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The Association Between Sleep and Physical Function Among Older Veterans in an Adult Day Health Care Program

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Abstract

OBJECTIVES—To examine whether sleep disturbance is associated with poor physical function in older veterans in an adult day health care (ADHC) program.

DESIGN—Cross-sectional study.

SETTING—One ADHC program in a Veterans Affairs Ambulatory Care Center.

PARTICIPANTS—Older veterans (N = 50) who were enrolled in a randomized controlled trial of a sleep intervention program and provided complete baseline data.

MEASUREMENTS—Participant characteristics (e.g., age, depression, relationship to caregiver, pain, comorbidity) were collected using appropriate questionnaires. Physical function was measured using the total score of activities of daily living (ADLs) and instrumental ADLs (IADLs) from the Older Americans Resources and Services Multidimensional Functional Assessment Questionnaire. Sleep was assessed subjectively (by the Pittsburgh Sleep Quality Index and the Insomnia Severity Index) and objectively (by wrist actigraphy).

RESULTS—As expected, participants required substantial assistance with ADLs and IADLs. A regression model showed that participant characteristics (i.e., marital status, use of sleep

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medication, comorbidity, and posttraumatic stress disorder) and living arrangement (i.e., living with a spouse and/or others) were significantly associated with poor physical function. Poorer objective sleep (i.e., total sleep time, total numbers of awakenings, and total wake time) was significantly associated with poor physical function, accounting for a significant proportion of the variance above and beyond participant characteristics.

CONCLUSION—Objective measures of nighttime sleep disturbance were associated with poor physical function among older veterans in an ADHC program. Further research is needed to determine whether interventions to improve sleep will delay functional decline in this vulnerable population.

Keywords

physical function; sleep; elders; veterans; adult day health care

INTRODUCTION

More than 4,600 adult day health care (ADHC) programs in the United States provide service to over 260,000 adults.[1] These programs are community-based day health programs that provide services such as supervision, daytime activities, nutrition, and assistance with activities of daily living (ADLs).[2] Patients who receive ADHC support are often frail older adults with cognitive impairment, behavioral problems, and limited physical function.[3] The primary goal of an ADHC program is to maintain or improve its patients' physical function so that they can stay in their home and delay or avoid admission to an institution. ADHC programs are also provided at some Veterans Administration (VA) medical centers for veterans at risk of nursing home placement.[3] These outpatient day programs provide health maintenance, rehabilitative services, socialization, and caregiver support in a congregate setting.[3] The need for ADHC in both non-VA and VA settings is expected to increase as the numbers of older adults, particularly those with disability, continues to rapidly grow.

Previous studies of ADHC programs have evaluated the effect of their services on their participants' health-related outcomes. Results have shown significant improvement in physical and psychosocial health among ADHC participants[2, 4] as well as their caregivers' well-being[5, 6] both in non-VA and VA settings. Although ADHC participants have more functional limitations than older adults using other health services in the community (e.g., home health care),[7] research on factors related to functional decline in ADHC participants is sparse.

Research in other populations suggests that poor sleep is associated with decline in physical function among older adults in assisted living facilities,[8] in community-dwelling older men[9] and older women,[10] and persons with comorbidities such as stroke[11] and rheumatoid arthritis.[12] In particular, having shorter or longer reported sleep duration, greater wakefulness after sleep onset, and lower sleep efficiency have all been shown to be risk factors for poor physical function in both cross-sectional[9, 10] and longitudinal studies.[8, 13] However, evidence of the relationship is scarce in older adults who have more physical limitation and are in need of more attention such as those in ADHC programs.

Although our previous work[14] suggests that poor sleep is common among veterans in ADHC programs, research on the relationship between sleep and physical function among older adults in ADHC programs is limited. If disturbed sleep is associated with worse physical function in this setting, managing sleep difficulties might effectively prevent or delay admission to institutional long-term care. The purpose of this study, therefore, was to test whether sleep disturbances are independently associated with poor physical function in ADHC participants after adjusting for other participant characteristics (e.g., age, comorbidity, depression), which may contribute to functional limitation in older adults.

