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HIV Prevention and Sex Behaviors as Organizing Mechanisms in a Facebook Group Affiliation Network Among Young Black Men Who Have Sex with Men

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Abstract

Online social networking sites (SNS)—the Internet-based platforms that enable connection and communication between users—are increasingly salient social environments for young adults and, consequently, offer tremendous opportunity for HIV behavioral research and intervention among vulnerable populations like young men who have sex with men (YMSM). Drawing from a cohort of 525 young Black MSM (YBMSM) living in Chicago, IL, USA April 2014–May 2015, we conducted social network analysis, estimating an exponential random graph model (ERGM) to model YBMSM's group affiliations on Facebook in relation to their sex behaviors and HIV prevention traits. A group's privacy setting—public, closed, or secret—was also modeled as a potential moderator of that relationship. Findings reveal that HIV positive individuals were more likely to affiliate with Facebook groups, while those who engaged in group sex were less likely to do so. When it came to the privacy of groups, we learned that HIV positive individuals tended not to belong to groups with greater privacy (e.g., closed and secret groups), while individuals who engaged in group sex and those who engaged in regular HIV testing were more likely to belong to those groups. Results also showed that individuals who engaged in condomless sex showed significant signs of clustering around the same set of groups. HIV positive individuals, on the

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Compliance with Ethical Standards

Conflict of interest Dr. Lindsay Young declares she has no conflict of interest. Dr. Kayo Fujimoto declares that she has no conflict of interest. Dr. John Schneider declares that he 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 Informed consent was obtained from all individual participants included in the study.

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other hand, were significantly less likely to demonstrate clustering. Implications for interventions and future research are discussed.

Keywords

HIV prevention; Sex behaviors; Social networking sites; Social network analysis; Young men who have sex with men

Introduction

While HIV incidence in the United States has declined significantly since the earliest days of the domestic epidemic, some groups remain disproportionately affected, particularly young men who have sex with men (YMSM), for whom rates of new infection continue to rise [1]. Among them, young Black MSM (YBMSM) continue to bear the heaviest burden of new infections, accounting for more than any other subgroup by race/ethnicity, age and sex [2]. A critical factor influencing sex behaviors and HIV prevention engagement among YMSM is the social contexts in which they are embedded [3, 4]. This environmental perspective stresses that both prevention and sex behaviors, like getting tested for HIV or engaging in condomless sex, are often shaped in milieus through processes of peer influence [5], social norms [6], and structural embeddedness [7, 8].

Today, online social networking sites (SNS)—i.e., the Internet-based platforms that enable connection and communication between users—are increasingly salient social environments for young adults and, consequently, offer tremendous opportunity for HIV behavioral research among high-risk populations like YMSM. About 90% of young adults are engaged with social media of some kind [9], with Facebook being the most popular platform [10]. Further, evidence suggests that young LGBTQ adults log into and engage one another on SNS more frequently than their heterosexual counterparts [11, 12].

As YMSM increasingly turn to SNS to find community and meet partners, public health research has followed suit, focusing largely on the relationship between the use of popular sexual networking/dating applications for MSM like Grindr and sexual risk engagement and exposure. To date, results of this research show both negative and positive outcomes associated with SNS use among at-risk MSM: some studies indicate positive associations between online partner-seeking and high-risk sexual behaviors [13–15]; others find no association [16–18]; and still others identify positive associations with protective behaviors [19].

Although studies like these help characterize MSM who employ social media for partner-seeking, the near exclusive focus on the dating dynamic neglects the perhaps critical role that more general purpose SNS like Facebook play in generating and supporting norms of prevention and risk. With respect to offline social contexts, research has emphasized the role of peer networks—such as friendships and schoolmates—for norm formation and informal social control, which can influence whether individuals engage in prevention-or risk-oriented behaviors [20–22]. General purpose SNS like Facebook, which have a broader user audience and are not uniquely designed for seeking partners, offer a more heterogeneous

social experience parallel to these offline peer networks. Although studies have shown a positive link between what adolescents talk about online and their attitudes toward and engagement in HIV risk and protective behaviors [23–26], the actual networks that create the contexts in which those conversations occur (i.e., the structure of their online relationships) remain underexplored as social pathways where exposure to prevention-and risk-oriented behaviors and attitudes occurs.

