AIDS and Behavior (2019) 23:302–311
https://doi.org/10.1007/s10461-018-2262-7

ORIGINAL PAPER

An Investigation of Racial and Ethnic Homophily on Grindr Among an Ongoing Cohort Study of YMSM

Paul Salamanca[1,2] · Patrick Janulis[1,2] · Mich Elliott[1,2] · Michelle Birkett[1,2] · Brian Mustanski[1,2] · Gregory Phillips II[1,2,3]

Published online: 23 August 2018

Abstract
Men who have sex with men (MSM), and especially MSM of color, are disproportionately affected by HIV. Previous research shows that MSM have high levels of racial/ethnic homophily (the tendency for people to have sex with others who share the same racial/ethnic identification) in sexual dyads, which may help explain HIV disparities. This study fills a gap in previous research by grounding network data from a cohort study of young MSM in Chicago (RADAR) in the contexts of virtual spaces (VSs) and examining differences in levels of racial/ethnic homophily using multilevel-logistic-regression models. Results show that Grindr differs from other VSs in proportions of racially/ethnically homophilous dyads and by partner racial/ethnic identification. After controlling for general homophily trends, sex partnerships formed on Grindr by Black MSM were significantly less likely to be homophilous than those of White MSM. While racial/ethnic groups differ in likelihood to form homophilous partnerships, this trend varies by VS.

Keywords HIV · AIDS · MSM · Networks · Race/ethnicity · Virtual spaces

Background

Since the start of the AIDS epidemic, HIV has disproportionately affected men who have sex with men (MSM). As of a 2015 Centers for Disease Control and Prevention (CDC) report, MSM accounted for more than half of the 1.2 million people living with HIV in the United States (US), and for about two-thirds of all new infections each year [1]. Moreover, disparities exist within subgroups of MSM. Black MSM have higher prevalence and incidence of HIV than other MSM racial/ethnic groups; in the US, Black MSM accounted for the highest numbers of both new and existing diagnoses of HIV in 2014, despite comprising around 1% of the population [1–4]. In 2014, the prevalence of HIV among Black MSM was estimated at 36.0%, more than twice the prevalence among White and Hispanic MSM (14.8% and 17.2%, respectively) [5]. Despite the greater burden of HIV in Black MSM, several studies have found that Black MSM report similar rates of condom use, less substance use, and fewer sexual partners than White MSM [6–8]. As individual behavior cannot fully account for HIV disparities, researchers have examined social-contextual and network factors to improve their understanding of these disparities [9]. Investigation into sexual networks of MSM has provided new insights into how HIV spreads within MSM communities, and has also led to compelling explanations of racial/ethnic health disparities. For example, one study of young MSM (YMSM) in Chicago found that while there were no individual-level differences in HIV risk behaviors, differences were found between White MSM and Black MSM in partner characteristics—Black MSM were significantly more likely to have sex partners who were older, Black, and serious partners [8].

Homophily, or the tendency for people to associate with others similar to themselves, has been shown to be a common feature of social relationships. Notably, racial and ethnic homophily creates the strongest divides in social networks; however, networks are also structured around gender, age, education, attitudes, and behavior [10]. This homophily

✉ Gregory Phillips II
glp2@northwestern.edu

1 Institute for Sexual and Gender Minority Health and Wellbeing, Northwestern University, Chicago, IL, USA

2 Department of Medical Social Sciences, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

3 625 N. Michigan Ave, Suite #14-043, Chicago, IL 60611, USA

is shaped by a number of selection forces at the individual and environmental level that make it easier for those with similar attributes to form and maintain relationships with each other; additionally, homophily is closely related to social influence, where the opinions, attitudes, and behaviors of people can greatly influence the opinions, attitudes, and behaviors of similar-others in their social networks [10]. Recent studies among the sexual networks of MSM confirm the importance of racial/ethnic homophily and have found high levels of racial/ethnic homophily within sexual dyads, wherein people are more likely to have sex with others who share the same racial/ethnic identification [8]. Additionally, qualitative studies have shown that White MSM are perceived to be the most desirable by all MSM, whereas Black and Asian MSM are seen as the least desirable [11]. While racial/ethnic homophily is widespread within the sexual networks of MSM, this dispreference for Black MSM and potentially other MSM of color may explain differing levels of racial/ethnic homophily and other network measures between racial/ethnic groups [8].

In the past few decades, MSM have increasingly been using online platforms to meet sex partners, with estimated proportions of MSM who use the Internet to meet people ranging between 75 and 85% [8, 12]. But in recent years with changing mobile technologies, studies have also shown that MSM are increasingly using Internet-enabled geosocial networking applications (GSNAs) to meet other men (for both sexual and non-sexual partnerships) [13–15]—for example, Grindr, a popular GSNA, reports more than 3 million daily active users in 234 different countries as of 2017 [16]. Similar to physical spaces, the users of these various GSNAs also have observable social norms, and norms can differ between virtual spaces. A study of social media users found that users negotiated what kind of content they would post on different social media platforms based on whether content was "appropriate" (i.e. normative) for that platform [17], and norms can be found on GNSAs as well. For example, Blackwell et al.'s series of qualitative interviews with Grindr users showed common social behavioral norms such as ignoring or blocking profiles without a picture of the user's face, resulting in a normative social incentive to create an identifiable and coherent profile in that space [18].

