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ORIGINAL PAPER

HIV and Sexuality Stigma Reduction Through Engagement in Online Forums: Results from the HealthMPowerment Intervention

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Abstract
HIV and sexuality stigma impede HIV prevention and care efforts. HealthMpowerment.org (HMP) is an interactive mobile phone- and web-based HIV prevention and care intervention for young Black men who have sex with men (YBMSM; ages 18–30) in the United States. HMP included three forums where participants could share their experiences. In this study, we explored whether engaging in stigma-related discussions was associated with changes in YBMSM's stigma-related scores throughout the trial. YBMSM (ages 18–30; N = 238) participating in HMP completed surveys at baseline, and 3 and 6 month follow-ups that included a series of scales focused on HIV and sexuality (internalized homophobia; sexual prejudice) stigma. Sixty-two participants contributed to the forums (1497 posts). We coded instances where YBMSM's conversations were stigma related (915 posts, 61.1%), including discussions of anticipated (74/915, 8.1%), experienced (125/915, 13.7%), internalized (410/915, 44.8%), and/or challenged (639/915, 69.8%) stigma regarding sexuality and HIV. Using a mixed methods approach, we examined whether changes in YBMSM's stigma scores were associated with stigma-related discussions within the forum. We controlled for age, HIV status, income, and educational attainment in these multivariable models. YBMSM who discussed experiencing HIV stigma in the forums reported decreases in perceived HIV stigma over time ($b = -0.37$, $p \leq 0.05$). YBMSM whose forum posts indicated anticipated HIV stigma reported increases in HIV stigma over time ($b = 0.46$, $p \leq 0.01$). Participants who challenged sexuality-related stigma in forums had lower internalized homophobia ($b = -0.68$, $p \leq 0.01$) at baseline. YBMSM whose discussions focused on experiencing sexuality-related stigma reported increases in internalized homophobia ($b = 0.39$, $p \leq 0.01$) and sexual prejudice ($b = 0.87$, $p \leq 0.05$) over time. Developing strategies to combat stigma remains a key priority. HMP created an online space where YBMSM could discuss HIV and sexuality stigma. Although a limited number of HMP participants authored the majority of these forum discussions, the discussions were associated with changes in the sample's stigma scores over time. Online interventions (e.g., social media, apps) should consider the inclusion of forums to address stigma and test the efficacy of forums to improve YBMSM's HIV prevention and care continuum outcomes.

Keywords Engagement · mHealth · Paradata · Men who have sex with men

Resumen
El estigma atribuido al VIH y a la sexualidad obstaculizan los esfuerzos de prevención y manejo del VIH. HealthMpowerment.org (HMP) es una intervención interactiva y en línea enfocada en la prevención y manejo del VIH para jóvenes negros que tienen relaciones sexuales con otros hombres (YBMSM, entre 18 y 30 años) en los Estados Unidos. HMP incluyó tres foros donde los participantes pudieron compartir sus experiencias. En este estudio, exploramos si la participación de YBMSM en discusiones relacionadas con el estigma estuvo asociado con cambios en los puntajes relacionados con el estigma a lo largo del estudio. YBMSM (edades 18–30; N = 238) que participaron en HMP completaron encuestas al inicio del estudio y en seguimientos a los tres y seis meses. Las encuestas incluyeron una serie de escalas enfocadas en el estigma de VIH y la sexualidad (homofobia internalizada, prejuicio sexual). Sesenta y dos participantes contribuyeron a los foros (1497 publicaciones). Codificamos instancias donde las conversaciones entre YBMSM estaban relacionadas con el estigma (915 publicaciones, 61.1%), incluyendo discusiones de estigma anticipado (74/915, 8.1%), experiencial (125/915, 13.7%),

