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Characterizing sleep problems in persons with Alzheimer's disease and normal elderly

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SUMMARY

We retrospectively analyzed sleep disturbance symptoms and estimated time in bed from the intake interviews of 399 healthy, non-demented elderly (NDE) and 263 persons with a diagnosis of possible (n = 53) or probable (n = 210) Alzheimer's disease (AD). Our primary objective was to identify what symptoms might underlie an individual's perception of 'sleep problems' and to determine if these were consistent within, and across, our two cohorts. We stratified each cohort according to whether or not they (or their caregiver) indicated that they had a 'sleep problem', and compared the frequency and endorsement rates of each of 21 sleep disturbance symptoms across those who did or did not endorse 'sleep problem'. For less than half of the symptoms in persons with AD, and a quarter of those in NDE, endorsement rates were significantly different depending on whether the reporter (or their sleep partner) did or did not report a sleep problem. Differences in mean frequency ratings between individuals reporting sleep problems relative to those not reporting were observed on 10 symptoms in both cohorts; six of these were the same symptom for both cohorts. When persons with subjective sleep problems in the AD and NDE cohorts were compared, only four of 21 symptoms were endorsed in one and not the other; two symptoms were significantly more frequent in one cohort than the other. Thus, within cohorts, the differences between persons with and without 'sleep problems' were relatively pronounced while the main differences in specific sleep-related symptoms between AD and NDE were not. Observed between-cohort differences appear to be driven by who is reporting, and the high prevalence of daytime sleeping in AD. Within-cohort differences reflect a clear distinction between persons with and without sleep problems, regardless of the reporter.

Keywords

Alzheimer's disease; healthy elderly; sleep disturbance; measurement

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INTRODUCTION

Changes in sleep are part of the aging process. For example, nighttime sleep can become more fragmented with age, with an increase in nighttime awakenings (Bliwise, 1999). As nighttime sleep changes, daytime sleep may increase, and sleep hygiene and diurnal cycles can become distorted. Additionally, Alzheimer's disease (AD) has also been implicated in the degeneration of sleep patterns (Bliwise, 1993; Bootzin *et al.*, 2001), and cross-sectional reporting suggests that sleep problems increase with AD severity (Moe *et al.*, 1995). Increases in nighttime awakenings and daytime sleep, as well as decreases in both slow-wave sleep and rapid eye movement (REM) sleep have been reported (Prinz *et al.*, 1982; Vitiello and Borson, 2001).

Insomnia, defined as a subjective sense of lack of sleep or insufficiently restorative sleep in spite of the opportunity to sleep, increases in prevalence with age (APA, 2000). Insomnia is a particularly subjective sleep problem: adequate opportunity for sleep can be objectively assessed but a person's sense of the insufficiency, or restorativeness, of their sleep cannot be objectified. This subjective sense may change with age (see, e.g. Buysse *et al.*, 1991; Vitiello *et al.*, 2004). In contrast to insomnia, 'sleep disturbance' may involve many – observable – nighttime behaviors. Thus, sleep disturbance assessments such as the Pittsburgh Sleep Quality Index (Buysse *et al.*, 1989) and the Sleep Disturbance Symptom Questionnaire (SDSQ, Tractenberg *et al.*, 2005) generate total scores that are based on the sums of ratings for individual symptoms. When these questionnaires are completed by caregivers or sleep partners, as was the case in the AD cohort in this study, there may be some loss of validity in certain items since the caregiver may sleep through symptomatic episodes. This parallels the clinical situation with memory impaired subjects when we rely on caregivers for symptomatic report.

In previous studies we found a marginal, albeit significant, association between sleep time (time in bed, TIB) and sleep disturbance symptoms (Tractenberg *et al.*, 2003, 2005); these reports described AD patients experiencing sleep disturbance who were participating in a clinical trial for melatonin to treat this condition (Tractenberg *et al.*, 2003), and in both AD patients and normal controls (Tractenberg *et al.*, 2005). Recently, we reported that an estimate of fewer than 6 h of nighttime sleep time (NST) was not more prevalent in persons with, relative to those without, sleep problems (Tractenberg *et al.*, 2005). This creates a methodological dilemma: TIB or NST are objective, but are not associated with self-reported sleep problems; and the sleep problems can be subjective (e.g. insomnia). In the present study we sought an understanding of the subjective sense of 'sleep problem'.

