Siberry, et al., 2013; Hosek, Landovitz, et al., 2017; Hosek, Rudy, et al., 2017). Significant differences were reported between adherent and nonadherent participants, with adherent participants being less worried about getting HIV ($p = .01$), being more comfortable with having sex with a person infected with HIV ($p = .01$), and fearing HIV drug resistance if they contracted HIV ($p = .004$). Moreover, nonadherent participants were more likely to agree with the statement *I worry that others will see me taking pills and think that I am HIV positive* (Hosek, Landovitz, et al., 2017).

Sexual Behaviors and HIV Acquisition Risk

One intervention study (Hosek, Siberry, et al., 2013) found a decline in unprotected anal sex acts, yet 98% of participants reported they did not change their medication adherence behaviors based on sexual activity. A later study by the same researchers found that participants who engaged in condomless sex had higher rates of PrEP use ($p = .01$; Hosek, Rudy, et al., 2017). However, another study found no significant difference in condomless anal sex between the intervention and control groups following the Life Steps intervention (Mayer et al., 2017). Yet another study found that condomless anal sex initially increased by 3% at the 3-month followup appointment and then decreased by 5% by Month 6 (Parisi et al., 2018).

Of the seven studies included in this review, three reported that there were no HIV seroconversions during the intervention or maintenance period. However, another study found four participants had seroconverted for an incidence rate of 3.29 over 100 person-years in a study sample of 142 participants (Hosek, Rudy, et al., 2017). In a study using cognitive counseling, three participants seroconverted for an incidence of 6.4 (Hosek, Landovitz, et al., 2017). The seroconversion data were consistent with taking fewer than two doses of PrEP per week. A number of STIs were reported over the course of the seven studies. One study reported an overall incidence of 66.44 per 100 person-years, with the greatest incidence found within the first 24 weeks after the intervention (76.48/100 person-years; Hosek, Rudy, et al., 2017). In another study by the same researchers, a total of 23 STIs were reported in 12 participants (Hosek, Landovitz, et al., 2017). Despite the long intervention time and positive outcomes, Parisi et al. (2018) diagnosed 16 STIs during the course of their study.

Discussion

Effective intervention studies are needed to address best practices for the uptake of and adherence to PrEP in the priority population of Black MSM. Most of the available literature

has reported open-label and clinical trials focused on PrEP efficacy. Successful implementation of PrEP should be driven by three elements: (a) adoption of the medication by the population most at risk, (b) adherence to the prescribed regimen, and (c) ongoing sexual health risk reduction behaviors (Golub, Operario, & Gorbach, 2010).

Our review was likely limited by the novelty of chemoprophylaxis as an effective strategy for the prevention of HIV infection. Taking ARV medication as an HIV prevention strategy has only been available since 2012. There had only been a 5-year period of open-label PrEP availability prior to the timeframe of this review. Given the novelty of PrEP, there may be ongoing behavioral studies that have not yet been published. Notwithstanding, the adherence data that are available from open-label clinical trials have shown that an emphasis on adherence is necessary and should be a research priority (Baeten et al., 2012; Grant et al., 2010; Thigpen et al., 2012).

Another potential limitation of our integrative review was the limited number of published studies that have included Black MSM in the study sample. Due to the scant number of published behavioral interventions, one of the articles in this review had a study population of mostly White (60%) men and also included transgender women (4.7%) in the sample (Parisi et al., 2018). Of note is the fact that the Parisi et al. (2018) article, consisting of a study population that was primarily White, was the only study that showed an increase in adherence to PrEP. Inclusion of this article may decrease the generalizability of the overall findings to the Black MSM population.

Surprisingly, only two studies in our review used a theoretical framework (Hosek, Green, et al., 2013; Mayer et al., 2017). One of these studies had originally been developed to enhance adherence to medication among PLWH (Mayer et al., 2017; Safren et al., 2001). A recent meta-analysis of interventions for medication adherence showed that behavioral interventions were more effective than cognitive strategies in increasing medication adherence (Conn & Ruppert, 2017).

Another consideration while addressing PrEP uptake and adherence was the vulnerability of the population of MSM. Men who have sex with men, specifically Black MSM, are known to be a hard-to-reach population with regard to research (Barros, Dias, & Martins, 2015). Challenges with the recruitment of hard-to-reach populations have historically led researchers to rely on convenience or purposive sampling, which increases the risk of internal bias within studies (Barros et al., 2015). Only one study addressed the challenge of reaching the priority population of Black MSM and the difficulty of encouraging initial uptake (Parisi et al., 2018). Further, MSM of color have historically been hesitant to partake in preventative health behaviors (Kirby & Thornber-Dunwell, 2014). Results from our review were consistent with other literature, which has indicated that stigma negatively impacts the uptake of prevention behaviors in some at-risk populations (Abbott & Williams, 2015).

