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Acceptability of Smartphone Application-Based HIV Prevention Among Young Men Who Have Sex With Men

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Abstract Young men who have sex with men (YMSM) are increasingly using mobile smartphone applications ("apps"), such as Grindr, to meet sex partners. A probability sample of 195 Grindr-using YMSM in Southern California were administered an anonymous online survey to assess patterns of and motivations for Grindr use in order to inform development and tailoring of smartphone-based HIV prevention for YMSM. The number one reason for using Grindr (29 %) was to meet "hook ups." Among those participants who used both Grindr and online dating sites, a statistically significantly greater percentage used online dating sites for "hook ups" (42 %) compared to Grindr (30 %). Seventy percent of YMSM expressed a willingness to participate in a smartphone app-based HIV prevention program. Development and testing of smartphone apps for HIV prevention delivery has the potential to engage YMSM in HIV prevention programming, which can be tailored based on use patterns and motivations for use.

Resumen Los hombres que mantienen relaciones sexuales con hombres (YMSM por las siglas en inglés de *Young Men Who Have Sex with Men*) están utilizando más y más aplicaciones para teléfonos inteligentes (smartphones), como Grindr, para encontrar parejas sexuales. En el Sur de California, se administró de forma anónima un sondeo en internet a una muestra de probabilidad de 195 YMSM usuarios de Grindr, para evaluar los patrones y motivaciones del uso de Grindr, con el fin de utilizar esta información para el desarrollo y personalización de prevención del VIH entre YMSM con base en teléfonos inteligentes. La principal razón para utilizar Grindr (29 %) es para buscar encuentros sexuales casuales (hook-ups). Entre los participantes que utilizan tanto Grindr como otro sitios de citas online, un mayor porcentaje estadísticamente significativo utilizó los sitios de citas online para encuentros casuales sexuales (42 %) comparado con Grindr (30 %). Un setenta porciento de los YMSM expresó su disposición para participar en programas de prevención del VIH con base en teléfonos inteligentes. El desarrollo y evaluación de aplicaciones para teléfonos inteligentes para el suministro de prevención del VIH tiene el potencial de involucrar a los YMSM en la programación de la prevención del VIH, que puede ser adaptada según los patrones y motivaciones de uso.

Keywords YMSM · HIV Prevention · Technology · Mobile · Smartphone · Grindr

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Introduction

Centers for Disease Control and Prevention (CDC) data suggests that over two-thirds of adolescents between the ages of 13 and 29 who are living with HIV were infected through male-to-male sexual contact [1]. Despite the expense and effort in developing and implementing behavioral interventions to reduce HIV risk behaviors among young men who have sex with men (YMSM), epidemiological data documents a 34 % increase in HIV infection rates among this population between 2006 and

2009 [2]. While some HIV prevention efforts have targeted YMSM, evidence suggests a disconnect between current prevention strategies and interest in those approaches among YMSM [3]. For example, surveillance and prevention data show that in general, older men who have sex with men (MSM) are over-represented in clinical- or research-based HIV prevention programs [3–5]. Several comprehensive reviews highlight the dearth of published HIV prevention interventions specifically tailored for YMSM [6–8]. However, those programs that have been specifically tailored to YMSM indicate that such targeted interventions can be effective in reducing HIV risk behavior [9–11]. Mpowerment, for example, is a CDC-endorsed community-based intervention aimed at emerging adult MSM, which has been effective in reducing unprotected anal intercourse (UAI) by as much as 27 % in intervention communities compared to control communities [12]. Success of Mpowerment and other interventions tailored to meet the needs of YMSM [9] indicate that targeted, youth-centered HIV prevention programs for YMSM may be most effective in reducing HIV risk behaviors [13, 14].

Technology Use and Sexual Health

Youth and young adults represent the digital generation, as over 90 % of 12-29 year olds are online and utilize the internet as a primary source of information gathering, communication, and social networking [15]. With such widespread access, the internet is an added resource for sexual health information. In fact, YMSM have been found to heavily utilize internet search engines, gay-friendly chat rooms, and pornography websites to gain information on sex behavior, sexuality, and sexual health [16–19]. Previous research has also highlighted racial/ethnic distinctions in internet usage among YMSM. For example, results from several quantitative studies have indicated that Black and Latino YMSM may be less likely to be exposed to or seek out HIV/AIDS information on the internet, when compared with White, Asian/Pacific Islander, and mixed race YMSM [18, 19]. Additionally, the internet has become a primary venue for meeting sex partners among YMSM [17, 20–22], which may introduce opportunities for HIV risk behavior among YMSM. Although there is no clear consensus in the extant literature regarding the association between meeting sexual partners online and increased HIV risk behaviors [23–30] Dragowski et al. [31] hypothesize that the internet may be a facilitator of multiple partnerships and other HIV risk behaviors for men who already engage in such behavior, rather than a catalyst for the behavior itself. Regardless, YMSM's use of the internet as a primary venue for information gathering and partner seeking underscores the need to further explore the acceptability of technology-based HIV prevention efforts among YMSM.

