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### Title

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### Permalink

<https://escholarship.org/uc/item/90m9s17s>

### Journal

J AIDS Journal of Acquired Immune Deficiency Syndromes, 78(2)

### ISSN

1525-4135

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### Publication Date

2018-06-01

### DOI

10.1097/qai.0000000000001645

Peer reviewed



# HHS Public Access

Author manuscript

*J Acquir Immune Defic Syndr.* Author manuscript; available in PMC 2019 June 01.

Published in final edited form as:

*J Acquir Immune Defic Syndr.* 2018 June 01; 78(2): 163–168. doi:10.1097/QAI.0000000000001645.

## Social Network Support and Decreased Risk of Seroconversion in Black MSM: Results of the BROTHERS (HPTN 061) Study

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### Abstract

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Conflicts of Interest

The additional authors have nothing to declare.

**Background and Setting**—Black men who have sex with men (MSM) in the United States (U.S.) have disproportionately high HIV infection rates. Social networks have been shown to influence HIV risk behavior; however, little is known about whether they affect the risk of HIV seroconversion. This study uses data from the BROTHERS (HPTN 061) study to test whether contextual factors related to social networks are associated with HIV seroconversion among black MSM.

**Methods**—We analyzed data from the BROTHERS study (2009–2011), which examined a multi-component intervention for black MSM in 6 U.S. cities. We ran a series of Cox regression analyses to examine associations between time-dependent measures of network support (personal/emotional, financial, medical, and social participation) and time to HIV seroconversion. We ran unadjusted models followed by models adjusted for participant age at enrollment and study location.

**Results**—A total of 1000 black MSM tested HIV negative at baseline and were followed at 6- and 12-month study visits. Twenty-eight men tested HIV positive. In adjusted hazard ratio models, study participants who remained HIV negative had higher proportions of social network members who provided personal/emotional (0.92 [95% CI = (0.85, 0.99)]), medical (0.92 [95% CI = (0.85, 0.99)]), or social participation (0.91 [95% CI = (0.86, 0.97)]) support.

**Conclusion**—Findings suggest that the increased presence of social network support can be protective against HIV acquisition. Future research should explore the processes that link social network support with sexual and other transmission risk behaviors as a basis to inform HIV prevention efforts.

### Keywords

Men who have sex with men; African Americans; social networks; social support; HIV seroconversion; prevention of sexual transmission

## Introduction

Despite evidence of a recent reduction in overall HIV incidence in the United States<sup>1</sup>, disparities in rates of HIV infection continue to exist among blacks, Latinos, and men who have sex with men. In particular, black men who have sex with men (BMSM) disproportionately represent incident HIV cases when compared to white MSM. Recent estimates indicate that BMSM accounted for 39% of new infections in MSM in 2015, and BMSM between the ages of 13 and 24 experienced an 87% increase in new HIV cases between 2005 and 2014.<sup>2</sup> Previous research indicates that individual risk factors such as condomless anal sex or substance use within the context of sexual activity do not provide sufficient explanations for these disparate infection rates<sup>3</sup>, though there is evidence that decreased HIV testing frequency contributes to increased HIV incidence in this population.<sup>4</sup>

In recent years, structural factors such as unemployment, lower income, economic hardships, incarceration, and limited access to health care/antiretroviral treatment (e.g., being uninsured or underinsured) have been highlighted as contributors to HIV infection disparities and decreased HIV testing access in BMSM.<sup>5–9</sup> There is also evidence that BMSM may be more likely to select sexual partners from communities of BMSM, which can lead to an increased

potential for HIV exposure due to a higher background prevalence of HIV.<sup>6</sup> While recent modeling research demonstrated that multiple sources significantly contribute to this disparity (including HIV care cascade challenges, partnership selection, and HIV-related stigma), several possible risk factors remain underexplored.<sup>10</sup>