This paper seeks to address this gap by investigating the relationship between the sex behaviors and HIV prevention engagement among a large cohort of YBMSM and their interactions with one another on Facebook. Like the offline world, online social networking environments offer users a variety of ways to meet and interface with their peers. For example, users can connect directly as Facebook “friends” or they can connect through their joint affiliations with Facebook groups. In this study we focus specifically on the mediated social interactions among YBMSM that occur around Facebook groups, also referred to as the “group affiliation network” [3, 27].

Like offline social venues [3, 28–30] or queer kinship groups [31–34], SNS-based group environments are settings where MSM interact with peers and form networks based upon their common group affiliations and shared group identity. So, as young sexual and racial minorities increasingly turn to online environments to interact with peers, it behooves researchers to understand how the sexual practices and HIV prevention behaviors of these individuals are organized around their virtual group environments, like those on Facebook, and whether features of those groups (e.g., a group’s privacy level) may attract certain types of members.

To these ends, we conceptualize the Facebook group memberships of YBMSM as a bipartite (or two-mode) network, comprised of two sets of nodes—YBMSM and Facebook groups—with edges between node sets representing a group membership tie. Then, using a class of statistical network models called exponential random graph models (ERGMs), we investigate the degree to which the sex behaviors and HIV prevention traits of YBMSM organize the structure of their Facebook group affiliations and, more specifically, assess the extent of behavioral clustering around Facebook groups. Findings from this analysis will reveal patterns of group affiliation that constitute online social contexts of prevention and risk for YBMSM and that have the potential to generate normative systems that support those behaviors.

Methods

Study Population

Data used in this study were collected from April 2014 to May 2015 as part of the second wave of a longitudinal cohort study of YBMSM living in South Side Chicago and adjacent South suburbs, the largest contiguous Black urban community in the United States [35]. Participants were recruited using a variant of classic link-tracing called Respondent Driven Sampling (RDS) [36]. Widely used in public health studies [37], RDS enables valid statistical inference of “hard to reach” populations (e.g., intravenous drug-users, sex

workers, men who have sex with men) by providing a design for sampling as well as a method for obtaining parameter estimates of the target population.

A group of 62 RDS “seeds”, drawn from a variety of social spaces that YMSM occupy, including LGBTQ social venues, online networking sites, community-based organizations, and HIV treatment and prevention programs, were used to generate the referral chains. Candidate participants were eligible to be interviewed if they: (1) self-identified as African American or Black, (2) were assigned male at birth, (3) were between 16 and 29 years of age (inclusive), (4) reported oral or anal sex with a male within the past 24 months, and (5) were willing and able to provide informed consent at the time of the study visit. Each respondent was given up to six vouchers to recruit others who met the same eligibility criteria. Respondents received \$60 for their participation and \$20 for each recruit who enrolled into the study. Sampling procedures resulted in a baseline sample of 618 YBMSM, 525 of which were retained at Wave 2 of the study when Facebook group data were collected.

At each study wave, respondents completed an interviewer-administered questionnaire, which included modules pertaining to demographics, sexual health and risk behaviors, and relational information about their sexual and social networks. Additionally, Facebook data, including Facebook group memberships, were obtained from consenting respondents, using a software application that accessed Facebook’s application programming interface (API) [38].

HIV-Related Attributes and Behaviors

HIV Status—The serostatus of each respondent was determined on the basis of blood testing conducted at the time of data collection. A dummy variable for those who were HIV positive was used in the model.

Sex Behaviors—Sex behaviors included measures of a respondent’s engagement in condomless sex and group sex [39]. Condomless sex was measured on the basis of frequency of condom use with named anal sex partners in the past 6 months. If the respondent indicated not always using condoms with any of their partners, they were coded as having had condomless sex. Group sex is a self-reported measure of whether or not a respondent indicated having engaged in sex with two or more partners at the same time at least once in the past 12 months.