Existing Technology-Based HIV Prevention Efforts for MSM

HIV practitioners have developed interventions that use the internet to reach diverse populations, including men who have sex with men [32–34]. Common within these interventions are features such as virtual scenarios and simulations, decision-making with virtual characters, and detailed answers or feedback following knowledge tests. For example, Bowen et al. [35] developed and tested the impact of web-based HIV prevention messaging for 475 MSM living in rural towns who were recruited through internet banner ads on a popular gay website. The authors' intervention, based on the Information-Motivation-Behavioral Skills (IMBS) model, consisted of two sessions, each including three modules: (1) a scripted discussion between an HIV-positive gay man and someone who had recently engaged in risky sexual behavior; (2) a scripted discussion about new and casual sexual partners; and (3) a skill-building exercise to identify risk reduction behaviors when looking for partners both on and off the internet. The intervention also included "Tell me more" buttons, which provided links to additional HIV/AIDS resources, as well as printable feedback based on the participants' responses. Results indicated a decrease in anal sex and an increase in condom use, as well as significant increases in HIV knowledge, condom self-efficacy, and outcome expectancies regarding safer sex. Another study, which used an online video intervention designed to promote disclosure of HIV status among MSM, was effective in increasing the odds of HIV status disclosure at last intercourse and decreasing the odds of intercourse with a casual partner at follow-up compared to baseline [36]. Yet another study using the internet as a platform for an HIV IMBS intervention found that the online program, which consisted of risk assessment and feedback, motivational exercises, and skills training, yielded more reductions in sexual risk behaviors with high risk partners as compared to a control group [37].

Mobile phone-based HIV prevention interventions that incorporate text messaging delivery have also been used with some success with MSM. For example, in Australia, MSM who enrolled in a text message-based intervention (which involved reminders for HIV/sexually transmitted infection (STI) testing and were tailored to participant risk behavior and ability to return for testing), were over four times as likely to re-test for HIV and other STIs compared to those who did not receive the intervention [38]. A more recent pilot study of a text messaging based HIV

prevention program for African American YMSM included text messaging to participants that focused on condom use and reductions in sexual partners, and was designed to promote self-efficacy and intentions for condom use. Results demonstrated that the intervention group had increased monogamy, higher sexual health knowledge, and more positive attitudes toward condoms after a 12-week intervention [39]. Finally, methamphetamine-using MSM who received a text message intervention focused on social support and health education were less likely to use methamphetamine, have unprotected sexual intercourse under the influence of methamphetamine, and engage in unprotected anal intercourse with HIV-positive partners than those in the control group [40].

Geosocial Networking Applications ("apps")

Geosocial networking apps (also referred to as "cruising apps" or "hook up apps") targeting MSM, such as Grindr, have emerged as a new digital technology through which YMSM are meeting sex partners [41, 42]. Launched in 2009, Grindr now reaches approximately 4 million users worldwide [43]. The Grindr interface includes a geo-locating feature, which allows users to connect with other nearby users. In addition, users have the capability to view pictures, see profile information (e.g. age, race/ethnicity, hobbies), and send text messages within the app. Grindr also allows users to display their exact physical location on a map contained within the app. Two recent studies of Grindr use among MSM in Los Angeles have documented HIV risk among Grindr users. A study by Rice et al. [42] found that nearly three-quarters used Grindr to find a sex partner. While YMSM in this study were statistically significantly more likely to use a condom with a partner met on Grindr than a partner met through another medium, the 15 % who reported UAI with their last partner met on Grindr had statistically significantly more lifetime and recent sex partners than YMSM who did not have UAI with their last Grindr-met partner. Another study by Landovitz et al. [41] found that 60 % of Grindr-using MSM used the application for sexual partnering and 70 % of users who engaged in UAI considered themselves to be at low risk of contracting HIV.

Grindr is not the only geosocial networking app targeting YMSM. In fact, in recent years many others have cropped up, including Scuff, Jack'd and Manhunt Mobile (to name a few). However, Grindr remains one of the most popular geosocial networking apps among MSM and has been used in at least one instance for recruitment into HIV prevention trials. A study by Burrell et al. [44] documented the success of using Grindr to enroll MSM in a large rectal microbicide trial conducted in Los Angeles County. Landovitz et al. [41] also documented that among HIV-positive Grindr users in their study, 52 % indicated that they would be willing to participate in a future HIV prevention trial. These results suggest that MSM using Grindr are willing to engage with HIV prevention efforts through this medium. However, to our knowledge, no studies have been conducted that specifically examine the acceptability of smartphone app-based HIV prevention interventions among YMSM.

