http://dx.doi.org/10.5665/sleep.3128

Persistent Sleep Disturbance: A Risk Factor for Recurrent Depression in Community-Dwelling Older Adults

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Study Objectives: The objective of this study was to examine the associations between the temporal and severity characteristics of sleep disturbance and subsequent depression in community-dwelling older adults.

Design: A prospective cohort study with assessment of sleep disturbance and depression at baseline and across 2 years of follow-up.

Setting: Three urban communities in the United States.

Participants: Community-dwelling older adults in whom prior depression (n = 145), current depression (n = 68), or never mentally ill (n = 206) were diagnosed at the baseline assessment.

Measurements and Results: Major depression at year 2, defined by the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders. Among patients with either a depression history or current depression at baseline, persistent sleep disturbance throughout year 1 was associated with persistent or recurrent depression at year 2, after adjustment for group status, antidepressant and hypnotic sedative use, severity of depressive symptoms, chronic medical burden, and sociodemographic variables (adjusted odds ratio = 5.20, 95% confidence interval [CI] = 1.16 to 23.29). Among those who were not depressed at year 1, persistent sleep disturbance throughout year 1 predicted depression recurrence during year 2 (adjusted hazards ratio = 16.05, CI = 1.21 to 213.06), independent of the severity of sleep disturbance. None of the older adults who were never mentally ill developed a depression.

Conclusions: Persistent sleep disturbance during a year-long period is associated with depression the following year. Among older adults with prior depression, identification of those with persistent sleep disturbance may optimize the efficacy of sleep related interventions to improve depression remission and/or prevent late-life depression.

Keywords: Sleep disturbance, aging, depression

Citation: Lee E; Cho HJ; Olmstead R; Levin MJ; Oxman MN; Irwin MR. Persistent sleep disturbance: a risk factor for persistent or recurrent depression in community-dwelling older adults. *SLEEP* 2013;36(11):1685-1691.

INTRODUCTION

Depression, one of the most common diseases in older adults, is a significant cause of morbidity and mortality.[1,2] As the population ages in high-income countries, depression is projected to become the greatest contributor to illness burden by the year 2030.[3] Moreover, because elderly persons with depression often do not receive diagnosis and treatment,[4] and current treatments achieve remission in only approximately 30-35% of older adults,[5] more than two-thirds of the disease burden remains,[6,7] leading to staggering healthcare costs.[8] Hence, efforts to identify risk factors that facilitate diagnosis and permit the development of targeted interventions to prevent depression are needed.[9-11]

In the elderly population, female sex, bereavement, prior depression, disability, and sleep disturbance are significant risk factors for depression.[11,12] Among modifiable risk factors, increasing attention has focused on sleep disturbance. Whereas longitudinal studies have found that mental health problems, especially depression, predict incident insomnia[13] and its persistence,[14,15] sleep disturbance also predicts depression. For example, in the general population, a recent meta-analysis of longitudinal epidemiologic studies reports that symptoms of insomnia predict depression (odds ratio [OR] = 2.6, confidence interval [CI] = 1.98-3.42), although the results were heterogeneous.[16] Importantly, findings in older adults are limited, with only eight existing studies identified, which include clinical and primary care populations.[11,17-23] Four of these studies describe the prospective effect of sleep disturbance on depression risk in community-dwelling older adults.[11,17,21,23] Two studies that considered the role of depression history[11,17] found that the association between sleep disturbance and depression recurrence is substantially greater than with its occurrence.[11,17]

Sleep disturbance in depressed patients often lingers and its persistence can represent a residual phase of a major mood disorder. Conversely, the emergence of disturbed sleep may be a precursor or prodrome of depression that occurs later in life.[24] Regardless of the temporal relationship between sleep disturbance and depressive episodes, few studies have evaluated the contribution of the persistence and severity of sleep disturbance to depression risk. Most prior studies assessed sleep disturbance at a single time point (i.e., baseline) with a single follow-up assessment of depression.[11,16,23] Nevertheless, some evidence suggests that persistent insomnia co-occurs with depression in adults[24-26] and in older adults in primary care settings,[22,27] and is associated with depression nonremission.[28] Yet, these studies concurrently assessed sleep disturbance and depression without consideration of their temporal overlap and

