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A comparison of temporal Facebook networks of young men who have sex with men (MSM), differentiated by awareness and use of preexposure prophylaxis (PrEP)

Aditya S. Khanna^{1,2}, Phil Schumm³, and John A. Schneider^{1,2,3}

¹Department of Medicine, University of Chicago, Chicago, IL 60637

²Chicago Center for HIV Elimination, University of Chicago, Chicago, IL, 60637

³Department of Public Health Sciences, University of Chicago, Chicago, IL 60637

Abstract

Young Black men who have sex with men (YBMSM) are the only population in the U.S. who have experienced rising HIV incidence over the past decade. Consistent preexposure prophylaxis (PrEP) use can substantially reduce the risk of HIV acquisition. What differentiates those who become aware of PrEP, and those who do not, remains largely unknown.

The social networks of YBMSM can impact their awareness of PrEP; to examine this impact, we used two waves of Facebook data from the “uConnect” study – a longitudinal cohort study of YBMSM in Chicago (n=266). While PrEP awareness increased from 45% at baseline to 75% at follow-up, its use remained low (4% and 6%). There were 88 PrEP-unaware individuals at baseline who became aware (BA) by follow-up, and 56 who remained persistently unaware (PU). While the PUs had a higher median number of total Facebook friends, the BAs had a higher median numbers of friends who participated in uConnect, who were PrEP-aware, and who practiced behaviors previously found to be associated with individual-level awareness of PrEP at baseline. The BAs also had substantially more “influential” friends. These findings demonstrate the potential of social networks in raising PrEP awareness and use among YBMSM.

Keywords

HIV prevention; men who have sex with men (MSM); preexposure prophylaxis (PrEP); social network modeling; Facebook and health promotion

Introduction

Young (<30 years) Black men who have sex with men (YBMSM) represent the only group in the United States among whom HIV incidence has increased over the past decade.¹ In

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Chicago, the number of new annual HIV infections among YBMSM (13–29 years) from 2004–2014 were at least five times higher than among their White counterparts.²

Pre-exposure prophylaxis (PrEP), which consists of a fixed once-daily oral dose of tenofovir disoproxil fumarate (TDF) and emtricitabine (FTC),³ if taken daily, can substantially reduce the probability of HIV acquisition. In July 2012, the US Food and Drug Administration (FDA) approved the use of PrEP,⁴ and the Centers for Disease and Control in Prevention (CDC) issued clinical practice guidelines in 2014.⁵ Among MSM adherent to PrEP, an efficacy of over 90% has been estimated.^{6,7}

Increasing awareness and use of PrEP among YBMSM is potentially an effective strategy to reduce new HIV infections.⁸ In past work, we identified some individual-level factors that were positively associated with awareness of PrEP at baseline.⁹ However, awareness (and use) of novel prevention strategies is not dependent only on individual-level activities and behavior; the networks and communities that individuals are embedded in can also influence relevant outcomes.¹⁰ To examine the association between social networks and PrEP awareness and use, we utilize longitudinal population-based cohort data from the “uConnect” study – a study of YBMSM in Chicago. Specifically, we use Facebook data across two waves to examine the relationship between dynamic network structure and PrEP awareness. Our team is using findings from this study to guide ongoing public health efforts to utilize social media as a platform to improve awareness and use of PrEP among YBMSM in Chicago.

Methods

Study Population

The uConnect study, conducted from 2013 to 2016, is a longitudinal study of YBMSM between 16 and 29 years of age, who reside on the South Side of Chicago and adjacent neighborhoods.⁹ Respondent Driven Sampling (RDS) was used to recruit respondents.¹¹ Eligibility criteria included self-reports of: 1) African American or Black ethnicity, 2) being male at birth, 3) age between 16 and 29 years (inclusive), 4) oral or anal sex with a male within the past 24 months, 5) willingness and ability to provide informed consent at the time of the study visit, and 6) primary residence in South Chicago.

Respondents were given up to six vouchers to recruit others; each respondent was given \$60 for participation, and \$20 for each successful recruit enrolled into the study. Recruitment for the study was terminated when the desired sample size was reached. Respondents were administered a behavioral questionnaire and tested for HIV, HIV RNA, and syphilis. All procedures were approved by the Institutional Review Board at the University of Chicago and NORC at the University of Chicago. In the current work, we use data from the first two waves of this study.