Previous research demonstrated that PrEP provided 96% protection at 4 doses per week and 99% protection at 7 doses per week for the prevention of HIV infection (Anderson et al., 2012). Data from the iPrEx trials showed that adherence to PrEP was strongly correlated

with the level of protection against HIV acquisition (Grant et al., 2010), and a 2006 meta-analysis showed that ARV therapy was most effective when PLWH remained adherent to prescribed regimens (Mills et al., 2006). The success of PrEP has been strongly correlated with the level of medication adherence in a number of clinical trials (Grant et al., 2010; Thigpen et al., 2012). However, it has been well documented that missing doses of PrEP medication, or starting and stopping PrEP medication, results in suboptimal HIV prevention protection (Anderson et al., 2012).

The use of self-reported adherence measures in all seven studies included in this review was concerning. A 2016 review of 117 medication adherence studies found that nonelectronic measurements of medication adherence often led to an overestimation of adherence (El Alili, Vrijens, Demonceau, Evers, & Hiligsmann, 2016). Hence, future PrEP uptake studies should consider using other medication adherence measures instead of relying predominantly on self-report.

Conclusion

The effectiveness of PrEP has been well established through randomized controlled trials (Baeten et al., 2012; Grant et al., 2010; Liu et al., 2016; McCormack et al., 2016; Thigpen et al., 2012). However, there is a dearth of published behavioral intervention studies that have addressed low PrEP uptake and medication adherence in Black MSM. Our review has demonstrated a clear need for intervention research with this priority population.

The state of the science with regard to the uptake of and medication adherence to PrEP among Black MSM appears to be in the beginning stage as evidenced by the scant number of behavioral interventions that have been published (Daughtridge et al., 2015; Hosek, Green, et al., 2013; Hosek, Siberry, et al., 2013; Hosek, Landovitz, et al., 2017; Hosek, Rudy, et al., 2017; Mayer et al., 2017; Parisi et al., 2018). While some studies in our review reported encouraging short-term outcomes, only one study reported a sustained change in medication adherence or risk reduction behavior at 12 months postintervention (Parisi et al., 2018). It should also be noted that in the only study reporting a sustained change, only 14% of the study sample consisted of Black MSM (Parisi et al., 2018).

The authors of the studies included in this review all provided recommendations for future interventions. Three articles recommended the use of more frequent contact with participants in the form of augmented or flexible visit schedules, booster calls or text messages, or check-ins (Hosek, Siberry, et al., 2013; Hosek, Landovitz, et al., 2017; Hosek, Rudy, et al., 2017). These recommendations were stated to be particularly helpful when working with a younger population that may need more frequent contact than older participants, as medication adherence in youth has been shown to be lower than that in adults (Hosek, Rudy, et al., 2017). Previous literature has shown that more frequent contact has been useful in increasing medication adherence to ARV medications in youth living with HIV and therefore may be useful for encouraging adherence to PrEP (Garofalo et al., 2016). One study (Hosek, Green, et al., 2013) discussed the importance of working closely with the target population and community members to create and adapt interventions. Authors noted that it was more cost-effective to implement prevention services in the community, rather

than in the clinic setting. Authors also discussed the need to better understand how race, ethnicity, sexual orientation, stigma, discrimination, and gender affect the uptake of and adherence to PrEP medication (Hosek, Landovitz, et al., 2017; Hosek, Rudy, et al., 2017; Mayer et al., 2017). Finally, the need to address HIV prevention as a whole, combining risk reduction behaviors with PrEP, was felt to be crucial to reduce risk of HIV acquisition in the MSM population.

Due to the scarcity of published behavioral intervention literature, it is difficult to make recommendations for future research, practice, or policy change with regard to effective intervention strategies to enhance PrEP uptake in Black MSM. Authors of the studies included in this review offered insight and recommendations for future studies, such as using booster text messages, more frequent interactions with participants, larger sample sizes, and community-based interventions. These recommendations should be considered as researchers, clinicians, and policy-makers strive to address the disproportionate burden of HIV disease-related morbidity and mortality in the Black MSM population.

