NEW RESEARCH

JCSM
Journal of Clinical Sleep Medicine

http://dx.doi.org/10.5664/jcsm.1666

Types of Sleep Problems in Adults Living with HIV/AIDS

Kathryn A. Lee, R.N., Ph.D., C.B.S.M.[1]; Caryl Gay, Ph.D.[1]; Carmen J. Portillo, R.N., Ph.D.[2]; Traci Coggins, B.S.[1]; Harvey Davis, R.N., Ph.D.[3]; Clive R. Pullinger, Ph.D.[4,5]; Bradley E. Aouizerat, Ph.D.[4,6]

[1]Department of Family Health Care Nursing, University of California, San Francisco, CA; [2]Community Health Systems, University of California, San Francisco, CA; [3]School of Nursing, San Francisco State University, San Francisco, CA; [4]Department of Physiological Nursing and Cardiovascular Research Institute, University of California, San Francisco, CA; [5]Department of Physiological Nursing, University of California, San Francisco, CA; [6]Institute for Human Genetics, University of California, San Francisco, CA

SCIENTIFIC INVESTIGATIONS

Objective: To characterize specific types of sleep problems experienced by adults with HIV.

Method: The design was cross-sectional involving sleep questionnaires, diaries, and wrist actigraphy. The convenience sample included 290 adults living with HIV, 22-77 years of age. Measures included self-report for sleep onset latency, and wrist actigraphy estimates of total sleep time at night, wake after sleep onset, and daytime sleep.

Results: Nearly half (45%) of the sample slept < 6 h per night. Difficulty falling asleep was reported by 34%, and 56% had fragmented sleep according to actigraphy; 20% had both problems, and 30% were good sleepers. Participants reporting difficulty falling asleep had actigraphy and clinical measures similar to the good sleepers, but subjectively they experienced greater sleep disturbance and symptom burden (particularly anxiety and morning fatigue) and reported more use of sleep medication. Participants with fragmented sleep reported low levels of sleep disturbance and symptom burden similar to the good sleepers, despite actigraphy measures indicating they obtained less sleep both at night and during the day. Sleep fragmentation was also associated with sociodemographic factors and slightly lower CD4+ T-cell counts. Participants reporting both sleep problems had actigraphy and clinical profiles similar to those who had only fragmented sleep, but their symptom experience was similar to participants with only sleep initiation difficulties.

Conclusions: Findings support the need for targeting efforts to improve sleep for the majority of adults living with HIV/AIDS and tailoring interventions to the specific type of sleep problem regardless of the person's clinical and demographic profile.

Keywords: HIV/AIDS, sleep, insomnia, actigraphy, symptom burden

Citation: Lee KA; Gay C; Portillo CJ; Coggins T; Davis H; Pullinger CR; Aouizerat BE. Types of sleep problems in adults living with HIV/AIDS. *J Clin Sleep Med* 2012;8(1):67-75.

Sleep problems affect about 30% of the population in the United States and are associated with higher healthcare utilization and use of sleep medication, as well as poor work performance and mood disorders.[1] Adults living with a chronic illness are at higher risk for sleep problems, and depending on the definition, sleep problems are experienced by 30% to 100% of HIV-positive adults.[2-9] It is unclear what type of sleep problem adults with HIV experience, or whether their sleep disturbance is related to the infection itself or to the medical treatment and side effects of medications. Sleep disturbance is not only prevalent, but also one of the more intense and distressful symptoms experienced in this population.[8-10] In HIV infection, poor sleep has been associated with disease progression, medication therapy, employment status, and lack of knowledge about behaviors that promote good sleep.[11-14] The specific type of sleep disturbance experienced by this population needs to be better understood in order to provide the most effective intervention to improve symptoms, daytime functioning, and quality of life.[8,15-18]

Fragmented sleep occurs in chronic health conditions and may not even be perceived by the patient.[19,20] With this type of sleep loss, it is rare to find complaints of initiation insomnia, but complaints of daytime sleepiness or fatigue are common and can lead to difficulty concentrating, poor cognitive functioning, depressive symptoms, and inability to be productive during the day. These daytime sequelae may be more difficult to assess and treat in a chronic illness population with high medical disability.[17,21]

Despite many studies on the epidemiology and covariates of sleep disturbance in HIV-infected adults, little is known about the specific types of sleep problems experienced in this population. Therefore, the purpose of this paper is to describe total sleep time as well as problems with falling asleep and staying asleep in the HIV/AIDS adult population. The extent to which

BRIEF SUMMARY

Current Knowledge/Study Rationale: Depending on the definition, a sleep problem is experienced by 30% to 100% of HIV-positive adults, and it remains unclear whether the problem is related to the infection itself, to HIV-specific treatment, or side effects of medications. The specific sleep problem needs to be better understood in order to provide the most effective intervention to improve sleep and quality of life.

Study Impact: Nearly half of this sample obtained less than 6 hours of sleep, without any effect on daytime function or mood. The least prevalent problem was difficulty falling asleep, but it was associated with more severe symptom experience. Since environment and sleep hygiene played a larger role in sleep problems than body weight or HIV clinical characteristics, reliance solely on medication to improve sleep should be discouraged and cognitive behavioral therapy should be considered, particularly in patient populations already burdened with multiple medications to manage their chronic illness.

the type of sleep problem is associated with disease and treatment characteristics as well as symptoms experienced during the day was also explored.

METHODS

Participants and Procedures

After approval of the study protocol by the Committee on Human Research, 350 adults living with HIV in the San Francisco Bay Area were recruited and enrolled using posted flyers at HIV-related clinical and community sites. The flyer indicated recruitment for a study about "symptoms and genetics" and was not specific to any particular symptom. Written informed consent was obtained prior to participation. Eligibility criteria included English-speaking adults at least 18 years of age, diagnosed with HIV for ≥ 3 months, not working nightshift schedules, and not pregnant within the prior 3 months. Study visits were conducted at the university's outpatient Clinical Research Center. After excluding subjects who tested positive on urine sample screening for illicit drugs (n = 31), subjects who could not provide a specimen (n = 1), and subjects with missing questionnaire or sleep diary data (n = 5) or actigraphy data (n = 27), the analysis for this sample included 290 adults with data for actigraphy and self-report measures.

