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Engagement in Care, Psychological Distress, and Resilience are Associated with Sleep Quality among HIV-Positive Gay, Bisexual, and Other Men Who Have Sex with Men

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Abstract

Objectives—We investigated risk and protective factors associated with sleep quality among a national sample of HIV-positive gay, bisexual, and other men who have sex with men (GBMSM).

Design—This study reports on findings from both an eligibility survey and baseline assessment for an online HIV risk reduction intervention.

Participants—There were 16,466 completed eligibility surveys. A total of 1,205 eligible men completed a baseline assessment after consenting to participate in the intervention.

Measurements and results—Among participants with a completed eligibility survey, men with an HIV-positive status had significantly worse sleep quality and more frequent use of sleep medications during the past month than HIV-negative men. Within the intervention sample (n = 1,205 HIV-positive participants), men with symptoms of anxiety (Adjusted odds ratio [AOR]=2.80; 95% confidence interval [CI]: 1.93–4.06) and depression (AOR=1.66; CI: 1.14–2.43), and who reported a detectable viral load in the past six months (AOR=1.57; CI: 1.06–2.33) had increased odds of poor sleep quality after controlling for demographic characteristics, socioeconomic status, ART use and adherence, substance use, and CD4 count. However, men with greater perceived resilience had decreased odds of reporting poor sleep quality during the past month (AOR=0.68; CI: 0.51–0.89).

Conclusions—Findings from this online study call for more attention to the role of sleep in immune system functioning and engagement in HIV care. Results further suggest a need to design and test culturally-appropriate sleep health interventions for GBMSM living with HIV that promote protective factors and target particular behavioral changes (i.e., stress reduction, substance use).

Keywords

sleep quality; HIV; psychological distress; resilience; gay and bisexual men

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Introduction

The prevalence of self-reported sleep disturbances among individuals living with HIV is staggering. Findings from a recent meta-analysis of 27 studies revealed a pooled prevalence of 58%,¹ which is considerably higher than the average prevalence of insomnia symptoms (10–33% based on variations in symptom assessment) and diagnoses (6%) in the general population.² Among those living with HIV, sleep disturbances and poor sleep quality are highly prevalent quality of life issues.^{3–5} Gay, bisexual, and other men who have sex with men (GBMSM) bear a disproportionate burden of HIV in the U.S.,⁶ though few studies have examined sleep quality specifically among this population.⁴

The U.S. Department of Health and Human Services' Healthy People 2020 initiative identified sleep health as a concern for individuals living with HIV/AIDS.⁷ In addition to depleting CD4 T lymphocytes and compromising the immune system, HIV is known to disrupt circadian rhythm and delay sleep phases.^{8–10} Research suggests that those living with HIV spend less time in restorative stages of sleep (i.e., slow-wave/deep sleep) compared to HIV-negative control participants.^{11,12} The inflammatory response to HIV is associated with dysregulation of homeostatic processes of the hypothalamic-pituitary-adrenal (HPA) axis.^{10,13} For example, HIV infection has been associated with above-optimal levels of the stress hormone cortisol.^{10,14} Excessive cortisol, particularly in the evening or during sleep, is problematic as it can result in wakefulness, lighter sleep, or reduced rapid eye movement (REM) sleep.^{15–17} Perhaps due to HIV-related inflammation or psychological distress, increased cortisol has also been implicated in enhanced HIV replication,^{18,19} making poor sleep quality a potential indicator of viral non-suppression.

Sleep disturbances or poor sleep quality in persons living with HIV have been associated with daytime sleepiness and fatigue,^{20–23} depression,^{3,20,24–26} and anxiety.^{24,26} Regarding HIV care, limited evidence suggests that short sleep duration or wake after sleep onset (WASO) may be associated with a lower CD4 count and higher viral load.^{24,27} However, other studies have not observed significant associations between insomnia and reduced immune functioning,^{3,20,26} suggesting the need for additional research. Self-reported ratings of poor sleep quality have been linked with suboptimal adherence to antiretroviral therapy (ART),^{24,25,28,29} which is critical for viral suppression.³⁰ Thus, efforts to better understand psychosocial mechanisms underlying sleep quality for persons living with HIV are greatly needed and may have a significant public health impact (i.e., suppressed viral load reduces HIV transmission risk).

Although HIV is linked to disruption of circadian rhythm and hormonal dysregulation-related sleep disturbances, there is reason to suspect that resilience in persons living with HIV may protect against the effects of psychological distress, including diminished sleep quality. According to the American Psychological Association,³¹ resilience is “the process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional, and behavioral flexibility and adjustment to external and internal demands.” Some researchers have observed better health outcomes among resilient individuals coping with a chronic illness,³² including HIV/AIDS.^{33,34} Nevertheless, studies

have not considered the potential effects of resilience on sleep among GBMSM living with HIV.

