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ORIGINAL PAPER

Applying the Information–Motivation–Behavioral Skills Model to Understand PrEP Intentions and Use Among Men Who Have Sex with Men

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Abstract
Research is needed to determine targets for interventions to increase pre-exposure prophylaxis (PrEP) uptake. The Information–Motivation–Behavioral Skills (IMB) model has not been tested for PrEP use among men who have sex with men (MSM). Men and transgender women and men were surveyed at a community event in the Midwest in 2016 ($N=476$, 60% White, $M_{age}=35$). New measures assessed PrEP knowledge, attitudes, stigma, descriptive and subjective norms, and intentions, and participants reported on PrEP use. We tested the IMB model for a subsample of HIV-negative MSM and transgender individuals ($N=357$) using structural equation modeling. Only 12% of participants used PrEP. New measures performed well and were reliable ($\alpha s=0.83$–0.94). Structural models generally supported the IMB model: knowledge, stigma, and self-efficacy were directly associated with use, and attitudes, stigma, and descriptive norms had indirect effects on use via self-efficacy. The IMB model may be useful when developing PrEP interventions for MSM.

Keywords Pre-exposure prophylaxis · Information–motivation–behavioral skills model · Men who have sex with men · HIV prevention

Introduction

HIV continues to present a critical health challenge, with nearly 50,000 new HIV infections each year in the U.S. [1]. Men who have sex with men (MSM) carry the highest risk for acquiring HIV infection, accounting for two-thirds of new infections [2]. However, new biomedical approaches to prevention show potential to reduce HIV incidence in MSM. Pre-exposure prophylaxis (PrEP), a daily medication similar to antiretroviral therapy, reduces the risk of HIV infection by 44–88% [3–7] in at-risk populations, with even greater reductions among those who are most adherent [8–10]. Thus, PrEP could make a significant impact on the HIV epidemic. Uptake has been growing consistently [11–15], but use of PrEP has not become widespread enough to impact HIV incidence [16]. It is estimated that 1.2 million adults in the U.S. would benefit from being on PrEP [17], but only an estimated 77,120 used PrEP in 2016 [18].

Research is needed to determine appropriate targets for interventions to increase PrEP uptake. One basis for HIV prevention interventions is the Information–Motivation–Behavioral Skills (IMB) model [19, 20]. The IMB model theorizes that that information about a target behavior (i.e., knowledge) and motivation to perform the behavior (based on factors such as attitudes, stigma, and social norms) lead to the development of relevant behavioral skills (i.e., individuals' objective and perceived abilities to perform the target behavior). These behavioral skills then contribute directly to behavior and also partially mediate associations between information and motivation and behavior itself. Although there are some critiques that health behavior theories such as the IMB model do not sufficiently address socioeconomic or social network factors [21], this model is generally well-supported by research [22, 23], typically

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explaining 35–51% of the variance in HIV-related behaviors such as condom use and medication adherence [24].

The IMB model has served as a guide for prevention interventions focused on condom use, and it has recently been proposed to be a useful model for explaining PrEP use [25]. Prior research provides some evidence that information, motivation, and behavioral skills may be influences on PrEP uptake, as reviewed by Dubov et al. [25]. In terms of information, studies tend to show relatively low PrEP awareness among MSM [26–31]. Surveys over time suggest that PrEP awareness and use are both increasing [14, 32–35], although awareness may not be growing in all populations [31], and some studies suggest that increases in awareness are not accompanied by increases in willingness to use PrEP or actual use [32, 33]. One study with people who use drugs (PWUD) at higher risk showed that those with greater PrEP knowledge had greater confidence they could use PrEP, although knowledge was not directly associated with willingness to use PrEP [36]. Very few studies have included assessments of PrEP knowledge, and thus there is little evidence about associations between knowledge and PrEP intentions or use.

Motivational factors such as attitudes, stigma, and social norms have also been suggested as potential influences on PrEP uptake. Negative PrEP attitudes have been reported as reasons for declining PrEP in studies of MSM [28, 37]. Additionally, demonstration projects and qualitative studies have reported PrEP stigma as a barrier to uptake [38–45]. Studies have suggested that peer norms may influence PrEP perceptions and intentions, with MSM indicating that few members of their social networks take PrEP [46] and being more interested in PrEP when they believe their friends would use it [47]. Research has also suggested that negative partner subjective norms may be perceived as barriers to PrEP use [39]. In a study of PWUD at higher risk, motivation to use PrEP (conceptualized as concerns about HIV, concerns about PrEP side effects, and feelings of responsibility to contribute to HIV prevention efforts) was associated with PrEP behavioral skills, but not directly associated with willingness to use PrEP [36]. Notably, few studies have directly investigated associations between attitudes, stigma, or social norms and PrEP intentions or use.

Finally, lack of behavioral skills and low self-efficacy have been described as barriers to PrEP uptake. For example, in qualitative studies, men have discussed inability to negotiate PrEP with sexual partners and concerns about their capacity to adhere to a daily medication as barriers to PrEP initiation [48–50]. Among Black MSM in LA, self-efficacy for obtaining and filling a PrEP prescription and managing PrEP side effects correlated with adoption intentions [51]. Additionally, one study found that self-perceived ability to discuss PrEP with a provider was correlated with PrEP intentions [52].

