

# Demographic and HIV status diversities as mechanisms of social integration and segregation among Black sexual and gender minorities enrolled in a community-based social network intervention

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## ABSTRACT

Drawing on a social integration and intersectionality framework, this study advances a dynamic network understanding of the mechanisms that enable differential patterns of within-group social integration and segregation among Black sexual and gender minorities (BSGM). Specifically, in a cohort of BSGM (18–35 years of age,  $n = 340$ ) participating in a community-based network intervention for HIV prevention, we examine how sexual, gender, age, and HIV status diversities contribute to friendship formation and maintenance patterns over the 12-month study enrollment period. We found attenuated social integration (or social activity) among non-gay-identified and older BSGM and evidence of social segregation (or homophily) on the basis of sexual identity and age similarities. Accounting for the moderating effects of the intervention revealed that the attenuated integration of non-gay-identified and older BSGM were stronger for participants who received the peer leadership training, and integration challenges were also found for transgender BSGM who received the peer leadership training. Meanwhile, BSGM living with HIV who received the peer leadership training were significantly more integrated than their counterparts in the control arm. These findings help us understand the complicated social fabric among BSGM and the dynamics that interventions for this community may have to contend with or alter.

## Introduction

In the United States, HIV is disproportionately concentrated among Black sexual and gender minorities (BSGM) despite no meaningful differences in their individual sexual risk behaviors relative to their White counterparts (Millett et al., 2007). Like many health disparities, studies suggest that HIV risks of BSGM are more attributable to social contextual factors rather than individual risk propensities (Millett et al., 2007), for example the density of HIV seropositivity in networks (Amirkhanian, 2014), as well as non-epidemiological features of networks like access to social support (Friedman et al., 2017) and experiences with HIV and intersectional stigmas (Bogart et al., 2015; Bowleg, 2012).

This turn toward social networks reflects a cornerstone of social epidemiology and sociology more broadly — that individuals are social beings whose health and health behaviors are irrevocably shaped by the nature of their social relationships (Durkheim, 1951; Valente, 2010).

Empirical studies of the relationship between health and social networks have established links between attenuated social connectivity and causes of mortality (Berkman, 1995; House et al., 1988), elaborated on network mechanisms of health outcomes, for example social support (Kawachi and Berkman, 2001) and social capital (Kawachi and Berkman, 2000), and identified properties of networks that facilitate the spread of disease and other health-related outcomes at the population level (Valente, 2005; Zhang and Centola, 2019).

While social network diagnostic studies in the traditions described above can be used to provide a more accurate understanding of the contexts that facilitate or impede HIV risks for BSGM, social network intervention studies provide an opportunity to improve their HIV prevention and care trajectories. Network interventions represent intentional, theoretically informed efforts to leverage or alter features of social networks to generate, accelerate, or sustain health behaviors and positive health outcomes (Hunter et al., 2017; Valente, 2012). In his

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seminal work on the subject, Valente (2012) outlined four ways in which social influence processes can be used to accelerate change, including: i) identifying influential individuals (i.e., peer change agents) in a focal population to champion behavior change among peers; ii) directing interventions towards groups of similar people who will undergo change at the same time; iii) activating links between people to facilitate the spread of information; and iv) altering networks by adding (or removing) nodes or ties to facilitate behavior change.

Although each intervention strategy can be distinguished by its complexity and data dependencies, collectively they share a central tenet that has implications for intervention work in BSGM communities: That social influence only works when the individuals undergoing change are close or consider themselves part of the same community (Pagkas-Bather et al., 2020). Given that BSGM can be subject to both racist and homophobic discrimination from society as a whole and in the White LGBTQ and Black heteronormative spaces that they navigate (Bowleg, 2013), leveraging the organic networks and shared sense of community *among* BSGM to promote HIV prevention and care engagement within their own ranks has been shown to be a viable and effective way to reach greater numbers of this multiply marginalized population (Hosek et al., 2015; Jones et al., 2008; Schneider et al., 2021).

However, BSGM themselves are not a monolith. The broadly construed BSGM category can be further divided into a variety of sub-groupings along a multidimensional spectrum of sexual and gender categories. For example, with the understanding that sexual minorities are those whose sexual identity, attractions, and behavior differ from the heterosexual norm (Wilson and Miyashita, 2016), individuals who explicitly identify with mainstream sexual minority labels such as “gay” would be included as would those who identify with non-gay labels like “bisexual,” “same gender loving,” and “down low.” Likewise, with the understanding that gender minorities are those whose gender identity and expression do not fall within a masculine/feminine binary or whose current gender identity differs from their sex assigned at birth (Wilson and Miyashita, 2016), individuals who identify as transgender would be included as would individuals who identify as non-binary or gender non-conforming.

Arguments have been made that differences between these sub-groups, particularly in terms of how closely the subgroup identifies with the mainstream of the BSGM community (i.e., Black gay cisgender men) and the degree of intersectional oppression faced by the subgroup, can help us understand HIV risk disparities *within* the BSGM community (Wilson and Miyashita, 2016; Young and Meyer, 2005). For example, non-gay-identified Black sexual minority men are more likely to report internalized homophobia (Hart et al., 2003), which has been linked to unplanned sex behavior (Operario et al., 2008). Anti-bisexual bias from gay-identified men can lead bisexual-identified Black men to feel less attachment to the gay community, which in turn affects their access to HIV prevention education and resources (Dodge et al., 2012). And finally, structural discrimination leads many Black transgender women to engage in sex work for economic survival, which can expose them to greater HIV risks compared to cisgender sexual minority men and transgender women of other ethnicities (Baral et al., 2013; Herbst et al., 2008).

Taken together, these statistics suggest that under the broad BSGM category there is tremendous diversity in identification and circumstances, which has implications for how we think about HIV risks and interventions for its members. And, a key mechanism undergirding the relationship between that diversity and HIV risks is the extent to which non-gay-identifying and non-cisgender subgroups connect with its gay-identifying, cisgender mainstream. In this study, we drew on a social integration framework combined with an intersectionality lens to advance a *network understanding* of the mechanisms that enable differential patterns of social inclusion and exclusion among diverse BSGM. To these ends, we investigated the determinants of friendship formation and maintenance over time among sexual-, gender-, age-, and HIV status-diverse BSGM participating in a peer leader social network

intervention for HIV prevention. Centering the impact of a network intervention on these social dynamics allowed us to determine whether the social activation received in the intervention brought differently marginalized BSGM together or whether it contributed to heightened fragmentation.

## Theory

### Integration and intersectionality

Classically defined, social integration is the dynamic process through which societal newcomers or minorities are incorporated into the social structure of a larger host society. In his foundational work on the subject, Durkheim (1951) posited that stronger social attachments and the shared values, norms, and identities that those attachments engender, fosters greater psychosocial well-being. Central to his theory is the belief that positive and consistent social interactions that constitute cohesive groups encourage an atmosphere of support and a sense of shared identity among group members, leading to a more positive sense of self (Bellah et al., 1996; Rose et al., 2014). Although social network methods had yet to be developed at the time of Durkheim’s work on this matter, it is clear that social networks were integral to his thesis, a connection that his intellectual successors have since made explicit (Berkman and Glass, 2000; Pescosolido, 1990; Tsai and Papachristos, 2015).