Limited research, however, has investigated the relationship between resilience and sleep outcomes.^{35–39} Findings from this work suggest that greater resilience is associated with fewer sleep disturbances among former prisoners of war,³⁵ lower levels of cortisol among sleep deprived military personnel,³⁶ and better coping with sleep disturbances in adult survivors of childhood abuse or trauma.³⁷ Conversely, low perceived resilience has been associated with increased odds of reporting frequent sleep difficulties among parents of pediatric cancer patients.³⁸ Kobayashi et al.³⁹ observed a negative correlation between total sleep time and nocturnal sympathetic nervous system activity (e.g., arousal, increase in heart rate) and a positive correlation between total sleep time and nocturnal parasympathetic nervous system activity (e.g., decrease in heart rate, restoration)¹⁷ in a sample of resilient, healthy young adult African Americans previously exposed to a high-impact traumatic event. Additional work is needed to better understand whether resilience protects against diminished sleep quality and other negative health outcomes in persons living with HIV.

Using data from an eligibility survey (comparisons by HIV serostatus) and baseline assessment (HIV-positive participants only), we report on findings from an online, video-based intervention designed for virally unsuppressed or ART nonadherent GBMSM living with HIV in the United States. This study aims to extend prior research by comparing self-reported sleep quality, HIV-related engagement in care, and psychological distress. Moreover, our study seeks to draw parallels between positive psychology's emphasis on well-being,⁴⁰ as opposed to ill health, and the promotion of sleep health rather than a focus on sleep deficiency or disorder.⁴¹ This is accomplished by examining both the predictive power of resilience on perceived sleep quality and the potential impact of resilience on the relationship between psychological distress and sleep quality. Our analyses investigate several hypotheses:

1. GBMSM living with HIV will be more likely to report poor sleep quality and more frequent use of sleep medications during the past month compared to GBMSM who are HIV-negative.
2. Evidence of viral non-suppression will be associated with poor sleep quality.
3. Positive screens for anxiety and depressive symptoms will be associated with poor sleep quality among GBMSM living with HIV.
4. Greater perceived resilience will be associated with better self-reported sleep quality and less use of sleep medications among GBMSM living with HIV.

Methods

Participants

Interested individuals were asked to complete an online survey to determine eligibility for Sex Positive!+, a video-based online intervention that aims to improve health outcomes for men living with HIV.⁴² Eligible participants for the online intervention had to: (a) be biologically male and identify their current gender as male; (b) be 18 years of age or older;

(c) report their race or ethnicity as White, Black, or Hispanic; (d) report an HIV-positive status; (e) report a past year detectable viral load or past month suboptimal ART adherence; (f) report serodiscordant condomless anal sex with a male partner in the past six months; (g) be able to read and respond in English; (h) reside within the United States or U.S. territories; (i) be willing to participate in an online intervention study for one year; and, (j) have a working e-mail address and cell phone number for intervention follow-up. We disqualified anyone who did not meet the inclusion criteria.

Recruitment

The goal of recruitment was to identify individuals online who were willing to be screened for eligibility to participate in a video-based HIV risk reduction intervention. We used quota sampling and targeted recruitment to increase representation of Black and Hispanic GBMSM as well as men between the ages of 18 and 29. This age group is overrepresented among those recently diagnosed with HIV infection, particularly young men of color, and is less likely to be adherent to HIV medications or in care.⁴³ Men were recruited through social networking websites, sexual partnering and dating websites (e.g., BGCLive, POZ Personals), online bulletin boards, and geosocial networking applications for sexual partnering. Based on previous research findings,⁴⁴ our targeted recruitment strategy included banner advertisements that mirrored the racial and ethnic composition of each subgroup. Banner advertisements, email blasts, and study-related postings to online bulletin boards indicated that this was a study for men living with HIV. Nearly all of the intervention participants were recruited from sexual partnering websites or Smartphone applications (94.5%). For the current report, separate analyses were conducted for the eligibility survey sample ($n = 16,466$) and the intervention sample with completed baseline assessments ($n = 1,205$) (see Figure 1 for participant flow diagram).

Procedure

The institutional review board at [name] approved all study procedures. Potential participants accessed the eligibility survey by clicking on an online study banner advertisement or study invitation link. Eligible individuals were directed to the study landing page and registration platform, which included a description of intervention activities and a consent form.

Measures (eligibility survey)

Participant characteristics—The eligibility survey included a set of demographic questions to assess age, race and ethnicity, gender identity, and sex at birth.

