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Positive Affect Is Associated With Fewer Sleep Problems in Older Caregivers but not Noncaregivers

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Purpose of the Study: Older adults who are depressed or are caregivers experience more sleep problems, whereas recent studies suggest that adults with high positive affect (PA) have fewer sleep problems. This study examined whether the associations of PA and depressive symptoms with sleep problems differed between caregivers and noncaregivers. ***Design and Methods:*** Face-to-face interviews were conducted with 92 caregivers to a relative or friend with Alzheimer's disease or Parkinson's disease, and 137 noncaregivers aged 60 years and older (mean 73.8 ± 7.9 years) from the Boston, Massachusetts, metropolitan area. Sleep problems were assessed using the Pittsburgh Sleep Quality Index (PSQI). Respondents were categorized as high PA (n = 122), low PA (n = 69), and depressive symptoms (n = 38) based on the Center for Epidemiologic Studies-Depression scale. ***Results:*** The mean PSQI score was 5.19 (SD = 3.26) and did not differ by caregiving status. In multivariable linear regression analyses among caregivers, those with high PA had significantly fewer sleep problems than their counterparts with low PA (adjusted mean PSQI score was 4.16 [SE = 0.50] vs. 5.69 [SE = 0.58], p = .05), whereas caregivers with depressive symptoms reported slightly more problems (adjusted mean 6.92 [SE = 0.80], p = .22). High PA and depressive symptoms were not associated with sleep problems among noncaregivers (adjusted mean PSQI scores were 4.88 [SE = 0.35], 5.38 [SE = 0.51], and 5.99 [SE = 0.73], respectively). Similar associations were found with PSQI scale components. ***Implications:*** Results suggest that routine screening and interventions to increase PA may reduce sleep problems among older caregivers.

Key Words: Caregiving, Sleep, Positive affect, Depressive symptoms

More than 50% of older adults in the United States experience sleep problems (Foley, Ancoli-Israel, Britz, & Walsh, 2004). Sleep problems in older adults have been linked with a decline in quality of life and an increase in health conditions such as impaired cognitive function, chronic illness, reduced mental health, and premature mortality (Foley et al., 2004; Roberts, Shema, Kaplan, & Strawbridge, 2000; Strine & Chapman, 2005). Persons with depressive symptoms (Cole & Dendukuri, 2003) and those who are caregivers (McCurry, Logsdon, Teri, & Vitiello, 2007) are more likely to experience sleep problems than their counterparts. Although caregivers consistently report more depression than noncaregivers (Pinquart & Sörensen, 2003), little is known about the combined effect of depression and caregiving

on sleep. Moreover, recent studies have found that positive affect (PA), a feeling of psychological well-being, is associated with better sleep quality (Bower, Bylsma, Morris, & Rottenberg, 2010; McCrae et al., 2008; Steptoe, O'Donnell, Marmot, & Wardle, 2008). To our knowledge, only two studies have examined the impact of both PA and depressive symptoms or negative affect on sleep problems (Bower et al., 2010; McCrae et al., 2008). The present study examined the associations between PA and depressive symptoms with sleep problems among older adults, and whether these associations differed between caregivers and noncaregivers.

PA is alternatively conceptualized as the bipolar opposite end of negative affect (Russell & Carroll, 1999) and as a construct that is independent of negative affect (Pressman & Cohen, 2005). There is evidence to support both views. With regard to studies of whether PA has unique health benefits, PA is conceptualized as separate from simply the absence of depressive symptoms (Pressman & Cohen, 2005), but as the spectrum of pleasant states and attitudes, such as feeling happy or grateful, or expressing appreciation (Fredrickson & Losada, 2005). PA appears to have a protective effect on health, including reduced risk of stroke, functional disability, and mortality in older populations (Ostir, Markides, Peek, & Goodwin, 2001; Pressman & Cohen, 2005). High levels of PA are especially protective; compared with persons with low PA, those with high PA are less likely to develop frailty (Park-Lee, Fredman, Hochberg, & Faulkner, 2009), inflammation (Friedman & Ryff, 2012), and other physical disorders (Weiser, 2012), are more likely to recover from acute medical events (Fredman, Hawkes, Black, Bertrand, & Magaziner, 2006; Ostir et al., 2002), and have lower mortality rates (Blazer & Hybels, 2004; Steptoe et al., 2008). These health benefits might be due, in part, to a lower prevalence of sleep problems among those with high PA because better sleep is associated with better health outcomes (Martin et al., 2011; Spira et al., 2010). However, studies that found fewer sleep problems among persons with high PA (Bower et al., 2010; McCrae et al., 2008; Steptoe et al., 2008) either did not focus on older adults (Bower et al., 2010) or did not examine both PA and depressive symptoms simultaneously (McCrae et al., 2008; Steptoe et al., 2008). Whether PA minimizes sleep problems among older adults remains relatively unknown.

