Published in final edited form as:

Sex Transm Dis. 2018 July ; 45(7): 462–468. doi:10.1097/OLQ.0000000000000784.

A network analysis of sexually transmitted diseases and online hookup sites among men who have sex with men

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Abstract

Background—Sexually transmitted diseases (STDs) are increasing among gay, bisexual, and other men who have sex with men (MSM). Little is known about the use of websites and mobile phone applications to meet sexual partners (“hookup sites”) and association with STD diagnoses.

Methods—We performed a demographic and behavioral assessment of 415 MSM presenting to the Rhode Island STD clinic. Bivariate and multivariable analyses assessed associations between using hook up sites and testing positive for syphilis, gonorrhea, or chlamydia. Venue-based affiliation networks were created to evaluate hookup sites and their association with STD diagnoses.

Results—Among 415 MSM, 78% reported meeting a partner online in the last 12 months, and 25% tested positive for at least one STD. Men who met partners online were more likely to be white (67% versus 54%, $p=0.03$) and have >10 lifetime partners (87% versus 58%, $p<0.05$). The most commonly used hookup sites included Grindr (78%), Scruff (35%), and Tinder (22%). In the multivariable analysis, only Scruff use was associated with testing positive for an STD (OR 2.28, 95% CI 1.09–4.94). However, among men who met partners online, 75% of men diagnosed with an STD had met a sexual partner on Grindr, including 100% of those who were diagnosed with gonorrhea.

Conclusions—Use of hookup sites was nearly ubiquitous among MSM undergoing STD screening. Specific hookup sites were significantly associated with STD diagnoses among MSM.

Greater efforts are needed to promote STD screening and prevention among MSM who meet partners online.

Keywords

STDS; MSM; PREVENTION; GRINDR; INTERNET

INTRODUCTION

Sexually transmitted diseases (STDs) including syphilis, gonorrhea, and chlamydia continue to be a significant cause of morbidity in the United States (US) (1). More than 1.9 million cases of syphilis, gonorrhea, and chlamydia were reported to the Centers for Disease Control and Prevention (CDC) in 2015, and national estimates predict that over 20 million new infections occur each year (1). Despite advances in screening and treatment, STDs continue to have a disproportionate impact on gay, bisexual, and other men who have sex with men (MSM) (1). In 2015, MSM accounted for 60% of all syphilis and 42% of gonorrhea cases, a 13% and 15% increase from 2014, respectively (1,2). Among MSM, behaviors such as condomless anal intercourse (CAI), engaging in casual or anonymous sex, and having multiple concurrent partners may increase the risk for STDs (1,3,4). Overlapping social and sexual networks are also associated with higher rates of STDs among MSM (1).

Use of websites and geosocial networking mobile applications (apps) used to meet sex partners (i.e., “hookup sites”) may also lead to increased risk of infection with HIV and other STDs among MSM (5,6). Though websites and apps differ in architecture and how communication between users takes place, many share the primary purpose of facilitating sexual encounters (3,5–8). MSM are up to seven times more likely than non-MSM to have sex with a partner they met online (3), and an estimated 3–6 million MSM meet sexual partners worldwide using internet-based technology (3,8). Research demonstrates that MSM who use hookup sites to meet sexual partners are more likely to engage in higher-risk behavior than men who do not meet partners online (5,6,8,9). Hookup site users may test less often for HIV/STDs (10), have higher rates of CAI (11), and have an increased rate of STDs (6,12). As hookup sites represent a virtual risk environment for STDs, understanding the demographics and behaviors of men who meet partners on these sites can facilitate development and targeting of effective public health promotion messages.

One approach to evaluating sexual networks among MSM is social network analysis (SNA). SNA describes the ties among network members (actors) and analyzes characteristics that influence disease transmission. SNA has previously been used to identify sexual networks of MSM and STD transmission (4,13–16). Specifically, SNA can be used to map where MSM meet sex partners by delineating “affiliation networks.” While sexual networks depict linkages of individuals and their direct sexual contacts, affiliation networks represent connections between individuals and the venues where they meet sexual partners (14,17,18). The probability of a connection is higher among MSM who use the same venues for partner recruitment, but sexual contact among members of an affiliation network is not guaranteed and two venue affiliates with the same STD may not be epidemiologically linked (18). However, by linking MSM to specific venues, SNA can evaluate which venues may be

“central” to the network (i.e. have the most connections) and which venues may be associated with testing positive for an STD (14). Previous network studies have focused on the role of physical venues (bars, bathhouses, sex parties, etc.) in facilitating the spread of STDs among networks of MSM (17,19). Internet venues have been found to have higher degrees of centrality (i.e., more connections to individuals in a network) than non-internet venues (17,19), and clusters of interconnected venues may play pivotal roles in their potential for transmitting disease throughout a given network (19–21). However, few studies have used this approach to evaluate online hookup sites and STD diagnoses (13,18,19). This study describes the affiliation networks of online hookup sites among MSM and investigates the relationship of these networks with testing positive for an STD.