Present Study

Just as studies on HIV prevention efforts for MSM using websites and mobile phones benefitted from understanding the ways in which MSM used these technologies [45], so can newer efforts that seek to use smartphone apps to disseminate HIV prevention information. The present study sought to understand YMSM's motivations for using and use patterns of Grindr, and document how these motivations and use patterns differ from YMSM's motivations and use patterns of other technologies that have been used for HIV prevention efforts previously (i.e. Facebook, online dating sites). In addition, this study documents YMSM's willingness to engage in smartphone app-based HIV prevention efforts. Understanding YMSM's Grindr use patterns and motivations for using Grindr compared to other popular technologies where HIV prevention information has been implemented successfully may enable interventionists to develop tailored HIV prevention programs that can be added on to or complement Grindr and other smartphone apps catering to YMSM.

Methods

Sampling and Data Collection

Utilizing the geo-locating feature of Grindr, research assistants created their own profiles to recruit YMSM Grindr users who were within a seven-mile radius of West Hollywood and Long Beach, CA, USA. These two cities were selected due to their high populations of MSM. The recruiters' profiles contained the institution's name and identified the recruiters as researchers; their profile pictures were of the research assistant or a stock photo. Individuals were eligible to participate if they were Grindr users, between the ages of 18–24 and had not previously participated in the study.

Participants were randomly selected based on their location at the time of recruitment. Profiles were filtered by age to include only those listed as 18–24. On Grindr, profiles are organized by geo-location, with the first profiles being closest in proximity to the user. Users appeared on a grid displaying four profile photos in each row and

continued for all users within a seven-mile range. Potential participants were selected using a randomization number chart displaying numbers between 1 and 4, to match the app's profile display. Randomly selected persons were sent a message providing information about the study. Interested participants received a link and unique log-in code to an anonymous, online survey, which took approximately 20–30 min to complete. Upon completion, participants received a $25 downloadable gift card to either iCard or Amazon.com. For every user who was approached, his distance from the recruiter was recorded. Recruiters were available to answer respondents' questions and to provide minor technical support through Grindr's chat feature. Recruitment occurred between 9 a.m. and 8 p.m. on weekdays.

Between August 8, 2011 and October 3, 2011 the two recruiters approached 1,523 YMSM. Details about recruitment are provided elsewhere [42]. Of the 1,523 men approached via the app, 26.5 % responded to the recruiters and 25.6 % agreed to participate. Of those men who agreed to participate ($n = 390$), 50.0 % ($n = 195$) completed the survey. Overall, 12.8 % of the men approached via Grindr text message completed the survey. Only eligible participants were randomly selected, so our overall response rate is calculated based on the proportion of those contacted who completed the survey, without any additional inflations of this rate based on excluding non-eligible participants from our calculations. The one other study we are aware of which has recruited YMSM through Grindr had a completion rate of 4.5 % [41]. All study procedures were approved by the Institutional Review Board of the University of Southern California. Secondary data analysis for the present study was approved by the Institutional Review Board of the University of California, Los Angeles.

Measures

Demographics

Participants were asked to identify their age in years (range 18–24), race/ethnicity (1 = African American, 2 = Latino/Hispanic, 3 = White, 4 = Asian/Pacific Islander, 5 = Other), highest level of education, which was dichotomized (0 = Less than college, 1 = Some college or more), current employment status (0 = Not currently working, 1 = Currently working), sexual identity (0 = Heterosexual, Bisexual, 1 = Gay, MSM), sexual attraction to males and females (1 = Not at all attracted, 2 = Not strongly attracted, 3 = Somewhat strongly attracted, 4 = Very strongly attracted), whether they were out (i.e., had disclosed their sexual identity) to family members, friends, and/or others (0 = No, 1 = Yes), and their relationship status (0 = Single, 1 = In a relationship).

Technology Use

YMSM were asked about both lifetime and current use of a range of online dating sites and geosocial smartphone apps, which were developed through formative work with a community advisory board (CAB). Grindr and Facebook log-on frequency was assessed with a six-point Likert-type scale (1 = Less than once a week, 2 = About once a week, 3 = A few days a week, 4 = Once daily, 5 = More than once a day but less than 5 times a day, 6 = 5 or more times a day). Participants were also asked which naked body parts they displayed in their Grindr and Facebook profiles, including face (0 = No, 1 = Yes), chest (0 = No, 1 = Yes), and abdomen (0 = No, 1 = Yes). Grindr does not permit "R"-rated photographs (e.g. underwear, butts, genitals, etc.).

Motivations for Using Grindr Versus Other Technologies

YMSM were asked to name their reasons for using three types of technologies: Grindr, Facebook, and gay-oriented internet dating sites (e.g. Manhunt, Adam4Adam). A list of motivations was generated by the CAB and included the following reasons: to make new friends, to meet people to hook up with, to meet people to date, to "kill time," to connect to the gay community, to find people to use substances with, to communicate with face-to-face friends, to connect with people from the past, and to connect with family. An open-ended response category allowed YMSM to write in other reasons for use, which were then collapsed into previously existing categories when appropriate. Those open-ended responses that could not be collapsed into previously existing categories are described in text. Finally, YMSM were asked to select their number one reason for using each particular technology.

