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Co-occurring Epidemic Conditions Among Southern U.S. Black Men Who Have Sex with Men in an Online eHealth Intervention

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Abstract

Black men who have sex with men (BMSM) face disproportionately higher risks for adverse sexual health outcomes compared to their non-Hispanic White counterparts. This disparity can be attributable to overlapping and intersecting risk factors at the individual and structural levels and can be understood through syndemic theory. Using longitudinal data from the HealthMPowerment trial (n = 363), six conditions related to stigma syndemics were indexed as a cumulative risk score: high alcohol use, polydrug use, depression and anxiety symptomology, and experiences of racism and sexual minority stigma. Using Poisson regression, we found a positive association between baseline risk scores and sexual risk behavior (*b*: 0.32, SE: 0.03, $p < 0.001$). Using a Generalized Estimating Equation, we also found a 0.23 decrease in the within-participant risk scores at 3-month follow-up (SE: 0.10, $p < 0.020$). Future work examining how care and prevention trials improve health outcomes in this population is needed.

Keywords Syndemics · Young Black MSM · mHealth interventions

Introduction

Significant disparities in HIV persist for men who have sex with men (MSM) and racial and ethnic minority populations. United States (U.S.) surveillance data indicate that MSM accounted for 71% of new HIV diagnoses in 2020 [1]. Furthermore, incident cases of HIV from 2008 to 2015 decreased by 14.8% for all risk groups except for MSM. Among MSM, incident cases decreased for white MSM, increased for Hispanic and Latino/Latinx MSM, and remained disproportionately high for Black MSM (BMSM) relative to population size [2]. Moreover, while the lifetime risk for HIV infection in the general US population is 1 in 99, the lifetime risk for BMSM is 1 in 2, or a 50% lifetime probability [3], indicating a clear priority for intervention and support. Racial and ethnic disparities in HIV reflect the ongoing, multiple social and structural adversities such as racism and homophobia that limit opportunities for sexual health promotion and HIV prevention within these communities [4]. Though numerous studies have identified multilevel social factors linked to poor HIV health outcomes, HIV researchers must tend to the interplay of these factors to inform strategies for scaling up prevention efforts.

Syndemic theory posits that co-occurring multilevel social risk factors and health conditions compound one another to increase individuals' risks for adverse health outcomes, above and beyond the presence of only one risk factor [5]. Working with community samples of MSM, researchers have applied syndemic perspectives to examine the excess burden of co-occurring psychosocial risk projected onto this community's HIV and other sexual health outcomes [6]. Empirical studies using a syndemic framework to examine MSM's sexual risk-taking and other outcomes typically focus on psychosocial and intra-individual-level factors such as drug and alcohol use, depression, anxiety, and post-traumatic stress disorder [7–9]. Researchers have observed syndemic exposures to at least additively contribute to increases in risk

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of sexually transmitted HIV among BMSM [10]. While individual-level factors are important to consider, people's lived experiences are shaped by co-occurring structural and social contexts, warranting an examination of factors, including poverty, racial/ethnic discrimination, incarceration, and geographic location. Individually, these factors have been found to exacerbate sexual risk and reproductive health outcomes among urban Black and Latino youth [11].

Prior studies with MSM have employed syndemic theory to examine pairs of epidemic health conditions, such as alcohol use and drug use [7, 8, 12, 13], or depression and anxiety [8, 12, 14], based on the idea that these pairings would exhibit synergistic interactions. However, applications of the theory have infrequently considered co-occurring structural determinants. For BMSM, racial discrimination and homophobia are co-occurring and related intersectional stigmas, not independent or unidimensional [15, 16], making measurement a challenging endeavor. Research on stigma syndemics highlighted by Lerman, Ostrach, and Singer suggests that structural stigmas are primary driving factors in syndemics [11], and that chronic stress caused by stigma can lead to maladaptive coping behaviors such as illicit drug use [17]. Thus, stigma syndemics should include structural discrimination, possible coping behaviors (e.g., drug and alcohol use), and commonly co-occurring epidemic health conditions (anxiety and depression). Although syndemic theory has been deployed in multiple ways when examining HIV among MSM, the specific mechanisms that drive syndemic exposure, whether they can change over time, or be identified as intervention targets, deserve further examination [5].

