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Poor sleep health and its association with mental health, substance use, and condomless anal intercourse among gay, bisexual, and other men who have sex with men

Dustin T. Duncan, ScD^{a,b,c,d,e,*1}, William C. Goedel^{a,b,f,1}, Kenneth H. Mayer, MD^{g,h}, Steven A. Safren, PhD^{g,i}, Joseph J. Palamar, PhD, MPH^{a,c}, Daniel Hagen, MPH^{a,b}, and Girardin Jean-Louis, PhD^a

^aDepartment of Population Health, New York University School of Medicine, New York, NY

^bCollege of Global Public Health, New York University, New York, NY

^cCenter for Drug Use and HIV Research, New York University Rory Meyers College of Nursing, New York, NY

^dPopulation Center, College of Arts and Science, New York University, New York, NY

^eCenter for Data Science, New York University, New York, NY

^fDepartment of Sociology, College of Arts and Science, New York University, New York, NY

^gFenway Health, The Fenway Institute, Boston, MA

^hDepartment of Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA

ⁱDepartment of Psychology, College of Arts and Sciences, University of Miami, Miami, FL

Abstract

Objectives—The purpose of this study was to evaluate the prevalence of poor sleep health (ie, poor sleep quality and short sleep duration) in a sample of men who have sex with men (MSM). In addition, this study examined whether poor sleep health was associated with depressive symptoms, substance use, and sexual risk behaviors in this sample.

Design—Cross-sectional survey.

Participants—Broadcast advertisements were placed on a popular smartphone application for MSM in January 2016 to recruit users in the London metropolitan area ($n = 202$) to complete a Web-based survey, which included validated measures of sleep quality and duration.

Measurements—Poor sleep quality was defined based on self-report as very or fairly bad. Short sleep duration was defined as less than 7 hours each night. Regression models were used to assess

*Corresponding author at: Department of Population Health, Spatial Epidemiology Lab, Department of Population Health, New York University School of Medicine, 227 East 30th Street, Room 621, New York, NY 10016. Tel.: +1 646 501 2674; fax: +1 646 501 2706. Dustin.Duncan@nyumc.org (D.T. Duncan).

¹Authors contributed equally.

associations between sleep variables and self-reported depressive symptoms, substance use, and sexual risk behaviors.

Results—About one-third (34.6%) of the respondents reported poor sleep quality and almost half (43.6%) reported sleeping less than 7 hours every night. Several poor sleep health variables were independently associated with depressive symptoms, substance use (eg, use of alcohol or marijuana), and condomless anal intercourse. For example, typical nightly sleep duration of less than 7 hours was associated with condomless receptive anal intercourse with a higher number of sexual partners (incidence rate ratio, 2.65; 95% confidence interval: 1.63–4.30; $P < .001$).

Conclusion—Sleep health promotion interventions should be developed for MSM, which may promote positive mental health as well as reduce substance use and sexual risk behaviors in this population.

Keywords

Poor sleep health; Depressive symptoms; Substance use; Sexual risk behaviors; Gay men's health; Men who have sex with men (MSM)

Introduction

Sleep, like nutrition and physical activity, is a critical determinant of health and well-being.¹ Poor sleep health has been implicated in poorer health outcomes across populations. Moreover, research on sleep patterns in the general population suggests that poor sleep quality and short sleep duration are highly prevalent, where only about 1 in 5 Britons (22%) sleep for the recommended 7 to 8 hours each night.² Despite the large and accumulating evidence on the prevalence and effects of poor sleep health, no prior studies have examined sleep health specifically among gay, bisexual, and other men who have sex with men (MSM), who experience multiple health disparities. To illustrate, MSM comprise the largest proportion of people living with HIV in the United Kingdom.³ In addition, MSM often experience syndemics of significant mental health and substance abuse disorders.⁴