Assessing PrEP awareness

To assess PrEP awareness, respondents were asked the question: “Before today, have you heard of PrEP?” at baseline and follow-up. The baseline survey was administered before formal CDC guidelines on PrEP were released. No other PrEP-related information was

provided to the participants at baseline, since our goal was to assess change in awareness and use of PrEP from factors other than participation in our study. Each respondent was administered a unique survey ID at baseline, and their identity was validated using these IDs at follow-up. The dates of administration of these surveys were recorded, enabling us to compute the length of time between baseline (2013–2014) and follow-up (2014–2015) interviews for each participant.

Generation of Facebook Networks

Facebook data were obtained from consenting respondents who appeared for the baseline and follow-up interviews in person, using an application within Facebook. This application facilitated unique individual identification of consenting study respondents from Facebook friend lists.¹² With privacy protections in place, the algorithm unambiguously linked friend lists of consenting individuals. A dataset with information on friendships between respondents, and between respondents and their non-respondent friends was thus compiled. This procedure was replicated at baseline (2013–2014) and follow-up visits (2014–2015) – a period that coincided with implementation of CDC guidelines for PrEP use.

Comparison of Facebook Networks

We compared the Facebook networks of individuals that remained *persistently unaware* (PU) of PrEP across the two waves, with individuals who were unaware at baseline, but *became aware* (BA) at follow-up. For the comparison, we restricted the baseline networks to individuals who were study respondents, and compared: i) the median number of total friendships, ii) the median number and proportion of friends who were PrEP aware, and iii) the median number and proportion of friends who were PrEP users. This restriction was made for two reasons: i) the full Facebook networks of uConnect respondents consisted of individuals who were not YBMSM, and therefore did not belong in the study population; ii) we did not have information on PrEP awareness and use for friends of the uConnect respondents who were not in the study themselves.

We also compared the PU and BA groups with respect to a number of variables that were found to be significantly associated with PrEP awareness at baseline.⁹ These variables were: having a primary care provider, participating in an HIV prevention program or research study (other than uConnect), having had an anorectal sexually transmitted infection test in the past two years, and membership in the House and Ball community – a national network of socially organized “houses” largely comprised of YBMSM and transgender women that has existed in Chicago since the 1930s. This comparison enables us to assess the presence of these behaviors – previously determined to be significant at the individual level – in the social networks of PU and BA individuals.

We also compared the full sizes of the Facebook networks of PUs and BAs, without restricting them to study respondents, as a measure of their total social activity.

Candidate peer change agent identification and comparison

We defined candidate peer change agents (cPCAs)^{13,14} as the 50 individuals who were most centrally located (details below) in the full Facebook networks of respondents at baseline.

This outcome is used to compare the “social capital” of persons in the two groups, defined as the resources and opportunities available to individuals by affiliation with other individual or organizational entities.¹⁵ While traditional cPCA selection has used an ensemble of methods (such as self-selection, peer nomination, or ethnographic observation),¹⁶ recent work has suggested that bio-behavioral interventions are most likely to be effective when they account for the network structure of high risk individuals.¹⁴ Such structural network assessments utilize formal mathematical and computational techniques, and position scores are computed for individuals, or ensembles of individuals.¹³

We used two such computational measures to identify cPCA's: Bonacich's eigenvector centrality algorithm,¹⁷ and Borgatti's “key player” algorithm.¹⁸ Eigenvector scores are an individual-level metric, and have been shown to be applicable to influence-type processes such as knowledge of a public health intervention.¹⁹ Key player is a set-based measure that finds a set of individuals that are maximally connected to all other individuals in the network (known as KPP-Pos in the literature),¹⁸ and is well-suited to public health problems where a set of agents are needed for optimal diffusion of practices. The median number of cPCAs present in the Facebook networks of the PU and BA groups was compared.

Computing

The *igraph*²⁰ and *influenceR*²¹ packages in R were used to compute the eigenvector centrality and key player measures respectively; all network data were also managed using *igraph*.

Results

Descriptive Statistics

There were 266 respondents who provided Facebook data at baseline and follow-up. These respondents had 2800 and 3301 Facebook friendships with other respondents at baseline and follow-up respectively.