Prevention Traits—Prevention-oriented attributes included regular HIV testing and awareness of pre-exposure prophylaxis (PrEP) for HIV prevention. To assess frequency of HIV testing, respondents were asked to indicate how many times they had been tested in the last 9 months (i.e., since their last study visit). Given CDC testing recommendations for men who have sex with men (every 3–4 months), a dummy variable was created, whereby regular testers were defined as those who had been tested at least twice since their last visit (~ 9 months prior). Awareness of PrEP was ascertained by asking respondents, “Before today, have you heard of PrEP?” No other PrEP-related information was presented to respondents at the time of data collection.

Generating the Facebook Group Affiliation Network

As a result of the Facebook data acquisition process, a deidentified dyadic dataset was compiled that included for each consenting respondent the Facebook groups to which they belonged at the time of data collection. The file also characterized each group by its privacy status, which is defined on the basis of who among members and non-members can see various aspects of the group's content. Groups can be *public*, *closed*, or *secret*, ranked in order of decreasing visibility to non-member Facebook users. Table 1 shows who can see various pieces of information for each type of group. To understand how the prevention and risk attributes of YBMSM are related to their preferences for groups with more or less visibility, we accounted for the different privacy levels as group attributes in the network analysis.

Analysis Procedures

Of the 525 respondents retained at Wave 2 of the study, 423 self-reported having an active Facebook profile, 347 of whom consented to Facebook data collection. As the aim of the study was to examine Facebook group affiliations among YBMSM, the sample was restricted to include only those who belonged to at least one group. This resulted in a final analytic sample of 301 YBMSM. The filtered cases ($n = 224$) included 99 individuals who did not have a Facebook profile, 76 individuals who had a Facebook profile but did not consent to Facebook data collection, and an additional 49 consenting respondents who did not belong to any Facebook groups. The filtered cases ($n = 224$) did not differ significantly from the analytic sample ($n = 301$) by HIV testing, PrEP awareness, condomless sex, sex drug use and group sex. However, the YBMSM in the analytic sample were more likely to be HIV positive (OR 1.75, $p < 0.05$). This difference means that results should be interpreted with this caveat in mind. Further, among the 347 Facebook users who consented to Facebook data collection, no differences were found between group members ($n = 301$) and non-members ($n = 46$) with respect to the aforementioned attributes.

The 301 YBMSM who were members of at least one Facebook group belonged to a total of 4743 unique Facebook groups, of which 1652 (34%) were *public*, 1924 (41%) were *closed*, and 1167 (25%) were *secret*. Approximately 80% of these groups ($N = 3813$) had only one respondent as a member. In that a key objective of the study is to assess the degree of clustering around Facebook groups, we included only groups whose membership included at least 4 members of our YBMSM sample. This yielded a sample of 269 groups. In making this methodological decision to restrict the group sample, we also ensured that we focused only on those groups that we could reasonably consider relevant for a large enough portion of respondents and the larger YBMSM community and, therefore, viable as points for potential intervention, should results of the study lead in that direction.

Data were analyzed using two-mode network analysis by creating an affiliation network composed of two sets (or modes) of actors—YBMSM ($N = 301$) and the Facebook groups with which they affiliate ($N=269$). Ties are defined only *between* members of each set but not *within* sets of nodes [40]. For this reason, the network is comprised only of YBMSM-to-Facebook group membership ties; ties connecting YBMSM to one another or ties connecting Facebook groups to one another are not accounted for using this approach.

We then used a class of statistical models for social networks called exponential random graph models (ERGMs) [41–44]. ERGMs permit inferences about how network ties emerge by estimating the likelihood of a tie being present (or absent) in the network as a function of small local tie-based configurations (or patterns). Each configuration represents a distinct social process, such as reciprocity or balance, and corresponds to a specific parameter in the model (depictions of two-mode configurations are shown in Table 1S in the supplement to the online version of this paper). From this perspective, ERGMs adopt a logic similar to logistic regression, in which a binary outcome like adoption of a behavior (or the presence of a tie in ERGMs) is modeled as a function of selected predictor variables (or local configurations in ERGMs) that are thought to explain the observed outcome. The configurations modeled in ERGMs can emerge from the connections actors make in response to other ties in their social environment (e.g., when popular venues continue to attract more YBMSM patrons) or in response to properties that exist outside the network like the attributes of other YBMSM (e.g., when HIV positive individuals tend to cluster around the same groups).