Recent evidence strongly suggests that difficulties falling asleep and sleeping through the night are not only typical symptoms of depression, but also may be independent risk factors for depression and low quality of life long-term.^{5,6} With regard to substance use, research in otherwise healthy adolescents and adults indicates that poor sleep can influence substance use (eg, use of marijuana, alcohol, cigarettes).^{7,8} As for sexual behaviors, studies in the general population have yielded conflicting results on the association with sleep health, with some evidence from the United States suggesting that there is a positive relationship between sleep and sexual behaviors in urban adolescents but not in rural adolescents.^{8,9}

Poor sleep health could be implicated in poor mental health because of increased stress due to suboptimal sleep. Laboratory-based studies have shown that sleep deprivation and poor sleep health can impair decision-making skills.¹⁰ Therefore, poor sleep health can be associated with increases in alcohol and substance use. Poor sleep health may also lead one to rely on alcohol and other depressants to fall asleep or stay asleep. Conversely, the use of stimulants (eg, cocaine, ecstasy/3,4-methylenedioxymethamphetamine [MDMA]) is associated with poor sleep architecture, suggesting a bidirectional relationship between

substance use behaviors and sleep health.¹¹ In the context of MSM and HIV transmission, poor sleep health may impair one's willingness and/or ability to negotiate condom use with a potential partner. However, no published research has examined whether sleep health is associated with mental health, substance use, or sexual risk behaviors among MSM and very few studies have been conducted investigating associations between sleep health and sexual risk behaviors overall.

The effects of poor sleep may be particularly salient for MSM who often use geosocial-networking smartphone applications to meet potential sexual partners for at least 2 reasons. First, previous work has shown that many MSM use these applications across the span of the day, including late night (9:30 PM to 2:30 AM) and early morning (2:30 AM to 6:30 AM).¹² These are oftentimes when bars, clubs, and other social venues might be closed. Second, the use of smartphones during these hours has been linked to poor sleep,¹³ suggesting that MSM who use geosocial-networking smartphone applications may have particularly poor sleep health. As such, the purpose of this study is to evaluate the prevalence of poor sleep health in a sample of MSM residing in London, England, recruited from a popular geosocial-networking smartphone application for MSM. In addition, this study examined whether poor sleep quality and short sleep duration were correlates of mental health, substance use, and sexual risk behaviors in the app-using sample. We note that these applications use global positioning system technology to form connections between users based on their current location.^{14,15} These geospatial technologies have generated quicker and easier ways for MSM to meet potential partners¹⁶ and, consequently, may facilitate users' ability to have multiple concurrent partners, thereby increasing their risk for acquiring and transmitting HIV¹⁷ and other sexually transmitted infections.¹⁶

Methods

Sample recruitment

Broadcast advertisements were placed on a popular geosocial-networking smartphone application for gay, bisexual, and other MSM in January 2016. Advertisements were limited to the London metropolitan area. In line with previous research,¹² users were shown an advertisement with text encouraging them to click through the advertisement to complete an anonymous Web-based survey. Users were shown this advertisement the first time they logged into the application during four 24-hour periods, which were intentionally not consecutive days. Precautions (eg, use of the "Prevent Ballot Box Stuffing" feature on Qualtrics) were taken to avoid and eliminate duplicate responses as done in previous research¹⁸ because participants could have theoretically viewed the advertisement 4 times during the recruitment period, but no duplicate responses were apparent. Participants were told that completing the survey would enter them for a chance to win £50.

At the end of the recruitment period (ie, four 24-hour periods), 1410 users had clicked through the advertisement and reached the landing page of the survey, and 202 users provided informed consent and completed the survey, representing an overall response rate of 14.3%. The survey included 47 items and took an average (SD) of 9.68 (5.65) minutes for users to complete. All protocols were approved by the New York University Committee on

Activities Involving Human Subjects before data collection. All respondents reported being at least 18 years old at the time of survey administration, an inclusion criterion.