A person's social relationships may significantly affect one's HIV risk in a myriad of ways. Friends, romantic partners, family members, or others who frequently interact with a person<sup>11</sup> may influence behavioral choices. In particular, social networks can influence one's likelihood of engaging in sexual risk behavior.<sup>12,13</sup> While several studies have examined how peer connections or social networks influence HIV-related risk behavior such as condomless anal sex<sup>12,13</sup>, HIV testing and prevention services<sup>14,15</sup>, or injection drug use<sup>16</sup>, there is little to no published information on whether social networks directly affect the risk of HIV seroconversion.<sup>17</sup>

To examine the association between social network characteristics and seroconversion in black MSM, this study used an egocentric network approach to examine data previously collected from the HIV Prevention Trials Network (HPTN) 061, the largest prospective cohort study among black MSM in six U.S. cities. This analysis explored whether network factors such as the presence of social support were associated with risk of seroconversion. Based on previous studies of social support, the study hypothesis was that increased levels of social support would be associated with a decreased risk of seroconversion.

## Methods

This study analyzed data from the BROTHERS (HPTN 061) study, which has been previously described in other publications.<sup>18,19</sup> Between 2009 and 2011, men across six U.S. cities (Atlanta, GA, Boston, MA, Los Angeles, CA, New York City, NY, San Francisco, CA, and Washington, DC) participated in a feasibility and acceptability study for an intervention to reduce HIV infections in self-identified black MSM. Study participants were at least 18 years of age and reported condomless anal sex with a man within the past 6 months. The study intervention included HIV/sexually transmitted infection (STI) screening at study sites both at baseline and at follow-up visits (at 6 and 12 months) while also offering peer health navigation to assist men in obtaining needed medical or psychosocial services. HIV seroconversion cases were confirmed retrospectively at the HPTN Laboratory Center (Baltimore, MD). Study participants provided demographic information (including age, education history, employment status, annual household income, relationship status, and sexual orientation), and interviewers used an in-person social network questionnaire to gather data about each participant's social contacts based on a previously validated survey instrument.<sup>20</sup> To ascertain a person's social support network, interviewers asked a series of questions beginning with the following: "If you wanted to talk to someone about things that are very personal and private is there anybody you could talk to?". If a participant indicated that there were network members who met this criterion, the interviewer subsequently asked him to name up to 5 people by using an identifier such as initials, nicknames, or a combination of letters to help each man remember the specified network member at future study visits. Then, the interviewer would repeat this process for three additional support criteria (i.e., 2. "Is there anybody who would go to a medical appointment with you?", 3. "Is

there anybody you know who you would ask to lend you \$100 or more if you need it?”, and 4. “Is there anybody that you get together with, spend time talking, relaxing or just hanging out with?”). Men could name network members from earlier questions or provide new names (up to a maximum of five for each question). Therefore, network members were capable of providing four types of social support: (1) personal/emotional, (2) medical, (3) financial, and (4) social participation. Respondents answered additional questions about their network contacts such as to which age category the person belonged. Participants completed the social network questionnaire at baseline and 6-month follow-up visits; network data referred to the six months prior to each assessment.

## Statistical Analyses

Univariate statistics and bivariate tests including Chi-square and Wilcoxon’s rank-sum test were completed to describe and compare participant demographic characteristics and social network variables across seroconversion categories. For univariate and bivariate analyses, network variables were averaged within participants across time points prior to calculating overall sample means. Network variables included social network size (the total number of people who provided any type of support), network composition measures that examined the proportion of network contacts who fit each of the four specific social support criteria described above, and whether the network contact was less than or equal to 30 years of age at the time of the questionnaire. This age classification of network contacts is similar to previous studies that have delineated young vs. old MSM.<sup>18,21</sup> We present both absolute counts and proportions for these variables in Table 1.