In statistical terms, the effect of each parameter is estimated by determining the prevalence of the modeled configurations in the observed network and then assessing their statistical likelihood above what would occur by chance alone [45]. A parameter estimate that is positive and significant indicates that ties are more likely to occur within the configuration tested than by chance alone. Conversely, parameter estimates that are negative and significant suggest that ties are less likely to occur within the configuration tested than by chance alone. ERGMs are deemed acceptable when the parameters converge, which occurs when the convergence t-ratios for each parameter reaches < 0.10 . Details about the specification, estimation, and simulation of ERGMs can be found in Lusher, Koskinen, and Robins, 2013.

Selecting which parameters to be included in an ERGM should be grounded in which distinct theories of social interaction one wants to test. Given that the focus of this analysis centers on the relationship between the HIV prevention and sex behaviors of YBMSM and their patterns of affiliation with Facebook groups, we estimated the effects of four types of attribute-based parameters to determine whether they were more likely to occur than expected by chance alone. Figure 1 illustrates the corresponding configurations of these effects.

The first three parameters are attribute-based *Edge* parameters. These parameters represent the likelihood of prevention-/risk-oriented YBMSM belonging to a Facebook group (Fig. 1a), the likelihood of YBMSM belonging to either a closed or secret Facebook group relative to a public group (Fig. 1b), and the likelihood of prevention-/risk-oriented YBMSM belonging to a closed or secret Facebook group relative to a public group (Fig. 1c). We also include a parameter called an *Alternating 4cycle*, which represents the likelihood of prevention-/risk-oriented YBMSM forming a social circuit with similar others around a common set of groups (Fig. 1d).

The model also includes two parameters that represent purely structural (or non-attribute) effects. The endogenous *Edge* parameter represents the overall propensity for YBMSM to

belong to Facebook groups, which corresponds to network density. The *Alternating K-star* parameter represents the tendency for YBMSM to belong to groups that are popular among other YBMSM and, therefore, corresponds to the variance in the distribution of the number of YBMSM members among Facebook groups. Modeling results were implemented using MPNet, a network estimation program designed for multilevel network data [46, 47].

Results

Individual, Group and Network Descriptives

Descriptive statistics for the full and analytic samples are shown in Table 2.

Regarding the analytic sample of 301 YBMSM Facebook group members, 44% were HIV positive and majorities were regular HIV testers (61%), were aware of PrEP (76%), and had engaged in condomless sex (59%). Far fewer respondents indicated engaging in group sex (17%). Descriptive results for the analytic sample are consistent with those for the full sample.

The Facebook group sample (N = 269) consisted of 78 (29%) *public* groups, 126 (47%) *closed* groups, and 65 (24%) *secret* groups. Due to the limited available information about secret groups, we were unable to examine topic-related group attributes in our model. That said, for context we provide a brief topical breakdown of the public groups (n = 68) and closed groups (n = 104) that had available descriptions, noting which groups were designed specifically as queer spaces and which ones were not. Of the 68 public groups, 35 (51%) were determined to be queer spaces. These groups focused on topics like LGBTQ identity/pride, Ballroom Culture, LGBTQ nightlife, and same-gender dating and sexual attraction. The remaining 33 (49%) public groups were considered non-LGBTQ spaces, in that they covered topics outside the LGBTQ identity framework, for example groups designed for professional promotion or pursuing recreational interests, groups about place-based community life, and groups designed as platforms for ad-hoc conversation. Likewise, among the 104 closed groups, 63 (61%) were deemed LGBTQ oriented, while the remaining 41 (39%) were not. Extrapolating these findings to secret groups would be impossible, though it would appear that the topical landscape skews more favorably toward LGBTQ-related interests as groups increase in privacy.

Figure 2 illustrates the two-mode Facebook group affiliation network in relation to group privacy status.

