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ORIGINAL PAPER

What's Sleep Got to Do with It?: Sleep Health and Sexual Risk-Taking Among Men Who have Sex with Men

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Abstract
Emerging evidence links poor sleep health with a range of adverse health behaviors, including condomless anal intercourse (CAI) among men who have sex with men (MSM). We tested associations between a range of sleep health indicators and sex outcomes in an online sample of 559 MSM in Paris France, recruited from a geosocial-networking phone application. Participants reported on sleep quality, sleep duration, problems falling asleep, and problems staying awake during wake-time activities, and four sex outcomes: numbers of receptive, insertive, and total CAI partners in the past three months, and use of substances before or during sex. In bivariate analyses, all four sleep variables were associated with the three CAI outcomes, whereas poor sleep quality and problems falling asleep were positively associated with using substances before or during sex. Most of these associations remained significant when adjusting for various socio-demographic and behavioral covariates. These findings highlight the importance of addressing sleep health to prevent HIV risk among MSM.

Keywords Sleep health · Tiredness · HIV · Condom use · Gay and bisexual men

Resumen
La evidencia emergente relaciona la mala salud del sueño con una variedad de comportamientos de salud adversos, incluyendo el sexo anal sin condón entre hombres que tienen sexo con hombres (HSH). Examinamos asociaciones entre una variedad de indicadores de salud del sueño y resultados sexuales en un grupo de 559 HSH en París, Francia, reclutados en una aplicación telefónica de redes geosociales. Los participantes reportaron la calidad del sueño, la duración del sueño, los problemas para conciliar el sueño y los problemas para mantenerse despiertos durante las actividades del despertar, y cuatro resultados sexuales: número de parejas receptivas (pasivas), activas, y totales de sexo anal sin condón, y uso de sustancias antes o durante el sexo. En los análisis bivariados, las cuatro variables del sueño se asociaron positivamente con los tres resultados de sexo anal sin condón, mientras que la mala calidad del sueño y los problemas de conciliar el sueño se asociaron positivamente con el uso de sustancias antes o durante el sexo. La mayoría de estas asociaciones siguieron siendo significativas cuando ajustamos para diversas covariables sociodemográficas y conductuales. Estos resultados destacan la importancia de abordar la salud del sueño para prevenir el riesgo de VIH entre HSH.

Palabras claves Salud del sueño · Cansancio · VIH · Uso del condón · Hombres gay y bisexuales

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Introduction

The detrimental effects of poor or inadequate sleep have been explored in relation to an expanding range of health behaviors, showing links to difficulties in: resisting cigarettes when trying to quit smoking [1], avoiding unhealthy eating [2, 3], and limiting one's alcohol or drug use (both for adolescents [4] and adults [5–7]). These findings accord with sleep science research which has shown that sleep loss impairs cognitive capacities involved in self-regulation (e.g., inhibitory control) [8] and increases risk-taking [9]. Furthermore, various health behavior models [10–12] have proposed that poor sleep leads to such behavioral outcomes via its deleterious impact on self-regulation. For example, in their model predicting substance use in adolescents, Edwards et al. [13] showed that poor sleep impairs the ability to regulate one's emotions, thereby increasing the odds of using substances.

A lesser-studied addition to this list of health behaviors that can be adversely affected by poor sleep is sexual risk-taking. Earlier experimental research showed that sleep-deprived college-aged males were less able to visually disengage from a sexual image [14], suggesting that poor sleep impairs the ability to regulate one's attention. However, the connection between sleep and sexual behavior has since remained largely unstudied, except for clinical studies examining *reduced* sexual function in people with chronic conditions (e.g., sleep apnea [15]), and a recent study in which women with poorer sleep quality reported greater sexual arousal after an induced sexual fantasy exercise [16]. Recently, survey research [6] has begun to explore the role of poor sleep in *increased* sexual risk-taking (e.g., the non-use of condoms)—which is especially relevant for the prevention of HIV and sexually-transmitted infections (STIs) among gay, bisexual, and other men who have sex with men (MSM) who, as a group, remain disproportionately affected by both HIV and rectal STIs [17]. For example, in a study of London-based MSM who use a popular geosocial-networking smartphone app—one purpose of which is to "hook-up" with sexual partners—Duncan et al. [6] observed a positive association between both poor sleep quality and short sleep duration (i.e., less than 7 h a night) and having greater numbers of partners with whom they had receptive anal sex.

