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**Perceived Neighborhood Safety is Associated with Poor Sleep Health Among Gay,
Bisexual, and Other Men Who Have Sex with Men in Paris, France**

Dustin T. Duncan, ScD ¹
Su Hyun Park, PhD, MPH ¹
William C. Goedel ¹
Noah T. Kreski, BA ¹
Jace G. Morganstein, MS ¹
H. Rhodes Hambrick, BS ¹
Girardin Jean-Louis, PhD ¹
Basile Chaix, PhD ^{2,3}

1. Spatial Epidemiology Lab, Department of Population Health, New York University School of Medicine, New York, NY USA
2. Sorbonne Universités, UPMC Univ Paris 06, UMR_S 1136, Pierre Louis Institute of Epidemiology and Public Health, Paris, France
3. Inserm, UMR_S 1136, Pierre Louis Institute of Epidemiology and Public Health, Paris, France

Correspondence to: Dustin T. Duncan, ScD, New York University School of Medicine, Department of Population Health, Spatial Epidemiology Lab, 227 East 30th Street, 6th Floor, Room 621, New York, NY USA 10016. Tel: 646-501-2674. Fax: 646-501-2706. Email: Dustin.Duncan@nyumc.org

Abstract

Recent studies have examined sleep health among men who have sex with men (MSM), but no studies have examined associations of neighborhood characteristics and sleep health among this population. The purpose of this study was to examine associations between perceived neighborhood safety and sleep health among a sample of MSM in Paris, France. We placed broadcast advertisements on a popular smartphone application for MSM in October 2016 to recruit users in the Paris (France) metropolitan area (n=580). Users were directed to complete a web-based survey, including previously used items measuring perceptions of neighborhood safety, validated measures of sleep health, and socio-demographics. Modified Poisson models were used to estimate risk ratios (RRs) and 95% confidence intervals (CI) for the associations between perceived neighborhood safety and the following outcomes: 1) poor sleep quality, 2) short sleep duration, and 3) self-reported sleep problems. Poor sleep health was common in our sample; e.g., 30.1% reported poor sleep quality and 44.7% reported problems falling asleep. In multivariate regression models, perceived neighborhood safety was associated with poor sleep quality, short sleep duration, and having sleep problems. For example, reporting living in a neighborhood perceived as unsafe during the daytime (vs. safe) was associated with poor sleep quality (aRR: 1.60; 95% CI: 1.01, 2.52), short sleep duration (aRR: 1.92; 95% CI: 1.26, 2.94), problems falling asleep (aRR: 1.57; 95% CI: 1.17, 2.11), and problems staying awake in the daytime (aRR: 2.16; 95% CI: 1.05, 4.43). Interventions to increase neighborhood safety may improve sleep health among MSM.

Keywords: *Spatial Epidemiology; Neighborhood Context; Perceived Neighborhood Safety; Poor Sleep Health; Gay Men's Health; Men Who Have Sex with Men (MSM)*

INTRODUCTION

Recent studies have examined sleep health among sexual minority populations (i.e., those who identify as lesbian, gay, or bisexual or who engage in same-sex sexual behavior), including men who have sex with men (MSM) [1, 2]. For instance, among a sample of MSM in London sampled from a popular geosocial-networking smartphone application ($n=202$), about one-third (34.6%) of the participants rated their sleep quality as poor and about half (43.6%) reported sleeping less than 7 hours on the average night [1]. Notably, in this sample of MSM, poor sleep quality and short sleep duration in the preceding month were associated with depressive symptoms and engagement in condomless anal intercourse as well as use of alcohol, marijuana and other drugs [1]. In various populations, poor sleep health has been associated with a wide range of other health outcomes, including cardio-metabolic outcomes such as diabetes and obesity [3, 4].

Social contexts, including neighborhoods, may influence health outcomes and behaviors [5, 6]. Emerging research, albeit sparse, has examined associations between perceived neighborhood safety and sleep health, including sleep quality, sleep duration and sleep problems [7-13]. A recent analysis from the World Health Organization's Longitudinal Study of Global Ageing and Adult Health found that feeling safe from crime and violence in one's neighborhood was associated with multiple sleep outcomes, reductions in short sleep, insomnia symptoms and poor sleep quality, among a large sample of adults ($n=39,590$) in six countries [12]. However, this nascent area of research has not considered the association between perceived neighborhood safety and sleep health among sexual minority individuals, who may feel particularly unsafe in their neighborhoods due to threats of homophobic violence and victimization [14]. Given the high rates of poor sleep health found among MSM in previous research [1, 2], future studies assessing perceived neighborhood safety are warranted.