Sexual Health Information Seeking

Four questions assessed sexual health information seeking of participants. Two dichotomously scored items assessed whether participants had ever used the internet to find information about HIV/AIDS or other STIs (0 = No, 1 = Yes) and whether participants had ever used the internet to find where to go for an HIV test (0 = No, 1 = Yes). Next, participants were asked whether they had received information regarding HIV/AIDS or sexual health from any of the following sources: health professionals, family members, friends, television, internet, STI/HIV clinics, mobile testing vans, or other sources. Finally, participants were asked the source they went to most often for information about HIV/AIDS or sexual health from the list above.

Table 1 Descriptive statistics of YMSM Grindr users in Los Angeles ($N = 195$)

Variable	*N*	% or mean (SD)
Mean age	195	21.77 (1.66)
Race/ethnicity		
Black/African American	9	4.60
Latino/Hispanic	64	32.80
White	78	40.00
Asian	19	9.70
American Indian or Alaska Native	1	0.50
Other	24	12.30
Sexual Orientation[a]		
Homosexual, gay	168	86.60
Bisexual	18	9.30
Heterosexual, straight	1	0.50
Questioning/unsure	4	2.10
Queer/other	3	1.50
Attraction to Males[b]		
Very strongly	168	86.20
Somewhat strongly	23	11.80
Not very strongly	4	2.10
Not at all	0	0.00
Attraction to females[c]		
Very strongly	3	1.50
Somewhat strongly	25	12.80
Not very strongly	63	32.30
Not at all	104	53.30
Highest education[d]		
Less than high school	5	2.60
High school graduate or GED	25	12.80
Some college	95	48.70
4 Year college/university degree	63	32.20
Master's degree or professional degree	7	3.60
Who participants are out to		
Parents	124	63.60
Siblings	128	65.60
Other family	110	56.40
Coworkers[e]	133	68.20
Friends	182	93.30
No one	12	6.20
Relationship status[f]		
Single	170	87.20
Male partner monogamous	2	1.00
Male partner open	1	0.50
Female partner monogamous	1	0.50
Boyfriend monogamous	16	8.20
Boyfriend open	5	2.60

[a] Comparison is homosexual, gay versus all others

[b] Comparison is strongly attracted versus all others

[c] Comparison is not at all attracted versus all others

[d] Comparison is some college or more versus all others

[e] Of those who had a job

[f] Comparison is single versus all others

Previous HIV Prevention Participation

Participants were asked whether they had ever participated in an HIV prevention class or training about HIV prevention, other than in school (0 = No, 1 = Yes). If so, participants were asked how long it had been since they participated in that program (1 = Within 1 month, 2 = More than 1 month but less than 6 months, 3 = 6 months to 1 year, 4 = Greater than 1 year) and their satisfaction with that program (1 = Very unsatisfied, 2 = Unsatisfied, 3 = Neither satisfied or dissatisfied, 4 = Satisfied, 5 = Very satisfied).

Acceptability of HIV Prevention Programming

Participants were asked whether they would be willing to take a class about HIV prevention in-person and/or online (0 = No, 1 = Yes), and if they would be willing to participate in a HIV prevention program delivered via a smartphone app (0 = No, 1 = Yes).

Data Analysis

Data was analyzed using SPSS, Version 19 [46]. Bivariate tests of association were used to determine whether there were differences in motivations for using Grindr versus Facebook and Grindr versus online dating websites. Chi square and *t* tests were also used to test for associations between willingness to participate in smartphone app-delivered HIV prevention programs and demographic characteristics, HIV testing histories, and sexual risk behaviors.

Results

Demographics

A total of 195 participants completed the online questionnaire. Mean age of participants was 22 years (SD = 1.7) and the majority had completed at least some college education (85 %). Forty percent of the participants identified as White, 33 % as Latino, 10 % as Asian/Pacific Islander, and 5 % Black/African American. Two-thirds reported being currently employed and 62 % reported being part of households earning over $20,000 per year. The majority identified as gay (87 %), reported strong attraction to males (86 %), and were out to friends, parents, siblings, and others (94 %). Eighty-seven percent of participants reported being single at the time of the survey. Table 1 contains participants' full demographic information.

Technology Use

Nearly all YMSM Grindr users also reported currently using Facebook (95 %). Sixty percent used Twitter and 71 % also used a gay dating site. The most popular sites for gay dating according to participants' current use were Adam4Adam (43 %) and OKCupid (18 %); much smaller numbers used Manhunt (6 %), Gay.com (6 %), or D-list (5 %). In addition to using Grindr, 46 % of participants currently used another smartphone app, such as Jack'd (20 %), Scruff (14 %), and Boy Ahoy! (10 %). Participants' lifetime gay dating site and smartphone app use was high, with nearly all participants having used at least one dating site and nearly 60 % having used a smartphone app other than Grindr (Table 2).