METHODS

Participants

We performed secondary analysis of data collected during the baseline phase of a randomized controlled trial of a nonpharmacological sleep intervention at one VA ADHC at a VA ambulatory care center. To be included in the study, participants had to be aged 60 or older, able to speak English and must have attended ADHC for at least 1 day per week for the prior month. Research staff collected data from participants in face-to-face interviews at the ADHC site. Data collection occurred between November 2010 and June 2012. In total, 123 individuals were considered for enrollment into the larger study. Of that number, 16 were discharged from the ADHC prior to completing baseline assessment, 15 had significant dementia (Mini-Mental State Examination [MMSE][15] score ≤ 15), 14 refused to complete the screening, 2 died, and 4 were found to be inappropriate (e.g., participating in another research study, socially inappropriate) or unable to communicate verbally. The remaining 72 participants consented to participate in the larger trial, of which 50 individuals had complete (non-missing) data on all variables (as described below). This study was approved by the Institutional Review Board of the VA Greater Los Angeles Healthcare System. Written informed consent was obtained from all enrolled participants.

Dependent Variable

Physical Function Assessment—Physical function was measured by using components of the Older Americans Resources and Services (OARS) Multidimensional Functional Assessment Questionnaire.[16] The instrument consists of 14 items and assesses one's level of independence in ADLs (i.e., eating, dressing, grooming, walking, getting in and out of bed, taking a bath or shower, and continence) and instrumental ADLs (IADLs: i.e., telephone use, going places beyond walking distance, shopping, preparing meals, doing housework, handling money, and taking medications). The total score for ADL/IADLs ranged from 0 to 28; higher scores indicated greater independence. Subscores for ADLs and IADLs and the total number of ADLs and IADLs for which participants needed assistance were also used in our analyses.

Independent Variables

Sleep Measures—Participants wore an actigraph (Actiwatch Spectrum, Philips Respironics) on their dominant wrist for a minimum of 3 consecutive days (i.e., 72 hours) regardless of whether the days occurred during the week or on a weekend. Using actigraphy for a minimum of 3 consecutive days is recommended by the Standards of Practice

Committee of the American Academy of Sleep Medicine.[17] The actigraph is a small, watch-sized device commonly used to measure sleep-wake patterns.[9, 18] Participants recorded bedtime and rise time for each night in a simple sleep diary. Total sleep time, total number of awakenings, and total wake time were calculated for the time between bedtime and rise time noted on the diary by the participant. Total nap time was also calculated as the total minutes of sleep after rise time and before bedtime on the days of recording.

The Pittsburgh Sleep Quality Index (PSQI)[19] was used as a subjective measure of sleep quality. This instrument is an 18-item questionnaire that assesses sleep quality and disturbances over the past month. A total score greater than 5 indicates poor quality sleep.[19] In addition, the Insomnia Severity Index (ISI) was used to measure severity of insomnia symptoms.[20, 21] Total scores range from 0 to 28 and are interpreted as follows: no insomnia (0–7), subthreshold insomnia (8–14), moderate insomnia (15–21), and severe insomnia (22–28).

Covariates

Demographic characteristics were collected at baseline, including age, gender, race/ethnicity, marital status, years of education, employment status, current residence status, and living arrangement. Duration of ADHC attendance was determined by a review of their medical records and calculated from the date of official enrollment into the program. Self-rated health data was obtained from the single item of the Short Form-12 Health Survey, scored as excellent/very good, good/fair, or poor.[22] Depression was measured by the Patient Health Questionnaire (PHQ)-9.[23] Pain was assessed by using the pain intensity subscale of the Geriatric Pain Measure.[24] Comorbidity was determined by the number of medical conditions in the participants' medical records that were defined by the International Classification of Diseases, Ninth Revision. Evidence of post-traumatic stress disorder (PTSD) was collected using the four-item Primary Care PTSD Screen.[25] Self-reported use of sleeping medication was collected from a single item on the PSQI. Cognitive function was measured with the MMSE[15] where a score below 24 suggests cognitive impairment. Caregiver characteristics were also collected and included the relationship with a primary caregiver and number of caregivers per individual participant.