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Key Considerations

- Few behavioral interventions have been developed and tested to increase the uptake of and adherence to PrEP medication in the priority population of Black MSM.
- No long-term or sustained change in medication adherence or risky sexual behavior has been observed in published behavioral intervention research for this population.
- Authors of published studies recommend contacting participants frequently; engaging the community to act; and working to understand how stigma, access to care, and discrimination hinder prevention services in the Black MSM population.

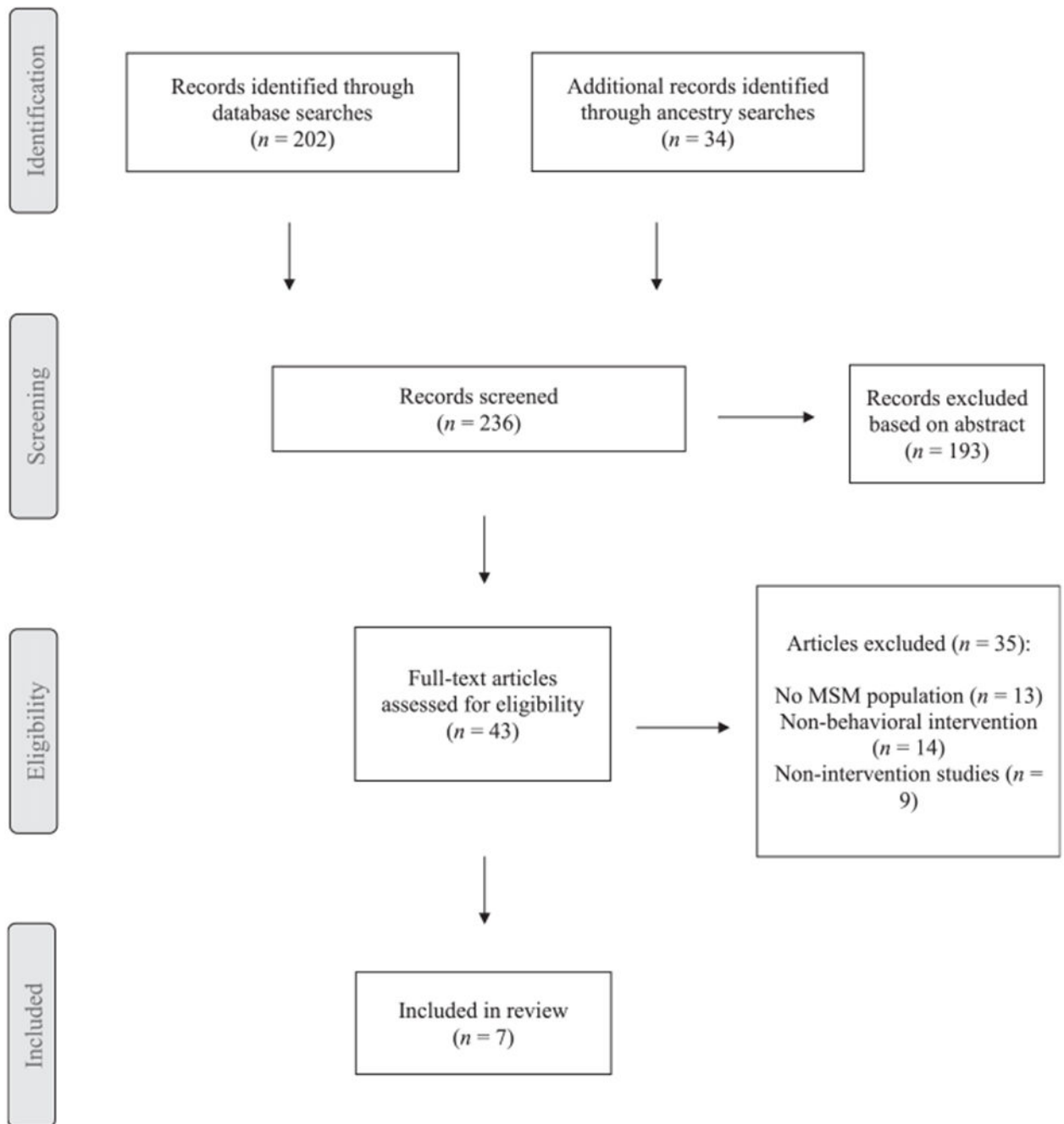


Figure 1. PRISMA flow diagram. *Note.* MSM = men who have sex with men. Adapted from Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7), e1000097.

Table 1.