Furthermore, we can conceptualize these social norms within virtual spaces (VSs) as distinct and distinguishable from social norms in physical spaces, as people develop strategies for managing their online image and self-presentation that are specific to VSs and not found in physical spaces [19]. Blackwell et al. also make this distinction in their critical approach to virtual social spaces, arguing that GSNAs allow for the complex layering of both physical and online boundaries which could result in distinct dual presentations of identity—e.g. when MSM were using Grindr but were physically present in "straight" spaces, their physical presentations of sexual identity and virtual presentations of sexual identity on Grindr could be at odds [18]. Thus, online and virtual presentations of the self and self-identity cannot be reduced to mere reflections of physical presentations, as users are able to strategically manage their online self-presentation (in different ways than they do offline). For example, a content analysis of profiles on another popular GSNA for MSM called Jack'd found significant differences between profiles of MSM in different racial groups [14, 16, 20]. In the sample, Black men more frequently discussed their masculinity than MSM in other racial/ethnic groups. Similarly, Asian MSM presented descriptions of sexual position preference in their profiles much less than other MSM. Additionally, in a study of Grindr profiles, differences between racial/ethnic groups of MSM were found in disclosing race/ethnicity on their Grindr profiles—White MSM had the highest rates of displaying race/ethnicity at 65.6% as compared to Black, Latino, and Asian MSM who were at 11.9%, 10.9%, and 2.4%, respectively. These are both examples of unique online strategies for managing self-presentation that are not found offline—in physical spaces, MSM are limited in their ability to affect how others perceive their masculinity or their race/ethnicity, whereas online those self-presentations can be managed through profiles.

Although there has been research on sexual scripts within MSM in various contexts [21, 22], sexual network analyses with MSM, and in particular YMSM, thus far have not taken into account the differing social norms within the spaces in which YMSM meet sex partners [8, 23, 24]. Few studies have focused on the role of virtual and situational social norms on the sex networks of YMSM, and on sex behaviors that occur from partnerships developed through GSNAs. This analysis will bridge this gap by analyzing the sexual networks of YMSM as they are situated in various VSs. As Grindr was the most reported VS for meeting sex partners, this analysis will attempt to contextualize sexual decision making in Grindr's particular social norms to explain why racial/ethnic differences in sexual network structures may occur. Thus, the aim of the current study is to examine racial/ethnic homophily in the sexual networks of YMSM in VSs by comparing the networks of partners met on Grindr to those met in other VSs.

Methods

Participants

Data for this paper were collected from RADAR, an ongoing cohort study of racially/ethnically diverse YMSM in Chicago. To be enrolled in the RADAR study, participants must be between 16 and 29 years of age, assigned male sex at birth, and speak English. Moreover, participants must report

having had sex with a man in the past year or identify as gay or bisexual. Every 6 months, participants complete a network interview and a psychosocial survey, and provide biological samples for HIV and sexually transmitted infection (STI) testing. In social network terminology, participants are called the egos, and the people who populate their networks (i.e. the partners that they list during the network interview) are called alters [25].

Ego-Level Attributes

Participant- or ego-level data were primarily collected through a self-administered computer survey. This survey assesses various psychological and social metrics such as demographic information, substance use behaviors, and strength of personal relationships. From this survey, the variables used were: age, gender, sexual orientation, education level, employment status, and race/ethnicity. Looking at ego race/ethnicity specifically, participants could select as many options as were applicable from the following list of racial categories: "American Indian or Alaska Native;" "Black/African-American;" "Asian;" "Native Hawaiian or Other Pacific Islander;" "White;" and "Other." In a separate question, participants were asked if they identified as Hispanic or Latino. Following the CDC approach, if any participant marked themself or any alters as Hispanic, they were coded as Hispanic (thus, the Hispanic category may contain participants of any racial category) [26]. Next, any selection of the established categories was coded as such (e.g., the "White" and "Black" categories in this study contain only non-Hispanic White and non-Hispanic Black YMSM). Any participant who wrote in several racial categories or a variant of "Multi-Racial" was coded as "Multi-Racial." Lastly, any participant whose answer did not fit one of the above was coded as "Other." Furthermore, all study participants had finger stick blood tested for HIV at the time of their baseline study visit using the Alere™ Determine™ HIV 1/2 Ab/Ag Combo 4th generation point of care (POC) test. All subjects who test "preliminary positive" on POC HIV tests received lab-based confirmatory testing following the current CDC HIV testing algorithm guidelines [27] .