Thus, preliminary evidence suggests that the IMB model could be applied to explain PrEP use. Additionally, one recent study has specifically tested the IMB model for PrEP willingness in a sample of PWUD at higher risk, finding support, with PrEP information and motivation associated with PrEP-related behavioral skills and behavioral skills associated with willingness to use PrEP [36]. However, the IMB model has not yet been tested for PrEP intentions or use among MSM, and, in fact, no quality measures of PrEP information, motivation, or behavioral skills exist for the general population. Testing and refining measures of these constructs, as well as exploring associations between these constructs and PrEP intentions and behaviors will provide a foundation for future PrEP-related intervention trials.

Therefore, to explore factors associated with MSM's PrEP intentions and use, we developed new measures using the framework of the IMB model, including measures of PrEP knowledge, PrEP attitudes, PrEP stigma, PrEP descriptive and subjective norms, PrEP self-efficacy, and PrEP intentions. We then evaluated the psychometric characteristics of these measures by assessing individual items and inter-item correlations, performing confirmatory factor analysis (CFA), calculating reliability, and testing for differential item functioning (DIF). Finally, we explored whether the IMB model explained MSM's PrEP intentions and use in a community sample.

Methods

Participants and Procedure

Participants completed an anonymous survey on paper at a community event in a mid-sized city in the Midwestern U.S. in June 2016. Participants were recruited by research staff at a table in a heavily trafficked Health and Wellness area at the event. To be eligible for participation, individuals had to be 18 years of age or older; identify as male, a man, or transgender; and not be visibly intoxicated or impaired. Demographic characteristics of the participants are included in Table 1. For *measurement evaluation*, the sample included 476 participants who identified as male or transgender. We *tested the IMB model* with a subsample of participants who were HIV-negative men and transgender women and men who engaged in sex with men. Participants were offered a small cash incentive or gift ($5 in value) in return for their time. Participation took approximately 10–20 min. The Medical College of Wisconsin Institutional Review Board approved all procedures.

Table 1 Demographic characteristics of the samples for measurement evaluation and IMB model testing

	Measurement evaluation ($N=476$) %/*M* (*SD*)	IMB model ($N=357$) %/*M* (*SD*)
Gender identity		
Male	91%	93%
Transgender woman	3%	3%
Transgender man	4%	3%
Other gender	2%	2%
Age	35.14 (14.30)	35.39 (13.98)
Race		
White	60%	61%
Black	22%	21%
Multiracial	7%	7%
Other race	11%	9%
Unreported	2%	2%
Latino ethnicity	15%	14%
Unemployed	11%	10%
Current student	23%	24%
Sexual partners		
Men only	66%	81%
Women only	15%	–
Men and women	13%	17%
Does not have sex	4%	–
Partner gender(s) not reported	2%	3%
HIV status		
HIV positive	7%	–
HIV negative	71%	81%
Unknown HIV status	17%	13%
Unreported HIV status	6%	6%

Measures

Measurement Development Process

New measure items were developed and reviewed by experts in HIV prevention and HIV providers. True–false knowledge items were developed by consulting PrEP informational materials from governmental and public health organizations, including AIDS.gov, SFHIV.org, CDC.gov, Project-Inform.org, and ACToronto.org. Items assessing knowledge, attitudes, stigma, norms, self-efficacy, and intentions were modeled after those from scales in other areas of HIV prevention and sexual health [53–62]. The initial survey included 18 items assessing knowledge, 18 assessing attitudes, 6 assessing stigma, 6 assessing descriptive norms, 11 assessing subjective norms, 11 assessing self-efficacy, and 4 assessing intentions. The number of items in scales was reduced based on assessment of item distributions, inter-item correlations, CFA models, and DIF, as described below. The final scales are described here, and full measures are available in the Online Appendix.

Demographics

Demographics assessed included age, gender identity, race and ethnicity, relationship status, employment status, income, student status, and place of residence. We coded whether participants identified as transgender (0 = no, 1 = yes). For relationship status, a dummy variable indicated whether or not participants considered themselves to be currently involved in a monogamous sexual relationship ("a committed relationship where you both have agreed to only have sex with each other," 0 = no, 1 = yes). For employment status, participants indicated whether they were currently unemployed and looking for work (0 = no, 1 = yes). Participants indicated their monthly income on a 6-point scale (1 = $0-$1000, 6 = $5001 +). Participants reported whether they were currently enrolled in school full- or part-time (0 = no, 1 = yes). Finally, we coded whether participants currently lived in a city as opposed to a suburban area, a small town, or a rural area (0 = no, 1 = yes).

Information: PrEP Knowledge

Knowledge was assessed with 13 items (e.g., "You should not use PrEP if you don't know your HIV status"; see the Online Appendix for all items). Participants had three response options: True, False, or Don't Know. Items were scored as correct (1) or incorrect/don't know (0); higher scores indicated more knowledge of PrEP.

Motivation: PrEP Attitudes

Attitudes were assessed with 5 items (e.g., "PrEP is effective at preventing HIV"; see the Online Appendix for all items). Responses were on a 5-point scale from strongly disagree (1) to strongly agree (5), with higher scores indicating more positive attitudes toward PrEP.

