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HIV status and sleep disturbance in college students and relationship with smoking☆

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ABSTRACT

Objective: Adults with HIV have greater sleep difficulties and are more likely to smoke cigarettes. We tested whether current smoking plays a role in sleep difficulties experienced by young adults with HIV.
Design: Cross-sectional.
Setting: Data were from the 2011–2014 waves of the National College Health Assessment, an annual survey conducted by the American College Health Association.
Participants: 108,159 (including N = 224 HIV positive) college students provided data for this study.
Measurements: Health conditions (including HIV positive status) were self-reported. Participants were also asked whether "sleep difficulties" were "traumatic or difficult for you to handle" over the past 12 months. Smoking was self-reported (smokers reported smoking on at least 20 of the last 30 days). Logistic regression models were adjusted for age, sex, survey year, current alcohol use or current marijuana use, diagnosis and/or treatment of anxiety or depression in last year.
Results: HIV positive students were more likely to be smokers (OR = 2.0, SE = 0.43, 95% CI [1.31, 3.05], $P = .001$) and were more likely to experience sleep difficulties (OR = 2.02, SE = 0.29, 95% CI [1.52, 2.68], $P < .0001$). While a significant HIV-x-smoking interaction was not found, when models were stratified by smoking, the relationship between HIV status and sleep difficulties was seen among non-smokers (OR = 1.97), and this relationship was stronger among smokers (OR = 2.64).
Conclusions: Among college students, HIV positive status is associated with increased sleep difficulties. These problems are worse among smokers. Sleep interventions are warranted in this vulnerable group, and could potentially enhance smoking cessation efforts.
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Introduction

More than 1.2 million people in the United States are living with human immunodeficiency virus (HIV).[1] Although the number of annual HIV infections has been declining since 2010, up to 40,000 Americans are still being newly infected each year.[2] With the emergence and widespread use of potent combinations of antiretroviral therapy (ART) among adults with HIV,[3] life expectancy is substantially extended,[4–6] and concomitantly non-AIDS cancers and cardiovascular disease have emerged as important causes of morbidity and mortality.[7] Underscoring this point are data showing that adults living with HIV are 2.6 to 2.7 times more likely to develop cancer of the lung and liver than the general population.[8] Similarly, both myocardial infarction and stroke incidence are elevated in HIV positive individuals compared to the general population, even after controlling for known risk factors.[9,10] Thus, in addition to treating the virus in adults with HIV, preventing and treating cancer and cardiovascular disease are major health priorities.[7,11]

Central to the comorbid conditions of cancer and cardiovascular disease is the behavioral risk factor of tobacco use. The negative health effects of smoking tobacco are well documented: smoking accounts for 30% of all cancer, and all heart disease, deaths in the US, and is associated with lung, head and neck, and several other cancers[12,13] Persons living with HIV (PLWH) have substantially

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higher smoking rates than the general population (42–54% vs 14%, respectively).[5,14] While up to 75% of PLWH report wanting to quit smoking,[15] current FDA-approved treatments for smoking cessation are only effective for 10–25% of treatment seeking smokers.[16–18] Importantly, the negative health effects of cigarette smoking (i.e., higher risk for cancer and cardiovascular disease) and HIV infection are synergistic – for example, the incidence rate ratios (IRRs) of smoking-related cancer associated with current smoking was 21.35 in PLWH, and 4.12 within the general population.[19] These lines of evidence have led to current smoking being identified as the most critical modifiable risk-factor to address in PLWH.[20]

Poor sleep health is emerging as a predictor of morbidity and mortality, as well as a determinant of substance use, including smoking tobacco. Sleep health (in adults) is achieved when the following criteria are met: (1) 7–8 hours of sleep per night; (2) falling asleep easily and being asleep for at least 90% of the time in bed; (3) achieving earlier sleep timing (i.e., earlier time in bed); (4) ability to remain alert during the day; and, (5) perceptions of achieving "good" sleep.[21] While these metrics of sleep health may relate differently to health outcomes, failure to meet one or more has been associated with cancer and cardiovascular diseases. For example, in adjusted models, short sleep duration (≤6 h) was associated with a 43% increased risk of any cancer type in a European cohort over a 7.8 year follow-up.[22] Similarly, short sleep has been associated with a 48% increase, and long sleep (≥9 h) a 38% increase in the relative risk of dying or developing coronary heart disease.[23]

