Article

JHP

Journal of Health Psychology
1–11

DOI: 10.1177/1359105318765632
journals.sagepub.com/home/hpq
SAGE

A multilevel examination of sleep, depression, and quality of life in people living with HIV/AIDS

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Abstract

Sleep problems are prevalent in people living with HIV/AIDS; however, few studies examine how poor sleep affects mental health and quality of life longitudinally. A sample of people living with HIV/AIDS from a randomized trial ($N = 240$; mean age = 47.18; standard deviation = 8.3; 71.4% male; 61.2% White) completed measures of depression (Montgomery–Åsberg Depression Rating Scale), health-related quality of life (AIDS Clinical Trial Group Quality of Life Measure), and life satisfaction (Quality of Life Inventory) at baseline and 4, 8, and 12 months. Controlling for time, condition, and relevant interactions, sleep problems significantly predicted worse outcomes over time ($ps < 0.001$). Findings have implications for the importance of identifying and treating sleep problems in people living with HIV/AIDS to improve mental health and quality-of-life outcomes.

Keywords

AIDS, depression, health behavior, health psychology, HIV, HIV infection, insomnia, quality of life, sleep

Introduction

Psychiatric and medical comorbidities, including problems like depression and difficulty with sleep, play an increasingly important role in the care of approximately 1.2 million people living with HIV/AIDS (PLWHA) in the United States. Depression is present in PLWHA at almost double the rates as their seronegative counterparts (Bing et al., 2000; Ciesla and Roberts, 2001). A recent meta-analysis of 27 articles with over 9000 PLWHA demonstrated high levels of sleep disturbances—affecting approximately 58 percent of the population (Wu et al., 2015), and some studies have found that as many as 70 percent of PLWHA in clinical samples endorse sleep problems (Phillips et al., 2005; Rubinstein and Selwyn, 1998).

Although frequently co-occurring, sleep problems (e.g. insomnia) and depression are

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best understood as two separate disorders. The separation of these conditions is evidenced by several recent studies, which suggest an independent course of sleep and depression. Sleep problems can precede and precipitate depressive episodes, leading to the development of depression (Jackson et al., 2014; Meerlo et al., 2015; Riemann, 2003). In addition, sleep problems may exacerbate depressive symptomology and remain as a residual symptom requiring treatment even after depressive symptoms remit (McClintock et al., 2011; Watanabe et al., 2011). Accordingly, there is a close association between sleep and depression, and perhaps even a causal role for sleep in the etiology and maintenance of depression.

Sleep problems have also been associated with reduced quality of life. For example, individuals with insomnia are more likely to have interfering daytime symptoms that can have significant repercussions in various areas of functioning including work, social, and family life (Ishak et al., 2012; Ohayon, 2002; Sivertsen, 2006). In addition, insomnia in the general population is associated with higher numbers of chronic medical conditions and worse quality of life (Taylor et al., 2007; Zammit et al., 1999). Among PLWHA, both depression (Ciesla and Roberts, 2001) and sleep problems (Crum-Cianflone et al., 2012) have been associated with lower health-related quality of life; anxiety and progression of HIV illness have been associated with more sleep problems in PLWHA, revealing a complex and interrelated relationship between sleep and psychiatric comorbidities in PLWHA (Downing et al., 2016). Since HIV/AIDS is now a chronic condition, there is an increased focus on comorbidities that could affect quality of life in adults living with HIV/AIDS (Millar et al., 2017).

Despite the reported high prevalence of sleep problems (Gamaldo et al., 2013; Lee et al., 2012; Rubinstein and Selwyn, 1998) and worse psychological and health functioning and quality of life (Crum-Cianflone et al., 2012; Phillips et al., 2005), among PLWHA, to date, no study has examined how sleep problems impact these outcomes over time. In addition, much of the existing research conducted to this point has been cross-sectional, limiting the temporal implications of these findings. A longitudinal investigation of these variables may help elucidate the importance of sleep problems in contributing to comorbid psychiatric and psychosocial functioning.

