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Pre-Exposure Prophylaxis (PrEP) Dissemination: Adapting Diffusion Theory to Examine PrEP Adoption

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Abstract

PrEP adoption among African-American men-who-have-sex-with-men (AAMSM) remains low. We applied Diffusion-of-Innovations (DOI) theory to understand PrEP adoption processes among young HIV-negative/status unknown AAMSM (AAYMSM; $N = 181$; 17–24 years). Quantitative and qualitative analyses were used to examine predictors of PrEP diffusion stages. Most AAYMSM were in the persuasion stage (PrEP-aware, hadn't adopted; 72.4%). Our results suggest that model antecedents are DOI stage-specific. PrEP awareness (knowledge stage) was associated with lower levels of social stigma ($p < .03$) and greater health literacy ($p < .05$), while sexual risk ($p < .03$) and education ($p < .03$) predicted PrEP adoption (12.2%). PrEP efficacy and side effects were primary innovation characteristics influencing adoption receptivity in the persuasion stage. Interventions to improve PrEP diffusion should be tailored to stage-specific antecedents depending on how a community is stratified across the DOI stages.

Resumen

La adopción de Pre-exposición Profilaxis (PrEP) entre hombres afroamericanos que tienen relaciones sexuales con otros hombres (HASH) sige baja. Aplicamos la teoría de la difusión

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Conflict of interest The authors have no conflict of interest or competing interests to declare.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All procedures, consent materials, and interview protocols were approved by the University of Michigan IRB which served as the primary IRB for this project (IRB approval was ceded by Oregon State University to the University of Michigan IRB).

Informed Consent Informed consent was obtained from all individual participants included in this study.

de innovaciones para comprender los procesos de adopción de la PrEP entre los hombres jóvenes afroamericanos que tienen relaciones sexuales con otros hombres (HJASH) VIH negativos/estado desconocido (HJASH; N = 181; 17–24 años). Se utilizaron análisis cuantitativos y cualitativos para examinar los predictores de las etapas de difusión de PrEP. La mayoría de los HJASH se encontraban en la etapa de persuasión (conscientes de la PrEP, no la habían adoptado; 72.4%). Nuestros resultados sugieren que los antecedentes del modelo son específicos de la etapas de la difusión de innovaciones. La conciencia de la PrEP (etapa de conocimiento) se asoció con niveles más bajos de estigma social ($p < .03$) y una mayor alfabetización en salud ($p < .05$), mientras que el riesgo sexual ($p < .03$) y la educación ($p < .03$) predijeron la adopción de la PrEP (12.2%). La eficacia y los efectos secundarios de la PrEP fueron las principales características de la innovación que influyeron en la receptividad de la adopción en la etapa de persuasión. Las intervenciones para mejorar la difusión de la PrEP deben adaptarse a los antecedentes específicos de la etapa, dependiendo de cómo se estratifique una comunidad en las etapas del la difusión de innovaciones.

Keywords

HIV/AIDS; African American; MSM; Social stigma; Diffusion

Introduction

Pre-exposure prophylaxis (PrEP), a powerful HIV prevention tool, is not reaching high-risk populations in the United States [1, 2]. African American men-who-have-sex-with-men (AAMSM) report low rates of PrEP adoption (4–7%) [3-5] as well as disproportionately high levels of HIV sexual risk behavior [6] and new HIV infections [7]. Recent results found AAMSM to be twice as likely as White MSM to terminate PrEP use [8]. Empirical research has examined correlates of PrEP dissemination outcomes, including awareness, intention to adopt, and adoption among AAMSM [3, 9, 10]. However, these studies often lack a theoretical framework to guide hypothesis development. We applied the Diffusion of Innovations (DOI) theory, relevant to prevention innovations [11], in examining PrEP diffusion among AAMSM.

Diffusion Theory & Prevention: Application to PrEP

Diffusion plays a major role in current dissemination-adoption models [12-15]. Most of this work, however, has focused on dissemination of health innovations at the organizational level, and less so at the individual-consumer level. The current work applies DOI theory [11] to individual-level adoption of a preventive health innovation. DOI theory has provided a useful basis for research on the adoption of innovations [11, 16]. The diffusion process is characterized as a series of five stages: knowledge, persuasion, decision, implementation, and confirmation. These stages, respectively, correspond to the processes of becoming aware of the innovation and its purpose, becoming persuaded to try the innovation, engaging in decision-making activities (e.g., trial use), implementing the innovation on a regular basis, and sustaining use over time [11].

Rogers [11] noted the need to address the unique aspects of prevention practices, such as PrEP, in applying diffusion concepts. Within the persuasion stage, beliefs about the

innovation are influenced by five innovation characteristics (see Fig. 1): relative advantage, compatibility, complexity, trialability, and observability [11]. In terms of observability, a successful PrEP outcome means not contracting HIV (i.e., outcomes are not directly observable for many prevention innovations). The absence of a clearly observable outcome may inhibit adoption motivation and slow progression from persuasion to subsequent stages [11]. Although event-driven/2–1-1 PrEP [i.e., a short-course regimen of taking PrEP before and after sex, which has gained international support [17] and demonstrated effectiveness in preventing HIV among high risk MSM in France and Canada [18]] may allow for trial use, daily PrEP protocols have discouraged direct trialability by requiring sustained use [1], which eliminates a key decision-making process. Without sufficient information about PrEP's observability or the opportunity for trial use, it may be more difficult for a potential adopter to discern the relative advantage of PrEP over alternative methods (e.g., condom use) [11].