The primary analyses for this manuscript were a series of Cox proportional hazard regressions on time to HIV seroconversion with time-dependent network covariates. The first set of regressions examined each covariate alone, and the second set examined network covariates while controlling for participant age at enrollment and study site. As increasing sexual partner age has been shown to increase seroconversion risk<sup>22–24</sup>, we tested for a similar relationship between participant age and the proportion of older social network members. We operationalized this relationship by testing an interaction between participant age (as a continuous variable) and the proportion of network members over age 30. Participants were considered to have seroconverted at the time they first tested positive at a follow-up visit and did not contribute further follow-up time, even if they attended future visits. Participants who did not seroconvert were censored at last follow-up; if a participant missed the first follow-up visit but attended the second, missing data were handled by carrying baseline values forward. To reduce the impact of variation in overall support network size on our analyses, composition measures accounted for that variation using proportions. All analyses were completed using SAS v.9.3 at a two-tailed level of significance of  $p < .05$ .

## Results

In total, 1167 black MSM were enrolled in this study that tested HIV negative at baseline and were eligible for follow-up. However, 167 of those men did not contribute any follow-up data (i.e., did not attend any study visits beyond baseline) and were not included in the

sample. The remaining 1,000 men were  $37.1 \pm 12.3$  years of age on average. Just under half (46%) had attended or completed postsecondary education, 21% were currently students, and 35% were currently working either full-time or part-time. Fifty-eight percent reported an annual household income of less than \$20,000. The majority of men in this study were single (89%), 48% identified as homosexual or gay, and 42% as bisexual. The average follow-up time in this sample was  $0.92 \pm 0.22$  person-years. Of these 1,000 men, 28 seroconverted during the study period, and the average follow-up time until seroconversion was  $0.44 \pm 0.27$  person-years.

Table 1 presents descriptive social network data by seroconversion status. Participants who seroconverted were younger (median age: 22.5 vs. 39;  $p$ -value  $< 0.001$ ) than those who did not seroconvert, had larger social networks (median size: 5 vs. 4;  $p$ -value = 0.045), and had a lower proportion of older network members (median proportion: 33.3% vs. 75%;  $p$ -value  $< 0.001$ ). In contrast, non-seroconverting participants reported higher proportions of network members providing personal (45.1% vs. 33.3%;  $p$ -value = 0.006), medical (35% vs. 23.8%;  $p$ -value = 0.039), financial (35% vs. 23.6%;  $p$ -value = 0.021), and social participation support (66.7% vs. 50.8%;  $p$ -value  $< 0.001$ ).

Table 2 presents the results of Cox regression analyses on time to seroconversion. Controlling for age at study entry and study site, increased personal/emotional, medical, and social participation support in the past 6 months were protective against seroconversion. Adjusted hazard ratios for 5-percent increases in network members providing personal/emotional, medical, and social support were 0.92 [95% CI = (0.85, 0.99)], 0.92 [95% CI = (0.85, 0.99)], and 0.91 [95% CI = (0.86, 0.97)], respectively and were statistically significant. These findings indicate that, for example, each 5% increase in network members providing personal/emotional support was associated with a 9% reduction in the risk of seroconversion. In addition, an interaction between participant age and percent of network members above age 30 was also significant ( $p = .026$ ). Figure 1 presents this interaction graphically by plotting the adjusted hazard ratios and confidence intervals for a 5% increase in network members over age 30 as a function of participant age at study entry. As can be seen in the figure, seroconversion risk steadily rises with increased participant age as social networks become increasingly composed of older men.

## Discussions

These findings suggest that increasing proportions of network members who provide personal/emotional, medical, or social participation support are associated with a greater delay in seroconversion when controlling for age and study site in a sample of black MSM at risk of HIV infection. This is one of the first studies to date that has measured the impact of social networks on HIV seroconversion in black MSM. While this study did not explore the mechanisms that may contribute to this protective relationship, previous studies have found that social support has positive benefits for health by affecting a person's coping mechanisms or increasing his engagement in health-promoting behaviors.<sup>25</sup> Though social rejection from key networks such as family or religious institutions can contribute to sexual risk behavior in BMSM<sup>26</sup>, there is also evidence that social support can mitigate minority-related stress and stigma that can contribute to HIV infection risk.<sup>27,28</sup> Being affiliated with