In addition to PA, caregiving might be an important determinant of sleep quality. Studies on caregiving and sleep have inconsistent results, with some finding caregivers had more sleep problems (Fonareva, Amen, Zajdel, Ellingson, & Oken, 2011; McKibbin et al., 2005; von Kanel et al., 2012) and others observing no direct association (Brummett et al., 2006; Kochar, Fredman, Stone, & Cauley, 2007). Additionally, some studies found that depressive symptoms explained the greater prevalence of sleep problems among caregivers (Brummett et al., 2006; von Kanel et al., 2012), whereas others found that the association between depressive symptoms and sleep varied by caregiving status (Kochar et al., 2007). We are unaware of any research on whether caregiving modified the relationship between PA and sleep.

PA and depressive symptoms might influence health differently in caregivers and noncaregivers, as caregivers report more stress (Pinquart & Sörensen, 2003) and thus may have greater potential to benefit from PA. Additionally, because caregivers typically experience more chronic stress, they might need to draw on PA as a coping resource more frequently than noncaregivers. Therefore, PA may have a stronger protective effect on sleep in caregivers than in noncaregivers. Alternatively, the benefits of PA may accumulate over time, leaving individuals with high PA generally more resilient (Fredrickson, 2001) and healthier on various dimensions including sleep quality. The single study to our knowledge that compared the effects of PA on health outcomes in caregivers and noncaregivers found that high PA was associated with lower risk of frailty in both caregivers and noncaregivers (Park-Lee et al., 2009), supporting the latter theory.

The current study assessed whether sleep problems differed across older community-dwelling adults with high PA, low PA, or high depressive symptoms. Additionally, in order to shed light on the inconsistent findings for caregiver status and sleep disturbance, we examined whether the relationships of high PA and depressive symptoms with sleep problems differed between caregivers and noncaregivers. We hypothesized that compared with participants with low PA, those with high PA would report fewer sleep problems and those with depressive symptoms would report more sleep problems. We further hypothesized that high PA would have a stronger protective impact on sleep in caregivers than in noncaregivers.

Design and Methods

Study Sample

The sample is from the Health Pathways Study, a study of the relationships among stress, metabolic syndrome, and health outcomes in older adult caregivers and noncaregivers. Community-dwelling adults from the Boston, Massachusetts metropolitan area were eligible if they were aged 60 years or older, spoke English as their primary language, and were free of cognitive impairment. Caregivers to individuals with Alzheimer's disease or Parkinson's disease were recruited from Boston University's (BU) Alzheimer's Disease Center and Parkinson's Disease Center. Caregivers were eligible if they were assisting an individual with Alzheimer's or Parkinson's disease with at least one of seven basic activities of daily living (ADLs; eating, dressing and undressing, grooming, walking across a room, getting in and out of bed, bathing, and toileting) or one of seven instrumental ADLs (IADLs; using the telephone, getting to places out of walking distance, going shopping, preparing meals, doing housework, taking medicine, and handling money). The caregiver's relationship to the care recipient and coresidence with the care recipient were not factors in determining eligibility. Noncaregivers were recruited through announcements in local newspapers and the Harvard Cooperative Program on Aging (HCPOA) newsletter, and recruitment letters sent directly to members of the HCPOA registry. Noncaregivers were eligible only if they were not currently assisting anyone with any ADLs or IADLs, and had not done so over the past year.