Measures

Sleep quality—To assess sleep quality, participants were asked, “During the past month, how would you rate your sleep quality overall?”.¹⁹ Response options were “very good,” “fairly good,” “fairly bad,” and “very bad.” These 4 options were collapsed into 2 categories—good sleep quality (including responses of very good and fairly good) and poor sleep quality (including responses of very bad and fairly bad) to improve statistical power given the low number of responses in the “very good” and “very bad” categories. Our collapsing approach for the 4-level sleep quality variable has been used in prior epidemiologic research.²⁰

Sleep duration—Self-reported typical sleep duration was measured with an item asking, “During the past month, how many hours of actual sleep did you get each night?”.¹⁹ Responses were open-ended but limited to a single integer. Although previous studies have often categorized sleep duration as short (< 6 hours), average (7–8 hours), and long (> 9 hours),²¹ these 3 categories were collapsed into 2 categories—short (< 6 hours) and average (≥ 7 hours)—to improve the statistical power given the low number of responses in the “long” category. Our approach to categorizing sleep duration is consistent with previous epidemiologic studies.²⁰

Mental health—The self-reported presence of depressive symptoms was assessed using the Patient Health Questionnaire-2, a reliable and validated screening tool for depressive symptoms.²² A dichotomous variable was created using score on the measure indicating the absence (score: <3) or presence (score: ≥ 3) of self-reported depressive symptoms.

Substance use—Participants were asked to check off substances they had used with the last 3 months from a list, including alcohol (> 5 drinks in a row), marijuana, acid/lysergic acid diethylamide (LSD), cocaine/crack cocaine, ecstasy/MDMA, ketamine, γ -hydroxybutyric acid/ γ -butyrolactone (GHB/GBL), methamphetamine, and nitrite inhalers (poppers). Dichotomous variables were created for alcohol use (use vs nonuse) and for recent drug use for 4 other substances (use vs nonuse of marijuana, cocaine, inhalant nitrite, club drugs, and methamphetamine). A composite variable indicating use and nonuse of club drugs including ecstasy/MDMA, GHB/GBL, ketamine, and LSD/acid was created.²³ Sensitivity analyses indicated the robustness of this composite variable. Cocaine and methamphetamine were excluded from this category because these drugs are used in a wider variety of contexts.²⁴

Condomless anal intercourse—First, participants indicated the total number of partners with whom they had had insertive anal intercourse and receptive anal intercourse in the preceding 3 months. For both behaviors, participants were then asked with how many of these partners they did not use a condom, hereafter referred to as condomless insertive anal intercourse and condomless receptive anal intercourse.

Demographic characteristics—Age was measured in a continuous manner and then categorized into 18 to 24 years, 25 to 30 years, 31 to 40 years, 41 to 50 years, and 51 years and older. Self-reported sexual orientation was categorized as gay, bisexual, and other. Ethnic groups were categorized as white/white British, black/black British, Asian/Asian British, and mixed/multiple ethnic groups/other. Employment status was categorized as employed, unemployed, student, and retired. Relationship status was categorized by participants as currently being in a relationship or not. HIV status was assessed based on self-report with 3 response options: HIV positive, HIV negative, and unknown/never tested.

Statistical analyses—First, descriptive statistics (eg, frequencies) were calculated. Next, bivariable and multivariable models were constructed to examine associations between poor sleep health (defined as poor sleep quality and short sleep duration as the 2 exposure variables) and the studied health outcomes—depressive symptoms, substance use, and the numbers of partners with whom they had insertive or receptive anal intercourse, with and without condoms. Log-binomial models (yielding prevalence ratios [PRs]) were fit for associations between sleep quality and sleep duration and the presence of depressive symptoms and alcohol, club drug, cocaine, inhalant nitrite, marijuana, and methamphetamine use. Although the most common method of modeling dichotomous outcomes is binary logistic regression, the odds ratios derived from these models may overestimate the PRs if outcomes are common.²⁵ Negative binomial regression models (yielding incidence rate ratios [IRRs]) were used to assess associations between sleep health variables and sexual intercourse. This modeling approach was selected as the numbers of partners for each behavior were count variables and overdispersed with regard to the mean.²⁶ In all multivariable models, demographic characteristics as well as the other outcomes were controlled for to more accurately estimate the association of interest. Statistical significance was determined at $P < .05$.

