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Examining the Impact of a Psychosocial Syndemic on Past Six-Month HIV Screening Behavior of Black Men who have Sex with Men in the United States: Results from the POWER Study

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Abstract

Syndemic production theory has been used to explore HIV transmission risk or infections but has not been used to investigate prevention behavior, or with large samples of non-Whites. This analysis is the first to explore the impact of syndemic factors on previous six-month HIV screening behavior among US Black MSM. Data from Promoting Our Worth, Equality and Resilience (POWER) were analyzed from 3,294 participants using syndemic variable counts and measures of interaction/synergy. Syndemic variables included: past three-month poly-drug use, depression, last year intimate partner violence, HIV risk and problematic binge drinking. BMSM reporting two syndemic factors were more likely to report screening (AOR=1.37, 95% CI: 1.04–1.80; p=.028) with no significant associations for three or more conditions. Measures of joint effect revealed that there were synergies among depression, problematic binge drinking and poly-drug use but these psychosocial factors cannot entirely explain testing patterns and excess disease burden among BMSM.

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INTRODUCTION

In 2006, Centers for Disease Control and Prevention (CDC) suggested recommendations for HIV testing, which included screening every six months for **men who have sex with men** (MSM) and annually for all others aged 15–64 (1, 2). This remains the current CDC recommendation which found recent support with the 2013 U.S. Preventative Services Taskforce "Grade A recommendation" (3). HIV screening is essential to limiting HIV transmission and is the first stage in the HIV cascade of care (4). Recently, there have been considerable changes to the framing of HIV treatment and care (5). With the focus of HIV viral suppression and elimination of transmission as goals of the national HIV/AIDS strategy, there was a renewed commitment to testing populations most at risk for HIV; chief among these groups are Black MSM, especially Black young (under age 30) men who have sex with men (BYMSM) (5). Current CDC estimates concluded that in the United States there is a 1 in 2 lifetime risk for BMSM to be diagnosed with HIV (6). In order to reduce HIV transmission, public health systems need to assure that individuals with HIV are diagnosed and successfully engaged in treatment while simultaneously encouraging HIV seronegative men to remain negative (7).

Historically, research on HIV transmission among BMSM found infrequent testing among BMSM which results in delayed optimal initiation of antiretroviral therapy (ART) (8, 9). Since 2006, BYMSM have had the highest incidence rates among all MSM under 30 (10, 11). Between 2006 and 2009, there was a 48% increase in the incidence of HIV among YBMSM (12). One HIV screening study conducted in six urban areas found that 77% of all young MSM in the sample were previously unaware of their HIV infection, and that 91% of the YBMSM in the sample were unaware of their infection (13). These data support the later analysis of Zanoni and Mayer (2014), which estimated that only 40% of HIV infections in people under 30 in the US were diagnosed (14). They concluded that normalizing HIV testing among YBMSM, was of particular importance (14).

Regardless of the serostatus of BMSM, a requisite step to addressing HIV transmission and viral suppression among this group is routine screening for HIV diagnosis. For men who are negative but exhibit risk, screening represents an opportunity to introduce prevention tools; while men who are diagnosed with HIV can be linked to care. Given the important nature of ensuring BMSM are aware of these HIV transmission prevention methods, understanding testing behavior is a necessity.

Using Syndemic theory to study HIV

Much of the current literature related to HIV transmission and biobehavioral intervention is grounded in the study of HIV risk behavior. One method used to study HIV outcomes has been the use of the theory of syndemic production. Syndemics, introduced to HIV research in 1994, occur when multiple epidemics occur simultaneously and work synergistically with risk factors to worsen health outcomes (15–17). Originally derived from biological factors, such as co-morbidities, the syndemic definition expanded to include biological and ecological factors that impacted health outcomes. Most often syndemic studies have explored psychosocial factors independently associated with HIV risk or HIV seroconversion.

Stall and colleagues (16) began to quantitatively model these phenomena by inclusion of a syndemic count variable in logistic regression. The initial study found significant associations of risk behavior with increasing numbers of psychosocial factors among urban MSM. Several studies replicated this method, usually with few non-White MSM. The psychosocial factors most often used in these syndemic count variable analyses consist broadly of polysubstance use, interpersonal violence, depression symptomologies and sexual risk with outcome variables of HIV risk activity or seroconversion (18). The resulting body of literature mostly based on the experiences of urban, White MSM has demonstrated a dose-response relationship, such that with increasing reports of the number psychosocial factors, MSM have been significantly more likely to report HIV risk or seroconversion in several studies (18).