Motivation: PrEP Stigma

Stigma was assessed with 5 items (e.g., "People who take PrEP are promiscuous"; see the Online Appendix for all items). Responses were on a 5-point scale from strongly disagree (1) to strongly agree (5), with higher scores indicating more PrEP stigma.

Motivation: PrEP Descriptive Norms

Descriptive norms were assessed with 6 items focusing on how people in the participants' communities and the participants' friends would feel about (1) learning more about

PrEP, (2) talking with their doctors about PrEP, and (3) taking PrEP (e.g., "People in my community would consider taking PrEP"; see the Online Appendix for all items). Responses were on a 5-point scale from strongly disagree (1) to strongly agree (5), with higher scores indicating more positive norms. Two subscales assessed community and friend norms; these subscales were highly correlated ($r = 0.75$) and combined for structural analyses.

Motivation: PrEP Subjective Norms

Subjective norms were assessed with 6 items assessing how participants' friends and sexual partner(s) would respond were the participant to take PrEP (e.g., "My friends would be supportive of me using PrEP"; see the Online Appendix for all items). Responses were on a 5-point scale from strongly disagree (1) to strongly agree (5), with higher scores indicating more positive norms. Two subscales assessed friend and sexual partner norms; these subscales were highly correlated ($r = 0.83$) and combined for structural analyses.

Behavioral Skills: PrEP Self-efficacy

Participants reported how difficult it would be for them to engage in 8 behaviors related to PrEP use (e.g., "How difficult would it be for you to visit a doctor who can provide PrEP?" see the Online Appendix for all items). Responses were on a scale from very hard to do (1) to very easy to do (4), with higher scores indicating greater self-efficacy.

PrEP Intentions

Intentions were assessed with 3 items asking about PrEP behaviors in the next three months (e.g., "During the next three months, I will talk to a health care provider about PrEP"; see the Online Appendix for all items). Responses were on a scale from definitely will not do (1) to definitely will do (4), with higher scores indicating greater intentions to use PrEP.

PrEP Use

Participants reported whether they were currently taking PrEP.

Data Analysis

Missing Data

To reduce participant demand, a well-established planned missingness approach [63] was used such that each individual participant completed only a subset of the new PrEP items assessing knowledge, attitudes, stigma, descriptive and subjective norms, and self-efficacy. Specifically, all participants completed 74–77% of these items, including 2–4 anchor items perceived as central to each scale along with approximately two-thirds of remaining items; the form which each participant completed was randomly determined. Aside from planned missing data, missing data was relatively rare. To address missing data, we used a full-information maximum likelihood (FIML) estimator (for assessment of the new PrEP measures) and multiple imputation (MI, for the structural models), both modern methods for dealing with missing data which allowed us to maintain the maximum sample size and avoid biases associated with complete case analysis or single imputations [64].

Assessment of New PrEP Measures

To test the functioning of the various PrEP measures, we followed strategies described in the literature [65]. We first examined descriptive statistics and item correlations to check for highly skewed or unbalanced distributions and excessively low or high inter-item correlations. We then used CFA to assure the unidimensionality of scales, strong factor loadings, and good model fit. Model fit was assessed using traditional fit indices [66], including the comparative fit index (CFI); the Tucker-Lewis index (TLI); and the root-mean-square error of approximation (RMSEA). Good fit is indicated by CFI and TLI values greater than 0.95 and RMSEA values less than 0.05, and acceptable fit by CFI and TLI values over 0.90 and RMSEA values less than 0.06 [66, 67]. Cronbach's alpha was used as an additional assessment of the degree of internal consistency. Because we desired measures that functioned well for individuals of different ages, races and ethnicities, and socioeconomic statuses, we also analyzed scale items for and attempted to minimize DIF, which occurs when two individuals with similar levels of an underlying construct (e.g., knowledge) have different probabilities of answering a particular item in a specific way (e.g., of correctly identifying a specific knowledge item as true or false) [68, p. 93]. To do this, we used moderated nonlinear factor analysis (MNLFA) in Mplus 7.4 as described by Bauer [69], testing for DIF based on age, race (non-Latino Whites vs. those of all other races/ethnicities), and income. These analyses were performed separately for each PrEP construct. Additionally, they were first performed on one randomly-selected exploratory half of the sample, with the second half of the sample serving as a confirmatory sample. Finally, when we proceeded to structural modeling, we tested the discriminant validity of our various PrEP constructs as well as their associations with PrEP intentions and use.

Testing the IMB for PrEP

Structural equation modeling (SEM) in Mplus was used to test the IMB model. The IMB constructs as well as intentions were modeled as latent variables, which were identified by fixing variances at 1. Individual items for each construct were grouped into three parcels of items per construct representing average scores on sets of items; these parcels served as the indicators for the latent constructs. Parcels were formed based on the balancing of factor loadings [70].

We first fit a measurement model including all latent constructs to assure latent constructs were adequate representations. We then constructed separate structural models for use (including all HIV-negative men and transgender women and men who have sex with men) and intentions (including only those not taking PrEP). In these models, directional paths led from knowledge, attitudes, stigma, descriptive norms, and subjective norms to self-efficacy and use/intentions, and from self-efficacy to use/intentions, in line with the IMB model. Additionally, paths led from demographic covariates to all constructs; covariate paths were maintained in the model if they were significant at the $p < 0.10$ level. Knowledge, attitudes, stigma, descriptive norms, and subjective norms were all allowed to correlate.