The purpose of this study was to examine associations between perceived neighborhood safety and sleep health among a sample of MSM in the Paris, France metropolitan area. This study, like past research [1], focuses on MSM who use geosocial-networking smartphone applications, given their frequent smartphone application use [15]. It is hypothesized that MSM who perceive their neighborhoods as unsafe will report poor sleep quality, shorter sleep duration, and more sleep problems.

METHODS

Sample Recruitment

For recruitment, this study used broadcast advertisements on a popular geosocial-networking smartphone application for MSM, limited to users in the Paris (France) metropolitan area in October 2016. Consistent with previous research [1, 15, 16], users were shown an advertisement with text encouraging them to click through the advertisement to complete an anonymous web-based survey. To encourage participation, the advertisement described that users who completed the survey were entered in a chance to win €65 (approximately \$70). The advertisement was placed during three consecutive weekday 24-hour periods. The advertisement appeared on the first instance a user logged onto the application in a 24-hour period. Precautions (e.g., use of the “Prevent Ballot Box Stuffing” feature on Qualtrics) were taken to avoid and eliminate duplicate responses as done in previous research [1], which resulted in no apparent duplicate responses.

The survey included 52 items. Our survey was translated from English into French using an adaptation of the TRAPD (translate, review, adjudicate, pretest, document) translation protocol [17]. The survey was translated to French by three native French speakers, and then reviewed and adjudicated by an additional native French speaker. The survey was pretested by back-translation by a fifth French-speaker who is a health researcher. The survey took an average of 11.4 minutes (SD=4.0) for users to complete, and was offered in French and English. The vast majority (94.3%) took the survey in French. At the end of the recruitment period, 5,206 users had clicked on the advertisement and reached the landing page of the survey, 935 users provided informed consent and began the survey, and 580 users provided informed consent and completed the survey. This represents an overall completion rate of 11.1%. All protocols were approved by the New York University School of Medicine Institutional Review Board prior to data collection.

Neighborhood Safety

We assessed day-time and night-time neighborhood safety as opposed to general neighborhood safety, given past research suggesting effect modification by time of day in associations between neighborhood safety and health behaviors [18, 19]. In line with previous research [18], we assessed a global perception of neighborhood safety during the day-time and night-time with the following two questions: “In general, how safe do you feel walking alone in

your neighborhood during the day?” and “In general, how safe do you feel walking alone in your neighborhood at night?” Response options were: “Very safe”, “Somewhat safe”, “Somewhat unsafe”, and “Very unsafe”. For analytical purposes, we combined “Somewhat unsafe” and “Very unsafe” due to the small number of responses in those categories. For the current study, we created two alternative explanatory variables. First, we created a dichotomous exposure variable: Safe (“Very safe” and “Somewhat safe”) vs. unsafe (“Somewhat unsafe” and “Very unsafe”). In addition, we created an additional trichotomous variable: Very safe, Somewhat safe and Unsafe (“Somewhat unsafe” and “Very unsafe”).

Sleep Health

In this study, we assessed sleep quality, sleep duration, and three aspects of sleep problems. Items were taken or adapted from The Pittsburgh Sleep Quality Index, which is a reliable and validated scale of sleep health [20].

Sleep Quality. We assessed sleep quality with the question, “During the past month, how would you rate your sleep quality overall?” [20]. Response options were “Very good”, “Fairly good”, “Fairly bad”, and “Very bad”. For analysis, these four options were dichotomized into two categories as good sleep quality (responses of very good and fairly good) and poor sleep quality (responses of very bad and fairly bad). Our collapsing approach for the four-level sleep quality variable has been used in past epidemiological research [21, 22].