Further, a recent study by Millar et al. [18] found that a majority of gay and bisexual men in a national U.S. cohort study reported that tiredness does not necessarily impede their desire for sex—and indeed, almost 30% also reported that tiredness can increase their sexual desire. Additionally, the authors also found that, for many men, tiredness increases the preference for being the receptive partner in anal sex—endorsed by almost 40% of those with a "versatile" sexual positioning identity. This latter finding provides some support for Duncan et al.'s finding that men with poorer sleep quality and shorter sleep duration reported having receptive anal sex with more partners [6]. Taken together, these studies highlight the importance of studying sleep health among MSM, which is further bolstered by recent findings of sleep disparities whereby MSM tend to report poorer sleep health compared to their heterosexual counterparts [19–21].

To build on the paucity of sleep research focused on sexual-risk taking among MSM, the current study examined associations between four sleep variables that are commonly assessed in population health studies [19, 20]—sleep quality, sleep duration, problems falling asleep at night, and problems staying awake during wake-time activities—and four sex outcomes associated with HIV risk: number of receptive condomless anal intercourse (CAI) partners, number of insertive CAI partners, total CAI partners, and the odds of using substances before or during sex. Given that receptive positioning in CAI represents a greater risk for HIV infection than insertive positioning [22], we differentiated between receptive and insertive CAI as outcomes. We hypothesized that each of the sleep variables (poor sleep quality, short sleep duration, problems falling asleep at night, and problems staying awake during wake-time activities) would be associated with greater rates of each of the CAI outcomes and with greater odds of having used substances before or during sex.

Methods

Participants

Participants were recruited into this online study via a broadcast advertisement placed on a popular geosocial networking app for MSM in Paris, France, in 2016. Upon being redirected to the anonymous web-based survey, participants had the option to complete the items in French or English. The English version of the survey was translated into French by three native French speakers and was then reviewed and adjudicated by an additional native French speaker. The survey was pretested via back-translation by a fifth French speaker who is a health researcher. Details of the study design and methods have been described previously [24]. Among 5206 users who clicked on the advertisement, 580 users signed informed consent and completed the survey. The protocols were approved by the New York University School of Medicine Institutional Review Board before data collection.

Measures

Demographics

We assessed age, sexual orientation, whether the participant was born in France, employment status, self-reported HIV status, current relationship status, and whether the participant was currently using pre-exposure prophylaxis (PrEP). We also asked about past 3-month drug use, including the following stimulant drugs: cocaine, MDMA, ketamine, GHB/GBL, methamphetamine, and prescription stimulants.

Sleep Duration

Typical sleep duration was measured by an item from the widely-used Pittsburgh Sleep Quality Index (PSQI; 23), which asks, "During the past month, how many hours of actual sleep did you get each night?". Responses were open-ended but were limited to a whole number. We combined responses into short (less than 7 h) versus average or longer (7 h or more), as indicated by recommendations from the National Sleep Foundation [20].

Sleep Quality

Subjective sleep quality was assessed using the final question in the PSQI [23]: "During the past month, how would you rate your sleep quality overall?". Response options included: "very good," "fairly good," "fairly bad," and "very bad". Given the small number of participants selecting the "very good" and "very bad" options, we collapsed responses into good versus poor sleep quality.

Sleep Problems

We assessed three sleep problems that are included in the PSQI [23]: trouble falling asleep, trouble staying awake during wake-time activities, and use of medications to help with sleep. We modified the original PSQI format which asks for frequencies of each problem in a typical week, to a "yes" or "no" response format for the following questions: "During the past month, have you experienced any of the following? (1) I had trouble sleeping because I could not get to sleep within 30 min (i.e., problems falling asleep) (2) I had trouble staying awake while driving, eating meals, or engaging in social activity (i.e., problems staying awake during wake-time activities) (3) I took medicine (prescribed or over the counter) to help me sleep". Due to the low Cronbach's alpha between these three sleep items in this sample ($\alpha = 0.21$), we analyzed each problem separately, consistent with previous studies [6, 24, 25].

Sexual Risk Outcomes

Participants were asked "In the past 3 months, with how many partners have you engaged in anal intercourse without a condom…" as either the receptive or insertive partner. The two count variables were also combined to form a total number of recent partners. Finally, participants were also asked whether they or their partners had used alcohol or drugs before or during sex in the past 3 months, indicated by a yes/no response.

