Sleep Pattern Differences Between Older Adult Caregivers and Older Adult Noncaregivers Using Objective and Subjective Measures

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Sleep Pattern Differences Between Older Adult Dementia Caregivers and Older Adult Noncaregivers Using Objective and Subjective Measures

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Study Objectives: Informal caregivers of persons with dementia often complain about poor quality sleep; however, studies on caregivers have mixed results when examining sleep values. The purpose of this study was to describe the sleep patterns in a subset of dementia caregivers who provide care during the night, and compare those patterns to noncaregiving adults.

Methods: Data from a study on dementia caregivers and from a study of sleep in older adults were used. Both studies used objective and subjective methods to measure sleep in the home setting over a 7-day period. Participants were over 60 years old and relatively healthy.

Results: Older dementia caregivers had worse objectively measured sleep than noncaregiving older adults, characterized by fewer minutes asleep and longer time to fall asleep. For subjectively measured sleep, depressive symptoms were the only predictive factor, with depressed participants reporting longer total sleep time, greater sleep onset latency, and wake after sleep onset. Caregivers’ sleep had greater night-to-night variability.

Conclusions: Caregivers consistently report poorer quality sleep and greater fatigue than noncaregivers. However, when sleep is measured objectively and subjectively, a mixed picture emerges regarding sleep deficits. Thus sleep changes are caused by a multitude of factors affecting sleep in a variety of ways. It is important for health care providers to assess sleep adequacy and depression in caregivers.

Keywords: Dementia, Alzheimer’s disease, caregivers, sleep, nighttime activity

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The majority of persons with dementia (PWD) are cared for in the home setting by informal caregivers, usually a female relative. Researchers have reported a variety of changes in caregiver sleep including changes in sleep quantity and quality. Because the results are variable, however, research is needed to determine whether there are factors that predict which caregivers are at risk for poor sleep. Accurate assessment and prevention is critical, because poor sleep in caregivers has been associated with sympathoadrenal medullary arousal, changes in immune function, poorer psychological state, and early institutional placement of the PWD. Additionally, interventions could be better targeted to the factors associated with poor sleep in dementia caregivers.

While caregivers consistently report poorer sleep quality than noncaregivers, the picture is not as clear when sleep is measured objectively or subjectively. In some studies, sleep quantity was considered normal because it was similar to age-matched controls, while in other studies, poorer sleep was attributed to causes such as depression or caregiver burden rather than caregiver status.

One reason for inconsistent findings may be the sampling strategy used in previous studies, namely, that all dementia caregivers were sampled regardless of the nighttime activity in the PWD. Approximately 25% to 54% of PWD have significant changes in their sleep-wake cycle, causing awakenings at night. These awakenings could have a significant impact on caregiver sleep quantity, since the PWD often requires supervision when up at night. This supervision is critical to prevent injuries, such as falls or inappropriate actions, such as home exits, associated with cognitive impairments typically seen in dementia. Thus caregivers who supervise PWD with nighttime activity are potentially most at risk for substantial sleep changes or disturbances. Secondly, inconsistent findings may be due to inadequate measurement of sleep. Thus research on caregiver sleep, using commonly accepted sleep measurements (e.g., sleep diaries and actigraphy over a period of time), is needed to fill this gap in knowledge.

Caregivers of PWD may develop night-to-night sleep deficits caused by the need to provide supervision or other caregiving tasks, and they may attempt to make up for this by sleeping longer in subsequent nights. If, however, researchers only examine the week’s mean values of sleep and wake variables, values may appear normal, and the pattern of high variability

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in night-to-night sleep would be lost. The perception of sleep adequacy may be affected by this inconsistent pattern of sleep over the week. Hence, analysis of the intra-individual variability of night-to-night sleep may help explain why most caregivers complain of poor sleep quality even if sleep times are in a normal range.

The purposes of this study were threefold:

1. To quantify sleep parameters in older adult caregivers of PWD with nighttime activity over a 7-day period in the natural caregiving setting (using both objective and subjective sleep measurement methods) and to compare these findings to a group of noncaregiving older adults.

The following measurements and variables were used:

a. Actigraphy (objective): total sleep time (TST), sleep onset latency (SOL), wake after sleep onset (WASO), and sleep efficiency (SE).

b. Sleep diary (subjective): total sleep time (TST), sleep onset latency (SOL), wake after sleep onset (WASO), sleep efficiency (SE), and sleep quality (SQ) rating.

c. Daytime functioning: Epworth Sleepiness Scale (ESS) and Fatigue Severity Scale (FSS).

d. To examine the night-to-night variability in caregivers’ sleep patterns and to compare these with sleep patterns of noncaregiving adults.