While many studies have employed the use of the syndemic count variable there have been critiques of such a simplified method of quantitative analysis. Tsai and Burns (2015) noted that the count analysis may have only accounted for additive effects, whereas a fundamental tenet of syndemics was the greater than additive impact on health outcomes. It was then suggested that researchers include measures of synergy among variables in order to better understand the relationship of contributing variables to outcomes (18). Recent studies of MSM by Ferlatte and colleagues (19) and Card and colleagues (20) used measures of synergy and provide additional support for a syndemic understanding of HIV risk and seroconversion; however, a study of Indian MSM by Tomori and colleagues (21) did not find significant synergies among psychosocial factors despite significant results using logistic regression with a count variable. Such seemly incongruent results may suggest that only conceptualizing syndemics based on psychosocial factors may be too narrow and may not adequately describe drivers of negative health outcomes experienced by non-White MSM.

The current study

Promoting Our Worth Equality and Resilience (POWER), an NIH-sponsored study of the [redacted for review], conducted a cross-sectional national study of MSM and transgender women at national Black Pride events between 2014 and 2017. POWER offered a large sample to explore the use of syndemic theory in relation to the HIV outcomes among BMSM. This analysis examined the impact **of a subset of** the most commonly included psychosocial syndemic variables related to previous six-month HIV screening. This study is the first to use a syndemic model to explore the outcome of the CDC recommended screening among BMSM. Based on previous literature it is hypothesized that BYMSM will be less likely than older BMSM to have been tested in the previous six months (14) and that BMSM in the sample will be less likely to be tested at increasing levels of psychosocial syndemic factor count totals (18).

METHODS

Eligibility, Recruitment and Study Procedures

Eligibility.—A community-based sample of 5,858 MSM and transwomen participated in the cross-sectional survey over the four-year study period (2014–2017). Participants were eligible for POWER if they were: 1) 18 years old or older; 2) were assigned male sex at

birth; 3) reported sex with at least one male in his/her lifetime. For this analysis, participants were included if they were: 1) 18 years old or older; 2) had anal sex with at least one male in the last 12 months; 3) did not identify as transgender; 4) identified as Black; and 5) self-reported being HIV negative or unknown status (at the time of the survey). Men were asked to self-report HIV status in the survey and offered confidential or anonymous HIV screening post-survey. Participants who reported being HIV positive, tested HIV positive, tested indeterminate or had missing HIV screening results were excluded from this analysis. The analytic sample for the current study is 3,294 BMSM.

Recruitment.—Participants were recruited at national Black Pride events in six cities across the country. Recruitment included indoor and outdoor events, as well as venues such as bars and nightclubs.

Study procedures.—The study used Windows-based tablets with the audio computer-assisted self-interviewer (ACASI) system. Each tablet provided a primary screener and documented consent from each participant included in the study. The researchers of this study obtained a waiver of written consent from the local university's institutional review board in order to obtain anonymous results. The 25-minute survey assessed demographic variables, sexual risk, and psychosocial variable results (e.g. depression). Participants were compensated $10 for their participation.

Human subject protections

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional review board of the [redacted for review] and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Measures

Outcome variable.—In order to study the adherence of participants to the CDC 2006 HIV screening recommendations, which suggest that sexually-active MSM should be tested for HIV every six months, a dichotomous outcome variable was assessed with the following question: "Have you been tested for HIV in the past 6 months?" Dichotomous responses (yes, no) were reported.

Demographic variables.—Participants reported their age category, income, sexual orientation (sexuality), and employment status as seen in Table 1. Participants also reported if they had current insurance coverage. All other variables used for analysis are included in Table 1 for reference.

Syndemic variables—A total of five variables were considered to contribute to a **psychosocial** syndemic for analysis which assessed variables within the four broad categories noted within previous HIV-related syndemic literature: substance use, mental health, interpersonal violence and HIV risk. Using the systematic review of Tsai and Burns (2015) as a guideline, this analysis used both poly substance (poly-drug) use and binge drinking frequency among a longer list of possible variables for substance use. While these are both limited in scope, which is acknowledged in study limitations, correlations of these

variables found that binge drinking and poly-drug use were not so highly correlated that they were interchangeable. Previous psychosocial syndemic studies have operationalized substance use or abuse variables using poly-drug use (16, 17, 22–24) or binge drinking frequency (22, 23, 25–28). Previous studies have also operationalized violence as intimate partner violence (17, 21, 22, 29) among other forms used. Mental health status has also been operationalized using several different validated scales, including the Center for Epidemiological Studies of Depression (CESD) scale (17, 22, 25, 30). For each variable, questions were isolated relating to the psychosocial syndemic factor and recoded as necessary. Comparisons of syndemic factors are found in Table 1.

Poly substance use.—Poly substance use was defined as the use of three or more substances in the previous three months as described in previous literature (16, 23). Substances included in the measure were: cocaine, crack, heroin, opiates, crystal meth, inhalants (e.g. “poppers”) and other party drugs. Results were recoded to dichotomous responses. The sum of the number of substances used were recoded into poly substance use as three or more (yes) or less than three substances (no).