a ballroom house or independent gay family community was recently linked to a greater likelihood of protective health behaviors such as pre-exposure prophylaxis (PrEP) awareness and increased health care access.<sup>29</sup> Having a higher proportion of social network members who provide personal, medical, or social support could possibly contribute to more exposure to health promoting interactions; there is evidence that specific network affiliations can affect HIV treatment access or PrEP knowledge for BMSM.<sup>15</sup> The increased depth of one's social support network may correspond with better overall sexual health, which can contribute to the success of social network strategies that target HIV testing in BMSM.<sup>30,31</sup> Such social network factors could act indirectly to reduce HIV transmission by mitigating contextual factors that can contribute to increased HIV risk such as incarceration, reduced access to health care, or financial instability that can lead to sex work, exchange sex, or homelessness.<sup>7</sup> While the BROTHERS study ended prior to FDA approval of PrEP in 2012, it is possible that our medical support finding could have implications for PrEP dissemination within a social network. For example, having a person who could accompany a man at high HIV seroconversion risk to a medical appointment may lead to subsequent discussions about PrEP that could facilitate his decision to start this medication. Network-focused interventions could broadly consider both sexual and non-sexual network members (such as close friends or family members) as targets for improved PrEP uptake. Future research should examine how social network support directly or indirectly reduces HIV risk in black MSM, which could lead to greater insight into social network characteristics that may mitigate or contribute to HIV risk behavior. This additional clarity could contribute to more specific targeting of BMSM via a functional support screener that could identify who may have greater HIV infection risk due to a lack of social network support and could benefit from initiating PrEP. This screener could lead to an increased emphasis on methods that can increase social network support, lead to improved HIV prevention strategies based on changing peer norms in regards to biomedical prevention, or increase the number of PrEP users within a subset of a social network, thereby increasing the prevalence of PrEP use within the entire network.

The interaction between participant age and the percentage of network members over age 30 suggests that having an older demographic makeup within a person's social network increased risks for seroconversion. Having an older social network may have increased the likelihood that black MSM in this study encountered older sex partners (who would have a higher possibility of being HIV positive). While past research has been inconclusive on how much age disassortativity contributes to disproportionate HIV infection rates<sup>32,33</sup>, this finding may provide further credence to previous studies that suggested older dating partners may contribute to HIV disparities in black MSM.<sup>22-24</sup> Additional research can determine how network member age factors into seroconversion risk for black MSM.

This study has some limitations. As previously noted by Koblin et al.<sup>18</sup>, various factors in the BROTHERS study including the availability of HIV/STI testing, referrals for additional care (including medical, supportive, and HIV/STI services), and peer counseling as an additional form of social support could have contributed to a decreased estimate of seroincidence. However, the rate of new HIV infections in this sample was still significantly high when compared to the national HIV incidence during the study's time period. The social network questionnaire assessed each participant's perception of whether network



members would provide support in the four functional domains; study findings may have differed if the questionnaire had measured instances of enacted support. There was also a limit on the number of network members that could be named by study participants. Study measures did not provide specific information about the dynamics or processes that compose social network relationships, which limited our ability to determine how social network support may directly or indirectly contribute to seroconversion risk. Qualitative data could have further clarified the mechanisms that link social network support to HIV infection. Sample selection was limited to six urban areas, which limits the results generalizability, and it is unclear how these findings would apply to rural black MSM, who are at particularly high risk of delayed HIV diagnosis.<sup>34</sup> It is also unclear how our network support findings may influence or could be impacted by the availability of PrEP given the study's timing. Despite these limitations, this study has several strengths including the size of the study sample, the multisite design that led to geographical variability, and the prospective nature of the analysis.