Depression

We measured depressive symptoms in the past 2 weeks by using the two depression items in the Patient Health Questionnaire-4 [26], a widely-used brief measure with well-established reliability and validity [27]. The two items—"feeling down, depressed, or hopeless," and having "little interest or pleasure in doing things"—are rated on a scale of 1 (*not at all*) to 4 (*nearly every day*) and were summed into a single score where higher scores indicate greater depressive symptomatology.

Statistical Analyses

Bivariate comparisons for each of the sleep variables by each demographic grouping tested whether sleep health differed by demographics. Subsequent analyses involved four sleep variables—sleep quality (referent = good), sleep duration (referent = at least 7 h), problems falling asleep (referent = no), and problems staying awake during wake-time activities (referent = no). We did not examine taking sleep medications, as very few participants endorsed this third sleep problem. χ^2 tests of independence checked whether any of the sleep variables differed according to whether the participant reported recent use of stimulant drugs.

Bivariate regressions (i.e., without covariates) were conducted separately for each sleep variable predicting the number of partners (for receptive CAI, insertive CAI, and combined total CAI) and the odds of whether the participant or their partner had used substances before or during sex in the past 3 months. Due to outliers, the CAI variables were each restricted to values within three standard deviations (SDs) of the mean and outlier values were reduced to the maximum value (the mean plus three SDs). Regressions exploring these count variables (i.e., number of partners) utilized a negative binomial distribution with log-link, whereas the odds of sex with substances were analyzed by binary logistic regressions. Multivariable regressions adjusted for the following covariates: age, sexual orientation (referent = gay), born in France (referent = no), HIV status (referent = HIV-negative), relationship (referent = single), current PrEP use

(referent = no), recent stimulant drug use (referent = none), and employment (referent = not full-time).

As an additional check, we re-ran all analyses while also adjusting for depression, as sleep problems and depression often co-occur or overlap [28]. Finally, sensitivity analyses were run for sleep duration—all analyses involving sleep duration were also run with a shorter cut-off of averaging 6 h or more versus less than 6 h.

Table 1 Demographic characteristics and sleep health ($N = 559$)

	Total	
	N	%
Total	559	100.0
Age		
18–24	84	15.0
25–29	103	18.4
30–39	180	32.2
40–49	139	24.9
≥ 50	54	9.5
Sexual orientation		
Gay	482	86.2
Bisexual	77	13.8
Born in France		
Yes	447	80.0
No	112	20.0
Employment status		
Employed/student	467	83.8
Unemployed/retired	90	16.2
Current relationship		
Single	376	67.4
Relationship	182	32.6
HIV status		
Negative	436	78.0
Positive or unknown	123	22.0
Current PrEP status		
Yes	39	7.0
No	520	93.0
Recent stimulant drug use		
Yes	83	14.8
No	476	85.2
Sleep quality		
Poor	172	30.8
Good	387	69.2
Sleep duration		
Less than 7 h	158	28.3
At least 7 h	388	69.4
Problems falling asleep (yes)	258	46.2
Problems staying awake (yes)	72	12.9
Took sleep medications (yes)	35	6.3

Note Missing data for some variables

Results

The demographic characteristics of the participants are displayed in Table 1, as well as frequencies for the four sleep variables. While 580 people participated in the wider study, only 559 completed the sleep items and were included in the current analyses. On average, the 559 MSM were 35.2 years old ($SD = 9.9$). The majority of participants identified as gay (86.2%), with 13.8% identifying as bisexual, and were born in France (80.0%). More than 65% reported being employed full-time, and most were single (67.4%) and self-reported being HIV-negative (78.0%). Only 39 (7.0%) reported current use of PrEP, and 83 (14.8%) reported at least some recent use of stimulant drugs. The range for depression score was 0–6, with an average score of 1.84 ($SD = 1.54$). For past-month sleep health, more than 30% reported poor sleep quality, 28.3% reported receiving less than 7 h of sleep per night in the past month, and 46.2% reported problems falling asleep within 30 min of trying to sleep. Only 12.9% reported problems staying awake during wake-time activities, and 6.3% reported taking sleep medications.