The number of PrEP-aware individuals was 121 (45%) at baseline, and 201 (75%) at follow-up. There were 10 (3.7%) and 16 (6.0%) PrEP users at each wave. Additionally, 56 (21%) participants were persistently unaware (PU) of PrEP at both waves, and 88 (33.1%) were unaware at baseline, but became aware (BA) by the follow-up interview. In Figure 1, the network positions of PU and BA individuals in each wave each wave illustrate that individuals in each group did not exist in mutually exclusive clusters.

The PU and BA groups were comparable in age, with a mean of 24 and 23 years at baseline and follow-up, respectively. The BAs were slightly more educated (66% had had some college, versus 60% of PUs), but both had comparable levels of employment (57% in both groups had part- or full-time employment). We also found that a comparable proportion of BAs and PUs had engaged in two of the four behaviors found to be associated with PrEP awareness at baseline: having a primary care provider, and membership in the House and Ball community. However, counterintuitively, PU individuals reported greater levels of participation in an HIV program or research study other than uConnect, and having had an anorectal or STI test in the two years prior to the survey (Table 1).

Comparison of Facebook Networks

The Facebook networks showed the following features (Table 2): the median number of Facebook friendships with other uConnect respondents was 8.0 among PUs and 15.0 among BAs. Additionally, the PU group had a median of 4.0 friendships with PrEP-aware individuals and 1.0 friendships with PrEP-using individuals at baseline; corresponding numbers for the BA group were 7.0 and 1.0 friendships with PrEP-aware and PrEP-using individuals respectively. The PU and BA groups had almost identical proportion of friends who were PrEP-aware (median 45%) and PrEP-using (median 12%). The median size of the full Facebook networks of the PU and BA groups at baseline were 1000.6 and 820.0, respectively.

We also found that BAs had substantially more friends engaged in behaviors that were found to be associated with PrEP-awareness at baseline; in particular, substantially greater number of BAs were found to: 1) have a primary care provider, 2) have participated in an HIV prevention program or study (other than uConnect), 3) have had an anorectal STI test, 4) be members of the House and Ball community (Table 2). For all metrics, the proportions of the friends who practiced these behaviors were more similar (than the absolute numbers).

Friendships with Candidate Peer Change Agents (cPCAs)

Members of the PU and BA groups were found to have a median of 2.5 and 5.0 friends respectively among cPCAs selected according to eigenvector centrality scores, and 2.0 and 4.0 friends selected using the key player algorithm.

Discussion

The importance of PrEP in HIV prevention is now recognized, yet, its uptake among YBMSM has been low. We analyzed a unique longitudinal dataset on this population, allowing us to compare a number of features among individuals who became aware (BA) of PrEP, and those who remained persistently unaware (PU) of it. Adoption of PrEP is a complex procedure, potentially influenced by multiple synergistic mechanisms. It is difficult to assess which single mechanism is the most effective; in this paper, our goal was to assess the possible role of social networks, which can act as a conduit for increasing PrEP awareness. Online communities, such as Facebook, provide one way to measure activity within these networks. Our goal here, therefore, was to compare the Facebook networks of PUs and BAs, to ascertain differences in dynamic network structure that are potentially associated with PrEP awareness. The network drivers of healthcare behaviors tend to receive less attention in the literature than individual-level behaviors; our assessment of such network drivers is therefore particularly innovative.

We found substantial differences in the Facebook networks of BAs and PUs. The BAs had a substantially greater number of friends participating in the uConnect study, and friends who were PrEP aware. BA individuals also had substantially more friends engaged in behaviors that were previously found to be associated with PrEP awareness at baseline. However, the percentage of friends that engaged in these activities were much similar. This result might

imply a strength-in-numbers argument: increasing the number of Facebook friends who were aware of PrEP might be more important than the proportion.

Additionally, the Facebook networks of BAs also consisted of a greater number of candidate peer change agents (cPCAs), regardless of which cPCA identification algorithm was used. Friendships with cPCAs provide a comparative measure of the social capital of the two groups of interest, and imply that individuals who became aware of PrEP may have had access to knowledge and resources through their social networks that those who remained unaware did not. This empirical result is consistent with fundamental sociological theory,²² and it provides a means to utilize the social networks of BMSM in an effort to increase awareness and use of PrEP in this group.