5. To explore the correlation patterns of sleep measured subjectively and objectively between caregivers and noncaregivers.

METHODS

Design

This was a post-hoc descriptive, correlational study. Caregiver data were taken from baseline measures of a study of dementia caregivers designed to test the effectiveness of a nighttime activity monitoring system in improving sleep in caregivers. Data for noncaregiving, relatively healthy, community-based older adults were taken from a previously studied sample described elsewhere. For both samples, sleep was measured objectively with actigraphy using the Mini Mitter Actiwatch-L and subjectively with self-report sleep diaries for 7 consecutive days of normal routine. Demographic, clinical, and questionnaire data were collected on Day 1, and subjective/objective sleep data collection began that night.

Participants

Informal caregivers ≥ 60 years of age providing direct care to a person with dementia with nighttime activity were recruited. Inclusion criteria for the caregiver subsample included the following: (a) ability to speak and read English; (b) not undergoing active treatment for sleep disorders (e.g., using prescription medications or sleep apnea treatments on a nightly basis); (c) living with the care recipient; and (d) a Mini-Mental Status Exam (MMSE) score ≥ 27. In addition, the care recipient was required to have an MMSE < 23, a medical diagnosis of dementia, and nighttime awakenings as reported by the caregiver. The sample size for the caregiver population was 31.

The noncaregiving older adult subsample was taken from a previous study on sleep in older adults who were relatively healthy, living in the community, and not diagnosed with sleep disorders other than insomnia; the study methods and sample characteristics have been previously reported. Interested participants were prescreened by telephone. In-person screening interviews were then conducted to include participants who met these criteria: (a) ≥ 60 years of age; (b) no self-report of sleep disorders diagnoses other than insomnia (e.g., sleep apnea, narcolepsy, restless leg syndrome); (c) no self-report of symptoms suggestive of other sleep disorders (e.g., heavy snoring, gasping for breath, leg jerks, daytime sleep attacks); (d) no severe psychiatric disorders (e.g., thought disorders, high levels of depressive symptomatology); (e) no cognitive impairment, defined as scoring in the impaired range on 3 or more subtests of the Cognistat; (f) no regular use of psychotropic or other medications (e.g., β-blockers) known to alter sleep; and (g) no medical conditions that affected the individual’s ability to be completely independent in normal daily functions. The sample size for the noncaregiving sample was 102.

The 2 subsamples were recruited throughout an entire calendar year from communities in North and Central Florida using similar methods (solicitation through media advertisements, community groups, and flyers). In addition, the dementia caregiver subsample was recruited through dementia support group leaders and announcements in the local chapter’s newsletter of the Alzheimer’s Association. Both studies received approval from a research university’s Institutional Review Board.

Measures

Objective Sleep

Actigraphy data were collected using the 2-channel Actiwatch-L with an integral ambient light sensor (max 150,000 lux) and an omnidirectional accelerometer with a sensitivity of ≥ 0.01 g-force worn on the participant’s nondominant wrist. Integrated degree and speed of motion sensed were used to calculate “counts” or values of activity. This digitally integrated method of examining motion is recommended as the most accurate, reflecting intensity of movement as well as number of motions. We utilized a 30-sec recording epoch for both samples in the study, which allows storage of 7.5 continuous 24-h periods of data.

In our noncaregiving subsample, there were 7 days’ worth of data for all participants. In the caregiving sample, participants were instructed to wear the watch for 7 consecutive days and nights. If the subject was not able/did not do this, data were used if a minimum of 3 sleep periods were collected. This minimum was chosen because recommendations made by the American Association of Sleep Medicine indicate that actigraphic studies should collect ≥ 3 days/ Nights of data for adequate representation of the subject’s sleep patterns.

Data were analyzed using Actiware-Sleep v. 3.3. The medium threshold/sensitivity setting was used in both samples, where total activity values > 40 are necessary in order to score an epoch as wake. Since both total sleep and total wake parameters are important in older adults and caregivers, we chose the medium threshold algorithm. A study comparing poly-
somnography to the same brand of actigraphy found that the values obtained using the medium threshold algorithm were in close agreement with polysomnography findings, and the total sleep time, sleep efficiency, and total wake times using actigraphy were not significantly different from polysomnographic values. Although the sample characteristics differed from this study, the researchers demonstrated that as detecting sleep accurately (sensitivity) increases, detecting wake accurately (specificity) decreases. Thus, the medium threshold algorithm was chosen, since we were interested in both sleep and wake variables.