For many preventive innovations, the unique challenges associated with reduced observability and unclear relative advantage contribute to a discrepancy between positive innovation-related beliefs (i.e., in the persuasion stage) and actual use (i.e., adoption) [11]. This gap may also apply to PrEP, given large observed differences between estimates of PrEP awareness and use among U.S. MSM [19, 20]. Reducing the persuasion-adoption gap for PrEP requires an understanding of individuals within the pre-adoption stages (i.e., knowledge, persuasion, decision), their PrEP-related beliefs, and factors associated with progression from pre-adoption to adoption. From a diffusion standpoint, PrEP adoption is considered an "optional" innovation decision—one facilitated by an autonomous individual rather than enforced by an organization or authority [11]. Consequently, the current investigation focuses on individual-level antecedents of PrEP pre-adoption stages [16].

Looking Within and Across PrEP Diffusion Stages

A DOI perspective highlights important gaps in the literature. For instance, many community-based studies among MSM in the U.S. focus on a single stage of PrEP diffusion, with little exploration of population heterogeneity within stages, or antecedents of progression across stages. Although research outside of the U.S. has looked at multiple steps in the diffusion process [21], studies among MSM in the U.S. have typically examined only one or two of three possible outcomes: PrEP awareness (i.e., knowledge stage) [3, 4, 9, 20, 22], willingness/intention (i.e., persuasion/decision stages) [23, 24], and/or adoption [10, 25-29].

Prior research has two additional limitations. First, studies often use MSM samples that are racially/ethnically mixed [20, 25, 29], obscuring sub-cultural differences in the antecedents of PrEP adoption. Secondly, few studies have examined all DOI stages for AAMSM [30, 31]. Studies of AAMSM have often examined PrEP awareness (knowledge stage) [3, 4, 9, 22], while PrEP intention (persuasion/decision stage) and adoption have been a greater focus among studies with mixed samples of MSM [23-29, 32-34].

Individual-Level Antecedents of PrEP Diffusion

Among samples of AAMSM, PrEP awareness (knowledge stage) has been linked with higher levels of education and employment, more knowledge of or experience with HIV testing, and lower levels of perceived stigma (i.e., AIDS-related stigma) [3, 4, 22]. Antecedents of PrEP adoption specific to AAMSM have been studied less frequently [10, 30, 31]. However, Rolle et al. [10] examined sociodemographic and behavioral predictors (e.g., educational attainment, unprotected anal intercourse) and found that having a recent sexually transmitted infection was the sole predictor of PrEP adoption among AAMSM. Other work among mixed MSM samples has linked motivational factors (i.e., sexual risk, financial resources) to PrEP adoption [25-29]. Social stigma (e.g., related to sexual orientation or HIV status), an important consideration in HIV research [35], may inhibit PrEP awareness and adoption [34, 36-38]. Stigma related coping responses (e.g., avoidance coping) may lead some men to avoid, for instance, health behaviors that might reveal their sexual orientation or HIV status (e.g., attending HIV/STI testing clinics, using HIV medications) [35, 39].

PrEP Awareness & Adoption in the Current Study

We employed a mixed-methods approach in examining antecedents of the pre-adoption stages (knowledge/persuasion/decision) of PrEP diffusion among African-American young MSM (AAYMSM). AAYMSM are of particular interest because they have high levels of HIV risk [1, 6]. We quantitatively examined antecedents hypothesized to differentiate those who are (a) aware of PrEP vs. unaware of PrEP, and (b) aware of PrEP but have not adopted it (pre-adopters) vs. aware of PrEP and have adopted it (adopters). Thus, adopters represent AAYMSM who, at a minimum, progressed past the pre-adoption stages. Informed by prior research, we hypothesize that PrEP awareness will be related to social stigma and health literacy indicators (education, HIV-literacy), such that low levels of social stigma and high health literacy will be associated with being PrEP-aware (knowledge stage). We expect that PrEP adoption will be associated with social stigma and motivational factors (e.g., sexual risk, health financial resources), such that low levels of social stigma and high levels of motivation predict progression from PrEP pre-adoption to adoption.

As noted previously, prevention innovations require a reconsideration of perceived innovation characteristics that may influence diffusion [11]. In particular, it's unclear what specific PrEP characteristics are most salient for progression through the persuasion stage toward adoption. We used an exploratory qualitative approach to examine participants' perceptions of innovation characteristics. The DOI model hypothesizes that the more receptive a person is to the innovation (i.e., the more that innovation characteristics are perceived to be positive), the more likely that one is to progress from persuasion to adoption [11]. Consequently, we stratified AAYMSM in the persuasion stage using perceived innovation characteristics to examine receptivity to PrEP and related antecedents.