Submitted for publication November, 2012
Submitted in final revised form May, 2013
Accepted for publication May, 2013

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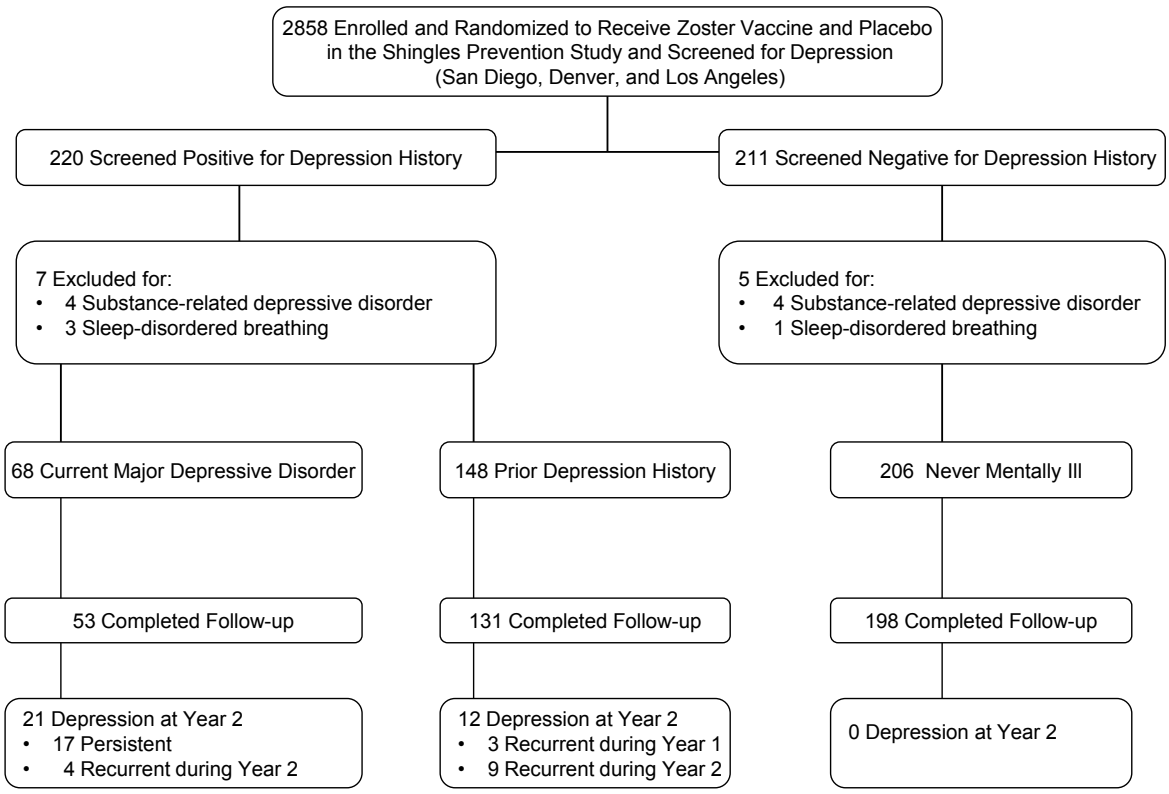

Figure 1—Consolidated Standards of Reporting Trials flow diagram of subject entry and evaluation.

it is not known whether persistent sleep disturbance plays an independent role in depression risk in older adults. Furthermore, most of the aforementioned studies have relied solely on patient-reported symptoms of depressive symptoms, and have not assessed the presence of depression using diagnostic criteria.

In this 2-year longitudinal study of community-dwelling older adults, we tested two hypotheses: (1) depression at year 2 will be higher among older adults with persistent sleep disturbance during year 1 (i.e., between the baseline and year 1 assessments) than those without sleep disturbance, and (2) among older adults who were not depressed at year 1, occurrence of depression during year 2 will be higher among those with persistent sleep disturbance during year 1 than those without sleep disturbance. To test these hypotheses, we performed repeated assessments using the Structured Clinical Interview for DSM-IV (SCID) for depression and the Pittsburgh Sleep Quality Index (PSQI) for sleep disturbance in a sample of community-dwelling older adults who had prior depression, current depression, or no history of mental illness.