Data for this study were from a 1-year three-arm randomized controlled trial for depression and medication adherence in PLWHA (Project TRIAD; Safren et al., 2016). To identify whether sleep problems were associated with depression, health-related quality of life, and life satisfaction over time in this sample, we examined how these variables co-occurred over time using longitudinal multilevel modeling. We hypothesized that poor sleep, specifically broken or shortened sleep characteristic of insomnia disorder, would be associated with higher levels of depression, greater impairment/worse health-related quality of life, and lower life satisfaction.

Methods

Participants and procedures

Participants for the trial ($N=240$ randomized) were recruited from three HIV clinics (two were hospital-based clinics and one was a community health clinic) and community self-referral in New England, USA. Participants for this study included the same individuals enrolled and randomized in the parent trial. Participants were recruited for the study from various clinics using medical provider referrals as well as flyers and more traditional methods of recruitment within each of the treatment settings. To be included in the study, participants had to be adults over the age of 18 who were HIV positive; been prescribed antiretroviral therapy (ART) for at least 2 months; and had a current diagnosis of depression (i.e. major depressive episode) and/or had previous diagnosis of depression for which they were receiving antidepressant medication and had residual symptoms of depression. Individuals were randomly assigned to either cognitive behavioral therapy

for adherence and depression treatment (CBT-AD), information with supportive psychotherapy for adherence and depression (ISP-AD), and enhanced treatment as usual which included a single session of adherence counseling and a letter to the participant's treatment provider about the depression diagnosis (ETAU). All procedures were reviewed and approved by the institutional review boards at Massachusetts General Hospital, Fenway Health, and The Miriam Hospital. Additional study methods can be found in the main outcome paper (Safren et al., 2016).

Measures

Depression. To assess depression, the total score minus the sleep item from the Montgomery–Åsberg Depression Rating Scale (MÅDRS) was used (Montgomery and Asberg, 1979). The MÅDRS is a clinical interview that assesses the presence and severity of depressive symptoms over the prior week based on a defined rating scale with anchor points at 0, 2, 4, and 6 with the option of rating the between scores 1, 3, and 5, as well. The MÅDRS was administered by independent assessors who were supervised weekly to review ratings and for reliability. The MÅDRS has been found to be valid and reliable (Montgomery and Asberg, 1979). In the current sample, the MÅDRS reliability at baseline was high (Cronbach's $\alpha = 0.82$). Additional details about the process for ensuring reliability and validity of measurement can be found in the primary outcome paper (Safren et al., 2016). The total score of the MÅDRS excluding the sleep score was used to assess depression.

Poor sleep. Interviewers evaluated the participant's sleep using the MÅDRS sleep questions (Montgomery and Asberg, 1979). As with all the items on the MÅDRS, the interviewer asks a minimum set of questions to arrive at each rating. The required stem questions, in bold, and scripted follow-up questions, in italics, were asked of participants. Any additional questions and/or clarifications are also allowed to arrive at a final rating. For the sleep rating, the questions were as follows:

1. **How has your sleeping been in the past week?** *How many hours have you been sleeping, compared with usual?*
2. **Have you had trouble falling asleep?** *How long has it been taking you to fall asleep this past week?*
3. **Have you been able to stay asleep through the night?** *Have you been waking up at all in the middle of the night? How long does it take you to go back to sleep?*
4. **Has your sleeping been restless or disturbed?**

The final rating by interviewers resulted in an overall number 0–6 for sleep quality, according to the MÅDRS rating system, with the following anchor points as guides: 0—sleeps as usual, 2—slight difficulty dropping off to sleep or slightly reduced light or fitful sleep, 4—sleep reduced or broken by at least 2 hours, and 6—less than 2 or 3 hours of sleep. The sleep score variable used for analyses was the number rating assigned by the clinician at the time of the interview.