Depression symptomology.—Depression symptomology likelihood was assessed using the CESD-10, **a shortened form of the CESD**, which screens for past-week depressive symptoms. The CESD-10 is comprised of 10 questions, including three questions which are reverse-coded, which were summed. A total score of 10 or more of a possible 30 was used to indicate likelihood of moderate to severe depressive symptoms as previously demonstrated in literature (31).

Intimate partner violence.—Intimate Partner Violence (IPV) was assessed using a single question: “In the past year, have you been in a relationship with a partner who has ever hit, kicked, slapped, beaten or in any other way physically assaulted you?” Dichotomous responses were reported.

Problematic binge drinking.—Binge drinking, defined as five or more drinks in one sitting, was measured by a single question in this analysis: “In the past 12 months, how often did you have 5 or more alcoholic drinks in one sitting?” Time responses were provided on a scale from “never” to “more than once a day.” Binge drinking was used as a dichotomous variable to determine if the participant was considered to have problematic drinking (more than one binge drinking episode per month) as seen in previous literature (22, 26, 32, 33).

Sexual risk.—A total of 13 questions were used to develop this dichotomous risk variable (0 = less to no risk, 1 = greater risk) based on five criteria used in CDC risk determination (34): recent HIV positive sexual partner, recent bacterial sexually transmitted infection (STI), history of condom use, number of sexual partners and history of sex work. To achieve the most conservative estimates, participants were considered at greater risk if they reported any of the risk factors listed. Three of these criteria, recent positive partner, recent bacterial STI and participation in sex work, were reported dichotomously. The remaining two variables were recoded to be dichotomous. For number of sexual partners, the question “In the past 12 months, with approximately how many different men have you had anal sex?” was dichotomized at three partners or more, the median found in this sample. BMSM

hypothesized to have “greater risk” were those with more than three partners, while men with three partners or less were considered “lower risk”. Lastly, participants were asked, “Of the times you had receptive anal sex (bottomed), what proportion of the time did your partner wear a condom?” and “Of the times you had insertive anal sex (topped), what proportion of the time did you wear a condom?” with responses ranging from “never” = 0 to “always” = 4. Participants who reported condom use half of the time or less were considered to have more risk.

Analytic procedure

All analyses were completed in Stata 14.2 (Stata Corp, College Station, TX). Listwise deletion was used for missing information including 27 participants who did not have complete information for psychosocial variables or the outcome variable. Respondents who answered “Don’t know” or “Refuse to answer” were recoded as missing for all variables. Bivariate logistic analyses were conducted in order to determine the relationship of each of the psychosocial variables with the dependent variable (HIV testing within the last six months) as seen in Table 2. Table 2 also shows the impact of the demographic variables on HIV testing within the last six months prior to survey, including the impact of age category on previous HIV screening behavior using BMSM 40 and over as the referent category. Lastly, a sequential logistic regression with the number of syndemic factor counts, controlling for demographic variables was conducted (Table 3) to understand if there was an additive interplay of syndemic variables that contributed to differences in testing within the previous six months. Further, the final model of the sequential regressions assesses the impact of any syndemic on HIV screening within the previous six months.

Three indices of interaction were computed among the syndemic variables and are presented in 2-way interactions (18). The relative excess risk of the interaction (RERI), attributable proportion due to the interaction (AP) and the synergy index (S) are appropriate for modeling the combined impact of experiences on behavior with AP as a most robust measure when using odds ratios (OR) (35–37). RERI is the difference between the observed OR and the expected OR for syndemic variables being compared (null value = 0). The second index, AP, is the proportion of the RERI to the observed OR when both syndemic variables are present (null value = 0); and the third index, S, is the ratio of risk due to exposure for both variables when there is and is not synergy (null value = 1) (35–38). These measures of interaction are displayed in Table 4.

RESULTS

Demographic characteristics of the sample stratified by outcome variable are presented in Table 1. The majority of the sample were YBMSM (64.2%), self-identified as gay/homosexual (79.7%), reported an annual income of $30,000 or more (55.7%), had at least some college education (59.9%), were single at the time of survey (74.7%), and reported having health insurance (83.5%). Relationship status and sexual orientation did not appear to differ significantly when comparing those tested to those not tested for HIV in the six months prior to survey.