Our purpose was to assess what older people mean when they say they have sleep problems, using clinically important sleep disturbance symptom ratings. We also wanted to compare people describing their own sleep with the responses of people reporting sleep patterns of another person with memory impairment. In light of the potential for AD to cause, or possibly worsen, sleep problems, we evaluated the sleep disturbance symptom characteristics of individuals who did or did not report having sleep problems separately in a cohort of non-demented elderly (NDE) and a cohort of persons with AD. We were then able

to compare the characteristics of sleep disturbance in persons with reported sleep problems across the two cohorts.

We have previously described the cohorts to be analyzed in the present paper. (Tractenberg *et al.*, 2005) Contrary to expectations, there were no significant differences in either total scores or numbers of symptoms endorsed by respondents in the NDE and AD cohorts. These findings suggest that the groups (NDE, AD) reported similar levels of sleep disturbance symptomotology. Not surprisingly, subjects who reported more symptoms were more likely to report that they had a 'sleep problem'. However, important differences in the types of sleep disturbance exhibited could not be determined in the analysis of only the total scores or counts of symptoms. The possibility that the groups differed in terms of specific symptoms, or their frequency, or both, is explored in the present analysis by focusing on the individual symptoms making up the SDSQ.

Observing a higher total score on the SDSQ for one person relative to another could be due to one of three causes: (1) A wider range (diversity) of symptoms is endorsed in one person relative to the other, but all endorsed symptoms are rated to have the same frequency; (2) the same symptoms could be endorsed by both individuals but in one person, they are exhibited with greater frequency relative to the other person; or (3) both a greater diversity and a greater frequency of symptoms explain the difference in SDSQ total scores. Similar total scores on the SDSQ will also not permit the distinction of whether sleep disturbance symptoms are fewer in number but greater in frequency in one person while greater in number but with lower frequency in the other; these are clearly different patterns of sleep disturbance, but if the total scores are similar then the differences are obscured.

To determine whether frequency or diversity of sleep disturbance symptoms, or both, differentiated respondents with and without sleep problems, we analyzed responses to the 20 SDSQ symptoms plus ratings for 'awakens feeling refreshed', comparing the average frequency ratings and endorsement across respondents who did or did not have sleep problems separately within each cohort. To determine whether NDE and persons with AD who have sleep problems are fundamentally different, we compared frequency and diversity of SDSQ symptoms in persons from each cohort with sleep problems.

METHODS

Subjects

Subjects with AD presented with memory complaints on referral by either self, family or health care provider. Each subject's clinical history and exam findings were presented at a weekly case conference where a consensus diagnosis was reached by a team of neurologists, geriatric psychiatrists, and neuropsychologists. Cognitively intact participants (nondemented elderly) were research subjects in institutional review board (IRB)-approved longitudinal studies of normal aging. These subjects are known to have been cognitively intact at the time they completed the questionnaire based on the extensive neurological and neuropsychological assessment they received as per protocol of the Oregon Brain Aging Study (OBAS) (Howieson *et al.*, 2003; Kaye *et al.*, 1994). The analyses presented here focus on these NDE (N = 399) and on the clinic patients who met the NINCDS-ADRDA criteria

for probable (n = 210) or possible (n = 53) AD (McKhann *et al.*, 1984). Consent to include personal and clinical data in the research database used in this study was signed by all participants at the time of their initial evaluation and enrollment. The data analyzed for this report include all AD patients and NDE subjects whose data were archived as of September 2002; all data were used in accordance with Health Insurance Portability and Accountability Act regulations (HIPAA, 1996).