Health-related quality of life. Health-related quality of life was measured by the AIDS Clinical Trial Group Quality of Life Measure 601-602 Short Form-21 (ACTG QOL 601-602 SF-21; Bozzette et al., 1995). ACTG QOL 601-602 SF-21 specifically assesses quality of life for PLWHA. These measures include overall/general quality of life (ACTG QOL 601-602) and the specific functional impairments (SF-21) from HIV/AIDS. All raw scores are log transformed on a 0–100 scale (where 0 = worst quality of life/greatest impairment and 100 = best quality of life/least impairment). The ACTG QOL 601-602 SF-21 measure has shown strong validity and reliability (intraclass correlation coefficients (ICCs) > 0.70 for all scales) in large samples of diverse gender and disease stage for PLWHA (Bozzette et al., 1995; Wu et al., 2005). Subscales assessed for this study included

general health, cognitive health, pain, and energy/vitality. These subscales measure impairment due to HIV in these domains, thus providing a measure of HIV health-related quality of life.

Life satisfaction. Life satisfaction was measured by the Quality of Life Inventory (QOLI; Frisch, 1994). The QOLI is a self-report questionnaire that assesses importance and satisfaction across 16 domains (e.g. health, friends, and community). Importance is assessed on a 3-point Likert-type scale ranging from 0 = not at all important to 2 = very important and satisfaction is rated on a 6-point Likert-type scale ranging from –3 = very dissatisfied to +3 = very satisfied. Scores are calculated by multiplying importance by satisfaction for each item to give more weight to those items of greatest importance to the participant. The sum yields an overall total quality-of-life score.

Data analytic plan

The current sample was composed of 240 individuals who were randomized in the parent trial (381 were screened) and assessed over 1 year at four approximately evenly spaced time points: baseline, 4-month, 8-month, and 12-month follow-up appointments. Time, in this study, was coded 0–3, with 0 = baseline, 1 = 4-month follow-up, 2 = 8-month follow-up, and 3 = 12-month follow-up. Prior to beginning the analyses, a variable for sleep problems centered within-person and a separate variable for person average sleep problems were created to assist in parsing apart the within (sleep problems centered within-person) and between (person average sleep problems) effects of sleep problems on outcomes of interest. This allowed us to separately model the between- and within-person effects of sleep problems on each outcome (Hoffman and Stawski, 2009) and more accurately parse apart the role of sleep problems in mental health and quality-of-life outcomes. Between-person effects are those that are attributed to differences between participants in the sample, in this case the differences between those with more sleep problems (on average) compared to those with fewer sleep problems (on average). Within-person effects, on the other hand, are those that are attributed to differences within each person, in this case the difference between one's average sleep problems and his or her current level of sleep problems.

Sample characteristics were obtained using SPSS version 22 (IBM Corp, 2013). All other analyses were performed using R version 3.3.2 (R Development Core Team, 2016) with various packages. Main analyses presented used lme4 package, linear mixed effects modeling in R (Bates et al., 2013). We examined issues of homoscedasticity and heteroscedasticity throughout the model building process. Data were plotted in histograms and all appeared relatively normal in distribution. As multilevel modeling allows for the retention of all observed waves of data, no participants were dropped from the analyses due to missing data. Measures of central tendency, deviation, and variance were obtained for each of the predictors and outcomes.

To assess the role of poor sleep in depression, health-related quality of life, and life satisfaction, multilevel modeling was used to model the effects of poor sleep over time on these outcomes. Using a bottom-up approach, we first conducted a model for random effects only, then a model for time and the random effects, and then four additional models, building them from the simplest to the most complex adding in the relevant predictors (within-person and between-person sleep problems) and covariates (time, treatment assignment, and their interactions; Hox, 2010). Predictors were added to the model in the following order: sleep problems centered within-person, which tested the level one predictor alone (Model 1), interaction between time and sleep centered within-person, which tested an interaction between level one predictors (Model 2), person average sleep problems and treatment group, which tested level two predictors (Model 3), and cross-level interactions between sleep problems centered within-person by treatment and time by treatment (Model 4). The final model (Model 5) is

the analysis of interest for each outcome as it presents Model 4 findings after non-significant interactions have been removed. Model 5 presents the relationships observed with between-person effects signifying the impact of having more sleep problems than average in the population and within-person effects signifying the time-varying impact of an individual having more sleep problems than they usually do. The final model for each outcome is depicted in Table 1 and the preliminary models and model equation are presented in the online appendix.