METHODS

The study was conducted between October 2014 and January 2017 at the Rhode Island STD Clinic, the only publically funded STD clinic in the state. The clinic serves approximately 3,000 patients per year, one third of whom identify as MSM. Men who reported having sex with another man in the past 12 months were offered enrollment into the study. Patients with multiple clinic visits during the study period were only eligible to participate once. A one-time, cross-sectional demographic and behavioral assessment was performed.

Sociodemographic data collected included age, race, ethnicity, education level, income, and insurance (public/private/none). Behavioral data collected included number of male and female sex partners in the past 12 months (inclusive of oral, anal, and vaginal intercourse), cumulative number of lifetime partners, drug use, and condom use. Participants were asked where they had met sex partners in the past 12 months, choosing from an extensive list of local sites such as bars and clubs, gyms, bathhouses, sex venues, and parking/cruising sites, as well as virtual venues including hookup sites. Data were also reviewed on clinical outcomes, including the results of testing for syphilis and pharyngeal/rectal/urethral chlamydia and gonorrhea. Extragenital tests for chlamydia and gonorrhea were collected by self-performed swabs, which have demonstrated sensitivity and specificity comparable to physician-collected specimens (22). Nucleic acid amplification testing (NAAT) was used to detect presence of chlamydia or gonorrhea in urethral and extragenital specimens (22).

Chi-square and Fisher’s exact tests were used to assess differences in socio-demographic and risk behavior differences between groups. A two sided p-value of less than 0.05 was considered statistically significant. Bivariate regression models identified sociodemographic and risk behavior factors associated with meeting partners online and having a positive STD diagnosis, and assessed the association between specific hookup site use and a positive STD result. Multivariable logistic regression determined the relationship between testing positive for an STD and meeting sex partners online. Model 1 and all subsequent models were a priori adjusted for age, race, ethnicity, income and education level. Model 2 investigated the association between STD result and use of hookup site to meet sex partners. Additional behavioral risk factors were adjusted for in Model 3. All statistical analyses were completed using R statistical software version 3.3.2.

A venue based, two-mode affiliation network analysis was performed to examine the linkages between MSM testing positive for an STD and use of hookup sites to meet sexual

partners. A person-hookup site matrix was transposed and multiplied by itself to create a sexual affiliation network (i.e., $V=(A^T)A$) (19,20). Core hookup sites, the mathematically defined most centrally and densely connected sites within the network structure, were identified by core-periphery analysis. UCINET 6 and NETDRAW were used for network centrality analysis and visualization (23). The ethics approval and research activities in this study were approved by The Miriam Hospital Institutional Review Board.

RESULTS

Demographics and Behaviors

A total of 415 MSM completed the demographic and behavioral risk assessment. The mean age of participants was 31 years old (range 17–81); 36% were non-white, 18% identified as Hispanic/Latino, 50% held a college degree or higher, and 80% were insured (Table 1). A total of 104 (25%) tested positive for an STD. More than three quarters of the population (78%) reported meeting a sex partner online in the last 12 months. Compared to MSM who were negative, men who were diagnosed with an STD were more likely to use alcohol two or more times a week (47% versus 35%) and report popper (44% versus 25%) and methamphetamine (14% versus 7%) use in the last 12 months (all p -values <0.05). Other behaviors were not associated with being diagnosed with an STD.

MSM reported meeting partners most frequently online compared to other venues (Table 2a). Men who met partners online were more likely to have sex partners of the same gender rather than partners of different genders as compared to men who did not meet partners online ($p<0.01$). Overall, MSM who met partners online were more likely to be white, have more than 10 lifetime sexual partners, and use poppers and other non-popper, non-marijuana drugs (Table 1). Use of Grindr was similar between white (76%) and non-white (92%, $p=0.20$). MSM who used Scruff were more likely to be white (42%) than non-white (23%, $p=0.03$). In contrast, non-white MSM were more likely to use Adam4Adam (25% versus 15%, $p=0.04$) and Jack'd (24% versus 13%, $p=0.01$).