Data Analysis

Descriptive statistics were calculated for all variables. Pearson correlations were calculated to test the association between physical function variables and sleep measures as well as the following participant characteristics: age, years of education, comorbidity, duration of ADHC attendance, depression, pain, and cognitive function, while Student t-tests and ANOVA were used to test the differences in physical function by the following participants' characteristics: race, marital status, employment status, living arrangement, health status, relationship to caregiver, sleep medication use, and PTSD. The significance level for each of the prior tests was assessed and tests yielding p-values significant at the 10% level of significance were used to select independent variables for inclusion in the nested regression model. A nested regression model was formed in which physical function was the dependent variable and the significant ($P < .10$) variables from the prior analyses were entered in three blocks. Block 1 included marital status, reported use of sleep medication, comorbidity, and

PTSD. Block 2 included living arrangement of the participant. Block 3 included sleep variables, specifically, total sleep time, numbers of nocturnal awakenings, and total nighttime wake time from actigraphy. For these statistical tests, $P < .05$ was considered statistically significant. Analyses were conducted using Stata statistical software (version 13, Stata Corporation, College Station, TX).

RESULTS

Participant Characteristics

Table 1 shows summary statistics for the participants' demographic and sleep characteristics. Table 2 shows summary statistics for the participants' physical function. Only 2 of 50 participants did not need assistance with any ADLs or IADLs. Participants had an average of two caregivers, and a spouse was typically the primary caregiver. Of the ADLs assessed, participants most frequently needed help with bathing (70%) and walking (56%). Of the IADLs, they relied most on others for assistance with housework (80%) and preparing meals (68%).

Relationships Among Sleep, Physical Function, and Covariates

In bivariate analyses, lower ADL/IADL total score was associated with objective (i.e., by actigraphy) evidence of more nighttime awakenings ($r = -0.31$, $P = .026$) and more daytime sleeping ($r = -0.32$, $P = .026$). Total sleep time at night was also significantly associated with the total number of ADL limitations ($r = 0.30$, $P = .036$). In addition, longer time spent in bed at night was associated with greater ADL impairment ($r = -0.41$, $P < .05$). Neither PSQI nor ISI scores were significantly associated with ADL/IADL scores. Married participants had significantly lower (a) total ADL/IADL scores (17.5±5.2 vs. 20.4±3.4), (b) ADL scores (8.9±2.6 vs. 10.0±1.3), and (c) IADL scores (8.6 ±3.3 vs. 10.3±2.4) and a higher total number of IADL limitations (4.3±2.1 vs. 3.2 ±1.9) than those who were unmarried (all P-values < .05). Participants with PTSD had higher numbers of ADL limitations than those without the disorder (4.2±1.3 vs. 2.3±1.8, $P = .018$). Participants living alone also had higher ADL/IADL scores (22.0±1.2, $P = .003$), IADL scores (11.6 ±0.7, $P = .002$), and lower number of IADL limitations (2.1±0.5, $P < .001$) than those living with spouses (16.8 ±0.9; 8.1±0.6; 4.7±0.4, respectively) or others (19.3±1.0; 9.6±0.7; 3.9±0.4, respectively).

Association between Sleep and Physical Function

The results of the nested regression models that tested associations between objective sleep and physical function are summarized in Table 3. The variables entered in Block 1 (marital status, sleep medication use, PTSD, and comorbidity) were, as a group, significantly related to physical function ($P = .026$, $R^2 = 0.214$). Living arrangement (i.e., living alone vs. living with a spouse or others) in Block 2 explained an additional 12.2% of the variance in physical function after accounting for the variables in Block 1 ($P = .027$). The contribution of objective sleep variables (total sleep time, total numbers of awakenings, and total wake time; Block 3) accounted for a significant proportion of the variance ($R^2_{change} = 12.8\%$, $P = .034$) in physical function above and beyond the Block 1 and 2 variables. In total, all 10 variables in Blocks 1, 2, and 3 were jointly associated with physical function ($R^2 = 46.4\%$, adjusted $R^2 = .344$).

DISCUSSION

As expected, the participants in the ADHC program had physical limitations and most needed assistance with ADLs and IADLs. We found that objectively measured “poor” sleep was significantly associated with poor physical function in this population, even after controlling for health problems such as PTSD, use of sleep medication, and demographic characteristics (i.e., marital status and living arrangement). Of note, objective sleep measures including prolonged nighttime sleep, increased total wake time, and higher numbers of nocturnal awakenings were associated with poor function in ADLs and IADLs.