Among the 301 YBMSM and 269 Facebook groups there a total of 2276 ties, corresponding to a network density of 0.03. YBMSM belong to on average 7.56 Facebook groups and Facebook groups have on average 8.46 YBMSM members. However, the dispersion of YBMSM membership is skewed; 5 of the 269 Facebook groups have 30 or more YBMSM members, whereas 124 have 5 or fewer YBMSM members. Public groups are the most popular with an average of 9.78 YBMSM members, while closed and secret groups have on average 8.17 and 7.54 YBMSM members, respectively. Although this graph represents overall structural patterns of the group affiliation network, it is limited in its ability to

identify some distinctive features of the observed network, which we examined by estimating ERGMs.

The Exponential Random Graph Model (ERGM)

Results of the two-mode ERGM are shown in Table 3. Reported in this table are parameter estimates and standard errors. The maximum likelihood (ML) estimate for a parameter reveals the direction of its propensity to exist in the network above what would be expected by chance alone. Significance is achieved when the absolute value of the ML estimate is greater than twice the magnitude of the standard error.

2-Mode Structural Effects—As noted, the model estimates the effects of two structural (or non-attribute) parameters, which represent local structural patterns in the Facebook group affiliation network. The Edge parameter is negative and significant, indicating that YBMSM are less likely than expected by chance to belong to Facebook groups (ML Estimate = -6.291 , SE = 0.613), which reinforces what we previously stated about the low density of this group affiliation network. Although the negative direction of this effect may seem to contradict what we argued earlier about levels of social media engagement among LGBTQ individuals, it should only be taken to mean that joining Facebook groups are calculated decisions for members of this sample and are not made haphazardly or with little thought. The positive and significant estimate of the Alternating K-Star parameter suggests that the network is centralized around a small number of very popular Facebook groups (ML Estimate = 1.120 , SE = 0.303), confirming what we observed in the graph visualization (Fig. 2).

Attribute-Based Edge Effects—The first set of attribute-based parameters shown in Table 2 reflect tendencies for individuals with prevention and sex behavior traits to belong to Facebook groups, irrespective of group privacy status. Results reveal that relative to random chance, HIV positive individuals were more likely to be affiliated with Facebook groups (ML Estimate = 0.933 , SE = 0.165), whereas those who engaged in group sex were less likely to affiliate with Facebook groups (ML Estimate = -0.375 , SE = 0.145), suggesting they were less active in the Facebook group network. Individuals who were tested regularly for HIV, had heard of PrEP, and engaged in condomless sex were no more or less likely to be affiliated with groups than expected by random chance.

To ascertain whether individuals with HIV-related behaviors and attributes have tendencies to affiliate with Facebook groups with more or less privacy status, we also estimated a suite of interaction edge parameters. HIV positive individuals were less likely than expected by chance to belong to secret groups relative to public groups (ML Estimate = -0.329 , SE = 0.136), whereas individuals who engaged in group sex were more likely to belong to secret groups than public ones (ML Estimate = 0.412 , SE = 0.171). Finally, regular HIV testers were also more likely to belong to groups offering some anonymity, as they were more likely to belong to closed groups than public ones (ML Estimate = 0.268 , SE = 0.110).

Attribute-Based 4-cycle Effects—The final set of parameters estimated in the two-mode ERGM represent the tendency for individuals with particular HIV-related behaviors

and attributes to belong to a common set of Facebook groups. This configuration (or pattern) of affiliation is referred to as a social circuit and speaks more broadly to the tendency for clustering to occur in an affiliation network. Results reveal that HIV positive individuals, who were more likely than expected by chance to belong to Facebook groups, were actually less likely to share groups in common with other HIV positive individuals (ML Estimate = -0.126 , SE = 0.032). Conversely, there was a positive and significant tendency for individuals who engage in condomless sex to cluster around a shared set of Facebook groups (ML Estimate = 0.052 , SE = 0.017). Results of the goodness-of-fit test are available as a supplement (see Supplement 1).

Discussion

As young sexual and racial minorities increasingly turn to online social networking environments to find community and take advantage of greater anonymity afforded to them in these spaces, an opportunity arises to employ these platforms in sexual health interventions. This study aimed to determine the extent to which online peer relationships among a large cohort of YBMSM are associated with HIV-related behaviors. In so doing, we demonstrated a method for assessing the feasibility of engaging YBMSM about HIV prevention in these spaces and identified which aspects of their online interactions are viable points for intervention or useful opportunities for engagement.