Instruments

This data set has been described in detail elsewhere (Tractenberg *et al.*, 2005). The Mini-Mental State Exam (MMSE, Folstein *et al.*, 1975), ranging from 0 (worst) to 30 was used to describe general cognitive functioning. Functional status was assessed with a modified activities of daily living (ADL)/instrumental activities of daily living (IADL) questionnaire based on Older American Resources and Services (OARS) Multidimensional Functional Assessment Questionnaire (Njegovan *et al.*, 2001). Items are scored on a three-point scale of assistance required (none, slight or full); total ADL and IADL scores are separately derived as the sums of assistance-requirement ratings ranging from 0 (best) to 27 (worst, ADL) or 21 (worst, IADL). The Cornell Depression Scale (Alexopoulos *et al.*, 1988a) assessed mood or affect signs, behavioral disturbances, physical symptoms of depression, sleep and diurnal symptoms, and depressive thinking. Higher scores indicate greater levels of depression in both demented and NDE subjects (Alexopoulos *et al.*, 1988b).

The Sleep Disturbance Symptom Questionnaire (described in detail in Tractenberg *et al.*, 2005) includes 20 symptoms of sleep disturbance. The 20 items of the SDSQ are rated for frequency ‘in previous months’ (i.e. an unspecified period of time) (0, never; 1, less than once per month; 2, at least once per month; 3, at least once per week; 4, nearly every day/night). Frequency ratings of at least once per month (2–4) were considered to represent endorsement of the symptom. In addition to summing the 20 frequency ratings to generate a total SDSQ score (0–80, higher scores suggesting more disturbance) sleep disturbance can be summarized as the number of symptoms endorsed; alternatively (as in the present report) the individual symptoms can be examined.

Cognitively intact participants fill the SDSQ out themselves while persons with AD almost always have the assistance of a family member or caregiver. Respondents reported their (or the patient’s) ‘usual’ bed and wake times, from which we estimated their usual TIB each night. Two additional queries are included with the SDSQ: ‘awakening feeling well-rested’ and whether or not the respondent considered him- or herself (or the patient) to have ‘sleep problems’. We included the former with our item-level analyses and used the latter to create the sleep problem subgroups (item endorsed, SP+; otherwise, SP−).

Statistical methods

The purpose of this analysis was to better understand the sleep disturbance reflected in the SDSQ total score. To do this, our analyses were focused at the item (symptom) level. The analyses were intended to explore two aspects of reported symptoms: whether the same or a different set of symptoms was reported (diversity) and whether symptoms were reported at a similar or different incidence (frequency). Frequency and diversity of symptoms exhibited

were each examined by comparing those reporting (SP+) to those not reporting (SP−) a sleep problem, within each cohort separately. We then compared diversity and frequency between persons endorsing sleep problems (SP+ only) across the two cohorts (AD SP+ versus NDE SP+).

To determine if diversity or frequency of SDSQ symptoms, or both, differentiated persons endorsing the 'sleep problems' item (SP+) from those not endorsing it (SP−) within each cohort, we defined diversity and frequency according to an earlier analysis (Tractenberg *et al.*, 2001). We defined diversity of SDSQ symptoms as a function of the symptoms that were endorsed by a given group. If more than 5% of individuals in a group had a frequency rating of at least once in the past month on an item, then the item was characterized as 'endorsed' by that group. Conversely, any item that was endorsed by fewer than 5% of the subjects was characterized as 'unendorsed' by that group. Items endorsed in one group and not in another represented a difference across the two groups in the diversity of symptoms exhibited. Frequency of an item was defined as the mean item rating in a group. Significant differences in average frequency ratings for an item across two groups would be interpreted as differentiating the two groups in terms of the frequency with which a symptom was exhibited.

All statistical analyses were carried out with SPSS 13.0 for Windows XP (SPSS Inc., Cary, NC, USA). Within each cohort (NDE, AD) separately, lists of endorsed items were compared across the two groups (SP+, SP−) to determine if there were behaviors observed in one group and not in the other (diversity). Mann–Whitney tests were conducted to compare the groups on frequency ratings for each item (frequency). Finally, the diversity and frequency comparisons were carried out for the two SP+ groups.