The majority (71%) of men who met partners online used more than one site to meet sex partners, using an average of 2.3 sites (range 0–9). MSM who used hookup sites also had twice the number of sex partners in the previous year (an average of 12.4 partners/year) compared to men who did not meet partners online (an average of 6.1 partners/year, $p<0.01$). Grindr was the most commonly reported online site used, with 78% of MSM who used hookup sites reporting meeting sex partners on this site in the last year (Table 2b), including 100% of hookup site users diagnosed with gonorrhea (Figure 1). Scruff was the only online hookup site to be associated with testing positive for an STD ($p<0.05$), with 34% of Scruff users receiving an STD diagnosis (Table 2b).

Multivariable Regression

In the multivariable analysis, those who earned an income in the range of \$12,000–\$29,000 (adjusted OR (aOR) 2.38, $p<0.05$) and those who held a college degree or higher (aOR 2.15, $p<0.05$) had higher odds of testing positive for an STD (Table 3). Use of Scruff to meet sexual partners was also associated with testing positive for an STD (aOR 2.16, $p<0.05$).

Higher frequency of alcohol consumption (aOR 2.87, $p<0.01$), crystal meth use (aOR 4.49, $p<0.05$), and lower frequency of condom use (aOR 2.30–3.67, $p<0.05$) were all behaviors associated with testing positive for an STD (Table 3).

Affiliation Network Analysis

The two-mode affiliation network of MSM who met partners online and tested positive for a given STD is depicted in Figure 2. Each line represents a connection between an individual and a hookup site used to meet sex partners. The network rendered a diameter of 3.0, indicating that any one individual was only three degrees of separation from any other individual in the network. There were no disconnected substructures of linked users or sites separate from the larger network depicted. The sexual affiliation network displayed in Figure 3 represents strength of ties (calculated as sum of cross products) connecting online hookup sites to each other by shared MSM users who tested positive for an STD. The network centralization was 0.21, expressing low variability in centrality between sites, meaning that many sites influenced connections in the network. K-core analysis evaluates network organization, measuring how network members are interconnected into subgroups, wherein subgroup members are interlinked to at least k other sites in the group. The output resulted in an 8-core maximal subgroup (Figure 3), illustrating the most cohesive regions of the network, and suggesting that Black Gay Chat, Mister, Jack'd, Bareback.com, and Recon are less connected sites. The affiliation network typified core/periphery structure, composed of several highly connected sites occupying the center of the network, encircled by a larger number of peripheral sites with fewer connections to each other than those in the center. Core/periphery analysis identified Scruff and Grindr as the network's densely connected central core. Among the 84 MSM with a positive STD result who met partners online in the past year, 91% reported meeting a sex partner on Scruff or Grindr.

DISCUSSION

This study is among the first to evaluate online hookup sites and STD transmission networks among MSM. Use of online hookup sites to meet sexual partners is a common practice among MSM. More than three quarters of individuals presenting for screening used at least one hookup site. Both individual-level risk behaviors and network-level structure were found to have an impact on STD diagnoses. Similar to other studies, we found that MSM who tested positive for an STD were more likely to have a lower income, higher alcohol consumption, use methamphetamines, and report less frequent condom use. Although disparities among race and STD diagnosis are well documented (1), no difference between STD diagnosis (any, gonorrhea, chlamydia, syphilis) and race were noted in this cohort. However, certain sites were associated with higher use among different racial groups. Additionally, specific online hookup sites were also found to be central components of affiliation networks among MSM (Grindr and Scruff), and were associated with greater likelihood of testing positive for an STD (Scruff). These data suggest that sexual networks within the context of specific online hookup sites may facilitate STD transmission among MSM.

Grindr and Scruff, the two core hookup sites that accounted for the most connections among MSM, are both apps that use a smartphone's internal global position system to identify other users in close proximity. Such apps are commonly used by men for the purposes of meeting other men and not always for the purposes of having sex. Grindr was first launched in 2009 with significant and substantial uptake since its release. Previous studies demonstrate that individuals who meet sexual partners on Grindr had greater odds of contracting both gonorrhea (aOR=1.25) and chlamydia (aOR=1.37) compared to individuals who did not meet partners online (6). Additional research has demonstrated that men who meet partners on hookup sites engage in behaviors associated with HIV/STD transmission (8,9). Our prior work demonstrates that a significant number of those that are newly HIV diagnosed have met partners online (3). This study expands on this existing literature to investigate the central nature of specific online hookup sites and their association with STD diagnoses.