Data Collection

Data were collected from May 2008 to September 2011. Trained interviewers conducted face-to-face interviews with participants in the early morning at the BU General Clinical Research Unit. The interview included questions on sociodemographic characteristics, physical and psychological health measures, and medications taken over the past month. Caregivers were also asked about their care recipient and their caregiving experience. This study was approved by the BU Medical Center's institutional review board; all participants provided informed consent.

Measures

PA and Depressive Symptoms.—A three-category PA variable was created from the 20-item Center for Epidemiologic Studies-Depression scale (CES-D) (Radloff, 1977) based on previously developed measures with high predictive validity (Fredman et al., 2006; Ostir et al., 2002). The CES-D scale asks how frequently the participant experienced each item in the previous week, with responses ranging from "rarely" to "most of the time." Scores range from 0 to 60, with scores of 16 or higher indicating high depressive symptoms (Radloff, 1977). This cutoff was used to classify participants with depressive symptoms in our sample. Four positively worded items comprise the PA scale ("I felt that I was just as good as other people," "I felt hopeful about the future," "I was happy," and "I enjoyed life"). Respondents with CES-D scores less than 16 were classified as "high PA" if they reported feeling all four PA items most of the time in the previous week, and as "low PA" if they reported these feelings less often. Thus, these three categories were mutually exclusive.

Sleep Quality.—The Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) was used. The scale consists of 19 items that assess various aspects of sleep during the past month along seven subscales: total scores range from 0 to 21, with higher scores reflecting poorer sleep quality. Total scores greater than 5 suggest moderate sleep problems in three or more areas, or more severe problems in at least two areas.

We analyzed the total PSQI score and two subscales, Subjective Sleep Quality and Daytime Dysfunction. These subscales were selected based on their associations with high PA and depressive symptoms in previous studies (Bower et al., 2010; McCrae et al., 2008).

Caregiving.—Participants were classified as caregivers or noncaregivers based on the criteria described in the *Study Sample* section.

Other Covariables

Sociodemographics.—We collected data on participants' self-reported age, race (white vs. other), gender, marital status (married vs. other), highest level of education obtained (recoded as attended college or more education vs. less education), and medication use (sleep medications and antidepressant or antianxiety medications). We

recorded whether caregivers were caring for a spouse (vs. other relative or friend), living with the care recipient, and the number of ADLs and IADLs they performed for the care recipient.

Physical Activity.—We created a dichotomous measure of physical activity based on participants' self-reported frequency of engagement in four items on the Physical Activity Scale for the Elderly (Washburn, Smith, Jette, & Janney, 1993): light sport, moderate sport, strenuous sport, and strengthening exercise. Respondents who reported performing any of these activities on 3 days or more over the past week were categorized as engaging in moderate physical activity; those who performed these activities less often were categorized as engaging in less than moderate physical activity.

Medical Conditions.—Respondents indicated whether a physician had told them that they had each of 15 chronic and acute conditions at the present time. The list, based on the most frequently reported diseases from the Older Americans Resources and Services Multidimensional Functional Assessment Questionnaire (Fillenbaum & Smyer, 1981), included conditions such as hypertension, arthritis, osteoporosis, and ocular diseases. The number of medical conditions were summed to create a total score (range 0–15).

Analysis

Bivariate associations between each covariate and PSQI score were assessed using *t* tests for dichotomous variables and Pearson's correlation tests for continuous variables. Associations of PA with all potential covariates were assessed by analysis of variance across the three categories of the PA variable.

We used multivariable linear regression to estimate the association between PA and total PSQI score. All models included indicator variables for high PA and depressive symptoms, with low PA as the reference group. Potential confounders were identified if their inclusion in the model containing only the indicator variables for high PA and depressive symptoms changed the beta coefficient for either of the latter variables by 10% or more. The initial multivariable model included all potential confounders. We sequentially removed the covariable with the highest *p* value to construct the most parsimonious and powerful model. The same set of covariables was used in analyses with the two PSQI component subscales as outcomes.