METHODS

Patients and Procedure

This article extends the findings of the Depression Substudy of the Department of Veterans Affairs Cooperative Study #403, Shingles Prevention Study,[29] and Cho et al.[17] by evaluating the effect of persistence and severity of sleep disturbance on depression at year 2 in community-dwelling older adults. The institutional review boards of the University of Colorado at Denver, University of California at San Diego, and University of California at Los Angeles approved all procedures.

The Depression Substudy screened 2,858 participants age 60 years or older from three urban areas (Los Angeles, Denver, and San Diego) to identify persons who screened negative for a depression history (n = 211) and those who screened positive for a depression history (i.e., either a current or past history of depression; n = 220[17]; Figure 1). Immediately following screening, screened eligible individuals underwent baseline assessment with administration of the SCID-IV and a systematic medical history interview. Inclusion, exclusion, and matching criteria have been described previously.[17,30,31]

Assessment methods included administration of the SCID-IV with characterization of the current and/or most recent three depression episodes (e.g., major or nonmajor classification, medication used, date of onset) as previously described.[17,30,31] Among those who screened eligible as having no history of a depression episode (n = 211), the more rigorous assessment methods of the SCID identified four participants with substance-related depressive disorder and these individuals were excluded. The medical history interview identified one participant with sleep disordered breathing and this individual was excluded. Among those who screened eligible as having a current or past history of depression (n = 220), SCID and medical history interviews excluded four participants with substance-related depressive disorder and three participants with sleep disordered breathing. The final sample was composed of the following groups based on SCID interview data: 145 individuals with prior history of depression; 68 with current depression; and 206 control individuals who were never mentally ill (Figure 1).

All participants were assessed at baseline, 6 weeks later, 1 year later, and 2 years later as previously reported[17,30,31]; follow-up rates at 6 weeks, year 1, and year 2 were 98.8% (n = 414), 93.8% (n = 393), and 91.2% (n = 382), respectively. Figure 1 shows the rates of year 2 follow-up for each group. Follow-up assessments included evaluation of depression with SCID interview with identification of date (± 1 month) of remission or recurrence. Depression severity was assessed with the 24-item Hamilton Depression Rating Scale (HAMD).[32] To eliminate overlap between the HAMD and PSQI, scores for three sleep disturbance-related items (questions 11, 12, and 13) were subtracted from the total HAMD score. The PSQI was used to assess the severity of sleep disturbance. The PSQI consists of 19 self-rated items that measure subjective sleep quality, sleep latency, and use of sleep medication during the past month. A PSQI global score > 5 has a sensitivity of 98.7% and a specificity of 84.4% as a marker for sleep disturbance.[33,34] We also evaluated chronic medical burden with the Chronic Disease Score (CDS), a standardized measure based on self-reported prescription medication use.[35]

Statistical Analysis

Analyses of the data were conducted using SPSS version 18 for Windows (IBM, New York, NY). Group differences in participant characteristics at baseline were compared using analysis of variance. For categorical variables, Pearson chi-square tests were used.

The primary outcome variable was the presence of DSM-IV-diagnosed depression at year 2. Logistic regression was used to evaluate the effects of sleep disturbance and its persistence on depression at year 2. Sleep disturbance (PSQI > 5) during the interval from baseline to year 1 was classified as persistent if it was present at all three assessments (i.e., baseline, 6 weeks, and 1 year), intermittent if present at one or two assessments, and absent if not identified at any assessment. As all independent variables were *a priori* potential risk factors for depression at year 2 (baseline depression status [prior depression, current depression, or control], antidepressant and sedative-hypnotic medication use, depressive symptoms [HAMD], and chronic medical burden [CDS]), or sociodemographic characteristics (age, sex, marital status, and education), they were included into the multivariable model. Because the overwhelming majority of the sample was Euro-American (96.7%), ethnicity was not included in analyses. We also assessed the potential effect modification by baseline depression status on the prospective association between persistent sleep disturbance and depression at year 2.