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internalizado (410/915, 44.8%), y/o impugnado (639/915, 69.8%). Usando un enfoque de métodos mixtos, examinamos si los cambios en los puntajes de estigma de YBMSM se asociaron con las discusiones relacionadas con el estigma dentro de los foros. Controlamos por la edad, el estado de VIH, los ingresos y el logro educativo de los participantes en estos modelos multivariables. Los YBMSM que discutieron experiencias de estigma relacionada con el VIH en los foros reportaron disminuciones en el estigma del VIH percibido a través del tiempo ($b = -0.37$, $p \leq 0.05$). YBMSM cuyas publicaciones en los foros indicaron temáticas de estigma anticipado acerca del VIH tuvieron aumentos en el estigma del VIH a lo largo del tiempo ($b = 0.46$, $p \leq 0.01$). Los participantes que desafiaron el estigma relacionado con la sexualidad en los foros reportaron menor puntaje de homofobia internaliza ($b = -0.68$, $p \leq 0.01$) al inicio del estudio. YBMSM cuyas discusiones se centraron en experiencias del estigma relacionado con la sexualidad informaron aumentos en la homofobia internalizada ($b = 0.39$, $p \leq 0.01$) y prejuicio sexual ($b = 0.87$, $p \leq 0.05$) a través del tiempo. El desarrollo de estrategias para combatir el estigma sigue siendo una prioridad clave. HMP creó un espacio en línea donde YBMSM pudieron hablar sobre el VIH y el estigma sexual. Aunque un número limitado de participantes de HMP redactó la mayoría de estas discusiones en el foro, las discusiones se asociaron con cambios a lo largo del tiempo en los puntajes de estigma de la muestra. Las intervenciones en línea (por ejemplo, redes sociales, aplicaciones) deben considerar la inclusión de foros para abordar el estigma y evaluar la eficacia de los foros para mejorar la prevención y manejo del VIH entre YBMSM.

Introduction

Young Black men who have sex with men who have sex with men (YBMSM; age 15–29) have the highest rates of new HIV infections compared with their non-Hispanic White counterparts [1]. Across every stage of the HIV care continuum, YBMSM underperform compared to their White peers [2–4]. These disparities have been linked to structural inequities, often manifesting as intersectional stigma across YBMSM's race, sexuality and HIV status. As a result, stigma-related processes must be addressed if we are to improve YBMSM's HIV prevention and care continuum outcomes [5–8].

While a growing number of studies describe intersectional stigma among YBMSM [9–12], few interventions have addressed intersectional stigma for HIV prevention and care outcomes and none have done so for HIV-positive and HIV-negative YBMSM together. HealthMpowerment (HMP), a mobile web-based intervention, was designed to reduce logistical, financial, and social stigma barriers [13] by engaging HIV-positive, negative, and status-unknown YBMSM in a supportive, online community [14]. Like other mobile health (mHealth) interventions, HMP presents a number of advantages to group-based in-person interventions. HMP was designed to be accessible from any location convenient to the participant, to promote interactive discussions between peers asynchronously, and to give users the capacity to co-create and share content relevant to their lives through contributing original multimedia (e.g. videos, images, poetry) and engaging with existing online content on the broader web. Results from the HMP randomized control trial can be found elsewhere [14]. In this report, we focus on HMP participants' experiences of HIV and sexual stigma over the first 6 months of trial follow-up, and examine how their engagement within the HMP site's forums were associated with changes in their stigma scores over time.

The availability of online user-generated content through online forums and message boards has created unexpected opportunities to understand forum users' perceptions, attitudes and experiences regarding sexual and HIV-related content [15–19]. Analysis of these online forums, is often constrained by researchers' inability to examine whether their forum exchanges are associated with changes in users' psychosocial characteristics over time. However, data collected within mHealth interventions can overcome this limitation, and offer opportunities to understand how participants' engagement and co-creation of intervention content is associated with behavior change [20, 21]. In a recent study, for instance, Zhang and Yang [22] used content analysis to illustrate how users' social support exchanges within an online forum were linked to smoking cessation. Building on this approach, we examined whether YBMSM's user-generated content within HMP was associated with changes in stigma over time.

Our study has three aims. First, we seek to characterize whether YBMSM's sexuality- and HIV-related stigma scores changed over time. Second, we explore whether YBMSM's changes over time vary based on participants' sociodemographic characteristics. Finally, we examine whether participants' engagement in stigma-related discussions on the site are associated with changes in stigma over time. Through a mixed-methods approach, we use participants' forum exchanges to gauge how YBMSM discuss sexuality- and HIV-related stigma on the site, and study how these exchanges influence YBMSM's stigma scores over time. These data can inform future mHealth interventions focused on stigma reduction for YBMSM.

Methods

Sample

Data for this analysis come from a randomized controlled trial comparing an online HIV intervention (HMP) to a control HIV/STI information site conducted between November 2013 and October 2015. Participants completed an online baseline survey at an in-person enrollment visit, were asked to use HMP for 3 months and then complete three online follow-up assessments (3, 6 and 12 months) post enrollment. To be eligible, participants had to identify as male sex assigned at birth, be between the ages of 18 and 30 (inclusive), identify as African American/Black, reside in North Carolina, and have access to a mobile device with internet connectivity. Eligible participants also had to report any of the following sexual risk behaviors (prior 6 months): condomless anal sex with a male partner, anal sex with 3+ partners, transactional sex, and/or anal sex with alcohol or drugs.