Inequities in the social determinants of health—such as being excluded from the formal labor market, health care, and insurance coverage—have been implicated for exacerbating risk and thwarting progress in HIV prevention and care for BMSM [18]. Reducing such disparities and health inequities is one of the four goals of the U.S. National HIV/AIDS Strategy for 2022 to 2025 (NHAS). One key NHAS objective is to reduce new diagnoses among priority populations such as young Black gay and bisexual men, and persons living in the geographic Southern U.S. [19]. Under the U.S. Department of Health and Human Services' Ending the HIV Epidemic (EHE) initiative, all priority states listed in Phase 1 are in the Southeast, which are necessary to target to achieve maximum impact. The seven Southeast states also have a disproportionate occurrence of HIV in rural areas [20]. A comprehensive evaluation of co-occurring multilevel risk factors may aid in meeting the goals outlined by the EHE initiative, and may be an effective approach, permitting relevant stakeholders to attend to BMSM's lived realities that shape, motivate, and facilitate engagement with HIV treatment and prevention interventions [21].

Accordingly, HIV intervention researchers have leveraged mobile heath (mHealth) interventions for several reasons. First, as of 2021, 96% of all U.S. adults 18 to 29 years old own a smartphone, and 28% use smartphones as their primary means of internet access [22]. Secondly, mHealth has the potential to connect underserved populations to resources across various types of social, structural, and geographic barriers [23]. However, a recent review outlined that the majority of current mHealth interventions primarily target education and behavior change, with limited focus on linkage to care and supportive services [24]. Despite high potential for effectiveness, HIV treatment and prevention interventions, particularly those delivered in mHealth contexts, have inadequately addressed syndemic factors that shape people's ability to participate in health-promotive services [25, 26]. Further, there is established literature documenting the importance of evaluating and improving engagement within mHealth interventions to fully impact behavioral change [27]. To date, attention within mHealth interventions to interpersonal and structural challenges and the impact it has on intervention engagement has not been evaluated.

Inspired by syndemic theory, the purpose of the current study is to characterize exposures to co-occurring epidemic health conditions using a secondary dataset from a convenience sample of North Carolina BMSM participating in an online mHealth intervention, and to examine whether these exposures changed at 3-month follow-up. Under a syndemic framework, disease burden is not only concentrated among clusters within the population, but also driven by social and cultural conditions such as socioeconomic disadvantages, racism, homophobia, and other inequities of stigma. These conditions place BMSM at higher risk for minority stress, or the stigma and discrimination that create stressful social environments [28], which in turn exacerbate psychosocial health outcomes and sexual risk [10]. Formal syndemic analyses have historically focused on older predominantly non-Hispanic White samples of MSM, but there has been less established work focusing on young BMSM in the U.S. South. Thus, we explore predictors related to stigma syndemics that are more appropriately described as co-occurring epidemic health conditions among this population. To measure the burden of stigma syndemics, we take a parsimonious approach to create an additive, cumulative risk score for these epidemic health conditions. We examine the associations between the risk score with sexual risk behaviors, and also describe changes in risk scores for this population while participating in the intervention. Describing and examining changes in cumulative burden among BMSM can inform local public health practice by scaling-up agencies' capacities to provide services to these communities and

comprehensively attend to their priority health needs [6]. In the context of mHealth interventions, risk scores are also a simple and comprehensive measure that can summarize cumulative trends in adversity and help identify the specific conditions that change during the study period.

We hypothesized that individuals with exposure to higher risk scores would be engaging in more sexual risk behaviors. We also sought to test whether participating in the intervention arm was associated with lower scores at follow-up. Specifically, our hypotheses were as follows: among this sample of 18-to-30-year-old BMSM, (H1) risk scores at baseline will be positively correlated with the number of condomless anal sex acts with unknown status or serodiscordant partners (SDCAS) at baseline; and (H2) for participants in the intervention arm, risk scores at 3-month follow-up will be lower than scores at baseline compared to participants in the control arm. Finally, we explore associations of baseline risk scores with intervention engagement.