Alter-Level Attributes

Partner- or alter-level data were primarily collected through the social network interview. In RADAR, network data are collected through an interviewer-assisted touchscreen-enabled application called netCanvas-R [28]. Study participants are prompted to name their social, sexual, and drug use partners within the past 6 months; provide information on these alters (e.g., relationship role, age, gender, race/ethnicity); and create links between alters in a participant aided sociogram approach [29]. All alter-level data collected through the network survey are treated as perceived (e.g. perceived HIV status, perceived age) because the data are reported from from the ego's viewpoint. The alter-level variables used were: age, gender, sexual orientation, race/ethnicity, HIV status, location met (online vs. elsewhere), and the specific application on which they met. The alter race/ethnicity variable was coded in the same way as the egos' race/ethnicity. Using both ego and alter race/ethnicity, a variable for racial/ethnic homophily was created where a sexual dyad was considered homophilous if both ego and alter were within the same racial/ethnic category.

Analytic Sample

A flowchart of how the analytic sample was obtained is found in Fig. 1. Although RADAR is a longitudinal study, this paper only uses baseline data that were collected as of June 22, 2016. Of the 773 individuals who completed a study visit by this date, only participants who reported meeting at least one sex partner online or through mobile applications were included within the analytic sample. At baseline, 677 participants (87.6%) reported meeting at least one sex partner, for a total of 2254 sex partners. Of those 677 participants, 429 participants (63.4%) reported meeting at least one sex partner online or through mobile applications for a total of 1183 sex partners (52.5%). Of these 429 participants, there were two who identified with unlisted racial categories and only one who identified as "Native Hawaiian or Other Pacific Islander." These participants' data were excluded due to extremely low cell counts that prevented our ability to investigate racial/ethnic homophily. Additionally, because there is racial/ethnic heterogeneity within multiracial people as an analytic group, homophily measures are inadequate in characterizing partnerships between multiracial people. Thus, the 36 participants who identified as multiracial were also excluded from this investigation. Lastly, 18 egos did not identify as male and were also excluded from this investigation. The final analytic sample thus contained 372 egos connected to 1022 alters that were met online or through mobile applications.

Statistical Analysis

Data cleaning and coding, as well as univariate analyses at the alter and ego level, were conducted in R using the generalized linear models (glm) package for binomial and multinomial logistic regression [26]. Since RADAR collects nested network data (egos reporting on sets of alters), pooled regression analyses would result in biased/invalid statistical estimates. Thus, each alter is treated as a unit of analysis within the ego. Differences within an ego's alters constitute within-level variation. Conversely, the differences between egos are treated as between-level variation. A statistical

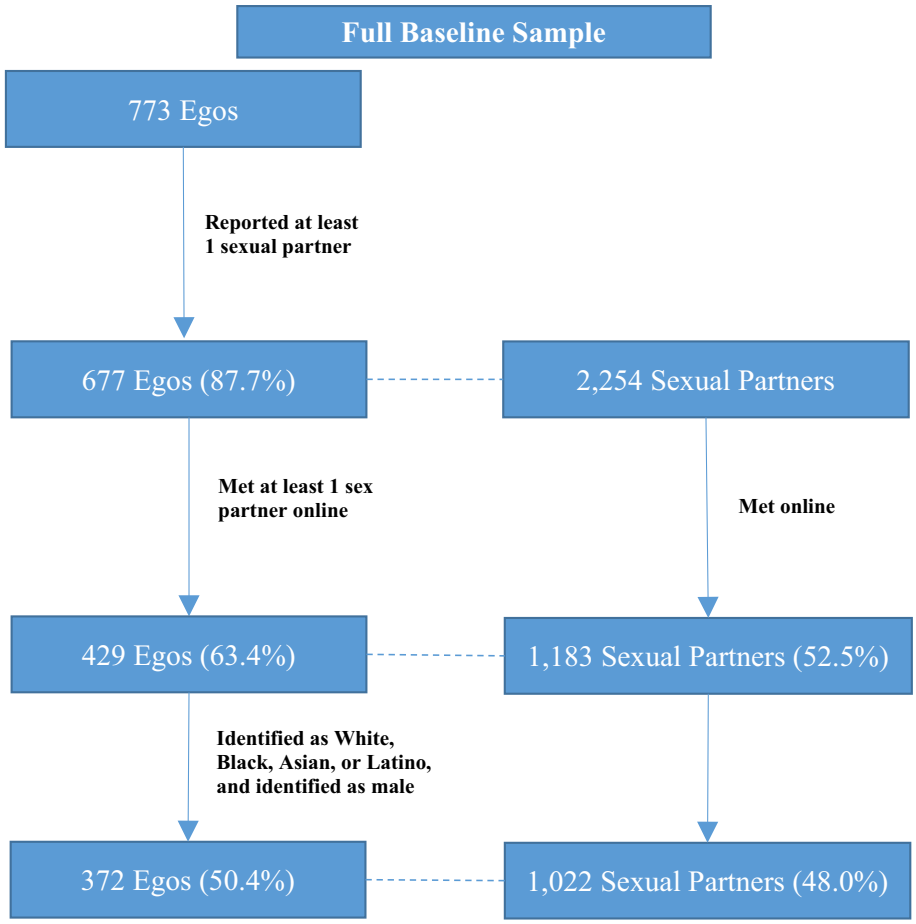

Fig. 1 Flowchart of analytic sample

model which treats these variations as separate is necessary; thus, multilevel logistic models are able to account for these two levels of variation. Consequently, multilevel analysis was used to account for this nested variance structure [30, 31]. Multilevel analyses using random intercepts, random slopes, and accounting for between variation at the ego and within variation at the alter level were conducted using Mplus [32]. The main analysis was a multilevel logistic model, with racial/ethnic homophily as the outcome variable. The between-level variables used were the racial/ethnic categorizations of the egos, with White egos used as a reference group. Additionally, the slope of Grindr was allowed to vary by the between-level racial/ethnic categories, again with White egos as the reference group. An additional measure of homophily called the E-I index was calculated for each ego [33]. The E-I index is calculated using this ratio:

$$\frac{E-I}{E+I}$$

where E denotes the number of external (or heterophilous) ties and I denotes the number of internal (or homophilous) ties. A negative E-I index suggests a generally homophilous network of partners, and vice versa.

Results

Ego Demographics

Descriptive statistics of egos are shown in Table 1. In the analytic sample of 372 egos who had met at least one sex partner online or through GSNAs, the mean age was 21.9 years. All egos were cisgender men. Most of the sample identified as gay (76.1%), with 65 (17.5%) identifying as bisexual. The sample was also racially/ethnically diverse, with similar proportions of White (30.1%), Black (31.7%), and Hispanic (35.2%) participants. However, Asian participants (3.0%) were underrepresented in the sample.

Sex Alter Demographics

Sex alter demographics are also located in Table 1. In the analytic sample of 1022 alters, the mean age was 25.8 years. Most (96.3%) were men, and 830 (81.2%) identified as gay or lesbian, followed by 110 (10.8%) who identified as bisexual. In terms of race/ethnicity, there were 442 (43.2%) White

Table 1 Descriptive statistics of RADAR egos and sex alters met online

	Egos ($n=372$)		Alters ($n=1022$)	
	M	SD	M	SD
Age (years)	21.9	3.7	25.8	7.1
	N	%	*N*	%
Gender				
Male	372	100.0	984	96.3
Female	0	0	22	2.2
Other	0	0	16	1.6
Sexual orientation				
Gay (gay/lesbian for alters)	283	76.1	830	81.2
Bisexual	65	17.5	110	10.8
Heterosexual/straight	2	0.5	16	1.6
Other	22	5.9	66	6.5
Race/ethnicity				
White	112	30.1	442	43.2
Black	118	31.7	247	24.2
Hispanic	131	35.2	252	24.7
Asian	11	3.0	31	3.0
Multiracial/other	–	–	50	4.9
	Tested		Perceived	
	N	%	*N*	%
HIV status				
HIV-positive	72	19.4	92	9.0
HIV-negative	300	80.6	699	68.4
Unknown	–	–	231	22.6
Education				
Less than high school	52	14.0	–	–
High school/GED/trade certficate	87	23.4	–	–
At least some college	233	62.6	–	–
Employment status				
Unemployed	109	29.3	–	–
Employed	263	70.7	–	–
	Egos who met partners		Alters met	
	N	%	*N*	%
Virtual spaces (Top 5)				
Grindr	170	45.7	473	46.3
Jack'd	73	19.6	135	13.2
Facebook	59	15.9	89	8.7
Tinder	55	14.8	81	8.5
Adam4Adam	26	7.0	41	4.0

partners, 247 (24.2%) Black partners, 252 (24.7%) Hispanic partners, 31 (3.0%) Asian partners, and 50 (4.9%) Multiracial or other (including Native American) partners.

Partnership Characteristics

Within the sample of egos who reported meeting at least one sex partner online, 426 egos reported a total of 1789 sex partners. The majority of these partners—1179 (65.9%) were met online or through GSNAs; the remainder were met

at school (181, 10.1%), at a bar or club (102, 5.7%), through work (47, 26.3%), or through other venues (280, 15.7%). Egos who met alters online or through GSNAs reported meeting these partners in 45 different VSs. In the analytic sample, nearly half of sex partners met online (473, 46.3%) were met through Grindr, which was the most represented VS in the sample. The next top four were Jack'd with 135 (13.2%), Facebook with 89 (8.7%), Tinder with 81 (8.5%), and Adam4Adam with 41 (4.0%). Of these top five virtual spaces, three (Grindr, Jack'd, and Tinder) are GSNAs and the other two are online social networking sites.

Homophily

Within an unconditional random intercepts model (i.e., a null model with no predictors) of racial/ethnic homophily, there was significant residual variance of racial/ethnic homophily between egos ($\sigma^2 = 4.10$, $p < 0.001$). This residual variance allows for the addition of more predictors, such as the location of platform where partners were met. When the online platform (Grindr vs. other VSs) was added as a predictor, there was a significantly negative effect on homophily [odds ratio (OR) 0.47]. This means that on average, sex partners met on Grindr were about half as likely to be homophilous partnerships than sex partners met in other VSs.