Results

Sample demographics

Demographic characteristics of the sample are shown in Table 1. The average (SD) age in the sample was 36.2 (11.5) years, where 38.7% of respondents were between 18 and 30 years old. Most (97.5%) described their sexual orientation as gay or bisexual. Almost three-fourths (71.8%) of the sample identified their ethnic group as white or white British. Most (85.2%) were either currently employed or enrolled in school. One-fifth (19.3%) reported currently being in a relationship with another man. Most (83.7%) self-reported their HIV status as negative and 11.4% reported their HIV status as positive.

Poor sleep health

About one-third (34.6%) of the respondents reported poor sleep quality and almost half (43.6%) reported sleeping less than 7 hours every night, with an average (SD) of 6.65 (1.69) hours of reported sleep each night (Table 2). The minimum amount of self-reported sleep duration was 2 hours, while the maximum amount was 15 hours.

Poor sleep health and mental health

More than a fifth (22.3%) of the sample reported experiencing depressive symptoms (Table 3). In multivariable models, both poor sleep quality (PR, 4.48; 95% confidence interval [CI], 1.85–10.88; $P = .001$) and short sleep duration (PR, 2.49; 95% CI, 1.06–5.81; $P = .036$) were significantly associated with the presence of depressive symptoms when controlling for demographic variables, substance use, and sexual intercourse.

Poor sleep health and substance use

More than half (53.0%) of respondents reported use of at least one substance in the last 3 months; 38.6% reported binge drinking. The most commonly used substances were reported to be inhalant nitrites (36.6%), marijuana (19.8%), GHB or GBL (14.9%), ecstasy or MDMA (14.9%), power cocaine or crack cocaine (14.4%), and methamphetamine (13.9%). Smaller portions of the sample reported recent use of ketamine (4.5%) or LSD/acid (1.0%).

In multivariable models (Table 4), poor sleep quality was associated with increased odds of marijuana use in the preceding 3 months (PR, 3.06; 95% CI, 1.27–7.36; $P = .013$) and poor sleep duration was associated with methamphetamine use in the preceding 3 months (PR, 2.84; 95% CI, 1.02–7.90; $P = .046$). Furthermore, poor sleep quality was associated with an increase in odds of reporting alcohol use (PR, 2.34; 95% CI, 1.11–4.91; $P = .025$).

Poor sleep health and condomless sex

Three quarters (75.2%) of respondents reported having engaged in insertive anal intercourse with one or more partners, with an average (SD) of 4.6 (8.3) partners. Almost half (45.0%) of the sample reported engaging in condomless insertive anal intercourse with one or more partners, with an average (SD) of 2.3 (5.8) partners. Almost two-thirds (64.9%) of respondents reported engaging in receptive anal intercourse with one or more partners, with an average (SD) of 3.3 (7.8) partners. More than one-third (37.1%) of the sample reported engaging in condomless receptive anal intercourse with one or more partners, with an average (SD) of 1.8 (6.9) partners. In multi-variable models, poor sleep quality was associated with reporting having condomless insertive anal sex with fewer partners (IRR, 0.52; 95% CI, 0.34–0.97; $P = .010$).