Notably absent from this conceptualization of social integration is acknowledgment of the challenges of achieving it, particularly for individuals with social identities (e.g., race, gender identity, sexual identity) that are subject to stigma and discrimination in larger host societies. Sexual minorities, for example, can experience considerable discrimination in heteronormative host societies, which exacerbates their isolation or, in some cases, can lead to internalized homophobia for those who choose to conceal their stigmatized identity (Frost et al., 2016). For this reason, the well-being of SGM is generally thought to be more contingent on their social integration in a more identity-specific community. A common finding in studies of HIV-related resilience among sexual minority men, for example, is that social integration among other sexual minority men can play a vital role in their general and HIV-specific well-being (Ramirez-Valles et al., 2010; Reed and Miller, 2016; Young et al., 2022).

However, intersectionality research underscores how within-group integration can be more complicated for multiply minoritized SGM. As a theoretical framework, intersectionality underscores the way in which multiple social identities such as race, gender identity, and sexual identity (to name a few) intersect at the level of individual experience to reveal multiple interlocking social inequalities (i.e., racism, cissexism, heterosexism) at the macro social-structural level (Bowleg, 2013; Crenshaw, 1989). What this means is that for people who have multiple minority identities, like BSGM, their navigation of the social world is not only impacted by racism, heterosexism, and cissexism stemming from the general population, but also by discrimination that exists within their respective racial/ethnic, sexual, and gender communities.

Indeed, BSGM tend to report higher levels of identity compartmentalization and stress related to having to negotiate their intersectional identities in various spaces (Ghabrial, 2017). And, studies have shown that their constrained access to social support can lead to loneliness, social isolation, and depression (Buttram et al., 2013; Kraft et al., 2000), which in turn have been linked to sexual risk behaviors (Buttram et al., 2013; LeGrand et al., 2014). Therefore, for BSGM, who can experience exclusion from both White SGM (McConnell et al., 2018) and Black heteronormative spaces (Bowleg, 2013), fostering durable relationships with other BSGM can be an important ingredient of both psychosocial and HIV health (Winiker et al., 2021) at both individual and community levels.

However, the diversity of the BSGM community itself means that not all BSGM experience their relationships with other BSGM in the same way. With a social structure that tends to center the Black gay cisgender

sexual minority man (Wilson and Miyashita, 2016), one must ask whether BSGM who fall outside of that profile are able to establish and maintain relationships with the mainstream of the BSGM community or whether they show signs of isolation or further segregation by subgroup.

#### *Integration and segregation as dynamic network phenomena*

Operationalizations of social integration as studied among SGM typically privilege their involvement in gay/queer community (e.g., affiliations with venues, organizations, kinship structures) (Fergus et al., 2009; Hotton et al., 2018; Ramirez-Valles et al., 2010) or their perceptions of community closeness or belonging (Frost and Meyer, 2012; McConnell et al., 2018). Although affiliations with social structures and cognitive attachments to community are important dimensions of social integration, neither capture social integration in its relational emergence, for example through friendships with other SGM. As such, we advance a dynamic network understanding of social integration, such that integration is viewed as a dynamic process, as opposed to a static state, that occurs in the context of BSGMs' evolving friendships characterized by tie formation, maintenance, and dissolution.

Specifically, we focus on two different patterns of network socialization among BSGM that represent two sides of the social integration coin. On the one side of that coin is social integration that cuts across diverse subgroups. To capture this, we assess whether BSGM with particular traits are more or less likely to create new friendships and maintain established ones, irrespective of whether the BSGM they are forming or maintaining relationships with have those traits. We call this attribute-based *activity*. When actors with certain traits have a greater tendency than those without those traits to form new relationships or maintain established ones, the trait has the chance to achieve or sustain its visibility in the network and, therefore, may be perceived as more normative (Kooti et al., 2012; Mungovan et al., 2011). Conversely, when BSGM with particular traits show signs of attenuated social activity, either in the form of being less likely to form new ties (i.e., stalled networks) or being more likely to dissolve established ones (i.e., shrinking networks), concern is raised, as their limited activity with other network members could lead to social isolation and poor social support (Emlet, 2006) as well as to the stigmatization of the identity itself.

On the other side of the integration coin is social segregation, which we conceptualize as social integration *within* subgroups. To capture social segregation we assess whether there is a greater tendency for BSGM with particular traits to create new friendships and maintain established ones with other BSGM who have the same traits. We refer to these patterns as attribute-based *homophily* (McPherson et al., 2001; Moody, 1999). Evidence of homophily among BSGM has been found in a variety of social contexts, including sex partnerships (Janulis et al., 2018; Schneider et al., 2013), LGBTQ social venue affiliations (Fujimoto et al., 2015, 2013), and online group affiliations (Young et al., 2018). Although, on its face, homophily appears to be a selective form of social integration, it can also be interpreted as a form of segregation, as like-with-like clustering limits the amount of exposure that individuals have to diverse others and may be indicative of selective avoidance of individuals with traits that are considered less appealing, counter-normative, or risky. An important implication of segregated socialization is that friendships based on shared traits create the opportunity for social influence to occur on a variety of behaviors that could reinforce or exacerbate an individual's HIV risk or protection (Fujimoto et al., 2015; Schaefer and Simpkins, 2014; Valente, 2010).

#### *Integration and segregation in a social network intervention*

The empirical context in which we study social integration and segregation among diverse BSGM is a peer leader social network intervention for HIV prevention. As described elsewhere (Schneider et al., 2021; Young et al., 2022; Young et al., 2018), the goal of the

intervention was to increase awareness of and linkage to the HIV prevention pill Pre-Exposure Prophylaxis (PrEP) among young BSGM living in Chicago. To these ends, a large cohort ( $N = 423$ ) of BSGM aged 18–35 who were assigned male sex at birth were recruited and randomly assigned to either an intervention or control condition. People living with HIV were not excluded from participation, as the intervention aimed to motivate participants to promote PrEP in their personal networks, not necessarily to adopt it themselves.

In the intervention condition, participants were trained to be PrEP peer leaders in the larger BSGM community. As such, developing their knowledge about PrEP and their communication skills to talk about it with their peers was the primary objective. Peer leadership training was adapted from the HIV Prevention Trials Network peer educational and mentoring program (Latkin et al., 2009; Mihailovic et al., 2015) and was divided into four modules: (1) HIV facts and myths; (2) background on PrEP; (3) conversational role plays; and (4) leveraging social media to spread awareness about PrEP. Following the baseline workshop, study staff administered monthly check-in calls with each participant, which were designed to help the participant devise personalized conversational strategies for approaching peers and to troubleshoot communication barriers. Additionally, quarterly gatherings were organized to bring peer change agents together to build community and collective capacity. Participants not assigned to the intervention were assigned to a minimal contact attention control condition (Lindquist et al., 2007) centered around a sexual risk assessment workshop. At no point were participants activated as peer change agents.