We also examined possible covariates including sociodemographic variables (age, gender, education level), antidepressant prescription at baseline, and viral load over time with sleep problems, health-related quality of life, and life satisfaction. There were no significant changes to the relationships of interest, so for parsimony the results are presented without additional covariates.

Results

Sample characteristics

The sample was composed of a diverse set of PLWHA ($N=240$) in a trial addressing depression and adherence to ART. Approximately 25.7 percent ($n=98$) of participants were women, 37.5 percent of the sample identified as a racial minority (African American/Black, Native Hawaiian/Pacific Islander, Native American, or other), and approximately 10.8 percent of the sample identified as Hispanic/Latino. On average, the participants were 47.43 years of age (standard deviation (SD) = 8.41; range = 22–66). Sexual orientation was assessed with five possible categories, and there was a range of sexual orientation in the sample: exclusively homosexual (30.2%), homosexual with some heterosexual experience (18.6%), bisexual (7.6%), heterosexual with some homosexual experience (8.7%), and exclusively heterosexual (32.0%). At baseline, most of the sample was virally suppressed (75%). When scores were imputed (undetectable viral load as 20) and transformed, log viral load in the sample at baseline ranged from 1.30 to 5.71 (M = 1.57; SD = 0.73) and CD4 ranged from 31 to 1579 (M = 573.07; SD = 278.92). There was a range of variability in sleep problems, depression, health-related quality of life, and life satisfaction. At baseline, approximately 70 percent of our sample had some level of sleep problems (e.g. broken sleep, restless sleep, or only sleeping a few hours per night) in the past week that warranted a clinician rating. Means, SDs, and range of values are presented in Table 2. Findings for within-person and between-person effects of sleep problems are reported below.

Depression

In the final, adjusted model, individuals with more sleep problems were significantly more likely to have worse depression over time compared to those with fewer sleep problems (indicated by significant between-person effects). Specifically, looking at the between-person sleep effects (i.e. across people), a one-unit increase in sleep problems was associated with a 1.51-unit increase on the MÅDRS over time ($\gamma=1.51$, standard error (SE) = 0.32, $p<0.001$). However, the within-person effect of sleep problems was not a unique predictor of depression.

Health-related quality of life

In the final, adjusted model, individuals who had more sleep problems, on average, were significantly more likely to have poorer health-related quality of life over time (indicated by significant between-person effects). Specifically, for each one-unit increase in sleep problems, on average, general health decreased by 2.90 points ($\gamma=-2.90$, SE = 0.88, $p<0.01$); cognitive health decreased by 2.98 points ($\gamma=-2.98$, SE = 0.92, $p<0.01$); pain worsened by over 4.03 points ($\gamma=-4.03$, SE = 0.95, $p<0.001$), and energy/vitality was, on average, lower by 2.17 points ($\gamma=-2.17$, SE = 0.80, $p<0.01$). However, in the final model with control variables, when individuals had more sleep problems, there were no significant changes in health-related quality of life.

Table 1. Fixed and random effects estimates for models of depression, health-related quality of life, and life satisfaction.