To determine whether caregiving modified the association between PA and sleep quality, we ran separate models for caregivers and noncaregivers and used *t* statistics to compare the slopes for the PA indicator from the two groups (Kleinbaum, Kupper, Nizam, & Muller, 2008). All analyses were performed using SAS version 9.3 (SAS Institute, Inc., Cary, NC).

Results

Sample Characteristics

Interviews were completed with 229 participants. Their mean age was 73.82 years (range 60–97), 83.41% were white, 68.56% were female participants, and 40.17% were caregivers. The mean PSQI score was 5.19 (*SD* = 3.26; Table 1). The majority of participants were categorized as having high PA (53.28%), whereas 30.13% had low PA and 16.59% exhibited depressive symptoms. Only two respondents who were classified with high depressive symptoms scored high on PA items.

High PA was associated with male gender, higher education level, having fewer medical conditions, and more frequent participation in moderate physical activity (Table 1). Participants with high PA were less likely to use antidepressants, or antianxiety or sleep medications. No other covariates were associated with high PA (Table 1).

Compared with noncaregivers, caregivers were younger and more likely to be white and married (all *p*s < .01). Mean PSQI score did not differ between caregivers and noncaregivers (5.22 and 5.18, respectively). Caregivers with high PA were less likely to be caring for a spouse and assisted their care recipient with fewer ADLs and IADLs compared with other caregivers.

PA and Other Factors Associated With Sleep Quality

Participants who were less educated and had more medical conditions reported poorer sleep quality. No other characteristics were associated with sleep quality.

Mean PSQI scores rose consistently from 4.48 (*SD* = 2.96) for those with high PA, to 5.59 (*SD* = 3.06) for those with low PA, to 6.79 (*SD* = 3.86) for those with depressive symptoms. Compared with those with low PA, those with high PA had PSQI scores that were on average 1.12 points lower (*p* = .02), whereas those with

Table 1. Sleep, Caregiving, and Sociodemographic Characteristics of Total Sample and by PA Category

Variable	Total sample (n = 229)	High PA (n = 122)	Low PA (n = 69)	Depressive symptoms (n = 38)	p Value across PA categories
Total PSQI score: *M* (*SD*)	5.19 (3.26)	4.48 (2.96)	5.59 (3.06)	6.79 (3.86)	<.01
Caregivers: *n* (%)	92 (40.17)	43 (35.25)	31 (44.93)	18 (47.37)	.12
Age: *M* (*SD*)	73.82 (7.89)	74.00 (7.49)	74.82 (8.07)	71.54 (8.55)	.11
Female gender: *n* (%)	157 (68.56)	77 (63.11)	49 (71.01)	31 (81.58)	.03
College education or more: *n* (%)	173 (75.55)	97 (79.51)	54 (78.26)	22 (57.89)	.02
White race: *n* (%)	191 (83.41)	105 (86.07)	56 (81.16)	30 (78.95)	.24
Married: *n* (%)	124 (54.15)	64 (52.46)	39 (56.52)	21 (55.26)	.66
Number of medical conditions: *M* (*SD*)	2.71 (1.60)	2.42 (1.41)	2.91 (1.62)	3.26 (1.93)	.01
Participate in moderate physical activity: *n* (%)	104 (45.41)	56 (45.90)	40 (57.97)	8 (21.05)	.08
Uses sleeping medication: *n* (%)	57 (24.90)	26 (21.32)	17 (24.64)	14 (36.84)	.02
Takes antidepressant or antianxiety medications: *n* (%)	50 (21.83)	16 (13.11)	16 (23.19)	18 (47.37)	<.01
Among caregivers only	**All caregivers (n = 92)**	**High PA (n = 43)**	**Low PA (n = 31)**	**Depressive symptoms (n = 18)**	**p Value across PA categories**
Alzheimer's caregivers: *n* (%)	44 (47.83)	18 (41.86)	17 (54.84)	9 (50.00)	.54
Parkinson's caregivers: *n* (%)	48 (52.17)	25 (58.14)	14 (45.16)	9 (50.00)	.54
Live with care recipient: *n* (%)[a]	77 (84.62)	35 (81.40)	27 (90.00)	15 (83.33)	.60
Spouse of care recipient: *n* (%)[a]	72 (79.12)	30 (69.77)	27 (90.00)	15 (83.34)	.02
Number of ADLs assisting with: *M* (*SD*)	2.80 (2.23)	2.28 (2.06)	3.03 (2.31)	3.67 (2.25)	.07
Number of IADLs assisting with: *M* (*SD*)	5.43 (1.60)	5.0 (1.79)	5.80 (1.45)	5.83 (1.10)	.05