Among the patients identified with depression at year 2, a subgroup was not depressed at year 1 but rather newly developed depression during the interval between year 1 and year 2. Such newly developed cases of depression were actually recurrent depression during that interval because no one in the control group developed depression. To examine the association of persistent sleep disturbance and newly developed depression at year 2, a survival analysis was performed. Using a Cox regression model including participants who were not depressed at year 1, depression-free survival was calculated from the date of the year 1 assessment to date of depression onset during year 2 (or at year 2 for censored cases), with adjustment using the same set of covariates described previously. The date of depression onset was based on follow-up SCID data. Sleep disturbance was categorized into three categories: persistent, intermittent, or absent.

To examine the association of sleep disturbance severity at baseline (i.e., PSQI total score) with depression at year 2, a logistic regression model was performed, using the same set of covariates described previously. Secondary analyses explored whether the effect of sleep disturbance severity on depression at year 2 remained after persistent sleep disturbance was entered into the model.

RESULTS

Demographic and Clinical Characteristics

Table 1 describes the characteristics of study participants at the baseline assessment. The control group was older and more likely to be married than the two depression groups, and the prior depression group was more educated than the control group and the current depression group. Sex, ethnicity, and chronic medical burden (i.e., CDS) did not differ among groups. Clinical variables related to the severity of depressive symptoms and sleep disturbance differed significantly among groups, with the current depression group having more severe depressive symptoms, worse sleep quality, and a greater proportion of patients with clinical sleep impairment (i.e., PSQI scores > 5) than the control or prior depression groups. Although the prior depression group had more severe depressive symptoms than the control group, the severity was quite low (i.e., mean HAMD of 2.0, which is considered "no or minimal symptoms"). The level of sleep disturbance in the depression groups was higher than that in the control group, with 46% of those with prior depression and 79% of those with current depression classified as having clinical sleep disturbance, compared with only 18% of control patients. Considering the depression groups, the number of major depressive episodes and rate of antidepressant and/or sleep medication use were significantly higher in the current depression group compared with the prior depression group. In the prior depression group, the median time since the last depressive episode was almost 10 years (118 months), indicative of a sustained period of remission.

At the year 2 follow-up, a depressive disorder was diagnosed in 33 participants, with 12 cases from the prior depression group and 21 cases from the current depression group including 17 cases who were persistently depressed throughout the 2-year period (Figure 1). The diagnosis of depression at year 2 was not made in any of the control patients, although depression was diagnosed in one individual at year 1, but this person was lost to follow-up at year 2. Hence, analyses of the prospective association of persistence of sleep disturbance with the presence of depression at year 2 were limited to patients in the prior and current depression groups (n = 213).

Predictors of Depression at Year 2

In prior analyses of this dataset, we demonstrated that the presence of sleep disturbance (PSQI > 5) at baseline is a risk factor for the recurrence of depression over a 2-year follow-up period among patients with a history of depression.[17] Here,

Table 1—Baseline participant characteristics

Variable	Prior depression (n = 145)	Current depression (n = 68)	Control (n = 206)	P
Age (60 to 95 years)[a], mean (SD), years	67.8 (6.4)	67.7 (5.7)	70.0 (6.3)	0.001
Sex, female, No. (%)	86 (58.3)	41 (60.3)	105 (51.0)	0.20
Marital status, married,[a] No. (%)	81 (55.9)	36 (52.9)	139 (67.5)	0.03
Ethnicity, Euro-American, No. (%)	143 (98.6)	63 (92.6)	199 (96.6)	0.08
Education (10 to 18 years),[b] mean (SD)	16.0 (2.2)	14.8 (2.3)	15.3 (2.3)	0.001
Chronic disease score (0 to 11), mean (SD)	2.3 (2.2)	1.8 (1.8)	1.9 (2.2)	0.17
HAMD (0 to 27, minus sleep items)[c], mean (SD)	2.0 (2.8)	9.4 (6.9)	0.8 (1.4)	< 0.001
PSQI (0 to 18)[c], mean (SD)	5.9 (3.7)	8.8 (3.9)	3.6 (2.8)	< 0.001
Sleep disturbance (PSQI > 5),[c] No. (%)	66 (45.5)	54 (79.4)	36 (17.5)	< 0.001
Persistent sleep disturbance,[c] No. (%)	44 (30.3)	28 (41.2)	16 (7.8)	< 0.001
Intermittent sleep disturbance,[c] No. (%)	53 (36.6)	31 (45.6)	51 (24.8)	< 0.001
No. of major depressive episodes (0 to 9),[c] mean (SD)	1.1 (0.9)	1.6 (1.4)	0 (0)	< 0.001
Antidepressant medication use,[c] No. (%)	47 (32.4)	32 (47.1)	0 (0)	< 0.001
Sedative-hypnotic medication use,[a] No. (%)	53 (36.6)	28 (41.2)	39 (18.9)	< 0.001
Depression at year 2[c], No. (%)	12 (9.2)	21 (39.6)	0 (0)	< 0.001