Parameter	Depression	General	Cognitive	Pain	Energy/vitality	QOLI
	γ (SE)	γ (SE)	γ (SE)	γ (SE)	γ (SE)	γ (SE)
Fixed effects						
Intercept	18.15 (1.24)***	50.74 (3.46)***	62.75 (3.61)***	65.40 (3.74)***	43.62 (3.12)***	18.74 (5.12)***
Level 1						
Time	−1.96 (0.22)***	2.63 (0.50)***	2.09 (0.49)***	1.41 (0.55)*	3.34 (0.55)***	−1.80 (1.41)
Sleep problems	0.60 (0.32)	−2.90 (0.88)**	−1.46 (0.41)***	−0.65 (0.46)	−1.45 (0.44)***	−5.08 (1.40)***
Time × Sleep problems	0.25 (0.18)					1.56 (0.56)**
Level 2						
Treatment group—CBT-AD	−2.73 (1.21)*	0.06 (3.37)	1.82 (3.47)	0.15 (3.61)	3.48 (3.01)	−9.81 (5.17)
Treatment group—ISP-AD	−0.99 (1.21)	3.09 (3.37)	−0.89 (3.46)	3.63 (3.61)	1.80 (3.01)	−2.62 (5.20)
Between-person sleep problems	1.51 (0.32)***	−2.90 (0.86)**	−2.98 (0.92)**	−4.03 (0.95)***	−2.17 (0.80)**	−2.25 (1.29)
Cross-level interactions						
Sleep problems × CBT-AD						2.93 (1.41)*
Sleep problems × ISP-AD						1.04 (1.42)
Time × CBT-AD						6.36 (1.76)***
Time × ISP-AD						6.37 (1.76)***
Random effects						
Intercept	26.98 (5.20)	285.97 (16.91)	374.55 (19.35)	348.44 (18.67)	210.48 (14.51)	603.02 (24.56)
Time	2.27 (1.51)	13.51 (3.68)	7.00 (2.64)	10.05 (3.17)	18.58 (4.31)	22.13 (4.70)
Residual	39.26 (6.27)	195.91 (14.00)	218.38 (14.78)	273.89 (16.55)	235.47 (15.35)	321.55 (17.93)
ICC for random effects model						
2*log likelihood	6107.5	7571.0	7622.2	7832.5	7643.5	7675.7

SE: standard error; QOLI: Quality of Life Inventory; CBT-AD: cognitive behavioral therapy for adherence and depression treatment; ISP-AD: information with supportive psychotherapy for adherence and depression; ICC: intraclass correlation coefficient.
Parameter estimates and standard errors are reported for each variable. Bolded entities are predictors of interest. General, Cognitive, Pain, and Energy/Vitality are all subscales of the ACTG QOL 601-602 SF-21. Sleep problems are within-person sleep problems (sleep problems centered within each person) and between-person sleep problems are labeled in the table. Procedures for model building as described in text were followed. However, only the final model results are presented for each outcome and reported in text.
Reduced-form equation

$$
\begin{aligned}
(Outcome)_{ti} = {} & \gamma_{00} + \gamma_{10}(Time)_{ti} + \gamma_{20}(Sleep\ Problems\ Centered\ Within\text{-}Person)_{ti} \\
& + \gamma_{30}(Time)(Sleep\ Problems\ Centered\ Within\text{-}Person)_{ti} \\
& + \gamma_{01}(CBT\text{-}AD)_{i} + \gamma_{02}(ISP\text{-}AD)_{i} + \gamma_{03}(Person\ Average\ Sleep\ Problems)_{i} \\
& + \gamma_{21}(Sleep\ Problems\ Centered\ Within\text{-}Person)(CBT\text{-}AD)_{ti} \\
& + \gamma_{22}(Sleep\ Problems\ Centered\ Within\text{-}Person)(ISP\text{-}AD)_{ti} \\
& + \gamma_{11}(Time)(CBT\text{-}AD)_{i} + \gamma_{11}(Time)(ISP\text{-}AD)_{i}\ \mu_{01} + \mu_{1i}(Time)_{ti} + e_{ti}
\end{aligned}
$$

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

Table 2. Descriptive statistics for predictors and outcome variables.

Psychosocial variable	Mean	SD	Min.[a]	Max.[a]
Sleep problems	2.59	1.87	0.00	6.00
Depression	17.58	9.68	0.00	44.00
General health	48.54	23.53	0.00	100.00
Cognitive health	58.60	23.86	0.00	100.00
Pain	58.34	25.55	0.00	100.00
Energy/vitality	44.99	22.83	0.00	100.00
Life satisfaction (QOLI)	12.63	32.61	–88.00	96.00

SD: standard deviation; QOLI: Quality of Life Inventory.
[a]Minimum and maximum values are reported as presented in the sample, but may not represent the possible limits of the range of scores.