Methods

Study Sample

The current analytic sample (n = 363) is a secondary analysis that uses data from HealthMPowerment, a multi-component mHealth randomized controlled trial, which recruited a convenience sample from November 2013 to October 2015. Eligible participants in the original study were those who self-reported: (1) being ages 18 to 30; (2) assigned male at birth; (3) Black racial identity; (4) currently residing in North Carolina; (5) having current access to a mobile device that connects to the internet; and (6) having engaged in at least one of the following behaviors in the past 6 months: (a) condomless anal sex with a male partner; (b) any anal sex with more than three male sex partners; (c) exchange of money, gifts, shelter, or drugs for anal sex with a male partner; or (d) anal sex within two hours of drug or alcohol use. Study recruitment occurred via social media, community venues, healthcare-based settings, and word of mouth. Participants were randomized to either an intervention or information-only control arm at 1:1 allocation. The intervention was a highly interactive, multi-component online platform including a discussion forum, interactive media, and a knowledge library. Designed as a holistic intervention for BMSM of all HIV statuses, HealthMPowerment addressed relevant health issues without considering specific co-occurring or synergistic exposures. Key components included providing information about HIV care and prevention, men's health and wellness, relationships, drugs and alcohol, as well as interactive features such as a discussion forum, a question submission system with answers from an HIV care provider, and a personal journal [29]. Mixed-methods analyses from this intervention reported on forum content where participants engaged in discussions on how to confront or avoid multiple stigmas [30–32]. Enrolled participants completed computer-assisted self-interview surveys at Baseline, 3, 6, and 12 months. Ethics approval was obtained from the Institutional Review Board at the University of North Carolina at Chapel Hill. Additional details of the intervention and protocol are described elsewhere [33, 34]. The current analysis uses deidentified data from baseline and 3-month surveys because the primary effectiveness outcomes of the HealthMpowerment intervention were assessed at 3-month follow-up [34].

Co-occurring Epidemic Health Conditions

Risk Scores

To examine exposure to co-occurring epidemic health conditions, cumulative risk scores based on conditions reported at baseline and 3-month follow-up were created using a count variable of six dichotomous conditions: (1) high alcohol use, (2) polydrug use, (3) symptoms of depression, (4) symptoms of anxiety, (5) experiences of racism and discrimination, and (6) experiences of sexual minority stigma.

Alcohol and Drug Use

Frequent alcohol use was determined using one item: "In the last 3 months, how many days did you use alcohol?" with continuous response options and instructions that defined alcohol. Those who reported not having any alcohol in the last 3 months were coded as 0 days. High alcohol use was determined by examining the distribution and creating a cut-off of one standard deviation above the mean at baseline.

Polydrug use was calculated using a summed variable of 11 items that assessed the past 3-month use of: marijuana, cocaine, heroin, methamphetamine, club drugs, nonprescribed opiates, hallucinogens, inhalants, PDE-5 inhibitors (Viagra, Cialis, Levitra), synthetic marijuana, or another drug (open text response; e.g., PCP or angel dust). Polydrug use was defined as any past 3-month use of two or more of the specified drugs and dichotomized accordingly.

Mental Health

Depressive symptomology was screened using the 20-item validated Center for Epidemiologic Studies Depression Scale (CES-D), with summed scores of 16 or above indicating clinical relevancy [35]. Anxiety symptomology was screened using the Generalized Anxiety Disorder 7-item scale (GAD-7), with a cutoff at summed scores of 10 indicating a positive screen for anxiety [36].

Discrimination

To examine both the experiences of racism and experiences of sexual minority stigma (e.g., homophobia), the original study adapted the 10-item Multiple Discrimination Scale [37] to create two parallel scales with 10 items each. Scale items captured participants' observations of interpersonal and institutional prejudices, including experiences with employment, housing, and healthcare (e.g., "In the past year, have you been denied a place to live/lost a place to live because of your race or ethnicity?" and "In the past year have you been treated poorly/made to feel inferior when receiving health care because you are gay?"). The recall period for baseline items specified experiences that occurred in the past 12 months, and the recall period for 3-month follow-up items specified experiences that occurred in the past 3 months. For this analysis, reporting at least one discriminatory experience was considered a positive screen on that scale.

Outcomes

Sexual risk was defined as the self-reported number of condomless anal sex acts with serodiscordant and unknown status partners (i.e., an HIV-positive participant with HIV-negative or unknown status partners; or an HIV-negative participant with HIV-positive or unknown status partners) in the past 3 months.

Intervention use was defined as the cumulative number of minutes between baseline and 3-month follow-up that the participant was logged in and exposed to study content. We examined both continuous minutes of engagement as well as dichotomized Low (< 60 min) versus high (≥ 60 min) engagement, which is consistent with previous work in this sample that estimated a stronger intervention effect for those with high engagement [34].