All data except depression at year 2 were obtained from the baseline assessment. [a]Indicates significantly different from control group. [b]Indicates significantly different from prior depression group. [c]Indicates significantly different from each other group. HAMD, Hamilton Depression Rating Scale; PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation.

Table 2—Associations of persistent sleep disturbance during year 1 with presence of depression at year 2[a,b]

	Odds ratio (95% CI)	P
Unadjusted		
Intermittent	4.29 (0.48-38.15)	0.19
Persistent	8.40 (0.99-71.59)	0.05
Model 1 adjusted for sociodemographic variables[b]		
Intermittent	3.06 (0.77-12.16)	0.11
Persistent	5.52 (1.46-20.91)	0.01
Model 2, adjusted for model 1+chronic medical burden		
Intermittent	3.09 (0.78-12.29)	0.12
Persistent	5.73 (1.50-21.91)	0.01
Model 3, adjusted for model 2+depressive symptoms		
Intermittent	2.74 (0.68-11.02)	0.16
Persistent	4.62 (1.17-18.30)	0.03
Model 4, adjusted for model 3+antidepressant and sedative-hypnotic use		
Intermittent	2.96 (0.69-12.62)	0.14
Persistent	4.86 (1.13-20.9)	0.03
Model 5, adjusted for model 4+baseline depression status		
Intermittent	2.55 (0.56-11.51)	0.23
Persistent	5.20 (1.16-23.29)	0.03

[a]Prior depression includes those who entered the study with a history of depression or current depression, not including control participants. [b]Reference is absent sleep disturbance group (n = 57). [c]Sociodemographic variables include age, sex, marital status, and education. Chronic medical burden includes chronic disease score. Depression symptoms were measured by Hamilton Depression Rating Scale (minus sleep items).

we examine the contribution of sleep disturbance severity and persistence during year 1 on depression at year 2. Across the three assessments that occurred during year 1, a total of 72 participants in the two depression groups were found to have persistent sleep disturbance; 30% of those with prior depression and 41% in the current depression group were categorized as having persistent sleep disturbance (Table 1). Intermittent sleep disturbance was observed for 84 participants; 37% of those with prior depression and 46% of those in the current depression group. The absence of sleep disturbance was observed for 57 participants; 33% of those with prior depression and 13% of those in the current depression group.

The presence of sleep disturbance varied across each of the assessments for each of the groups (Figure S1). For example, in the prior depression group, sleep disturbance at baseline had remitted in 18% at 6 weeks, and sleep disturbance at 6 weeks had remitted in 18% at year 1. Conversely, among those in the prior depression group without sleep disturbance at baseline, 22% had the onset of sleep disturbance at 6 weeks and 24% had the onset of sleep disturbance at year 1. In the current depression group, sleep disturbance present at baseline had remitted in 22% at 6 weeks, and sleep disturbance at 6 weeks had remitted in 13% at year 1. Conversely, among those in the current depression group without sleep disturbance at baseline, 36% had the onset of sleep disturbance at 6 weeks and 35% had the onset of sleep disturbance at year 1.