Given the extensive use of online hookup sites among MSM to meet sexual partners, these sites offer an ideal approach for health promotion and HIV/STD prevention messaging. For example, this study demonstrates that most MSM who are diagnosed with an STD, including 100% of men who tested positive for gonorrhea, met partners on Grindr. While no causality can be inferred between using online hookup sites and STD transmission, this study suggests that once an STD (i.e. gonorrhea) enters the network of men using a specific site, it may be transmitted amongst a number of users. Given that the type of hookup sites may vary from one region to another, it is important to determine specific hookup sites used in a given community. HIV/STD prevention and outreach on these sites offer an ideal public health opportunity, and evidence supports that it is feasible and acceptable to reach MSM through hookup sites for HIV/STD testing (24–26), prevention and outreach (24–27), and partner notification services (26,28). Given the limited resources available to STD prevention and public health institutions, cost of advertising on hookup sites has been a limiting factor to effective health promotion on these sites (3). Some apps (e.g., Scruff) now offer geo-targeted advertising at no cost for public health non-profit organizations. Using existing culturally-sensitive messaging that has been developed may also help mitigate costs (bhocpartners.org). Given the increasing burden of STDs among MSM, additional efforts are needed for HIV/STD prevention and health promotion messaging on hookup sites used by MSM to meet sexual partners. Multiple and overlapping site use was common among men in our affiliation network. The prominence of Grindr and Scruff in the network demonstrate that additional advertising on peripheral sites may be redundant, as 9 in 10 MSM with a positive STD result who met partners online used either Grindr or Scruff. Interventions that promote education and awareness of HIV testing and other prevention interventions may be most cost-effective and have the highest impact when focused on these “core” sites. However, it is unknown whether targeting these core sites in the network would lead to improved outcomes. Visualization of sexual affiliation networks and core online hookup sites can help guide public health institutions' outreach and interventions and further study is needed on how effective these strategies are.

The study also found that specific risk behaviors may also contribute to STDs. Notably, use of methamphetamines in the past 12 months was a significant risk factor for a positive STD diagnosis. This may compound the risk among MSM who meet partners online. Individuals may disclose their preferences for using methamphetamines or other drugs on their online

profiles (often coded as “parTy and play” or “PnP”). These men represent a group at especially high risk of STD acquisition, which may lead to other behaviors such as CAI and multiple sex partners (29). Many SNA theories postulate that persons with elevated risk levels tend to belong to the same networks (7,14,30), warranting further study into how methamphetamine use may impact STD transmission risk among MSM who meet partners online.

LIMITATIONS

This study is subject to several limitations. Individuals self-reported venues where they had met partners, but did not name the partners met at that venue, therefore limiting the ability to evaluate the spread of disease throughout the entire network. This study sampled men presenting for testing at a single STD clinic in a specific region which may limit generalizability. The potential for information bias in the study was minimal, as a standardized questionnaire was issued to collect survey information and validated diagnostic tests were used to screen for STDs. To limit selection bias, all MSM who presented for STD screening or treatment at the clinic during the study period were offered enrollment into the study. However, information on refusal rate was not collected. Importantly, the study relied on cross-sectional data analyses and could not determine causation between using hookup sites and being diagnosed with an STD.

CONCLUSION

In Rhode Island, the majority of MSM presenting for HIV and STD screening services meet partners online. Two apps accounted for the overwhelming majority of hookup sites used by these men. A large proportion of MSM with recently diagnosed STD could be reached with health promotion messaging on Scruff and Grindr.

Acknowledgments

Sources of Funding: Philip A. Chan is supported by the NIH (R01MH114657). Additional support was provided by the Providence/Boston Center for AIDS Research (P30AI042853).