All *P*-values were adjusted according to Holm (1979) in order to account for multiple comparisons (21 in all: 20 SDSQ items plus 'awakening feeling refreshed'), and adjusted two-tailed $P < 0.05$ were considered significant.

RESULTS

Table 1 presents the demographic and background variables for SP+ and SP− by cohort (NDE, AD).

In the AD cohort, people not endorsing a sleep problem had significantly less education than those reporting a sleep problem ($P < 0.05$), whereas the opposite was true for the NDE cohort ($P < 0.001$). Sleep problems in the AD cohort were reported in people with significantly longer duration of AD ($P < 0.05$) and significantly worse ADLs (but not IADLs).

In both the cohorts, people with sleep problems (SP+) had significantly higher SDSQ total scores and numbers of symptoms endorsed (both $P < 0.001$) and significantly worse depression scores (both $P < 0.01$) but no differences in estimated TIB were observed.

When variables for SP+ were compared across cohorts, NDE SP+ were found to be significantly older ($P < 0.001$), have significantly less education ($P < 0.01$) depressive

symptoms and TIB (both $P < 0.001$); not surprisingly their MMSE, ADL and IADL scores were all significantly better than for AD SP+ (all $P < 0.001$).

Table 2 presents the frequency ratings and endorsement rates (diversity) per item for the SP + and SP− subgroups in each cohort.

Table 2 reflects all item-level results. Asterisks are used to identify significant (or, with a +, marginally not-significant) findings when persons endorsing 'sleep problem' (SP+) were compared to individuals not endorsing this item (SP−) within each cohort. This is true for both halves of the table, i.e. for both frequency ratings and endorsment rates. In this manner, SDSQ symptoms that differentiate SP+ and SP− in terms of the frequencies of the symptoms, or their diversity, within each cohort can easily be seen; any symptom where an asterisk appears for one cohort and not the other cohort suggests that AD and NDE are different in terms of this symptom and its relationship to sleep problems.

Similarly, crosses are used to identify significant (or, with a +, marginally not-significant) findings when comparisons are between NDE and AD respondents who endorsed the sleep problem item. This is true for both frequency and diversity comparisons, but for these analyses, the appearance of a cross suggests a difference between the SP+ individuals in the two cohorts for that symptom. These differences are outlined below.

Frequency

Among the AD cohort, 11 of the 21 items had significantly higher average frequency ratings (no. of wakeups per night; drowsy during day; equal day, night sleep time; takes >30 min to fall asleep; wakes up during night for >1 h; wakes up too early; restless sleep; lies awake tense/worried; trouble breathing; uses medication to get to sleep; has bowel/bladder problems at night) in SP+ relative to SP−. One item (awakes feeling refreshed) had significantly lower average frequency in SP+ and two were marginally more frequent, on average, in SP+ (breathes irregularly, takes naps during the day, both adjusted $P = 0.06$). In the NDE cohort, nine of the 21 items had significantly higher average frequency ratings (takes >30 min to fall asleep; wakes up during night for >1 h; wakes up too early; restless sleep; lies awake tense/worried; wakes at night with pain; uses medication to get to sleep; has bowel/bladder problems at night; has restless legs during sleep), and one item (awakes feeling refreshed) had significantly lower average frequency in SP+.

Of the 14 symptoms that differentiated SP+ and SP− in the AD cohort, eight also differentiated SP+ and SP− in the NDE group (asterisked items in Table 2). Six symptoms were more frequent in SP+ AD relative to SP− AD but were no different for SP+ and SP− in NDE (no. of wakeups per night; drowsy during day; daytime naps; equal day, night sleep time; trouble breathing; breathes irregularly); two other symptoms were more frequent in SP + NDE relative to SP− NDE but these were not different for SP+ and SP− in AD (night pain, restless legs).