Notes: ADLs = activities of daily living; IADLs = instrumental activities of daily living; PA = positive affect; PSQI = Pittsburgh Sleep Quality Index.
[a]n = 91.

depressive symptoms had mean PSQI scores that were 1.20 points higher (p = .06; Table 2). In multivariable models, participants with high PA had significantly better PSQI scores than those with low PA, whereas participants with depressive symptoms did not differ from those with low PA (Table 2). With regard to the PSQI components, respondents with high PA reported significantly better Subjective Sleep Quality (p < .01) and less Daytime Dysfunction (p < .01) than respondents with low PA, whereas those with depressive symptoms had poorer functioning. PA was not associated with any of the other PSQI components.

PA and Sleep Quality Stratified by Caregiving Status

In unadjusted analyses among caregivers, mean PSQI scores increased from 4.00 (*SD* = 2.94) in those with high PA, to 5.77 (*SD* = 2.80) in those with low PA, to 7.17 (*SD* = 4.08) in those with depressive symptoms (Table 2). Noncaregivers exhibited a similar pattern, with mean PSQI scores ranging from 4.73 (*SD* = 2.96) in those with high PA, to 5.45 (*SD* = 3.29) in those with low PA, to 6.45 (*SD* = 3.72) in those with high depressive symptoms.

Similar patterns between PA and sleep problems were observed in multivariable models as in unadjusted analyses. Among caregivers, adjusted mean PSQI scores rose from 4.16 (*SE* = 0.50) to 5.69 (*SE* = 0.58) to 6.92 (*SE* = 0.80) in those with high PA, low PA, and depressive symptoms, respectively (Table 2). Among noncaregivers, adjusted PSQI scores also rose from those with high PA (4.88, *SE* = 0.35) to low PA (5.38, *SE* = 0.51) to depressive symptoms (5.99, *SE* = 0.73), although these scores were not significantly different from each other. However, the relationship between high PA and PSQI score did not differ significantly between caregivers and noncaregivers (z score = –1.07, p = .28) nor did the relationship between depressive symptoms and PSQI (z score = 0.09, p = .93). An unstratified analysis with interaction terms representing caregiver status with each PA and depressive level found similar results.

In adjusted models, both caregivers and noncaregivers with high PA showed nonstatistically significant trends toward better Subjective Sleep Quality scores than respondents with low PA (Table 3). Respondents with depressive symptoms did not differ in Subjective Sleep Quality from those with low PA. The associations between PA and

Table 2. Associations Between PA and Depressive Symptoms With Total PSQI Score, Unadjusted and Adjusted Linear Models for the Total Sample and Stratified by Caregiving Status

	Unadjusted						Adjusted[a]					
	Total sample		Caregivers		Noncaregivers		Total sample		Caregivers		Noncaregivers	
	β (95% CI)	*p* Value	β (95% CI)	*p* Value	β (95% CI)	*p* Value	β (95% CI)	*p* Value	β (95% CI)	*p* Value	β (95% CI)	*p* Value
High PA[b]	–1.12 (–2.05, –0.18)	.02	–1.77 (–3.25, –0.30)	.02	–0.71 (–1.95, 0.52)	.26	–0.98 (–1.92, –0.04)[b]	.04	–1.53 (–3.08, 0.01)	.05	–0.50 (–1.72, 0.72)[b]	.42
Low PA	Ref	—	Ref	—	Ref	—	Ref	—	Ref	—	Ref	—
Depressive symptoms[c]	1.20 (–0.06, 2.45)	.06	1.39 (–0.46, 3.24)	.14	1.00 (–0.73, 2.73)	.25	0.72 (–0.59, 2.02)[c]	.28	1.22 (–0.74, 3.19)	.22	0.61 (–1.19, 2.41)[c]	.51

Notes: PA = positive affect; PSQI = Pittsburgh Sleep Quality Index.
[a]Adjusted for age, gender, education, number of medical conditions, and physical activity.
[b]z Score for adjusted difference in PSQI scores for those with high PA and those with low PA, comparing caregivers and noncaregivers, was –1.07 (p = .28).
[c]z Score for adjusted difference in PSQI scores for those with depressive symptoms and those with low PA, comparing caregivers and noncaregivers, was 0.09 (p = .93).