Analyses

Data were cleaned and analyzed using SAS version 9.4. To examine co-occurring exposures and sexual risk (H1), a Poisson regression model was used to determine if risk scores were positively associated with number of SDCAS acts at baseline. To examine changes in risk scores over time between study arms (H2), a Generalized Estimating Equation with independent specification was used, followed by McNemar's tests to examine within-person changes in specific epidemic conditions. To explore intervention engagement, we modeled the risk score as a predictor of minutes spent engaging with the intervention using Poisson regression models, and also as a predictor of high vs. low usage with logistic regression. All models controlled for HIV status, age, insurance status, and income for possible confounding.

Results

Demographics

Participant characteristics by exposure to co-occurring epidemic health conditions are presented in Table 1. Among 363 participants with complete data at baseline and 3 months, the average age was 24.3 years (SD: 3.2), with most identifying as gay (68.3%) or bisexual (21.2%). Only 22.9% had a college degree or higher, and half (53.2%) had income less than $11,000. Most had some form of health insurance (69.9%), and about half were living with HIV (43.0%). The mean number of past 3-month SDCAS acts was 1.7 (SD: 12.0). To examine differences in demographic characteristics, the risk score was dichotomized into unexposed (0 or 1 condition) vs. exposed (2 or more conditions). No demographic differences by exposure were detected.

Baseline Epidemic Health Conditions

Most participants (65.6%) reported 2 or more co-occurring epidemic health conditions with a sample average of 2.1 conditions (SD: 1.5). Six conditions were indexed in this sample (Table 2) using single items or scales with moderate-to-high internal consistency reliability: 9.9% of participants were categorized as high alcohol use; 17.6% reported polydrug use; 43.0% screened positive (score ≥ 16) for depressive symptomology ($\alpha = 0.90$); 26.0% screened positive (score ≥ 10) for anxiety ($\alpha = 0.93$); 53.7% reported experiences of racism ($\alpha = 0.88$); and 60.3% reported experiences of sexual minority discrimination ($\alpha = 0.88$).

Sexual Risk

The model examining Hypothesis 1 (Table 3) indicated a significant positive correlation of 0.32 SDCAS acts with each additional condition at baseline (*SE*: 0.03, 95% CI 0.26, 0.37, $p < 0.001$), controlling for HIV status, insurance, income, and age. All covariates were statistically significant, with HIV-positive status associated with greater number of SDCAS acts (*b*: 0.33, *SE:* 0.08, 95% CI 0.17, 0.50), and one higher income level associated with greater number of SDCAS acts (*b*: 1.89, *SE:* 0.10, 95% CI 1.69, 2.09), controlling for covariates. Having insurance was associated with fewer number of SDCAS acts (*b*: −0.53, *SE:* 0.09, 95% CI −0.71, −0.36) and being older age associated with fewer number of SDCAS acts (*b*: −0.12, *SE:* 0.02, 95% CI −0.15, −0.09), controlling for covariates.

Table 1 Participant characteristics by exposure to co-occurring epidemic health conditions at baseline (n = 363)

	Total sample	Co-occurring epidemics	
	n = 363	Unexposed	Exposed
		n = 125	n = 238
Age, mean (SD)	24.3 (3.2)	24.4 (3.2)	24.3 (3.2)
Education			
Some high school or less	27 (7.4)	10 (8.0)	17 (7.1)
High school, GED, or some technical school/college	253 (69.7)	87 (69.6)	166 (70.0)
College, professional/technical degree, or more	83 (22.9)	28 (22.4)	55 (23.1)
Income[a]			
< $11,000	192 (53.2)	57 (46.0)	136 (57.14)
$11,000–$20,999	69 (19.1)	27 (21.8)	42 (17.7)
$21,000–$30,999	52 (14.4)	21 (17.0)	31 (13.0)
≥ $31,000	48 (13.3)	19 (15.3)	29 (12.2)
Health insurance	254 (69.9)	90 (72.0)	164 (68.9)
Currently employed	253 (69.7)	92 (73.6)	161 (67.7)
Sexual identity			
Gay	248 (68.3)	85 (68.0)	163 (68.5)
Bisexual	77 (21.2)	27 (21.6)	50 (21.0)
Queer, questioning, and other identity	33 (9.1)	13 (10.4)	20 (8.4)
Straight	5 (1.4)	0 (0)	5 (2.1)
HIV status			
Positive	156 (43.0)	51 (40.8)	105 (44.1)
Negative/unknown	207 (57.0)	74 (59.2)	133 (55.9)
# Serodiscordant condomless anal sex acts, *mean* (*SD*)	1.7 (12.0)	0.3 (0.8)	2.4 (14.8)
Intervention engagement, minutes, *mean* (*SD*)	66.1 (174.0)	81.3 (210.3)	58.1 (151.3)