HIV testing history—Participants reported results from their most recent HIV test as part of the eligibility survey. Response options included: Positive, Negative, Never obtained results, Indeterminate, Never been tested, and Prefer not to answer. For the purpose of determining eligibility for the intervention, anyone who indicated that their most recent HIV test result was Positive received two follow-up items to assess whether or not they had a past year detectable viral load (data not reported).

ART adherence—The eligibility survey assessed current use of antiretroviral medications (yes, no). Participants also completed a 3-item measure of ART adherence (past 30 days) as part of the eligibility survey.⁴⁵ The items were transformed to a 0–100 scale, with suboptimal ART adherence defined as a mean score of < 90%. The ART adherence measure had high internal consistency (Cronbach’s coefficient alpha [α] = 0.83).

Sleep quality and use of sleep medication—We used two items from the Pittsburgh Sleep Quality Index (PSQI) that measure subjective sleep quality and use of sleeping medication.⁴⁶ Specifically, participants were asked as part of the eligibility survey to rate their overall sleep quality during the past month. Response options included: very good, fairly good, fairly bad, and very bad. Responses of fairly bad and very bad on this item were considered poor sleep quality. The survey also assessed how often participants took medication, prescribed or over the counter, to help with their sleep. Response options included: not during the past month, less than once a week, once or twice a week, and three or more times a week.

Measures (baseline assessment)

Socioeconomic characteristics—Eligible participants who enrolled in the online intervention were asked during the baseline assessment about their highest level of education, current employment status, annual income, and current living situation. The baseline assessment also included an item to measure perceived city size where participants reside (e.g., rural area, suburb of a big city, big city).

HIV care—The baseline assessment included items to measure recent (past six months) viral load test results and CD4 count. Men who reported having a viral load test were asked to select their most recent results from the following: My viral load was undetectable, OR < 200 copies/ml; My viral load was detectable, OR > 200 copies/ml; I don’t know—but I think I was undetectable; I don’t know—but I think I was detectable. For participants who reported having a CD4 test during the past six months, we asked if their count was 200, 201–349, 350–499, or 500.

Substance use—We measured past three months use of painkillers, amphetamines, depressants, erection medication, marijuana, cocaine, crack, crystal methamphetamine, ecstasy, heroin, methadone, ketamine, hallucinogens, synthetics, poppers, and gamma-Hydroxybutyric acid (GHB) in the baseline assessment. For data analysis, we focused on four drug categories: prescription drugs (painkillers, amphetamines, depressants, erection medication), marijuana, illicit stimulants (cocaine, crack, crystal methamphetamine), and other substances (ecstasy, heroin, methadone, ketamine, hallucinogens, synthetics, poppers, GHB). Participants also completed the 3-item version of the Alcohol Use Disorders Identification Test (AUDIT-C), a brief screening instrument to identify individuals who are heavy drinkers or have active alcohol use disorders.⁴⁷ Each item included a 5-pt scale (0–4). The AUDIT-C had a Cronbach’s alpha of 0.75. Responses were totaled across the three items, with a score of 4 indicating a positive screen for men.

Symptoms of depression and anxiety—We used the 2-item Patient Health Questionnaire Depression Scale (PHQ-2) and the 2-item Generalized Anxiety Disorder Scale (GAD-2) to measure symptoms of depression and anxiety in the past 14 days. Scores of ≥ 3 on each scale are considered clinically significant.⁴⁸ The PHQ-2 and GAD-2 had high internal consistencies (Cronbach's $\alpha = 0.84$ and 0.85 , respectively).

Resilience—The baseline assessment included a modified version⁴⁹ of the Connor-Davidson Resilience Scale (CD-RISC2), a 2-item measure of self-rated resilience during the past month with demonstrated reliability and validity in diverse patient populations.⁵⁰ Response options ranged from 0 (not true at all) to 4 (true nearly all of the time). The modified version of the CD-RISC2 had a Cronbach's alpha of 0.71 . Responses were totaled across both items. We dichotomized resilience (score of ≤ 6 , score of 7 or 8) based on a negatively skewed distribution, with a higher score indicating greater perceived resilience.

Data analysis

Data cleaning and analyses were performed with IBM SPSS version 22. Responses from the eligibility survey were merged with those from the baseline assessment. Descriptive statistics were computed for all variables. Bivariate and multivariable logistic regression analyses were conducted to examine associations with sleep quality and use of sleep medications. Predictor variables included participant and socioeconomic characteristics, indicators of HIV care, symptoms of anxiety and depression, resilience, and substance use. Odds ratios (adjusted for multivariable) and 95% confidence intervals (CI) are reported for logistic regression analyses. Pearson correlations were conducted to examine relationships between psychological distress variables and resilience. We then tested to see whether resilience moderated the relationship between psychological distress and perceived sleep quality using interaction terms [anxiety symptoms $\times$ resilience; depressive symptoms $\times$ resilience], entered as separate (and independent) steps in the multivariable logistic regression model.