Methods

Background & Participants

Data on PrEP were collected in 2016 within a larger study of oral HIV self-testing among AAYMSM in Chicago (N = 181), who were either HIV negative (76%) or HIV status unknown (24%) (*reference blinded for review*). Eligibility criteria included: (a) self-identifying as African American/Black, (b) male sex assigned at birth or currently identifying as a male, (c) being 17–24 years of age inclusive, (d) having sex of any kind with another male in the past 12 months (i.e., sexual orientation was defined behaviorally; we did not assess sexual self-identity because the parent study focused on HIV testing and sexual risk behavior), (e) being HIV negative or HIV status unknown, and (f) having never self-administered an oral HIV self-test. Quota sampling was used to obtain relatively similar levels of individuals with low (i.e., high school or less) vs. high (i.e., > high school) education. Participants also reported relatively high levels of unemployment (24% unemployed & not in school; 10% working part-time & not in school). The majority of participants were PrEP eligible (based on current U.S. prescribing guidelines), given high levels of sexual risk reported (59% any unprotected receptive anal intercourse (URAI) in last year). All procedures, consent materials, and interview protocols were approved by the (*removed for blinded review*) which served as the primary IRB for this project (IRB approval was ceded by (Oregon State University) to (University of Michigan)).

Recruitment & Data Collection

Participants were recruited through venues serving AAYMSM in Chicago. All interviews were conducted in a private setting at participating agencies and were audio recorded. Detailed interview procedures and study protocols are described by Catania et al. [39].

Measures

Demographics

Age, education, and medical coverage were dichotomized: Age (years), (0) = 17–20, (1) = 21–24; Education, (0) = > High School/GED, (1) = ≤ High School/GED; Medical coverage, (0) = Cash, (1) = Insurance/other (see Table 1).

Sexual Behavior

We assessed self-reported frequency of condom use during receptive anal intercourse (RAI) over the previous year (0 = Never to 6 = All the time), and generated a binary variable to reflect sexual risk broadly [1 = Any unprotected RAI (URAI), 0 = No URAI] (see Table 1).

HIV Health Literacy

HIV health literacy was measured using an index of 8 items that assessed practical knowledge of relevance to HIV prevention and treatment (see Table 1).

Social Stigma

We adapted Fortenberry's HIV-related social stigma scale [40, 41] for use with AAYMSM (see Appendix A). Items were summed and averaged to reflect a mean total score for each participant, with higher scores indicating greater perceived stigma (see Table 1); the scale showed adequate internal consistency in the sample (Cronbach's alpha = 0.71).

PrEP Awareness, Adoption, & Discontinuance

All participants (n = 181) were asked: "Have you heard about PrEP, a medication you can take that will help prevent you from getting HIV?" (i.e., assesses awareness of PrEP and its function). Participants who had heard of PrEP (n = 160) were asked: "Are you currently taking PrEP?". Responses were coded as follows: PrEP awareness (1 = Never Heard of PrEP, 0 = Heard of PrEP) and PrEP adoption (1 = On PrEP, 0 = Not on (but aware of) PrEP). Individuals who reported having tried PrEP but were no longer using it were categorized as having discontinued use.

Perceived Innovation Characteristics

Open-ended questions were used to assess participants' perceptions of PrEP. To avoid priming participants' answers, these questions were structured very generally. For example, "Tell me what you have heard about PrEP?", "In your opinion do you think PrEP works for most people or it is only working for some?". Interviewers constructed probes ad hoc depending on the depth of respondents' answers.

Data Analysis

SPSS and Stata15 were used to manage and analyze quantitative data. Preliminary bivariate tests indicated that age was relatively redundant with level of education (χ^2 = 35.45, $p < 0.001$), employment (χ^2 = 13.32, $p = 0.001$), and medical coverage (χ^2 = 5.69, $p = 0.02$), and was thus excluded from analysis. Open-ended responses regarding PrEP perceptions were extracted and organized in thematic categories [42]. Multiple coders were employed in achieving consensus. We used directed content analysis [43] to explore characteristics hypothesized by Rogers [11] to influence the persuasion stage, and to see if additional concepts might arise from the data. Initial descriptive analyses were followed by categorical analysis, in which passages were sorted according to the five key innovation characteristics identified by Rogers (i.e., compatibility, complexity, observability, trialability, relative advantage) [11]. Further description of exploratory qualitative analysis is provided within the Results section.

Results

Overview

Approximately 12% of participants (n = 21/181) reported never having heard of PrEP. The majority of men (72%; n = 131) were aware of PrEP but had not adopted it (i.e., preadopters). Approximately 12% of men (n = 22) had adopted PrEP, and another 4% (n = 7) had discontinued PrEP use. Multivariate analyses examined correlates of participants who were (a) unaware vs. aware of PrEP (including adopters), and (b) adopters vs. pre-adopters

(aware of PrEP but hadn't adopted). The sample of men who discontinued PrEP was too small for quantitative analytic purposes, but we provide a brief qualitative analysis of this sub-group.

PrEP Awareness: Aware vs. Unaware

We conducted bivariate analyses (as a data reduction step) comparing participants who had never heard of PrEP (n = 21) with those who had (n = 160; Table 2). Only social stigma and HIV health literacy were retained in a multivariate logistic regression model (Omnibus X^2 = 8.32, p = 0.01; Hosmer and Lemeshow fit, p = 0.61). Both social stigma and HIV health literacy were statistically significant, with those who were unaware of PrEP reporting higher levels of perceived social stigma and lower HIV health literacy than those who were PrEP aware (Table 3).