Procedures

Eligible participants attended an in-person office visit where they consented and enrolled into the trial. Participants then filled out a computer-assisted survey, which took on average 60 min. Participants received $50 for completing the baseline survey. Follow-up surveys took on average 30 min and were completed online. Participants received $30 for each follow-up survey completed. The University of North Carolina's Institutional Review Board approved the study procedures.

Measures

We include summary statistics for our variables of interest in Table 1.

Sociodemographic Characteristics

Participants were asked to state their age (in years), their highest educational attainment (1 = 8th grade or less; 3 = completed high school or GED; 8 = more than a college degree), and last year's earnings as an indicator of income (1 = Less than $10,999; 2 = $11,000–20,999; 3 = 21,000–30,999; 4 = $31,000–40,999; 5 = 41,000–50,999; 6 = 51,000–60,999; 7 = 61,000–70,999; 8 = Over $71,000). We dichotomized age (0 = 18–24 year olds; 1 = 25–30 year olds). Educational attainment was collapsed into three categories (less than a high school education; a high school education or some college education; completed a technical or college degree).

HIV Status

Participants were asked to self-report their HIV status at baseline as HIV-negative, HIV-positive, or HIV status unknown. We created a dummy variable for HIV status (0 = = HIV negative or unknown; 1 = HIV positive).

Internalized Homonegativity

Participants completed a 5-item internalized homophobia scale [23]. An example item includes, "I feel that being gay/bisexual is a personal shortcoming for me." Item responses were assessed on a 5-point scale (1 = Strongly disagree, 5 = Strongly Agree). We computed a mean score, where higher scores indicate greater homonegativity. The internalized homonegativity scale yielded high reliability in our sample (Cronbach's alpha: baseline = 0.87; 3 month: 0.89; 6 month: 0.90).

Sexual Prejudice

Participants were asked to answer two questions focused on their perceptions regarding LGBTQ prejudice: "I believe the world is a dangerous place for LGBTQ people" and "In the last 12 months, I have perceived a rise in homophobia/transphobia". These two items were created by the study team, and could be answered using an 11-point scale (0 = strongly disagree, 10 = strongly agree). We computed a mean score, where higher scores indicate greater perceived sexual prejudice. The prejudice scale yielded moderate reliability in our sample (Cronbach's alpha: baseline = 0.56; 3 month: 0.63; 6 month: 0.73).

Perceived HIV Stigma

Participants completed Stewart's 10-item subscale [24] on felt-normative stigma towards people living with HIV in their community. An example item includes, "In your community, how many people think that if you have HIV you have done wrong behaviors?". Participants were asked to answer this question on a 4-point scale (0 = No one; 1 = Very few people; 2 = Some people; 3 = Most people). We computed a mean score, where higher scores indicated greater perceived HIV stigma in the community. The HIV stigma scale yielded high reliability in our sample (Cronbach's alpha: baseline = 0.96; 3 month: 0.97; 6 month: 0.96).

Table 1 Descriptive statistics

	N(%)/M (SD)	Range
Age		
18–24	132 (55.5%)	
25–30	106 (44.5%)	
Education		
Less than high school	28 (11.8%)	
High school/some college	141 (59.2%)	
Has technical/college degree	69 (29.0%)	
Income		
Less than $10,999	121 (50.8%)	
$11,000–20,999	46 (19.3%)	
$21,000–30,999	36 (15.1%)	
$31,000 or more	35 (14.7%)	
HIV status (baseline self-report)		
HIV-negative/unknown	131 (55.0%)	
HIV-positive	107 (45.0%)	
Internalized homonegativity		1 (strongly disagree)–5 (strongly agree)
Baseline	2.32 (1.09)	
3 month	2.38 (1.10)	
6 month	2.39 (1.07)	
Sexual prejudice		0 (strongly disagree)–10 (strongly agree)
Baseline	4.44 (2.39)	
3-month	4.75 (2.60)	
6 month	4.77 (2.83)	
Perceived HIV Stigma		0 (no one)–3 (most people)
Baseline	1.63 (0.86)	
3 month	1.41 (0.90)	
6 month	1.30 (0.89)	
Forum engagement (sexuality)		
Internalized	31 (13%)	
Challenged	29 (16.4%)	
Experienced	21 (8.8%)	
Anticipated	12 (5.0%)	
Forum engagement (HIV)		
Internalized	11 (4.6%)	
Challenged	26 (10.9%)	
Experienced	14 (5.9%)	
Anticipated	14 (5.9%)	