Because participants were recruited from a larger community-based cohort, participants came into the study with established social relationships, which were captured at baseline in the form of their Facebook friendship connections. These friendships were observed again 12 months later. Although Facebook friendships do not necessarily mean the same thing as a physical world friendship, research has shown that there tends to be considerable overlap between who one knows in the physical world and who one connects with on Facebook (Reich et al., 2012; Young et al., 2020). Further, Facebook friendships were an important vehicle of communication and capacity building among participants assigned to the intervention condition, as such learning whether and how those dynamics centered, isolated, or segregated members of the study cohort is warranted. Thus, the design of the study itself and the established relationships that participants brought with them into the study, provided an opportunity to study whether and how patterns of social integration and segregation in an organic and evolving online social network among study participants were affected by the intervention.

In our analysis, we focused on four identity-based characteristics as mechanisms of integration and segregation — sexual and gender identity, which were the primary characteristics of interest, as well as age and HIV status. With respect to age, research has shown that younger people prefer to stay connected and engage with peers through technology (Palfrey and Gasser, 2011) and, therefore, may also be more likely to grow or alter their relationships in technological settings. Further, decades of homophily research has shown that age homophily in friendships is nearly ubiquitous (Spencer and Pahl, 2018) and is primarily informed by strong social norms (Williams and Nussbaum, 2013) and an underlying desire to be connected to people with similar life experiences (McPherson et al., 2001). Our consideration of HIV status as an organizing mechanism stems from research showing that people living with HIV often experience stigma and social marginalization from society as a whole as well as within SGM communities (Chan and Mak, 2019; Courtenay-Quirk et al., 2006). As such, people living with HIV, may be less integrated or more segregated in the online friendships among BSGM.

Taken together, the identity-based diversities of this BSGM cohort and the social activation that half of them received by virtue of their peer leadership training led us to ask the following: 1) Do sexual, gender, age, and HIV status diversities organize patterns of network integration and

segregation among Black sexual and gender minorities?; and 2) To what extent are these patterns affected by the social network intervention?

## Methods and measures

### Study design and sample

This study draws on data collected 2016–2018 from participants enrolled in the previously described peer leader HIV prevention intervention (Schneider et al., 2021; Young et al., 2018). Participants were eligible if they: 1) were 18–35 years of age, 2) identified as Black or African American, 3) were assigned male sex at birth, 4) had sex with a man in the past 12 months, and, due to the social media presence of the intervention, 5) had an active Facebook profile.

Recruitment occurred using respondent-driven sampling (RDS) (Heckathorn, 1997), which provides a mechanism for sampling hard to reach populations like SGM and methods for making statistical inferences about the target population. RDS referral chains began with an initial set of RDS “seeds” who met study eligibility criteria and who occupied central or bridging positions (i.e., structural signatures of having large and diverse networks, respectively) in a previously derived Facebook friendship network among the intended population (Khanna et al., 2017). Once enrolled, “seeds” were enlisted to recruit their peers, and the process continued until the recruitment target was reached. As a result, 423 BSGM were successfully enrolled at baseline, 346 of which were retained at 12-months.

### Data collection

Participants consented to three types of data collection at baseline and 12-month assessment points. A computer-assisted self-administered survey included modules on HIV prevention behaviors, PrEP related dispositions, sex behaviors, substance use, and demographics; biomedical testing determined participants’ HIV status; and, a manual download of participants’ Facebook friend lists enabled the construction of an online network vis-à-vis other study participants. Written consent for all forms of data collection was obtained from participants at their baseline visit, and all procedures were approved by the Institutional Review Board of the University of Chicago and NORC at the University of Chicago.

### Measures

#### Facebook friendship network

Using the lists of Facebook friends acquired from consenting participants at baseline and 12-months, we created two unweighted, undirected edge lists representing Facebook friendships at each time point. With the Facebook usernames of each participant, we were able to locate other study participants in the Facebook friend lists of every other participant, which allowed us to restrict the friendship network to include ties among consenting study participants only.

#### BSGM attributes

All attributes were assessed in the baseline assessment of the intervention study. Sexual identity was assessed using the question, “Do you consider yourself” (single choice: gay/lesbian, straight/heterosexual, bisexual, queer, asexual, or something else). Due to having too few or entirely absent observations in the queer and asexual response categories, the analysis presented in this study features a recoded version of sexual identity that combined “queer” and “asexual” responses with the “other/something else” category. As such, we modeled gay/lesbian, straight/heterosexual, bisexual, and other/something else sexual identities. Gender identity was assessed using the question, “Do you consider yourself to be:” (single choice: male, female, transfeminine, transmasculine, gender non-conforming, or something else). Among the participants included in the analytic sample ( $n = 340$ ), six participants

identified as female, one participant identified as transmasculine, and no participants identified as gender non-conforming or as something else. As such, the gender identity variable was recoded, such that: 1) the six participants who identified as female were grouped with the participants who identified as transfeminine, given that a condition of study eligibility was assignment of male sex at birth, and 2) the participant who identified as transmasculine was grouped with the participants identifying as transfeminine to create a neutral transgender identity category. For modeling purposes, we created a dichotomous indicator for transgender (relative to cisgender male) identity. A continuous measure of age was calculated using participants’ birthdates provided during screening and enrollment. Finally, HIV status was measured on the basis of blood tests for those who consented to lab testing or self-reports for those who opted out. From these data, a dichotomous indicator variable was created for HIV positive status.

### Intervention effects

To determine the extent to which the social network intervention influenced patterns of integration and segregation among the BSGM participants, we include a dichotomous indicator for treatment arm assignment, as well as a series of interaction terms to capture the moderating effects of treatment arm assignment on the relationships between the attributes described above and the likelihood of tie formation and maintenance.

### Controls

In recognition that one’s ability to form and maintain friendships with other BSGM study participants may be contingent on other social obligations, for example the demands of managing other friendships (Arnaboldi et al., 2015), we also control for the overall size of a participant’s Facebook friendship network, which includes friendships with people who were not enrolled in the study. The distribution of participants’ Facebook friend counts ( $M = 1820$ ,  $SD = 1402$ ) was bimodal. As such we opted to transform the original count variable into a 3-level ordinal variable, using the distribution itself to create categories for small (8–1000 friends), medium (1001–3800 friends), and large (3801–4506 friends) networks.

### Analytic sample and approach

In total, 340 of the 346 study participants retained at 12-months had complete survey and network data at both time points and were included in the analysis. The 6 filtered cases were excluded on the basis of having no survey data. That each of the 6 participants completed their baseline Facebook data collection and completed all data collection at 12-months suggests that technical error was most likely responsible for the missing data, not refusal to take the survey.

To assess the dynamic processes of social integration and segregation among BSGM in the sample, we implemented an extension of the cross-sectional exponential random graph model (ERGM) designed for dynamic networks called the separable temporal exponential random graph model (STERGM) (Krivitsky and Handcock, 2014). Cross-sectional ERGMs are defined as (Robins et al., 2007):

$$\Pr_{\theta}(Y = y|X) = \frac{\exp\{\theta \cdot g(y, X)\}}{c(\theta, X, y)} \quad (1)$$

where  $\Pr(Y = y)$  is the probability that the observed network ( $y$ ) equals the simulated network ( $Y$ ),  $\theta$  represents a vector of network configurations or parameters (i.e., the determinants with which one tries to explain the structure of the network),  $g(y, X)$  is a vector of network statistics that correspond to the  $\theta$  parameters, and  $c(\theta, X, \mathcal{Y})$  is a normalizing quantity which ensures that the summation over the space of all possible networks on  $n$  nodes,  $\mathcal{Y}$ , is a proper probability distribution.