Using logistic regression analysis, we found that persistent sleep disturbance during year 1 was a robust predictor of depression at year 2, even after adjusting for baseline depression status, antidepressant and hypnotic-sedative medication use, severity of depressive symptoms, chronic medical burden, and sociodemographic variables including age, sex, marital status, and years of education (adjusted OR = 5.20, CI = 1.16 to

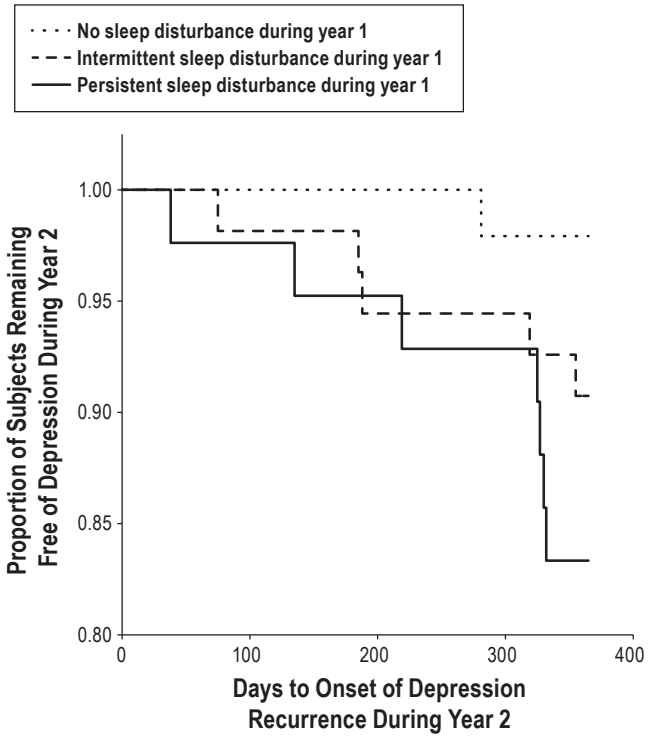

Figure 2—Time to onset of depression recurrence during year 2 stratified by sleep disturbance during year 1.

23.29, P = 0.03; Table 2). This effect was not modified by baseline depression status (i.e., current versus prior depression; P = 0.81). Intermittent sleep disturbance was not significantly associated with depression at year 2 (adjusted OR = 2.55, CI = 0.56 to 11.51, P = 0.23; Table 2). In addition, when sleep disturbance was identified only at the year 1 assessment but not persistent throughout the year, this recent sleep disturbance was also not predictive of depression at year 2 (unadjusted OR = 3.88, CI = 0.77 to 19.66, P = 0.10). Finally, although we had excluded four patients who reported sleep disordered breathing, an additional seven participants endorsed items 5d and 5e of the PSQI (item scores > 3), which suggested the presence of symptoms of sleep apnea; exclusion of these additional seven participants did not alter the results.

Most participants (58%) with depression at year 2 had persistent sleep disturbance during year 1. Only 33% and 9% of participants with depression at year 2 reported intermittent and absent sleep disturbance, respectively, during year 1 ($\chi^2 = 9.30$, P = 0.01).

Additional analyses were performed to test whether severity of sleep disturbance predicted depression at year 2. Using logistic regression analyses, we found no association between severity of sleep disturbance and depression at year 2 (adjusted OR = 1.12, CI = 0.98 to 1.23, P = 0.11). Further adjustment for the presence of persistent sleep disturbance did not alter this nonsignificant result (OR = 1.02, CI = 0.85 to 1.21, P = 0.85).

Predictors of Depression Recurrence at Year 2

Of the 33 participants with depression at year 2, 13 experienced a recurrence of depression between year 1 and year 2 (Figure 1). In other words, these participants were not depressed at year 1 but had a recurrence of depression during year 2, including nine in the prior depression group and four who had been depressed at baseline but had remitted at year 1. To determine whether persistent sleep disturbance was prospectively associated with depression recurrence during year 2, a survival analysis was performed. As shown in Figure 2, persistent sleep disturbance during year 1 was a significant predictor of depression recurrence during year 2 after controlling for the socio-demographic and clinical variables, including baseline depression status, listed previously (adjusted hazards ratio = 16.05, CI = 1.21 to 213.06, P = 0.035). Intermittent sleep disturbance was not significantly associated with depression recurrence during year 2 (adjusted hazard ratio = 5.61, CI = 0.47 to 66.96, P = 0.17). Severity of depressive symptoms (with sleep items deleted), antidepressant use, low level of education, unmarried status, and younger age were also significant predictors of depression recurrence during year 2 (Table 3).