Subjective Sleep Quality were similar for caregivers and noncaregivers with high PA (z score = −0.45, p = .66) and those with depressive symptoms (z score = 0.53, p = .60). For the Daytime Dysfunction component, caregivers with high PA, but not noncaregivers with high PA, reported slightly less dysfunction than those with low PA. By contrast, noncaregivers with depressive symptoms reported significantly worse Daytime Dysfunction than those with low PA, whereas there was no association among caregivers. The associations between PA and Daytime Dysfunction did not significantly differ between caregivers and noncaregivers with high PA (z score = −1.21, p = .22) or those with depressive symptoms (z score = −1.71, p = .24).

Discussion

In this cross-sectional study, we found that compared with older adults with low PA, those with high PA had significantly fewer sleep problems. Participants with depressive symptoms had more sleep problems than those with low PA, but this association was not statistically significant. Furthermore, caregivers but not noncaregivers with high PA reported fewer sleep problems than those with low PA, suggesting that caregiving modified the relationship between PA and sleep. Thus, the results partially supported our hypothesized association between PA and sleep problems. The results also supported our hypothesis that high PA would have a stronger, protective impact on sleep in caregivers than noncaregivers.

The mean PSQI score of 5.19 in our sample reflects moderate sleep problems and is consistent with previous studies of older adults (Brummett et al., 2006; Buysse et al., 1991; Fonareva et al., 2011; Martin et al., 2011). In exploratory analyses, we found that, consistent with published literature (Bower et al., 2010), high PA was more strongly associated with Subjective Sleep Quality and Daytime Dysfunction than with other components of the PSQI. Our stratified multiple regression analyses also found differences between caregivers and noncaregivers in the relationships between PA and these PSQI components.

To our knowledge, the present study was the first to compare the associations between high and low PA, as well as depressive symptoms, with sleep problems in older caregivers and noncaregivers. Our results are consistent with previous studies of PA and sleep problems (Bower et al., 2010; McCrae et al., 2008; Steptoe et al., 2008). Although two of these studies focused on older adults (McCrae et al., 2008; Steptoe et al., 2008), none directly compared participants with high and low PA. One study (McCrae et al., 2008) found that PA was associated with Subjective Sleep Quality but not with objective sleep quality in older adults, supporting our use of the PSQI, a subjective sleep quality measure. That study found that current PA was influenced by the prior night's sleep but did not evaluate the association between PA and sleep on the subsequent night. Other studies suggest that PA and sleep are associated through a bidirectional relationship (Steptoe et al., 2008), consistent with evidence of bidirectional relationships between affect or general stressors and sleep quality (Vitaliano, Murphy, Young, Echeverria, & Borson, 2011). Future research should examine the directionality of this association because our cross-sectional design prevented assessment of the temporal relationships among these factors. However, our finding that high PA and depressive symptoms were more strongly associated with sleep in caregivers than noncaregivers would have similar clinical implications, regardless of the directionality of this relationship.

Differences in PA may have contributed to the inconsistent results across previous studies of caregiving, depressive symptoms, and sleep problems. Although we found comparable prevalence of sleep problems in caregivers and noncaregivers, we observed fewer sleep problems among high PA than low PA caregivers in multivariable models. Several studies reported poorer sleep among caregivers to a relative with dementia compared with noncaregivers, but controlling for depressive symptoms eliminated these associations (Brummett et al., 2006; Rowe, McCrae, Campbell, Benito, & Cheng, 2008). In contrast, another study found that older women caregivers and noncaregivers who were not depressed did not differ in sleep quality; however, caregivers who were depressed had more sleep problems than nondepressed noncaregivers (Kochar et al., 2007). To our knowledge, no published study on caregiving and sleep problems has also considered PA.