In both samples, sleep diary recordings were used to begin the determination of the Bedtime and Out-of-Bed analysis window. The nearest point corresponding to objective signs of bedtime and out-of-bed activity (change in activity and light) was used as either Bedtime or Out of Bed Time. If objective signs differed (light changes occurred at a different point than activity changes), then the objective sign closest to the sleep diary time was given precedence in the decision. A single researcher in each study was responsible for establishing all Bedtime—Out-of-Bed analysis windows to ensure they were set similarly across all participants in both samples. Both researchers were trained by the same senior researcher, who substantiated that at least 10% of each subsample’s analysis windows were set correctly.

Within these analysis windows, the Actiware program scored each epoch as sleep or wake using activity values from that epoch and those surrounding it. The algorithm used to identify sleep or wake is as follows: 23

\[
\text{Total Activity Value for Epoch } A = E_{A+1}(0.20) + E_{A+2}(0.20) + E_{A+3} (0.04) + E_{A+4} (0.04)
\]

Where \( E_A \) = activity value for that epoch and \( E_{A+1}, E_{A+2}, E_{A+3}, E_{A+4} \) = activity values in adjacent epochs). If the Total Activity Value for Epoch A exceeded the threshold value of 40, it was scored as wake; values \( \leq 40 \) were scored as sleep.

These values were used by Actiware to establish sleep start and sleep end, using the 10-minute period where no more than one epoch is scored as wake or sleep, respectively. Additionally, the activity values were used to calculate sleep and wake variables within the sleep interval. Table 1 provides definitions of sleep variables selected for analyses in this study. 17

**SUBJECTIVE SLEEP**

Sleep diary data, collected simultaneously with actigraphy data, required participants to complete a standard form each morning during the study period. 24 Data were collected on bedtime, sleep start, number of awakenings, minutes awake during night, wake time, out-of-bed time, minutes spent napping the previous day, and a sleep quality rating. 24 The SQ rating was established by asking participants to rate quality of the previous night’s sleep on a 5-point scale ranging from 1 (very poor) to 5 (excellent).

**DAYTIME FUNCTIONING**

*Epworth Sleepiness Scale (ESS).* This self-administered scale was used to measure daytime sleepiness in both samples. 25

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**Table 1—Definitions of Actigraphic Sleep Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bedtime</strong></td>
<td>Set by researchers as the point at which there was a notable decrease in activity amplitude, a decrease in ambient light, and/or the time recorded in a sleep diary.</td>
</tr>
<tr>
<td><strong>Out-of-Bed time</strong></td>
<td>Set by researchers as the point at which there was a notable increase in activity amplitude, an increase in ambient light, and/or the time recorded in the sleep diary.</td>
</tr>
<tr>
<td><strong>Time in Bed</strong></td>
<td>Bed Time – Out-of-Bed time</td>
</tr>
<tr>
<td><strong>Sleep Start</strong></td>
<td>Calculated as the first 30-sec epoch in a 10-min interval in which only one epoch is scored as wake.</td>
</tr>
<tr>
<td><strong>Sleep End</strong></td>
<td>Calculated as the last 30-sec epoch with no activity in the 10-min interval before Get up Time.</td>
</tr>
<tr>
<td><strong>Total Sleep Time</strong></td>
<td>Amount of time scored as sleep between Sleep Start and Sleep End.</td>
</tr>
<tr>
<td><strong>Wake After Sleep</strong></td>
<td>Amount of time scored as wake between Onset and Sleep End.</td>
</tr>
<tr>
<td><strong>Onset (WASO)</strong></td>
<td>(Total Sleep Time x Time in Bed) x 100</td>
</tr>
<tr>
<td><strong>Sleep Efficiency (SE)</strong></td>
<td>Time in minutes between Bedtime and Sleep Start.</td>
</tr>
<tr>
<td><strong>Sleep Onset Latency (SOL)</strong></td>
<td>Time in minutes between Bedtime and Sleep Start.</td>
</tr>
</tbody>
</table>

Eight common daytime activities, such as watching television or driving, were scored with regard to how likely they were to induce sleep, ranging from 0 (would never doze) to 3 (high chance of dozing). Possible summed scores ranged from 0–24 with higher scores indicating more daytime sleepiness. The ESS has demonstrated adequate validity and reliability, and is a simple, inexpensive measure. 25 26 The Cronbach α in this study for the caregiver subsample was 0.73; for the noncaregiving subsample, it was 0.62.