Diversity

We planned to define the groups' endorsement of any item based on a 5% cut-off (Tractenberg *et al.*, 2001). However, more than 5% endorsed every item except one (uses

alcohol to get to sleep). Thus, with this definition of 'endorsement', there were no differences in the diversity (range) of symptoms reported for SP+ and SP− in either cohort.

To further explore the diversity of symptoms, we compared endorsement rates for SP+ with SP− in each cohort by chi-square analysis. After correction for (21) multiple comparisons eight items were endorsed in significantly more SP+ respondents than SP− in the AD cohort (equal day, night sleep time; takes >30 min to fall asleep; wakes up during night for >1 h; wakes up too early; restless sleep; lies awake tense/worried; uses medication to get to sleep; and has bowel/bladder problems at night); one was only marginally not significantly higher in SP+ (nighttime awakenings, adjusted $P = 0.065$).

Of these nine items with higher endorsement rates in SP+ within the AD cohort, five were also endorsed by significantly more SP+ than SP− in the NDE cohort (takes >30 min to fall asleep; wakes up during night for >1 h; wakes up too early; restless sleep; and uses medication to get to sleep); one was only marginally not significantly higher in SP+ (lies awake tense/worried, adjusted $P = 0.08$). Based on diversity (as a function of endorsement rate), SP+ AD were different from SP− AD on nine of 21 symptoms; SP+ NDE were different from SP− NDE on six symptoms. These differences are shown in Table 2 with asterisks (+* for adjusted *P*-values between 0.05 and 0.08). It can be seen that only three of 21 symptoms has different asterisk patterns for the two cohorts: nighttime awakenings; equal day, night sleep time, and bowel/bladder problems at night. Thus, the patterns of symptom diversity for SP+ and SP− are similar for the two cohorts while the patterns of symptom frequency for SP+ and SP− were not as similar.

Sleep problems in AD versus NDE

The diversity and frequency of symptoms as exhibited by persons in each cohort with sleep problems were examined. When frequency was compared across SP+ AD and SP+ NDE, six of the 21 SDSQ items were different in terms of average frequencies (as indicated by daggers in Table 2). Average frequency was higher for the AD SP+ subgroup for four symptoms (takes naps during the day; equal day, night sleep time; snores heavily; breathes irregularly) and lower for the AD SP+ subgroup for two symptoms (wakes up during night for >1 h; wake at night with pain).

In terms of diversity of sleep disturbance symptoms exhibited by SP + AD and SP + NDE, of the 21 symptoms evaluated, four had different endorsement rates for AD versus NDE with sleep problems: two were endorsed for significantly fewer AD than NDE (takes >30 min to get to sleep; wake up during the night for >1 h) and two were endorsed for significantly more AD than NDE (naps during day; equal day, night sleep time). One additional symptom was marginally more frequently endorsed for AD than NDE (snores heavily, adjusted $P = 0.06$). Based on diversity (as a function of endorsement rate) then, SP+ AD were different from SP+ NDE in terms of five of 21 symptoms: takes >30 min to get to sleep; wake up during the night for >1 h; naps during day; equal day, night sleep time and snores heavily.

DISCUSSION AND CONCLUSIONS

The Sleep Disturbance Symptom Questionnaire includes 20 symptoms that are clinically important nighttime (or associated) behaviors generally reflective of the scope of ‘sleep problems’ within a clinical framework. One additional item, ‘awakens feeling refreshed’ generally reflects a concern to capture insomnia. We found that a subset of these 21 questions differ between persons with and without a subjectively defined ‘sleep problem’ and that was true for both NDE and AD, i.e. irrespective of the reporter.

We observed important differences in the diversity of exhibited symptoms and in reported frequencies of the SDSQ items that differed for SP+ and SP− within cohorts, but in both cohorts we observed that SP+ reflected long sleep latencies (>30 min) and a tendency to lie awake worrying, as well as restless sleep, waking too early, waking during the night for at least 1 h and the use of medication to get to sleep; having bladder and bowel problems at night also followed this trend (Table 2). That is, these were the symptoms that accounted for subjective complaints in both groups. Conversely, we found that over 91% of all NDE endorsed ‘awakens feeling refreshed’ (in both SP+ and SP−); 93% of AD SP− endorsed this and over 77% of AD SP+ endorsed this item as well; thus although awakening feeling refreshed was more frequent in SP− than SP+ within both cohorts, not feeling refreshed on awakening was not generally perceived by these elderly persons as a sleep problem.