In addition to completing demographic and symptom questionnaires, the assessment included wearing a wrist actigraph monitor for 72 continuous hours during weekdays, and anthropometric measures of height, weight, and circumference of neck, waist, hips, and thighs. Participants provided a urine sample for toxicology screening using RediCup (Redwood Toxicology Laboratory, Inc, Santa Rosa CA, USA) and a copy of their most recent laboratory results for CD4+ T-cell count and viral load. Anti-retroviral therapy (ART) was determined by review of the participant's report of current medications. This analysis includes self-report and actigraphy measures of their sleep in relation to demographic and clinical characteristics.

Measures

Objective Nocturnal and Daytime Sleep

Sleep and activity were estimated with a noninvasive battery-operated wrist actigraph microprocessor that senses motion with a piezoelectric beam that detects movement and acceleration (Mini Motionlogger Actigraph, AAM-32 Ambulatory Monitoring, Inc. Ardsley, NY). Actigraphy provides continuous movement counts, and data were sampled in 30-sec epochs using zero-crossing mode. The actigraphy monitor was worn continuously on the non-dominant wrist for 72 h on 3 consecutive weekdays between Monday and Friday to control for potential weekend variability and reduce subject burden in this patient population. Wrist actigraphy has been validated with EEG measures of sleep and wake time for healthy and disturbed sleepers.[22-24]

Bedtime and final wake times were determined by one of two approaches: (a) participant's pressing the event marker on the actigraph for "lights out" and "lights on," or (b) diary entry of clock times that matched with a 50% change in movement during the same 10-min block of time on actigraphy. If these were not available, bedtime was deemed missing. The Cole-Kripke algorithm was used to calculate total sleep time (minutes), number of awakenings, and percent time spent awake after falling asleep using an automatic sleep scoring program (Action4 Software Program, Ambulatory Monitoring Inc., Ardsley, NY) to reduce any researcher scoring bias. The mean for 3 nights of complete data was used for analysis of nighttime sleep. To estimate daytime sleep, the time after final awakening to the next bedtime was marked, and sleep diary notations of nap times were noted. Daytime minutes of sleep were calculated after excluding any time when the monitor was off the participant's wrist. The mean for 3 complete days was used for analysis of daytime sleep.

Subjective Sleep

To estimate general perception of sleep problems, 2 self-report measures were administered: the Pittsburgh Sleep Quality Index (PSQI) and a sleep diary. The PSQI was used to describe their sleep history.[25] The PSQI asks participants how often they experience sleep related problems on a scale of 0 (not during the past month) to 3 (≥ 3 times a week) and has adequate validity with laboratory polysomnography. Scores can range from 0 to 21, and scores > 5 indicate substantial sleep disturbance.[25] Specific questions address the time it usually takes to fall asleep at night and how much sleep the respondent usually gets each night.

A sleep diary was completed each evening that included a brief description of activity, meals, alcohol and caffeine consumption, tobacco use, and stressors and symptoms experienced during the day. Each morning, participants recorded their bedtime, wake time, the amount of time it took to fall asleep, and whether they took anything to help them sleep. The sleep diary was also used in cases where participants neglected to press the event marker on the actigraph monitor to indicate lights out and final awakening times. The average of the 3 nights' diary entries was used for analyses that involved sleep onset latency.

Symptom Experience

The Memorial Symptom Assessment Scale (MSAS) assesses 32 symptoms with regard to presence (yes/no) as well as frequency, severity, and distress.[26] The number of individual MSAS symptoms experienced was used to estimate symptom burden and ranged from 0 to 32. Within the MSAS are 7 symptoms related to sleep problems: lack of energy, difficulty sleeping, difficulty concentrating, feeling drowsy, feeling irritable, feeling nervous, and worrying. The symptom experience of this sample was previously reported in more detail.[10]

In addition to the MSAS "lack of energy" item, the sleep diary described above asked 4 specific items that were descriptors of fatigue (tired, sleepy, drowsy, fatigued) on a scale of 0 (not at all) to 10 (extremely) in the evening before bedtime and in the morning upon awakening. These items were derived from the 18-item Lee Fatigue Scale.[27] The 18-item version has well-established validity and high internal consistency reliability in previous studies with cancer[28] and other HIV samples,[8] and the current brief 4-item version had a Cronbach α coefficient of 0.84 for the first evening diary entry and an intraclass correlation (ICC) of 0.81 for consistency between the 3 evenings. The Cronbach α coefficient was 0.91 for the first morning diary entry, and the ICC was 0.80 for the 3 mornings.

The Center for Epidemiological Studies-Depression Scale (CES-D) was used to assess frequency of depressive symptoms during the past week. The 20-item CES-D score can range from 0 to 60, with higher scores indicative of more frequent symptoms of depression; scores ≥ 16 indicate the need for further clinical evaluation for major depression. The CES-D has well-established concurrent and construct validity.[29] In this study, internal consistency reliability (Cronbach α coefficient) was 0.88.

The Profile of Moods States (POMS) 9-item subscale for Tension-Anxiety was used to assess severity of anxiety in the past week. Scores can range from 0 to 36, with higher scores indicating a more severe level of anxiety. The POMS has well-established concurrent and construct validity.[30] In this study, the subscale was internally consistent, with a Cronbach α coefficient of 0.86.

Statistical Analysis

Descriptive statistics were used to summarize demographic and clinical characteristics. The 72 h of continuous actigraphy data were analyzed for each individual using Action4 software (Ambulatory Monitoring, Inc. Ardsley, NY). This software allows for automatic sleep scoring as described in the methods section. These data were entered into SPSS, Version 15.0 software (SPSS, Inc, Chicago IL, USA) for group analyses. ANOVA with Scheffe post hoc testing was used to compare short sleepers (< 6 h total nocturnal sleep by actigraphy measures) with typical sleepers (6.0-7.9 h) and long sleepers (≥ 8 h).

Actigraphy recording of wake after sleep onset (WASO) was averaged over the 3 nights, and WASO > 15% was used to dichotomize the sample. In the uncontrolled home, without a sleep technician to document lights out time, pressing the actigraphy event marker to indicate lights can be unreliable and invalid on any given night. Therefore, the participant's diary report of time to fall asleep was averaged over the 3 nights, and sleep onset latency (SOL) > 30 min was used to dichotomize the sample. Group differences in types of sleep problems were assessed with χ^2 tests of independence for categorical variables and either one-way ANOVA or independent *t*-tests for continuous variables. Post hoc testing compared each sleep problem group to the reference group of good sleepers using either pairwise χ^2 tests adjusted for the number of comparisons (categorical variables) or Dunnett test (continuous variables). Transformations were conducted to normalize skewed distributions. Spearman correlation coefficients (r) were use to estimate associations between continuous variables with non-normal distributions. Significance was set at $p < 0.05$ for all analyses.