Results

Eligibility survey (n = 16,466)

Among the 16,466 men who completed the eligibility survey, the mean age was 39.6 years ($SD = 12.3$). Frequencies for age categories were as follows: 18–29 (25.7%), 30–39 (25.1%), 40–49 (23.5%), and 50 or older (25.1%). Nearly half of participants who completed the eligibility survey identified their race as White (47.5%); 32.6% identified as Black and 13.8% identified as Hispanic or Latino. Among those who had ever been tested for HIV ($n = 15,824$), most reported that their last test result was positive (86.6%). Although our recruitment efforts targeted men living with HIV, a small percentage of men reported their most recent test result as negative (11.1%). More than a third of men living with HIV reported suboptimal ART adherence or that they were not currently taking medications to treat their HIV (36.9; $n = 5,051$ out of 13,700 participants with an HIV-positive status). A third of all participants completing the eligibility survey described their sleep quality during the past month as fairly bad or very bad (33.2%). Moreover, 31.5% of participants reported using sleep medications during the past month. As expected, men who reported their HIV

status as positive (compared to negative) had significantly increased odds of describing their sleep quality during the past month as fairly bad or very bad (Table 1). Men living with HIV also had significantly increased odds of reporting that they used sleep medications at least once or twice a week during the past month.

Intervention sample baseline assessment (n = 1,205)

Descriptive statistics for the baseline sample are reported in Table 2. More than half of participants were younger than 40 (55.4%) and identified their race as White (61.2%). Regarding socioeconomic status, 44.4% of the baseline sample reported a four-year college degree or higher, 51.0% indicated that they were working full-time, and most earned less than \$60,000 a year (75.8%). Slightly more than half of participants reported living in a large urban area (52.0%). Regarding HIV care, most participants reported suboptimal ART adherence or not currently taking HIV medication (75.5%). Nevertheless, only 19.2% indicated a recent detectable viral load. Approximately half of participants in the baseline sample indicated a CD4 count in the normal range of at least 500 cells (48.5%).

Nearly half of participants in the baseline sample were considered to have an alcohol use disorder (45.0%). Self-reported past 90-day drug use was highly prevalent, particularly for other substances (e.g., Heroin, Hallucinogens) (59.9%). As shown in Table 2, 23.3% of participants had a positive screen for depressive symptoms and 22.4% had a positive screen for anxiety symptoms. Approximately half of men in the baseline sample scored a 7 or 8 (49.1%) on the adapted CD-RISC2 indicating greater perceived resilience.

Bivariate analyses revealed that age, socioeconomic status, HIV care, mental health, use of sleep medications, and past 90-day drug use were significantly associated with poor sleep quality (Table 3). Men age 30–39 had increased odds of reporting poor sleep quality while men age 50 or older had decreased odds of reporting poor sleep quality. Participants reporting an annual income of less than \$20,000 or an “other” living situation also had increased odds of reporting poor sleep quality. Those who reported at least a four-year college degree, working full-time, and an income of at least \$60,000 had decreased odds of endorsing poor sleep quality. Further, participants with a recent (past 6 months) detectable viral load, a positive screen for symptoms of anxiety or depression, and those who indicated past 90-day use of prescription drugs, stimulants, or other substances had increased odds of reporting poor sleep quality. Those who indicated using sleep medications at least once or twice a week during the past month also had significantly increased odds of reporting poor sleep quality. Those reporting high ART adherence for the past 30 days, a recent CD4 count of at least 500, and greater perceived resilience had decreased odds of endorsing poor sleep quality. The dependent variable was not associated with race or ethnicity, city size, past 90-day use of marijuana, or having an alcohol use disorder.

In a multivariable logistic regression model (Table 3), men with a recent detectable viral load had increased odds of reporting poor sleep quality during the past month. Participants with a positive screen for symptoms of anxiety or depression also had significantly increased odds of reporting poor sleep quality. There remained a significant association between sleep quality and past 90-day use of prescription drugs. Older participants (50+) and those with greater perceived resilience had significantly decreased odds of reporting poor sleep quality

during the past month. Sleep quality was not associated with race or ethnicity, education, employment status, annual income, city size, ART adherence, recent CD4 count, or having an alcohol use disorder in the multivariable model.

We observed weak, but significant negative correlations between resilience and positive screens for symptoms of anxiety ($r = -0.19$, $p < .001$) and depression ($r = -0.20$, $p < .001$), thus we further tested for interaction effects of psychological distress and resilience on sleep quality. The two interactions, entered independently, did not result in a significant change to the multivariable model [anxiety symptoms x resilience (Step $\chi^2 = 0.13$, $p = 0.72$), depressive symptoms x resilience (Step $\chi^2 = 0.05$, $p = 0.81$)].