Forum Coding

Intervention arm participants had access to three spaces where they could share and receive information and experiences and garner social support. *The Forum* was a space where participants could initiate or contribute to conversations within various topic areas (e.g. Getting Tested, Safer Sex, Dating & Relationships, Healthy Living, Fashion & Entertainment, Life Skills, Current Events). In the *Ask Dr. W* section of the site, participants could post anonymous questions to a board-certified infectious disease doctor; the question and response were then posted (within 48 h) for all participants to view. Finally, in the *Getting Real* section participants could share and comment on multimedia content that they created themselves (e.g. poetry, videos, images, reflections) or that they linked to on the web (e.g. news stories, YouTube videos). For the purpose of this analysis, each participant contribution to any of the three areas of the site—whether initial or commenting, original or sharing a link—is counted as one "post".

Earlier foundational HIV-stigma work [8, 25, 26] has characterized stigma in several dimensions: instances of discriminatory events and experiences (*experiencing stigma*), expectations of future discrimination (*anticipated*

stigma), and acceptance of negative societal attitudes as part of one's own values and beliefs (*internalized stigma*) [7]. Taken on their own, these three domains provide an incomplete understanding of stigma as they assume that individuals are passive victims of oppression. Stigmatized populations may also attempt to address stigma by naming, confronting, resisting, or otherwise countering these experiences, beliefs, practices, and perceptions—constituting a fourth domain (*challenging stigma*) [7, 27].

We operationalized these four definitions in order to analyze participant contributions (posts) to the intervention website to understand the nature of how YBMSM used this virtual space to share and discuss stigma-related experiences (Table 2). We were particularly interested in identifying what roles an online intervention might play in processing, internalizing, and challenging stigmatizing experiences and ideas. The lead analyst (KM) reviewed all posts made to the site during the study period and developed a preliminary categorization of sexual minority and HIV-related stigma. This categorization was used by two different analysts to independently code all posts in one section of the site (Ask Dr. W). For each post, the nature of HMP posted stigma content was classified as experienced, anticipated, internalized, or challenging stigma. The coding and analytic framework was refined and the research team then coded for type and characterization of stigma on the remaining two intervention sections (The Forum, Getting Real). Once coding was complete, the lead analyst reviewed all code applications by section of the site (Forum, Ask Dr. W, Getting Real) to identify any analytic divergence that emerged as a result of the team discussions and evolving analytic framework. Definitions and illustrative examples of coded posts are provided in Table 2. Notably, many posts reflected more than one type of stigma and were thus assigned multiple codes.

We coded instances where YBMSM's conversations were stigma related (915 posts, 61.1%), including discussions of anticipated (74/915, 8.1%), experienced (125/915, 13.7%), internalized (410/915, 44.8%), and/or challenged (639/915, 69.8%) stigma regarding sexuality and HIV. Each participant was given a score to indicate whether they had contributed sexuality or HIV stigma-related posts to discussions (e.g., anticipated, challenged, internalized, experienced) in the forums (see Table 1). Of note, participants living with HIV were more likely to contribute to HIV-related posts than their HIV negative peers: anticipated stigma (78.6% vs. 21.4%; $\chi^2_{(1)} = 6.79$; $p = 0.009$), challenged stigma (69.2% vs. 30.8%; $\chi^2_{(1)} = 6.95$; $p = 0.008$), internalized stigma (72.7% vs. 27.3%; $\chi^2_{(1)} = 3.59$; $p = 0.058$), and experienced stigma (85.7% vs. 14.3%; $\chi^2_{(1)} = 9.99$; $p = 0.002$). There were no differences by HIV status on sexuality-related stigma posts.