RESULTS

Sample Characteristics

Demographic and clinical characteristics for the 290 participants included in this analysis are presented in **Table 1**. The sample was ethnically diverse and predominantly male, reflecting the local population of adults living with HIV infection. Over half (59%) of the women in the sample were African American. Most participants had been living with HIV for many years; 70% were currently receiving anti-retroviral therapy (ART); 51% had received an AIDS diagnosis; and most were unemployed (86%) or receiving medical disability assistance (75%).

Sleep Quantity

The sample's total sleep time across the 3 nights ranged from < 2 to > 11 h/night (mean = 6.2 ± 1.6 h). Almost half of the sample (45%, n = 131) averaged < 6 h of sleep per night; another 42% (n = 121) slept ≥ 6 h, but less than 8 h; and 13% (n = 38) slept an average ≥ 8 h per night (**Table 2**).

"Long sleepers" are typically defined as adults sleeping ≥ 9 h, but in this sample, only 9 participants met this criterion, and they did not differ from the 29 participants sleeping 8-9 h per night on other variables of interest. Therefore, these 2 groups were collapsed into a single group of participants sleeping ≥ 8 h per night for the purpose of this analysis. The primary difference between participants sleeping ≥ 8 h and the groups obtaining less sleep at night was that the longer sleepers reported more depressive symptoms on the CES-D. Long sleepers also spent more time in bed at night, had better sleep efficiency, and slept more during the day, although their perceived sleep quality on the PSQI did not differ from the other groups. Long sleepers were more likely to be Caucasian and college educated, but were otherwise similar to participants sleeping less on demographic and clinical variables.

In contrast to the long sleepers, participants sleeping < 6 h/night spent less time in bed, had lower sleep efficiency, and slept less during the day than longer sleepers, but did not report significantly more sleep disturbance or worse symptom experience. However, short sleep was associated with lower CD4+ T-cell counts (398 ± 256 vs. 494 ± 269, $t_{275} = 3.03$, $p = 0.003$) and higher viral load values (2.09 ± 1.99 vs. 1.58 ± 1.91, $t_{269} = 2.14$, $p = 0.033$). Short sleepers were also more likely to be African American, have less education, and have lower income.

Problems Falling Asleep

Difficulty falling asleep, defined as an average SOL > 30 min, was reported by 100 participants (34% of the sample). Only 15% of the participants (n = 42) averaged < 10 min to fall asleep by their diary recording over the 3 nights. Self-reported SOL was highly variable (range 1 to 160 min) and not normally distributed (30.2 ± 26.4, median = 21.7). Diary report of SOL was correlated with the usual amount of time to fall asleep reported on the PSQI (Spearman r = 0.60, $p < 0.001$), indicating that the 3 nights of monitoring were typical of the participants' usual sleep onset latency during the prior month. Self-reported SOL was also weakly correlated with actigraphy estimates of SOL (Spearman r = 0.13, p = 0.025), WASO (Spearman r = 0.13, p = 0.024) and time in bed (Spearman r = 0.22, $p < 0.001$). Diary reports of time to fall asleep were unrelated to total sleep time at night and daytime napping. Self-reported SOL was also unrelated to reported use of alcohol, caffeine, and tobacco, as well as measures of BMI, neck circumference, or waist circumference.

Problems Maintaining Sleep

Wake after sleep onset (WASO) was calculated from wrist actigraphy as the percentage of time spent awake af-

Table 1—Demographic and clinical characteristics by type of sleep problem

Characteristic	Total Sample (n = 290)	Good Sleep (n = 88)	Falling Asleep Only (n = 41)	Staying Asleep Only (n = 102)	Both Sleep Problems (n = 59)	Statistics[a] (when p < 0.20)
Demographic						
Age (years)	45.0 ± 8.4	44.3 ± 9.7	45.3 ± 8.7	44.9 ± 7.3	45.8 ± 7.9	ns
Gender						ns
Male	194 (67%)	63 (72%)	27 (66%)	64 (63%)	40 (68%)	
Female	74 (25%)	21 (24%)	13 (32%)	26 (25%)	14 (24%)	
Transgender	22 (8%)	4 (4%)	1 (2%)	12 (12%)	5 (8%)	
Race						$\chi^2(6) = 17.6$, p = 0.007
African American	111 (38%)	25 (28%)	10 (24%)	47 (46%)*	29 (49%)*	
Caucasian	118 (41%)	46 (52%)	23 (56%)	32 (31%)*	17 (29%)*	
Other	61 (21%)	17 (19%)	8 (20%)	23 (23%)	13 (22%)	
Education						$\chi^2(3) = 9.93$, p = 0.019
High school or less	227 (78%)	61 (69%)	29 (71%)	87 (85%)*	50 (85%)*	
More than high school	63 (22%)	27 (31%)	12 (29%)	15 (15%)*	9 (15%)*	
Employment Status						$\chi^2(3) = 9.50$, p = 0.023
Not employed	244 (84%)	67 (76%)	34 (83%)	87 (85%)	56 (95%)*	
Employed or student	46 (16%)	21 (24%)	7 (17%)	15 (15%)	3 (5%)*	
Household Income						$\chi^2(3) = 6.10$, p = 0.107
< $1,000/month	200 (69%)	56 (64%)	24 (59%)	74 (73%)	46 (78%)	
$1,000/month or more	90 (31%)	32 (36%)	17 (41%)	28 (27%)	13 (22%)	
Clinical						
CD4+ T-cell count (cells/mm^3)[b]	450 ± 267	497 ± 296	467 ± 220	427 ± 262	412 ± 256	$F_{3,272} = 1.61$, p = 0.187
< 200 cells/mm^3	48 (17%)	14 (17%)	2 (5%)	22 (22%)	10 (18%)	$\chi^2(3) = 5.65$, p = 0.130
≥ 200 cells/mm^3	228 (83%)	69 (83%)	36 (95%)	76 (78%)	47 (82%)	
Viral Load (log_{10} copies/mL)[b]	1.80 ± 1.96	1.51 ± 1.91	1.88 ± 2.06	1.93 ± 1.96	2.00 ± 1.97	ns
Undetectable (< 50 copies/mL)	136 (50%)	49 (59%)	19 (50%)	44 (46%)	24 (45%)	ns
Detectable (≥ 50 copies/mL)	134 (50%)	34 (41%)	19 (50%)	52 (54%)	29 (55%)	
Anti-Retroviral Therapy (ART)						$\chi^2(3) = 7.16$, p = 0.067
Not on treatment	86 (30%)	18 (20%)	12 (29%)	32 (31%)	24 (41%)*	
On treatment	204 (70%)	70 (80%)	29 (71%)	70 (69%)	35 (59%)*	
AIDS Diagnosis						ns
No	141 (49%)	41 (47%)	18 (44%)	53 (52%)	29 (49%)	
Yes	149 (51%)	47 (53%)	23 (56%)	49 (48%)	30 (51%)	
Years since HIV Diagnosis	12.1 ± 6.9	12.1 ± 6.4	12.7 ± 7.3	12.1 ± 7.0	11.7 ± 7.1	ns
BMI						
Male	26.0 ± 4.8	25.2 ± 4.0	27.0 ± 7.1	26.1 ± 4.0	26.4 ± 5.2	ns
Female	29.0 ± 6.4	29.1 ± 5.7	25.6 ± 2.8	30.0 ± 6.7	30.3 ± 8.3	$F_{3,70} = 1.74$, p = 0.166
Transgender	29.1 ± 6.9	24.0 ± 6.6	32.0 ± 0.0	30.4 ± 6.7	29.4 ± 7.9	ns
Neck circumference (cm)						
Male	38.4 ± 2.7	37.8 ± 2.6	38.6 ± 3.3	38.8 ± 2.4	38.7 ± 2.8	$F_{3,189} = 1.59$, p = 0.194
Female	34.5 ± 3.0	34.3 ± 3.2	33.2 ± 1.4	35.0 ± 2.9	34.9 ± 3.9	ns
Transgender	37.9 ± 3.6	34.1 ± 2.7	40.2 ± 0.0	38.8 ± 3.7	38.5 ± 2.2	$F_{3,18} = 2.27$, p = 0.115
Waist circumference (cm)						
Male	93.6 ± 12.3	91.5 ± 10.7	96.2 ± 16.8	93.2 ± 11.8	95.7 ± 11.9	ns
Female	93.3 ± 14.2	92.9 ± 14.2	83.9 ± 7.0	97.5 ± 13.0	95.1 ± 17.9	$F_{3,70} = 2.98$, p = 0.037
Transgender	95.6 ± 13.7	83.7 ± 12.4	97.3 ± 0.0	99.5 ± 13.5	95.5 ± 13.5	ns