Sleep Duration. Typical sleep duration was measured with the question asking, “During the past month, how many hours of actual sleep did you get each night? (This may be different from the number of hours you spent in bed.)” [20]. Responses were open-ended but limited to a single integer. As done in prior research [23-25], long sleep was defined as 9 hours or more of sleep. Short sleep duration was defined as less than 7 hours for this study, also consistent with previous epidemiological studies [21, 26].

Sleep Problems. We also examined sleep problems with the question, “During the past month, have you experience any of the following?” We then listed three statements: 1) “I had trouble sleeping because I could not get to sleep within 30 minutes.” (problems falling asleep also known as sleep latency) 2). “I had trouble staying awake while driving, eating meals, or engaging in social activity.” (problems staying awake in the daytime also known as daytime dysfunction) 3) “I took medicine (prescribed or “over the counter”) to help me sleep.” (use of

sleeping medication). All statements had “Yes” and “No” responses. Because the low Cronbach’s alpha between the three measures of sleep problems in this sample (0.21), we analyzed each sleep problem separately.

Socio-Demographic Variables

Participants were asked to report their age (in years) and this continuous variable of age was categorized into five groups: 18-24, 25-29, 30-39, 40-49, 50 years and older. Participants also reported their sexual orientation (gay, bisexual, straight, other), whether or not they had been born in France (yes, no), employment status (employed, unemployed, student, retired), and current relationship status (single, relationship with a man, relationship with a woman).

Statistical Analysis

Descriptive statistics were first calculated for all study variables. Next, the socio-demographic and perceived neighborhood characteristics of the sample by levels of sleep health were compared using chi-square statistics. We performed the modified Poisson model with robust variance estimation to estimate risk ratios (RRs) and 95% confidence intervals (CI) for the associations between perceived neighborhood safety and the following binary outcomes: 1) poor sleep quality, 2) short sleep duration; and 3) self-reported sleep problems [27]. This approach has been suggested as one useful alternative method for estimating relative risk for binary outcomes, when log-binomial regression model fails to converge [28]. Because odds ratios do not correspond to relative risks, various approaches have been proposed to model binary outcome data with methods providing relative risks. One of them, which is more and more frequently used, is the modified Poisson model [29]. We dichotomized sleep duration as short sleep duration and not, due to the low prevalence of long sleepers. In addition, due to the low prevalence of use of sleeping medication and therefore limited power, we dropped this variable from all multivariate models. In the multivariable regression models with the trichotomous neighborhood safety variable, we computed a p-value for the trend. All socio-demographic variables were included in these models as covariates. Analyses for this study were conducted using Stata 14 (Stata Corp, College Station, TX).

RESULTS

Table 1 shows sample socio-demographic characteristics and perceived neighborhood characteristics by poor sleep health. The median age was 34 years old. Most identified their sexual orientation as either gay (84.0%) or bisexual (11.9%). Most participants (77.6%) were

born in France. In addition, most respondents were employed (66.9%). The majority of participants reported being single (65.2%).

Poor sleep health was common in our sample, where 30.1% reported poor sleep quality and 44.7% reported problems falling asleep. The mean sleep duration of the sample was 7.06 hours (SD, 1.28; range, IQR, 6.0-8.0; 10th percentile, 6.0; 90th percentile, 8.0). The percentages of short- and long- duration sleepers were 71.1% (n=391) and 6.6% (n=38), respectively. Most participants felt very safe or somewhat safe in the daytime (93.1%) and in the nighttime (85.5%) in their neighborhood. However, more participants felt unsafe during the nighttime as compared to the daytime (11.7% and 4.3%, respectively). At the bivariate level, we found differences in sleep health by perceived neighborhood safety (data not shown). For example, those who perceived daytime and nighttime neighborhood safety as somewhat unsafe or very unsafe were more likely to report poor sleep quality (Chi-square *p*-value <.05).