Life satisfaction

In the final, adjusted model for life satisfaction, we did not find a significant between-persons effects for sleep. However, there was a within-person effect for sleep problems and life satisfaction such that *when* a person experienced a one-unit increase in sleep problems, relative to their own average, life satisfaction decreased by 5.08 points on the QOLI scale (γ=–5.08, SE=1.40, $p<0.001$). There was also significant interaction between time and sleep, such that the magnitude of this relationship changed significantly over time (γ=1.56, SE=0.56, $p<0.01$). There was also a significant interaction between sleep problems and the CBT condition (γ=2.93, SE=1.41, $p<0.05$). Finally, there were also significant cross-level interactions between time and treatment.

Discussion

The results presented in this analysis reveal a complex relationship between sleep problems and depression, health-related quality of life, and life satisfaction for PLWHA enrolled in a longitudinal depression trial. A unique finding of these analyses was that the between-person effects of sleep problems were significant for depression and health-related quality of life, but not life satisfaction, and the opposite was true for the within-person effects of sleep problems. These findings suggest that with regard to health-related quality of life and impairment, those who report a higher level of sleep problems will have more health-related impairments including worse general health, lowered cognitive functioning, higher levels of pain, and less energy. Specifically, given the anchor points of the MÅDRS, those individuals who, on average, report sleep problems as problematic as "sleep difficulty dropping off to sleep or slightly reduced light or fitful sleep" (i.e. receive a score of 3 or higher on the sleep item) would have the most impairment. If present within a primary care, infectious disease, or mental health clinic, these individuals would likely report experiencing significant sleep problems several nights per week, and, we might expect, these individuals would also report several health-related impairments. In addition, the results suggest that that generally when this population has greater sleep problems, they also have reduced life satisfaction.

Although the original study examined the efficacy of a depression and medication treatment, we treated intervention condition as a control variable, so we could uniquely examine the contribution of sleep to health-related quality of life and life satisfaction. Of note, sleep problems did not differ as a function of intervention condition, and, as reported in the main outcome paper, both intervention conditions had improvement in depression. Consistent with this hypothesis, life satisfaction saw a significant improvement in both treatment conditions over time. Overall, our findings were largely in agreement with our initial hypotheses that sleep problems would be

associated with higher levels of depression, worse health-related quality of life, and lower life satisfaction. This is not surprising given the substantial amount of literature to suggest that in the general population sleep problems, especially insomnia, are strongly associated with quality of life (Ishak et al., 2012; Zammit et al., 1999). For example, in a study of HIV-positive African American women conducted by Phillips et al. (2005), which compared good and poor sleepers based on a cut-off score of 7 on the Pittsburgh Sleep Quality Index, good sleepers had significantly higher levels of health-related quality of life compared to poor sleepers, independent of HIV disease progression. In addition, there have been several studies examining the relationship between mental health and quality of life in PLWHA (Bing et al., 2000; Psaros et al., 2013; Safren et al., 2012). However, to our knowledge, the role of sleep in association with mental health or quality of life in PLWHA has largely been unstudied.

Thus, our study is unique in that it examines sleep as it is associated with various aspects of health-related quality of life and that it examines how sleep impacts quality of life using a novel analytic technique, which had never been used before in this population to analyze the impact of sleep problems on HIV health. This approach allowed us to identify variance attributable to both within-person and between-person effects of sleep problems and, therefore, provided a more refined explanation of how sleep problems are associated with depression and HIV-specific health-related quality of life and life satisfaction. As such, this provides interpretations that are more meaningful and, therefore, can provide us with more clarity on future directions for research and practice.