STERGMs assume that processes of tie formation and persistence (or maintenance) are separable from each other, meaning they occur for



different reasons, and, therefore, are considered conditionally independent (Krivitsky and Handcock, 2014). As such, the evolution of a random network at time  $t$  ( $y^t$ ) into a random network at time  $t + 1$  ( $y^{t+1}$ ) is modeled as two separate processes.

As described by Krivitsky and Goodreau (2019), given an observed network at time  $t$  ( $y^t$ ), the *formation network*  $Y^+$  is generated from an ERGM controlled by a vector of formation parameters  $\theta^+$  and formation statistics  $g^+(y^+, X)$ , conditional on only adding ties:

$$\Pr(Y^+ = y^+ | Y^t; \theta^+) = \frac{\exp\{\theta^+ \cdot g^+(y^+, X)\}}{c(\theta^+, X, y^+(Y^t))}, y^+ \in y^+(y^t) \quad (2)$$

Simultaneously, the *dissolution network*  $Y^-$  is generated from an ERGM controlled by a (possibly different) vector of dissolution parameters  $\theta^-$  and dissolution statistics  $g^-(y^-, X)$ , conditional on only dissolving ties from  $y^-$ :

$$\Pr(Y^- = y^- | Y^t; \theta^-) = \frac{\exp\{\theta^- \cdot g^-(y^-, X)\}}{c(\theta^-, X, y^-(Y^t))}, y^- \in y^-(y^t) \quad (3)$$

As is the case when modeling the presence or absence of ties in a cross-sectional network, the formation and persistence of ties can be modeled as responses to the network itself (i.e., structural effects) or as responses to external factors, such as actor or dyadic attributes (i.e., attribute-based effects). Both structural and attribute-based effects are modeled as parameterized network statistics and are interpreted in log-odds metrics relative to forming a new tie (formation model) and maintaining an established tie (persistence model). In the formation model, a positive parameter for a statistic indicates a higher probability that ties are forming to increase that feature's prevalence, while a negative parameter indicates a higher probability that ties are forming to minimize that feature's prevalence. In the persistence model, a positive parameter indicates a higher probability that ties are being maintained to preserve the prevalence of a feature, while negative parameters indicate higher probabilities that the feature is being reduced through tie dissolution (Krivitsky and Handcock, 2014).

Table 1 describes the parameters included in both STERGMs featured in this study. Both the formation and persistence models included two parameters for each actor attribute — (1) an *activity term* representing the tendency for actors with that attribute to form or maintain ties with other network members, irrespective of their attribute status, and (2) a *homophily term* representing the tendency for actors with that attribute to form or maintain ties with other actors who also have that attribute. As such, we interpret significant attribute-based activity to mean that actors with a certain trait are more integrated with other network members (irrespective of those other members' attribute status), whereas significant homophily is taken to mean that network actors are divided by a certain trait and, therefore, segregated as a group.

To account for the way in which tie formation and maintenance are influenced by conditions of the network itself, we also included four structural effects — 1) the required *edge* parameter that represents the overall selectivity that an actor applied when forming or maintaining ties, 2) the *geometrically weighted edge-wise shared partner (gwesp)* parameter to represent the probability that ties are formed or maintained to increase shared partners among connected dyads (i.e., network closure), 3) the *geometrically weighted dyad-wise shared partner (gwdsp)* parameter to represent the probability that ties are formed or maintained to increase shared partners among unconnected dyads, and 4) the *geometrically weighted degree (gwdegree)* parameter to represent network concentration (or preferential attachment) tendencies. Structural terms were selected on the basis of extant theory, as was the case for including the *gwesp* term to account for the well-established social tendency to strive for social balance in relationships (Heider, 1946), as well as goodness-of-fit considerations. Models were run using the *statnet* 'tergm' package (version 4.0.2) in R Studio (version 1.4.1717) (RStudio Team, 2021).

**Table 1**

Parameters included in the separable temporal exponential random graph models (STERGM).

Effect (parameter type)	Description
<i>Structural effects</i>	
Geometrically weighted edge-wise shared partner (gwesp)	Probability that ties are formed or maintained to increase shared partners among connected dyads
Geometrically weighted dyad-wise shared partner (gwdsp)	Probability that ties are formed or maintained to increase shared partners among unconnected dyads
Geometrically weighted degree (gwdegree)	Dispersion of edges across nodes, following a non-preferential attachment
<i>Primary Attribute Effects</i>	
Sexual identity, activity (nodefactor)	Effect of sexual identity (gay, straight, bisexual, or something else) on tie formation and maintenance
Sexual identity, homophily (nodematch)	Tendency for actors to form or maintain friendships with actors who are of the same sexual identity
Gender identity, activity (nodefactor)	Effect of gender identity (transgender female or cisgender male) on tie formation and maintenance
Gender identity, homophily (nodematch)	Tendency for actors to form or maintain friendships with actors who are of the same sexual identity
Age, activity (nodecov)	Effect of actor age on tie formation and maintenance
Age, homophily (absdiff)	Tendency for actors to form or maintain friendships with actors who are of similar age.
HIV status, activity (nodefactor)	Effect of HIV status on tie formation and maintenance
HIV status, homophily (nodematch)	Tendency for actors living with HIV to form or maintain friendships with other actors also living with HIV
<i>Treatment Main and Interaction Effects</i>	
Treatment, activity (nodefactor)	Effect of treatment assignment on tie formation and maintenance
Sex identity * Treatment, activity (nodefactor)	Effect of treatment assignment on the relationship between sexual identity (gay, straight, bisexual, or something else) and tie formation and maintenance.
Gender identity * Treatment, activity (nodefactor)	Effect of treatment assignment on the relationship between transgender identity and tie formation and maintenance.
Age * Treatment, activity (nodecov)	Effect of treatment assignment on the relationship between age and tie formation and maintenance.
HIV status * Treatment, activity (nodefactor)	Effect of treatment assignment on the relationship between living with HIV and tie formation and maintenance.
<i>Control Attribute Effects</i>	
Total number of Facebook friends, activity (nodefactor)	Effect of friendship network size <sup>a</sup> (small, medium, large) on tie formation and maintenance with study participants

<sup>a</sup> Size of Facebook friendship network includes participant *and* non-participant Facebook friends

## Results

### BSGM sample characteristics

Table 2 presents descriptive statistics for actor-level characteristics for all participants, and then stratified by participants who were assigned to the treatment and control arms of the parent intervention study. We also report p-values of tests of difference (i.e., Chi-Squared tests for categorical measures and independent t-tests for numeric measures) between treatment and control group participants on each characteristic. Among all BSGM in the analytic sample ( $N = 340$ ), mean age was 25.75 years ( $SD = 4.18$ ). A majority of the sample (62.4%,  $n = 210$ ) identified as gay and about a quarter of the sample (26.2%,  $n = 89$ ) identified as bisexual. A large majority (90.9%,  $n = 309$ ) identified as cisgender male, with the remaining 9% ( $n = 31$ ) identifying as

**Table 2**

Summary statistics for individual-level characteristics, stratified by study arm assignment (treatment arm vs. control arm).