In multivariate regression models (adjusting for socio-demographic covariates), perceived daytime neighborhood safety was associated with poor sleep quality, short sleep duration, problems falling asleep and problems staying awake in the daytime (Table 2). For example, participants reporting feeling unsafe in their neighborhood during the daytime were more likely to report poor sleep quality (aRR: 1.60; 95% CI: 1.01, 2.52), short sleep duration (aRR: 1.92; 95% CI: 1.26, 2.94), problems falling asleep (aRR: 1.57; 95% CI: 1.17, 2.11), and problems staying awake in the daytime (aRR: 2.16; 95% CI: 1.05, 4.43) compared to those who reported feeling safe in their neighborhood during the daytime. Analyses of the trichotomous measure of perceived neighborhood safety in relation to sleep health revealed a dose-response relationship, including in the association between perceived daytime neighborhood safety and sleep health (Table 2). In particular, there is a dose-response relationship for all the trichotomous measures of neighborhood safety (daytime and nighttime) except for two: 1) the relationship between nighttime neighborhood safety and problems falling asleep 2) the relationship between nighttime neighborhood safety and problems staying awake. Fewer associations were found between perceived nighttime neighborhood safety and the studied sleep health outcomes. Those who reported feeling unsafe in their neighborhood at night, however, were more likely to report poor sleep quality (aRR: 1.44; 95% CI: 1.04, 1.98) compared to those who reported feeling safe in their neighborhood at night.

DISCUSSION

While comparative research on sleep health by sexual orientation has resulted in inconsistent findings (with some studies showing disparities in sleep health by sexual orientation and others finding no disparities) [30-32], existing evidence demonstrates that MSM suffer from poor sleep health [1, 2]. This is the first study to examine the association between perceived neighborhood safety and sleep health among a sample of MSM. Among this sample of MSM in Paris, France metropolitan area recruited from a popular geosocial-networking smartphone application, we found that MSM who perceive their neighborhoods as unsafe were more likely to rate their sleep quality as poor, report short nightly sleep duration, and report sleep problems. These associations existed in a dose-response relationship, in that decreasing perceptions of neighborhood safety increased the likelihood of reporting poor sleep quality, short sleep duration, and sleep problems. These findings are consistent with studies in other populations demonstrating associations between perceived neighborhood safety and similar sleep outcomes [7-13]. It has been suggested by previous research that perceived neighborhood safety is associated with poor sleep health through increased psychological distress [8, 33-36]. These associations may exist among MSM through a minority stress pathway, where stigma, prejudice, and discrimination related to identifying as gay or bisexual and/or engaging in same-sex sexual behaviors create a hostile and stressful social environment inimical to health and wellness, including healthy, regular sleep [37, 38]. In this study, we found differences in effects of daytime vs. nighttime neighborhood safety on sleep health. Interestingly, although the 95% confidence intervals were wide, associations were more robust and stronger with daytime neighborhood safety and poor sleep health in our sample, perhaps because daytime safety speaks to the overall dangerousness of the neighborhood. Also, contrary to fear of non-specific victimization, fear of violence due to discrimination can occur during the daytime and past research has shown that daytime victimization is a concern for different populations [39]. Further, people can avoid going out during the night and many people try to limit this, but that people cannot avoid going out during the day, so safety during the day matters more. We further note that the prevalence of sleep health varied by the different dimensions assessed. For example, 28.5% of individuals with a short sleep duration, which is relatively low. However, 45% of participants reported problems falling asleep.

Future Research

Future research can make use of objective measures of unsafe neighborhoods, including data from surveys of victimization or homophobia or crimes reported by local police departments, which can be aggregated to a neighborhood-level. These studies should assess whether these

associations with poor sleep health are specific to particular types of crime, including lesbian, gay, bisexual, and transgender (LGBT) hate crimes compared to other crimes, as LGBT hate crime rates have been associated with multiple health outcomes, including suicidal ideation and attempts, and illicit substance use, among sexual minority youth [40, 41]. In addition, future studies can examine use objective measures of sleep (e.g. through sleep polysomnography and/or actimetry) and rely on longitudinal designs to strengthen the ability to draw causal inferences. Moreover, experimental research such as cluster randomized trials and natural experiments can be conducted and evaluated to further understand the potential causal association between neighborhood safety and sleep health among MSM. We also note that future research can utilize global positioning system (GPS) methods to measure the multiple neighborhood contexts MSM populations may experience [42, 43]. Additionally, future studies should include a wide range of potential confounding covariates, including exposure to noise in one's neighborhood as well as examine neighborhood safety as a correlate of sleep health from an intersectional perspective, including focusing on perhaps Black MSM. Future interventions aimed at improving sleep health among MSM could examine effect modification by perceptions of neighborhood safety to determine the extent to which these broader contextual factors affect the efficacy of individual-level interventions. This future research can help inform interventions at the neighborhood level (e.g., problem-oriented policing) [44], which may improve sleep health among MSM.