Individual Study Information

Authors, Year, Design	Intervention	Population	Theoretical Framework	Adherence	Results
Daughtridge, Conyngham, Ramirez, & Koenig, 2015	<ul style="list-style-type: none"> Participants given first 7 pills of PrEP and MA strategies discussed 	Mean age: 21	NR	Weighted average adherence to PrEP = 73%, median = 82% for those who had taken PrEP for 1 month	Condom use: 74% reported inconsistent condom use
Prospective, one group	<ul style="list-style-type: none"> Report to clinic for medication pickup once a week 	Range: 17–26		MA: 79% at 16 weeks, 69% at 24 weeks, 88% at 28 weeks	Sexual partners: 43% reported \$3 sexual partners in the last 3 years
	<ul style="list-style-type: none"> Weekly Facebook messages to remind of visit and medication pickup 	Race/ethnicity: 13 Black, 6 biracial, 2 White		Missed doses: NR	Seroconversions: 0
	<ul style="list-style-type: none"> Promote well-being, organized activities, weekly social worker organized workshops 	Total: <i>n</i> = 20			STIs diagnosed: 7
	<ul style="list-style-type: none"> Consistent access to peer and provider resources 				
Hosek, Siberry, et al., 2013	<ul style="list-style-type: none"> Group-based intervention adapted from 3MV 	Mean age: 19.97	NR	Median number of doses missed = 10/30 in FTC/TDF arm	Condom use: In all treatment arms, there was a decline in unprotected anal sex (differences between groups not statistically significant)
RCT, three groups	<ul style="list-style-type: none"> Explored HIV risk among MSM within the context of dual identities (as racial and sexual minorities) Adapted for youth of mixed racial and ethnic identities for this study 	Range: 18–22		No statistically significant differences in FTC/TDF arm versus placebo arm in doses missed	Sexual partners: NR
	<ul style="list-style-type: none"> Participants completed 3MV intervention and were then randomized to 1 of 3 arms: (a) daily oral FTC/TDF, (b) daily oral placebo, or (c) no pill 	Race/ethnicity: 53% Black, 40% White		MA declined toward end of study, 98% reported no change in medication behaviors based on sexual activity	Seroconversions: 0
	<ul style="list-style-type: none"> Delivered in a seminar format for 2 days 	Total: <i>n</i> = 58		Missed doses: Common reasons: (a) away from home (b) simply forgot, and (c) too busy	STIs diagnosed: 17
Hosek, Green, et al., 2013	<ul style="list-style-type: none"> 7 sessions focused on cultural and social norms, relationship dynamics, other STIs, psychological influences on risky behaviors 	Mean age: 19.97	Social Cognitive Theory and Trans-theoretical Model	NR (see Hosek, Siberry, et al., 2013)	NR

Authors, Year, Design	Intervention	Population	Theoretical Framework	Adherence	Results
Hosek, Landovitz, et al., 2017	<ul style="list-style-type: none"> Participants received a personalized cognitive counseling session 	Race/ethnicity: 53% Black, 40% White (in parent study) Total: $n = 6$ Mean age: 16.5 NR		Measurement: dried blood spots	Condom use: did not change during study
Prospective, one group	<ul style="list-style-type: none"> Participants who received “integrated next-step” counseling were given condoms, safety assessment performed at each visit 	Range: 15-17		MA: 95% had detectable drug levels during the first 12 weeks of treatment with declining levels. Those without protective levels were more likely to agree with the statement <i>I worry that others will see me taking pills and think I am HIV positive</i> . Levels of protection by Week: 4 = 54%, 8 = 47%, 12 = 49%, 24 = 28%, 36 = 12%, 48 = 22%	Sexual partners: did not change during study
	<ul style="list-style-type: none"> PrEP supplied to participants 	Race/ethnicity: 29% Black, 33% mixed race, 14% White, 21% Hispanic Total: $n = 47$		Missed doses: ACTG Adherence Follow-up Questionnaire adapted to understand reasons for missed doses. Most common reasons for missing pills were being away from home, too busy, forgetting, changes in routine	Seroconversions: 3 acquired HIV during study for an incidence of 6.4 (95% CI, 1.3-18.7) consistent with taking fewer than 2 doses per week at the time of exposure STIs diagnosed: during 48 weeks, 23 STIs diagnosed in 12 participants
Hosek, Rudy, et al., 2017	<ul style="list-style-type: none"> Interventions varied between sites 	Mean age: 20.2 NR		Measurement: PrEP medication levels assessed by intracellular TFX-DP and FTC concentrations	Condom use: For those who engaged in condomless sex, use of PrEP was higher ($p = .01$)
Prospective, one group	<ul style="list-style-type: none"> Comprehensive HIV package was provided, including risk reduction counseling, condoms, STI screening, treatment, biomedical data collection, and “next step” counseling 	Range: 18-22		MA: 90% had detectable drug levels Week 12, 81% Week 24, 69% Week 48. At 24 weeks, 34% had levels consistent with 4 pills/week. Adherent participants less worried about getting HIV ($p = .01$), were more comfortable with having sex with PLWH ($p = .01$), and feared developing medication resistance if they contracted HIV ($p = .004$)	Sexual partners: Average of 5 sexual partners reported at baseline
	<ul style="list-style-type: none"> Next-step counseling used exploration, problem solving, and behavioral skills to prevent HIV 	Race/ethnicity: 66% identified as Black, 29% White 26% Latino		Missed doses: ACTG Adherence Follow-up Questionnaire used to detect missing doses and reasons for missing doses. Most reported reason for missing medication was “forgot.” Other reasons included being away from home or too busy. Some participants reported wanting to avoid side effects or not wanting to be seen taking medications	4 seroconversions occurred (HIV incidence rate of 3.29 over 100 person-years)