Table 2 Coding definitions and examples of stigma-related posts to three areas of healthMpowerment.org intervention website

Stigma domain	Definition	Example post[a]	Stigma content
Anticipated	Posts that express or comment on fear of, concern about, or expectation of future stigma or discrimination from an action, identity, characteristic, or behavior. Post should be in reference to one's own anticipated stigma	"Do I have to tell every single person I have sex with I'm HIV positive? Most people don't even know what undetectable means and even after explaining, they just can't get past the part where you said HIV"	HIV
Experienced	Posts that describe instances of stigmatizing or discriminatory events and experiences. Post may center around one's own personal experience or the experience of someone else if the poster describes being personally impacted in a stigmatizing way	"Some years ago when my grandma found out I was gay she also thought I had AIDS"	Sexuality HIV
Internalized	Posts that reflect acceptance or endorsement of negative societal attitudes or language around HIV/sexual minority status as part of one's own values, beliefs, or language. Post may be in reference to oneself, specific others, or society more broadly	"Do you feel bad being gay because it is unnatural and has huge risk for incurable diseases?"	Sexuality HIV
Challenged	Posts that name, confront, resist, question, or otherwise counter stigmatizing and discriminatory experiences, beliefs, practices, perceptions, portrayals, and language. Post may be in reference to oneself, specific others, or society more broadly	"Well I feel like myself, this is who I really am inside I'm a gay African American male and I love who I am"	Sexuality

[a]Posts are excerpted to show the most relevant section of text

Data Analytic Strategy

This analysis focus on baseline and 3-(intervention completion) and 6 month (3 month post-intervention completion) follow-up survey data from the 238 participants who enrolled in the study and were randomized into the intervention arm. Given the exploratory nature of our study, we hypothesized that any association between forum posts and changes in stigma scores over time would be more likely to be observed in the short-term. Therefore, we modeled the association between forum posts and changes in stigma outcomes within the first 6 months of the study to strengthen both the internal validity and the statistical conclusion validity of our analysis. Hierarchical Linear Modeling (HLM; v. 7.0) was used to fit a multilevel linear growth curve model of the change (i.e. increase or decrease) in stigma scores over time [28]. While a repeated regression performs list-wise deletion for cases with missing values in one or more data points, HLM maximizes all available data because its algorithms do not require information across all follow-ups to compute growth estimates for all participants. These growth curve models allowed us to (1) examine whether stigma scores changed over time among HMP intervention participants, (2) explore whether mean stigma scores at baseline (e.g., mean intercept) varied based on participants' characteristics, and (3) test whether there was an association between participants' engagement in stigma-related discussions within the site and changes in stigma over time.

The HLM analysis was conducted for each of our three outcomes (internalized homophobia, sexual prejudice, and HIV stigma). For each outcome, we modeled changes in stigma over time by including a linear time variable at Level 1 (i.e., data collection time-point; e.g., baseline, 3 month follow-up, and 6 month follow-up). At Level 2 (i.e., person-centered baseline characteristics), we included participants' sociodemographic characteristics (e.g., age, HIV status, income, education) and likelihood of engaging in the forums to discuss experiences of internalizing, challenging, experiencing or anticipating stigma. Parameters for the full model are presented in Tables 3 and 4. For brevity, we highlight the significant findings ($p < 0.05$) from our final models below.

Table 3 Linear growth curve models of sexuality stigma among YBMSM

	Internalized homophobia				Sexual prejudice			
	b	SE	t	p	b	SE	t	p
Baseline score, π_0								
Intercept, β_{00}	2.33	0.14	17.20	< 0.001	4.21	0.25	16.70	< 0.001
Age, β_{01}	0.20	0.15	1.32	0.19	0.16	0.31	0.52	0.61
HIV status, β_{02}	0.05	0.15	0.31	0.76	0.02	0.31	0.06	0.95
Income, β_{03}	−0.07	0.07	−0.98	0.33	−0.08	0.14	−0.58	0.56
No HS, β_{04}	−0.05	0.23	−0.21	0.84	0.09	0.52	0.17	0.87
Technical/College degree, β_{05}	0.15	0.18	0.84	0.41	0.06	0.35	0.17	0.87
Internalized, β_{06}	0.44	0.29	1.53	0.13	-0.36	0.51	−0.72	0.47
Challenged, β_{07}	−0.68	0.22	−3.15	0.002	0.06	0.41	0.14	0.89
Experienced, β_{08}	0.17	0.33	0.51	0.61	0.76	0.67	1.13	0.26
Anticipated, β_{09}	−0.01	0.38	−0.04	0.97	−0.54	0.68	−0.79	0.43
Time, π_1								
Intercept, β_{10}	0.10	0.09	1.17	0.24	0.29	0.18	1.60	0.11
Age, β_{11}	0.02	0.09	0.26	0.79	−0.44	0.20	−2.16	0.03
HIV status, β_{12}	−0.12	0.09	−1.37	0.17	0.24	0.20	1.18	0.24
Income, β_{13}	0.06	0.04	1.47	0.14	0.14	0.09	1.49	0.14
No HS, β_{14}	0.00	0.15	0.03	0.98	0.91	0.34	2.64	0.009
Technical/College degree, β_{15}	−0.30	0.11	−2.79	0.006	−0.19	0.23	−0.84	0.40
Internalized, β_{16}	−0.14	0.10	−1.35	0.18	0.00	0.32	−0.01	0.99
Challenged, β_{17}	−0.15	0.10	−1.52	0.13	−0.61	0.34	−1.81	0.07
Experienced, β_{18}	0.39	0.13	2.92	0.004	0.87	0.40	2.20	0.03
Anticipated, β_{19}	0.17	0.14	1.19	0.23	0.10	0.44	0.23	0.82