PrEP Pre-Adopters vs. Adopters

We examined bivariate correlates of PrEP adopters (n = 22) vs. pre-adopters (i.e., PrEP aware but had not adopted PrEP; n = 131; excluding those who had previously adopted but discontinued PrEP; Table 2). Sexual risk, educational attainment, and medical coverage were entered into a multivariate logistic regression model (Omnibus X^2 = 11.52, p = 0.01; Hosmer and Lemeshow fit, p = 0.95). We found statistically significant relationships between PrEP adoption and sexual risk, education, and health insurance; such that, PrEP adopters were more likely to report sexual risk and have higher levels of education, and, unexpectedly, less likely to have health insurance (Table 3).

Key Innovation Characteristics: Qualitative Analysis

We used responses to open-ended PrEP questions to explore key innovation characteristics originally hypothesized by Rogers [11] to operate in the persuasion stage. Approximately 57% (n = 91) of PrEP-aware participants reported holding opinions about PrEP. However, despite being aware of PrEP, 43% did not demonstrate sufficient understanding of PrEP to report details on PrEP characteristics. It may be that these men were more likely to be in the knowledge stage (i.e., learning what PrEP is and how it works), and men who described PrEP characteristics were likely in the persuasion stage (i.e., knowledgeable about PrEP and forming related beliefs). We examined for differences in the independent variables between men reporting opinions about PrEP use (n = 91) vs. those who had not formed opinions about PrEP (n = 69). The two groups did not differ significantly on any of the study variables (data available from first author), suggesting that they may represent the same sub-population.

Based on content analysis, we identified three innovation characteristics which accounted for the vast majority of passages among AAYMSM in the persuasion stage (compatibility, observability, relative advantage; see Table 4). Two of the hypothesized characteristics were not mentioned (complexity, trialability; see Table 4). While trialability was not expected to be an observed characteristic, it was less clear whether complexity would be a relevant factor. While men did make observations such as the need to take the pills daily, no negative or positive connotations were associated with these observations (e.g., "I heard it's a pill you take once a day").

With regard to compatibility, we observed three dimensions including perceived PrEP efficacy, side effects, and personal need (i.e., sexual risk perception; see Table 4). The most common dimensions reported were related to PrEP efficacy and side effects. While PrEP efficacy statements were relatively polarized, there was greater variability in perceptions of side effects. That is, some believed side effects to be minimal, and others described them as moderate-severe (see Table 5). Observability was mentioned only within the context of having "observed" the outcomes of taking PrEP on HIV serostatus among individuals in their social network (see Table 4). That is, observability in this context refers to vicarious observability, rather than direct observations of the effects on one's own serostatus. A minority of respondents mentioned beliefs concerning the relative advantage of PrEP vs. condoms with some individuals preferring condoms, and others PrEP (see Table 4). Several participants indicated they would prefer using both condoms and PrEP as a form of "double coverage" (see Table 4, footnote b).

Receptivity to Adopting PrEP

We took the perspective that if a person believed PrEP to have high efficacy and few side effects, they were on the path to adoption. That is, they were closer to being persuaded to adopt PrEP than those with more negative PrEP beliefs. We stratified men in the persuasion stage into three groups reflecting their receptivity to PrEP adoption, based on the perceived levels of PrEP efficacy (highly effective vs. differentially effective/ineffective) and side effects (severe, moderate, low/none; see strata definitions and sample passages in Table 5). Men who described side effects as minimal or non-existent and/or PrEP as highly effective were classified as "Highly Receptive" ($n = 40$). Those who perceived moderate side effects and/or expressed uncertainty about PrEP's efficacy were considered "Moderately Receptive" ($n = 20$), and those who described side effects as severe and/or perceived low efficacy were considered "Least Receptive" ($n = 9$). If participants reported perceptions that fit within multiple strata (e.g., high efficacy and moderate side effects), all passages were reviewed and categorized based on the overall perception being expressed.

We further explored for differences among receptivity groups and in relation to adopters. We hypothesized that highly receptive men in the persuasion stage would be similar to PrEP adopters (i.e., with respect to variables correlated with adoption). In contrast, men who are moderately to least receptive to adopting PrEP would be significantly different from adopters and/or highly receptive men. An omnibus multinomial regression model was constructed to assess relationships between hypothesized independent variables (medical coverage, social stigma, HIV health literacy, education, sexual risk) and a four-category dependent variable (1 = Adopters, 2 = Highly Receptive, 3 = Moderately Receptive, 4 = Least Receptive). This overall model was significant (Omnibus $X^2 = 28.8$, $p < 0.02$) and significant group differences were found for two variables, educational attainment and sexual risk. Adopters had higher educational attainment compared to the Highly Receptive group [Relative Risk Ratio (RRR) = 3.59, $p < 0.04$]. Regarding sexual risk, Adopters were more likely to report sexual risk than the Least Receptive group (RRR = 12.25, $p < 0.02$). No other groups differed on sexual risk or education.

Discontinuance

We examined passages from men who discontinued PrEP (n = 7). These men described their experiences with PrEP as largely positive, with several endorsing PrEP's efficacy and preventive benefit. Reasons for stopping PrEP included experiences with side effects and, as indicated below, social stigma concerns, and HIV risk uncertainties with unprotected sex.