The PrEP use model was fit using a robust weighted least squares (WLSMV) estimator appropriate for categorical outcomes, while the PrEP intentions model was fit using a full information maximum likelihood estimator robust to non-normality (the MLR estimator [71]). Model fit was again assessed using traditional fit indices [66]. We report standardized factor loadings, correlations, and unstandardized linear and probit regression coefficients (for continuous and categorical outcomes, respectively). When testing mediation, 95% CIs were calculated using the distribution-of-the-product method in RMediation [72]. This is recommended given the non-normal distribution of indirect effects. For indirect effects, unstandardized coefficients and 95% CIs are reported.

Results

Assessment of New PrEP Measures

For all items, we evaluated item distributions and inter-item correlations, fit a CFA model, evaluated reliability, and tested for DIF. Refined versions of all scales had good CFA model fits, were reliable (αs = 0.83–0.94), and demonstrated minimal evidence of DIF based on age, race/ethnicity, and income. Key information from these evaluations is presented in Table 2; further information is available from the author.

Table 2 Evaluation of new PrEP-related measures in a sample of men and transgender women and men ($N = 476$)

PrEP Scale	Items		α	CFA Fit, Exploratory Sample ($n = 236$)					CFA Fit, Confirmatory Sample ($n = 240$)			
	Initial	Final		X^2 (df)	RMSEA	CFI	TLI	Factor Loadings	X^2 (df)	RMSEA	CFI	TLI	Factor Loadings
Knowledge	18	13	0.90	97.00 (65)**	0.05	0.99	0.99	≥ 0.65, *ps* < .001	87.46 (65)*	0.04	0.99	0.99	≥ 0.63, *ps* < .001
Attitudes	18	5	0.79	2.12 (5)	0.000	1.00	1.05	≥ 0.58, *ps* < .001	3.93 (5)	0.000	1.00	1.01	≥ 0.63, *ps* < .001
Stigma	6	5	0.83	8.03 (5)	0.05	0.99	0.97	≥ 0.44, *ps* < .001	7.04 (5)	0.04	0.99	0.98	≥ 0.36, *ps* < .001
Descriptive norms	6	6	0.93	5.16 (5)	0.01	1.00	1.00	≥ 0.81, *ps* < .001	2.53 (5)	0.000	1.00	1.02	≥ 0.83, *ps* < .001
Subjective norms	11	6	0.94	7.72 (8)	0.000	1.00	1.00	≥ 0.86, *ps* < .001	4.74 (8)	0.000	1.00	1.04	≥ 0.83, *ps* < .001
Self-efficacy	11	8	0.87	65.99 (20)***	0.10	0.97	0.96	≥ 0.69, *ps* < .001	59.45 (20)***	0.09	0.98	0.97	≥ 0.59, *ps* < .001
Intentions	4	3	0.90	–	–	–	–	≥ 0.91, *ps* < .001	–	–	–	–	≥ 0.90, *ps* < .001

PrEP Pre-Exposure Prophylaxis, *CFA* confirmatory factor analysis; *RMSEA* root-mean-square error of approximation; *CFI* comparative fit index, *TLI* Tucker-Lewis index

***p < 0.001, **p < 0.01, *p < 0.05

Descriptive Information

Focusing on the subsample of participants who were HIV-negative men and transgender women and men who engaged in sex with men, only 12% of participants were taking PrEP, but 69% had heard of PrEP and 37% said they would probably or definitely start taking PrEP in the next 3 months (for intentions scale, $M = 2.63$ on a 1-to-4 scale, $SD = 0.88$). Participants answered less than half ($M = 45\%$) of the PrEP knowledge items correctly on average ($M = 5.83$ items out of 13, $SD = 4.08$). Attitudes toward PrEP were generally positive ($M = 3.75$ on a 1-to-5 scale, $SD = 0.75$), while PrEP stigma was low to moderate ($M = 2.50$ on a 1-to-5 scale, $SD = 0.94$). Both descriptive and subjective norms were relatively positive ($Ms = 3.76$ and 4.10 on 1-to-5 scales, respectively, $SDs = 0.88$ and 0.87). In terms of self-efficacy, participants viewed starting and taking PrEP as "somewhat easy to do" on average ($M = 3.14$ on a 1-to-4 scale, $SD = 0.63$). Further descriptive information related to individual scale items is available from the author.

Measurement Model

A measurement model including latent constructs representing knowledge, attitudes, stigma, descriptive norms, subjective norms, and intentions fit the data well, $X^2(131, N = 357) = 257.77$, RMSEA = 0.05, CFI = 0.96, TLI = 0.95. All factor loadings were positive and highly significant, $ps < 0.0001$. As expected, all IMB constructs were correlated with one another and with intentions. Knowledge was positively correlated with attitudes, $r = 0.53$, $p < 0.001$, descriptive norms, $r = 0.24$, $p < 0.001$, subjective norms, $r = 0.30$, $p < 0.001$, self-efficacy, $r = 0.27$, $p < 0.001$, and intentions, $r = 0.20$, $p = 0.001$. Attitudes were positively correlated with descriptive norms, $r = 0.52$, $p < 0.001$, subjective norms, $r = 0.67$, $p < 0.001$, self-efficacy, $r = 0.43$, $p < 0.001$, and intentions, $r = 0.40$, $p < 0.001$. Descriptive norms were positively correlated with subjective norms, $r = 0.65$, $p < 0.001$, self-efficacy, $r = 0.42$, $p < 0.001$, and intentions, $r = 0.39$, $p < 0.001$. Subjective norms were positively correlated with self-efficacy, $r = 0.38$, $p < 0.001$, and intentions, $r = 0.34$, $p < 0.001$. Self-efficacy was positively correlated with intentions, $r = 0.39$, $p < 0.001$. Stigma was negatively correlated with knowledge, $r = -0.37$, $p < 0.001$, attitudes, $r = -0.28$, $p < 0.001$, descriptive norms, $r = -0.31$, $p < 0.001$, subjective norms, $r = -0.26$, $p < 0.001$, self-efficacy, $r = -0.32$, $p < 0.001$, and intentions, $r = -0.14$, $p < 0.05$.