Sleep health is also implicated as a determinant of smoking. While insomnia (difficulty getting to, and staying asleep) has long being recognized as a clinically -verified symptom of nicotine withdrawal,[24] more recent data points to smokers being more vulnerable to poor sleep health (i.e., short sleep duration, low sleep efficiency) than non-smokers,[21 25 26] and poor sleep health has been associated with failure to quit smoking.[27–30] Prospective data suggest that independent of time, worsening sleep health is associated with greater cigarette consumption and nicotine dependence.[31] In addition to being more likely to smoke than the general population, persons living with HIV (PLWH) are also more likely to experience poor sleep health.[32] Data suggest that 70% of PLWH have insomnia as compared to 30% of the general population,[33] while, seven in ten PLWH are poor sleepers, nearly half (45%) get insufficient sleep, and 56% have fragmented sleep.[32] Thus, adults living with HIV experience a "double-whammy" in terms of risk for comorbid cancer and cardiovascular diseases since they are substantially more likely to smoke, and experience poor sleep health.

Recent work points to sleep health as being a plausible up-stream target with which to optimize response to standard smoking cessation treatment.[34] Specifically, given that poor sleep health is common in smokers, is exacerbated following cessation, and is known to predict relapse, improved sleep health could potentially ameliorate these effects and promote cessation.[34] As a precursor to this question, the current study sought to examine if young adults (i.e., college students) living with HIV experienced sleep difficulties, and the extent to which being a frequent smoker (i.e., smoking on at least 20 of the last 30 days) was linked to these difficulties. A positive signal from this study would provide essential rationale for linking current tobacco use to poor sleep health in PLWH.

Participants and methods

Data source and participants

Data were obtained from the National College Health Assessment (NCHA) II, an annual survey of US college/university students conducted by the American College Health Association.[35] Complete information about this dataset is available online (https://www.acha.org/NCHA/NCHA). Data from 2011–2014 were used, since these years included identical questions. Surveys are administered on paper, in person, across college campuses each year (44 in 2011, 51 in 2012, 57 in 2013, and 34 in 2014). Different campuses are included each year and thus years can be combined (as there is no duplication). Institutions are kept anonymous in the survey, as are individuals, in order to promote honest reporting. Previous information about the generalizability, reliability, and validity of the dataset is available and indicates a response rate of 60%;[36] data from the NCHA is considered to be both reliable and valid and of empirical value for representing college students nationally.[37]

Measures

This study examines the extent to which frequent smoking exacerbates the association between HIV status and sleep difficulties. The outcome of sleep difficulties was measured by a single survey item, "Within the last 12 months, has _____ been traumatic or very difficult for you to handle?" with a number of health conditions listed, one of which being "sleep difficulties." A dichotomous yes/no response is solicited. The independent variable of HIV status was solicited from the question that asked, "Within the last 12 months, have you been diagnosed or treated by a professional for Human Immunodeficiency Virus?" (yes/no).

To assess smoking status (hypothesized moderator), students were asked, "Within the last 30 days, on how many days did you use cigarettes?" Students who responded that they smoked at least once per day in 20 of the last 30 days were classified as smokers (the rest were classified as nonsmokers). This definition allowed the consideration of frequent smokers, and not occasional or "weekend smokers" as is quite common in college students.[38] The covariates of age, sex, and survey year (2011, 2012, 2013, 2014), were also included in the analysis. Given the association between current (i.e., ≥1 drink in the last 30 days) alcohol use,[39,40] current marijuana use,[41,42] diagnosis and/or treatment for depression in last year, and diagnosis and/or treatment for anxiety[43,44] in last year with both poor sleep health and being HIV positive, these variables were also included in the analysis.

Analytic plan

American College Survey data from years 2011, 2012, 2013 and 2014 were obtained and collapsed into one dataset comprising N = 112,849 subjects. Students with missing data for any of the study variables were excluded (N = 4466), leaving 108,383 participants in the final analytic sample. Significant differences were observed for age and sex between subjects with and without complete data, thus these variables were included as covariates.