Individual Characteristics	Full Sample (N = 340) n (%)	Treatment Arm (n = 174) n (%)	Control Arm (n = 166) n (%)	Treatment vs. Control Differences p-value <sup>a</sup>
Sexual Identity				0.461
Gay	210 (62.4)	115 (66.1)	96 (58.5)	
Heterosexual/ Straight	10 (2.9)	4 (2.3)	6 (3.7)	
Bisexual	89 (26.2)	40 (23.0)	48 (29.3)	
Other/Something else	29 (8.5)	15 (8.6)	14 (8.5)	
Gender Identity				0.037
Cisgender male	309 (90.9)	164 (94.3)	144 (87.8)	
Transgender	31 (9.1)	10 (5.7)	20 (12.2)	
Age, Mean (SD)	25.75 (4.18)	26.14 (4.30)	25.36 (4.04)	0.043
HIV (positive) status	145 (42.7)	74 (42.5)	69 (42.1)	0.932
Treatment arm assignment	174 (51.2)	–	–	
Facebook friendship network size				0.417
Small (8–1000 friends)	128 (37.6)	61 (35.1)	67 (40.4)	
Medium (1001–3800 friends)	137 (40.3)	76 (43.7)	61 (36.7)	
Large (3801–4506 friends)	75 (22.1)	37 (21.2)	38 (22.9)	

<sup>a</sup> Reported p-values are from Pearson's chi-squared tests for categorical characteristics and independent t-tests for numeric characteristics

transgender. A little less than half of the participants (42.7%,  $n = 145$ ) were living with HIV. As is shown, there were two significant differences between the treatment and control groups on these characteristics, namely participants assigned to the treatment arm tended to be older ( $p = .043$ ) than those assigned to the control arm and there were more transgender participants in the control arm than the treatment arm ( $p = .037$ ).

#### Facebook network characteristics

Characteristics of the dynamic Facebook friendship network are summarized in Table 3. At baseline, 3893 friendship ties were observed among the 340 BSGM, corresponding to a mean degree of 22.90 and network density of 0.07. About 26% of the friendships that could have

**Table 3**

Network-level characteristics of the Facebook friendship network at baseline and 12-months.

Characteristic	Baseline	12-months
Edge count	3893	5207
Mean (SD) Facebook friendships	22.90 (19.53)	30.63 (25.39)
Network density	0.07	0.09
Transitivity (network closure)	0.26	0.31
Centralization (network concentration)	0.17	0.25
	Period 1	
Number of new Facebook friendship ties	2148	
Number of Facebook friendship ties maintained	3059	
Number of dissolved Facebook friendship ties	834	
Jaccard Index <sup>a</sup>	0.51	

<sup>a</sup> The Jaccard index measures the amount of change between observed waves, and indicates whether the data collection points are not too far apart. Values between 0.3 and 0.6 are desired to meet assumptions that the network change process is gradual (Snijders et al., 2010).

formed a triad were indeed transitive (i.e., fully balanced or closed), while friendship centralization (i.e., the variability in the friendship degrees of network actors) was relatively moderate (17%). At 12-months, the network was more connected, with 5207 observed ties. The network also increased in transitivity (+5%) and centralization (+8%), which we attribute to features of the platform itself; Facebook's 'friend of a friend' recommender facilitates triadic closure and friend counts made visible on users' profiles make status-based friendship requests more likely. In total, 2148 new Facebook friendship ties were formed and 834 were dissolved between waves. These dynamics translate into a Jaccard coefficient of 0.51, which is within the acceptable range (0.30–0.60) for concluding that there is meaningful change in friendship ties between time periods (Snijders et al., 2010).

#### Mechanisms of Facebook friendship formation and persistence

Table 4 presents estimates and standard errors obtained from two STERGMs, one that remains agnostic to the moderation effects of the parent study intervention (model 1) and the other that explicitly models them (model 2). To facilitate interpretation of results, we calculated the exponential function of the estimates (odds ratios) and reported them in text. Further, for each model, we sequentially present the effects of each parameterized mechanism on both tie formation and persistence so that one can more easily contextualize the effects of a given parameter on the full range of dynamic change in the friendship network.

#### Model 1

Starting with the structural effects, we learned that BSGM tended to be selective with whom they formed new Facebook friendships (*edges form*,  $OR = 0.01$ ,  $p < .001$ ). The positive effect of the geometrically weighted edgewise parameter for both tie formation (*gwesp form*,  $OR = 1.46$ ,  $p < .001$ ) and persistence (*gwesp persists*,  $OR = 1.12$ ,  $p < .001$ ) indicated that BSGM tended to form new ties and maintain established ones to create and sustain closure in their online friendships. With the positive geometrically weighted edge-wise (*gwesp*) term accounted for, the negative geometrically weighted dyad-wise shared partner (*gwdsp*) term (*gwdsp form*,  $OR = 0.98$ ,  $p < .001$ ) indicated that friendships were less likely to be formed to increase shared partners among unconnected dyads. Finally, the negative geometrically weighted degree term (*gwdegree form*,  $OR = 0.17$ ,  $p < .001$ ) is interpreted to mean that there was a centralization (or popularity) force at play. Put another way, it showed a tendency for ties to be less equitably dispersed across network actors, such that it reinforced the popularity of a small number of actors.

Next, we turn to the effects of attribute-based activity terms. When positive (negative) and significant, these terms represent tendencies for BSGM with those traits to be more (less) integrated in the BSGM Facebook friendship network. To begin, results showed that social integration was contingent on sexual identity. BSGM who identified as bisexual (*bisexual activity form*,  $OR = 0.81$ ,  $p < .001$ ) or as another sexual identity other than gay, heterosexual, or bisexual (*other sexual identity activity form*,  $OR = 0.87$ ,  $p = .033$ ) were less likely to form new online friendships than their gay counterparts. Neither sexual identity group were any more or less likely to maintain their established friendships. With respect to gender identity, transgender BSGM were no more or less likely than their cisgender male counterparts to form or maintain friendships. Older BSGM were significantly less likely than their younger counterparts to form new online friendships (*age activity form*,  $OR = 0.99$ ,  $p = .002$ ), however they were more likely than younger BSGM to maintain established ties (*age activity persists*,  $OR = 1.02$ ,  $p = .009$ ). This suggests that older BSGM have more stable Facebook friendships, while younger BSGM have greater turnover in those relationships. Finally, BSGM living with HIV were more likely to form new online friendships (*HIV positive activity form*,  $OR = 1.07$ ,  $p = .007$ ) than their HIV negative counterparts, however they were less likely to maintain established friendships (*HIV positive activity persists*,  $OR = 0.86$ ,  $p = .007$ ). Again, this suggests that BSGM living with HIV have greater turnover in their

**Table 4**

Separable temporal exponential random graph models of attribute-based social integration and segregation in a dynamic Facebook friendship network among Black sexual and gender minorities, without (Model 1) and with (Model 2) treatment arm interaction effects (N = 340).