Due to the potential for overlap, we excluded sleep medications from the multivariable logistic regression model in favor of past 90-day prescription drug use. Thus, subsequent bivariate analyses were conducted to examine associations between resilience and frequency of using sleep medications during the past month. As hypothesized, participants with greater perceived resilience had significantly decreased odds of reporting frequent use of sleep medication during the past month ($OR = 0.63$, 95% CI = 0.45 – 0.88).

Discussion

Sleep disturbances and poor sleep quality are highly prevalent quality of life issues among individuals living with HIV.^{3–5} The current study investigated factors associated with self-reported sleep quality among an ethnically diverse sample of GBMSM living with HIV. We obtained full or partial support for our hypotheses. Men reporting psychological distress and poor health outcomes related to their HIV care had significantly worse sleep quality during the past month. Further, resilience emerged as a potential protective factor against diminished sleep quality, which extends the literature on sleep and HIV.

More than a third of participants living with HIV who completed the eligibility survey reported poor sleep quality during the past month (35.1%), which is considerably lower than that reported in a recent meta-analysis of diverse HIV populations (58%).¹ Nevertheless, this group had significantly increased odds of reporting poor sleep quality and frequent use of sleep medications compared to HIV-negative men, providing support for our first hypothesis. Although these findings are consistent with some prior research that has compared sleep-related variables between HIV-negative and HIV-positive populations,^{12,51} other studies have not detected differences.^{11,20}

There was partial support for our second hypothesis, in that participants who reported a detectable viral load in the past six months had increased odds of reporting poor sleep quality in bivariate and multivariable analyses. This finding adds support to recent research that detected significant associations between short sleep duration or WASO and higher viral loads among those living with HIV.^{24,27} Although ART adherence and CD4 count were associated with sleep quality in bivariate analyses as previous studies have reported,^{24,25,28,29} the findings did not maintain significance in the final multivariable model. Nevertheless, these data suggest a complex relationship between sleep, ART adherence, and viral suppression that warrants additional study. Episodes of delayed or

disrupted sleep, known to contribute to daytime sleepiness and fatigue in those living with HIV, are likely to result in occasional noncompliance to medication regimens. The cyclical nature of this pattern is a possible explanation for why poor sleep quality was significantly associated with having a recent detectable viral load. Longitudinal research that objectively and contemporaneously monitors fluctuations in sleep quality, ART adherence, viral load, and CD4 count is needed to determine appropriate causal mechanisms that might benefit from intervention.

As other researchers have observed,^{3,20,24,25,26} and confirming our third hypothesis, participants with positive screens for symptoms of anxiety and depression were at increased odds of reporting poor sleep quality. Additionally, resilience predicted self-reported sleep quality and use of sleep medications, providing support for our final hypothesis. More specifically, participants who scored higher on the resilience measure had lower odds of reporting poor sleep quality or use of sleep medications during the past month. Interestingly, resilience did not moderate the relationship between either of the psychological distress variables and sleep quality. Although the current study is not able to demonstrate how resilience impacts sleep quality, the findings suggest that promoting protective factors (e.g., positive outlook or optimism, adaptability, self-efficacy) in individuals with HIV may benefit sleep health and lead to better overall health outcomes.

Participant characteristics were not associated with perceived sleep quality in multivariable analyses, with the exception of older men (age 50+ vs. 30–39) having decreased odds of reporting poor sleep quality during the past month. Moreover, socioeconomic status was not associated with sleep quality in the multivariable model. This is surprising as some evidence has established links between low socioeconomic status and worse sleep health among individuals living with HIV.^{5,20,24} Nevertheless, several socioeconomic factors were associated with sleep quality in bivariate analyses that should be considered in subsequent studies. Specifically, those with more education, full-time employment, and an annual income of at least \$60,000 had significantly decreased odds of reporting poor sleep quality in bivariate analyses suggesting the importance of economic stability in protecting against diminished sleep quality.

Our analyses further revealed extensive substance use among participants in the Sex Positive! intervention, and associations with poor sleep quality. Indeed, GBMSM who reported using illicit stimulants, prescription drugs, or other substances during the past three months had significantly increased odds of poor sleep quality in bivariate analyses. Prescription drug use remained a significant predictor in multivariable analyses. This raises the possibility that participants' drug use, recreational or otherwise, contributed to delayed sleep onset or sleep disturbances. Research suggests that for some people this relationship may be bidirectional. Prolonged sleep disturbances may lead to increased substance use as a means to cope with the chronic stress and side effects of poor sleep.⁵² Subsequent studies should address compounding risk factors that users of licit and illicit substances have for diminished sleep health.^{52,53}