Prior research in other settings has reported significant associations between total sleep time and physical function. For example, a large cohort study of older women[10] (N=2,889) found that participants with shorter (<6 hours) and longer (≥7.5 hours/night) sleep time measured by actigraphy had higher odds of having a functional limitation (i.e., self-reported difficulty with at least one of the IADLs) than those who slept 6.8–7.5 hours/night. This association remained significant for those who slept longer, even after adjusting for covariates (e.g., age, depression, comorbidity, cognitive function). Additionally, women who experienced ≥1.6 hours of wakefulness after sleep onset had higher odds of a functional limitation than those with < .7 hours. In other work, a cross-sectional telephone survey of older adults (N=1,026) found that decreased function in performing IADLs was associated with both early (≤9 pm) and late bedtime (≥1 am) and early (≤5 am) and late (≥9 am) wake-up time, based on self-reported sleep.[26] Our study builds upon these findings by including objectively monitored sleep in addition to self-report measures. Most of the participants in previous studies were living actively (e.g., working) in the community; those with significant disabilities were excluded from participation in the studies. Our findings provide increasingly strong evidence of the relationships between sleep and physical function in older adults with poor functional limitations.

Our findings have important clinical implications. Sleep assessment might be a useful adjunct in evaluating the functional outcomes of ADHC participants. The mechanism underlying the relationships between sleep and physical function is not well-known. Although research has yet to show whether nonpharmacological sleep interventions can delay or prevent limitations in physical function, studies have reported that sleep intervention programs could improve health-related quality of life in older adults.[27] This raises the possibility that such interventions might help delay or prevent limitations of physical function in ADHC patients who are typically at high risk for decline. We adjusted for participant characteristics in our models, which may explain the relationship. However, the association between sleep and physical function was significant after adjusting for marital status, sleep medication use, comorbidity, and PTSD. Other factors such as inflammation or neuroendocrine dysfunction might explain the associations.[9] For example, sleep loss has been related to inflammation[28], which is associated with functional decline.[29]

To our knowledge, this is the first study to investigate whether a significant association exists between sleep and physical function in vulnerable older adults in an ADHC program. Further, by using objective and subjective sleep variables, we were able to explore both

patient perceived sleep quality and actual measured sleep variables. This is a key strength of our analysis.

Nonetheless, this study has several limitations. First, our sample size was small and primarily male, which may limit generalizability to older women or nonveterans in community-based ADHC programs. Second, the participants' reported sleep quality was fairly good (average actigraphy measured sleep efficiency >80%), although they had long spells of nocturnal wake time and daytime sleeping. Perhaps participation in an ADHC program led to improvements in sleep quality or to underreporting of sleep-related symptoms as participants focused on other areas of well-being. Finally, because of the larger study's enrollment criteria, our participants had higher cognitive function; those with moderate or severe cognitive difficulties were excluded.

In conclusion, long sleep time and fragmented sleep (i.e., longer wake time, higher numbers of nocturnal awakenings) was significantly associated with poor physical function among older veterans in an ADHC program. Strategies to address poor sleep may enable ADHC participants to remain maximally independent in performing ADLs and IADLs, thereby reducing caregiver burden and enhancing quality of life.

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The funding agencies had no direct role in the conduct of the study; the collection, management, analyses and interpretation of the data; or preparation or approval of the manuscript.

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Conflicts of Interest

Elements of Financial/Personal Conflicts	Yeonsu Song		Cathy A. Alessi		Michael Mitchell		Stella Jouldjian		Karen R. Josephson		Joseph Dzierzewski		Constance H. Fung		Juan C. Rodriguez		Jennifer L. Martin	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Employment or Affiliation		X		X		X		X		X		X		X		X		X
Grants/Funds		X		X		X		X		X		X		X		X		X
Honoraria		X		X		X		X		X		X		X		X	X	
Speaker Forum		X		X		X		X		X		X		X		X		X
Consultant		X		X		X		X		X		X		X		X		X
Stocks		X		X		X		X		X		X		X		X		X
Royalties		X		X		X		X		X		X		X		X		X
Expert Testimony		X		X		X		X		X		X		X		X		X
Board Member		X		X		X		X		X		X		X		X	X	
Patents		X		X		X		X		X		X		X		X		X
Personal Relationship		X		X		X		X		X		X		X		X		X

For “yes”, provide a brief explanation:

JLM: Honoraria for speaking: Equinox Fitness. Member of the Board of Directors of the Sleep Research Soceity.