References

1. Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance 2015. Atlanta, GA: U.S. Department of Health and Human Services; 2016.
2. Centers for Disease Control and Prevention. Sexually transmitted disease surveillance 2014. Atlanta, GA: U.S. Department of Health and Human Services; 2015.
3. Chan P, Towery C, Poceta J, Bertrand T, Kantor R, Harvey J, et al. Frequent use of online hookup sites for meeting sexual partners among men who have sex with men: A call for urgent public health action. *Public Health Rep.* 2016; 131(2):264–71. [PubMed: 26957661]
4. Poon CM, Lee SS. Sex networking of young men who have sex with men in densely connected saunas in Hong Kong. *Sex Transm Dis.* 2013; 40(12):933–8. [PubMed: 24220354]
5. Grosskopf NA, LeVasseur MT, Glaser DB. Use of the internet and mobile-based “apps” for sex-seeking among men who have sex with men in New York City. *Am J Mens Health.* 2014; 8(6):510–20. [PubMed: 24658284]
6. Beymer MR, Weiss RE, Bolan RK, Rudy ET, Bourque LB, Rodriguez JP, et al. Sex on demand: geosocial networking phone apps and risk of sexually transmitted infections among a cross-

- sectional sample of men who have sex with men in Los Angeles County. *Sex Transm Infect.* 2014; (90):567–72. [PubMed: 24926041]
7. Grov C, Hirshfield S, Remien R, Humberstone M, Chiasson MA. Exploring the venue's role in risky sexual behavior among gay and bisexual men: an event-level analysis from a national online survey in the U.S. *Arch Sex Behav.* 2013; 42(2):291–302. [PubMed: 22012413]
 8. Tang W, Best J, Zhang Y, Liu F, Tso LS, Huang S, et al. Gay mobile apps and the evolving virtual risk environment: a cross-sectional online survey among men who have sex with men in China. *Sex Transm Infect.* 2016; 92(7):508–14.
 9. Young SD, Szekeres G, Coates T. The relationship between online social networking and sexual risk behaviors among men who have sex with men (MSM). *PLoS One.* 2013; 8(5):1–4.
 10. Rendina HJ, Jimenez RH, Grov C, Ventuneac A, Parsons JT. Patterns of lifetime and recent HIV testing among men who have sex with men in New York City who use Grindr. *AIDS Behav.* 2014; 18(1):41–9. [PubMed: 23925515]
 11. Landovitz RJ, Tseng C-H, Weissman M, Haymer M, Mendenhall B, Rogers K, et al. Epidemiology, sexual risk behavior, and HIV prevention practices of men who have sex with men using GRINDR in Los Angeles, California. *J Urban Health.* 2013; 90(4):729–39. [PubMed: 22983721]
 12. Lehmiller JJ, Loerger M. Social networking smartphone applications and sexual health outcomes among men who have sex with men. *PLoS One.* 2014; 9(1):e86603. [PubMed: 24466166]
 13. De P, Singh AE, Wong T, Yacoub W, Jolly AM. Sexual network analysis of a gonorrhoea outbreak. *Sex Transm Infect.* 2004; 80:280–5. [PubMed: 15295126]
 14. Fujimoto K, Williams M, Ross M. Venue-based affiliation networks and HIV risk-taking behavior among male sex workers. *Sex Transm Dis.* 2013; 40(6)
 15. Stephens SC, Fann CK, Strona FV, Wolf W, Cohen SE, Philip SS, et al. Identifying syphilis risk networks through venue attendance in San Francisco. *Sex Transm Dis.* 2014; 41(5):333–7. [PubMed: 24722390]
 16. Doherty IA, Padian NS, Marlow C, Arak SA. Determinants and consequences of sexual networks as they affect the spread of sexually transmitted infections. *J Infect Dis.* 2005; 191(Suppl 1):S42–54. [PubMed: 15627230]
 17. Leung KK, Poon CM, Lee SS. A comparative analysis of behaviors and sexual affiliation networks among men who have sex with men in Hong Kong. *Arch Sex Behav.* 2015; 44(7):2067–76. [PubMed: 25451510]
 18. Frost SDW. Using sexual affiliation networks to describe the sexual structure of a population. *Sex Transm Infect.* 2007; 83(Suppl 1):i37–i42. [PubMed: 17664363]
 19. Fur R, Henderson EA, Read RR, Godley J, Roy C, Bush K. Use of the social network analysis to quantify the importance of sex partner meeting venues in an infectious syphilis outbreak in Alberta, Canada. *Sex Transm Infect.* 2011; 87(Suppl 1):P1–S4.10.
 20. Holloway I, Rice E, Kipke M. Venue-based network analysis to inform HIV prevention efforts among young gay, bisexual, and other men who have sex with men. *Prev Sci.* 2014; 15(3):419–27. [PubMed: 24464324]
 21. Oster AM, Wejnert C, Mena LA, Elmore K, Fisher H, Heffelfinger JD. Network analysis among HIV-infected young black men who have sex with men demonstrates high connectedness around few venues. *Sex Transm Dis.* 2013; 40(3):206–12. [PubMed: 23403601]
 22. Centers for Disease Control. Sexually transmitted diseases treatment guidelines, 2015. *MMWR.* 2015; 64(3)
 23. Borgatti, SP., Everett, MG., Freeman, LC. *Ucinet for Windows: Software for Social Network Analysis.* Harvard, MA: Analytic Technologies; 2002.
 24. Sun CJ, Stowers J, Miller C, Bachmann L, Rhodes SD. Acceptability and feasibility of using established geosocial and sexual networking mobile applications to promote HIV and STD testing among men who have sex with men. *AIDS Behav.* 2015; 19(3):543–52. [PubMed: 25381563]
 25. Lampkin D, Crawley A, Lopez TP, Mejia CM, Yuen W, Levy V. Reaching suburban men who have sex with men for STD and HIV services through online social networking outreach: a public health approach. *Immune Defic Syndr.* 2016; 72(1):73–8.