Descriptive statistics for each study variable, for the whole sample, and stratified by smoking status were generated. To test the main and interactive effects of HIV and smoking status (HIV X Current smoker) on sleep difficulties, a logistic regression model of sleep difficulties was estimated with age, sex, year of survey, current alcohol, marijuana use, as well as diagnosis and/or treatment for anxiety or depression in the last year were entered as covariates. To estimate the odds of sleep difficulties in college students with HIV who smoked versus those that did not smoke, we stratified the logistic regression model by smoking status (i.e., smoker versus non-smoker). An imbalance in the sample of students who reported being HIV positive and HIV negative (n = 224 versus n = 108,159) was noted, and because of this all analyses were re-run using a matched sample. Specifically, a sample of HIV negative students who matched the HIV positive students on all study covariates was generated. Statistical significance was set at 0.01, and all analyses were conducted in STATA version 15.[45]

Table 1
Sample characteristics (N = 108,383)

Variable	Category/units	Complete sample n = 108,383	Stratified by HIV status			Stratified by smoking status		
			HIV - n = 108,159	HIV + n = 224	*P*	Non-smoker n = 103,650	smoker n = 4733	*P*
HIV	Yes	0.21% n = 224				0.19% n = 202	0.46% n = 22	<.001
Smoker	Yes	4.37% n = 4733	4.36% n = 4711	9.82% n = 22	<.001			
Current alcohol use	Yes	62.53% n = 67,770	62.52% n = 67,622	66.07% n = 148	.304	61.67% n = 63,925	81.24% n = 3845	<.001
Current marijuana	Yes	15.17% n = 16,444	15.15% n = 16,386	25.89% n = 58	<.001	14.08% n = 14,596	39.05% n = 1848	<.001
Anxiety	Yes	12.71% n = 13,780	12.69% n = 13,725	24.55% n = 55	<.001	12.16% n = 12,604	24.85% n = 1176	<.001
Depression	Yes	11.03% n = 11,957	11.00% n = 11,899	25.89% n = 58	<.001	10.42% n = 10,805	24.34% n = 1152	<.001
Sleep difficulties	Yes	25.51% n = 27,645	25.47% n = 27,550	42.41% n = 95	<.001	24.75% n = 25,650	42.15% n = 1995	<.001
Female	Yes	66.54% n = 72,121	66.57% n = 72,006	51.34% n = 115	<.001	66.82% n = 69,255	60.55% n = 2866	<.001
Age [Mean ± SD]	Years	22.19 ± 5.99	22.18 ± 5.98	25.03 ± 11.51	<.001	22.03 ± 5.81	25.56 ± 8.45	<.001
Survey year	2011	24.44% n = 26,490	24.45% n = 26,442	21.43% n = 48	.099	24.16% n = 25,038	30.68% n = 1452	<.001
	2012	24.40% n = 26,450	24.41% n = 26,398	23.21% n = 52		24.33% n = 25,222	25.95% n = 1228	
	2013	28.33% n = 30,706	28.32% n = 30,626	35.71% n = 80		28.47% n = 29,510	25.27% n = 1196	
	2014	22.82% n = 24,737	22.83% n = 24,693	19.64% n = 44		23.04% n = 23,880	18.11% n = 857	

Results

The analytic sample was made up of 108,383 college students. Of these, 0.21% (n = 224) self-reported being HIV positive, 3.58% (n = 3880) reported being smokers, and 25.51% (n = 27,645) had sleep difficulties. The mean age was 22.19 years (SD = 5.99), and 66.54% were female (see Table 1). When we compared the sample characteristics of smokers versus non-smokers, a significantly greater proportion of smokers reported being HIV positive (7.14% vs. 3.57%; $P = .004$), and having sleep difficulties, (41.86% vs. 24.90% of non-smokers; $P < .001$). A greater proportion of smokers reported current alcohol and marijuana use, diagnosis/treatment for anxiety or depression in the last year. Additionally, smokers had a higher mean age than non-smokers, and a greater proportion of smokers were male (see Table 1).

A logistic regression analysis supported the hypothesis that HIV status predicted smoker status. In a model adjusted for age, sex, and survey year, HIV status was associated with an increased likelihood of being a smoker (OR = 2.0, SE = 0.43, 95% CI [1.31,3.05], $P = .001$).

HIV status was associated with an increased likelihood of sleep difficulties overall. In a model adjusted for age, sex, smoking status, and survey year, HIV was associated with an increased likelihood of sleep difficulties (OR = 2.13, SE = 0.28, 95% CI [1.63,2.76], $P < .0001$); adjustment for the additional covariates of current alcohol or marijuana use, and diagnosis or treatment for anxiety or depression did not substantially alter the significant association between HIV status and reported difficulty sleeping (OR = 2.02, SE = 0.29, 95% CI [1.52, 2.68], $P < .0001$). When the interaction term for HIV status and smoking was entered into the fully -adjusted model, the interaction was not significant (OR = 1.30, SE = 0.97, 95% CI [0.47, 3.56], $P = .62$).