Structural Models

Looking at all HIV-negative men and transgender women and men who have sex with men, the model for PrEP use (Fig. 1) fit the data well, $X^2(249, N = 357) = 308.57$, RMSEA = 0.03, CFI = 0.96, TLI = 0.96. Attitudes, stigma, and descriptive norms predicted self-efficacy, $B = 0.28$ (0.12), $p < 0.05$, $B = -0.20$ (0.06), $p = 0.001$, and $B = 0.22$ (0.09), $p < 0.01$, respectively. Those with more PrEP stigma reported lower self-efficacy for PrEP use, while those who felt more positively toward PrEP and those with more positive descriptive norms reported higher self-efficacy for PrEP use. Knowledge, stigma, and self-efficacy predicted use, $B = 0.28$ (0.09), $p < 0.01$, $B = -0.18$ (0.08), $p < 0.05$, and $B = 0.29$ (0.10), $p = 0.001$, respectively. Thus, those who knew more about PrEP and those with more self-efficacy for use were more likely to be current PrEP users, while those holding more PrEP stigma were less likely to be users. However, subjective norms were not associated with either self-efficacy or use. In line with the IMB model, attitudes, stigma, and descriptive norms had indirect effects on use via self-efficacy (attitudes: $B = 0.08$ [0.04], 95% CI 0.01, 0.18, $p < 0.05$; stigma: $B = -0.06$ [0.03], 95% CI −0.12, −0.01, $p < 0.01$; descriptive norms: $B = 0.06$ [0.03], 95% CI 0.01, 0.14, $p < 0.01$). IMB constructs and demographics explained 57% of the variance in use.

Looking only at those participants not yet using PrEP, the model for PrEP use intentions (Fig. 2) had acceptable fit, $X^2(267, N = 310) = 417.37$, RMSEA = 0.04, CFI = 0.95, TLI = 0.94. Stigma and descriptive norms predicted self-efficacy, $B = -0.18$ (0.09), $p < 0.05$, and $B = 0.26$ (0.12), $p < 0.05$, respectively; those with more PrEP stigma reported lower self-efficacy for PrEP use, while those with more positive descriptive norms reported higher self-efficacy for PrEP use. Attitudes, descriptive norms, and self-efficacy predicted intentions, $B = 0.28$ (0.13), $p < 0.05$, $B = 0.32$ (0.11), $p < 0.01$, and $B = 0.17$ (0.08), $p < 0.05$, respectively. Thus, those who felt more positively about PrEP themselves, those who thought friends and community members were more likely to use PrEP, and those with greater self-efficacy for PrEP use reported greater intentions to use PrEP. Neither knowledge nor subjective norms was associated with self-efficacy or intentions. Additionally, contrary to the IMB model, self-efficacy did not mediate the effects of knowledge, attitudes, stigma, descriptive norms, or subjective norms on intentions, although there were marginally significant indirect effects of stigma and descriptive norms on intentions via self-efficacy in the hypothesized directions (stigma: $B = -0.03$ [0.02], 95% CI −0.08, 0.002, $p < 0.10$; descriptive norms: $B = 0.05$ [0.03], 95% CI −0.002, 0.12, $p < 0.10$). IMB constructs and demographics explained 35% of the variance in intentions.

Associations between demographic controls and model constructs are shown in Table 3. To summarize, in the PrEP use model, participants who were Latino and unemployed had lower knowledge scores, while those with higher income knew more about PrEP. Latinos and unemployed individuals had more negative attitudes about PrEP. Those in