Further research is needed to design and test the feasibility of interventions to improve sleep quality among individuals living with HIV. Previous attempts have shown benefits of

acupuncture⁵⁴ and reduced caffeine intake⁵⁵ on sleep quality. Buchanan and colleagues recently reported significant improvements in sleep quality and total sleep time among a clinic-based sample of adults living with HIV following a multi-session behavioral intervention for insomnia.⁵⁶ However, two additional pilot interventions targeting changes in sleep hygiene behavior demonstrated minimal or nonsignificant improvement in sleep duration or efficiency, self-reported sleep disturbances, and daytime activity.^{57,58} Despite obvious contributions to the literature on sleep promotion and HIV, these studies are limited by small sample sizes, lack of a control or a matched-control condition, high attrition, lack of objective sleep measures, or self-reported compliance to experimental protocol. Findings from Dreher⁵⁵ highlight the potential utility of self-regulation on improving sleep quality among HIV populations. Interventions that target an individual's ability to self-regulate (or exert self-control)⁵⁹ in the context of sleep health may lead to better HIV-related outcomes through reductions in psychological distress and changes in sleep hygiene (e.g., time to bed, relaxation activities). Specifically, self-monitoring of sleep activity and quality coupled with brief motivational interviews that target particular behavioral changes, such as time to bed or stress reduction, have the potential to be efficacious in the long term.

Several study limitations should be acknowledged. First, participants were recruited primarily through sexual partnering websites and geosocial networking applications. As such, the findings may not generalize to GBMSM living with HIV who do not have Internet access or own a Smartphone, or who do not access these types of websites or applications. Second, eligibility criteria for the Sex Positive!^[+] intervention were highly selective (e.g., past year detectable viral load or past month suboptimal ART adherence), thus limiting generalizability of our findings. Further, the prevalence of suboptimal ART adherence in the eligibility survey sample may be underrepresented as we did not implement this measure until after study launch. Third, we did not assess whether participants have variable or erratic work schedules that may have contributed to their sleep quality or use of sleep medications. Also, because the Sex Positive!^[+] intervention focuses on HIV risk reduction, we did not collect participants' sleep history. Thus, we are not able to make any conclusions about the chronicity of participants' reported sleep quality and use of sleep medications. Likewise, as the data are cross-sectional, it remains unclear whether participants' psychological distress contributed to their poor sleep quality. Repeated assessment of perceived sleep quality and associated risk factors over a period of time would provide more clarity on this issue. Lastly, a potential limitation is that participants self-reported their sleep and health outcomes. However, a recent validation study of 639 individuals living with HIV participating in an ongoing prospective study in New York found that recall of viral load agreed with the Department of Health's registry data 85% of the time.⁶⁰

Conclusion

Notwithstanding these limitations, the findings provide a better understanding of perceived sleep quality among a national sample of GBMSM living with HIV. This study extends prior research by investigating risk and protective factors that may be contributing to sleep quality. Our results corroborate past work regarding the negative impact of psychological distress on sleep in HIV populations while suggesting that individuals who are more resilient may experience better sleep health. Moreover, given the significant associations between sleep

quality and HIV-related care, this study argues for more attention to the role of sleep in immune system functioning for sexual minorities living with HIV. Lastly, a potential implication of this research is provider-driven education of patients living with HIV about the importance of sleep health in well-being.

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Figure 1.
Participant Flow Diagram.

Table 1

Differences in self-reported sleep quality and use of sleep medications by HIV Status among a sample of GBMSM completing an eligibility survey for an online HIV risk reduction intervention.

	Total N (%)	Never tested n (%)	Unknown or Indeterminate n (%)	Negative n (%)	Positive n (%)	OR, 95% CI ^b
Number of participants ^a	16,466 (100)	270 (1.6)	332 (2.0)	1,792 (10.9)	13,700 (83.2)	--
Past month sleep quality:						
Very good	2,890 (18.0)	62 (23.0)	54 (16.3)	482 (26.9)	2,292 (16.7)	0.55* (0.49 – 0.61)
Fairly good	7,738 (48.1)	132 (48.9)	160 (48.2)	845 (47.2)	6,601 (48.2)	1.04 (0.94 – 1.15)
Fairly bad	4,302 (26.7)	61 (22.6)	93 (28.0)	362 (20.2)	3,786 (27.6)	1.51* (1.34 – 1.70)
Very bad	1,164 (7.2)	15 (5.6)	25 (7.5)	103 (5.7)	1,021 (7.5)	1.32* (1.07 – 1.63)
Use of sleep medications:						
Not during past month	10,576 (67.1)	200 (79.1)	211 (66.8)	1,264 (73.4)	8,901 (66.0)	0.71* (0.63 – 0.79)
< once a week	1,599 (10.1)	15 (5.9)	27 (8.5)	164 (9.5)	1,393 (10.3)	1.10 (0.92 – 1.30)
1 – 2 times a week	1,271 (8.1)	19 (7.5)	22 (7.0)	98 (5.7)	1,132 (8.4)	1.52* (1.23 – 1.88)
3 times a week	2,325 (14.7)	19 (7.5)	56 (17.7)	197 (11.4)	2,053 (15.2)	1.39* (1.19 – 1.63)

Abbreviations: OR, odds ratio; CI, confidence interval.