> "I got PrEP from my doctor and I was taking it. And then I was doing research on it, and stopped taking it. Because I was like…do I want to have sex with some-one who is HIV positive even if there's a chance that I won't get it? I was like no, I don't think so…old fashion way."
>
> (Relative Advantage of PrEP vs. Condoms)

> "I just didn't feel good carrying it around. So I stopped. Because it made it look like something it wasn't, the medication box…So I just stopped, because it looked different. You know, maybe people would think like I was (HIV positive)."
>
> (Compatibility Concerns: Social Stigma Anxieties)

Discussion

We applied DOI theory [11] to examine PrEP adoption processes among AAYMSM. In the current study (i.e., in 2016), most men were within the pre-adoption stages (knowledge, persuasion, decision) of the diffusion process. Thus, the majority of AAYMSM in this study had moved beyond awareness of the innovation, but had not progressed to adoption. We identified individual-level correlates that delineated AAYMSM at different stages of the PrEP diffusion process. Social stigma and HIV literacy were both related to PrEP awareness but not to adoption. Sexual risk, education, and medical coverage discriminated pre-adopters from those who had adopted PrEP, but were unrelated to PrEP awareness. We also found that men in the persuasion stage could be stratified based on their perceptions of compatibility (i.e., PrEP effectiveness and side effects). Future studies sh7ould examine the persuasion stage in terms of stratifications that may require more tailored interventions to move people from non-receptiveness to full receptiveness.

Collectively, the current results are consistent with findings from MSM, demonstrating key individual-level influence (e.g., stigma, sexual risk) on PrEP uptake [44, 45]. Importantly, our findings suggest that predictors of PrEP diffusion are not uniform across stages; rather, different psychosocial and behavior factors have a greater relative importance depending on where one is in the PrEP decision-making process. Social stigma and related HIV literacy deficits may be more salient factors at a fundamental step in the diffusion process (knowledge stage), but may not differentiate adopters from non-adopters once men have progressed to the persuasion/decision stages. Similar patterns were observed in a study among Black MSM across five U.S. cities, which found HIV stigma to predict PrEP awareness but not adoption, and income to predict PrEP adoption but not awareness [31]. Research which further delineates and characterizes AAYMSM at different points in the diffusion process can aid in tailoring intervention efforts to reach and support men in progressing from PrEP awareness to adoption.

PrEP Awareness (Knowledge Stage)

Men who were PrEP unaware reported lower HIV literacy than PrEP aware men. Low HIV literacy not only reflects a poor understanding of basic HIV testing/prevention-related facts, but also poor awareness of medical progress in HIV prevention. However, few participants (12%) reported being uninformed about PrEP reflecting, perhaps, efforts to inform the Chicago AAYMSM community [46, 47].

PrEP unaware men had significantly higher social stigma scores than men who were PrEP aware. The AAYMSM community is subjected to high levels of social stigma related to homophobia and racism. In the African American community, AAYMSM experience social stigmatization related to both their sexual orientation and perceived HIV status; in the White community, they are further stigmatized because of their race [37, 48-55]. That is, the confluence of multiple complex identities may create unique stigmatization experiences for AAYMSM which impede PrEP awareness. Future work should adopt an intersectional perspective to further explore the dynamic stigmatization experiences faced by AAYMSM and how they influence PrEP diffusion processes; a similar approach has recently been utilized to examine PrEP uptake among young cisgender Black women in the U.S. [56].

Socially stigmatized individuals may become hyper-vigilant to avoid mistreatment by the dominant community, resulting in high levels of stress and the development of maladapative coping strategies [35, 48, 49]. Such strategies (e.g., behavioral or cognitive avoidance coping) are thought to interfere with the uptake of HIV-related health practices and information [35, 39, 55, 57]. That is, men with high levels of social stigma may avoid information on PrEP, either directly (e.g., not listening to friends who talk about PrEP) or indirectly (e.g., not being exposed to PrEP messaging due to an avoidance of sexual healthcare visits). Previous work has shown that social stigma inhibits uptake of intervention programming and learning HIV self-testing protocols [39, 55, 57]. Identifying strategies for reducing the impact of avoidance coping on acquiring HIV-related information is important.

Persuasion Adoption Stages

Men in the persuasion stage and PrEP adopters did not differ in terms of social stigma; however, men reported recent URAI were more likely to adopt PrEP, suggesting that perceived risk is an important adoption motivator. Further, adoption was more likely among better educated men, who may have more access to PrEP information or belong to PrEP-positive networks. PrEP public health messages may also be more successful in reaching men with higher levels of education.

Our qualitative analyses suggest that perceived characteristics of PrEP, specifically PrEP's compatibility with the needs of the consumer (i.e., efficacy and side effects), play a role in movement through the persuasion stage towards adoption. These findings are echoed by a recent analysis among young MSM, which found that PrEP use was associated with fewer concerns about PrEP efficacy and side effects [19]. In addition, our qualitative results suggest that discontinuance is associated with concerns about side effects, social stigma, and attributing greater protection to condom use than PrEP. These findings point out the value of

considering innovation characteristics at multiple points in the diffusion process as they may also be reasons for discontinuing PrEP adoption [58].

Contrary to prior studies, we found that men with health insurance were less likely to adopt PrEP. One possible explanation is that coupon programs (e.g., Gilead Advancing Access program, available since 2014) [59], with options to assist men without health insurance, have provided a key resource for PrEP adopters. Participants were primarily drawn from low income neighborhoods, where coupon use may be more prevalent. It is also possible that some AAYMSM wished to avoid insurance records or payment statements that document their physician visits or medication use, particularly if insured through their parents vs. independently [60]. For example, patients may fear accidental disclosure of their PrEP use to family. The current study was unable to explore these possibilities.