The important differences in individuals with subjective sleep problems tended to reflect both the reporter (self for NDE, sleep partner for AD) and what is known about AD. Namely, NDE with SP+ did not report as much heavy snoring or irregular breathing as caregivers reported for AD with SP+, and nighttime awakenings due to pain and of at least 1 h duration might be more frequently/more accurately reported by NDE answering for themselves than by caregivers. Increased reporting of sleep-related breathing symptoms in the AD cohort and pain-related awakenings in the NDE are possibly (plausibly) artifacts of who is reporting; that caregivers reported more daytime sleep in the AD group, is consistent with objective sleep studies in dementia subjects. Another important point is that the two groups of subjects in this analysis were not age-matched; the NDE cohort was older than the AD cohort. It is likely that a very old but healthy cohort has more overlap in sleep symptoms with dementia patients than a true age-matched healthy cohort would have.

It is important to note that the AD and NDE group results may be similar because of the fact that the reporter in each cohort is cognitively normal; that is, respondents in the NDE cohort are NDE and answer for themselves while respondents in the AD cohort are NDE who answer for the patient in most cases. It is possible that it is not the persons with AD whose sleep is most similar to the NDE cohort but rather, their caregivers’ responses that are similar. Additionally, it is unclear whether any differences between groups (AD, NDE) are due not to actual differences in the sleep disturbance symptoms but instead are due to the level of awareness of the symptoms in the reporters (i.e. full awareness for NDE, partial awareness for caregivers for persons with AD). Finally, because the SDSQ was administered in a general clinical setting, it is not possible for us to comment on the correspondence between subjective (personal) and objective (second person) reports of sleep problems or sleep disturbance symptoms. These are problems in any context where proxy reporting is

required; our data do not provide specific answers but rather specific suggestions for our future research to address this question.

In spite of lingering questions about the perspective of the reporter, because the areas of differences in SP+ across cohorts reflected known characteristics of the cohorts as well as the reporting, our results suggest that caregiver reports might accurately reflect sleep and nighttime behaviors, such as those included in the SDSQ. Six symptoms (takes >30 min to fall asleep; wakes up during night for >1 h; wakes up too early; restless sleep; lies awake tense/worried; has bowel/bladder problems) distinguishing SP+ from SP− were independently identified within each cohort, suggesting that the clinical concern with 'sleep disturbance' might need to focus specifically on restlessness and the tendency to wake up during the night. Five of the six items differentiating SP+ from SP− generally reflect the increased fragmentation that Bliwise (1999) described in elderly as well as results describing persons with AD (Bliwise, 1993; Bootzin *et al.*, 2001; Moe *et al.*, 1995; Prinz *et al.*, 1982; Vitiello and Borson, 2001). This supports a conclusion that caregiver reports for AD patients and NDE self-reports are valid and even comparable.

Although not conclusive because of the differences in reporter perspective, our results suggest that even with this age imbalance between groups, daytime sleep is the most distinctive feature of sleep disturbance in AD patients. Thus, attempts to define independent criteria for establishing a diagnosis of sleep disturbance in persons with AD and NDE (i.e. Yesavage *et al.*, 2003) may need to focus on day–night sleep ratio or amount of daytime sleep.