26. Wohlfeiler D, Hecht J, Volk J, Raymond HF, Kennedy T, McFarland W. How can we improve online HIV and STD prevention for men who have sex with men? Perspectives of hook-up website owners, website users, and HIV/STD directors. *AIDS Behav.* 2013; 17(9):3024–33. [PubMed: 23180156]
27. Holloway I, Rice E, Gibbs J, Winetrobe H, Dunlap S, Rhoades H. Acceptability of smartphone application-based HIV prevention among young men who have sex with men. *AIDS Behav.* 2014; 18(2):285–96. [PubMed: 24292281]
28. Pennise M, Inscho R, Herpin K, Owens J Jr, Bedard B, Weimar A, et al. Using smartphone apps in STD interviews to find sexual partners. *Public Health Rep.* 2015; 130(3):245–52. [PubMed: 25931628]
29. Race K. ‘Party and Play’: online hook-up devices and the emergence of PNP practices among gay men. *Sexualities.* 2015; 18(3):253–75.
30. Amirkhanian YA. Social networks, sexual networks and HIV risk in men who have sex with men. *Curr HIVAIDS Rep.* 2014; 11(1):81–92.

Figure 1.
Percentage of positive sexually transmitted diseases (STD) diagnoses among MSM who met partners online, by use of hook-up site.

Figure 2. Sociogram of MSM with a positive sexually transmitted diseases (STD) diagnosis who met sex partners in Rhode Island using a hook-up site in the last 12 months (N=84)
Core hook-up sites are colored in blue, periphery hook-up sites are colored in grey.

Figure 3. Venue-based affiliation network for MSM with a positive sexually transmitted diseases (STD) diagnosis who met partners in Rhode Island using a hook-up site in the last 12 months (N=84)

Each node denotes an online hook-up site visited by MSM, colored by k-core, and thickness of ties referring to the strength of network ties (shared members). K-cores measure which subgroup members share a stronger connection to each other than other members. Red nodes belong to the 8-core, grey nodes the 7-core, blue nodes the 6-core, pink nodes the 4-core, and black nodes the 0-core.

Table 1

Demographic and Behavioral Characteristics of the study cohort (N=415)

	Met partners online in Rhode Island [‡]				p-value
	TOTAL	YES	NO		
	N (%)	n (%)	n (%)		
Total	415	322 (77.6)	93 (22.4)		
Age					0.519
13–29 years	248 (59.8)	195 (60.6)	53 (57.0)		
30–39 years	86 (20.7)	68 (21.1)	18 (19.4)		
40 years or older	81 (19.5)	59 (18.3)	22 (23.7)		
Race					0.025
White	264 (63.6)	214 (66.5)	50 (53.8)		
Non-White	151 (36.4)	108 (33.5)	43 (46.2)		
Ethnicity					0.082
Non-Hispanic/Latino	338 (81.5)	268 (83.2)	70 (75.3)		
Hispanic/Latino	77 (18.5)	54 (16.8)	23 (24.7)		
Education level					0.462
High school diploma or less	77 (18.6)	56 (17.4)	21 (22.6)		
Some college/Other	131 (31.6)	105 (32.6)	26 (28.0)		
College degree or higher	207 (49.9)	161 (50.0)	46 (49.5)		
Income (N=412)					0.177
Less than \$12,000	122 (29.6)	97 (30.2)	25 (27.5)		
\$12,000–\$29,999	80 (19.4)	59 (18.4)	21 (23.1)		
\$30,000–\$59,999	137 (33.3)	102 (31.8)	35 (38.5)		
\$60,000 or greater	73 (17.7)	63 (19.6)	10 (11.0)		
Health insurance					0.630
None	82 (19.7)	62 (19.3)	20 (21.5)		
Private	241 (58.1)	191 (59.3)	50 (53.8)		
Public	92 (22.2)	69 (21.4)	23 (24.7)		
Tested positive for any STD[*]					0.369
No	311 (74.9)	238 (73.9)	73 (78.5)		