Our qualitative data suggest that stigma may result in some men discontinuing PrEP. A growing body of work has identified PrEP stigma as a multifaceted phenomenon—involving stigma related to HIV, sexuality, and PrEP itself—and an important factor for PrEP adherence and persistence [61, 62]. Operationalizing PrEP adherence and understanding factors which facilitate persistent use is a complex challenge [63]. In our study, we did not assess how long adopters had been on PrEP, and thus cannot determine who was in the implementation (starting regular use) vs. confirmation stages (sustained use). It will be important for future work to continue exploring the role of PrEP stigma in sustained use and discontinuance.

Limitations and Strengths

This is one of the first investigations to apply the DOI framework to PrEP adoption among AAYMSM in the U.S., similar to prior work among gay and bisexual men in Australia [64, 65]. Our opportunistic sample limits generalizability of findings. Further we note that PrEP adoption data are based on self-reports of unknown validity. However, the current study provides insights into how the DOI model may aid in identifying factors important at different stages of the adoption process. Our work also underscores the importance of monitoring the diffusion process at the community level, and consideration of segmenting populations within specific DOI stages. We focused on social stigma and health literacy as potential antecedents of stage progression, however, other social-psychological variables may also be important to explore, such as self-identity formation and institutional trust, that prior work suggests may impact PrEP adoption (e.g., 66-70). Further, we assessed sexual risk by asking men about URAI; this behavior may have been underreported, potentially causing error which may have weakened the association with PrEP adoption. Observed differences across PrEP receptivity groups in terms of medical coverage, education, and sexual risk may have been larger and/or statistically significant among a larger sample of AAYMSM. Lastly, the current study recruited 17–24 year old men who reported same-gender sexual activity in the past year, but did not include sexually-inactive males who may have identified as gay, bisexual, or queer. These latter individuals may respond differently to PrEP messages.

Conclusions

Findings suggest that, at the time of our study (2016), PrEP diffusion is in the early stages among AAYMSM. Recent evidence indicates AAYMSM continue to lag in PrEP adoption [5, 67, 71, 72]. As PrEP uptake improves among AAYMSM, it will be important for further research and intervention efforts to examine how perceptions and antecedents of PrEP adoption might shift over time. PrEP diffusion may face challenges common to preventive innovations, including the inherent uncertainty associated with success; in addition, PrEP's lack of trialability may inhibit adoption motivation. In our study, perceived social stigma and HIV literacy emerged as salient factors in the earlier stages of diffusion (awareness), while motivational factors such as sexual risk appeared to play a larger role in later stages (persuasion, adoption). Future research might expand on our findings to explore how various social-structural and organizational factors (e.g., housing or financial instability; exposure to PrEP messaging from healthcare providers) influence PrEP-decision making processes for AAYMSM. In addition, PrEP regimens and delivery methods are being modified in ways that may impact dissemination and uptake. For instance, event-driven/"2–1-1″ PrEP [17] has the potential to accelerate PrEP adoption by providing greater trialability and better compatibility for some men. Further research is needed on the impact of these new PrEP protocols for community dissemination.

Understanding a population's position within the diffusion process is key to identifying factors that motivate progress toward adoption, suggesting that intervention and research strategies could be tailored for individuals at different points in the diffusion process. Such efforts might utilize indicators of individual-level behavior change to assess the effects of social diffusion interventions [11]. Moreoever, community-based diffusion is important to understanding prevention at the individual-population level, versus the diffusion of PrEP at the clinical or organizational level [73, 74] which may require adaptation of the DOI model.

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Appendix A

Adapted social stigma items

The original Fortenberry scales were developed in young adult populations (male and female, multiple racial and sexual identities) in the U.S. at high risk for HIV/STIs and among adult samples in Kenya [40, 41]. In the U.S., higher levels of perceived social stigma were associated with lower rates of HIV and STI test-seeking. The Kenyan study found that stigma scores varied with social context, being higher and stable over time in rural vs. urban regions, suggesting that the Fortenberry measure may be sensitive to geographic differences in social norms regarding HIV-positive persons. The adapted scale factor analyzed into

two factors, one reflecting self-image and the other HIV testing. Preliminary analyses indicated that both measures were significantly correlated ($r = 0.40$, $p < 0.001$), and the HIV testing stigma measure had a substantially larger association with PrEP awareness than the self-image measure. The HIV testing scale may reflect situationally-specific social stigma related to attending HIV testing clinics or treatment centers to access HIV testing (see table below). Our analyses suggest that the testing measure is assessing elements of social stigma beyond HIV testing specifically, and may instead represent social stigma related to revealing sexual orientation or HIV status in the social context of a health clinic. Therefore the testing stigma measure was selected for use in final analyses.