Unexposed: reporting 0 or 1 conditions; Exposed: reporting 2 or more conditions

[a]Does not add up to total sample size due to missing responses

Table 2 Baseline epidemic health conditions (n = 363)

Individual condition	n (%)
Zero conditions reported	53 (14.6)
Alcohol use	36 (9.9)
Polydrug use	64 (17.6)
Depression symptomology	156 (43.0)
Anxiety symptomology	94 (26.0)
Experiences of racism and discrimination	195 (53.7)
Experiences of sexual minority stigma	219 (60.3)

Change in Risk Scores Over Time

At baseline, the mean risk score was 2.59 (SE: 1.48) in the control arm and 2.70 (SE: 1.54) in the intervention arm. At 3-month follow-up, risk scores were 2.34 (SE: 1.46) in the control arm and 2.22 (SE: 1.51) in the intervention arm. Change in risk scores between arms was modeled using a Generalized Estimating Equation controlling for the effects of HIV status, insurance, income, and age. There was a significant effect of time, indicating an overall decrease in risk scores from baseline to 3 months of 0.23 (SE: 0.10, 95% CI −0.42, −0.04, $p < 0.020$) across participants in both study arms, controlling for the

Table 3 Poisson regression model predicting number of Serodiscordant Condomless Anal Sex acts (n = 353)

	b	SE	95% CI	
Risk Score	**0.32**	**0.03**	**0.26**	**0.37**
HIV positive	**0.33**	**0.08**	**0.17**	**0.50**
HIV negative/unknown	Ref.	–	–	–
Insurance	**−0.53**	**0.09**	**−0.71**	**−0.36**
Income				
< $11,000	Ref.	–	–	–
$11,000–$20,999	0.88	0.12	0.65	1.11
$21,000–$30,999	**1.89**	**0.10**	**1.69**	**2.09**
≥ $31,000	1.00	0.15	0.71	1.28
Age	**−0.12**	**0.02**	**−0.15**	**−0.09**

Does not add up to total sample size due to missing responses on the outcome

Bold indicates $p < 0.001$

non-significant effects of study arm, time by arm interaction, and model covariates.

To determine which specific conditions decreased, within-person changes for each of the six reported conditions from baseline to 3 months were also examined using McNemar's t-tests. Overall, there were significant decreases in polydrug use (17.6% to 11.9%, McNemar's χ^2 $p < 0.003$), experiences of racism (53.7% to 47.9%, McNemar's χ^2 $p < 0.038$), and experiences of sexual minority stigma (60.3% to 53.7%, McNemar's χ^2 $p < 0.032$), but not for symptoms of alcohol use, anxiety, or depression. When examining results by intervention condition, both study arms had reductions in polydrug use, experiences of racism, and experiences of homophobia. However, only intervention participants reported statistically significant reductions in polydrug use (21.6% to 12.5%, McNemar's χ^2 $p < 0.001$).

Intervention Engagement

Between baseline and 3-month follow-up, participants engaged with the intervention for 66.1 min on average (SD: 174.0), with 82.3% of participants reporting low usage (< 60 min). We used general linear models to predict intervention usage (both continuous and dichotomous for high vs. low usage) based on risk scores for the total sample, and within both arms, but none of the models were significant or had any significant covariates.