In addition, in multivariable models (Table 5), poor sleep quality was associated with reporting receptive anal intercourse with a greater number of partners (IRR, 1.54; 95% CI, 1.01–2.35; $P = .043$) and condomless receptive anal intercourse with a greater number of partners (IRR, 2.36; 95% CI, 1.45–3.84; $P = .011$). Likewise, typical sleep duration of less than 7 hours was associated with receptive anal intercourse with a greater number of sexual partners (IRR, 1.71; 95% CI, 1.14–2.56; $P = .010$). Typical sleep duration of less than 7 hours was also associated with reporting condomless receptive anal sex with a higher number of partners in multivariable models (IRR, 2.65; 95% CI, 1.63–4.30; $P < .001$).

Discussion

This is the first study to examine sleep health in a sample of gay, bisexual, and other MSM on geosocial networking apps. In addition, this study is the first to examine poor sleep health

variables as correlates of mental health, substance use, and condomless anal sex among MSM. Therefore, this study provides a meaningful contribution to the literature in a high-risk sample of MSM: app-using MSM. About one-third reported poor sleep quality and about half of respondents reported typically sleeping less than 7 hours each night, meaning a large portion of the sample receives an insufficient amount of sleep each night. In this study, poor sleep quality and short sleep duration were associated with depressive symptoms, substance use (eg, alcohol, marijuana, methamphetamine), and some condomless anal intercourse behaviors among MSM. No previous studies have examined sleep health among MSM, so these findings cannot be directly compared with those of other studies. However, multiple studies found that poor sleep health is a robust predictor of poor health outcomes,^{27,28} including mental health, substance use and sexual risk behaviors in general populations.^{5–10}

There are a number of potential explanations for these findings. Via increased stress, poor sleep health can influence depression and, subsequently, substance use. This, in turn, can lead to sexual risk behaviors such as condomless sex. As for substance use, individuals may rely on alcohol and other depressant substances to fall asleep or stay asleep²⁹; at the same time, it is generally acknowledged that substance use exerts an adverse physiological impact on sleep quality and duration. As stated previously, poor sleep health may impair one's ability to make decisions¹⁰ and to negotiate condom use with a potential sexual partner. In addition, poor sleep health may also reduce one's self-efficacy³⁰ for engaging in safer sexual practice. Paradoxically, though, we found that poor sleep quality was associated with reporting having condomless insertive anal sex with fewer partners. This was an unexpected finding and requires further investigation. It is possible, however, that this is due to differences in physical exertion of individuals who are insertive partners vs receptive partners—perhaps when insertive sexual partners have poor sleep they are too tired to engage in sexual intercourse.

Future research directions

Future empirical research should aim to investigate the unidirectional and potentially bidirectional causal mechanisms linking poor sleep to mental health, substance use, and sexual risk behaviors, including pathophysiologic mechanisms. Prospective study designs could be used to assess longitudinal changes in these variables. In addition, given the conflicting findings regarding sleep quality and condomless insertive and receptive intercourse, future research should differentiate between main and casual partners, the HIV status of each partner, and the number of sex events per partner, which may reveal more nuanced associations between sleep and sexual risk behaviors. Moreover, studies should examine sleep health among large samples of MSM and samples not recruited only through geosocial-networking smartphone applications and MSM samples across different geographic locations. In addition, the use of objective measures of sleep and health behaviors would advance the science by going beyond self-reported measures. For example, sleep can be measured using accelerometers,³¹ and mental health, substance use and sexual risk behaviors could be assessed using ecological momentary assessment methods to minimize recall bias.³² Finally, given that our sample of sexual minority men often suffered from poor sleep health, future research can also examine correlates of poor sleep health in

sexual minority men, such as psychosocial stress.^{33,34} Although such research has not been conducted among sexual minority men, it is well known that sexual minorities experience increased stress and related anxiety,³⁵ which could contribute to sleep difficulties.