**Fatigue Severity Scale (FSS).** The FSS measures impact of fatigue on functional outcomes using 9 items scored on a 7-point scale (1 = strongly disagree, 7 = strongly agree). 27 Item scores are averaged to create a mean FSS score. The FSS has high internal consistency, concurrent validity, good test-retest reliability, is sensitive to change, and discriminates well. 28 29 Because of an electronic coding error, one item was deleted from the caregiver subsample, and means for available items for both groups were reported. The Cronbach α for the noncaregiver sample was 0.91; the caregiver subsample was 0.88.

**DEPRESSIVE SYMPTOMS**

A different measure of depressive symptoms was used in each sample, thus z-scores were created for each subject for comparison between the 2 subsamples. The z-scores were calculated using previously published normative data from each instrument (see below). Values reported herein represent individual participants’ scores minus the mean for established normative data, and then divided by the standard deviation for the subsample.

The Beck Depression Inventory-II (BDI-II) was used to measure depressive symptoms in the noncaregiving subsample. 30 31 The BDI-II was developed to indicate presence and severity of depressive symptoms (over the past 2 weeks) consistent with
DSM-IV criteria for depression. Each item is rated on a 4-point scale (0-3); the total possible score is 63, with higher scores indicating more severe depressive symptoms. Previous researchers have demonstrated internal consistency (0.92-0.93), test-retest reliability (0.93), and also content, construct, and factorial validity.\textsuperscript{12,34} The BDI-II has also demonstrated no difference according to age, sex, or ethnicity in later research.\textsuperscript{31,35,36} The comparative normal group used in the initial psychometrics and for creating our z-scores consisted of 120 predominately white college students (mean age 19.58 years), who had a mean score of 12.56 (SD = 9.93).\textsuperscript{30}

The Center for Epidemiologic Studies Depression scale (CES-D)\textsuperscript{37} was used to measure depressive mood in the caregiver subsample. Designed as a self-report measure of current depressive symptomatology, the CES-D asks respondents to rate how often they have had the 20 symptoms during the last week, on a 4-point scale from “rarely or none of the time” to “most of the time.” Sum scores range from 0 to 60, with higher scores indicating more depressive symptoms. Three normative samples and one patient sample were used to establish parameters, with the largest normative adult sample (N = 2514) demonstrating a mean of 9.25 (SD = 8.58). The CES-D was found to have high internal consistency and adequate test-retest reliability, as well as demonstrated validity.\textsuperscript{37} In addition, the CES-D has been used successfully to assess prevalence of symptoms in the elderly and has demonstrated excellent sensitivity and specificity with regard to detecting a high level of depressive symptoms in older adults.\textsuperscript{38,39} In the original form, 4 items on the CES-D were worded in the positive direction to assess for positive affect, requiring reverse scoring of these items.\textsuperscript{37} Later research called into question the validity of using the positive affect questions within the tool.\textsuperscript{40} Thus, in the current research, the 4 positively worded questions were changed to reflect negative affect.

Although the CES-D and BDI-II measure similar constructs, they are not identical. The BDI-II measures severity of symptoms, while the CES-D assesses frequency of indicators. However, in a study that compared the 2 measures in the same sample, adequate comparability was demonstrated with a Pearson $r$ of 0.69 ($p < 0.001$), suggesting similar concepts are measured.\textsuperscript{36}

Statistical Analysis

SPSS 14.0 and SAS 9.1 were used to analyze the data. Descriptive statistics, including an intra-individual coefficient of variation (I-I CV) to describe night-to-night variation,\textsuperscript{31,42} were used to compare the samples with regard to demographic and clinical variables. Subjective and objective sleep variable 7-day means, as well as daytime functioning parameters of sleepiness and fatigue, were compared using traditional descriptive statistics and $t$-tests.