In bivariate analyses, found in Table 2, BYMSM (OR=2.14, 95% CI: 1.73–2.64; p<.001) and BMSM aged 30–39 (OR=1.79, 95% CI: 1.39–2.25; p<.001) were significantly more likely to have been tested than BMSM 40 and older. Participants who earned $30,000 or more annually were more likely to have been tested in the last six months (OR=1.35, 95% CI: 1.17–1.56; p<.001), as were men who were college educated (OR=1.70, 95% CI: 1.44–2.01; p<.001) or had post-baccalaureate or graduate education (OR=1.45, 95% CI: 1.14–1.85; p=.002) as compared to men with a high school education or less. Men who did not have insurance at the time of the survey were less likely to have been tested in the last six months (OR=0.73, 95% CI: 0.61–0.88; p=.001) compared to those with insurance. Among the syndemic variables, only those with higher HIV risk were significantly more likely to have been tested in the previous six months (OR=1.20, 95% CI: 1.01–1.41; p=.042).

A sequential logistic regression was performed to assess whether participants had been tested for HIV within the previous six months as predicted by number of reported syndemic variables, including: problematic drinking, poly-drug use, past year intimate partner violence, depression and sexual risk, while controlling for demographic variables. Correlations of syndemic variables ranged from 0.09 (HIV risk and depression) to 0.23 (poly-drug use and intimate partner violence) with all correlations p<.01. Syndemic levels were established by the sum of the number of syndemic factors experienced as reported by each participant. There were six levels of syndemic factor counts (0 to 5 reported syndemic factors).

Table 3 displays the results of the multivariable logistic regressions. Model 1 contains the results of the demographic variables. Model 2a contains the results of syndemic factor counts controlling for demographic variables, showing that men with one (AOR=1.35, 95% CI: 1.03–1.77; p=.028) or two (AOR=1.37, 95% CI: 1.04–1.80; p=.028) syndemic variables were statistically more likely to be tested for HIV in the last six months than men who reported experiencing no syndemic factors. There were no significant associations for men who reported three or more syndemic variables in this sample. To further examine this phenomenon, model 2b contains a dichotomous “any syndemic” variable, comparing BMSM without a syndemic (those experiencing 0–1 factors) and BMSM experiencing two or more factors, defined as a syndemic. There was no significant difference estimated by AOR for model 2b.

Table 4 displays the results of the tests of joint effects resulting in RERI, AP and S. In order to aid in the understanding of these data, the outcome variable of HIV testing in the previous six months was reverse coded (0 = yes, 1=no). As HIV screening is a form of secondary prevention, extant literature dictates that preventative factors may be better understood when reverse coded (38). All RERI and AP with greater than zero were considered to have a greater than additive effect, while a negative value for RERI or AP indicates less than additive (38). Synergy index (S) values above 1 indicated synergy between factors, while values below one indicated less than synergy between factors. There were four instances of synergy among syndemic variables that resulted in higher odds of not being screened in the last six months: poly-drug use and depression (AP=0.01, S=1.02), sexual risk and problematic drinking (AP=0.17, S=1.98), poly-drug use and problematic drinking (AP=0.16, S=3.70) and problematic drinking use and depression (AP=0.16, S=3.70).

DISCUSSION

This study is the first to examine HIV screening using syndemic theory among a large sample of BMSM. Several important results were found in the analysis. The hypothesis that BYMSM were less likely to be screened in the previous six months when compared to older BMSM was not supported. BYMSM were significantly more likely have been tested in the past six months than BMSM aged 40 and over. This suggests that BYMSM are indeed being screened for HIV and that public health efforts to reach this group may have had an impact on this group.

Second, in multivariable logistic analysis, men who experienced one or two syndemic factors were significantly more likely to have been screened for HIV in the previous six months than men who reported experiencing no factors. As these odds ratios demonstrated that men who were at risk were more likely to test, it appears that these most-used syndemic variables do not adequately explain any pattern of HIV screening among BMSM.

Third, tests of the joint effects of variables and synergy were helpful in uncovering factors that contributed to a lack of testing and further revealed that although the prevalence of poly-drug use may have been low in the sample, experience of poly-drug use did have synergy with depression and problematic drinking. Further, problematic drinking had synergy with depression, sexual risk and poly-drug use. When poly-drug use or problematic drinking are present with other factors, synergy is possible, but the results of the regressions do not indicate that these individual behavioral-level factors can entirely explain a lack of testing among BMSM. This may suggest that larger, structural factors are more influential in the HIV screening behavior of BMSM, particularly BYMSM and that public health investments in community-based testing have had a positive effect in producing these behaviors, although it is still not clear if those at the greatest risk (experiencing a greater number of syndemic variables) were any more likely than those reporting no factors to be screened.