[a]Analyses included an omnibus ANOVA and Dunnett post hoc tests comparing each sleep problem group to the good sleep group. [b]Lower sample sizes due to missing laboratory data. *Post hoc testing indicates this group significantly differs (p ≤ 0.05) from good sleep group.

Table 2—Sleep characteristics and symptom experience by sleep quantity

Variable	Short Sleep (< 6 h) (n = 131)	Typical Sleep (6 – 7.9 h) (n = 121)	Long Sleep (≥ 8 h) (n = 38)	Statistics[a] (when p < 0.20)
Demographic				
Race				$\chi^2(4) = 24.9$, p < 0.001
African American	66 (50%)**	37 (30%)*	8 (21%)*	
Caucasian	34 (26%)**	60 (50%)*	24 (63%)*	
Other	31 (24%)	24 (20%)	6 (16%)	
Education				$\chi^2(2) = 11.1$, p = 0.004
High school or less	113 (86%)*	90 (74%)	24 (63%)*	
More than high school	18 (14%)*	31 (26%)	14 (37%)*	
Household Income				$\chi^2(2) = 9.16$, p = 0.010
< $1,000/month	102 (78%)*	76 (63%)	22 (58%)*	
$1,000/month or more	29 (22%)*	45 (37%)	16 (42%)*	
Clinical				
CD4+ T-cell count (cells/mm^3)[b]	398 ± 256*	502 ± 273*	470 ± 259	$F_{2,273} = 4.62$, p = 0.011
Viral Load (log_{10} copies/mL)[b]	2.09 ± 1.99	1.56 ± 1.89	1.61 ± 2.00	$F_{2,267} = 2.29$, p = 0.103
Perceived Sleep Disturbance				
PSQI Global score	7.7 ± 3.8	7.3 ± 3.7	7.2 ± 3.3	ns
Actigraphy				
Time in bed (minutes)	452 ± 78**	511 ± 59**	593 ± 70**	$F_{2,287} = 65.6$, p < 0.001
Total sleep time (minutes)	284 ± 58**	416 ± 34**	526 ± 46**	$F_{2,287} = 473$, p < 0.001
Sleep efficiency (% of TIB)	63.9 ± 14.6**	82.1 ± 9.1**	89.0 ± 6.02**	$F_{2,287} = 110$, p < 0.001
Wake after sleep onset (%)[b]	30.6 ± 14.9**	14.2 ± 8.7**	8.5 ± 6.1**	$F_{2,287} = 91.1$, p < 0.001
Day sleep (minutes)[b]	44 ± 51*	58 ± 57	86 ± 80*	$F_{2,280} = 6.8$, p = 0.001
Symptom Experience				
Number of symptoms (MSAS)	9.5 ± 5.8	8.2 ± 5.7	10.8 ± 6.6	$F_{2,277} = 3.2$, p = 0.043
Depression (CES-D)[b]	16.0 ± 10.2*	16.3 ± 10.7*	21.2 ± 11.3**	$F_{2,285} = 3.1$, p = 0.023
Anxiety (POMS subscale)[b]	8.3 ± 7.0	8.7 ± 6.9	10.3 ± 7.7	ns
Fatigue (sleep diary)				
Morning	3.4 ± 2.3	3.7 ± 2.3	3.7 ± 2.1	ns
Evening	5.3 ± 2.3	5.1 ± 2.2	5.5 ± 2.1	ns
Evening-Morning difference	1.9 ± 1.9	1.5 ± 1.9	1.7 ± 1.8	ns

[a]Analyses for comparing the 3 groups included χ^2 for demographic variables and an omnibus ANOVA and Scheffe post hoc tests for continuous variables. [b]Square root transformation used to normalize distribution. *Post hoc testing indicates this group significantly differs (p ≤ 0.005) from one of the other groups. **Post hoc testing indicates this group significantly differs (p ≤ 0.005) from both of the other groups.

ter falling asleep and could range from 0 (no awake time after sleep onset) to 100% (awake the entire night). Fragmented sleep or difficulty maintaining sleep was common in this sample, with 56% (n = 161) having WASO above 15%. The 3-night mean WASO ranged from 0.63% to 78.9% (mean = 20.9% ± 14.8%, median = 17.5%), and was weakly correlated with habitual sleep efficiency on the PSQI (Spearman r = −0.15, p = 0.016), suggesting that the WASO observed during the 3-day monitoring period was somewhat consistent with the participants' self-report of their typical amount of sleep fragmentation. WASO was inversely correlated with actigraphy measures of total sleep time at night (Spearman r = −0.71, p < 0.001) and daytime sleep quantity (Spearman r = −0.23, p < 0.001). There was no relationship between WASO and self-reported use of tobacco, alcohol or caffeine, or measures of BMI, neck circumference, or waist circumference.