Participants who have a High School Education or Some College serve as Referent Group. HIV-negative YBMSM serve as referent group

Table 4 Linear growth curve models of HIV stigma among YBMSM

	HIV stigma			
	b	SE	t	p
Baseline Score, π_0				
Intercept, β_{00}	1.73	0.10	17.76	< 0.001
Age, β_{01}	0.02	0.11	0.16	0.87
HIV status, β_{02}	−0.30	0.12	−2.52	0.01
Income, β_{03}	0.05	0.05	1.11	0.27
No HS, β_{04}	0.05	0.17	0.31	0.76
Technical/College degree, β_{05}	0.02	0.12	0.18	0.86
Internalized, β_{06}	−0.04	0.28	−0.16	0.88
Challenged, β_{07}	0.15	0.24	0.60	0.55
Experienced, β_{08}	0.47	0.24	1.94	0.05
Anticipated, β_{09}	−0.76	0.25	−3.03	0.003
Time, π_1				
Intercept, β_{10}	−0.20	0.06	−3.52	< 0.001
Age, β_{11}	−0.08	0.06	−1.30	0.19
HIV status, β_{12}	0.07	0.06	1.15	0.25
Income, β_{13}	−0.04	0.03	−1.19	0.24
No HS, β_{14}	−0.12	0.12	−0.97	0.33
Technical/College degree, β_{15}	0.14	0.07	2.05	0.04
Internalized, β_{16}	−0.18	0.15	−1.16	0.25
Challenged, β_{17}	0.09	0.13	0.66	0.51
Experienced, β_{18}	−0.37	0.18	−2.05	0.04
Anticipated, β_{19}	0.46	0.16	2.81	0.005

Participants who have a High School Education or some College serve as Referent Group. HIV-negative YBMSM serve as referent group

Results

Internalized Homophobia

At baseline, internalized homophobia symptoms (i.e., mean intercept score) were lower among participants who would challenge stigma regarding gender and sexuality in their forum discussions [$b = -0.68$ (SE = 0.22); $p = 0.002$]. Age, HIV status, income, and educational attainment were not significantly associated with differences in internalized homophobia at baseline (see Table 3).

After adjusting for baseline differences in our growth curve model, the overall change in internalized homophobia followed a linear relationship over time. This decreasing linear relationship, however, was only observed for participants who reported having at least a high school degree [$b = -0.30$ (SE = 0.11); $p = 0.006$]. Participants who reported experiencing sexuality-related stigma in their forum discussions were more likely to report greater internalized homophobia symptoms over time [$b = 0.39$ (SE = 0.14); $p = 0.004$]. No association was observed between changes in internalized homophobia scores and internalizing, challenging, or anticipating sexuality-related stigma. There were also no differences by age, HIV status, or income.

Sexual Prejudice

At baseline, the mean intercept for perceived sexual prejudice did not differ by age, HIV status, income, educational attainment, or forum engagement. After adjusting for baseline differences in our growth curve model, the overall change in sexual prejudice followed a linear relationship over time. This decreasing linear relationship, however, was only observed for participants who were younger [$b = -0.44$ (SE = 0.20); $p = 0.03$]. Participants without a high school education were more likely to report perceived sexual prejudice over time [$b = 0.91$ (SE = 0.34); $p = 0.009$]. Participants who reported experiencing sexuality-related stigma [$b = 0.87$ (SE = 0.40); $p = 0.029$] were more likely to report sexual prejudice over time. No association was observed between changes in sexual prejudice and internalizing, challenging or anticipating sexuality-related stigma in forum discussions, HIV status, or income.