Appendix Table: HIV testing social stigma measure items

Getting tested for HIV would make me feel ashamed
I would feel embarrassed if a doctor asked me if I needed an HIV test Getting myself tested for HIV would make me feel like I failed to take care of myself
I would find it embarrassing to ask for an HIV test

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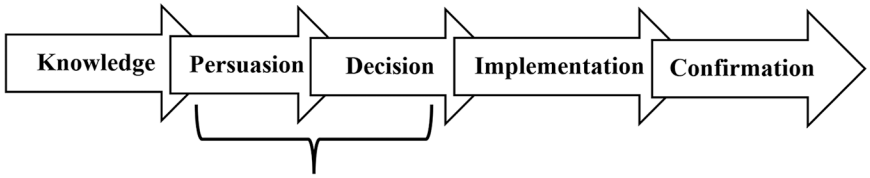
Standard Diffusion Stages



Key Innovation Characteristics That Influence Decision-Making

Characteristic	Definition	PrEP Examples
Compatibility	Consistency with values, experiences & needs	High compatibility: PrEP use may align with perceived HIV risk for someone with multiple and/or casual sexual partners Low compatibility: someone who doesn't have sex often may see their HIV risk as too low for daily PrEP use
Complexity	Difficulty in understanding & using innovation	High complexity: remembering to take a PrEP pill every day may be perceived as too difficult Low complexity: it may be easy to add PrEP to daily medication or supplement routines
Relative advantage	Innovation is perceived as better than alternative(s)	High advantage: it may be sexually satisfying to prevent HIV without having to use condoms Low advantage: PrEP has more side effects than condoms
Trialability	Innovation can be tried on a limited basis	PrEP trialability has been limited under standard daily use protocols; recent shifts to event-driven/2-1-1 PrEP[a] may allow for trial use
Observability	Results of innovation are visible to others	It is difficult to observe the outcome of PrEP (i.e., absence of HIV), but it may be inferred from HIV testing results

[a]Event-driven/2-1-1 PrEP, which involves taking a short-course PrEP regiment before and after sex (17), was not available in the U.S. in 2016, the point at which our data were collected.

Fig. 1.

Diffusion of innovations theory [11] applied to HIV pre-exposure prophylaxis (PrEP)

Table 1

Independent variables: descriptive data

Independent variables	**% of sample[a] (N = 181)**
Age: 17–20 yrs. (vs. 21–24 years)	48 (52)
Education: ≤ high school/GED (vs. > High school/GED)	67 (33)
Medical coverage: insurance/other (vs. cash)	93 (7)
Sexual risk: reported URAI/last year. (vs. did not report URAI)[b]	59 (41)
	Mean (SD), range
Social stigma[c]	1.28 (.52), 1–4
HIV health literacy[d]	5.11 (.09), 1–8
HIV health literacy items	*% Correct*
What does it mean if a person has an HIV positive test result? *[Correct = person has HIV/AIDS]*	89
What does it mean if a person has an HIV negative test result? *[Correct = person does not have HIV/AIDS]*	90
If a person gets infected with HIV, how long does it usually take before an HIV test would show he is infected? *[Correct = ≥3 mo.]*	49
If a man has some risk for getting HIV from sex or drug use, how often should he get tested (in a year)? *[Correct = 2–4 times/yr.]*	76
Have you heard of a new HIV test that can tell if you are infected with HIV very soon after being exposed to an infected partner (i.e., next/5th generation test)? *[Correct = yes]*	17.7
If you recently found out that you had HIV, would you feel it was important to see a doctor right away or would you wait a month or two, or not go at all? *[Correct = right away]*	61.9
In your opinion, is it possible that the current HIV medications could be used to prevent giving HIV to another person? *[Correct = yes]*	49.2
Do you know of a health center or clinic you could go to for HIV treatment or medications? *[Correct = yes]*	79.6

[a] Percentages rounded to nearest whole value

[b] URAI = any unprotected receptive anal intercourse in previous year

[c] See Appendix A for stigma scale construction and items

[d] Participants were asked a series of open-ended and yes/no questions about various HIV prevention and treatment-related health practices. Responses were coded as correct or incorrect, and correct responses were summed to determine the total score

Table 2

Bivariate results for PrEP awareness and PrEP adoption among African American young MSM (N = 181)

	PrEP aware (n = 160)	PrEP unaware (n = 21)	Test statistic	p-value[a]	PrEP Adopters (n = 22)	Non-adopters (n = 138)	Test statistic	p-value[a]
Health literacy[b]	M: 5.19	M: 4.52	t(179) = 2.19	**.02**	M: 5.05	M: 5.19	t(151) = .49	.63
Social stigma	M: 1.24	M: 1.56	t(179) = 2.05	**.03**	M: 1.30	M: 1.24	t(151) = −0.48	.63
Education[c]			$\chi^2(1, N = 181) = 2.13$	.22			$\chi^2(1, N = 153) = 4.84$	**.05**
≤ HS/GED	104 (65.0%)	17 (81.0%)			10 (45.5%)	94 (69.5%)		
> HS/GED	56 (35.0%)	4 (19.0%)			12 (54.5%)	44 (30.5%)		
Insurance			$\chi^2(1, N = 176) = 0.16$	.65			$\chi^2(1, N = 149) = 4.40$	**.06**
Insurance/other	144 (92.9%)	19 (90.5%)			18 (81.8%)	126 (94.7%)		
Cash	11 (7.1%)	2 (9.5%)			4 (18.2%)	7 (5.3%)		
Sexual risk[d]			$\chi^2(1, N = 181) = 0.37$	.63			$\chi^2(1, N = 153) = 3.61$	**.07**
No URAI	65 (40.6%)	10 (47.6%)			5 (22.7%)	60 (44.3%)		
Any URAI	95 (59.4%)	11 (52.4%)			17 (77.3%)	78 (55.7%)		