Our findings regarding PA, caregiving, and sleep may be explained by psychological, physiological, or social characteristics of PA. From a psychological standpoint, individuals with high PA report better general health and fewer physical symptoms of underlying disease (Pressman & Cohen, 2005), suggesting that regardless of objective sleep quality, participants with high PA

Table 3. Associations Between PA and Depressive Symptoms With Subjective Sleep Quality and Daytime Dysfunction, Unadjusted and Adjusted Linear Models Stratified by Caregiving Status

	Unadjusted				Adjusted[a]			
	Caregivers		Noncaregivers		Caregivers		Noncaregivers	
	β (95% CI)	*p* Value	β (95% CI)	*P* Value	β (95% CI)	*p* Value	β (95% CI)	*p* Value
Subjective Sleep Quality								
High PA	−0.29 (−0.61, 0.02)	.07	−0.20 (−0.46, 0.05)	.12	−0.29 (−0.62, 0.04)[b]	.09	−0.19 (−0.44, 0.06)[b]	.14
Low PA	Ref	—	Ref	—	Ref	—	Ref	—
Depressive symptoms	0.42 (0.02, 0.82)	.04	0.20 (−0.15, 0.56)	.26	0.28 (−0.14, 0.70)[c]	.19	0.13 (−0.24, 0.50)[c]	.49
Daytime Dysfunction								
High PA	−0.29 (−0.59, 0.02)	.07	−0.06 (−0.31, 0.19)	.63	−0.28 (−0.60, 0.05)[b]	.09	−0.01 (−0.26, 0.24)[b]	.92
Low PA	Ref	—	Ref	—	Ref	—	Ref	—
Depressive symptoms	0.11 (−0.27, 0.50)	.55	0.37 (0.01, 0.72)	.04	0.09 (−0.33, 0.50)[c]	.68	0.42 (0.06, 0.79)[c]	.02

Note: PA = positive affect.

[a]Adjusted for age, gender, education, number of medical conditions, and physical activity.

[b]*z* Score for adjusted difference in Subjective Sleep Quality scores for those with high PA and those with low PA, comparing caregivers and noncaregivers, was −0.45 ($p = .66$). *z* Score for adjusted difference Daytime Dysfunction scores for those with high PA and those with low PA, comparing caregivers and noncaregivers, was −1.21 ($p = .22$).

[c]*z* Score for adjusted difference in Subjective Sleep Quality for those with depressive symptoms and those with low PA, comparing caregivers and noncaregivers, was 0.53 ($p = .60$). *z* Score for adjusted difference in Daytime Dysfunction for those with depressive symptoms and those with low PA, comparing caregivers and noncaregivers, was −1.71 ($p = .24$).

may report fewer sleep problems than their low PA counterparts. Analyses of our sample supported better health in participants with high PA on measures ranging from self-reported medical conditions to objective measures of timed walking pace. Caregivers with high PA may perceive themselves as strong, capable individuals, and thus may be less likely than noncaregivers to report sleep problems. Several studies have found that PA has a stronger influence on health under stressful conditions (Folkman & Moskowitz, 2000; Zautra, Johnson, & Davis, 2005) and caregivers tend to be under greater psychological stress than noncaregivers. Therefore, caregivers with high PA might experience greater protection against sleep problems than noncaregivers with high PA.

Both PA and caregiving may affect sleep quality through common physiological pathways. High PA is associated with lower levels of the stress hormones cortisol and interleukin-6 (IL-6) (Steptoe et al., 2008). Caregiving is associated with elevated stress hormones, such as cortisol (Prinz, Bailey, & Woods, 2000), IL-6, and insulin (Vitaliano, Scanlan, Krenz, & Fujimoto, 1996). In our sample, perceived stress levels decreased from participants with depressive symptoms to those with low PA to those with high PA, and caregivers were more stressed than noncaregivers. Higher cortisol levels, associated with both low PA and caregiving, are linked with impaired sleep in older adults (Prinz et al., 2000). If caregivers are more susceptible to the physiological impact of affective states because they are under chronic stress, then the physiological benefits of high PA may be greater and the physiological harm of depression may be worse in caregivers than in noncaregivers. This may contribute to our observation of a greater PA-related difference in sleep problems among caregivers than noncaregivers.