HIV Stigma

Baseline perceived HIV stigma scores (i.e., mean intercept) were greater among HIV-negative participants [$b = 0.30$ (SE = 0.12); $p = 0.013$] and participants who shared experiences of HIV stigma in the forums [$b = 0.47$ (SE = 0.24); $p = 0.05$]. Participants whose forums posts described anticipated HIV stigma reported lower baseline scores in their perceived HIV stigma [$b = -0.76$ (SE = 0.25); $p = 0.003$]. Age, HIV status, income, and educational attainment were not significantly associated with differences in HIV stigma at baseline (see Table 4).

After adjusting for baseline differences in our growth curve model, the change in perceived HIV stigma over time followed a linear relationship. Participants with a technical or college degree, however, had a slower decrease in perceived HIV stigma [$b = 0.14$ (SE = 0.07); $p = 0.041$] than peers with less educational attainment. Participants who reported experiencing HIV-related stigma in their forum discussions reported less perceived HIV stigma over time ($b = -0.37$ (SE = 0.18); $p = 0.041$). Participants who reported anticipating HIV-related stigma in their forum discussions were more likely to report perceived HIV stigma over time ($b = -0.37$ (SE = 0.18); $p = 0.041$). No association was observed between changes in HIV stigma over time and internalizing or challenging HIV stigma, age, HIV status, or income.

Discussion

Stigma remains a key priority in HIV prevention and care efforts; however, strategies to address stigma through mHealth interventions remain underexplored. Using a mixed-methods approach to characterize YBMSM's user-generated content within the HealthMPowerment forums, we found evidence to support the notion that YBMSM's user-generated posts regarding stigma are associated with participants' changes in sexuality- and HIV-related stigma over time.

YBMSM had moderate scores of internalized homophobia at baseline, with these scores remaining stable over time for most of the sample. Among YBMSM whose posts referenced sexuality-related stigma, however, we observed differences in internalized homophobia when YBMSM voiced challenging or experiencing stigma in their posts. YBMSM who reported lower internalized homonegativity scores at baseline were more likely to contribute posts focused on challenging sexuality-related stigma, suggesting that YBMSM who feel greater sexual pride may feel more empowered to speak up against sexuality-related stigma. Alternatively, these YBMSM may write posts that challenge sexuality-related stigma as a way of offering support to their peers. Conversely, YBMSM whose posts described experiencing sexuality-related stigma were more likely to report greater internalized homophobia over time. One possible interpretation for this finding is that YBMSM who share these experiences might be more mindful over time of how they have internalized anti-gay norms into their self-concept. Alternatively, it is possible that these YBMSM are still exploring and coming to terms with their sexuality. At present, however, we are unable to test these mechanisms or make inferences regarding the causal order between writing about experiencing sexuality-related stigma and changes in internalized homonegativity. Future research examining these proposed pathways is warranted.

YBMSM's baseline mean scores for sexual prejudice were moderate and remained stable over time for most of the sample; however, YBMSM whose posts included content regarding experiencing sexuality-related stigma reported greater sexual prejudice over time. Similar to the internalized homophobia findings, these associations may be attributable to YBMSM's greater awareness of anti-gays norms in their social environments over time. At present, however, we cannot establish whether increases in sexual prejudice are the result of learning about peers' experiences of sexuality-related stigma and/or whether they are sharing experiences that arose as they participated in our study. Sexual prejudice also increased over time among YBMSM who did not have a high school education or who were younger. YBMSM who are younger and/or who do not have a high school education may have reported greater awareness of sexual prejudice, either because they became more mindful of these biases in their communities after engaging on the site and learning from their peers' experiences, and/or because they were more likely to experience prejudice over time. It is also possible that YBMSM who are older and have greater educational attainment have greater social capital and are afforded opportunities to move into more LGBT-affirming communities where sexual prejudice is less pronounced [29, 30]. At present, we are unable to test these proposed relationships; future research may be helpful to understand how these factors contribute to sexual prejudice among YBMSM.