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Table 1

Descriptive statistics for study participants with and without sleep problems by cohort

	Non-demented elderly		Poss/prob AD	
Score/value	**SP+ (*N* = 325)**	**SP− (*N* = 74)**	**SP+ (*N* = 73)**	**SP− (*N* = 190)**
Age (years)	83.6 ± 7.3†††	81.5 ± 8.7	74.8 ± 12.6	73.7 ± 11.5
Sex (% female)‡	68.9	58.8	53.4	54.2
Education (years)	13.2 ± 2.7††	14.1 ± 2.7***	14.2 ± 3.3	13.4 ± 3.3*
Duration of AD (years)			5.2 ± 3.0	4.4 ± 2.8*
Mini-mental state exam (MMSE)	28.1 ± 1.5†††	28.2 ± 1.5	18.7 ± 7.2	19.4 ± 6.0
ADL	0.3 ± 0.7†††	0.2 ± 0.6	3.5 ± 3.7	2.2 ± 2.9*
IADL	0.1 ± 0.4†††	0.8 ± 0.7	7.6 ± 5.1	6.6 ± 4.3
Cornell Depression Scale	2.2 ± 1.7†††	1.3 ± 1.6**	5.2 ± 3.3	3.2 ± 3.2***
Sleep score (sum of 20 SDSQ ratings)§	22.5 ± 6.8	15.9 ± 7.6***	23.3 ± 8.6	14.7 ± 7.8***
Number of endorsed symptoms	7.6 ± 2.6	5.0 ± 2.9***	7.4 ± 2.9	4.5 ± 2.8***
Estimated nighttime time in bed (TIB in h)	8.1 ± 1.2†††	8.1 ± 1.1	9.3 ± 1.8	9.0 ± 1.4
Percentage of group with ≤ 6 h TIB[a]	8.2	5.6	2.8	3.8

Non-demented elderly (NDE) are healthy elderly subjects with normal cognitive function at the time of sleep symptom assessment. Poss/prob AD: individuals met NINCDS-ADRDA criteria for possible or probable Alzheimer's disease. Sample sizes given reflect number of respondents, however, the numbers for whom each variable were recorded varied. SP+, Endorsed 'sleep problems'; SP−, did not endorse 'sleep problems'; ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living.

$^{***}P \leq 0.001$;

$^{**}P < 0.01$;

$^{*}P < 0.05$ across SP+, SP− within cohort;

$^{\dagger\dagger\dagger}P < 0.001$;

$^{\dagger\dagger}P < 0.01$ across SP+ (across cohorts).

‡Chi-squared contingency test and inference tests are Mann–Whitney non-parametric comparisons of means.

§'Awakens feeling well rested' and 'have sleep problems' were excluded from this score.

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Table 2

Sleep symptoms: mean ± SD frequency ratings and endorsement rates (%) for SP+, SP− by cohort