^aHIV testing history not reported for 372 cases.

^bOdds ratios and confidence intervals presented for HIV-positive participants (referent = HIV-negative).

$P < .001$
*

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Table 2

Characteristics of eligible Sex Positive! intervention participants.

Age (n = 1,204):	n (%)
18–29	300 (24.9)
30–39	368 (30.5)
40–49	317 (26.3)
50 and older	219 (18.2)
Race and ethnicity (n = 1,205):	
White	738 (61.2)
Black	258 (21.4)
Hispanic / Latino	209 (17.3)
Education (n = 1,204):	
Less than a college graduate	669 (55.5)
College graduate or higher	535 (44.4)
Employment status (n = 1,205):	
Not working full-time	590 (49.0)
Working full-time	615 (51.0)
Annual income (n = 1,163):	
Less than \$20,000	423 (35.1)
\$20,000–\$59,999	490 (40.7)
\$60,000 and higher	250 (20.7)
Living situation (n = 1,200):	
House	492 (40.8)
Apartment	618 (51.3)
Other	90 (7.5)
City size (n = 1,202):	
Rural area	50 (4.1)
Small town	102 (8.5)
Suburb of a small urban area	56 (4.6)
Small urban area	112 (9.3)
Suburb of a large urban area	256 (21.2)
Large urban area	626 (52.0)
ART adherence ^a (n = 1,072):	
Not currently taking ART	167 (13.9)
Suboptimal adherence	743 (61.7)
High adherence	162 (13.4)
Past 6 months detectable viral load (n = 1,078):	
No	847 (70.3)
Yes	231 (19.2)
Recent CD4 count (n = 1,205):	
200	71 (5.9)
201 – 349	110 (9.1)

Age (n = 1,204):	n (%)
350 – 499	184 (15.3)
500 or higher	584 (48.5)
Don't know or missing	256 (21.2)
Depressive symptoms (n = 1,196):	
Negative screen	915 (75.9)
Positive screen (score of 3)	281 (23.3)
Anxiety symptoms (n = 1,195):	
Negative screen	925 (76.8)
Positive screen (score of 3)	270 (22.4)
Resilience (n = 1,199):	
Score of 6 or less	607 (50.4)
7 to 8	592 (49.1)
Alcohol use disorder (n = 1,186):	
No	644 (53.4)
Yes	542 (45.0)
Past 90 day drug use (n = 1,181):	
Prescription drugs ^b	575 (47.7)
Marijuana	583 (48.4)
Illicit stimulants ^c	483 (40.1)
Other substances ^d	722 (59.9)
Use of sleep medications (n = 1,197):	
Not during the past month	755 (62.7)
Less than once a week	164 (13.6)
Once or twice a week	116 (9.6)
Three or more times a week	162 (13.4)

Percentages based on completed baseline sample (N = 1,205).

^aAntiretroviral therapy (ART) adherence missing 133 cases who enrolled prior to the implementation of this screening measure.

^bPrescription drugs included painkillers, amphetamines, depressants, and erection medication.

^cIllicit stimulants included cocaine, crack, and crystal methamphetamine.

^dOther substances included ecstasy, heroin, methadone, ketamine, hallucinogens, synthetics, GHB, and poppers.

Table 3

Factors associated with poor sleep quality in a sample of GBMSM living with HIV.