Group Comparisons

Although there was a weak association between difficulty falling asleep and difficulty maintaining sleep (Spearman r = 0.13, p = 0.024), the 2 sleep problems were largely independent. As such, the sample was divided into 4 groups based on the presence or absence of the 2 sleep problems. There were 41 (14%) who had difficulty falling asleep only, defined as taking > 30 min to fall asleep on average as reported in the sleep diary. There were 102 (35%) who only had a problem maintaining sleep, averaging > 15% WASO recorded by actigraphy. There were an additional 59 participants (20%) who had both types of sleep problems. The reference group consisted of 88 participants (30%) who had neither problem and were considered "good sleepers" for group analyses.

The groups were compared and results are reported in Tables 1 and 3. The groups differed on demographic factors, such as race, education, income, and employment status, but did not

Table 3—Sleep characteristics and symptom experience by type of sleep problem

Variable	Total Sample (n = 290)	Good Sleep (n = 88)	Falling Asleep Only (n = 41)	Staying Asleep Only (n = 102)	Both Sleep Problems (n = 59)	Statistics[a] (when p < 0.20)
Perceived Sleep Disturbance						
PSQI						
Global score	7.4 ± 3.7	6.2 ± 3.2	8.8 ± 3.4*	7.2 ± 3.7	8.8 ± 3.9*	$F_{3,285}$ = 8.8, p < 0.001
Global scores > 5	189 (65%)	43 (49%)	36 (88%)*	66 (65%)	44 (75%)*	$\chi^2(3)$ = 21.9, p < 0.001
Subscales						
Sleep quality	1.09 ± 0.74	0.94 ± 0.69	1.29 ± 0.68*	1.02 ± 0.80	1.31 ± 0.70*	$F_{3,284}$ = 4.2, p = 0.006
Sleep onset latency	1.43 ± 0.97	1.08 ± 0.85	1.93 ± 0.96*	1.20 ± 0.89	2.02 ± 0.88*	$F_{3,277}$ = 19.3, p < 0.001
Sleep efficiency	0.66 ± 0.92	0.47 ± 0.75	0.55 ± 0.90	0.70 ± 0.89	0.97 ± 1.12*	$F_{3,281}$ = 3.8, p = 0.011
Sleep duration	0.80 ± 1.10	0.52 ± 0.90	0.90 ± 1.14	0.80 ± 1.11	1.15 ± 1.24*	$F_{3,269}$ = 3.8, p = 0.010
Sleep disturbance	1.60 ± 0.65	1.47 ± 0.57	1.68 ± 0.57	1.60 ± 0.69	1.75 ± 0.71*	$F_{3,285}$ = 2.5, p = 0.059
Medication	0.89 ± 1.22	0.69 ± 1.15	1.29 ± 1.29*	1.00 ± 1.27	0.71 ± 1.15	$F_{3,282}$ = 3.0, p = 0.033
Daytime dysfunction	1.07 ± 0.74	1.11 ± 0.76	1.20 ± 0.64	0.94 ± 0.75	1.18 ± 0.76	$F_{3,279}$ = 1.9, p = 0.134
Usual hours of sleep	7.1 ± 1.5	7.3 ± 1.4	7.1 ± 1.3	7.1 ± 1.6	6.6 ± 1.7*	$F_{3,281}$ = 2.6, p = 0.052
Usual minutes to fall asleep	26.2 ± 23.6	18.5 ± 13.2	40.7 ± 30.1*	18.0 ± 12.9	41.9 ± 31.4*	$F_{3,277}$ = 26.1, p < 0.001
Usual sleep efficiency	84.1 ± 15.1	88.0 ± 12.6	82.6 ± 15.3	84.5 ± 15.0	78.4 ± 16.8*	$F_{3,269}$ = 4.8, p = 0.003
Take sleep medication (diary)	72 (25%)	15 (17%)	18 (45%)*	28 (28%)	11 (19%)	$\chi^2_{(3)}$ = 13.0, p = 0.005
Actigraphy						
Time in bed (min)	495 ± 84	488 ± 85	504 ± 56	484 ± 90	517 ± 85	$F_{3,286}$ = 2.3, p = 0.078
Total sleep time (min)	371 ± 99	429 ± 86	436 ± 66	317 ± 85*	332 ± 83*	$F_{3,286}$ = 42.1, p < 0.001
Sleep < 6 h/night	131 (45%)	17 (19%)	4 (10%)	73 (72%)*	37 (63%)*	$\chi^2(3)$ = 80.5, p < 0.001
Sleep ≥ 8 h/night	38 (13%)	22 (25%)	12 (29%)	4 (4%)*	0 (0%)*	$\chi^2(3)$ = 36.8, p < 0.001
Sleep efficiency (% of TIB)	74.8 ± 15.4	87.6 ± 7.7	86.3 ± 7.0	65.3 ± 13.3*	63.8 ± 11.7*	$F_{3,286}$ = 105, p < 0.001
Wake after sleep onset (%)[b]	20.9 ± 14.8	8.5 ± 6.2	9.3 ± 5.6	30.2 ± 12.9*	31.2 ± 11.4*	$F_{3,286}$ = 168, p < 0.001
Day sleep (minutes)[b]	55 ± 59	68 ± 64	77 ± 75	43 ± 53*	43 ± 39*	$F_{3,279}$ = 6.3, p < 0.001
Nap ≥ 60 min/day	93 (33%)	34 (40%)	20 (50%)	24 (24%)*	15 (26%)	$\chi^2(3)$ = 12.1, p = 0.007
Nap ≥ 120 min/day	40 (14%)	18 (21%)	9 (23%)	9 (9%)*	4 (7%)*	$\chi^2(3)$ = 10.5, p = 0.015
Symptom Experience						
Number of symptoms (MSAS)	9.2 ± 5.9	8.6 ± 5.4	11.0 ± 6.2	8.4 ± 5.7	10.2 ± 6.5	$F_{3,276}$ = 2.8, p = 0.038
Depression (CES-D)[b]	16.8 ± 10.6	16.3 ± 11.5	18.8 ± 9.1	15.8 ± 10.8	17.9 ± 9.9	$F_{3,284}$ = 1.8, p = 0.150
Anxiety (POMS subscale)[b]	8.7 ± 7.0	8.3 ± 7.2	11.7 ± 7.4*	7.5 ± 6.7	9.3 ± 6.7	$F_{3,279}$ = 4.3, p = 0.006
Fatigue (sleep diary)						
Morning	3.6 ± 2.3	3.7 ± 2.4	4.3 ± 2.3	3.2 ± 2.1	3.6 ± 2.5	$F_{3,284}$ = 2.5, p = 0.062
Evening	5.2 ± 2.2	5.5 ± 2.1	5.5 ± 2.1	5.0 ± 2.3	5.2 ± 2.4	ns
Evening-Morning difference	1.7 ± 1.9	1.8 ± 1.9	1.2 ± 1.8	1.8 ± 1.9	1.6 ± 2.1	ns