Finally, persons with higher PA have stronger social ties than other adults (Cohen & Pressman, 2006). Greater social interaction has been associated with better sleep quality (Friedman, 2011). Caregivers tend to have less time to maintain social relationships; however, caregivers with high PA may be more likely to seek out social opportunities than noncaregivers who have not experienced a lapse in their social lives. This association between high PA and social interaction may also contribute to observed differences in sleep problems across the groups of caregivers and noncaregivers.

This study had several limitations. Like most studies of PA and sleep problems (Bower et al., 2010; Steptoe et al., 2008; Stewart, Rand, Hawkins, & Stines, 2011) and caregiving and sleep problems (Fonareva et al., 2011; McKibbin et al., 2005; Spira et al., 2010), it was cross-sectional and therefore was unable to assess the temporal relationship between PA and sleep problems. Few participants reported depressive symptoms, thereby limiting the power to detect statistically significant differences between participants with high depressive symptoms and those with low PA, or between associations stratified by caregiver status. Our measure of PA came from the CES-D scale, which was not originally designed for this purpose, but factor analyses have consistently identified PA as a separate factor that improves the fit of the CES-D scale (Blazer & Hybels, 2004; Edwards, Cheavens, Heiy, & Cukrowicz, 2010). Additionally, our measure of sleep problems was based on self-report, which differs from objective sleep measures in some studies (Martin et al., 2011; McCrae et al., 2008; Rowe et al., 2008; von Kanel et al., 2012) but was better than objective sleep measures at predicting 1-year mortality (Martin et al., 2011); this is important when considering the long-term impact of sleep problems.

This study also had a number of strengths. Sleep was measured using the PSQI, which is the most frequently used self-report sleep measure (Kim & Rose, 2011) and has excellent reliability and validity (Buysse et al., 1989). PA and depressive symptoms were measured using the CES-D scale, which is widely used in studies of community-dwelling older adults. Based on published methods (Fredman et al., 2006; Ostir et al., 2002), we distinguished participants with high depressive symptoms from those with PA and then differentiated respondents with high and low levels of PA. Post hoc analyses using alternative categorization of the CES-D score confirmed that our results were not simply due to differences in levels of depressive symptomology but reflected a protective effect specific to high PA. Previous studies were unable to disentangle the independent effects of depressive symptoms and caregiving on sleep problems because these measures were highly correlated. However, depressive symptoms and caregiving were not strongly correlated in our sample. Thus, we were able to investigate the separate and combined effects of depressive symptoms and caregiving on sleep problems. Differences did exist between caregivers and noncaregivers on characteristics such as stress, affect, and activity levels, providing possible explanations for our findings. We also fit two separate regression models and

used z statistics to compare the associations of PA and sleep problems between caregivers and noncaregivers, which allowed the associations between covariates and sleep quality to differ for caregivers and noncaregivers; an alternative approach using statistical interaction terms erroneously assumes that the association between covariates and sleep quality is the same for both caregivers and noncaregivers. Finally, our sample included caregivers to adults with Parkinson's disease and caregivers to adults with dementia, allowing our findings to be generalizable to a broader population.

In conclusion, these results suggest that PA might be important for the prevention of sleep problems in older adults. Caregivers experiencing sleep problems who have depressive symptoms or low PA might be good candidates for interventions that increase PA (Moskowitz et al., 2012) and reduce depressive symptoms. Recent studies have shown that clinical interventions can increase PA (Charlson et al., 2007; Moskowitz et al., 2012) and subsequently improve health behaviors (Ogedegbe et al., 2012). A brief PA intervention might reduce sleep problems, thus avoiding the need for sleep medications while simultaneously improving overall quality of life for caregivers and older adults in general. Given that sleep problems are associated with adverse health outcomes and mortality in older adults, our results suggest that better sleep may be a mediator of the association between PA and health outcomes; future prospective studies should examine these relationships.

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