Repeated measurement analyses were performed using mixed effect models, which have become a primary method for analysis of longitudinal data. Mixed effect models can efficiently handle unbalanced data and estimate both effects of covariates and variance components simultaneously while accounting for fixed effects of participant characteristics and for correlation between repeated measurements from the same participant. In this study, we used mixed effect models to examine the within-participant, night-to-night variance in caregivers’ and noncaregivers’ sleep variables to determine if the night-to-night variance was different between the 2 groups. At the same time, we modeled the between-group (fixed effects) differences with TST$_{ok}$, SOL$_{ok}$, WASO$_{ok}$, as outcomes and with fixed covariates of age, education, depression z score, and number of prescribed medications. As there was no significant time trend in measurements of sleep variables, a time trend was not included in these models as a fixed effect. The mixed effect models are specified by the following expressions:

$$ y_{ij} = x_{ij}' \beta + s_{ij} + e_{ij} \quad \text{where } i = 1, 2, ..., n \text{ participants, } j = 1, 2, ..., m \text{ occasions, } y_{ij} \text{ is the measurement of a sleep variable of individual } i \text{ on occasion } j; x_{ij} \text{ is the vector of regressors, including group, age, education, depression and medication, and } \beta \text{ is the corresponding vector of regression coefficients; the random subject effect } s \sim N(0, \sigma_s^2) \text{ and } \sigma^2_{\text{by}} \text{ represents the between-participants variance; and the errors } e_{ij} \sim N(0, \sigma^2_{\text{by}}) \text{ and } \sigma^2_{\text{by}} \text{ are the within-participants night-to-night variance for } g = \text{ caregivers or noncaregivers group; that is, we allowed the between-participants and within-participants variances to be different for 2 groups. Then we tested whether the variances were significantly different between 2 groups.}$

For each of the subsamples, objective sleep measures were compared with subjective sleep measures by group and by depression score. Pearson $r$ correlations and $t$-tests were used to compare the groups. Descriptive statistics of under- and over-reported comparisons of objective to subjective measures were reported. Because of the exploratory nature of this research question, the $\alpha$ level was set at 0.01.

RESULTS

Descriptive Statistics

In general, both noncaregiver ($n = 102$) and caregiver ($n = 31$) samples were predominantly female (64% and 74%, respectively), white (96% and 97%, respectively), and currently married (72% and 84%, respectively). Ages ranged from 60 to 89 years in the noncaregiver sample (M = 72.8, SD = 6.8) and 61 to 86 years in the caregivers (M = 70.7, SD = 7.8). There were no significant differences between groups with regard to age, gender, race, or marital status. The noncaregiver sample had a significantly greater level of education (40% with graduate education) than the caregiver sample (13% with graduate education) ($\chi^2 = 17.16, p = 0.002$).

Two measures were collected to evaluate the effect of sleep on daytime functioning. Sleepiness during the day (ESS) was significantly higher for caregivers than noncaregivers (M = 15.13, SD = 3.60 and M = 7.93, SD = 3.16, respectively; $t = 10.62, p < 0.001$). Fatigue severity (FSS) scores were not significantly different between groups.

Since high levels of depressive symptoms and poorer health are both associated with changes in sleep, groups were compared on these variables. Caregivers had significantly higher depressive symptom scores than noncaregivers, with z-scores of $0.50 \pm 1.14$ and $-0.73 \pm 0.48$, respectively ($t = 5.83, p < 0.001$). There were no significant differences in the number of medications, used as a proxy variable for health status in this
Differences in Objective and Subjective Sleep Variables by Group

<table>
<thead>
<tr>
<th>Measure</th>
<th>Objective (actigraphy)</th>
<th>Subjective (sleep diary)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-caregiver</td>
<td>Caregiver</td>
</tr>
<tr>
<td>TST</td>
<td>Mean</td>
<td>428.67</td>
</tr>
<tr>
<td></td>
<td>I-I CV</td>
<td>12.38</td>
</tr>
<tr>
<td>SE</td>
<td>Mean</td>
<td>87.27</td>
</tr>
<tr>
<td></td>
<td>I-I CV</td>
<td>5.36</td>
</tr>
<tr>
<td>SOL</td>
<td>Mean</td>
<td>12.52</td>
</tr>
<tr>
<td></td>
<td>I-I CV</td>
<td>102.18</td>
</tr>
<tr>
<td>WASO</td>
<td>Mean</td>
<td>40.73</td>
</tr>
<tr>
<td></td>
<td>I-I CV</td>
<td>37.04</td>
</tr>
<tr>
<td>SQ</td>
<td>Mean</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>I-I CV</td>
<td>---</td>
</tr>
</tbody>
</table>

TST = total sleep time; SE = sleep efficiency; SOL = sleep onset latency; WASO = wake after sleep onset; SQ = subjective sleep quality; I-I CV = Intra-Individual Coefficient of Variation (SD / Mean X 100).

study, indicating relatively similar health status ($t = 0.64$, $p < 0.53$).