Discussion

This study examines the effect of cumulative risk scores on sexual risk behaviors for HIV, and extends existing knowledge by demonstrating that risk scores related to stigma syndemics are not immutable, and may possibly be intervened upon within the context of an intervention. Our primary finding supported that baseline co-occurring epidemic health conditions were associated with the number of SDCAS acts, consistent with other studies demonstrating the association of psychosocial distress with sexual risk behaviors for HIV among BMSM and MSM of other races and ethnicities [12–14, 38]. Notably, risk scores significantly decreased for both intervention and control arm participants over time. Among the six conditions, decreases were reported for polydrug use, experiences of racism, and experiences of sexual minority stigma. There appears to be a benefit for all participants in the trial. Decreases in polydrug use is notable because reductions could suggest less need to use drugs as a coping mechanism, or possibly the use of other coping strategies instead.

Our study was inspired by syndemic theory to guide our selection of predictors, contributing to the current body of knowledge by focusing on young BMSM in the Southern U.S. In line with the idea that structural and societal factors drive syndemics, we included experiences of racial/ethnic and sexual minority discrimination as a determinant using a stigma syndemics lens. Prioritizing BMSM, particularly those living in the US South, is essential for ending the HIV/AIDS epidemic and addressing concentrated disadvantage; however, few other studies have exclusively focused on this population using a syndemic framework [10, 39]. In our study sample, the majority of participants were exposed to co-occurring adverse structural and psychosocial conditions. We also observed a substantially higher prevalence of polydrug use in the past three months in our sample compared to the Southern urban sample by Chandler and colleagues (17.6% vs. 3.3%), which included BMSM 18 and older. Additionally, about half of all participants reported experiences of racial/ethnic discrimination, sexual minority stigma, and depression symptomology. Given that SDCAS with unknown status or virally unsuppressed partners can facilitate the transmission or acquisition of HIV and other sexually transmitted infections, this finding emphasizes the continued need for interventions to address sexual health risks under the varied societal contexts where individuals experience psychosocial distress, minority stress, and polydrug use.

We acknowledge that a formal syndemic analysis would require examining synergistic effects (i.e., interaction or moderation) between well-documented co-occurring psychosocial variables such as depression and anxiety, or drug use and alcohol use [40]. However, the focus of this paper was to examine whether cumulative risk scores changed within the context of the intervention. This allowed us to conceptualize a cumulative burden of risk that could shift over time in simple, interpretable terms. More advanced methods that account for the synergistic effects of structural inequities or differing trajectories of unique risk profiles could be considered in future work.

Although our definition of sexual risk for HIV was created using counts of higher-risk sex acts with both serodiscordant and unknown status partners, the parent study did not collect information on whether participants or their partners were using biomedical prevention strategies during sexual encounters (i.e., Post-/Pre-Exposure Prophylaxis [PEP/PrEP], or Treatment as Prevention [TasP]). Qualitative work has documented the changing dynamics of moral negotiations around HIV status disclosure within the context of these new advances [41], which continues to reshape HIV-related stigmas. However, we expect that PrEP usage among our intervention participants would have been low during the enrollment period from 2013 to 2015 and thus likely did not influence observed results for the present study. This is likely because the U.S. Food and Drug Administration approved PrEP in 2012 [42], and there has been slow uptake of biomedical prevention strategies among BMSM,

especially in the U.S. South [43–47]. Adapting and updating interventions in the current context of greater biomedical behavioral prevention rollout may better inform complementary approaches to addressing syndemic exposures among BMSM.

This study did not include other commonly-examined psychosocial syndemic variables, such as intimate partner violence [13], childhood sexual abuse [7, 14, 48], and sexual compulsivity [13], which could also account for sexual risk behaviors. In particular, previous studies with BMSM have found greater sexual risk outcomes for those with exposures to violence in combination with drug use, depressive symptomology, and sexual compulsivity [49, 50]. Because the parent study was not originally designed to examine specific syndemics, information about these factors was not available. Future work can examine exposure to multiple forms of violence, such as child maltreatment, intimate partner violence, and community or neighborhood violence.

The findings from the present study suggest that cumulative risk scores can predict sexual risk, but that this relationship is likely complex. More salient predictors and validated measures are needed to effectively examine the synergistic effects on sexual risk outcomes. Determining a priori the specific combination of syndemic factors and their theorized causal pathways can help target the most urgent needs in HIV care and prevention for this population.

For participants in this mHealth intervention trial, risk scores from baseline to 3-month follow-up decreased across both study arms, indicating that participating in the information control arm may still confer a benefit. Importantly, score decreases were primarily driven by decreases in polydrug use. Notably, measurement of alcohol use relied on items developed by the research team that approximated similar items on other alcohol use disorder scales, but have not been tested for psychometric properties. To more reliably assess high alcohol use, future work should use validated measures such as the validated 3-item AUDIT-C measure for alcohol use disorder or add items that examine the latent construct of hazardous alcohol use.