In a HIV-matched samples analysis (i.e., a sample of 224 non-HIV students was generated to match the 224 HIV-positive students on study covariates, see Supplemental Table 1), students who reported having HIV had a 89% increased odds of reporting sleep difficulties (OR = 1.89, SE = 0.40, 95% CI [1.25, 2.87], $P = .003$; see Supplemental Table 2).

To further examine the relationship between smoking status with HIV on sleep difficulties, we stratified the regression model by

Table 2
Logistic regression models of sleep difficulties (1 = yes) to show independent association with HIV status in smokers and non-smokers

Smokers n = 4733				Non-smokers n = 103,650			
Study variable	Odds ratio (SE)	95% CI	*P*	Study variable	Odds ratio (SE)	95% CI	*P*
HIV Positive	1.97 (0.91)	0.81, 5.10	.14	HIV Positive	1.78 (0.27)	1.32, 2.39	<.001
Age	0.99 (<0.01)	0.98, 1.00	.002	Age	1.00 (<0.01)	1.00, 1.00	.994
Female	1.00 (0.06)	0.88, 1.13	.95	Female	1.22 (0.02)	1.18, 1.26	<.001
Alcohol	0.83 (0.08)	0.70, 0.97	.40	Alcohol	1.01 (0.02)	0.98, 1.05	.41
Marijuana	1.23 (0.08)	1.08, 1.40	.002	Marijuana	1.27 (0.03)	1.22, 1.32	<.001
Anxiety	1.54 (0.13)	1.29, 1.82	<.001	Anxiety	1.81 (0.05)	1.73, 1.90	<.001
Depression	1.98 (0.17)	1.67, 2.35	<.001	Depression	2.50 (0.07)	2.38, 2.63	<.001
Year (Ref = 2011)	-	-	.73	Year (Ref = 2011)	-	-	<.001
2012	0.91 (0.07)	0.78, 1.07	.26	2012	1.01 (0.02)	0.96, 1.05	.82
2013	0.95 (0.08)	0.81, 1.11	.53	2013	1.06 (0.02)	1.01, 1.10	.01
2014	0.96 (0.09)	0.81, 1.15	.65	2014	1.10 (0.02)	1.06, 1.15	<.001

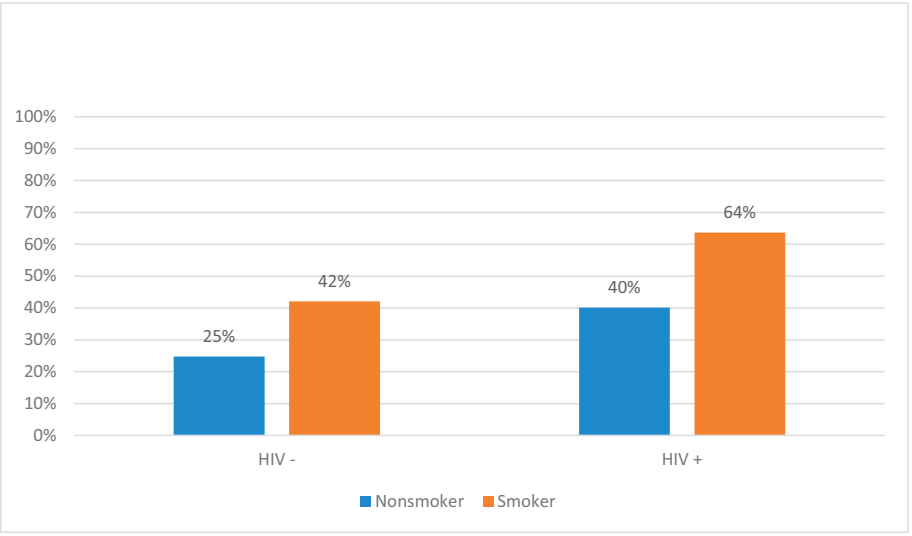

Figure 1. Prevalence of self-reported sleep difficulties is highest in HIV positive students who smoke.

smoking status. The results (displayed in Table 2 and illustrated in Fig. 1) showed that adults with HIV who smoked had a 264% increased odds of reporting sleep difficulties while adults with HIV who were non-smokers had a lower, 197% increased odds of reporting sleep difficulties.