As use of Grindr was significantly associated with racial/ethnic homophilous partnering, race/ethnicity of ego was added to the model to look at differences in homophily by race/ethnicity. Among YMSM who met partners on Grindr, there were no differences in levels of racial/ethnic homophily between Hispanic, White, and Asian egos (Table 2). However, Black egos were significantly less likely than White egos to have racially/ethnically homophilous sex partners met on Grindr (OR 0.05). Looking at VSs other than Grindr, Hispanic and Asian egos all reported significantly fewer homophilous sexual partnerships than White egos (OR 0.18 and OR 0.03, respectively). Although some of these point estimates are rather small and might be driven by smaller cell sizes (further explained in Table 3), confidence intervals shown in Table 2 remain fairly tight. Conversely, on VSs other than Grindr, Black egos were more likely to report homophilous partnerships than White egos (OR 2.15), although this association was marginally insignificant ($p = 0.07$). At least for Black egos, this was a reversal of general racial/ethnic homophilous trends—on VSs outside of Grindr, Black YMSM were the most likely to have homophilous sex partners, but within Grindr, Black YMSM were significantly less likely to have homophilous sex partners. Table 4 shows the number of egos who have met at least one sex partner on Grindr or on another virtual space (egos who use multiple virtual spaces to meet partners may be in

Table 2 Odds ratio of simple slopes of multilevel logistic regression model of the association between racial/ethnic homophily and app use

Ego race/ethnicity	Odds ratios for racial/ethnic homophily			
	Grindr		Other VS	
	Estimate (95% CI)	*p* value	Estimate (95% CI)	*p* value
White (reference)	–	–	–	–
Black	**0.05 (0.015, 0.14)**	< 0.01	2.15 (0.94, 4.91)	0.07
Hispanic	1.23 (0.68, 2.23)	0.71	**0.18 (0.08, 0.42)**	< 0.01
Asian	0.31 (0.09, 1.02)	0.05	**0.03 (0.01, 0.17)**	< 0.01

Bolded estimates indicate significance at 95% confidence

Table 3 Sex partnerships within RADAR by race/ethnicity, by apps used to meet partners

Ego race/ethnicity	White	Black	Hispanic	Asian	Multiracial/other	Average E-I index	Total
Grindr (Egos, $N = 176$)							
White	156 (65.5)	15 (6.3)	40 (16.8)	13 (5.5)	14 (5.9)	−0.30	238
Black	20 (35.1)	11 (19.3)	24 (42.1)	1 (1.8)	1 (1.8)	0.30	57
Hispanic	65 (40.1)	9 (5.6)	76 (46.9)	4 (2.5)	8 (4.9)	0.04	162
Asian	12 (80.0)	0 (0.0)	1 (6.7)	1 (6.7)	1 (6.7)	0.90	15
Other virtual spaces (Egos, $N = 284$)							
White	105 (70.5)	5 (3.4)	27 (18.1)	5 (3.4)	7 (4.7)	−0.32	149
Black	13 (6.2)	168 (79.6)	14 (6.6)	2 (0.9)	14 (6.6)	−0.65	211
Hispanic	67 (37.4)	38 (21.2)	67 (37.4)	3 (1.7)	4 (2.2)	0.10	179
Asian	4 (36.4)	1 (9.1)	3 (27.3)	2 (18.2)	0 (0.0)	0.72	11

Table 4 Egos who have met sex partners by RADAR ego race/ethnicity and virtual space

Ego race/ethnicity	Virtual space	
	Grindr (*N*, %)	Other VS (*N*, %)
White	72 (64.3)	72 (64.3)
Black	21 (17.8)	108 (91.5)
Hispanic	70 (53.4)	82 (62.6)
Asian	7 (63.6)	6 (54.5)
Total	170	284

both categories). Of the 118 Black YMSM in the analytic sample, 21 (17.8%) reported meeting at least one partner on Grindr. Conversely, 108 (91.5%) of Black YMSM in the analytic sample reported meeting at least one partner on a VS other than Grindr. Furthermore, homophily significantly varied across venue attendance types ($F = 6.23$, $p < 0.01$) with homophily tending to be higher among individuals who met partners at both types of VSs ($M = -0.24$, $SD = 0.71$) and only other VSs ($M = -0.31$, $SD = 0.89$) compared to individuals who met partners only on Grindr ($M = 0.06$, $SD = 0.88$).

Race/Ethnicity of Partners

Table 3 shows a more in-depth look at the dyadic partnerships by ego and alter race/ethnicity, and then by VS. Table 3 also shows the E-I index for each racial/ethnic group, where homophilous ties are considered internal links and heterophilous ties are considered external links [33]. The E-I Index significantly varied by race/ethnicity overall ($F = 19.38$, $p < 0.01$) and for both Grindr ($F = 7.16$, $p < 0.01$) and other VSs ($F = 16.36$, $p < 0.01$). Looking at rates of homophily across all virtual spaces, 92 (79.3%) of white participants, 105 (82.0%) of Black participants, 75 (55.6%) of Hispanic participants, and 2 (18.2%) of Asian participants all reported at least one racially/ethnically homophilous sex partnership. Comparing alter and ego race/ethnicity, alter racial/ethnic proportions are similar between Grindr and other VSs for all ego racial/ethnic groups except for Black YMSM. Focusing on the partner proportions of Black YMSM, on Grindr the majority of Black egos' sex partners (24, 42.1%) were Hispanic, followed by White partners (20, 35.1%)—only 19.3% were also Black. In contrast, on other VSs, the vast majority of Black egos' sex partners were also Black (168, 79.6%).