These findings suggest that PLWHA who endorse the highest levels of sleep problems (e.g. reporting several nights of disrupted or restless sleep) also experience higher levels of depression and health-related impairments in multiple domains. This is true even when controlling for the effects of depression treatment over time. Concerning future research and practice, we recommend screening for sleep problems in HIV/AIDS and referring those individuals with the highest complaints to treatment for their sleep problems. Although this study included participants enrolled in a depression trial, and sleep problems and depression are highly comorbid (Manber and Chambers, 2009), there is some evidence to suggest that independently treating sleep problems can have positive effects on depression symptomatology (Carney et al., 2017; Manber et al., 2011, 2008). Sleep problems, when compared to other comorbidities, are relatively easy to manage within a clinical setting. There are brief, efficacious behavioral interventions for sleep (e.g. cognitive behavioral therapy for insomnia), which often requires only six sessions in total, much shorter than other therapies, and has even been shown to be effectively administered in as little as two sessions (Edinger and Sampson, 2003), reducing cost and clinical burden. Sleep problems may also be treated with pharmacotherapy including, but not limited to, antihistamines (e.g. diphenhydramine hydrochloride), benzodiazepines (e.g. alprazolam, lorazepam), or hypnotics (e.g. zolpidem) for those who are unable to participate in a cognitive behavioral intervention (e.g. cognitively impaired individuals) or those for whom that option is unavailable (Schutte-Rodin et al., 2008).

Of note, there was also a significant association between when a person has more sleep problems and their life satisfaction as measured by the QOLI. This suggests that for the general population of PLWHA in clinical settings it may also be beneficial to provide a low-dose behavioral intervention such as health education about sleep hygiene to improve sleep and quality of life (Hudson et al., 2008; Taibi, 2013). This universal approach to sleep problems may also help prevent progression to a more serious disorder (and health-related impairments seen in those with high levels of sleep problems) that over time may require more intensive interventions.

The strengths of this study should be interpreted in light of its limitations. This study is limited by utilizing an assessment of sleep that was derived from a depression measure, as opposed to being a sleep-specific assessment.

However, there are four specific questions required to be asked of sleep, all of which are consistent with questions one would ask to arrive at the DSM-5 diagnosis of insomnia disorder, and interviewers were able to ask follow-up probes before rating sleep difficulties. This provides a much stronger measure than most of the existing sleep research in PLWHA, which largely relies on self-reported complaints of sleep. Another potential limitation is that the sample is based on adults participating in a study of depression and HIV; our results may not generalize to non-depressed PLWHA. However, given the high prevalence of lifetime depression within PLWHA (nearly 80%) and the high co-occurrence of these conditions, we believe these findings to be generalizable to most PLWHA clinical samples. Finally, we did not have information about, and thus could not control for, any active diagnosis of a sleep problem or treatment with sleep medications.

Future research should seek to build on our investigation by including a more thorough evaluation of sleep problems across time points and include patient-rated items in addition to those rated by a clinician. In addition, validation of the reported sleep problems through actigraphy and sleep logs within PLWHA would be useful in further explicating the relationships between sleep problems in PLWHA and associated impairments in mood, health, and quality of life. Future studies should also aim to include time since diagnosis/HIV progression, if data are available, to better understand the relationship disease progression may have with sleep concerns in this population.

To our knowledge, this is the first study to examine the impact of sleep on psychosocial comorbidities of HIV including depression, health-related quality of life, and life satisfaction over time. Results suggest a strong relationship between sleep problems and these domains such that those individuals with higher sleep deficits also exhibited more depression and health-related impairments. Results also suggest that for cognitive health and energy, when a person had more sleep problems compared to his or her own average, he or she experienced a significant impairment. These findings suggest that greater sleep problems may contribute to worse depression, lower health-related quality of life, and poorer life satisfaction in PLWHA.

Declaration of conflicting interests

B.G.R., J.S.L., S.A.B., C.A.B., and M.P. declare that they have no conflicts of interest. S.A.S. receives royalties for authorship on books from Oxford University Press, Guilford Publications, and Springer/Humana Press.

Ethical approval

This article does not contain any studies with animals performed by any of the authors. 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.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Funding for data collection for this project came from Safren (R01MH084757 and 9K24DA040489) and Rogers (1F31MH113481). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Drug Abuse, National Institute of Mental Health, or the National Institutes of Health.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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