Although this study has many strengths, such as the sample size, there are limitations to these data. POWER is cross-sectional in nature and relies heavily on self-report data which are subject to recall bias. Several of the syndemic variables were defined by a single question or scale (e.g. binge drinking frequency) and it is possible that a single item was not exhaustive and may underestimate the prevalence of factors impacting behavior. An additional limitation is the use of the median number of sexual partners among respondents to signify lower and greater HIV risk. While there are risk assessment tools available enumerating the number of sexual partners to determine risk, extant literature notes that present tools underperform in predicting HIV risk and seroconversion among BMSM (39, 40). Further, survey data indicating the serostatus of all sexual partners reported were not available. Depression symptomology was measured using a validated scale, however, due to the nature of depression, it is possible that those most depressed may have been less likely to attend social events where data were collected, and therefore may be underrepresented in these results. Similarly, these data were collected at Black Pride events, and there may be a difference among BMSM who have the access to attend compared to those without the ability to attend such events. It is also possible that the results of the study may be subject to social desirability given the personal nature of many of the questions; however, the

researchers attempted to limit social desirability by maintaining the anonymity of participants. The generalizability of the sample may be limited, although the data have been taken from a large, national sample at more than 80 venues within the United States.

This study contributes novel information into the literature of BMSM by modeling the impact of syndemic variables on reports of HIV screening and shifts intervention conversations from deficits (e.g. condomless anal intercourse) to prevention-based outcomes. The implications of these findings reiterate earlier studies stating that individual behavioral factors are not the primary contributor to HIV disparities among BMSM and other MSM and **strengthen calls for more relevant HIV risk screening tools**. Additionally, this analysis highlights that poly substance use, while not very prevalent in this population, is an important predictor of not being screened when it has synergy with other variables. Lastly, this analysis provides a framework to study factors related to HIV prevention behaviors in other levels of the social ecology. For example, a recent latent class analysis used psychosocial and structural variables to explore an HIV testing syndemic among a largely (97%) heterosexual sample of Black men (41). Efforts to describe meaningful syndemics will be furthered by expanding the variables used when contemplating a syndemic as a way to underscore probable cultural differences in how HIV impacts MSM of varying race and ethnicity.

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REFERENCES

1. Branson BM, Handsfield HH, Lampe MA, Janssen RS, Taylor AW, Lyss SB, et al. Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings. Morbidity and Mortality Weekly Report: Recommendations and Reports 2006;55(14):1-CE-4.
2. U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. HIV testing among men who have sex with men−−21 cities, United States, 2008. MMWR Morbidity and mortality weekly report 2011;60(21):694. [PubMed: 21637183]
3. Moyer VAJAoim. Screening for HIV: US preventive services task force recommendation statement 2013;159(1):51–60.
4. Gardner EM, McLees MP, Steiner JF, Del Rio C, Burman WJ. The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. Clinical infectious diseases 2011;52(6):793–800. [PubMed: 21367734]
5. Millett GA, Crowley JS, Koh H, Valdiserri RO, Frieden T, Dieffenbach CW, et al. A way forward: the National HIV/AIDS Strategy and reducing HIV incidence in the United States. JAIDS Journal of Acquired Immune Deficiency Syndromes 2010;55:S144–S7. [PubMed: 21406986]