Discussion

In general, we found high levels of racial/ethnic homophily in the sexual networks of YMSM in VSs, which corroborates previous research on the composition of sexual networks of YMSM [34]. This supports our hypothesis that YMSM are generally racially/ethnically homophilous with their sex partners, both in physical spaces and in VSs.

However, these trends in racial/ethnic homophily are not monolithic. In fact, there was significant variation in levels of racial/ethnic homophily by both ego racial/ethnic identification and by VS (Grindr vs. others). In our study, Black YMSM had significantly fewer racially/ethnically homophilous partnerships formed through Grindr than White YMSM, even after controlling for general racially/ethnically homophilous trends of YMSM. One possible explanation for this finding may lie in the diverse nature of VSs. As physical spaces, and notably metropolitan areas like Chicago, remain highly segregated along racial/ethnic lines, VSs may be less segregated than physical spaces, providing users of differing racial/ethnic backgrounds with more opportunities to interact with one another [8, 23]. As VSs are much less limited by physical location, social interactions (and subsequently, sexual encounters) that are more difficult to facilitate in physical spaces may become more commonplace in VSs [35]. Interactions between MSM of different racial/ethnic groups or between MSM who do not frequent the same physical spaces are therefore more accessible, thus leading to less racial/ethnic sexual homophily.

That being said, not all VSs may be conducive to racial/ethnic heterophily. GSNAs are unique VSs in that users are grounded in a physical location. Looking at Grindr specifically, users are presented with a list of people within a certain geographical proximity, with whom they can interact. Thus, to facilitate an initial interaction, two Grindr users must be within a certain distance of each other (although, subsequent interactions are not limited in this way). Therefore, social interactions on Grindr between MSM who do not frequent the same physical spaces are only facilitated insofar as those men are at some point in the same area. Similar to effects of urban segregation, racial/ethnic mixing on Grindr is consequently inihibited by this feature. Relative to other VSs, Grindr may only facilitate racial/ethnic mixing as long as men are in close proximity within a diverse neighborhood.

Additionally, this explanation does not justify why Grindr is only associated with less homophily for certain racial/ethnic groups (namely Black MSM), and moreover, why Black MSM are more homophilous on VSs other than Grindr. Our findings on Black homophily add nuance to previous research on variations in levels of racial/ethnic homophily, which have found that Black MSM are highly homophilous, [36–38] but did not account for social spaces in which partnerships were identified. Thus, the answer may lie in the kinds of men that use Grindr and in the social norms of Grindr as a VS. As shown in Table 3, Black MSM tended to meet partners through other VSs, while White MSM and other racial/ethnic groups were somewhat split between the two categories. White MSM in the sample had the largest

proportion who had met partners on Grindr. These findings mirror other research with Grindr users, which demonstrated the greatest proportion of users were White MSM (around 40% of users in both samples), with Black MSM between 4 and 7% [39]. Thus, the disproportionate representation of White MSM on Grindr may indicate its existence as a space in which White MSM are "preferred" as sex partners, while Black MSM are "dispreferred;" sociosexual norms of Grindr as a VS may indicate White partners as sexually desirable and Black partners as less desirable or even undesirable. Looking at Black heterophily through this lens, Black users may tend to have sex partners that are not Black because there are few other Black Grindr users. Furthermore, it makes sense that many BMSM would choose to use other GSNAs and frequent other VSs to find sex partners, especially if they are looking for other partners that are Black.

Limitations

Due to how race/ethnicity was coded, estimates of multiracial homophily in sexual dyads are difficult to interpret, and thus multiracial homophily was not included in this analysis. For example, a sexual dyad between a biracial White MSM and a monoracial White MSM would be coded as heterophilous, despite the two partners sharing a racial identification of "White." The exclusion of multiracial people from this investigation should be a topic for future investigation. Although the sample was racially/ethnically diverse, the dataset suffers from low cell counts of egos and alters in certain racial categories (namely Native American, Native Alaskan, Native Hawaiian, Asian, and Pacific Islander MSM), which affects the estimation of logistic regression models. Different coding of participants' responses to race (such as aggregating categories or interpreting open responses) could dramatically change results in other studies, and comparisons between past studies and future investigations need to be carefully and explicitly examined with respect to coding methodologies. Moreover, in terms of generalizability, part of the sample was recruited through partner and peer recruitment, a possible source of selection bias, and all the data in this analysis are self-reported from the viewpoint of the egos. As the race/ethnicity of alters was based on the ego's perception rather than on self-report, there is potential for bias and inaccurate reporting; however, another study of sexual networks of YMSM found a high degree of accuracy in perceived race/ethnicity, strengthening its use within this analysis [40]. Furthermore, it is also possible that selection effects may play a role in how levels of homophily differ by virtual space. However, among the egos in the analytic sample, a Chi squared model comparing partners met online vs. those met offline showed that levels of homophily were significantly different between the two groups of partners ($\chi^2 = 5.9273$, $p = 0.01$). This dissimilarity between online and offline ties supports our explanation of norms rather than selection effects. Comparisons between online and offline ties are beyond the scope of this paper (such as differences in levels of homophily of offline ties and their comparisons of offline ties among racial/ethnic groups), and future investigations should further explore those differences and similarities. Lastly, while the dataset comes from an ongoing cohort study, sufficient data to examine this question is only currently available from the baseline data. Accordingly, this analysis used cross-sectional data which limits our causal interpretations.