	Frequency‡				Endorsement§			
	Non-demented		Poss/prob AD		Non-demented		Poss/prob AD	
SDSQ symptom	SP+	SP−	SP+	SP−	SP+	SP−	SP+	SP−
(1) Number of wake-ups per night	2.7 ± 1.1	2.7 ± 1.1	2.5 ± 1.2	1.9 ± 1.1*	93.0	86.2	92.9	78.0+*
(2) Drowsy during the day	1.9 ± 1.1	1.7 ± 1.1	2.3 ± 1.1	1.9 ± 1.1*	66.2	60.4	75.7	64.8
(3) Takes naps during the day	1.8 ± 1.1†	1.8 ± 1.2	2.5 ± 1.2	2.0 ± 1.2+*	60.8†	59.4	77.8	68.7
(4) Equal sleep time day = night	0.2 ± 0.6†	0.1 ± 0.2	0.8 ± 1.2	0.3 ± 0.7*	2.8†	2.5	20.6	5.6*
(5) Takes >30 min to fall asleep	2.2 ± 1.1	1.2 ± 1.0*	1.6 ± 1.3	0.7 ± 0.9*	76.4†	34.5*	52.2	14.9*
(6) Wakes up during night for >1 Hr	2.2 ± 1.0†	1.1 ± 1.0*	1.5 ± 1.1	0.7 ± 0.8*	81.9†	33.1*	51.5	13.3*
(7) Wakes up too early	2.1 ± 1.1	1.2 ± 1.0*	2.0 ± 1.1	0.9 ± 0.9*	73.5	38.1*	66.2	24.1*
(8) Restless sleep	1.7 ± 1.0	1.0 ± 0.9*	1.8 ± 1.0	1.0 ± 0.9*	57.4	26.2*	56.1	24.3*
(9) Lies awake tense/worried	1.2 ± 1.0	0.8 ± 0.8*	1.6 ± 1.1	0.7 ± 0.8*	33.3	17.5+*	50.8	17.2*
(10) Snores heavily	0.7 ± 1.1†	0.9 ± 1.2	1.4 ± 1.4	1.2 ± 1.2	20.4+†	29.6	46.9	36.5
(11) Has trouble breathing	0.3 ± 0.6	0.3 ± 0.7	0.7 ± 1.1	0.3 ± 0.8*	7.4	6.0	21.0	7.7
(12) Breathes irregularly	0.2 ± 0.6†	0.3 ± 0.8	0.8 ± 1.1	0.4 ± 0.9+*	8.2	8.2	24.1	11.8
(13) Twitches/jerks in sleep	0.7 ± 0.9	0.5 ± 0.8	1.2 ± 1.4	1.1 ± 1.2	19.3	14.1	33.3	35.8
(14) Wakes up with headache	0.5 ± 0.9	0.4 ± 0.7	0.7 ± 1.0	0.5 ± 0.8	15.5	8.4	20.0	12.7
(15) Wakes at night with pain	1.0 ± 1.0†	0.6 ± 0.9*	0.5 ± 0.9	0.5 ± 0.8	30.4	16.6	13.3	12.1
(16) Uses medication to help get to sleep	1.0 ± 1.0	0.3 ± 0.7*	0.8 ± 1.3	0.3 ± 0.7*	37.5	10.0*	25.0	7.2*
(17) Uses alcohol to help get to sleep	0.1 ± 0.2	0.1 ± 0.3	0.0 ± 0.4	0.0 ± 0.3	0.0	1.3	1.5	0.6
(18) Has bowel/bladder problems at night	2.0 ± 1.3	1.5 ± 1.4*	1.8 ± 1.4	1.0 ± 1.3*	62.7	45.8	55.2	27.1*
(19) Has muscle cramps during sleep	1.4 ± 1.0	1.1 ± 1.0	0.9 ± 0.8	0.8 ± 0.9	46.5	38.3	29.7	23.6
(20) Has restless legs during sleep	1.5 ± 1.0	0.9 ± 1.1*	0.9 ± 1.2	0.6 ± 0.9	54.8	30.9	25.0	17.6
(21) Awakes feeling well rested	2.8 ± 1.0	3.2 ± 1.0*	2.5 ± 1.1	3.2 ± 1.0*	91.7	91.6	77.0	91.3

Non-demented are healthy elderly subjects with normal cognitive function at the time of sleep symptom assessment. Poss/prob AD: individuals met NINCDS-ADRDA criteria for possible or probable Alzheimer's disease. Sample sizes given reflect number of respondents, however, the numbers for whom each variable were recorded varied. SP+: Endorsed 'sleep problems'; SP−: did not endorse 'sleep problems'. Frequency ratings compared by Mann–Whitney non-parametric comparison; endorsement compared by chi-square;

*indicates Holm-adjusted $P < 0.05$ for SP+ versus SP− within the cohort;

†indicates Holm-adjusted $P < 0.05$ for AD SP+ versus NDE SP+ (across cohorts);

+*indicates Holm-adjusted *P*-value for SP+ versus SP− is marginally not significant,

+†indicates Holm-adjusted *P*-value for AD SP+ versus NDE SP+ is marginally not significant (range: 0.059–0.08; see text for values).

‡Frequency (ratings for 'in previous months'): 0, never; 1, less than once per month; 2, at least once per month; 3, at least once per week; 4, nearly every day/night).

§Endorsement: ratings of at least once per month (2–4) – 'endorsed'; ratings of never/less than once per month (0 or 1) – 'un-endorsed'.