**Objective Sleep Measured with Actigraphy**

The univariate and bivariate analyses of sleep variables are displayed in Table 2. Caregivers had significantly lower TST, and SE, and had longer SOL. However, both groups had a substantial amount of WASO, and this variable did not significantly differ between groups.

Not only did caregivers get less overall sleep with lower sleep efficiencies, they also had greater night-to-night variation with significantly higher TST, and SE, I-I CV values. Compared to noncaregivers, higher I-I CV values for TST indicate that caregivers had a wider night-to-night variation of minutes asleep during the 7-night recording period. In contrast, noncaregivers’ lower TST, I-I CV values indicated a more consistent amount of sleep each night. The same concept would apply to SE, I-I CV’s, with caregivers having greater night-to-night variability than noncaregivers.

While caregivers had significantly longer SOL, times, the I-I CV’s were not significantly different between caregivers and noncaregivers. However, the high I-I CV’s indicated that SOL was not consistent from night-to-night for both groups.

**Subjective Report of Sleep using a Sleep Diary**

Using bivariate analyses, caregivers had significantly lower TST, and SE. In contrast to objective measures, caregivers also had significantly higher WASO during the night than noncaregivers (see Table 2). Unlike the actigraphic data, SOL reported times did not differ between the 2 groups. Caregivers rated their sleep quality as significantly lower than noncaregivers (0.5 points on a 5-point scale).

As with objective sleep measurement, the I-I CV’s for TST, and SE were significantly greater for caregivers than noncaregivers, indicating that caregivers reported more variable sleep times from night-to-night. There were not significant differences in the I-I CV’s for SOL, WASO, or SQ, indicating that night-to-night values for these variables were not different by group. Both groups had relatively high values for SOL, and WASO.

**Mixed Effect Models of Between Group and Within Subject Differences of Sleep Variables**

In multivariate models controlling for age, education, depression, and total number of medications, group differences suggesting worse sleep in caregivers were confirmed for TST, and SOL (see Table 3). In contrast, the significant bivariate group differences for TST or WASO were not confirmed; however, depression was a significant predictor of these variables. Depression was also a significant covariate predicting SOL.

In multivariate models controlling for age, education, depression and total number of medications, group differences in intra-individual variability were similar to those seen in the bivariate models for TST and revealed even greater statistically significant differentiation between the groups for SOL, WASO, I-I CV, and WASO, all in the direction of greater variability for the caregiver group. These findings may have reflected the control over the covariates and/or the efficiency of the mixed effect models.

**Associations Between Subjective and Objective Sleep Data as a Function of Caregiving Status**

In order to explore the associations between subjective and objective sleep measures for each group, we calculated Pearson $r$ between the objective and subjective measure of each sleep variable (see Table 4, column 1) and used paired $t$-tests to determine if these values were significantly different (see Table 4, column 2). In contrast to the noncaregivers, caregivers’ subjective and objective data generally showed higher correlations between objective and subjective sleep times, and the objective and subjective times were not significantly different from each other. A difference score between partici-
somewhat surprising. Of all the sleep variables examined, during the night than noncaregivers. This latter finding was also a trend towards caregivers spending more time awake sleep than noncaregivers. Although not significant, there was a trend for depressive symptoms, age, health condition, and education for caregivers vs. noncaregivers. These discrepant findings for subjective versus objective sleep measures and caregivers versus noncaregivers are consistent with a recent review highlighting the complex, multifactorial nature of caregiver sleep. The review supports the idea that changes in caregiver sleep do not match well with other common areas of sleep research, such as insomnia or sleep apnea. Additional research is needed to further understand the unique alterations in sleep that account for poorer sleep without a concomitant increase in WASO. Unfortunately, data about the nature of night awakenings were not collected in either study; future research that collects such information is needed.