Adopting a two-mode network analytic approach, we used a class of stochastic models called exponential random graph models (ERGMs) to determine the ways in which the prevention and sex behaviors of the aforementioned cohort structure their group affiliations on Facebook. We found that HIV positive individuals were more likely than expected to affiliate with Facebook groups while those who engaged in group sex were less likely to affiliate with Facebook groups. When it came to the privacy of these groups, HIV positive individuals were less likely to belong to groups with stricter privacy protections, like closed and secret groups. Conversely, individuals who engaged in group sex and who were regular HIV testers were more likely than expected by chance to belong to secret and closed groups, respectively, revealing their preference for groups that offered degrees of anonymity and privacy from non-members.

We also found tendencies for YBMSM with particular prevention and sex behavior traits to cluster together around a common set of Facebook groups. Of the attributes included in the model, only condomless sex showed significant signs of clustering. Namely, individuals who engaged in condomless sex were more likely to affiliate with a common set of groups. Meanwhile, despite their greater propensity to belong to Facebook groups, HIV positive individuals were significantly less likely to cluster around a common set of groups.

The featured analysis reveals several important findings with implications for intervention and outreach in online settings. First, our analytic approach helps us see which types of behaviors are more likely to be associated with face-book groups with greater degrees of group-level privacy. For example, we learned that individuals who engage in group sex are more drawn to the anonymity and exclusiveness of secret groups as opposed to groups that would reveal their identities to non-members. Given the stigma that can surround sex

behaviors like group sex, we infer that individuals who engage in these behaviors may prefer online environments that afford them a greater degree of protection from the scrutiny of others, especially if the groups to which they belong facilitate their engagement in the stigmatized behavior. From an intervention perspective, this suggests that it will be challenging for outsiders like public health officials or caseworkers to propagate HIV-related information to members of these protected groups, as their access is impeded. Rather, online interventions for individuals who engage in socially stigmatized behaviors may need to encourage and train subjects to facilitate the spread of HIV-related information in their own networks, including in their closed, protected milieus like private Facebook groups.

Second, our findings draw attention to important clustering patterns, namely among individuals who engage in condomless sex, which we posit form the relational infrastructure through which behavioral norms emerge [48]. From a network perspective, risky or protective norms are most likely to emerge in the social clusters that bring together people who are similarly disposed to engage in certain risks or protections and, consequently, create contexts that support those behaviors and influence others' perceptions of their normativity. Although it is beyond the scope of this study to assess how norms are communicatively constructed in these clustered settings, identifying the relational infrastructure that brings at-risk individuals together and would likely support patterns of reinforced communication is critical for planning where prevention outreach and the invigoration of protective norms are needed and most likely to thrive. For example, interventions that aim to diffuse information about PrEP for prevention or the importance of frequent testing within these group-mediated clusters of at-risk individuals would not only capture a larger at-risk audience, but would also ensure repeated message exposure across multiple group settings, which is critical for solidifying new prevention-oriented norms in at-risk populations.

Finally, our analysis also uncovers a noticeable absence of group-mediated clustering among people living with HIV (PLWHA), a trend also identified in other analysis of Ballroom House affiliations among members of the same YBMSM cohort [34]. Due to the emotional support that clustered peer interactions can facilitate, this lack of clustering among PLWHA raises a potential concern about their ability to locate and leverage support from one another in their online social lives. Increasingly, social media platforms like Facebook play an important role in HIV-related [49] programs, in large part because of the relative anonymity that they provide and the social and emotional support they can generate [50]. Further, research has shown that obtaining information from other PLWHA, for example about disease management, can be more influential than receiving it from public health professionals due to factors like stigma and discrimination from the mainstream medical community as well as the trust and credibility generated among PLWHA through their shared experiences [51, 52]. Although it is quite possible that seropositive individuals give and receive support from one another in shared social contexts outside Facebook, our findings reveal a potential opportunity gap that stands to be filled with intervention efforts aimed at building online support groups specifically for the HIV positive community.