Twenty-eight percent of participants reported using Grindr more than once but less than five times per day, and an additional 51 % reported using the technology five or more times per day. The majority of participants showed their face in their Grindr profile picture (83 %); smaller percentages showed their bare chest (28 %) and abdomen (20 %). Participants used Grindr for a variety of reasons, including to "kill time" when bored (86 %), make new friends (80 %), connect to the gay community (65 %), meet people to date (65 %), and meet people to "hook up" with (67 %). Seven participants provided open-ended responses not collapsible into pre-existing categories, which included: "curious from hearing a lot about the app," "ego boost," "gay-dar/just to see who's around me," "networking opportunities," "research," "to get off," "look around not to hook up though," and "to keep my self-esteem high." When asked their number one reason for using Grindr, the most popular answer was to meet people to hook-up with (28 %).

Among those who used both Grindr and Facebook, a greater percentage reported face visibility on Facebook compared to Grindr ($p < 0.001$). Both chest and abdomen visibility was higher in Grindr profiles than in Facebook profiles ($p < 0.001$, and $p < 0.01$ respectively). When assessing rationale for use of each technology, Grindr and Facebook were found to differ on all reasons. Significantly more individuals reported using Grindr to make new friends (80 vs. 56 %, $p < 0.001$), meet people to "hook up" with (67 vs. 8 %, $p < 0.001$) meet people to date (65 vs. 24 %, $p < 0.001$), "kill time" (86 vs. 71 %, $p < 0.001$), connect with the gay community (65 vs. 32 %, $p < 0.001$), and find people to drink and use drugs with (12 vs. 7 %, $p < 0.05$) compared to Facebook. Facebook was reported to be used more, compared to Grindr, to communicate with face-to-face friends (89 vs. 31 %, $p < 0.001$) and connect with people from the past (83 vs. 12 %, $p < 0.001$). When participants were asked to indicate their number one reason for using each technology, significantly more respondents

Table 2 Current and lifetime social media and gay dating website and app use

Variable	*N*	%
Sites currently used		
Myspace	20	10.3
Facebook	184	94.80
Twitter	116	59.80
Adam4Adam	84	43.30
Manhunt	12	6.20
OK cupid	35	18.00
D-list	10	5.20
Gay.com	11	5.70
Match	3	1.50
J-date	0	0.00
eHarmony	2	1.00
Chemistry	1	0.50
Other	14	7.20
No current account on a site	5	2.60
Sites used in lifetime		
Myspace	176	90.70
Facebook	183	94.30
Twitter	149	76.80
Adam4Adam	129	66.50
Manhunt	77	39.70
OK cupid	53	27.30
D-list	62	32.00
Gay.com	71	36.60
Match	32	16.50
J-date	5	2.60
eHarmony	6	3.10
Chemistry	11	5.70
Other	19	9.80
Never had an account on a site	1	0.50
Current smartphone app use (other than Grindr) ($n = 180$)		
Scruff	26	14.40
Skout	6	3.30
Zoost	1	0.60
Boy, ahoy!	18	10.00
MIU met	3	1.70
Jack'd	36	20.00
Other	25	13.90
No current use other than Grindr	98	54.40
Lifetime smartphone app use (other than Grindr) ($n = 177$)		
Scruff	47	26.60
Skout	17	9.60
Zoost	10	5.60
Boy, ahoy!	62	35.00
MIU met	8	4.50
Jack'd	51	28.8
Other	7	4.00
No use other than Grindr	74	41.80

Table 3 Comparison of Grindr use to Facebook use ($N = 188$)

Technology use variables	Grindr		Facebook			
	N	%	*N*	%	*t*	*p* value
Log-on frequency[a]					−1.776	0.077
Less than once a week	3	1.60	0	0.00		
About once a week	4	2.13	1	0.53		
A few days a week	16	8.51	14	7.45		
Once a day	17	9.04	15	7.98		
More than once a day but less than 5 times per day	53	28.19	49	26.06		
5 or more times a day	95	50.53	109	57.98		
Profile picture visibility						
Face	155	82.45	184	98.40	−5.733	<0.001
Chest	52	27.66	21	11.23	5.046	<0.001
Abs	37	19.68	20	10.70	3.112	0.002
Reasons for using						
Make new friends	150	79.79	104	55.61	8.231	<0.001
Meet people to hook up with	126	67.02	15	8.02	17.161	<0.001
Meet people to date	123	65.43	44	23.53	12.046	<0.001
"kill time" when bored	162	86.17	132	70.59	6.173	<0.001
Connect to gay community	122	64.89	59	31.55	9.553	<0.001
Find people to drink and use drugs with	23	12.23	13	6.95	2.204	0.029
Communicate with face-to-face friends	59	31.38	167	89.30	−17.069	<0.001
Connect with people from past	23	12.23	155	82.89	−29.486	<0.001
Connect with family	1	0.53	132	70.59	−131.705	<0.001
Other	7	3.72	6	3.19	0.396	0.693
#1 Reason for use						
Make new friends	37	20.00	16	8.56	3.881	<0.001
Meet people to hook up with	51	27.57	0	0.00	8.364	<0.001
Meet people to date	43	23.24	4	2.14	6.778	<0.001
To "kill" time when bored	41	22.16	25	13.37	2.872	0.005
Connect to gay community	13	7.03	0	0.00	3.729	<0.001
Find people to drink and use drugs with	0	0.00	0	0.00		
Communicate with face-to-face friends	0	0.00	120	64.17	−18.252	<0.001
Connect with people from past	0	0.00	15	8.02	−4.028	<0.001
Connect with family	0	0.00	4	2.14	2.016	0.045
Other	0	0.00	3	1.60	1.741	0.083