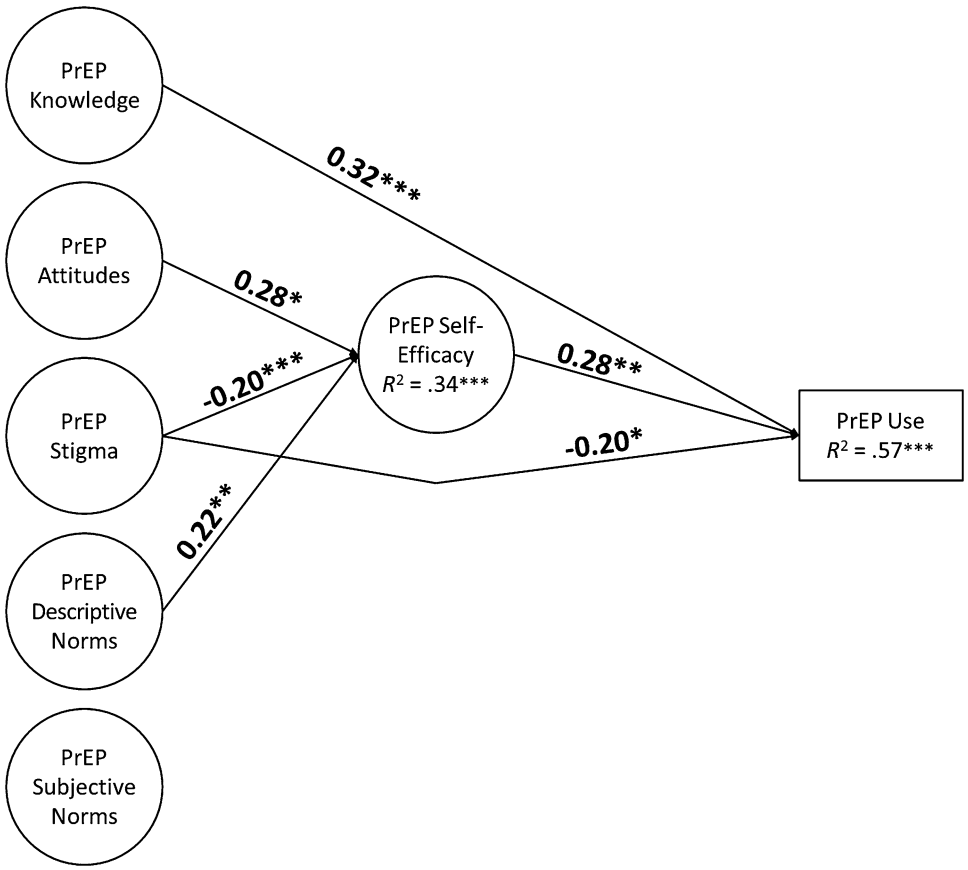

Fig. 1 The Information-Motivation-Behavioral Skills (IMB) model for PrEP use for HIV-negative men and transgender women and men who have sex with men ($N = 357$). The structural equation model fit the data well, $X^2(249) = 308.57$, RMSEA = 0.03, CFI = 0.96, TLI = 0.96 (average over 100 imputations). Unstandardized linear and probit regression coefficients are reported for continuous and categorical outcomes respectively

monogamous relationships and unemployed individuals perceived more PrEP stigma, while those with higher income and students perceived less PrEP stigma. Those who were unemployed had more negative descriptive and subjective PrEP norms. Participants who were older and Black reported greater PrEP self-efficacy. Finally, accounting for other IMB constructs, participants who were Latino and Black were more likely to be using PrEP, while those in monogamous relationships were less likely to be using PrEP. Similar patterns were seen in the intentions model. In addition, participants who were Black had greater intentions to use PrEP, while those in monogamous relationships had lower intentions to use PrEP.

Discussion

New PrEP-related measures were successfully piloted with a diverse sample of MSM and transgender individuals. Results suggested that the IMB model is applicable to PrEP use among MSM, with knowledge, attitudes, stigma, descriptive norms, and self-efficacy all playing roles. The IMB model and these new measures may be useful when developing and assessing interventions to increase PrEP uptake.

In our sample from a community event in a midsized Midwestern city, relatively few participants (12%) were currently using PrEP. Research has suggested that PrEP uptake has been slower outside of major coastal cities [73, 74]. Investigating correlates of use and intentions among men and transgender individuals in these areas may be particularly important.

In line with the IMB model, information (PrEP knowledge); motivation (PrEP attitudes, PrEP stigma, and PrEP descriptive norms); and behavioral skills (PrEP self-efficacy) all had associations with PrEP use. PrEP knowledge was directly associated with PrEP use. Notably, a number of studies focused on condom use have not found associations between information (knowledge) and behavior [20, 75–79], leading investigators to posit that information may not be as central as theorized by the IMB model. However, it is possible that when focusing on a behavior where many individuals know very little, such as PrEP use, gaining a base level of knowledge may be essential. Research has suggested that many primary care doctors depend on patients to initiate conversations about PrEP [80]; therefore, MSM and transgender individuals may need at least a basic understanding of PrEP to effectively broach the topic with their providers. Some previous research has suggested that MSM of color may be less aware of and less knowledgeable