Conclusion

This research presents important implications for future investigations into network drivers of HIV among YMSM in VSs. Racial/ethnic homophily in sexual networks can perpetuate disparities, as individuals in high HIV prevalence groups (such as BMSM) are more likely to have sex with others in the same group. Thus, for interventions that are implemented within a certain VS (such as Grindr), researchers must be cognizant of the groups of MSM that actually frequent a virtual space, as well as the types of partnerships that are formed in that space. This study has shown that both of those properties can vary significantly between virtual spaces.

More work is needed to study the determinants of racial/ethnic homophily, especially with respect to how MSM of color negotiate finding sexual partners in spaces where they are less desired as partners and how MSM of color navigate heterophilous partnerships. Although there have been many investigations into heterophilous partnerships, these remain understudied with respect to networks and spaces [41, 42]. As there are many ways to eroticize (or deprecate) people of color, these future investigations should include qualitative approaches as well—in order to tease out the complexities and intersectionalities that sexual minorities of color face in their sex lives and in order to gain a more comprehensive understanding of what causes these widening health inequalities.

Acknowledgements RADAR is supported by NIDA and NIAID of the NIH (U01DA036939, PI: Mustanski; R01DA025548-S1, PI: Mustanski; R03DA033906, PI: Birkett; K08DA037825, PI: Birkett; P30AI117943, PI: D'Aquila). The research is supported by the SROP program of the Northwestern Graduate School, and the Mellon-Mays Undergraduate Fellowship of the Andrew W. Mellon Foundation.

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflicts of interest.