A central tenet of this study is that peer networks, and the messaging and influence that occur therein, are critical components of norm formation and behavioral adoption in populations at risk for HIV [3, 20, 22]. Therefore, in harnessing online networks as a means

to connect with at-risk YMSM and engage them in HIV prevention and care, efforts should be made to instigate peer-driven information dissemination and communication about HIV prevention in these settings, an approach that is rapidly becoming a salient feature of public health interventions among at-risk populations [5, 53–56]. This can be accomplished in a variety of ways. For online groups that are more accessible to outsiders and that are openly oriented to LGBTQ audiences, interventionists could approach group administrators about posting digital marketing materials, for example about HIV testing, in the hopes of increasing members' exposure to and awareness of salient prevention information. Groups that promote LGBTQ nightlife events, for example, might be conducive to this approach. In online settings that are less accessible to outsiders (e.g., secret Facebook groups) and/or where members' levels of distrust in the mainstream health community might be high, interventionists will benefit from working with popular opinion leaders in the target population, training them to share and discuss HIV-related information with their peers in their personal online networks, including group settings. Finally, when working with target individuals who experience high levels of HIV or homophobic stigma and, consequently, who may resist sharing or being exposed to HIV-related information in established networks, interventionists may need to build new private group spaces for targeted individuals to join where they can receive and discuss information about HIV prevention and care in settings protected from outside scrutiny. In the end, further research is needed that compares the effectiveness of these strategies across different populations and different network contexts.

Strengths and Limitations

Methodologically, our study has several strengths that advance our understanding of the relationship between social networks and HIV-related behaviors and attributes. First, as YMSM spend more time in online social networking environments, interacting with peers and meeting partners, it belies the research community to turn its attention to the peer networks that emerge in those spaces to understand their role in HIV prevention and risk engagement. To date, research in this vein has relied primarily on self-reported SNS use and self-reported data about online partners to draw inferences about the relationship between HIV risk and prevention and online social networking behaviors. While useful for characterizing SNS users, this leaves unaddressed the relationship between network structure and HIV-related behaviors. This study responds to this gap by capturing the actual social structure of these networked environments toward understanding how HIV-related behaviors contribute to the over-all organization of online relationships. Second, rather than investigate features of network structure as predictors of HIV risk and prevention outcomes, we flip the equation to better understand the degree to which HIV-related behaviors of network members influence the structure of their online relationships. In so doing, we showcase how to find where in a network risky and protective behavioral norms may emerge and, consequently, which aspects of the network could be intervened with or leveraged. And finally, we turn our attention to an underexplored type of online network—a two-mode network based on Facebook group affiliations. In offline contexts, group-mediated interactions have been shown to influence substance use and HIV risk engagement among adolescents and other high-risk populations [3, 21, 57]. As such it is important that we extend that focus to include their online counterparts.

That said, our findings should also be considered in light of their limitations. First, we were unable to explore how group subject matter (or topic) factored into patterns of group affiliation using the sample presented here. This was due to the fact that many of the groups in our sample lacked a description and because private groups are unsearchable and, therefore, impossible to thematically categorize. More specific knowledge of the types of groups that tend to attract prevention-and/or risk-oriented individuals will inform more effective and tailored interventions in these settings. Looking forward, constructing a narrower sample of just the groups with descriptions would allow us to explore subject matter as a possible factor in patterns of group affiliation. Second, because these data are cross-sectional, inferences about cause and effect cannot be made. Therefore, we are unable to determine whether the risk and protective traits associated with Facebook group membership are the adopted outcomes of membership or its antecedents. This has implications for understanding the temporal dynamics of norm formation in these settings. Finally, our data come from young Black MSM in Chicago and, as such, are specific to this community. Although, results may not be generalizable to other MSM subpopulations or to other non-MSM highrisk populations, we believe that the featured ERGM-based approach to studying the social infrastructure of prevention and risk environments offers tremendous promise across a wide breadth of populations and social contexts.