Perceived HIV stigma decreased over time for the entire sample, yet this decrease was muted among YBMSM who had completed a technical or college degree—perhaps signaling that YBMSM with greater educational attainment remain more vigilant of perceived HIV stigma than peers with less educational attainment. The association between HIV status and perceived HIV stigma was also intriguing as YBMSM living with HIV perceived less HIV stigma at baseline than their HIV-negative peers, yet their perceived stigma scores did not differ over time. YBMSM whose posts reflected anticipated HIV stigma reported lower perceived HIV stigma at baseline, and subsequently reported increases in perceived HIV stigma over time. These findings might reflect how YBMSM's participation in the forums and reading peers' HIV-related posts increase their awareness of HIV stigma in their communities. Conversely, YBMSM whose posts reflected experiencing HIV stigma were more likely to report greater perceived HIV stigma at baseline, and less likely to report perceived HIV stigma over time. Similar to the sexuality-related stigma findings, it is possible that participants who share experiences of stigma in the forums access social support from their peers and share coping strategies to buffer their impact when these experiences occur. Additional research examining these mechanisms is warranted, as they may help inform future stigma reduction interventions.

To our knowledge, HealthMPowerment is the first mHealth intervention to purposefully provide a space where YBMSM can share their experiences and discuss stigma-related content irrespective of their HIV status. A recent review of HIV and sexual health interventions for Black MSM [31] explicitly notes the importance of recognizing the role of stigma for developing successful interventions. Prior *in-person* sexual risk-reduction interventions with BMSM have included addressing stigma through a variety of successful approaches including empowerment [32] and using peer opinion leaders [33]. These elements could be integrated within a future mHealth stigma-amelioration and reduction intervention for YBMSM through guided forums and other dynamic activities whereby users can identify

and share stigma-related experiences, receive social support and learn approaches to challenge stigma through peer exchanges, and benefit from tailored content based on users' baseline and/or follow-up stigma scores.

Our study has several limitations deserving mention. First, we recruited a convenience sample in a southern state of the United States. While our findings may not be generalizable, our data highlight the importance of addressing stigma in a region where the bulk of the epidemic occurs among racial/ethnic minority MSM. Second, we relied on an individual-level approach to identify who contributed to stigma-related discussions in the forums. Moreover, within many posts, participants often alluded to several forms of stigma within the same conversation. Given the dynamic nature of these forums and rich conversations that emerged, future research examining how exchanges between participants contribute to changes in outcomes may be warranted [22], as these findings may inform network-level interventions in this area. Third, although only a small number of participants posted onto the forum, the total number of posts was remarkable and associated with changes in stigma scores over time. Unfortunately, our user-engagement metrics were not designed to identify whether participants read the information even if they did not contribute posts to the forum (e.g., "lurkers"). This might be particularly true for participants who joined the trial later in the recruitment process, thereby benefiting from reading the existing forum threads discussing these topics without necessarily having to post. As a result, while it is possible that participants who read the user-generated content also benefited, we have no way to quantitatively capture these effects in our data. Future research examining the prevalence of lurking behaviors through paradata [20] and its association with changes over time is needed. Reading/lurking behavior could be operationalized as an exposure variable (e.g. clicked on X challenging stigma posts), or as a complex engagement variable (e.g. users' estimated minutes exposed to challenging stigma content could be derived by computing the number of minutes within The Forum and the percent of Forum content containing challenging stigma posts). Variables tracking reading/lurking behaviors will require careful attention to how they are operationalized, aggregated for use, and interpreted in future analyses. Finally, we were unable to examine longer-term relationships (e.g., 12 month) between forum posts and stigma outcomes in our analyses given that we had limited statistical power to model a robust nonlinear curve (e.g., quadratic, cubic) adequately with our sample size. Future research examining non-linear changes in stigma over time, as well as the long-term association between stigma-related posts and these prospective changes, are warranted.

The Internet has facilitated open dialogue and encouraged health-related discussions through supportive interactions with peers across the country [13, 34, 35]. Although public forums have been used in prior HIV research, efforts to understand how participants' user-generated content within mHealth interventions contributes to HIV-related outcomes over time are warranted. Findings from HMP underscore the importance of examining how user-generated content within these interventions is associated with behavioral changes over time. Online interventions (e.g., social media, apps) should consider the inclusion of forums to address stigma and test the efficacy of forums to reduce YBMSM's experiences of stigma. Future methodological and substantive research in this area is vital, as it may serve to test how social exchanges in the site contribute to behavior change, including how social support exchanged between users contributes to these processes. User-generated content may also provide new opportunities for hypothesis generation and design thinking, including how to catalyze exchanges between users within mHealth interventions.

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Compliance with Ethical Standards

Conflict of interest The authors declare that there are no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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

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