6. U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. Diagnoses of HIV Infection in the United States and Dependent Areas, 2014 HIV Surveillance Report 2014;26.
7. Haire B, Kaldor JM. Ethics of ARV based prevention: treatment- as- prevention and PrEP. Developing world bioethics 2013;13(2):63–9. [PubMed: 23594312]
8. Christopoulos KA, Das M, Colfax GN. Linkage and retention in HIV care among men who have sex with men in the United States. Clinical infectious diseases. 2011;52(suppl_2):S214–S22. [PubMed: 21342910]
9. Millett GA, Flores SA, Peterson JL, Bakeman R. Explaining disparities in HIV infection among black and white men who have sex with men: a meta-analysis of HIV risk behaviors. Aids 2007;21(15):2083–91. [PubMed: 17885299]
10. Maulsby C, Millett G, Lindsey K, Kelley R, Johnson K, Montoya D, et al. HIV among black men who have sex with men (MSM) in the United States: a review of the literature. AIDS and Behavior 2014;18(1):10–25. [PubMed: 23620241]
11. Scott HM, Pollack L, Rebchook GM, Huebner DM, Peterson J, Kegeles SM. Peer social support is associated with recent HIV testing among young black men who have sex with men. AIDS and Behavior 2014;18(5):913–20. [PubMed: 24065436]
12. Prejean J, Song R, Hernandez A, Ziebell R, Green T, Walker F, et al. Estimated HIV incidence in the United States, 2006–2009. PloS one 2011;6(8):e17502. [PubMed: 21826193]
13. MacKellar DA, Valleroy LA, Secura GM, Behel S, Bingham T, Celentano DD, et al. Unrecognized HIV infection, risk behaviors, and perceptions of risk among young men who have sex with men: opportunities for advancing HIV prevention in the third decade of HIV/AIDS. JAIDS Journal of Acquired Immune Deficiency Syndromes 2005;38(5):603–14. [PubMed: 15793373]
14. Zanoni BC, Mayer KH. The adolescent and young adult HIV cascade of care in the United States: exaggerated health disparities. AIDS patient care and STDs 2014;28(3):128–35. [PubMed: 24601734]
15. Singer M AIDS and the health crisis of the US urban poor; the perspective of critical medical anthropology. Social science & medicine 1994;39(7):931–48. [PubMed: 7992126]
16. Stall R, Mills TC, Williamson J, Hart T, Greenwood G, Paul J, et al. Association of cooccurring psychosocial health problems and increased vulnerability to HIV/AIDS among urban men who have sex with men. American journal of public health 2003;93(6):939–42. [PubMed: 12773359]
17. Parsons JT, Grov C, Golub SA. Sexual compulsivity, co-occurring psychosocial health problems, and HIV risk among gay and bisexual men: further evidence of a syndemic. American Journal of Public Health 2012;102(1):156–62. [PubMed: 22095358]
18. Tsai AC, Burns BF. Syndemics of psychosocial problems and HIV risk: a systematic review of empirical tests of the disease interaction concept. Social Science & Medicine 2015;139:26–35. [PubMed: 26150065]
19. Ferlatte O, Salway T, Samji H, Dove N, Gesink D, Gilbert M, et al. An Application of Syndemic Theory to Identify Drivers of the Syphilis Epidemic Among Gay, Bisexual, and Other Men Who Have Sex With Men. Sexually transmitted diseases 2018;45(3):163–8. [PubMed: 29420444]
20. Card KG, Lachowsky NJ, Armstrong HL, Cui Z, Wang L, Sereda P, et al. The additive effects of depressive symptoms and polysubstance use on HIV risk among gay, bisexual, and other men who have sex with men. Addictive behaviors 2018;82:158–65. [PubMed: 29533847]
21. Tomori C, McFall AM, Solomon SS, Srikrishnan AK, Anand S, Balakrishnan P, et al. Is there synergy in syndemics? Psychosocial conditions and sexual risk among men who have sex with men in India. Social Science & Medicine 2018;206:110–6. [PubMed: 29615297]
22. Dyer TP, Shoptaw S, Guadamuz TE, Plankey M, Kao U, Ostrow D, et al. Application of syndemic theory to black men who have sex with men in the Multicenter AIDS Cohort Study 2012;89(4): 697–708.
23. Mimiaga MJ, O'CLEIRIGH C, Biello KB, Robertson AM, Safren SA, Coates TJ, et al. The effect of psychosocial syndemic production on 4-year HIV incidence and risk behavior in a large cohort of sexually active men who have sex with men. Journal of acquired immune deficiency syndromes (1999) 2015;68(3):329. [PubMed: 25501609]

24. Parsons JT, Millar BM, Moody RL, Starks TJ, Rendina HJ, Grov CJHP. Syndemic conditions and HIV transmission risk behavior among HIV-negative gay and bisexual men in a US national sample 2017;36(7):695.
25. Herrick A, Stall R, Egan J, Schrager S, Kipke MJJoUH. Pathways towards risk: syndemic conditions mediate the effect of adversity on HIV risk behaviors among young men who have sex with men (YMSM) 2014;91(5):969–82.
26. Jie W, Ciyong L, Xueqing D, Hui W, Lingyao H. A syndemic of psychosocial problems places the MSM (men who have sex with men) population at greater risk of HIV infection. PloS one 2012;7(3):e32312. [PubMed: 22479319]
27. Mustanski B, Garofalo R, Herrick A, Donenberg GJAoBM. Psychosocial health problems increase risk for HIV among urban young men who have sex with men: preliminary evidence of a syndemic in need of attention 2007;34(1):37–45.
28. Sullivan KA, Messer LC, Quinlivan EBJApc, STDs. Substance abuse, violence, and HIV/AIDS (SAVA) syndemic effects on viral suppression among HIV positive women of color 2015;29(S1):S42–S8.
29. Illangasekare SL, Burke JG, McDonnell KA, Gielen ACJJoiv. The impact of intimate partner violence, substance use, and HIV on depressive symptoms among abused low-income urban women 2013;28(14):2831–48.
30. Friedman MR, Stall R, Plankey M, Wei C, Shoptaw S, Herrick A, et al. Effects of syndemics on HIV viral load and medication adherence in the multicenter AIDS cohort study. 2015;29(9):1087.
31. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of. Prev Med 1994;10:77–84.
32. Wong CF, Kipke MD, Weiss G. Risk factors for alcohol use, frequent use, and binge drinking among young men who have sex with men. Addictive Behaviors 2008;33(8):1012–20. [PubMed: 18495364]
33. Plankey MW, Ostrow DG, Stall R, Cox C, Li X, Peck JA, et al. The relationship between methamphetamine and popper use and risk of HIV seroconversion in the multicenter AIDS cohort study. Journal of acquired immune deficiency syndromes 2007;45(1):85. [PubMed: 17325605]
34. Smith DK, Koenig LJ, Martin M, Mansergh G, Heneine W, Ethridge SF, et al. Preexposure prophylaxis for the prevention of HIV infection–2014: clinical providers' supplement 2014.
35. Kalilani L, Atashili J. Measuring additive interaction using odds ratios. Epidemiologic Perspectives & Innovations 2006;3(1):5. [PubMed: 16620385]
36. Rothman KJ, Greenland S, Walker AM. Concepts of interaction. American journal of epidemiology 1980;112(4):467–70. [PubMed: 7424895]
37. Hosmer DW, Lemeshow S. Confidence interval estimation of interaction. Epidemiology 1992;3(5): 452–6. [PubMed: 1391139]
38. Knol MJ, VanderWeele TJ, Groenwold RH, Klungel OH, Rovers MM, Grobbee DE. Estimating measures of interaction on an additive scale for preventive exposures. European journal of epidemiology 2011;26(6):433–8. [PubMed: 21344323]
39. Jones J, Hoenigl M, Siegler A, Sullivan P, Little S, Rosenberg EJStd. Assessing the performance of three HIV incidence risk scores in a cohort of black and white MSM in the South 2017;44(5):297.
40. Wilton J, Mishra S, Tan DHJJoAIDS. Considerations for using the HIRI-MSM screening tool to identify MSM who would benefit most from PrEP 2017;76(2):e58–e61.
41. Turpin RE, Slopen N, Chen S, Boekeloo B, Dallal C, Dyer T. Latent class analysis of a syndemic of risk factors on HIV testing among black men. AIDS care 2018:1–8.