Met partners online in Rhode Island [‡]						
	TOTAL		YES		NO	
	N	(%)	n	(%)	n	(%)
Yes	104	(25.1)	84	(26.1)	20	(21.5)
Sexual Orientation						
Same gender only	324	(78.1)	261	(81.1)	63	(67.7)
Bisexual or other	91	(21.9)	61	(18.9)	30	(32.3)
Lifetime partners						
10	82	(19.8)	43	(13.4)	39	(41.9)
11–20	99	(23.9)	78	(24.2)	21	(22.6)
> 20	234	(56.4)	201	(62.4)	33	(35.5)
Frequency of condom use						
Always or abstain from sex	106	(25.1)	83	(25.8)	23	(24.7)
Most of the time	166	(40.0)	136	(42.2)	30	(32.3)
Sometimes	77	(18.6)	58	(18.0)	19	(20.4)
Rarely or never	66	(15.9)	45	(14.0)	21	(22.6)
Frequency of alcohol consumption						
Once a month or less	95	(22.9)	72	(22.4)	23	(24.7)
2–4 times a month	162	(39.0)	128	(39.8)	34	(36.6)
2 or more times a week	158	(38.1)	122	(37.9)	36	(38.7)
Drug use						
Popper use, last 12 months	124	(29.9)	112	(34.8)	12	(12.9)
Marijuana use, last 12 months	233	(56.1)	184	(57.1)	49	(52.7)
Other drug use [‡] , last 12 months	83	(20.0)	73	(22.7)	10	(10.8)
Crystal meth use, last 12 months	36	(8.7)	32	(9.9)	4	(4.3)
Injection drug use, ever	18	(4.3)	15	(4.7)	3	(3.2)
						0.550

* Includes results of syphilis, gonorrhea (urine, oral, rectal), and chlamydia (urine, oral, rectal) testing

[‡] Any non-popper, non-marijuana use: crystal meth, GHB, ecstasy, LSD, heroin, ketamine, crack, etc.

[‡] Men who used an online hookup site to meet sexual partners in Rhode Island, past 12 months

Table 2a

Venue where met partners in Rhode Island, last 12 months (N=415)

	STD Result*						
	TOTAL		POSITIVE		NEGATIVE	p-value	
	N	(%)	n	(%)	n		(%)
Did not meet any partners	23	(5.5)	6	(5.8)	17	(5.5)	0.907
At work	41	(9.9)	6	(5.8)	35	(11.3)	0.105
In school	65	(15.7)	16	(15.4)	49	(15.8)	0.928
At a gym	38	(9.2)	15	(14.4)	23	(7.4)	0.032
Church/religious service	2	(0.5)	0	(0.0)	2	(0.6)	
Social organization	30	(7.2)	6	(5.8)	24	(7.7)	0.507
Bar/club	171	(41.2)	49	(47.1)	122	(39.2)	0.157
Cruising area	16	(3.9)	4	(3.8)	12	(3.9)	0.995
Bathhouse/sex venue	44	(10.6)	13	(12.5)	31	(10.0)	0.468
Video store	28	(6.8)	8	(7.7)	20	(6.4)	0.657
Strip Club	11	(2.7)	3	(2.9)	8	(2.6)	0.864
Gay Party	50	(12.1)	17	(16.3)	33	(10.6)	0.120
Sex Party	24	(5.8)	7	(6.7)	17	(5.5)	0.632
Online	322	(77.6)	84	(80.8)	238	(76.5)	0.369
Public Bathroom	7	(1.7)	4	(3.8)	3	(1.0)	0.048
Through friends	161	(38.8)	41	(39.4)	120	(38.6)	0.879
Other	27	(6.5)	8	(7.7)	19	(6.1)	0.571