	Model 1				Model 2			
	Tie Formation		Tie Persistence		Tie Formation		Tie Persistence	
Effect	Est	SE	Est	SE	Est	SE	Est	SE
<i>Structural effects</i>								
Edges	-4.49 ***	0.22	0.32	0.43	-5.40 ***	0.29	0.69	0.57
Gwesp ( $\alpha = .5$ )	.36 ***	0.01	0.11 ***	0.01	0.36 ***	0.01	0.11 ***	0.01
Gwdsp ( $\alpha = .5$ )	-.02 ***	0.00	-0.01	0.01	-0.02 ***	0.00	-0.01	0.01
Gwdegree ( $\alpha = 1$ )	-1.80 ***	0.46	0.13	0.42	-1.80 ***	0.47	0.18	0.42
<i>Integration Effects</i>								
Heterosexual, activity	-0.05	0.08	0.24	0.22	-0.06	0.10	0.36	0.27
Bisexual, activity	-0.21 ***	0.04	-0.13	0.08	-0.16 **	0.05	0.19 +	0.12
Other sexuality, activity	-0.12 *	0.06	0.26 +	0.14	-0.53 ***	0.11	0.24	0.20
Transgender, activity	0.12	0.10	-0.29 +	0.17	0.11	0.11	-0.21	0.18
Age, activity	-0.01 **	0.00	0.02 **	0.01	0.01 +	0.00	0.01	0.01
HIV positive, activity	0.07 **	0.02	-0.15 **	0.06	-0.02	0.04	-0.33 ***	0.09
<i>Segregation Effects</i>								
Sexual identity, homophily	0.33 *	0.14	0.00	0.24	0.34 *	0.14	-0.02	0.24
Transgender identity, homophily	0.19	0.12	-0.19	0.19	0.20 +	0.12	-0.30	0.19
Age, homophily	-0.03 ***	0.01	-0.05 ***	0.01	-0.03 ***	0.01	-0.05 ***	0.01
HIV positive, homophily	0.08 +	0.04	-0.06	0.08	0.09 +	0.04	-0.07	0.08
<i>Covariate Control Effects</i>								
Friendship network size - medium, activity	-0.20 ***	0.03	-0.07	0.08	-0.20 ***	0.03	-0.04	0.08
Friendship network size - large, activity	-0.34 ***	0.04	-0.11	0.08	-0.35 ***	0.04	-0.09	0.08
<i>Treatment Effects</i>								
Treatment, activity	-0.09 ***	0.03	0.16 **	0.06	1.31 ***	0.21	-0.24	0.45
Heterosexual * Treatment, activity					-0.64 ***	0.13	-0.11	0.27
Bisexual * Treatment, activity					-0.81 **	0.25	-0.83	0.51
Other sexuality * Treatment, activity					-0.76 ***	0.14	-0.86 **	0.30
Transgender * Treatment, activity					0.03	0.10	-0.58 **	0.21
Age * Treatment, activity					-0.03 ***	0.01	0.02	0.01
HIV positive * Treatment, activity					0.18 ***	0.05	0.40 **	0.12
N	340				340			
AIC	18,582				18,515			
BIC	18,887				18,927			

\*\*\*  $p < .001$ ; \*\*  $p < .01$ ; \*  $p < .05$ ; +  $p < .10$ ; Convergence t-ratios for all parameters were less than the 0.10 threshold.

networks.

Results also revealed tendencies for BSGM to segregate on the basis of attribute similarities. First, friendships were more likely to be formed among BSGM of the same sexual identity, as evidenced by the positive effect of the sexual identity homophily term in the formation model (*sexual identity homophily<sub>form</sub>*,  $OR = 1.39$ ,  $p = .015$ ). Additionally, evidence for age homophilous segregation was found. The negative effect of the absolute difference parameter (*absdiff*) in both the formation and persistence submodels indicated that new online friendships were more likely to be formed (*age homophily<sub>form</sub>*,  $OR = 0.97$ ,  $p < .001$ ) and established ones more likely to be maintained (*age homophily<sub>persist</sub>*,  $OR = 0.95$ ,  $p < .001$ ) between BSGM of similar (i.e., less different) ages. No evidence was found for significant segregation tendencies by gender identity or HIV status.

These patterns of integration and segregation emerged while also controlling for the effects of being assigned to the treatment arm and the overall size of participants' Facebook friendship networks. Somewhat surprisingly, results indicated that BSGM who were assigned to the treatment arm of the intervention, where they were trained and activated to engage with their peers about PrEP, were less likely than their control arm counterparts to form new online friendships with other BSGM (*treatment activity<sub>form</sub>*,  $OR = .91$ ,  $p < .001$ ). That said, the activation that participants received in the treatment arm did have a positive impact on friendship maintenance, such that those who were in the treatment arm were more likely to maintain their established online friendships (*treatment activity<sub>persist</sub>*,  $OR = 1.17$ ,  $p = .007$ ). Additionally, participants who had more Facebook friends to manage were less likely to form new friendships with other BSGM (*medium sized network<sub>form</sub>*,  $OR = 0.82$ ,  $p < .001$ ; *large sized network<sub>form</sub>*,  $OR = 0.71$ ,  $p < .001$ ), confirming what Arnaboldi et al. (2015) have noted about the cognitive constraints that place limits on how large our social networks can

become.

#### Model 2

In model 2 (Table 4), we estimated the moderation effects of the intervention by including terms that represented an interaction ( $X * W$ ) between each primary attribute ( $X$ ) and treatment arm assignment ( $W$ ). A positive (negative) significant effect of one of these terms indicates that the relationship between the attribute ( $X$ ) and tie formation or maintenance was stronger (weaker) for those in the treatment arm ( $W$ ). With respect to tie formation tendencies, results showed that for participants in the treatment arm, being older (*age\*treatment<sub>form</sub>*,  $OR = 0.97$ ,  $p < .001$ ) and identifying as heterosexual (*heterosexual\*treatment<sub>form</sub>*,  $OR = 0.53$ ,  $p < .001$ ), bisexual (*bisexual\*treatment<sub>form</sub>*,  $OR = 0.44$ ,  $p < .001$ ), or something else other than gay, heterosexual, or bisexual (*other sexuality\*treatment<sub>form</sub>*,  $OR = 0.47$ ,  $p < .001$ ) decreased the odds of forming new friendship ties. Those who identified as something else other than gay, heterosexual, and bisexual, were also less likely to maintain their friendships over the course of the study (*other sexuality\*treatment<sub>persist</sub>*,  $OR = 0.42$ ,  $p < .001$ ). A similar trend of friendship dissolution was found for transgender participants in the treatment arm (*transgender\*treatment<sub>persist</sub>*,  $OR = 0.56$ ,  $p = .006$ ). Conversely, treatment arm participants who were living with HIV were more likely to form new friendships (*HIV positive\*treatment<sub>form</sub>*,  $OR = 1.20$ ,  $p < .001$ ) and maintain established friendships (*HIV positive\*treatment<sub>persist</sub>*,  $OR = 1.49$ ,  $p < .001$ ).