**DISCUSSION**

Older caregivers of PWD with nighttime activity reported poorer quality sleep than noncaregiving older adults and rated their sleep as fair. Caregivers also reported greater levels of daytime sleepiness than noncaregivers. These findings on self-report of poorer sleep quality in caregivers have been consistent from study to study. When sleep was measured objectively, and after adjusting for depressive symptoms, age, health condition, and education, caregivers took longer to fall asleep and had less total sleep than noncaregivers. Although not significant, there was also a trend towards caregivers spending more time awake during the night than noncaregivers. This latter finding was somewhat surprising. Of all the sleep variables examined, wake time during the night was anticipated to be particularly problematic for the caregivers, because the present sample included only caregivers who reported nighttime activity in the PWD. Thus factors that ordinarily contribute to disturbed sleep (stress, anxiety, poor health) were expected to combine with awakenings to provide care for PWD, producing greater wake time in caregivers. The present findings do not provide strong support for this argument. It is possible that although there is not greater time awake, awakenings occur erratically during the night since night awakenings in PWD differ significantly from night-to-night. The unpredictable awakenings may occur during deeper sleep, resulting in a perception of poorer sleep without a concomitant increase in WASO. Unfortunately, data about the nature of night awakenings were not collected in either study; future research that collects such information is needed.

Interestingly, the observed differences in objectively measured sleep were not duplicated when sleep was measured subjectively and the models were adjusted for level of depressive symptoms. This result may not seem surprising, given the high levels of depressive symptoms in the caregiving sample and the well-established relationship between depression and poor sleep (both subjective and objective). These discrepant findings for subjective versus objective sleep measures and caregivers versus noncaregivers are consistent with a recent review highlighting the complex, multifactorial nature of caregiver sleep. The review supports the idea that changes in caregiver sleep do not match well with other common areas of sleep research, such as insomnia or sleep apnea. Additional research is needed to further understand the unique alterations in sleep that account for poorer sleep rating and higher levels of fatigue.

Caregiver sleep was also more variable from night to night, likely indicating that poor nights of sleep are mixed with good nights of sleep. Since, on average, caregivers had only 6.5 h of sleep/night, there would be some nights caregivers did not get this amount. Since this irregular sleep pattern also promotes the perception of poor sleep, all efforts should be made to manage nighttime awakenings in the PWD to improve caregiver sleep.

### Table 3—Fixed Effects Models of Sleep Variables

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>TST (_s) Coefficient (St. error)</th>
<th>SOL (_s) Coefficient (St. error)</th>
<th>WASO (_s) Coefficient (St. error)</th>
<th>TST (_a) Coefficient (St. error)</th>
<th>SOL (_a) Coefficient (St. error)</th>
<th>WASO (_a) Coefficient (St. error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Intercept</td>
<td>393.47 (48.43)</td>
<td>13.49 (1.39)</td>
<td>23.78 (19.67)</td>
<td>426.98 (57.44)</td>
<td>41.03 (19.09)</td>
<td>69.23 (28.76)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.35 (0.64)</td>
<td>0.09 (0.14)</td>
<td>0.52* (0.26)</td>
<td>-0.85 (0.78)</td>
<td>-0.22 (0.26)</td>
<td>0.03 (0.39)</td>
</tr>
<tr>
<td>Education(^a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some high school</td>
<td>54.07* (24.53)</td>
<td>0.54 (5.15)</td>
<td>-0.24 (10.06)</td>
<td>33.87 (30.47)</td>
<td>12.91 (10.36)</td>
<td>7.73 (15.01)</td>
</tr>
<tr>
<td>High school grad</td>
<td>32.37* (14.62)</td>
<td>5.53 (3.23)</td>
<td>-1.00 (5.96)</td>
<td>0.24 (17.90)</td>
<td>16.75 (6.02)</td>
<td>8.07 (8.89)</td>
</tr>
<tr>
<td>Some college</td>
<td>28.06* (11.75)</td>
<td>1.51 (2.57)</td>
<td>-1.24 (4.79)</td>
<td>30.07 (14.78)</td>
<td>7.71 (4.90)</td>
<td>-4.56 (7.35)</td>
</tr>
<tr>
<td>College graduate</td>
<td>12.73* (11.37)</td>
<td>2.81 (2.43)</td>
<td>-3.26 (4.65)</td>
<td>17.61 (14.11)</td>
<td>1.76 (7.01)</td>
<td>-1.71 (7.01)</td>
</tr>
<tr>
<td>Depression z-score</td>
<td>-3.24 (8.11)</td>
<td>-1.10 (1.92)</td>
<td>-2.30 (3.28)</td>
<td>-23.70** (8.49)</td>
<td>6.21* (2.80)</td>
<td>12.56** (4.18)</td>
</tr>
</tbody>
</table>