Table 3—Predictors of depression recurrence during year 2

Predictors	Adjusted hazard ratio[a,b] (95% CI)	P
Persistent sleep disturbance	16.05 (1.21-213.06)	0.04
Intermittent sleep disturbance	5.61 (0.47-66.96)	0.17
Age[c]	0.84 (0.74-0.96)	0.01
Sex	0.70 (0.19-2.60)	0.59
Marital status[d]	12.24 (1.83-82.08)	0.01
Education[e]	0.55 (0.38-0.79)	0.001
Chronic medical burden	1.00 (0.70-1.44)	0.99
Depressive symptoms[f]	0.81 (0.67-0.97)	0.02
Use of antidepressant medications[g]	5.01 (1.39-18.07)	0.01
Use of sedative-hypnotic medications	1.32 (0.28-6.15)	0.72
Depression group status[h]	6.74 (0.80-56.83)	0.08

[a]Adjusted for all other variables in the table. [b]Reference is the absence of sleep disturbance group (n = 57). [c]Younger age is more likely associated with depression recurrence than older age. [d]Not married is more likely associated with depression recurrence than married. [e]Fewer years of education is more likely associated with depression recurrence than more years of education. [f]Greater depressive symptoms is more likely associated with depression recurrence than less depressive symptoms. [g]Use of antidepressants medications is more likely associated with depression recurrence than nonuse of such medications. [h]Current depression at baseline is more likely associated with depression recurrence than prior depression history. All variables except chronic and intermittent sleep disturbance were measurements at baseline. Chronic medical burden was evaluated by Chronic Disease Score. Depressive symptoms were measured by Hamilton Depression Rating Scale (minus sleep items).

DISCUSSION

The results of this 2-year longitudinal study of community-dwelling older adults confirmed our hypotheses. Among older adults with a history of depression or current depression, sleep disturbance that persisted for 1 year predicted depression during the following year. Furthermore, among older adults who were not depressed at the year 1 assessment, persistent sleep disturbance predicted depression recurrence during year 2. Importantly, the prospective association of persistent sleep disturbance with depression persistence and recurrence was

independent of baseline depression status, other depressive symptoms, sociodemographic characteristics, chronic medical burden, and antidepressant and sedative-hypnotic use. Neither intermittent sleep disturbance nor its severity was associated with depression or its recurrence at year 2. However, this study may not have been adequately powered to evaluate the role of intermittent sleep disturbance; studies using larger sample sizes and longer follow-up periods may be required. Nevertheless, these findings are unique in showing that persistent sleep disturbance predicts depression 1 year later, as ascertained by diagnostic interview, among community-dwelling older adults with prior depression.

These observations are consistent with meta-analytic findings that insomnia predicts depression,[16] and extend understanding of the role of sleep disturbance in the natural course and outcome of depression.[25,26] Our results suggest that depression history and the persistence of sleep disturbance might contribute to the heterogeneity of prior results. First, a prospective association between sleep disturbance and depression appears to be specific to those with a history of depression. At year 2, no control participants had depression, even though one-third of this group reported sleep disturbance with a quarter of those having persistent sleep disturbance. Only two studies[11,17] have evaluated the role of depression history in subsequent depression in community-dwelling older adults, although many studies have used clinical samples with such a history.[16,23] Further, none of the prior studies used a SCID interview, for example, to obtain a history of lifetime Axis I disorders. Hence, it is possible that prior findings linking sleep disturbance with depression risk were due to the inclusion of those with a depression history, who were not identified as such. Nevertheless Jaussent et al. found that elderly individuals with persistent insomnia and without a depression history were at risk for depressive symptoms over 6 years, although a comparative evaluation of risk between those with and without a depression history was not reported.[11] Second, the persistence of sleep disturbance, but not its severity, is strongly associated with depression risk. Whereas prior studies included participants who showed varying durations of insomnia, from several weeks to longer than 1 year,[16] sleep disturbance was typically assessed at a single time point. Moreover, sleep disturbance and depression have often been concurrently assessed without consideration of their temporal overlap.[24-26] Third, there appears to be a cumulative effect of sleep disturbance on depression risk.