Experiences of racism and sexual minority stigma also significantly decreased, which supports prior qualitative work with this study sample that describe resilience processes whereby participants exchanged various forms of social support on the online platform [30]. In particular, more recent mixed-methods work suggested that participating in destigmatizing healthcare and social interactions in the intervention was associated with improved psychological well-being and HIV care outcomes [30–32]. Although the intervention was not designed to target any particular syndemics, these interactions may have modeled positive social support with peers and clinicians in a virtual space, which may have impacted participants' social learning and how they navigate future experiences of stigma in physical and social environments. This may explain the decrease in polydrug use as a coping mechanism. However, the specified recall period at baseline (past 12 months) was longer than the period specified at follow-up (past 3 months), and may also possibly indicate longer accumulated experiences of discrimination prior to the study, thereby resulting in smaller detectable decreases. Nonetheless, it is important for future work to examine whether intervention participants could become better equipped to navigate (e.g., confront or avoid) anticipated stigma, which may potentially avert the abuse of drugs or alcohol as a coping mechanism and enable healthier coping options.

Prior work with this sample found that greater engagement with the intervention (60 min or more) was associated with fewer acts of condomless anal intercourse (including serodiscordant, concordant, and unknown status partners) at follow-up [34]. However, in the current analysis, exposure to co-occurring epidemic health conditions did not differentially affect engagement in the trial. These findings underscore the inherent difficulty in defining the metrics that can capture meaningful or effective engagement in online interventions [33]. It is possible that both syndemics and engagement have causal relationships with sexual risk behaviors, but not with each other. Conversely, it may be that better capturing the metrics of engagement may elucidate more salient associations with syndemics. For example, participants who are most exposed to syndemics may benefit from a more intensive intervention or require tailored content for facilitating care services for their specific needs. A recent systematic review of syndemics among MSM calls for additional evidence on cultural tailoring of interventions [6]. Tailoring interventions to the conditions and stressors relevant to the individual's lived experiences while simultaneously capturing their usage data can help build an evidence base for intervention efficacy among syndemically-exposed populations. Accordingly, our forthcoming trial of HealthMPowerment 2.0 builds on this work and uses a multilevel approach by providing access to HIV and viral load testing and medical providers, an interactive social network, and content that intentionally addresses multiple socioculturally-relevant stigmas [51]. We emphasize a status-neutral approach with BMSM populations, especially because syndemics can increase sexual risk-taking for MSM regardless of HIV status [6].

Additionally, facilitating individuals' capacities to overcome barriers to accessing clinics, services, and culturally competent health information has become increasingly relevant in HIV-related healthcare contexts and an organizational climate debilitated by the novel coronavirus pandemic (Covid-19). In recent surveillance, researchers found that a sample of MSM continued to report multiple sex partners despite national recommendations for physical distancing [52]. Due to physical distancing and remote working

measures implemented during the Covid-19 pandemic, populations who are online may have even fewer demographic differences from those offline.

Future evaluations informing the effects that specific combinations of co-occurring exposures can have on sexual risk-taking will be critical to developing more comprehensive, effective, and tailored interventions, and maximize opportunities that facilitate BMSM's engagement in HIV prevention. Online interventions are an increasingly important mode of delivery, especially during periods of physical distancing and lockdown measures. Nationally, across stages of the HIV prevention and care continuum, BMSM report suboptimal engagement [53–55]. One strategy to enhance uptake and acceptability may be to develop ready-for-tailoring interventions that are responsive to the various pathways for stigma, thereby decreasing psychosocial distress, and ultimately attenuating the risk for HIV acquisition and transmission. To this end, it is key to focus on engagement in care and preventative behaviors while recognizing that forms of stigma and discrimination exist at multiple levels and at the same time. Syndemics research to advance this work should consider not only the psychosocial conditions, but also structural and socioenvironmental to better understand the dynamics under which syndemics amplify risk and ways that public health practitioners can enhance the processes of health empowerment.

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Data Availability Data can be made available through the corresponding author.

Code Availability Syntax for statistical analyses can be made available through the corresponding author.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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