Additionally, bivariate associations between sleep variables and demographic characteristics, as tested by χ^2 tests of independence (or, for age, *t*-tests), showed that: sleep quality did not differ with respect to any of the demographic groupings; sleep duration did not differ, except that HIV-positive men were more likely to report short sleep duration than HIV-negative men (27% vs. 19%, respectively; $\chi^2(1) = 4.08$, $p < 0.05$); proportions of men experiencing problems falling asleep differed only by age (men reporting this problem were, on average, younger; 33.4 versus 36.6 years, respectively; $t(557) = 3.66$, $p < 0.001$), and by HIV status (HIV-positive men were more likely to report this problem than HIV-negative men; 55% versus 44%, respectively; $\chi^2(1) = 4.39$, $p < 0.05$). Problems staying awake during wake-time activities did not differ by any demographic grouping. Sleep duration distributions did not differ by use of stimulant drugs. However, those reporting stimulant use were more likely to report problems falling asleep—$\chi^2(1) = 6.51$, $p < 0.01$—and problems staying awake—$\chi^2(1) = 8.71$, $p < 0.01$.

For the sexual risk variables, 51.8% of the sample reported at least one event in the past 3 months of CAI. The average number of partners with whom the participant had receptive CAI was 2.07 ($SD = 9.92$), and to deal with the outlier cases, values more than three SDs above the mean were reduced to 32. The average number of partners with whom the participant had insertive CAI was 1.69 ($SD = 6.62$), and to deal with the outlier cases, values more than three SDs above the mean were reduced to 21. The average number of total partners for any CAI events was 3.67 ($SD = 15.01$), and to deal with the outlier cases, values more than three SDs above the mean were reduced to 48.

Table 2 Bivariate associations between sleep health variables and recent HIV risk behaviors

	Outcome 1: number of partners receptive CAI	Outcome 2: number of partners insertive CAI	Outcome 3: total number of CAI partners	Outcome 4: have used substances before or during sex
	RR (95% CI)	RR (95% CI)	RR (95% CI)	OR (95% CI)
Sleep quality				
Poor	1.35** (1.08, 1.68)	1.27* (1.00, 1.60)	1.33** (1.08, 1.63)	1.68** (1.16, 2.42)
Good (ref.)	–	–	–	–
Sleep duration				
Less than 7 h	1.98*** (1.57, 2.48)	1.32* (1.04, 1.68)	1.66*** (1.35, 2.06)	1.39 (0.96, 2.03)
At least 7 h (ref.)	–	–	–	–
Problems falling asleep				
Yes	1.61*** (1.30, 1.98)	1.38** (1.11, 1.72)	1.59*** (1.32, 1.93)	1.74** (1.24, 2.44)
No (ref.)	–	–	–	–
Problems staying awake during wake-time activities				
Yes	1.36* (1.01, 1.83)	1.54** (1.13, 2.09)	1.31 (0.98, 1.72)	1.09 (0.66, 1.79)
No (ref.)	–	–	–	–

RR rate ratio, *OR* odds ratio, *CI* confidence intervals

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 2 displays the bivariate associations between the four sleep variables and the four sex outcomes. Eleven of the 12 possible associations between each of the four sleep variables and the three CAI outcomes reached statistical significance (i.e., $p < 0.05$). Having poor sleep quality, short sleep duration, problems falling asleep, or problems staying awake during wake-time activities were each associated with greater numbers of receptive CAI partners, insertive CAI partners, and total CAI partners, except for the association between problems staying awake and the total number of CAI partners, which only reached marginal significance of $p = 0.06$. Notably, the associations for the four sleep variables were strongest for number of partners with whom participants had receptive CAI. In terms of having used substances before/during sex in the past 3 months, only poor sleep quality and problems falling asleep were significantly associated with increased odds of reporting this outcome.

In multivariable regression models, similar patterns of results were observed, while adjusting for age, sexual orientation, relationship status, being born in France, HIV status, current PrEP use, any recent stimulant drug use, and employment. Poor sleep quality and problems falling asleep were both associated with the receptive CAI and total CAI outcomes and the odds of having used substances before/during sex, but were not associated not with insertive CAI. Short sleep duration (i.e., averaging less than 7 h) was associated with a greater number of partners for receptive CAI and total CAI, but not with insertive CAI partners nor with odds of having used substances before/during sex. Having problems staying awake during wake-time activities was not associated with any of the four outcomes.

Further, in sensitivity analyses, when shorter sleep duration was coded as averaging less than 6 h of sleep, its multivariable associations with receptive CAI partners and total CAI partners were stronger in magnitude (aRR = 1.96, $p < 0.01$, and aRR = 1.55, $p < 0.05$, respectively). As an additional check, we also adjusted for depression as was done in Duncan et al. [6]. Each of the significant associations in the multivariable analyses listed above remained significant, and none of the non-significant associations became significant Table 3.