Table1.

Demographic and Syndemic Variables of Negative BMSM by Previous Six-Month Screening Status in the POWER Sample 2014–2017 (N =3,297)

	Report HIV screening in past six months?		
Demographic Variable	**No (n= 1,097) n (%)**	**Yes (n = 2,170) n (%)**	**χ^2 Variance, p value**
Age			51.6, p<001
18–29	636 (58.0)	1464 (67.5)	
30–39	253 (23.0)	482 (22.2)	
40+	208 (19.0)	224(10.3)	
Sexuality			4.0, p=.261
Gay/Homosexual	857 (78.2)	1745 (80.5)	
Heterosexual	13(1.2)	17 (0.78)	
Bisexual	205 (18.7)	378(17.4)	
Other	21 (1.9)	29(1.3)	
Annual Income			16.5, p<.001
$0–29,999	525 (48.5)	884(41.0)	
$30,000+	551 (51.5)	1273 (59.0)	
Education			39.5, p<.001
High school or less	361 (33.0)	498(23.0)	
Some college or college	558 (53.8)	1379(63.7)	
Post Bac/Graduate	144(13.2)	289(13.3)	
Relationship status			2.2, p=. 139
Single	802 (75.0)	1648 (77.3)	
Partnered	267 (25.0)	482 (22.6)	
Current Insurance			
Yes	882 (80.5)	1843 (84.9)	10.5, p=. 001
No	214(19.5)	327(15.1)	
Syndemic Variables			
3-month Poly-drug Use (3 or more)			2.0, p=.157
No	1055 (96.2)	2107(97.1)	
Yes	42 (3.8)	63 (2.9)	
CESD-10			3.3, p=.070
No	644 (58.7)	1345 (62.0)	
Yes	453(41.3)	825 (38.0)	
Intimate Partner Violence (12 months)			3.1, p=.080
No	938 (85.6)	1803 (83.2)	
Yes	158(14.4)	364(16.8)	
HIV Risk (12 months)			4.1, p=.042
Lower Risk	285 (26.0)	494 (22.8)	
Greater Risk	812(74.0)	1676(77.2)	
Problematic Drinking			0.978, p=.323
No	669(61.0)	1360 (62.2)	

	Report HIV screening in past six months?		
Demographic Variable	**No (n= 1,097) n (%)**	**Yes (n = 2,170) n (%)**	**χ^2 Variance, p value**
Yes	427 (39.0)	805 (34.8)	

Table 2.