Study implications

Although the extent to which lesbian, gay, bisexual and transgender health disparities extend to the field of sleep health is rarely examined, this study clearly suggests that a large proportion of MSM in this sample has poor health, including sleeping less than 7 to 9 hours, the recommended sleep duration for adults.³⁶ Given its associations with adverse health behaviors and outcomes, promotion of sleep health should be considered in guidelines for lesbian, gay, bisexual and transgender-affirmative healthcare practice and as part of public health campaigns targeted to MSM. Such campaigns can use both “traditional” and smartphone-based interventions using geosocial-networking smartphone applications such as Grindr, Jack’d, and Scruff, applications commonly used by MSM.¹² Although no existing public health interventions that directly address sleep health in MSM, sexual health promotion interventions targeted to MSM have leveraged these applications.³⁷

Study limitations

The findings of this study are subject to several limitations. First, variable cutoff points for sleep duration have been used and in this study were derived from self-reported measures rather than objective accelerometer data, which may be less biased by poor recall. Second, in this study, other health behaviors and outcomes were analyzed based on self-reported data. Same-source bias could thus be an issue, as the exposure and outcomes were all examined via self-report. Furthermore, residual confounding (eg, omitted variable bias) might be a concern. It is possible that the survey excluded important confounding variables associated with both the independent variable and the dependent variable (eg, self-regulation, health consciousness). Consequently, these variables cannot be controlled in the multivariable regression analyses. In addition, this study used a cross-sectional design, therefore precluding any causal inference, given that reverse causation is possible. In addition, the incongruence between the 3-month recall period for substance use and sexual behaviors and 1-month recall period for sleep quality and duration is an additional limitation of this study.

Given that this sample was recruited from a geosocial-networking smartphone application in the London metropolitan area, these findings may only be generalizable to MSM who use geosocial-networking smartphone applications in London. Indeed, these relationships could be different in MSM who do not use these applications and in MSM in different rural and urban settings in England and beyond. In addition, there might be seasonal variation in sleep quality and duration among Londoners,³⁸ which was not captured in this survey conducted in January 2016; however, the evidence on such seasonal variation in sleep among adults in the United Kingdom is conflicting.³⁹ Lastly, the sample was recruited from a single geosocial-networking smartphone application and given that there are many applications commonly used by MSM,¹² these findings may not be generalizable to MSM who use other applications or non-app using MSM (as there was no comparison group in this study). We note, though, that we specifically selected this location because it has the highest number of users of this application worldwide.⁴⁰

Conclusion

Poor sleep health was common among this sample of MSM who use geosocial-networking smartphone applications in London. In addition, poor sleep health was associated with the presence of depressive symptoms, substance use, and condomless anal sex. Sleep health promotion should be targeted to MSM, as it may reduce adverse sleep-related health behaviors and outcomes in this vulnerable population.

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Table 1

Sample demographics (n = 202)

	% (n)
Age (y)	
18–24	14.9 (30)
25–30	23.8 (48)
31–40	30.7 (62)
41–50	18.8 (38)
51	11.9 (24)
Sexual orientation	
Gay	87.1 (176)
Bisexual	10.4 (21)
Other	2.5 (5)
Ethnic group	
White/White British	71.8 (145)
Black/Black British	5.4 (11)
Asian/Asian British	7.9 (16)
Mixed/Multiple ethnic groups/other	13.9 (28)
Employment status	
Employed	73.1 (147)
Unemployed	10.9 (22)
Student	12.4 (25)
Retired	3.5 (7)
Current relationship	
Yes	19.3 (39)
No	80.7 (163)
Self-reported HIV status	
Positive	11.4 (23)
Negative	83.7 (169)
Unknown/Never tested	5.0 (10)

Table 2

Self-reported sleep health, mental health, substance use, and sexual risk behaviors