[a] Two-tailed p-values reported for bivariate statistics. Hypothesis driven one-tailed p-values were used to determine significant bivariate relationships eligible for inclusion in multivariate regression models (p-values for significant relationships indicated in boldface)

[b] *M* = Mean

[c] *HS/GED* = High school diploma or GED

[d] Unprotected receptive anal intercourse in the previous year

Table 3

Multivariate results for PrEP awareness & adoption among AAYMSM

Variable	Adjusted odds ratio [se] (Z-statistic)
Outcome: PrEP awareness	
HIV health literacy	0.74 [0.13] * (Z = −1.66)
Social stigma	2.05 [0.24] ** (Z = 1.96)
OUTCOME: PREP ADOPTION	
Any URAI/last year	2.92 ** [1.62] (Z = 1.93)
Education > high school/GED	2.40 * [1.15] (Z = 1.82)
Medical coverage = insurance/other	0.24 ** [0.17] (Z = −2.01)

AAYMSM = African American young men-who-have-sex-with-men. URAI = unprotected receptive anal intercourse. Multivariate models included independent variables found to have significant bivariate associations with PrEP outcomes (see Table 2)

* $p < .05$

** $p < .03$; hypothesis-driven one-tailed p-values

Table 4

Perceptions of PrEP characteristics among Chicago AAYMSM in the persuasion stage

Innovation characteristic	PrEP characteristic	N mentioned	Sample quotes
Compatibility	PrEP efficacy	47	“I would think that it would work for most people…seems like a helpful thing to lower the risk of transmitting” "I don’t believe it to be working because basically to me PrEP is nothing but a HIV pill…so basically it’s just a gimmick to me"
Compatibility	Side effects	29	"They’ve talked about side effects, but I don’t think they’re major side effects” "Some people say it has side effects to it that make you really sick"
Compatibility	Personal need (i.e., sexual risk)	4	“I should be on it but I don’t have sex that much…I would say if you are addicted to sex, then you should be on it” “I’m not taking it because I’m only having sex with one partner”
Observability (vicarious)	Preventive benefit	3	“…because I know some people that are on PrEP…I don’t know their sexual history, but I’ve been there a couple times for testing and they have always been negative” “I do have a friend that uses PrEP and I take it that he’s doing good because him and his partner don’t use protection…and I know for a fact both of them get tested together and both of their results are negative”
Relative advantage[a]	PrEP vs. other prevention methods (e.g., condoms)	8	“…the same thing happen with a condom, the pill can do the same thing. Except for the pill doesn’t work…you could have raw sex, and end up with HIV” "I think it’s good because like everybody has slip ups and I don’t always use protection in the heat of the moment so it would probably be a good thing because you never know"

African American young MSM (AAYMSM; 2016) in the persuasion stage were aware of PrEP but had not yet adopted it

[a]A small number of respondents (n = 9) indicated an advantage to using both prevention methods (e.g., “…once I do get into a committed relationship then we both take the pill…and…still use condoms…”)

Table 5

Definitions used to stratify men in the persuasion stage based on perceptions of PrEP efficacy and side effects

Concept & definition	Example passages
PrEP efficacy[a]	
Highly effective: Perceptions of PrEP as a highly effective, completely or consistently effective medication in preventing HIV transmission	"It works for all…It is the cure, like what else is there to say about it? It works for everybody" "I think PrEP works for most people, the majority of people. Because how PrEP work. And because I know people who was on PrEP"
Differentially effective/ineffective: Perceptions of PrEP as differentially effective, working for some people but not others, or is ineffective (i.e., it doesn't work)	"I never really believed in it though. I just look at it, ya'll gonna take a pill to not get HIV …why don't you just use a condom" "I don't think it would work all of the time…I just don't believe it"
Side effects[b]	
Severe: Perceptions of life-disrupting physical or psychological symptoms attributable to PrEP	"I have a friend that's on PrEP, but, his body be breaking out…like he be having rashes on his neck, he get dizzy real quick…so that's why I don't do it" "They (friends on PrEP) said the side effects is like dramatic…they feel sick, or they feel like they're throwing up, or you feel drowsy all day when you take it, stuff like that"
Moderate: Perceptions of physical or psychological symptoms that are moderately distressful and attributable to PrEP; symptoms that may last for short period of time (e.g. a few weeks/months) and are tolerated by the person	"It's just the beginning parts (for friends on PrEP), where it's the symptoms of it. But I think it's good. It's just, the first few months will be about you feeling the symptoms. He told me it was like 3 months…of nausea" "They (friends on PrEP) recommend it, but they still talk about the side effects. It gives you headaches, diarrhea…"
Low/none: Perceptions of the absence of symptoms or mild symptoms, lasting only days in duration or mildly interfering with the person's life or physical functioning	"They (peers on PrEP) don't mind it, they haven't experienced any side effects or anything" "…she (friend on PrEP) reacted well to it like it didn't have any bad side effects on her"

Among African American young MSM in Chicago (2016); men in the persuasion stage were aware of PrEP but had not yet adopted it

[a] *Don't know:* Statements in which participants describe not hearing about or knowing about the effectiveness and/or side effects of taking PrEP