[a] Comparison: daily or more use versus less use

reported using Grindr to make new friends (20 %), to meet people to hook up with (28 %), to meet people to date (23 %), and to "kill time" (22 %) compared to Facebook. The main reason for Facebook use was to communicate with face-to-face friends (64 %) (Table 3).

Five statistically significant differences emerged between motivations for using Grindr compared to online dating sites. Grindr was used by a greater percentage of participants to make new friends (78 vs. 63 %), "kill time" (86 vs. 64 %), connect with the gay community (64 vs. 42 %), and communicate with face-to-face friends (29 vs. 13 %), compared to gay dating site use. Further, when participants indicated their main reason for using both technologies, meeting people to "hook up" with was reported by a greater percentage of participants for dating sites (42 %), compared to Grindr (29 %) (Table 4).

Information Seeking and Previous Prevention Program Participation

The majority of respondents (89 %) reported having ever used the internet to find information about HIV/AIDS or other STIs, and 79 % used the internet to find a location for HIV testing. The top three sources for sexual health information were the internet (39 %), HIV/STI testing locations (25 %), and health professionals (24 %). A

Table 4 Comparison of Grindr use to gay dating site use ($n = 138$)

Technology use variables[a]	Grindr		Dating sites			
	N	%	*N*	%	*t*	*p* value
Reasons for using						
Make new friends	108	78.26	87	63.04	4.318	<0.001
Meet people to hook up	101	73.19	102	73.91	−0.191	0.848
Meet people to date	89	64.49	89	64.49		
"kill time" time when bored	118	85.51	88	63.77	7.228	<0.001
Connect to gay community	88	63.77	58	42.03	5.294	<0.001
Find people to drink and use drugs with	19	13.77	14	10.14	1.231	0.221
Communicate with face-to-face friends	40	28.99	18	13.04	4.113	<0.001
Connect with people from past	19	13.77	11	7.97	1.969	0.051
Connect with family	0	0.00	2	1.45	1.419	0.158
Other	4	2.90	0	0.00		
#1 Reason for use						
Make new friends	28	20.44	19	13.77	1.929	0.056
Meet people to hook up	40	29.20	58	42.03	−3.291	0.001
Meet people to date	35	25.55	35	25.36	0.050	0.961
"Kill time" time when bored	26	18.98	19	13.77	1.549	0.124
Connect to gay community	8	5.84	5	3.62	1.102	0.272
Find people to drink and use drugs with	0	0.00	0	0.00		
Communicate with face-to-face friends	0	0.00	0	0.00		
Connect with people from past	0	0.00	1	0.72	1.000	0.319
Connect with family	0	0.00	0	0.00		
Other	0	0.00	1	0.72	1.000	0.319

greater percentage of those who had used the internet to find an HIV testing site had been tested for HIV [X^2(df = 1) = 22.96, 86.1 vs. 42.9 %, $p < 0.01$].

Over one-third of participants had ever participated in an HIV prevention program (36 %), with half of those participating over 1 year prior to the study. Of those who had participated in an HIV prevention program previously, 77 % reported being satisfied or very satisfied with the program attended. YMSM who previously participated in HIV prevention programs were more likely to identify as gay, be currently single, have ever had a HIV test, and have a lifetime history of an STI diagnosis ($p < 0.05$). Of note, there were no statistically significant differences in sexual risk behaviors between YMSM who participated in an HIV prevention program versus those who had not.

Willingness to Participate in Future Prevention Efforts

Eighty percent of respondents expressed a willingness to participate in HIV prevention programs in the future, regardless of delivery mode. Online and smartphone app-based programs were more favorable (71 and 70 %, respectively) than in-person interventions (57 %). One-quarter of YMSM preferred only technology-based prevention programs, while 56 % indicated willingness to participate in both technology-based and in-person interventions. Merely 1 % of respondents indicated that they would only be willing to participate in a program that was delivered in-person. Importantly, 20 % indicated that they would not be willing to participate in an HIV prevention program. There were no statistically significant differences in willingness to attend future HIV prevention programs (regardless of delivery) among participants by demographic characteristics, HIV testing histories, and sexual risk behaviors.