[a]Analyses included an omnibus ANOVA and Dunnett post hoc tests comparing each sleep problem group to the good sleep group. [b]Square root transformation used to normalize distribution. *Post hoc testing indicates this group significantly differs (p ≤ 0.05) from good sleep group.

differ by gender, age, or self-reported use of tobacco, alcohol, or caffeine. There were small clinical differences between the groups, and significant differences on measures of sleep and symptom experience. As shown in **Table 3**, all 4 groups had a mean PSQI score > 5 indicating significant sleep disturbance. Each sleep problem group was compared to the good sleepers and can be summarized as follows:

Trouble falling asleep only: Participants who reported trouble falling asleep but had no difficulty staying asleep (n = 41) reported significant sleep disturbance on the self-report measures, despite obtaining the most sleep of the 4 groups, both at night (7.3 ± 1.1 h) and during the day (1.3 ± 1.3 h). In fact, this was the only group that obtained more sleep according to actigraphy than they reported on the PSQI. Only 10% of the adults in this group obtained < 6 h of sleep per night, and nearly one-third (29%) obtained ≥ 8 h of sleep at night. This group also reported the highest symptom burden, the most symptoms of anxiety and depression, and the highest ratings of morning fatigue. The demographic and clinical characteristics of this group were similar to the good sleepers. Women with difficulty falling asleep had slightly lower waist circumference than good sleepers, but there was no group differences on anthropometric measures among men or the small sample of transgender adults.

Trouble staying asleep only: Participants who had trouble maintaining sleep, but no trouble initially falling asleep (n = 102) represented the largest proportion of the sample (35%). On average, this group obtained the least amount of sleep (5.3 h), although on the PSQI they reported usually ob-

taining 7.1 h of sleep. While their sleep efficiency was low (65%), they reported less sleep disturbance on the self-report measures than participants with trouble falling asleep, and they had the lowest symptom burden (total number of symptoms, as well as symptoms of depression, anxiety, and fatigue) of all 4 groups. Participants who only had trouble staying asleep were more likely to be African American and less likely to be Caucasian, and tended to have less education and lower incomes than the good sleepers. While the differences were not statistically significant, their CD4+ T-cell counts were somewhat lower and their viral load counts were slightly higher than the good sleepers, and they were slightly less likely to be receiving anti-retroviral therapy.

Trouble falling and staying asleep: Participants who had trouble both falling and staying asleep (20%, n = 59) obtained an average of 5.5 ± 1.4 h of sleep at night and 0.7 ± 0.6 h of sleep during the day, and had an average sleep efficiency of only 64%. In contrast to the previous group, participants with both sleep problems reported more sleep disturbance on the self-report measures and also reported more symptom burden (overall as well as symptoms of depression and anxiety specifically). This group reported a surprisingly low rate of sleep medication use (19%) given the severity of their sleep problems. This group was more likely to be African American and less likely to be Caucasian, less likely to be employed, and tended to have less education and income than the good sleepers. This group had the lowest CD4+ T-cell count and the highest viral load values, and was significantly less likely to be on anti-retroviral therapy compared to the group of good sleepers.

DISCUSSION

This study utilized a cross-sectional convenience sample of adults with HIV/AIDS to describe the types of sleep problems they experience and the potential impact on daytime sleep and function. Their sleep was very poor considering the minimal monitoring with an actigraph in their own home environment. The mean PSQI global score was above 6 even for the good sleepers living with HIV. This is still better sleep than recently reported in another sample of slightly younger adults with HIV, where the mean PSQI score was 12.3 and all subjects were above the cut-point of 5.[31] The majority of subjects in that study were African American.

Total sleep time at night in our sample ranged from less than 2 to more than 11 hours, and sleep efficiency ranged from 18% to 98%. One-third of the sample reported trouble falling asleep (SOL > 30 min), and more than half of the sample had severely fragmented sleep (WASO > 15%). Participants with fragmented sleep had objectively worse sleep (72% had < 6 h of sleep per night by actigraphy, with an overall sleep efficiency of 65%), although the group with trouble falling asleep reported more sleep disturbance and more severe symptom burden. Despite their nighttime sleep fragmentation, the group with WASO > 15% slept less during the day than the group with good sleep or the group reporting only problems falling asleep at bedtime. Using the PSQI self-report measure, other researchers also report a range of 2 to 12 hours, with a mean of 5 to 6 hours sleep and sleep efficiency better than 85% in their samples of HIV-infected adults.[9,32]

Considering the high rates of medical disability and unemployment in this sample, it was surprising that only a third took a nap for more than one hour during the day. It was also interesting that napping was most common in the group with problems falling sleep (50%) and least common (24%) among participants with only fragmented sleep, since they tended to obtain less sleep during the night. The prevalence of napping was similar to that reported for a community sample of women in which 31% reported naps,[16] and similar to Darko and colleagues' sample of men with AIDS in which 50% reported napping.[33] Rather than only 6 to 7 hours of sleep, however, the men in that sample reported an average of 9 hours sleep at night.[33]

One dimension of sleep rarely included in published reports is amount of actual sleep obtained during the night regardless of difficulty falling asleep or staying asleep. Only nine participants met criterion of more than 9 hours sleep. When these nine adults were combined with participants sleeping 8 hours or longer, this group actually had significantly better sleep efficiency compared to participants getting less sleep, but they had no difference in subjective sleep quality on the PSQI. Nearly half of this sample obtained less than 6 hours of sleep on average across the three nights of monitoring, and they were in bed later and arose earlier and slept less during the day, without any significant differences in daytime function or mood. In fact, participants who slept less than 6 hours actually had slightly lower morning fatigue ratings as well as fewer anxiety and depressive symptoms compared to participants who slept 6 hours or more. The group who slept less than 6 hours per night had significantly lower CD4+ T-cell counts and higher viral load values, but it remains unclear how these clinical variables affect or are affected by sleep disturbance. While at least 7 hours of sleep is recommended for most healthy adults, future research should examine in more detail how health and clinical outcomes, as well as daytime functioning, are impacted by less than 6 hours of sleep in chronic illness populations such as adults living with HIV/AIDS.