TST = total sleep time; SOL = sleep onset latency; WASO = wake after sleep onset; \(_s\) = objective; \(_a\) = subjective.
St. error = standard error.
Total meds = total number of prescribed medications.
\(*p < 0.05; \**p < 0.01; \***p < 0.001

Referent category—completed graduate education; \(^b\) or more medications; \(^c\) noncaregivers.
sleep. Particular efforts are needed to reduce night-to-night sleep variability (due more to night supervision of PWD than an inability to sleep). For example, newly developed bed monitoring devices that alert caregivers when care recipients leave the bed may reduce the level of arousal and tendency to “sleep with an open ear.”44 Such devices will not prevent care recipients from receiving needed care or reduce the actual amount of time spent providing care. Instead, this reduction in sleep-interfering arousal should allow caregivers to gain deeper, more restorative sleep during those portions of the night when care is not required.

In general, sleep patterns as measured by sleep diaries were not highly correlated with sleep data collected objectively, particularly in noncaregiving older adults who complained of poor sleep. This finding was not surprising as other research efforts have also experienced difficulty finding concordance between subjective and objective measures of sleep.45 Sleep diaries and actigraphy were more highly correlated for caregivers than they were for noncaregivers, however, and this has important implications. Sleep diaries are widely used in clinical research and practice. Although they are generally considered easy to administer (requiring ~5 min/day), caregivers may consider diaries burdensome. Thus a potential benefit of the close association between actigraphy and sleep diaries is that actigraphy may serve as a suitable substitute for diaries in this population. Wearing an actigraph requires little effort and may be solely used to obtain daily sleep information without placing additional burden on caregivers. One caveat to this suggestion is that sleep diary/actigraphy comparisons conducted herein were based on weekly means of the sleep variables. As results indicate, caregiver sleep is highly variable from night to night, so future research comparing sleep diary and actigraphy on a daily basis is warranted before any definitive suggestions about the utility of actigraphy as a substitute can be made. Further investigation is also needed to determine the best algorithm threshold (medium or high) in the older adult population. Additionally, information could be collected to differentiate whether the caregiver is waking as a result of the caregiver role or for personal needs. This would help differentiate actual sleep disruptions due to caregiving, which could not be accomplished in the present study.

In conclusion, we found that caregivers’ sleep patterns are significantly worse than noncaregivers’ in some domains. In other areas, poorer sleep was related to depression rather than caregiver status. These results highlight the complex, multifactorial nature of caregivers’ sleep patterns and the need for additional research to elucidate those factors and to determine the best intervention strategies for improving caregiver sleep. It will be important for clinicians and researchers to understand tendencies of the different types of sleep measurements, particularly for non-normative populations such as caregivers. For them, objective measures appeared to be less influenced by depression, while subjective sleep measures were significantly influenced by depression. Finally, the present study illustrates the need for greater attention to the level of analysis applied to caregiver sleep data. Given findings that reflect a high degree of night-to-night variability in caregiver sleep, greater focus on intra-individual variability is warranted.

**ACKNOWLEDGMENTS**

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**REFERENCES**


### Table 4—Associations of Objective and Subjective Sleep Values by Caregiver Status

<table>
<thead>
<tr>
<th>Measure</th>
<th>r-value</th>
<th>Paired t-test</th>
<th>% reporting</th>
<th>% depressed reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noncaregivers (n = 102)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TST</td>
<td>0.49***</td>
<td>2.84***</td>
<td>44.1</td>
<td>40.0</td>
</tr>
<tr>
<td>SOL</td>
<td>0.29**</td>
<td>5.90***</td>
<td>78.4</td>
<td>86.7</td>
</tr>
<tr>
<td>WASO</td>
<td>0.28**</td>
<td>3.69***</td>
<td>25.5</td>
<td>26.7</td>
</tr>
<tr>
<td>Caregivers (n = 31)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TST</td>
<td>0.46</td>
<td>0.92</td>
<td>51.6</td>
<td>33.3</td>
</tr>
<tr>
<td>SOL</td>
<td>0.68***</td>
<td>2.52</td>
<td>67.7</td>
<td>66.7</td>
</tr>
<tr>
<td>WASO</td>
<td>0.59**</td>
<td>0.05</td>
<td>45.2</td>
<td>50.0</td>
</tr>
</tbody>
</table>

Sbj. = sleep diary; Obj. = actigraphy; TST = total sleep time; SOL = sleep onset latency; WASO = wake after sleep onset. Alpha level = 0.01, ***p < 0.001; **p < 0.01; *p < 0.05.