Authors, Year, Design	Intervention	Population	Theoretical Framework	Adherence	Results
Mayer et al., 2017	<ul style="list-style-type: none"> Assessed participant desire to remain on PrEP and provided strategies to remain adherent Initial counseling session same for all participants but then randomized into 1 of 2 groups: "Life Steps for PrEP" or time- and session-matched control Participants given 30-day supply of PrEP 	<p>Total: $n = 142$</p> <p>Mean age: 38.24</p>	"Life Steps" based on principles of Cognitive Behavioral Therapy, Problem Solving Therapy, Motivational Interviewing model	<p>Measurement: MA tracked with Wisepill, an electronic monitoring device</p>	<p>STIs: Overall STI rate was 66.4 with the greatest incidence in the first 24 weeks (76.48/100 person-years)</p> <p>Condom use: no statistically significant differences in MA or condomless anal sex between intervention and comparison groups ($p = .47$)</p>
RCT, two arms		<p>Range: NR</p>		<p>MA: For 824 of 1,028 weeks of monitoring, participants had >80% adherence. No statistically significant difference between intervention and comparison groups in adherence (83% vs. 77%; $p = .037$). In the final week, 52.8% of those who said they had condomless sex had plasma levels consistent with daily use, 41.7% reported no condomless sex, and 5.4% reported condomless sex without consistent use</p> <p>Missed doses: NR</p>	<p>Sexual partners: NR</p> <p>Seroconversions: NR</p>
	<ul style="list-style-type: none"> "Life Steps", centered on medication adherence, sexual behaviors, and overcoming barriers Topics included barriers to adherence and biological factors of HIV Each visit allowed participants to check in about adherence including schedules, barriers, and problem solving Risk reduction and adherence counseling at baseline 	<p>Race/ethnicity: 86% White, 2% Black, 8% Latino, 4% other</p> <p>Total: $n = 39$</p>			<p>STIs diagnosed: NR</p>
Parisi et al., 2018, prospective		<p>Mean age: NR</p>	NR	<p>Measurement: Self-reported as more than 4 pills per week</p>	<p>Condom use: Condomless anal sex increased by 3% at the 3-month follow-up and decreased by 5% at 6 months</p> <p>Sexual partners: NR</p>
One group	<ul style="list-style-type: none"> Mental health, substance use, and STI screening provided at all visits as needed Baseline visit, followup at 30 days, risk reduction, and MA issues discussed Quarterly visits scheduled with PrEP and condom distribution 	<p>Range: 18-55 +</p>		<p>MA: At Month 1, all participants reported they were adherent. At 3 months, 82/87 participants (94.3) reported being adherent. At 6 months, 84/87 participants (96.6%) reported adherence</p> <p>Missed doses: NR</p>	<p>Seroconversions: 0</p> <p>STIs diagnosed: 16</p>

Authors, Year, Design	Intervention	Population	Theoretical Framework	Adherence	Results
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Total: $n = 171$

Note. ACTG = AIDS Clinical Trial Group; FTC/TDF = emtricitabine/tenofovir disoproxil; MA = medication adherence; STI = sexually transmitted infection; MSM = men who have sex with men; NR = not reported; PLWH = people living with HIV; PrEP = pre-exposure prophylaxis; RCT = randomized controlled trial; TFV-DP = tenofovir diphosphate; TGF = transgender female; MV = Many Men, Many Voices (Centers for Disease Control and Prevention, 2010).