Ethical Approval All procedures involving human participants were in accordance with the ethical standards of the institutional review board at Northwestern University and with the 1964 Helsinki declaration and its later amendments.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Centers for Disease Control and Prevention. CDC fact sheet: HIV among gay and bisexual men. Atlanta: CDC; 2015.
2. Centers for Disease Control and Prevention. Prevalence and awareness of HIV infection among men who have sex with men—21 cities. Morb Mortal Wkly Rep. 2010;59(37):1201–7.
3. Centers for Disease Control and Prevention. CDC fact sheet: HIV among African American gay and bisexual men. Atlanta: CDC; 2016.
4. Matthews DD, Herrick A, Coulter RW, Friedman MR, Mills TC, Eaton LA, et al. Running backwards: consequences of current HIV incidence rates for the next generation of black MSM in the United States. AIDS Behav. 2016;20(1):7–16.
5. Centers for Disease Control and Prevention. HIV infection risk, prevention, and testing behaviors among men who have sex with men—National HIV behavioral surveillance, 20 U.S. Cities, 2014. HIV Surveillance Special Report. 2016 (15).
6. Millett GA, Flores SA, Peterson JL, Bakeman R. Explaining disparities in HIV infection among black and white men who have sex with men: a meta-analysis of HIV risk behaviors. AIDS. 2007;21(15):2083–91.
7. Magnus M, Kuo I, Phillips G, Shelley K, Rawls A, Montanez L, et al. Elevated HIV prevalence despite lower rates of sexual risk behaviors among black men in the District of Columbia who have sex with men. AIDS patient care and STDs. 2010;24(10):615–22.
8. Mustanski B, Birkett M, Kuhns LM, Latkin CA, Muth SQ. The role of geographic and network factors in racial disparities in HIV among young men who have sex with men: an egocentric network study. AIDS Behav. 2015;19(6):1037–47.
9. Clerkin EM, Newcomb ME, Mustanski B. Unpacking the racial disparity in HIV rates: the effect of race on risky sexual behavior among Black young men who have sex with men (YMSM). J Behav Med. 2011;34(4):237–43.
10. McPherson M, Smith-Lovin L, Cook JM. Birds of a feather: homophily in social networks. Ann Rev Soc. 2001;27:415–44.
11. Paul JP, Ayala G, Choi K-H. Internet sex ads for MSM and partner selection criteria: the potency of race/ethnicity online. J sex Res. 2010;47(6):528–38.
12. Phillips G, Birkett M, Hammond S, Mustanski B. Partner preference among men who have sex with men: potential contribution to spread of HIV within minority populations. LGBT Health. 2016;3(3):225–32.
13. Rosser BS, Wilkerson JM, Smolenski DJ, Oakes JM, Konstan J, Horvath KJ, et al. The future of Internet-based HIV prevention: a report on key findings from the men's INTernet (MINTS-I, II) sex studies. AIDS Behav. 2011;15(1):91–100.
14. Landovitz RJ, Tseng C-H, Weissman M, Haymer M, Mendenhall B, Rogers K, et al. Epidemiology, sexual risk behavior, and HIV prevention practices of men who have sex with men using GRINDR in Los Angeles, California. J Urban Health. 2013;90(4):729–39.
15. Benotsch EG, Kalichman S, Cage M. Men who have met sex partners via the Internet: prevalence, predictors, and implications for HIV prevention. Arch Sex Behav. 2002;31(2):177–83.
16. Grindr press kit (press release). 2017.
17. Zhao X, Lampe C, Ellison NB, editors. The social media ecology: user perceptions, strategies and challenges. In: Proceedings of the 2016 CHI conference on human factors in computing systems. New York: ACM; 2016.
18. Blackwell C, Birnholtz J, Abbott C. Seeing and being seen: co-situation and impression formation using Grindr, a location-aware gay dating app. New Media Soc. 2015;17(7):1117–36.
19. Rui JR, Stefanone MA. Strategic image management online: self-presentation, self-esteem and social network perspectives. Inf Commun Soc. 2013;16(8):1286–305.
20. Zou H, Fan S. Characteristics of men who have sex with men who use smartphone geosocial networking applications and implications for HIV interventions: a systematic review and meta-analysis. Arch Sex Behav. 2016;46:1–10.
21. Mutchler MG. Young gay men's stories in the states: scripts, sex, and safety in the time of AIDS. Sexualities. 2000;3(1):31–54.
22. Parsons JT, Vicioso KJ, Punzalan JC, Halkitis PN, Kutnick A, Velasquez MM. The impact of alcohol use on the sexual scripts of HIV-positive men who have sex with men. J Sex Res. 2004;41(2):160–72.
23. Birkett M, Kuhns LM, Latkin C, Muth S, Mustanski B. The sexual networks of racially diverse young men who have sex with men. Arch Sex Behav. 2015;44(7):1787–97.
24. Tieu H-V, Liu T-Y, Hussen S, Connor M, Wang L, Buchbinder S, et al. Sexual networks and HIV risk among black men who have sex with men in 6 US cities. PLoS ONE. 2015;10(8):e0134085.
25. Miller B. "Dude, where's your face?" Self-presentation, self-description, and partner preferences on a social networking application for men who have sex with men: a content analysis. Sex Cult. 2015;19(4):637–58.
26. Knoke D, Yang S. Social network analysis. Thousand Oaks: Sage; 2008.
27. Control CfD, Prevention. Laboratory testing for the diagnosis of HIV infection: updated recommendations. Atlanta: Centers for Disease Control and Prevention; 2014.
28. Hogan B, Melville JR, Philips GL II, Janulis P, Contractor N, Mustanski BS, et al. Evaluating the paper-to-screen translation of participant-aided sociograms with high-risk participants. San Jose: Computer Human Interaction '16; 2016.
29. Hogan B, Carrasco JA, Wellman B. Visualizing personal networks: working with participant-aided sociograms. Field Methods. 2007;19(2):116–44.
30. R Core Team. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2015.
31. Venables WN, Ripley BD. Random and mixed effects. Modern applied statistics with S. Berlin: Springer; 2002. p. 271–300.
32. Snijders TA. Multilevel analysis. Berlin: Springer; 2011.
33. Krackhardt D, Stern RN. Informal networks and organizational crises: an experimental simulation. Soc Psychol Q. 1988. https://doi.org/10.1177/1525822X06298589.
34. Muthén LK, Muthén BO. Mplus user's guide. 6th ed. Los Angeles: Muthén & Muthén; 1998–2010.
35. Logan JR. The persistence of segregation in the 21st century metropolis. City Commun. 2013;12(2):160–8.
36. Raymond HF, McFarland W. Racial mixing and HIV risk among men who have sex with men. AIDS Behav. 2009;13(4):630–7.
37. Mimiaga MJ, Reisner SL, Cranston K, Isenberg D, Bright D, Daffin G, et al. Sexual mixing patterns and partner characteristics of black MSM in Massachusetts at increased risk for HIV infection and transmission. J Urban Health. 2009;86(4):602–23.
38. Tieu H-V, Murrill C, Xu G, Koblin BA. Sexual partnering and HIV risk among black men who have sex with men: New York City. J Urban Health. 2010;87(1):113–21.

39. Kaltenbrunner A, Scellato S, Volkovich Y, Laniado D, Currie D, Jutemar EJ, et al. editors. Far from the eyes, close on the web: impact of geographic distance on online social interactions. In: Proceedings of the 2012 ACM workshop on workshop on online social networks. New York: ACM; 2012.
40. Phillips G 2nd, Janulis P, Mustanski B, Birkett M. Validation of tie corroboration and reported alter characteristics among a sample of young men who have sex with men. Soc Netw. 2017;48:250–5.
41. Bubriski A. Interracial lesbian and gay couples: navigating private and public experiences. Electron Theses Dissertations. 2013. http://stars.library.ucf.edu/etd/2610
42. Rostosky SS, Riggle ED, Savage TA, Roberts SD, Singletary G. Interracial same-sex couples' perceptions of stress and coping: an exploratory study. J GLBT Fam Stud. 2008;4(3):277–99.