Discussion

In this online survey study of 559 MSM recruited via a popular geosocial networking app, we found that four indicators of poor sleep were each associated with greater numbers of recent CAI partners, both when these counts were separated by positioning (especially for being the receptive partner) and when summed together (i.e., total CAI). All but one of the twelve associations were significant in bivariate analyses, and six of these associations remained significant in multivariable analyses adjusting for age, stimulant drug use, PrEP use, and other demographic variables. Additionally, of the four sleep variables, both having poor sleep quality and having problems falling asleep were also associated with greater odds of having used substances before or during sex. This pattern of associations remained significant in additional analyses adjusting for depression—and further, the effects

Table 3 Multivariable analyses for the associations between sleep variables and recent HIV risk behaviors

	Outcome 1: number of partners receptive CAI aRR (95% CI)	Outcome 2: number of partners insertive CAI aRR (95% CI)	Outcome 3: total number of CAI partners aRR (95% CI)	Outcome 4: have used substances before or during sex aOR (95% CI)
Model 1				
Sleep quality (ref. good)				
Poor	1.58*** (1.22, 2.04)	1.19 (0.91, 1.54)	1.36** (1.08, 1.71)	1.76** (1.19, 2.59)
Model fit statistics	Likelihood ratio	Likelihood ratio	Likelihood ratio	Nagelkerke R^2
	$\chi^2(9) = 289.64$***	$\chi^2(9) = 226.80$***	$\chi^2(9) = 326.74$***	0.14
Model 2				
Sleep duration (ref. at least 7 h)				
Less than 7 h	1.71*** (1.32, 2.21)	1.13 (0.86, 1.48)	1.43** (1.13, 1.81)	1.36 (0.91, 2.02)
Model fit statistics	Likelihood ratio	Likelihood ratio	Likelihood ratio	Nagelkerke R^2
	$\chi^2(9) = 287.31$***	$\chi^2(9) = 225.69$***	$\chi^2(9) = 324.85$***	0.12
Model 3				
Problems falling asleep (ref. no)				
Yes	1.48* (1.06, 2.08)	1.26 (0.87, 1.82)	1.42*** (1.06, 1.90)	1.49* (1.04, 2.13)
Model fit statistics	Likelihood ratio	Likelihood ratio	Likelihood ratio	Nagelkerke R^2
	$\chi^2(9) = 113.83$***	$\chi^2(9) = 76.79$***	$\chi^2(9) = 134.21$***	0.14
Model 4				
Problems staying awake (ref. no)				
Yes	1.00 (0.60, 1.64)	1.15 (0.65, 2.04)	0.95 (0.61, 1.48)	0.96 (0.56, 1.66)
Model fit statistics	Likelihood ratio	Likelihood ratio	Likelihood ratio	Nagelkerke R^2
	$\chi^2(9) = 108.67$***	$\chi^2(9) = 75.58$***	$\chi^2(9) = 128.94$***	0.13

aRR adjusted rate ratio, *aOR* adjusted odds ratio, *CI* confidence intervals, *covariates* age, sexual orientation (ref. = gay), being born in France (ref. = no), HIV status (ref. = negative), current PrEP use (ref. = no), any recent stimulant drug use (ref. = no), relationship status (ref. = single), employment (ref. = student, unemployed, or retired)

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

of short sleep duration (coded as averaging less than 7 h of sleep per night) were even larger when short sleep length was recoded as averaging less than 6 h of sleep.

This work contributes to recent findings linking poor sleep [6] or tiredness [18] with sexual risk-taking among sexual minority men, and it extends the work of Duncan et al. [6] by testing additional indicators of poor sleep health and adjusting for a wider range of covariates. Our cross-sectional findings also resonate with earlier experimental work of Zarcone et al. [14] which found that sleep-deprived men were less able to direct their visual attention away from sexual images, implicating reduced self-regulation, consistent with general sleep research linking tiredness with reduced executive functioning [8]. More generally, it connects with other studies which found links between poor sleep and adverse health behaviors such as smoking [1], unhealthy eating [2, 3, 29], and substance use [5–7], as well as with findings from sleep deprivation studies linking sleep loss with increased risk-taking [9].