This study demonstrated that significant associations exist between the proportion of social network members who provide emotional, medical, and social participation support and risk of seroconversion in a sample of black MSM at risk of HIV infection. Our findings suggest that increased levels of support in one's social network may be protective factor against acquiring HIV. While the exact mechanisms of these findings remain unclear, future research should ascertain how social network support directly or indirectly influences seroconversion risk, which could lead to strategies that improve and subsequently mobilize social support to improve HIV testing frequency, PrEP dissemination, emotional resilience, or health care access while also reducing financial insecurity or other structural barriers to contribute to HIV infection disparities.

## Acknowledgments

Keith A. Hermanstynne was supported by the UCLA-Robert Wood Johnson Clinical Scholars Program, and he received study design feedback and research mentorship on this project from Kenneth B. Wells and Nina T. Harawa. Steven Shoptaw received support via the P30 MH058107 grant.

Source of Funding:

Dr. Shoptaw reports grant support MH P30058107 from the National Institute of Mental Health during the conduct of the study and clinical supplies from Medicinova, Inc. and Gilead Sciences, Inc. outside of the submitted work.

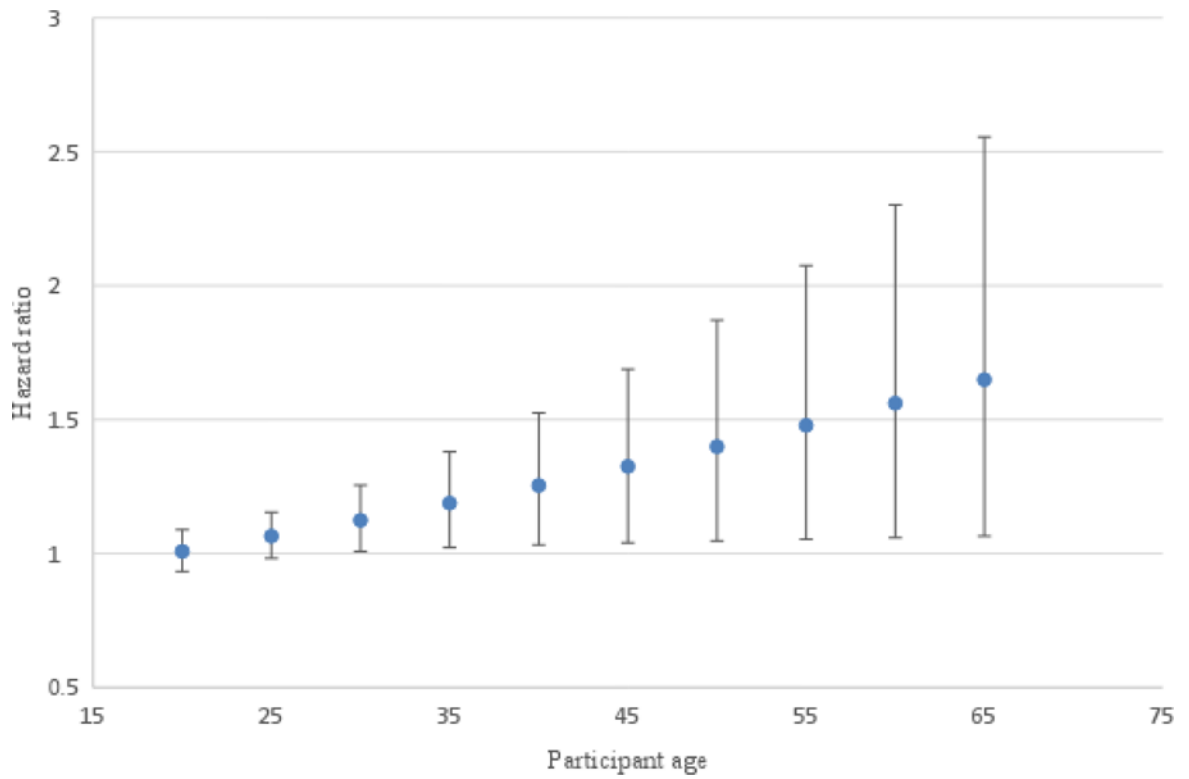
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**Figure 1.** Hazard ratio for HIV seroconversion per 5% increase in male network members over 30 years old, plotted as a function of participant age at study entry in the BROTHERS (HPTN 061) study (n = 1000)

**Table 1**

Frequencies/medians of demographic and network variables for participants in the BROTHERS (HPTN 061) study who HIV seroconverted (n = 28) and those who did not (n = 972).