Analysis of Seronegative BMSM in POWER Reporting an HIV Test in the Previous Six Months in the POWER Sample, 2014–2017 (n=2,170)

Demographic Variable	Odds Ratio	95% CI	p value
Age			
18–29	2.14	1.73 – 2.64	p<.001
30–39	1.79	1.39 – 2.25	p<.001
40+ (ref)	1.0		
Sexuality			
Gay/Homosexual (ref)	1.0		
Heterosexual	0.64	0.31 – 1.33	p=232
Bisexual	0.91	0.75 – 1.09	p=.303
Other	0.68	0.38 – 1.20	p=180
Annual Income			
$0–29,999 (ref)	1.0		
$30,000+	1.35	1.17 – 1.56	p<.001
Education			
High school or less (ref)	1.00		
Some college or college	1.70	1.44 – 2.01	p<.001
Post Bac/Graduate	1.45	1.14 – 1.85	p=.002
Relationship status			
Single (ref)	1.0		
Partnered	1.02	0.82–1.23	p=139
Current Insurance			
Yes (ref)	1.0		
No	0.73	0.61 – 0.88	p=.001
Syndemic Variables			
3-month poly-drug use (3 or more)			
No (ref)	1.0		
Yes	0.75	0.50 – 1.12	p=.350
CESD-10			
No (ref)	1.0		
Yes	0.87	0.75 – 1.01	p=0.070
Intimate Partner Violence (12 mts)			
No (ref)	1.0		
Yes	1.20	0.98 – 1.47	p=.080
HIV Risk (12 months)			
Lower Risk (ref)	1.0		
Greater Risk	1.20	1.01 – 1.41	p=.042
Problematic Drinking			
No (ref)	1.0		
Yes	0.93	0.79 – 1.08	p=323

Demographic Variable	Odds Ratio	95% CI	p value
Syndemic Presence (2+ issues)			
No (ref)	1.0		
Yes	0.99	0.92 – 1.07	p=.855

Table 3.

Multivariable Analysis to Evaluate the Association of Syndemic Factor Count and HIV Screening in the Previous Six Months in the POWER Sample, 2014–2017 (n = 2,170)

Model	AOR	95% CI	p value
Model 1 (demographic variables)			
Age			
18 – 29	2.18	1.74 – 2.72	p<.001
30 – 39	1.68	1.30 – 2.16	p<.001
40+ (ref)	1.0		
Sexuality			
Gay/Homosexual (ref)	1.0		
Heterosexual	1.04	0.49 – 2.21	p=.923
Bisexual	0.97	0.80 – 1.19	p=.788
Other	0.67	0.37 – 1.21	p=.184
Education			
High school or less (ref)	1.0		
Some college or college	1.51	1.26 – 1.81	p<.001
Post Bac/Graduate	1.26	0.96 – 1.65	p=.099
Income			
0 – 29,999 (ref)	1.0		
30,000+	1.26	1.06 – 1.50	p=.009
Relationship status			
Single (ref)	1.0		
Partnered	0.86	0.72–1.03	p=.098
Current Insurance			
No	0.76	0.70 – 0.94	p=.012
Yes (ref)	1.0		
Model 2a (number of syndemic factors)			
Syndemic = 0 (ref)	1.0		
Syndemic = 1	1.35	1.03 – 1.77	p=.028
Syndemic = 2	1.37	1.04 – 1.80	p=.028
Syndemic = 3	1.24	0.91 – 1.69	p=164
Syndemic = 4	1.58	0.98 – 2.53	p=.08O
Syndemic = 5	1.03	0.70 – 3.10	p=511
Model 2b			
Any Syndemic (2+ factors)	1.06	0.91 – 1.24	p=472

Note: all models were controlled for year and city of data collection in addition to demographic variables. Models 2a and 2b were conducted controlling for demographic variables.

Table 4.

Analysis of Syndemic Variable Interaction for BMSM who did not Report HIV Screening in the Previous Six Months in the POWER Sample, 2014–2017 (n = 1,097)

		Odds Ratio Expected	Observed	RERI	AP	S
Poly-drug use	**Depression**	**1.39**	**1.41**	**0.02**	**0.01**	**1.02**
Poly-drug Use	Intimate Partner Violence	1.60	1.00	−0.59	−0.59	0.01
Depression	Intimate Partner Violence	0.76	1.08	0.32	0.29	−0.35
Depression	**Problematic Drinking**	**1.07**	**1.27**	**0.20**	**0.16**	**3.70**
Depression	Sexual Risk	0.75	0.93	0.18	0.20	0.28
IPV	Sexual Risk	0.74	0.72	−0.01	−0.02	1.06
Intimate Partner Violence	Problematic Drinking	1.00	0.91	−0.09	−0.10	−29.49
Sexual Risk	**Problematic Drinking**	**1.26**	**1.51**	**0.25**	**0.17**	**1.98**
Poly-drug use	**Problematic Drinking**	**1.07**	**1.27**	**0.20**	**0.16**	**3.70**

Note: RERI: relative excess risk of the interaction; AP: attributable proportion of the relative excess risk of the interaction; S: synergy index; **bold type indicates synergy between variable pairs**; due to the low prevalence of poly-drug use in this sample, an analysis of joint effects and synergy between sexual risk and poly-drug use could not be completed.