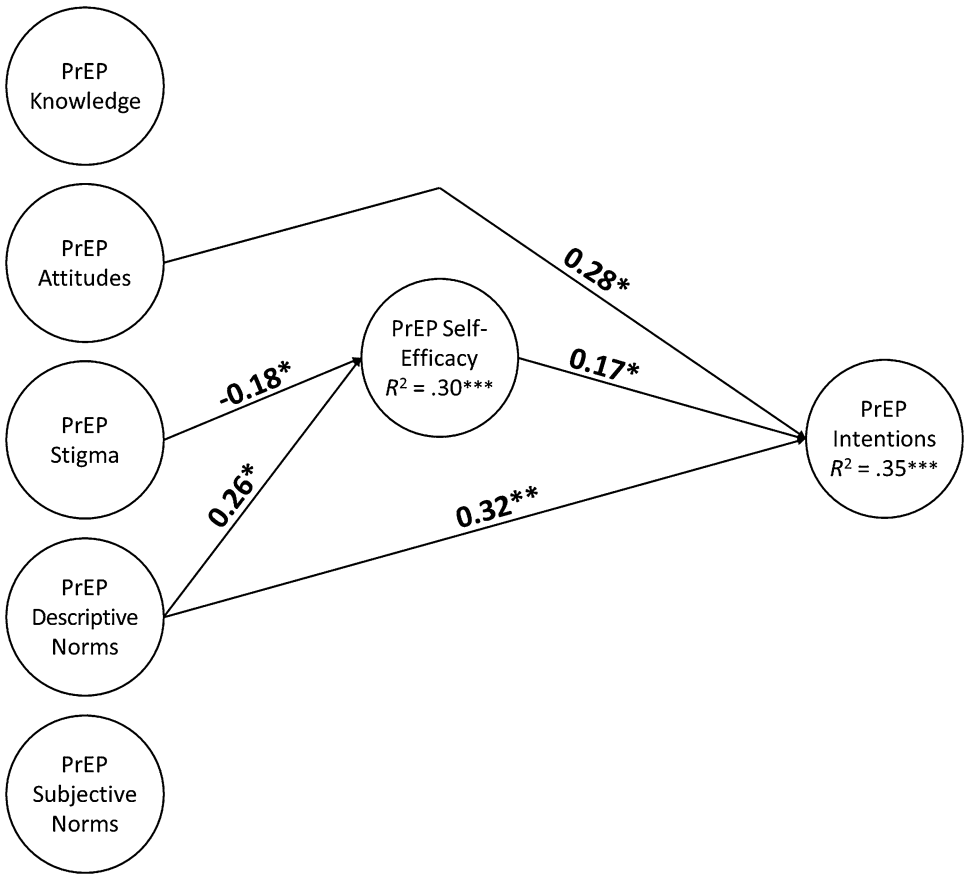

Fig. 2 The Information-Motivation-Behavioral Skills (IMB) model for PrEP intentions for HIV-negative men and transgender women and men who have sex with men and who are not currently using PrEP ($N = 310$). The structural equation model had an acceptable fit, $X^2(267) = 417.37$, RMSEA = 0.04, CFI = 0.95, TLI = 0.94 (average over 100 imputations). Unstandardized linear regression coefficients are reported

about PrEP [81–83]. In our study, Latino MSM were less knowledgeable than White and Black MSM about PrEP, while multiracial MSM knew more about PrEP. Thus, in this Midwestern city, or at least among those attending this particular community event, educational efforts and health campaigns may be succeeding in reaching Black and multiracial men, but not Latino men. Notably, PrEP knowledge was low overall, with the average participant answering less than half of the knowledge questions correctly. Increasing PrEP awareness and knowledge among MSM in general, and among Black and Latino MSM in particular, may be key to increasing PrEP uptake among those most at risk of HIV.

Multiple motivational constructs were associated with both use and intentions. As hypothesized by the IMB model, PrEP attitudes, stigma, and descriptive norms all had indirect effects on PrEP use via PrEP self-efficacy; PrEP stigma also had a direct association with use. PrEP attitudes and descriptive norms both also had direct associations with PrEP intentions. Research in other domains of sexual health, including condom use, HIV testing, and adherence to HIV antiretrovirals, has long supported the importance of motivation to intentions and behavior [19, 84–89]. Past qualitative research with MSM and transgender women has suggested that PrEP stigma (e.g., labeling PrEP users as "Truvada whores" [90]) is quite common, and that this stigma is an impediment to PrEP uptake [38–45]. Our research shows *quantitative* associations between PrEP stigma and use in line with the IMB model, and suggests that stigma may contribute to use beyond knowledge, attitudes, norms, and self-efficacy. The associations between PrEP descriptive norms and self-efficacy and intentions suggest that public health campaigns focused on making MSM aware of PrEP use by others in their community may be effective. By encouraging individuals to talk to others they know about PrEP, the CDC's "Talk PrEP" campaign capitalizes on this approach [91]. Interestingly, although all other motivational constructs had associations with self-efficacy, intentions, or use, when testing the full IMB model, PrEP subjective norms were not associated with any of the three, despite having positive bivariate correlations with self-efficacy ($r = 0.38$, $p < 0.001$) and intentions ($r = 0.34$, $p < 0.001$) in preliminary analyses. This suggests that participants' impressions of others' attitudes toward PrEP use may be less important than participants' own attitudes, perceptions of stigma, and ideas about others' behaviors.

Finally, as expected, self-efficacy for PrEP use was positively associated with both PrEP use and PrEP intentions. Our measure of PrEP self-efficacy assessed a variety of behaviors involved in receiving a prescription for PrEP and taking PrEP, finding that participants perceived some to

Table 3 Associations between demographic controls and PrEP-related measures in a sample of men and transgender women and men who have sex with men