Discussion

The present study sought to understand YMSM Grindr users' technology use patterns, motivations for using Grindr compared to other popular technologies, and willingness to participate in smartphone app-based HIV prevention programs in the future. Results indicate that YMSM who use Grindr also use a variety of other technologies, including Facebook, online dating sites, and other smartphone apps. In addition, the majority (89 %) sought sexual health information online, and the internet was the most popular medium in which to seek sexual health information. These results are consistent with studies of

MSM in general. Hooper et al. [47] found that online resources, such as internet search engines, gay, lesbian, bisexual, and transgender websites, and health websites were among the most popular venues accessed for information about same-sex sex, HIV, STIs, and sexual health. Our results emphasize the importance of internet-based sexual health resources for YMSM who use a range of technologies.

Motivations for Grindr Use

Motivations for using Grindr included, but were not limited to: finding sex partners, meeting friends, killing time, and connecting to the gay community. The assumption that Grindr is only used to facilitate sexual encounters is oversimplified; in fact, less than 30 % of participants indicated this was their number one reason for using the technology. Interestingly, Grindr users access Grindr for very different reasons than other popular technologies, such as Facebook and gay oriented dating websites. While Facebook was used more for connection with individuals who were already known to the YMSM participants, Grindr was used to facilitate new connections, especially with other individuals in the gay community. Grindr also seems to fill a different social role for YMSM than gay dating sites. For individuals who used both Grindr and gay dating sites, Grindr was used more to pass the time, make new connections, and maintain friendships. It could be that because of its geosocial capabilities YMSM are able to feel more connected to the gay community because they are able to see the proximity of individuals around them. More YMSM Grindr users reported using gay dating sites for "hooking up" compared to Grindr, underscoring the fact that Grindr plays a unique role in the lives of YMSM compared to these other technologies. As Grindr and other smartphone apps, which facilitate connections between YMSM, become an increasingly important part of the social and cultural landscape for this population, it is crucial for public health professionals to consider how these technologies may be used to promote health and wellbeing among YMSM.

Willingness to Engage in Technology-Based HIV Prevention

Over 80 % of YMSM in our study indicated that they would be willing to participate in future HIV prevention programming delivered online or via smartphone apps. YMSM who are willing to participate in HIV prevention prefer brief interventions that can be implemented within their social networks and the social contexts of which they are already a part [13]. With large swaths of YMSM utilizing the internet and smartphone apps like Grindr to seek romantic and sexual partners and sexual health information, prevention programs should be tailored to these contexts [48]. According to a 2013 study by the Pew Research Center, 91 % of all Americans have a cell phone and 56 % of these have smartphones [49]. These numbers are growing by the year: in 2010 only 17 % of cell phone owners used their phone to search health-related information; in 2012 this number rose to 31 % for cell phone users and 52 % for smartphone users [50]. These data indicate a growing trend toward the use of smartphone technology as a primary mechanism for seeking health-related information. Given difficulties faced in engaging YMSM in traditional HIV prevention efforts [3–5], our findings point to the need to develop and test online and smartphone app-based HIV prevention programming tailored for YMSM.

The design and delivery of smartphone app-based HIV prevention programs warrants further investigation. Simple programs that provide quick references to nearby HIV testing locations could be integrated into existing platforms that include geolocating features, such as Grindr. YMSM in our study who sought HIV testing locations online were more likely to be tested. Making testing locations easily searchable within apps already being used by YMSM may simultaneously raise awareness and facilitate access to community service providers. HIV preventionists may also be wise to consider development of standalone smartphone apps that can be accessed by YMSM for HIV prevention information, including interactive chat functionality with HIV interventionists. Mobile health (mhealth) has been used to describe the practice of medicine and public health that is facilitated through mobile devices, including smartphones [51]. We can envision an app that facilitates communication with medical providers to access biomedical HIV prevention (e.g. PrEP and PEP), provides streaming content on issues that are relevant to YMSM (e.g. battling homophobia and discrimination, condom negotiation), and tracks HIV testing dates and results so that YMSM can share up-to-date sexual health information with potential sex partners.

Developing strategies that are attractive, engaging, informative, and culturally-relevant are imperative in addressing HIV prevention within the YMSM digital generation [52]. A needs assessment of internet-using MSM demonstrated the desire for detailed HIV prevention content relevant to MSM sexual health that could be delivered through sexually-explicit messaging and coupled with additional information about health and wellbeing and relationship building [47]. The utilization of interactive web-based and smartphone technologies to deliver HIV prevention messaging to MSM have shown promise. For example, interactive video to simulate sexual encounters and interpersonal dynamics that may develop during the course of real-life sex negotiation have been shown to

reduce HIV risk behaviors [53]. Next steps for HIV prevention researchers should be the development and feasibility testing of online and smartphone app-based HIV prevention programs grounded in the preferences of YMSM themselves.