Discussion

Adults with HIV are substantially more likely to experience sleep difficulties, and be current smokers, than the general population. The current study extends this knowledge base by showing that the positive association between HIV status and smoking is evident even in young adults, and that the positive association between sleep difficulties and HIV status is substantially greater in young adults who smoke: indeed the majority of HIV positive college students who smoke experience sleep difficulties. These data add to our understanding of the relationship between tobacco use with poor sleep health in young adults with HIV.

Our results showed that while only 0.2% of the college student sample were HIV positive, this group had a more than two-fold increased odds of being daily smokers than those without HIV. Although population rates for current smoking in adults have reached an all-time low of 14%,[46] these declines belie substantially higher rates of current smoking in sub-populations such as adults living with HIV for whom rates as high as 54% have been reported.[5,14] Three key lines of evidence demonstrate that adults living with HIV disproportionately experience the negative health effects associated with cigarette smoking. First, while most adults with HIV who smoke want to quit, they are substantially less likely to choose, and be adherent to bupropion or varenicline,[47] which are two of the most effective FDA-approved pharmacotherapies for smoking cessation. Thus, the quitting success of HIV treatment seeking smokers is considerably lower than population levels. Second, some of the benefits afforded by combination antiretroviral therapy are negated in cigarette smokers. For example, in adjusted models, adults with HIV who smoked had increased mortality and decreased quality of life as compared to their non-smoking peers.[48] Third, adults with HIV who smoke have substantially greater risk for comorbid conditions including cardiovascular diseases and cancer. Our data extend this literature base by showing that the positive association between HIV status and being a current smoker is present even in a younger adult population of college students. Moreover, given the synergistic negative effects of smoking on the health of those with HIV who smoke, cessation efforts may need to be emphasized in young adults with HIV so their trajectory of health into later adulthood can be improved.

Our finding that sleep difficulties were more common in college students with HIV that smoked on at least 20 of the last 30 days, extends current literature showing that adults with HIV have poorer sleep than non-HIV populations, and that smokers have poorer sleep than non-smokers. For example, PLHIV are significantly more likely to report getting short sleep duration and poorer sleep quality than the general population.[32] Similarly, as compared to non-smokers, smokers spend less time in deeper, more restful sleep-states,[49,50] have a longer sleep onset latency,[49–53] shorter sleep duration,[49,51] and later sleep timing.[54] Indeed up to 80% of smokers habitually experience sleep disturbances,[26] that can become exacerbated following cessation, and predict relapse.[27] These lines of evidence converge to suggest that smoking cessation may be particularly important to PLWH to improve sleep health, and that maintaining sleep health through the quitting process may be important to achieving sustained abstinence.[34]

Results from the current study should be interpreted with consideration of some design limitations. The use of cross-sectional, self-reported data precludes the evaluation of the temporal relationship between variables and make findings vulnerable to self-report bias. The preponderance of single-item, dichotomous response options (yes/no) used to assess study constructs could be considered to lack sensitivity. For example, the presence of sleep difficulties was assessed using a single dichotomous item, at a single point of time. This assessment may not capture students who may not consider their sleep difficulties sufficient enough to answer "yes" to this item. Moreover, the single-point-in-time assessment does not capture the fluctuations in sleep difficulties that may occur throughout a semester. With regards to the assessment of smoking status, the use of e-cigarettes and vaping products were not queried. The assessment of HIV status did not capture untreated HIV positive subjects who were diagnosed more than 12 months prior to the survey; this could have led to underestimated findings. Use of HIV medications would also have been useful to know since these may have affected sleep difficulties. Also of note is that approximately half our HIV positive sample were female (49.2%), this diverges from national rates showing that 23% of those in the USA living with HIV are female.[55] While this can at least be partially explained by the fact that females were over-represented in the current sample (i.e., 67% of the total sample were female), it does suggest that the analytic sample in this study may not be generalizable.

Conclusions

The current study is the first to examine the extent to which tobacco use magnifies sleep disturbances experienced by young adults with HIV. Some of the main contributions to the literature from this study are to show that the higher odds of sleep difficulties and current smoking in PWHIV are evident, even in young, college age adults who have HIV. Moreover, our result that sleep disturbances were substantially more common in college students with HIV who smoked, warrants replication using objective and clinical assessments. Future studies that test the effects of smoking cessation on sleep health metrics in college students with HIV are needed, as are studies that test the extent to which sleep health interventions may optimize response to smoking cessation treatments in this high-risk group.[34] The results from this body of work could identify smoking cessation as a strategy to ultimately improve sleep health in young adults with HIV.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleh.2019.05.002.

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