	% (n)
Sleep quality	
Very good	10.9 (22)
Fairly good	54.5 (110)
Fairly bad	27.7 (56)
Very bad	6.9 (14)
Sleep duration ^a (h)	
<5	7.9 (16)
5–6	35.7 (72)
7–8	46.5 (94)
>8	6.4 (13)
Depressive symptoms	
Absent	77.7 (157)
Present	22.3 (45)
Alcohol (>5 drinks)	38.6 (78)
Club drugs	23.3 (47)
Ecstasy/MDMA	14.9 (30)
GHB/GBL	14.9 (30)
Ketamine	4.5 (9)
LSD/Acid	1.0 (2)
Cocaine	14.4 (29)
Inhalant nitrites	36.6 (74)
Marijuana	19.8 (40)
Methamphetamine use	13.9 (28)
Insertive anal intercourse	
0 partners	24.6 (48)
1 partners	75.4 (147)
Receptive anal intercourse	
0 partners	34.4 (67)
1 partners	65.6 (128)
Condomless insertive anal intercourse	
0 partners	55.0 (111)
1 partners	45.0 (91)
Condomless receptive anal intercourse	
0 partners	62.9 (127)
1 partners	37.1 (75)

Abbreviations: MDMA, 3,4-methylenedioxyamphetamine; GHB/GBL, γ -hydroxybutyric acid/ γ -butyrolactone; LSD, lysergic acid diethylamid.

^aNightly.

Table 3

Multivariable associations between poor sleep health and depressive symptoms

	Depressive symptoms, PR (95% CI)
Poor sleep quality	4.48 ^{**} (1.85–10.88)
Short sleep duration	2.49 [*] (1.06–5.81)

Adjusted for age, sexual orientation, ethnic group membership, employment status, relationship status, HIV status, alcohol use, club drug use, cocaine use, inhalant nitrite use, marijuana use, methamphetamine use, and engagement in condomless insertive and receptive anal intercourse.

Abbreviations: PR, prevalence ratio; CI, confidence interval.

^{*} $P < .05$.

^{**} $P < .01$.

^{***} $P < .001$.

Table 4
Multivariable associations between poor sleep health and substance use: log-binomial regression

	Alcohol use, PR (95% CI)	Club drug use, PR (95% CI)	Cocaine use, PR (95% CI)	Inhalant nitrite use, PR (95% CI)	Marijuana use, PR (95% CI)	Methamphetamine use, PR (95% CI)
Poor sleep quality	2.34* (1.11–4.91)	1.04 (0.46–2.40)	1.13 (0.41–3.09)	1.38 (0.66–2.90)	3.06* (1.27–7.36)	1.52 (0.53–4.38)
Short sleep duration	1.96 (0.95–4.04)	1.09 (0.50–2.39)	1.11 (0.43–2.87)	1.26 (0.62–2.53)	1.22 (0.53–2.77)	2.84* (1.02–7.90)

Adjusted for age, sexual orientation, ethnic group membership, employment status, relationship status, HIV status, presence of depressive symptoms, engagement in condomless insertive anal intercourse, and engagement in condomless receptive anal intercourse.

Abbreviations: PR, prevalence ratio; CI, confidence interval.

* $P < .05$.

** $P < .01$;

*** $P < .001$

Table 5

Multivariable associations between poor sleep health and number of sexual partners: negative-binomial regression

	Insertive anal intercourse, IRR (95% CI)	Condomless insertive anal intercourse, IRR (95% CI)	Receptive anal intercourse, IRR (95% CI)	Condomless receptive anal intercourse, IRR (95% CI)
Poor sleep quality	0.71 (0.48–1.07)	0.54 [*] (0.340–0.87)	1.54 [*] (1.013–2.35)	2.36 [*] (1.450–3.84)
Short sleep duration	0.88 (0.61–1.26)	0.81 (0.532–1.24)	1.71 [*] (1.139–2.56)	2.65 ^{***} (1.634–4.30)

Adjusted for age, sexual orientation, ethnic group membership, employment status, relationship status, HIV status, presence of depressive symptoms, alcohol use, club drug use, cocaine use, inhalant nitrite use, marijuana use, and methamphetamine use.

^{*} $P < .05$.

^{**} $P < .01$.

^{***} $P < .001$.