Table 1

Characteristics of Participants (N = 50) in a VA Adult Day Health Care Program

Characteristics	Value
Age, mean ± SD (range)	77.4 ± 9.8 (60–97)
Male, n (%)	47 (94)
White, n (%)	34 (68)
Married, n (%)	25 (50)
Education, years, mean ± SD (range)	14.4 ± 2.3 (8–20)
Current employment status, n (%)	
Unable to work	8 (16)
Volunteer	1 (2)
Retired	41 (82)
Months of participation in ADHC[a], mean ± SD (range)	12.9 ± 24.0 (0.05–120)
Current residence [a], n (%)	
Own home	29 (59.2)
Relative or friend's home	8 (16.3)
Institution (e.g., assisted living facility, board and care home)	12 (24.5)
Living arrangement, n (%)	
Alone	13 (26)
Spouse/spouse and others	21 (42)
Others	16 (32)
Comorbidity, mean ± SD (range)	24.1 ± 14.9 (4–68)
Self-rated health, n (%)	
Excellent/very good	20 (40)
Good/fair	29 (58)
Poor	1 (2)
Caregiver [b], n (%)	
Spouse	15 (30.6)
Adult child	10 (20.4)
Other relative/neighbor	5 (10.2)
Paid caregiver	12 (24.5)
Total no. of caregivers per person [b], mean ± SD	2.2 ±1.0 (1–5)
Reported use of sleep medication, n (%)	10 (20)
Posttraumatic stress disorder, n (%)	6 (12)
Depression, mean ± SD (range)	5.5 ± 5.1 (0–20)
Pain, mean ± SD (range)	15.3 ± 12.3 (0–39)
Mini-Mental State Examination, mean ± SD (range)	25.1 ± 3.2 (16–30)

[a] n=49;

[b] n = 43

Table 2

Characteristics of Participants' (N = 50) Sleep and Physical Function

Sleep and Physical Function	Value
Sleep	
Subjective Sleep	
Pittsburgh Sleep Quality Index score, mean± SD (range)	6.0±4.2 (1–15)
Insomnia Severity Index score, mean± SD (range)	7.8±6.4 (0–22)
Total time in bed [a], min, mean± SD (range)	8.8±1.8 (6–14)
Objective sleep	
Total sleep time, min, mean ± SD (range)	464.8 ± 86.9 (294.3–719.6)
Sleep efficiency, %, mean ± SD (range)	83.7 ± 7.5 (56.3–96.4)
Total wake time, min, mean ± SD (range)	89.2 ± 41.5 (25.8–229)
Total numbers of awakenings, mean ± SD (range)	25.2 ± 8.8 (6.6–45.7)
Total nap time [b], min, mean ± SD (range)	272.8 ± 144.3 (68–598)
Physical Function	
ADLs/IADLs	
Total score of ADLs/IADLs, mean ± SD (range)	18.9 ± 4.6 (7–26)
Subtotal score of ADLs, mean ± SD (range)	9.5 ± 2.1 (3–12)
Subtotal score of IADLs, mean ± SD (range)	9.5 ± 2.9 (2–14)
Total no. of ADLs limitation, mean ± SD (range)	2.5 ± 1.8 (0–6)
Total no. of IADLs limitation, mean ± SD (range)	3.8 ± 2.0 (0–7)
Subitems of ADLs	
Eating, n (%)	11 (22)
Dressing, n (%)	17 (34)
Grooming (e.g., combing hair, shaving), n (%)	8 (16)
Walking, n (%)	28 (56)
Getting in and out of bed, n (%)	12 (24)
Taking a bath or shower, n (%)	35 (70)
Trouble getting to bathroom on time, n (%)	16 (32)
Subitems of IADLs	
Using telephone, n (%)	13 (26)
Getting to places beyond walking distance, n (%)	23 (46)
Shopping for groceries or clothes [b], n (%)	20 (41)
Preparing own meals, n (%)	34 (68)
Doing housework, n (%)	40 (80)
Taking own medication, n (%)	30 (60)
Managing own money, n (%)	28 (56)

ADLs = activities of daily living; IADLs = instrumental activities of daily living

[a] n=36;

[b] n=49

Table 3

Regression Models Predicting Participants' (N = 50) Physical Function

Outcome	F (df)	*P*-value	R^2	R^2 change
Block 1				
Marital status, reported use of sleep medication, comorbidity, posttraumatic stress disorder	3.06 (4, 45)	.026	0.214	--
Block 2				
Living arrangement	3.95 (2, 43)	.027	0.336	0.122
Block 3				
Total sleep time, no. of awakenings, total wake time	3.19 (3, 40)	.034	0.464	0.128