If we compare the primary attribute-based activity effects in models 1 and 2, one can see that the direction and significance of these effects in both the formation and persistence models remained relatively unchanged when the treatment interaction terms were added. This suggests that our initial analysis as shown in model 1 tended to reflect the organic tendencies of control group participants whose social

inclinations were not intervened on in the parent intervention. Further, although some caution should be used when interpreting main effects once interaction terms are introduced, we note that, like the interaction terms, the main effects of bisexual identity (*bisexual activity form*,  $OR = 0.85$ ,  $p = .002$ ) and a sexual identity other than gay, heterosexual, or bisexual (*other sexuality form*,  $OR = 0.59$ ,  $p < .001$ ) were also negative and significant. This suggests that control arm participants who were bisexual or identified as something else other than gay, heterosexual, or bisexual were also less likely to form new online friendships, however the negative relationship between these sexual identities and new friendship formation was more pronounced for those assigned to the treatment arm. Results reveal a different pattern for participants living with HIV. As noted, BSGM in the treatment arm who were living with HIV were more likely to maintain their friendships with other BSGM participants. However, the main effect of HIV status on tie maintenance showed a negative effect in the moderation model (*HIV positive activity persist*,  $OR = 0.72$ ,  $p = .001$ ), which suggests that the risk of friendship dissolution for BSGM living with HIV was concentrated among control arm participants.

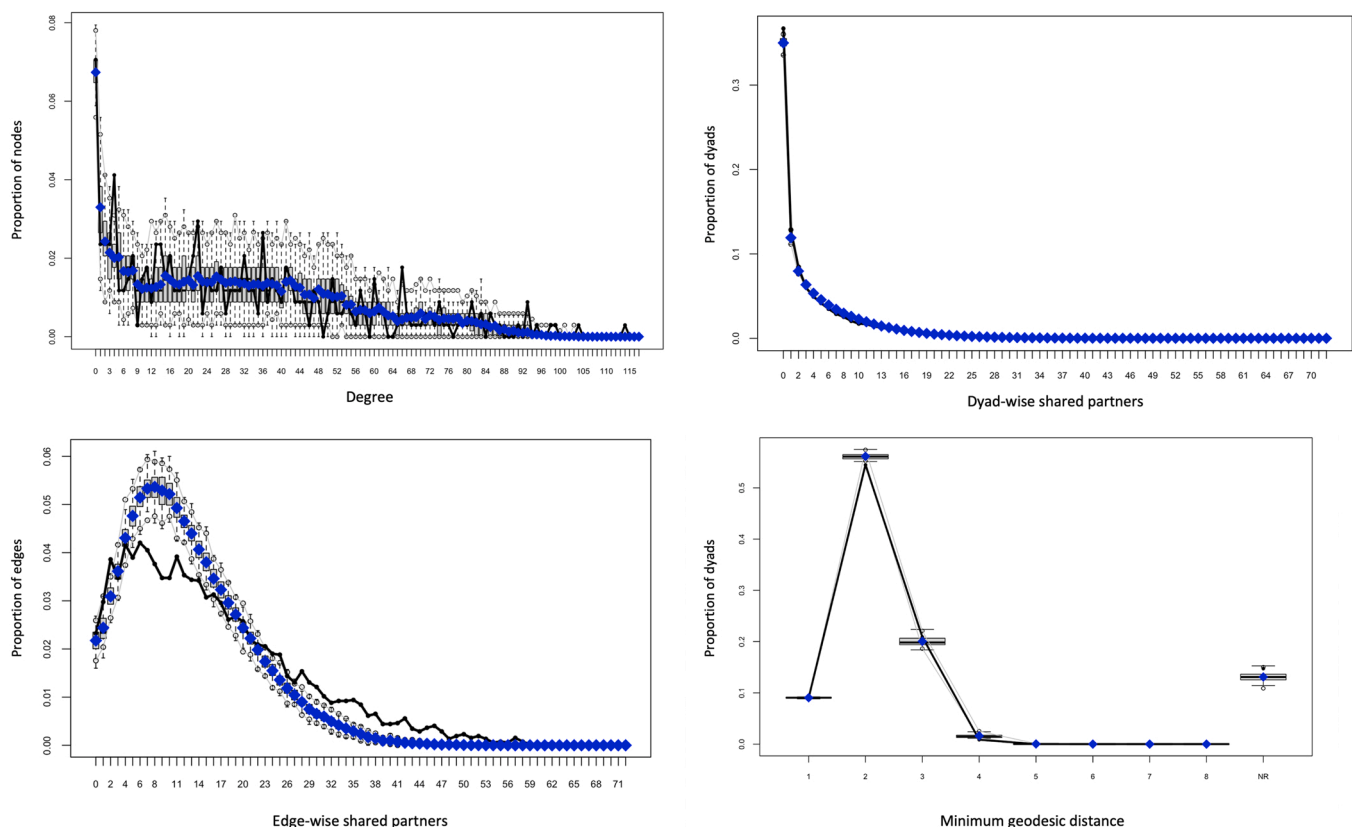
#### Goodness-of-Fit

Goodness of fit simulations were performed to determine how well the model reproduced structural features of the observed graph. Specifically, we examined the distributions of degree, dyad-wise shared partners, edge-wise shared partners, and geodesic length. Fig. 1 presents boxplots for these distributions obtained from the graphs sampled from the simulated model. Data from the observed network are represented by the black dots. It can be seen that the observed network is consistent with the simulated graphs on the proportion of nodes with a given degree, proportion of dyads with a given dyad-wise shared partner count,

and the proportion of edges with a given geodesic length. It can also be seen that the simulated graphs over-represented the presence of edge-wise shared partners, most notably the proportion of edges with about 8–12 edge-wise shared partners. Efforts were made to improve modeling of the edge-wise shared partner distribution by adding specific terms for the range of edge-wise shared partner counts that our model struggled to match, however excessive correlation among model terms prevented model convergence.

#### Discussion

This study examined patterns of within-group network integration and segregation in a diverse cohort of Black sexual and gender minorities (BSGM) participating in a social network intervention. Motivating these efforts were three starting premises: 1) within-group social integration can be an important asset for BSGM, particularly as a source of support and resilience in the face of HIV-related vulnerabilities and other minority stressors (Frost and Meyer, 2012); 2) BSGM themselves are not monolithic (Wilson and Miyashita, 2016); heterogeneity in identity-based characteristics like sexual and gender identity, age, and HIV status engender different social circumstances, which may contribute to tendencies to segregate along lines of difference rather than integrate across them; and 3) that social network interventions that aim to activate members of a focal community to promote health behavior change among peers are uniquely positioned to create new opportunities for interaction among network members and build community capacity (Young and Schneider, 2021). As such, the aims of this study were to determine whether the diverse demographics of BSGM and differences in HIV status functioned as mechanisms of their within-group integration and segregation over time, and whether the



**Fig. 1.** Final model for Facebook friendship tie formation and maintenance: goodness of fit diagnostic plots for degree distributions, dyad-wise shared partner distributions, edge-wise shared partner distributions, and geodesic distributions: small black dots connected by lines present distributions for the observed network; boxplots present the variation in the proportion of nodes (for degrees), dyads (for dyad-wise shared partners and geodesics), or edges (edge-wise shared partners), with a given degree, dyad-wise shared partner count, edge-wise shared partner count, or geodesic length.



social activation that these BSGM received in a social network intervention influenced those patterns.