Despite these limitations, results of this study provide a structural account of sex behaviors and HIV prevention engagement in an online group-mediated social environment. Because of the high prevalence of HIV among YMSM of color, the paucity of HIV interventions developed for this community, and the stigma and discrimination that prevent YMSM of color from seeking sexual health care from traditional LGBTQ-and HIV-affiliated settings [58], prevention and outreach strategies need to be developed that leverage the social spaces that are more relevant to this community like the groups they affiliate with on SNS platforms like Facebook. Identifying how HIV prevention and sex behaviors bring structure to their online affiliation networks is an important initial step toward these ends.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1.

Attribute-based parameters among YBMSM i and j and Facebook groups k , l , m included the two-mode ERGM that estimate **a** the likelihood of prevention-/risk-oriented YBMSM belonging to a Face-book group, **b** the likelihood of YBMSM belonging to a public/ closed/ private Facebook group, **c** the likelihood of prevention-/risk-oriented YBMSM belonging to a public/closed/private Facebook group, and **d** the likelihood of prevention-/risk-oriented YBMSM forming a social circuit with membership in common groups

Fig. 2.

The network structure of Facebook group membership among 301 young Black men who have sex with men shown as a 2-mode Facebook group affiliation network: Chicago, IL, USA; April 2014–May 2015. The two 2-mode Facebook group affiliation network is comprised of 301 young Black men who have sex with men and 269 Facebook groups. Among these nodes there are a total 269 Facebook groups, 78 of which are public groups, 126 are closed groups, and 65 are private groups. Among these nodes are a total of 2,276 ties. YBMSM are shown as circles, public groups are shown as squares, closed groups are shown as triangles, and private groups are shown as diamonds. All group nodes (squares, triangles and diamonds) are sized by number of YBMSM members

Table 1

Visibility of Facebook groups by privacy status

Type of group	Who can see the group information		
	Group name	Description	Members
Public	Anyone	Anyone	Anyone
Closed	Anyone	Anyone	Members only
Secret	Members only	Members only	Members only

Table 2

Descriptive statistics of young Black men who have sex with men (YBMSM) who participated in Wave 2 of the uConnect Study: Chicago, IL, USA; April 2014–May 2015

Variable	No. (%) or Mean (SD; Min, Max)	
	Full sample (N = 525)	Analytic sample (N = 301)
HIV positive	214 (41)	133 (44)
Condomless sex	287 (55)	178 (59)
Group sex	83 (16)	52 (17)
Regular testing	329 (63)	185 (61)
PrEP awareness	378 (72)	228 (76)

Table 3

Exponential random graph model of the 2-mode Facebook group affiliation network with HIV-related behaviors and group privacy modeled as covariates: Chicago, IL, USA; April 2014–May 2015

Parameter	ML Estimate (SE)
2-mode structure	
Edge density	−6.291 [*] (0.613)
Alternating K-star	1.120 [*] (0.303)
YBMSM attribute-based edges	
HIV positive	0.933 [*] (0.165)
Condomless sex	− 0.006 (0.129)
Group sex	− 0.375 [*] (0.145)
Regular testing	0.046 (0.126)
Prep awareness	0.162 (0.172)
Group attribute-based edges	
Public groups (reference)	-
Closed groups	− 0.207 (0.159)
Secret groups	− 0.080 (0.191)
YBMSM × group attribute-based edges	
HIV positive × closed group	− 0.057 (0.116)
HIV positive × secret group	− 0.329 [*] (0.136)
Condomless sex × closed group	− 0.137 (0.108)
Condomless sex × secret group	− 0.084 (0.131)
Group sex × closed group	0.039 (0.148)
Group sex × secret group	0.412 [*] (0.171)
Regular testing × closed group	0.268 [*] (0.110)
Regular testing × secret group	− 0.225 (0.139)
PrEP awareness × closed group	0.000 (0.140)
PrEP awareness × secret group	0.211 (0.166)
YBMSM attribute-based 4-cycles	
HIV positive	− 0.126 [*] (0.032)
Condomless sex	0.052 [*] (0.017)
Group sex	0.027 (0.073)
Regular testing	0.027 (0.017)
PrEP awareness	0.018 (0.018)

*
p < 0.05