Variable	Seroconverted n (%) / median (interquartile range)	Did not seroconvert	<i>p</i> <sup>a</sup>
Site			.02
Overall	28 (X%)	972 (X%)	
Boston, MA	1 (4%)	163 (17%)	
New York, NY	2 (7%)	197 (20%)	
Washington, DC	3 (11%)	138 (14%)	
San Francisco, CA	4 (14%)	144 (15%)	
Atlanta, GA	8 (28%)	173 (18%)	
Los Angeles, CA	10 (36%)	157 (16%)	
Age at enrollment	22.5 (13)	39 (22)	<.001
Social network size	5 (3.8)	4 (2.5)	.045
Number of social network members providing personal/emotional support	2 (2)	2 (2)	.77
Percent of network providing personal/emotional support	33.3 (26.4)	45.1 (38.1)	.006
Number of social network members providing medical support	1 (2.3)	1.5 (1.5)	.90
Percent of network providing medical support	23.8 (32.5)	35 (30)	.039
Number of social network members providing financial support	1 (1)	1.5 (1.5)	.89
Percent of network providing financial support	23.6 (18.3)	35 (33.7)	.021
Number of social network members providing social participation support	3.8 (3)	3 (2.3)	.48
Percent of network providing social participation support	50.8 (35.7)	66.7 (33.3)	<.001
Percent of network members over 30 years old	33.3 (57.7)	75 (67.5)	.005

<sup>a</sup>Chi-square tests were used for categorical variables and Wilcoxon's rank-sum test was used for continuous variables

Note: All variables besides age at enrollment and site were time-varying and referred to the 6 months preceding assessment. These measurements were averaged across time periods for each participant prior to computing the means presented in this table.

**Table 2**

Unadjusted and age + site adjusted hazard ratios from Cox regression analysis of HIV seroconversion risk in the BROTHERS (HPTN 061) study (n = 1000)

Variable	Unadjusted HR (95% CI)	Age + Site-Adjusted HR (95% CI)
Site		
Boston, MA (Ref)	(Ref)	
New York, NY	1.65 (0.15, 18.23)	
Washington, DC	3.73 (0.39, 35.98)	
San Francisco, CA	4.28 (0.48, 38.27)	
Atlanta, GA	7.42 (0.93, 59.37)	
Los Angeles, CA	10.44 (1.33, 81.74) <sup>*</sup>	
Age at enrollment		
	0.92 (0.88, 0.96) <sup>*</sup>	
In past 6 months...		
Social network size	1.08 (0.92, 1.27)	1.09 (0.92, 1.29)
Percent of network providing personal/emotional support <sup>a</sup>	0.91 (0.85, 0.98) <sup>*</sup>	0.92 (0.85, 0.99) <sup>*</sup>
Percent of network providing medical support <sup>a</sup>	0.93 (0.86, 1.00)	0.92 (0.85, 0.99) <sup>*</sup>
Percent of network providing financial support <sup>a</sup>	0.95 (0.88, 1.02)	0.95 (0.88, 1.02)
Percent of network providing social participation support <sup>a</sup>	0.91 (0.86, 0.97) <sup>*</sup>	0.91 (0.86, 0.97) <sup>*</sup>
Percent of network members over 30 years old <sup>a</sup>	0.94 (0.90, 0.99) <sup>*</sup>	–

<sup>a</sup>HR shown refers to 5 percent increase

<sup>\*</sup> $p < .05$