Policy Implications and Further Research

The rising popularity of smartphone geosocial networking apps, like Grindr, coincides with the passage and implementation of the Affordable Care Act (ACA), a focus on HIV treatment as prevention, and the expansion of mobile health (i.e., mHealth) interventions for a variety of chronic health conditions [51]. The development of smartphone app-based HIV prevention programming for YMSM should be undertaken with attention to the current political and social climate [54]. A central goal of the ACA is to significantly increase access to health services for all Americans, including YMSM and people living with HIV/AIDS, by providing a continuum of affordable coverage options through Medicaid and new Health Insurance Exchanges [55]. Outreach to YMSM in general, and specifically HIV-positive YMSM who are not linked to HIV care, may be facilitated through the use of mobile technologies, including smartphone apps. Internet-based outreach has worked in engaging MSM who are not accessible otherwise because they do not openly identify as gay or bisexual (and therefore may not attend gay social venues) but may be engaging in high-risk behaviors [56]. Smartphone apps, like Grindr, present opportunities for discreet, targeted outreach to YMSM in the communities where they live and work. HIV prevention interventions that can be delivered through smartphone apps have the potential to increase HIV testing and linkage to appropriate HIV services by capitalizing on the geolocation feature of smartphones, which could enable YMSM to find nearby HIV testing centers and clinical settings. Finally, communication between YMSM and healthcare providers could be facilitated through smartphone apps. Automated message reminders about regular HIV testing, medication adherence, and medical visits along with live chat may help to increase provider-patient interactions and promote health behavior for both HIV-negative and HIV-positive YMSM. Smartphone app-based HIV prevention may be just the type of cost-effective and high-impact preventive interventions called for by the ACA.

In order to facilitate outreach, HIV testing, and linkage to appropriate HIV services through mobile technologies, researchers and HIV interventionists must be prepared to partner with key stakeholders in the YMSM community, including YMSM themselves, community-based organizations that focus on HIV prevention and treatment, and YMSM smartphone app developers. These partnerships may be difficult to strike based on potentially competing interests between YMSM smartphone app developers and those who seek to prevent HIV among YMSM. As our research demonstrates, YMSM use apps like Grindr to meet potential sex partners; add-on functionality that reminds YMSM about their HIV risk may be unappealing to YMSM smartphone app developers if they fear such messaging will deter app usage by their customers. Similarly, community-based agencies may be reluctant to work with partners like YMSM smartphone app developers if they fear that their reputation may be tarnished by partnering with "hook-up app" companies. All stakeholders are likely to have important insights about the design and functionality of smartphone app-based HIV prevention for YMSM; researchers must find a way to bridge potentially competing interests in order to promote the health and wellbeing of YMSM. Our work shows that YMSM are amenable to smartphone app-based HIV prevention; formative research on YMSM's preferences for design and functionality of smartphone app-based HIV prevention are needed, followed by practical development, implementation, and evaluation of these interventions.

Limitations

As with all cross-sectional studies, the results presented here indicate correlation and not causation. Additionally, we do not know the specifics of the types of HIV prevention programs, nor the content of the programs, that participants reported attending previously. Rates of program participation are slightly higher than previous studies with YMSM in Los Angeles, which also excluded HIV prevention programs delivered in schools [6], so it is possible our sample is more favorable to HIV prevention programming than other YMSM. Asking participants about their willingness to attend a "class" about HIV may have prompted diverse interpretations about what an HIV prevention program would entail; and it is possible this operationalization may have biased some participants' responses. Although there was racial/ethnic diversity within the sample, the relatively small numbers of African American participants indicate limited generalizability to this population. African American YMSM (AAYMSM) are at heightened risk for HIV infection compared to their White and Latino counterparts; further research should focus specifically on AAYMSM's smartphone app use in order to determine whether and how smartphone app-based HIV prevention can be tailored for AAYMSM. Finally, as this sample was recruited from a smartphone app; there may be an inherent bias in the desire for smartphone app-based HIV prevention programs.

Conclusions

Despite considerable investment in HIV prevention for YMSM, infection rates in this population continue to rise. Our findings demonstrate that smartphone app-based HIV prevention efforts are acceptable to YMSM. In fact, these programs may be more effective modalities for HIV prevention among YMSM than traditional efforts that are delivered in person, since larger percentages of YMSM are willing to engage with HIV prevention through smartphone apps than in person. Researchers must engage diverse YMSM in the development and testing of smartphone app-based HIV prevention efforts in order to formulate culturally-appropriate programs that will gain traction among YMSM who are increasingly connected through technology.

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