Sleep fragmentation was associated with short sleep times, but difficulty falling asleep was not. Given the association between short sleep duration and adverse clinical outcomes such as poor immune function and higher viral load, interventions are needed to better identify and address sleep fragmentation among adults living with HIV. Most studies of sleep fragmentation examine the role of BMI and waist or neck circumference without attention to sociodemographic factors. In this sample of adults with HIV infection, we did not find strong associations between self-reported snoring or fragmented sleep and anthropometric measures typically associated with sleep disordered breathing. The sociodemographic correlates of both short sleep duration and sleep fragmentation would suggest that environmental and sleep hygiene factors may play a larger role than body weight in this population and be a more critical aspect of an effective intervention.

One limitation of this study design was the self-report measures for symptom experience, including problems falling asleep and the mental health symptoms of anxiety and depression. Future research should include more objective clinical assessments of adults who complain about their sleep. It may be that adults with fragmented sleep are less aware of their sleep loss and its effects on their daytime function or have more dif-

ficulty with self-report measures. It may also be the case that adults who report problems initiating sleep are highly focused on their sleep and so aware of their sleep problem that they take sleep medication expecting relief, but then spend more time in bed at night and napping during the day.[34] Consistent with the findings of this study, Phillips and colleagues reported that their sample spent about 8 hours in bed and obtained about 6 hours sleep by self-report.[32]

Another limitation of this study was that the amount of sleep was objectively assessed with movement counts using wrist actigraphy, and this measure may have overestimated the amount of sleep actually obtained. If this is the case, then the poor sleep efficiency and low total sleep time would be even worse. Of interest was the finding that good sleepers and those only reporting problems falling asleep reported an average of 7.2 hours sleep on the PSQI and actigraphy findings were similar, while the group with fragmented sleep had a large discrepancy between their self-reported sleep time (6.9 h) and actigraphy (5.4 h). Self-report measures of sleep time may be less valid for adults with problems maintaining sleep, and more research needs to be done with this particular type of sleep problem in populations living with a chronic illness.

Finally, the least prevalent type of sleep problem experienced by this sample was difficulty falling asleep, but it was associated with the most severe symptom experience. Sleep onset latency was determined with a subjective sleep diary measure and then used to identify subjects having difficulty falling asleep. In contrast, sleep fragmentation was determined objectively using actigraphy to classify subjects with fragmented sleep. We cannot exclude the possibility that the greater sleep disturbance and symptom burden in those with sleep onset difficulties could be a function of our identification by self-report, while the lower sleep disturbance and symptom burden in those with sleep fragmentation could be a function of our identification by objective measures. Subjective reports of sleep problems would be expected to be more closely associated with self-reported symptoms than objective measures of sleep problems.

Participants who only experienced difficulty falling asleep did not differ by age, but were more likely to take sleep medication. In this cross-sectional design with a non-random convenience sample, the low prevalence may not be reflective of the rate of initiation insomnia in the general population of adults living with HIV/AIDS. It would also be difficult to conclude whether the sleep medication was helping, or whether long sleep onset latency would have been even worse without the medication.

Further research is needed to explore the effects of the sleep medication taken at night on daytime function, including time spent napping. The group that only experienced problems falling asleep also reported more fatigue in the morning upon awakening, but were not any more fatigued in the evening than the good sleepers. Compared to good sleepers and those who only experienced fragmented sleep, the group with difficulty falling asleep reported more symptoms, including symptoms related to depression and anxiety. Their self-report measures were closely aligned with the objective actigraphy findings, indicating that they were more accurate in their perceptions of sleep than the group with fragmented sleep. Participants with difficulty falling asleep were also the group most likely to complain about their sleep, and since their sleep efficiency was similar to the group of good sleepers, interventions may be better focused on strategies to relieve anxiety and restrict time spent in bed in order to shorten sleep onset latency.[35,36] Rather than relying solely on medication to improve sleep, cognitive behavioral therapy should also be considered, particularly in populations already burdened with medications used to manage their chronic illness.[37]