There are important limitations in our work. Firstly, increasing the awareness and uptake of a novel prevention strategy requires efforts at many levels; social networks, whether offline or online, cannot by themselves explain observed disparities in the awareness and use. The period over which follow-up data for this study were collected (2013–2015) coincided with other PrEP awareness campaigns, and it is difficult to disaggregate the impact any one approach might have had. It is also difficult to assess how well online social networks reflect social interactions offline, and therefore network data should ideally reflect both modes of interaction. Channeling individuals with social capital to improve community health is a strategy that could be expanded further; however, identifying effective peer leaders is a difficult problem. Our computational findings presented here, especially with regards to cPCA identification, should be explored further with qualitative/ethnographic work.

This study provides a novel examination of possible differences in the social networks between groups that became PrEP aware, and those who did not. The longitudinal nature of the uConnect study is a real strength because it provides the ability to examine a range of variables – at both the individual and network levels – that may be associated with the awareness and use of PrEP. The findings of this study are by no means limited to HIV and PrEP, but can provide useful hypotheses to be examined in the context of prevention methodologies for other diseases. Secondly, our examination of Facebook networks in this community is a valuable assessment of an under-utilized channel for engagement in prevention among YBMSM. The use of these networks is being utilized for health promotions in other contexts, particularly obesity control,²³ and smoking cessation,²⁴ and prior work has shown the feasibility of Facebook HIV/AIDS prevention among MSM.^{25,26}

Further work in this area is in progress. We have a separate dataset where individuals provided detailed in-person interviews on their offline networks, consisting of confidants and sex partners; assessments of the correlation between these offline networks and PrEP awareness and use are underway. We are engaged in modeling studies to identify which measures of centrality are best suited for identifying individuals to maximize diffusion of PrEP awareness in this population, and assessing the extent to which different centrality algorithms agree with each other. The most influential individuals are being invited back for PrEP training, and the present analysis suggests that the social networks of Black MSM may be an effective vehicle for disseminating and influencing adoption of PrEP. Future work in

this area will be well suited to consider the mechanisms of diffusion and PrEP awareness and adoption, both conceptually and empirically.

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- Persistently Unaware (PU) of PrEP
- Became Aware (BA) of PrEP

Figure 1.
Facebook networks of uConnect participants at baseline (2013–2014, top panel) and follow-up (2014–2015, bottom panel), n=266, Chicago.

Table 1

Comparison of individuals who remained persistently unaware (PU) and those who became aware (BA),
uConnect study, Chicago

	Persistently Unaware (n=56)	Became Aware (n=88)
Age	n (%)	n (%)
<21	12 (21)	23 (26)
21–24	24 (43)	36 (41)
>24	20 (36)	29 (33)
Income		
<\$20K	40 (71)	67 (76)
Education		
High-school/GED or less	17 (38)	28 (32)
Some college	27 (48)	43 (41)
College degree or higher	12 (21)	17 (19)
Employment status		
Unemployed	20 (36)	43 (49)
Part-time	25 (45)	27 (31)
Full-time	11 (19)	18 (20)
Housing instability (past 12 months)	20 (36)	28 (32)
Has Primary Health Care Provider	36 (64)	55 (63)
Ever participated in an HIV prevention program or research study	32 (57)	38 (43)
Anorectal STI test (<2 years)	24 (43)	29 (33)
House/Ball Membership	23 (41)	36 (41)

Table 2

Comparison of baseline Facebook networks of individuals who remained persistently unaware (PU) and those who became aware (BA), uConnect study, Chicago

	Persistently Unaware	Became Aware
Median number of friends who were uConnect respondents	8.0	15.0
Median number of total Facebook friends	1001	820
Median number (%) of PrEP-aware friends	4.0 (50%)	7.0 (50%)
Median number (%) of PrEP-using friends ^I	1.0 (8%)	1.0 (7.5%)
Median number (%) of friends with a primary care provider	4.0 (58%)	9.0 (58%)
Median number (%) of friends who had participated in an HIV prevention program/study (other than uConnect)	3.0 (33%)	5.0 (34%)
Median number (%) of friends with an anorectal STI test (<2 years)	2.5 (28%)	4.5 (33%)
Median number (%) of friends in the House/Ball community	2.0 (23%)	4.0 (25%)
Median number (%) of friends who were selected as cPCAs by eigenvector centrality	2.5 (36%)	5.0 (42%)
Median number (%) of friends who were selected as cPCAs by keyplayer	2.5 (25%)	4.0 (25%)

^I The denominator for the percentage calculate only includes number of undiagnosed individuals.