	% Poor sleep	Bivariate OR (95% CI)	Multivariable AOR ^e (95% CI)
Age:			
18–29	39.3	0.85 (0.65, 1.11)	0.81 (0.56, 1.19)
30–39	48.4	1.44 * (1.12, 1.84)	1.0
40–49	44.8	1.15 (0.89, 1.50)	1.08 (0.76, 1.54)
50 and older	32.0	0.59 * (0.43, 0.80)	0.59 * (0.38, 0.91)
Race and ethnicity:			
White	41.8	1.04 (0.82, 1.32)	1.08 (0.80, 1.46)
Black or Hispanic / Latino	42.8		1.0
Education:			
Less than a college graduate	45.7		1.0
College graduate or higher	37.6	0.72 * (0.57, 0.90)	0.86 (0.63, 1.15)
Employment status:			
Not working full-time	48.0		1.0
Working full-time	36.6	0.62 * (0.49, 0.78)	0.78 (0.55, 1.11)
Annual income:			
< \$20,000	50.9	1.73 * (1.36, 2.20)	0.92 (0.56, 1.51)
\$20,000–\$59,999	39.0	0.80 (0.63, 1.01)	0.87 (0.59, 1.27)
\$60,000	35.2	0.69 * (0.52, 0.92)	1.0
Missing	33.3	0.68 (0.35, 1.30)	0.51 (0.21, 1.23)
Living situation:			
House	41.3	0.95 (0.75, 1.20)	1.0
Apartment	41.2	0.93 (0.74, 1.17)	0.95 (0.71, 1.28)
Other	52.2	1.56 * (1.01, 2.40)	0.87 (0.50, 1.53)
City size:			
Rural area	40.0	0.91 (0.51, 1.62)	0.55 (0.27, 1.13)
Small town	47.1	1.24 (0.83, 1.86)	1.21 (0.72, 2.03)
Suburb of a small urban area	42.9	1.03 (0.60, 1.77)	1.17 (0.62, 2.21)
Small urban area	40.2	0.91 (0.61, 1.36)	0.93 (0.57, 1.53)
Suburb of a large urban area	41.8	0.98 (0.74, 1.30)	0.92 (0.65, 1.32)
Large urban area	42.2	1.00 (0.80, 1.26)	1.0
ART adherence ^d :			
Not currently taking meds	50.7	1.45 * (1.01, 2.06)	0.98 (0.57, 1.69)
Suboptimal adherence	43.1	1.04 (0.79, 1.36)	1.41 (0.94, 2.12)
High adherence	34.6	0.66 * (0.47, 0.94)	1.0
Past 6 months detectable viral load:			
No	38.8	0.63 * (0.49, 0.80)	1.0

	% Poor sleep	Bivariate OR (95% CI)	Multivariable AOR ^e (95% CI)
Yes	48.5	1.37 [*] (1.03, 1.83)	1.57 [*] (1.06, 2.33)
Missing	53.5	1.67 [*] (1.15, 2.41)	1.56 (0.84, 2.87)
Recent CD4 count:			
< 500	43.0	1.05 (0.82, 1.34)	0.98 (0.71, 1.35)
500	38.9	0.77 [*] (0.61, 0.96)	1.0
Don't know or missing	48.6	1.39 [*] (1.05, 1.84)	1.03 (0.65, 1.64)
Depressive symptoms:			
Negative screen	35.4		1.0
Positive screen (score of 3)	63.9	3.23 [*] (2.45, 4.27)	1.66 [*] (1.14, 2.43)
Anxiety symptoms:			
Negative screen	34.5		1.0
Positive screen (score of 3)	68.4	4.11 [*] (3.07, 5.50)	2.80 [*] (1.93, 4.06)
Resilience:			
Less than 7	49.0		1.0
7–8	35.1	0.56 [*] (0.45, 0.71)	0.68 [*] (0.51, 0.89)
Alcohol use disorder:			
No	40.7		1.0
Yes	43.7	1.13 (0.90, 1.42)	1.13 (0.85, 1.50)
Past 90 day drug use:			
Prescription drugs ^b	48.7	1.67 [*] (1.33, 2.10)	1.58 [*] (1.16, 2.16)
Marijuana	44.6	1.21 (0.96, 1.52)	0.84 (0.63, 1.12)
Illicit stimulants ^c	50.3	1.74 [*] (1.38, 2.20)	1.36 (0.96, 1.84)
Other substances ^d	45.4	1.38 [*] (1.09, 1.75)	0.96 (0.68, 1.34)
Use of sleep medications:			
Not during the past month	35.0	0.45 [*] (0.36 – 0.57)	--
Less than once a week	43.9	1.09 (0.78 – 1.52)	--
Once or twice a week	61.2	2.36 [*] (1.59 – 3.50)	--
Three or more times a week	59.9	2.30 [*] (1.64 – 3.23)	--

Abbreviations: *OR*, odds ratio; *CI*, confidence interval; *AOR*, adjusted odds ratio. Row percentages presented for poor sleep.

^a Antiretroviral therapy (ART) adherence.

^b Prescription drugs included painkillers, amphetamines, depressants, and erection medication. Due to the potential for overlap with prescription drugs, we excluded use of sleep medications from the multivariable model.

^c Illicit stimulants included cocaine, crack, and crystal methamphetamine.

^d Other substances included ecstasy, heroin, methadone, ketamine, hallucinogens, synthetics, GHB, and poppers.

^e $\chi^2 = 163.65$, $df = 30$, $p < 0.001$, Nagelkerke $R^2 = 0.20$.

^{*} $P < 0.05$.