Using two waves of Facebook friendship data collected from a cohort of BSGM living in Chicago, we modeled the tendency for BSGM with each attribute to form (and maintain) ties with other BSGM (irrespective of whether those individuals also possess the attribute) as an indicator of attribute-based social integration, and the tendency to form (and maintain) friendships that facilitate homophilous clustering of BSGM with each attribute as an indicator of attribute-based segregation. The adoption of a dynamic network modeling approach allowed us to recast social integration and segregation as processes that occur over time through specific social patterns that emerge in the formation of new friendships and the maintenance (or dissolution) of established ones.

In line with previous studies finding that diversity within the broad category of BSGM is associated with differential health outcomes among its members (Boellstorff, 2011; Wilson and Miyashita, 2016; Young and Meyer, 2005), we found that sexual and gender identity, age, and HIV status differences among BSGM were also associated with differential social outcomes vis-à-vis other BSGM. However, by taking a dynamic relational approach to the analysis, our results revealed more nuance than would studies adopting a static conceptualization of integration. In particular, having the ability to distinguish between tie formation and dissolution, allowed us to demonstrate that the risk of attenuated integration among non-gay-identified (i.e., bisexual and other sexuality) BSGM was primarily rooted in their lower probabilities of forming new friendships with other BSGM (i.e., non-growing networks), not in their tendency to dissolve relationships with other BSGM (i.e., shrinking networks). Having the ability to juxtapose the effects of an attribute on tie formation and dissolution also gave us the opportunity to identify BSGM who appeared to be rehauling their networks, as was evident for BSGM living with HIV who were more likely to form new friendships and more likely to dissolve old ones.

The relational approach also gave us the opportunity to demonstrate tendencies toward social segregation (or homophilous clustering), a counterpart to integration, which we conceptualized as a response to a group's marginalization from the mainstream of the focal community and/or their natural tendency to seek relationships with similar others. Our analysis revealed strong tendencies toward age-based segregation, such that friendships among BSGM were more likely to be formed and maintained to support age cohort clustering. We also found evidence for clustering on sexual identity, but only in as it motivated the formation of new friendships, not the tendency to maintain established ones.

Finally, and perhaps most importantly, when looking at how these effects were contingent on whether or not a participant underwent the peer leadership training, we were able to demonstrate that, again, attribute-based differences among BSGM determined who was more likely or willing to contribute to and reap the social benefits of the community-building aspects of the intervention. Counter to what we expected, that the social network intervention would activate participants to engage with a broader range of the BSGM community, we found that the training and motivation that participants received in the treatment arm failed to integrate BSGM who were at the margins of the intended focal population — i.e., those who were not younger gay-identified cisgender men. Specifically, BSGM in the treatment condition who were older and who were non-gay-identified (i.e., identified as heterosexual, bisexual, or some other sexual identity) were less likely than their control arm counterparts to form new friendships with other study participants. Additionally, unlike their control arm counterparts, transgender BSGM peer leaders were at risk of attenuated integration due to their greater tendency to dissolve friendships. These patterns of disenfranchisement from the community-building that undergirded the intervention were, however, entirely absent for BSGM living with HIV. Specifically, our analysis showed that BSGM living with HIV responded to their social activation to be PrEP ambassadors, as they were more likely than their control arm counterparts to build new relationships with other BSGM and to maintain established ones.

Taken together, our findings underscore that in this cohort social integration among BSGM was a complex phenomenon that hinged on an underrecognized hierarchy of characteristics that favored younger, gay-identified BSGM as opposed to those who were older and non-gay-identified. Results also suggest that interventions that aim to stimulate community-building among BSGM are likely to reinforce these hierarchies unless there is a concerted attempt to engage with and meet the needs of its underrepresented subgroups. As such, our study has practical implications for researchers and practitioners seeking to engage BSGM in HIV prevention and treatment services. First, as Wilson and Miyashita (2016) argue, targeted HIV prevention efforts among sexual and gender minorities necessarily relies on people's sense of being a part of a common community to be successful. For example, if messaging about the HIV prevention pill PrEP features two Black men in a romantic embrace or a group of young Black men enjoying a night out at a gay bar, the BSGM viewer needs to see themselves in the schema of romantic intimacy or gay social life to see the relevance of the message to their life. Our analysis offers insights into which types of BSGM are less attached to the mainstream of the Black SGM community and, therefore, might be less likely to identify with appeals that center on an openly gay lifestyle.

That said, our analysis also highlights a potential pathway for reaching subgroups that are less integrated with the BSGM community as a whole, namely through their homophilous clustering. That BSGM segregated on the basis of being a part of the same age cohort and sharing the same sexual identity, reveals an opportunity to reach those subgroups with messaging that resonates with their shared life experiences and identity structures. Finally, our study makes it clear that social network interventions, particularly those that leverage peer leaders, need to be cognizant of the diversity within the BSGM community and speak to it directly when recruiting peer leaders, hiring staff who train peer leaders, and designing intervention materials. To these ends, Valente (2012) posits that segmentation based interventions, which acknowledge the relevance of membership in distinct subcommunities, may be best suited for increasing engagement in groups that have been traditionally marginalized within the larger BSGM community.

Having noted the insights of the study, we must also acknowledge its limitations. First, although Facebook is a salient space for peer-based connection and community-building, which was why we leveraged it in the intervention, it is by no means the only way that participants were connected to one another. Offline relationships were almost certainly activated as well. As noted earlier, previous research has shown that Facebook friendships and offline relationships do have a tendency to overlap (Reich et al., 2012; Young et al., 2020). However, the effort required to form and maintain Facebook friendships and the frequency with which relational changes occur relative to changes in offline friendships suggest that the meaning of Facebook ties are likely to be substantively different from their offline counterparts. As such, it remains unclear whether the same mechanisms of integration and segregation would have manifested in the offline networks of BSGM study participants. For example, longitudinal studies of adolescent offline friendships have shown a fair amount of attrition (or dissolution) in named friends over time (Noel and Nyhan, 2011). Conversely, Facebook friendships may be more persistent, not because these relationships are more meaningful, but rather because there is little cost to preserving them for the user. Therefore, it is plausible that we would have observed more significant patterns associated with tie dissolution had we been analyzing offline relationships.

Second, although we accounted for the effect of having more third party (i.e., non-participant) Facebook friends on participants' tendencies to form and maintain relationships with the other BSGM in the study, we were unable to characterize those third party friends. The implication is that network actors, for example bisexual study participants, who demonstrated signs of attenuated social integration in our analysis, may be at less risk for this social outcome than we observed, as they may have formed new Facebook friendships with other BSGM who

were not in the study but who occupy important (albeit unobserved) positions in the BSGM Facebook friendship network.

Finally, by design, this study was contingent on its intervention context and, therefore, findings had to be interpreted with the specific conditions of the network intervention in mind. Additionally, our singular focus on a cohort of BSGM living in Chicago means that we are unable to extrapolate our findings beyond this cohort. Despite its limited generalizability, what we offer is a generalizable analytic framework for evaluating the dynamics of social integration and segregation in other populations and network contexts.

## Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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