* Includes results of syphilis, gonorrhea (urine, oral, rectal), and chlamydia (urine, oral, rectal) testing

Use of online hook-up sites and prevalence of STDs among MSM meeting partners online in RI, last 12 months (N=322)

Table 2b

	Total Users		Any STD *		Gonorrhea *		Chlamydia *		Syphilis	
	N	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Grindr	252	(78.3)	71	(28.2)	24	(9.5)	41	(16.3)	18	(7.1)
Scruff	114	(35.4)	39 [†]	(34.2) [†]	13 [†]	(11.4) [†]	18	(15.8)	10	(8.8)
Tinder	71	(22.1)	17	(23.9)	6	(8.5)	8	(11.3)	4	(5.6)
Adam4Adam	60	(18.6)	19	(31.7)	4	(6.7)	14	(23.3)	3	(5.0)
Jack'd	53	(16.5)	15	(28.3)	4	(7.5)	10	(18.9)	4	(7.5)

* Includes results of urine, oral and rectal testing

[†] Significant at p<0.05

Table 3
Adjusted odds ratio (aOR) and 95% confidence interval (CI) of MSM with an STD diagnosis in Rhode Island

	Model 1*		Model 2†		Model 3‡	
	aOR	95% CI	aOR	95% CI	aOR	95% CI
Intercept	0.13	(0.06, 0.27)	0.10	(0.04, 0.25)	0.02	(0.004, 0.07)
Age						
13–29 years (Ref)	1.00		1.00		1.00	
30–39 years	0.80	(0.42, 1.46)	0.77	(0.41, 1.43)	0.72	(0.37, 1.36)
40 years or older	0.80	(0.41, 1.54)	0.78	(0.39, 1.52)	0.83	(0.39, 1.68)
Race						
White (Ref)	1.00		1.00		1.00	
Non-White	1.21	(0.71, 2.06)	1.42	(0.82, 2.47)	1.70	(0.95, 3.05)
Ethnicity						
Non-Hispanic/Latino (Ref)	1.00		1.00		1.00	
Hispanic/Latino	1.10	(0.56, 2.12)	1.01	(0.51, 1.98)	1.07	(0.52, 2.15)
Income						
<\$12,000 (Ref)	1.00		1.00		1.00	
\$12,000–\$29,999	2.38	(1.21, 4.74)	2.51	(1.27, 5.05)	2.37	(1.15, 4.94)
\$30,000–\$59,999	1.26	(0.64, 2.48)	1.18	(0.60, 2.36)	1.02	(0.50, 2.10)
\$60,000	1.93	(0.86, 4.41)	1.76	(0.77, 4.06)	1.57	(0.66, 3.77)
Education						
High school diploma or less (Ref)	1.00		1.00		1.00	
Some college	1.48	(0.71, 3.25)	1.49	(0.71, 3.29)	1.67	(0.76, 3.86)
College degree or higher	2.15	(1.06, 4.67)	2.13	(1.04, 4.64)	2.68	(1.26, 6.10)
Use of hookup site						
None (Ref)			1.00		1.00	
Scruff			2.16	(1.12, 4.29)	2.28	(1.09, 4.94)
Other site			1.03	(0.56, 1.97)	1.06	(0.54, 2.11)
Alcohol consumption						
Once a month or less (Ref)					1.00	
2–4 times a month					1.96	(0.97, 4.12)

	Model 1 [*]		Model 2 [†]		Model 3 [‡]	
	aOR	95% CI	aOR	95% CI	aOR	95% CI
2 or more times a week					2.87	(1.42, 6.07)
Crystal meth use past 12 months						
No (Ref)					1.00	
Yes					4.49	(1.25, 17.53)
Lifetime sex partners						
10 (Ref)					1.00	
11–20					1.05	(0.48, 2.36)
>20					0.88	(0.42, 1.89)
Frequency of condom use						
Always or abstain from sex (Ref)					1.00	
Most of the time					2.30	(1.18, 4.72)
Sometimes					3.67	(1.68, 8.30)
Rarely or never					2.54	(1.09, 6.01)

^{*} Model 1: demographics (age, race, ethnicity, income, education)

[†] Model 2: Model 1 + use of hook-up sites

[‡] Model 3: Model 2 + behavioral risk factors (alcohol consumption, crystal meth, lifetime partners, condom use)