Our finding regarding the associations between the sleep variables and number of CAI partners for receptive CAI is consistent with previous work by Duncan et al. [6]. It is also supported by research showing that tiredness increases the preference for being the receptive partner in a substantial proportion of MSM [18]—and it is highly concerning given that receptive CAI represents the greater risk for HIV infection [22]. This highlights the need for future research to further explore the role of poor sleep and tiredness in sexual behavior—and the public health importance of doing so, especially in relation to MSM, who tend to experience poorer overall sleep health [19–21] and greater rates of HIV and STI infection [17]. The tailoring of sleep health interventions [30] to improve the sleep health of MSM may help individuals to better manage their sexual risk behavior and other associated health behaviors, particularly among HIV-positive MSM, as numerous studies have shown higher rates of sleep disturbance related to HIV [31], which was also indicated in the current study. The innovative addressing of sleep hygiene in HIV prevention efforts may be helpful both for minimizing HIV risk and for improving overall health. It is noteworthy that the prevalence of short sleep duration (here, approximately 30%) among this French sample of MSM appears somewhat lower than the prevalence (approximately 40%) reported by sexual minority men in the U.S. [20], which further underscores the CDC's declaration of poor sleep as a "public health epidemic" in the U.S. [32].

Our findings that men reporting poor sleep quality and problems falling asleep were more likely to also report the use of alcohol or drugs before or during sex suggests a potentially complex or mutually-reinforcing dynamic. For example, some men may be using substances to either combat their tiredness resulting from poor sleep [33] or to complement the sexual event, and this use may contribute to poor subsequent sleep or problems falling asleep, thereby increasing tiredness the following day. The item regarding use of substances during sex did not ask about whether the sex event had involved condoms—however, we adjusted for recent stimulant drug use, and the effects of two of the four sleep variables remained significant. Only problems with staying awake during wake-time activities became a non-significant predictor of the four sex outcomes when stimulant drug use and the remaining covariates were adjusted for.

The current study does have a number of limitations to consider. First, these data were self-reported and asked for typical or average levels of sleep quality and sleep duration, and for the presence versus absence of sleep problems. Objective data from sleep actigraphy or daily diaries would yield more nuanced information about sleep health. The data were cross-sectional in nature, so causality cannot be confirmed—for example, it is possible that men who are more sexually active, with a greater number of partners, may be experiencing poorer sleep due to other logistical factors such as not consistently sleeping in one's own home or sleeping at less regular, routine hours if out late at bars or clubs. Additionally, the study design cannot confirm whether sleep problems occurred prior to or after the sexual event/s being reported on. More contextualized information is needed about when and under what conditions, these men are having sex with their partners, and methodologies such as daily diaries and timeline follow-back interviews could gather more intensive longitudinal data. Items relating to number of partners do not necessarily reflect greater totals of separate sex events, as some events may have involved multiple partners and some partners may have been repeat partners, and this level of detail was not gleaned in the current study. Additionally, some partners may have been counted twice in the total variable if they had both receptive and insertive CAI with the participant. Further, we did not ask about numbers of partners for sex with condoms. Future studies should ask about sex with and without condoms, and the number of events, in order to determine whether the ratio of CAI to sex with condoms is associated with sleep health. The item regarding use of substances during sex did not ask about the type of substance used and did not distinguish between one's own and one's partner's use of substances. Greater detail about substance use before or during sex is needed. While we adjusted for numerous covariates, residual confounding may still be an issue, as with all observational research. Finally, we focused on MSM in the Paris metropolitan area who used a popular geosocial-networking app, which may limit the generalizability of our results.

In sum, the current study contributes to emerging evidence that, at least among MSM, poor sleep health and increased sexual risk-taking are connected, even when adjusting for depression and drug use. Future studies could explore whether such dynamics may apply to other populations, and whether specific subgroups of MSM are at heightened risk for poor sleep health (e.g., race or ethnicity, socioeconomic status, younger age), and/or are more susceptible to the effects of poor sleep on mood, cognition, and decision-making. Future research should investigate possible mediators or mechanisms for the observed associations, such as emotion dysregulation, impulsivity, increased negative affect, or attempts to boost positive affect. Investigating the co-occurrence of substance use and sex in the context of poor sleep should also be prioritized in order to better address both HIV and substance use prevention in this population. In light of our findings, we recommend that sexual health interventions tailored to MSM populations should integrate sleep health as a core aspect.

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Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflicts of interest.

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

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