REFERENCES

1. Morgenthaler T, Kramer M, Alessi C, et al. Practice parameters for the psychological and behavioral treatment of insomnia: an update. An American Academy of Sleep Medicine report. *Sleep* 2006;29:1415-19.
2. Lee KA, Portillo C, Miramontes H. Influence of sleep and activity patterns on fatigue in women with HIV infection. *J Assoc Nurses AIDS Care* 2001;12 (Suppl):23-31.
3. Rubinstein ML, Selwyn PA. High prevalence of insomnia in an outpatient population with HIV infection. *J Acquir Immune Defic Syndr* 1998;19:260-5.
4. Vogl D, Rosenfeld B, Breitbart W, et al. Symptom prevalence, characteristics, and distress in AIDS outpatients. *J Pain Symptom Manage* 1999;18:253-62.
5. Nokes KM, Kendrew J. Correlates of sleep quality in persons with HIV disease. *J Assoc Nurses AIDS Care* 2001;12:17-22.
6. Justice AC, Rabeneck L, Hays RD, Wu AW, Bozzette SA. Sensitivity, specificity, reliability, and clinical validity of provider-reported symptoms: a comparison with self-reported symptoms. Outcomes Committee of the AIDS Clinical Trials Group. *J Acquir Immune Defic Syndr* 1999;21:126-133.
7. Reid S, Dwyer J. Insomnia in HIV infection: a systematic review of prevalence, correlates, and management. *Psychosom Med* 2005;67:260-69.
8. Hudson A, Kirksey K, Holzemer W. The influence of symptoms on quality of life among HIV-infected women. *West J Nurs Res* 2004;26:9-23.
9. Robbins JL, Phillips KD, Dudgeon WD, Hand GA. Physiological and psychological correlates of sleep in HIV infection. *Clin Nurs Res* 2004;13:33-52.
10. Lee KA, Gay C, Portillo CJ, et al. Symptom experience in HIV-infected adults: a function of demographic and clinical characteristics. *J Pain Symptom Manage* 2009;38:882-93.
11. Dreher HM. The effect of caffeine reduction on sleep quality and well-being in persons with HIV. *J Psychosom Res* 2003;54:191-8.
12. Koppel BS, Bharel C. Use of amitryptyline to offset sleep disturbances caused by efavirenz. *AIDS Patient Care STDS* 2005;19:419-20.
13. Nunez M, de Requena DG, Gallego L, Jimenez-Nacher I, Gozalez-Lahoz J, Soriano V. Higher efavirenz plasma levels correlate with development of insomnia. *J Acquir Immune Defic Syndr Hum Retrovirol* 2001;28:399-400.
14. Phillips KD, Skelton WD. Effects of individualized acupuncture on sleep quality in HIV disease. *J Assoc Nurses AIDS Care* 2001;12:27-39.
15. Nokes KM, Chidekel JH, Kendrew J. Exploring the complexity of sleep disturbances in persons with HIV/AIDS. *J Assoc Nurses AIDS Care* 1999;10:22-9.
16. Hudson AL, Portillo CJ, Lee KA. Sleep disturbances in women with HIV or AIDS: efficacy of a tailored sleep promotion intervention. *Nurs Res* 2008;57:360-6.
17. Smith MT, Huang MI, Manber R. Cognitive behavior therapy for chronic insomnia occurring within the context of medical and psychiatric disorders. *Clin Psychol Rev* 2005;25:559-92.
18. Roth T, Roehrs T, Pies R. Insomnia: Pathophysiology and implications for treatment. *Sleep Med Rev* 2007;11:71-9.
19. American Psychiatric Association. *Diagnostic and* Statistical Manual of Mental Disorders, *4th Ed. (DSM-IV)*. Washington DC: APA, 1994:551-7.
20. National Institutes of Health State of the Science Conference Statement on Manifestations and Management of chronic insomnia in adults, June 13-15, 2005. *Sleep* 2005;28:1049-57.
21. Roth T. Cormorbid insomnia: current directions and future challenges. *Am J Manag Care* 2009;15:S6-S13.
22. Cole RJ, Kripke DF, Gruen W, Mullaney DJ, Gillin JC. Automatic sleep/wake identification from wrist activity. *Sleep* 1992;15:461-9.
23. Ancoli-Israel S, Clopton P, Klauber MR, Fell R, Mason W. Use of wrist activity for monitoring sleep/wake in demented nursing-home patients. *Sleep* 1997;20:24-7.
24. Lichstein KL, Stone KC, Donaldson J, et al. Actigraphy validation with insomnia. *Sleep* 2006;29:232-9.
25. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28:193-213.

26. Portenoy RK, Thaler HT, Kornblith AB, et al. The Memorial Symptom Assessment Scale: an instrument for the evaluation of symptom prevalence, characteristics and distress. *Eur J Cancer* 1994;30A:1326-36.
27. Lee KA, Hicks G, Nino-Murcia G. Validity and reliability of a scale to assess fatigue. *Psychiatry Res* 1991;36:291-8.
28. Miaskowski C, Paul SM, Cooper BA, et al. Trajectories of fatigue in men with prostate cancer before, during, and after radiation therapy. *J Pain Symptom Manage* 2008;35:632-43.
29. Sheehan TJ, Fifield J, Reisine S, Tennen H. The measurement structure of the Center for Epidemiologic Studies Depression Scale. *J Pers Assess* 1995;64:507-21.
30. McNair DM, Lorr M, Droppleman LF. *Manual for the Profile of Mood States*. San Diego: Educational and Industrial Testing Services 1971.
31. Hand GA, Phillips KD, Dudgeon WD. Perceived stress in HIV-infected individuals: Physiological and psychological correlates. *AIDS Care* 2006;18:1011-17.
32. Phillips KD, Mock KS, Bopp CM, Dodgeon WA, Hand GA. Spiritual well-being, sleep disturbance, and mental and physical health status in HIV-infected individuals. *Issues Ment Health Nurs* 2006;27:125-39.
33. Darko DF, McCutchan JA, Kripke DF, Gillin JC, Golshan S. Fatigue, sleep disturbance, disability, and indices of progression of HIV infection. *Am J Psychiatry* 1992;149:514-20.
34. Morgan K, Dixon S, Mathers N, Thompson J, Tomeny M. Psychological treatment for insomnia in the regulation of long-term hypnotic drug use. *Health Technol Assess* 2004;8:1-81.
35. Morin CM, Bootzin RR, Buysse DJ, Edinger JD, Espie CA, Lichstein KL. Psychological and behavioral treatment of insomnia: update of the recent evidence (1998-2004). *Sleep* 2006;29:1398-414.
36. Espie CA, Inglis SJ, Tessier S, Harvey A. The clinical effectiveness of cognitive behaviour therapy for chronic insomnia: implementation and evaluation of a sleep clinic in general medical practice. *Behav Res Ther* 2001;39:45-60.
37. Edinger JD, Wohlgemuth WK, Krystal AD, Rice JR. Behavioral insomnia therapy for fibromyalgia patients. *Arch Intern Med* 2005;165:2527-35.

ACKNOWLEDGMENTS

This research was supported by a grant from the National Institute of Mental Health (NIMH, 5 R01 MH074358). Data collection was supported by the General Clinical Research Center at UCSF CTSA (1 UL RR024131). Dr. Aouizerat was also supported by an NIH Roadmap K12 (KL2 RR024130); Dr. Davis was supported by an NIH Research Infrastructure in Minority Institutions (RIMI) award (5P20 MD0005444). The authors acknowledge the contributions to the study from Ryan Kelly, Yeonsu Song, Kristen Nelson, and Matthew Shullick.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication August, 2010
Submitted in final revised form August, 2011
Accepted for publication August, 2011
Address correspondence to: Kathryn A. Lee, R.N., Ph.D., Professor and James & Marjorie Livingston Chair, Box 0606, University of California, San Francisco, 2 Koret Way, Room N415Y, San Francisco, CA 94143-0606; Tel: (415) 476-4442; Fax: (415) 753-2161; E-mail: Kathryn.lee@nursing.ucsf.edu

DISCLOSURE STATEMENT

This was not an industry supported study. The authors have indicated no financial conflicts of interest.