PrEP Use Model (HIV-negative men and transgender individuals who have sex with men, $N = 357$)							
	Knowledge	Attitudes	Stigma	Des. Norms	Sub. Norms	Self-Efficacy	Use
Age						0.15 (0.06)*	−0.21 (0.13)$^{+}$
Latino	−0.46 (0.19)*	−0.54 (0.20)**					0.83 (0.27)**
Black						0.38 (0.18)*	0.86 (0.25)***
Multiracial	0.47 (0.28)$^{+}$						
Transgender		−0.48 (0.25)$^{+}$					
Monogamous			0.32 (0.12)*				−0.50 (0.25)*
Unemployed	−0.42 (0.20)*	−0.52 (0.24)*	0.50 (0.20)*	−0.37 (0.21)$^{+}$	−0.57 (0.21)**		
Income	0.09 (0.04)**		−0.09 (0.04)*				
Lives in a city			−0.25 (0.14)$^{+}$				
Student			−0.29 (0.15)*				
PrEP intentions model (HIV-negative men and transgender individuals who have sex with men and are not currently taking PrEP, $N = 310$)							
	Knowledge	Attitudes	Stigma	Des. Norms	Sub. Norms	Self-Efficacy	Intentions
Age						0.17 (0.05)***	
Latino	−0.64 (0.18)***	−0.62 (0.19)***			0.36 (0.14)**		
Black							0.97 (0.18)***
Multiracial	0.49 (0.23)*						
Transgender							
Monogamous			0.27 (0.12)*			−0.46 (0.13)***	−0.46 (0.13)***
Unemployed	−0.47 (0.22)*	−0.56 (0.25)*	0.41 (0.21)$^{+}$	−0.37 (0.18)*	−0.71 (0.25)**		
Income					−0.07 (0.03)*		
Lives in a city	0.23 (0.13)$^{+}$						
Student							

Unstandardized linear and probit regression coefficients (for continuous and categorical outcomes, respectively) and standard errors from final structural equation models are reported. Age was divided by 10 for analyses, such that an increase of 1 in age is equivalent to 10 years. Income was assessed on a 6-point scale

PrEP Pre-Exposure Prophylaxis, *Des. Norms* Descriptive Norms, *Sub. Norms* Subjective Norms

***p < 0.001 **p < 0.01 *p < 0.05 $^{+}$p < 0.10

be quite easy (e.g., getting tested for HIV, which 57% said would be "very easy to do") and others to be more difficult (e.g., finding a way to pay for PrEP, which only 25% said would be "very easy to do"). These findings are in line with prior research suggesting that the cost of PrEP [37, 39, 92, 93] and lack of insurance [45, 92, 94] are barriers to PrEP use. Interestingly, while some prior studies have suggested that MSM may be uncomfortable talking with health care providers about sexual behavior, sexual orientation, and PrEP [95–97], participants in our sample felt it would be relatively easy to discuss sexual behaviors with their doctors (45% said this would be "very easy" and 31% "somewhat easy"). The positive associations between PrEP self-efficacy and behavior are in line with research focused on other HIV prevention behaviors, such as condom use, HIV testing, and adherence to HIV antiretrovirals [84, 88, 98–100]. These findings are also consistent with those of Shrestha et al., who found in a test of the IMB model with PWUD at higher risk that behavioral skills were positively associated with PrEP willingness [36]. Including skills components in interventions may help increase PrEP self-efficacy and overcome obstacles to initiating PrEP use.

Although this study is one of the first that we know of to develop multiple IMB-related measures for PrEP use and to test the IMB model for PrEP use in a sample of MSM and transgender individuals, there are several limitations to consider. First, the cross-sectional nature of our research precludes us from determining cause and effect. It is possible, for example, that individuals learn more about PrEP in the process of beginning to take it, or that using PrEP reduces perceptions of PrEP stigma. Future research using longitudinal data is needed. Second, our participants were recruited at one community event. Though our sample was diverse in in terms of age, race/ethnicity, and income,

our new PrEP measures and the IMB model for PrEP use should be tested among men recruited from other settings and from other geographic locations. Third, our new measures performed well and captured many of the constructs commonly included in the IMB model; however, there are additional predictors that fit within the IMB model that could be considered in future research. For example, risk perceptions are another dimension of motivation and should be tested as a predictor of PrEP use. Additionally, information, attitudes, stigma, or social norms about HIV or HIV prevention in general or other forms of HIV prevention (e.g., condom use) may influence PrEP outcomes; future research could consider this possibility. As qualitative and quantitative researchers continue to increase our understanding of factors influencing PrEP use, these new PrEP-related scales may need to incorporate additional items: for example, it is possible that self-efficacy for PrEP use may also involve overcoming partner obstacles. Finally, although the IMB model is well-supported by past research [22–24], there are limitations to the model itself, and other constructs not considered in this model may be important predictors of PrEP use. For example, researchers have identified structural barriers not explicitly acknowledged by the IMB model (such as issues with access to care and insurance) as potential influences PrEP use [45, 92, 94]. Incorporating constructs from other theories of health behavior in addition to the IMB model may lead to stronger interventions.

In conclusion, we found support for new measures of PrEP-related constructs, including knowledge, attitudes, stigma, descriptive and subjective norms, self-efficacy, and intentions. These measures may be useful for future research. Additionally, this research provides preliminary evidence that the IMB model constructs may present reasonable targets for future intervention programs aiming to increase PrEP uptake. Effective intervention programs to increase PrEP uptake will be essential to reducing disparities in PrEP use and HIV prevalence.

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Compliance with Ethical Standards

Conflict of interest Jennifer L. Walsh declares that she has no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent The data collected in this study were fully anonymous. Due to the low-risk nature of the study, participants received an informational letter describing the study, and completion of the survey constituted consent.

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