Study Limitations

This study has limitations. The cross-sectional design of the study precludes any causal inference and reverse causation is possible (e.g., poor sleep health may increase one's perceptions of their neighborhood as unsafe). This survey included a limited number of variables to increase participation, so residual confounding may also be an issue. For example, we did not evaluate typical times our sample uses apps, which could be a control variable. In addition, we included relationship status as a confounder, however in this context a live-in partner would be a more important confounder of the association given this person may affect the perception of safety and could also affect sleep resulting from co-sleeping. However, these data were unavailable regarding marital status or live-in partnership status. Another limitation is same-source bias [45], as the exposures and outcomes were both measured via self-report. Because we used a self-report measure of sleep health (rather than an objective measure of sleep health), measurement error in sleep is possible, including error due to recall bias. For example, sleep duration may be different from the number of hours someone spends in bed,

which may be subject to inaccurate reporting and best measured objectively. We cannot state with certainty the bias of the sleep estimates, given the paucity of sleep research among MSM populations (especially using objective assessments of sleep). However, in general populations, subjective estimates of sleep tend to be greater among healthy sleepers, perhaps because of social desirability. Among those with insomnia, estimates are lower. In addition, differential measurement error according to the true outcome is possible due to people having sleep problems exaggerating their importance (which is common, people stating that they did not sleep in fact slept for few hours). It could overestimate the estimated effect on sleep time. Thus, estimates vary contingent upon the person being queried. While there are discrepancies, subjective data provide an important window into the person's perception of their sleep need and/or what they think would be appropriate for healthy living. In addition, we used The Pittsburgh Sleep Quality Index, a validated scale [20]. This self-report method of measurement may also introduce misclassification due to social desirability bias not just in estimates of sleep but also neighborhood safety (e.g., more MSM may have reported their neighborhood as safe). In addition, this study only assessed one's perceptions of their residential neighborhood. This focus on a single neighborhood context may limit our assessment of exposure to unsafe neighborhoods as emerging research on spatial polygamy has shown that MSM experience and interact with multiple neighborhood contexts during their daily lives [46]. Furthermore, this study did not assess specific domains of neighborhood safety (e.g., exposure to crime or violence, experiences of victimization) or utilize objective measures of neighborhood safety (e.g., crime rates reported by police departments). While we examined different aspects of sleep health, other sleep outcomes (such as sleep insomnia and obstructive sleep apnea) were not examined in this study. This study was also conducted in a single urban geographic location in Western Europe. Therefore, our findings may not be generalizable to other less populous regions outside Western Europe. Also, the recruitment of the sample from a single geosocial-networking smartphone application may reduce generalizability as these findings may be different for MSM who do not use these smartphone applications. These results also might not be generalizable even among MSM who use geosocial-networking smartphone applications. Unfortunately, for example, we do not know the number of users that viewed the advertisements but chose not to participate in the survey. Finally, this study did not ask to participants in which neighborhood or in which municipality they were living, so we could not apply spatial models or multilevel models to control for within-area correlation of the outcome.

Conclusions

Perceived neighborhood safety was associated with sleep health among MSM in Paris, where MSM who rated their neighborhoods as unsafe reported poor sleep quality, short sleep duration, and sleep problems. Although our study provides cross-sectional evidence, it suggests that interventions to increase perceived neighborhood safety could improve sleep health among this population.

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Table 1. Socio-demographic characteristics of respondents by poor sleep health

	Total, n(%)	Poor sleep quality, n=174		Short sleep duration, n=159		Problems falling asleep, n=259		Problems staying awake in the daytime, n=73		Use of sleeping medication, n=37	
		n	%	n	%	n	%	n	%	n	%
Age											
18-24	84 (14.5)	29	34.5	18	21.4	48	57.1	8	9.5	2	2.4
25-29	103 (17.8)	36	35.0	30	29.1	56	54.4	18	17.5	9	8.7
30-39	180 (31.0)	53	29.4	53	29.4	82	45.6	17	9.4	10	5.6
40-49	139 (24.0)	41	29.5	42	30.2	55	39.6	22	15.8	11	7.9
≥ 50	54 (9.3)	13	14.1	15	27.8	17	31.5	7	13.0	3	5.6
Sexual orientation											
Gay	487 (84.0)	150	30.8	131	26.9	228	46.8	64	13.1	29	6.0
Bisexual	69 (11.9)	19	27.6	23	33.3	25	36.2	7	10.1	5	7.3
Born in France											
Yes	450 (77.6)	134	29.8	129	28.7	211	46.9	53	11.8	23	5.1
No	113 (19.5)	39	34.5	29	25.7	47	41.6	20	17.7	13	11.5
Employment status											
Employed	388 (66.9)	116	29.9	114	29.4	168	43.3	48	12.4	18	4.6
Unemployed	84 (14.5)	23	27.4	20	23.8	39	46.4	11	13.1	9	10.7
Student	81 (14.0)	30	37.0	21	25.9	48	59.3	12	14.8	7	8.6
Current Relationship											
Yes	172 (29.7)	53	30.8	50	29.1	79	45.9	24	14.0	10	5.8
No	378 (65.2)	116	30.7	104	27.5	174	46.0	46	12.2	24	6.4
Daytime Neighborhood Safety											
Very safe	320 (55.2)	85	26.6	76	23.8	137	42.8	33	10.3	16	5.0
Somewhat safe	220 (37.9)	77	35.0	70	31.8	106	48.2	34	15.5	13	5.9
Somewhat unsafe	18 (3.1)	8	44.4	10	55.6	13	72.2	3	16.7	3	16.7
Very unsafe	7 (1.2)	4	57.1	2	28.6	3	42.9	3	42.9	4	57.1
Nighttime Neighborhood Safety											

Very safe	210 (36.2)	55	26.2	51	24.3	85	40.5	20	9.5	9	4.3
Somewhat safe	286 (49.3)	91	31.8	85	29.7	138	48.3	40	14.0	15	5.2
Somewhat unsafe	53 (9.1)	20	37.7	15	28.3	29	54.7	9	17.0	6	11.3
Very unsafe	15 (2.6)	8	53.3	7	46.7	7	46.7	4	26.7	6	40.0

Table 2. Multivariate association (aRRs)^a between perceived neighborhood safety and poor sleep health

	Poor sleep quality	Short sleep duration	Problems falling asleep	Problems staying awake in the daytime
	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)
Daytime Neighborhood Safety				
Model 1.				
Safe	Referent	Referent	Referent	Referent
Unsafe	1.60 (1.01, 2.52)	1.92 (1.26, 2.94)	1.57 (1.17, 2.11)	2.16 (1.05, 4.43)
Model 2.				
Very safe	Referent	Referent	Referent	Referent
Somewhat safe	1.41 (1.08, 1.83)	1.40 (1.05, 1.85)	1.13 (0.94, 1.37)	1.46 (0.90, 2.35)
Unsafe	1.86 (1.15, 3.00)	2.23 (1.43, 3.49)	1.66 (1.21, 2.26)	2.55 (1.20, 5.43)
Test for trend	<i>p</i> =0.002	<i>p</i> =0.001	<i>p</i> =0.016	<i>p</i> =0.019
Nighttime Neighborhood Safety				
Model 1.				
Safe	Referent	Referent	Referent	Referent
Unsafe	1.44 (1.04, 1.98)	1.31 (0.90, 1.91)	1.22 (0.96, 1.54)	1.48 (0.82, 2.70)
Model 2.				
Very safe	Referent	Referent	Referent	Referent
Somewhat safe	1.19 (0.88, 1.60)	1.26 (0.92, 1.72)	1.15 (0.93, 1.42)	1.42 (0.83, 2.43)
Unsafe	1.59 (1.10, 2.31)	1.51 (0.99, 2.30)	1.32 (1.01, 1.73)	1.84 (0.92, 3.71)
Test for trend	<i>p</i> =0.024	<i>p</i> =0.046	<i>p</i> =0.050	<i>p</i> =0.071

aRR=adjusted risk ratio; CI=Confidence Intervals

Model 1: Dichotomous

Model 2: Trichotomous

^aAdjusted for age, sexual orientation, origin (born in France), employment and relationship status

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