Understanding the role of nonmodifiable (e.g., depression history) and modifiable (e.g., persistent sleep disturbance) risk factors for depression has advanced a compelling rationale for developing targeted interventions for the prevention of depression in older adults. Whereas a universal prevention approach may be optimal for reducing population-wide incidence of depression, such an approach would be an enormous enterprise, with an estimated 35,000 participants required to demonstrate a decrease in depression incidence.[36] However, by selectively targeting older adults with a depression history and persistent sleep disturbance, the number needed to treat (NNT) is dramatically reduced.[17] For example, assuming the use of a behavioral intervention (e.g., cognitive behavioral therapy for insomnia) with a 50% treatment efficacy,[37] the NNT is reduced to less than 10. Considering the various sleep interventions available, it should be noted that use of sedative-hypnotic medications was not protective in the current study, although our determination of prescription and over-the-counter sleep medication use relied on self-report, and we did not assess whether use frequency or dosage met clinical treatment adherence guidelines. Behavioral interventions have been found to be effective in the treatment of insomnia in older adults,[37] without the risk profile of sedative-hypnotic medications.[38]

We could not examine the relationship between persistent sleep disturbance and subsequent depression in the control group because none of the participants developed depression during year 2. The relatively short duration of follow-up may have affected these results.[39-42] Also, the incidence of depression in the elderly is variable, ranging from 2 to 22.6 per 1000 person-years, and it is those older adults with a history of depression who are more likely to experience depressive episodes. Finally, late-onset depression is often related to medical illness, including cardiovascular disease and neurological condition, but our study sample had low levels of medical morbidity and was primarily Euro-American. That is, persistent sleep disturbance may be less associated with depression risk in elderly populations who are neither mentally nor physically ill.

Several other limitations of our study should be considered when interpreting the results. First, these observations do not necessarily generalize to community-dwelling older adults who have not had prior depression. Second, this study focuses only on unipolar, not bipolar, depression. Third, only 11 participants from intermittent sleep disturbance group had depression at year 2, which may have resulted in low power to detect associations between sleep disturbance and depression prevalence or recurrence, despite a high hazard ratio (5.61). However, another study also demonstrated that single-episode insomnia is not associated with an increase in depressive symptoms at follow-up.[26] Fourth, our assessment of sleep quality relied on self-report. Whereas actigraphy or polysomnography is arguably the objective standard to assess sleep disturbance, the diagnosis of insomnia relies on subjective reports of sleep disturbance and daytime impairment similar to the PSQI.

Despite these methodological limitations, several major strengths distinguish this current study from previous efforts. First, the separate evaluation of depression from sleep disturbance, over a 1-year interval, provides evidence for a contribution of persistent sleep disturbance to depression risk; in contrast, concurrent evaluation of sleep disturbance and depression does not define a prospective risk relationship.[24,25] Second, depression was assessed with the SCID, which is known as the gold standard for the diagnosis of depression and is reliable in assessing depression history.

In conclusion, persistent sleep disturbance during a year-long period is associated with depression the following year. Persistent sleep disturbance is also prospectively associated with depression recurrence among individuals those who were not depressed 1 year earlier. These results provide evidence that the identification of older adults with current or prior depression, as well as persistent sleep disturbance, may optimize the efficacy of sleep related interventions to improve depression remission and/or prevent late-life depression. Finally, further studies are needed to identify the characteristics of previously depressed populations who develop persistent sleep disturbances for priority monitoring of depression recurrence.

DISCLOSURE STATEMENT

This was not an industry supported study. This work was supported by National Institute of Mental Health R01-MH 55253 and in part by VA Cooperative Study Program, Office of Research and Development, Department of Veterans Affairs; a grant from Merck & Co., Inc. to the VA Cooperative Studies Program; National Institute of Health grants R01-AG034588; R01-AG026364; R01-CA119159; R01-HL079955; R01 HL095799; P30-AG028748 to Dr. Irwin; UCLA CTSI UL1TR000124; the Cousins Center for Psychoneuroimmunology; and the James R. and Jesse V. Scott Fund for Shingles Research. Dr. Levin receives research funds, consultation fees, and royalties from intellectual property from Merck and Co. He has also received research support from GlaxoSmithKline and MedImmune and serves on the Adjudication Board for GlaxoSmithKline. The other authors have indicated no financial conflicts of interest. The sponsors had no influence on the design or conduct of the study.

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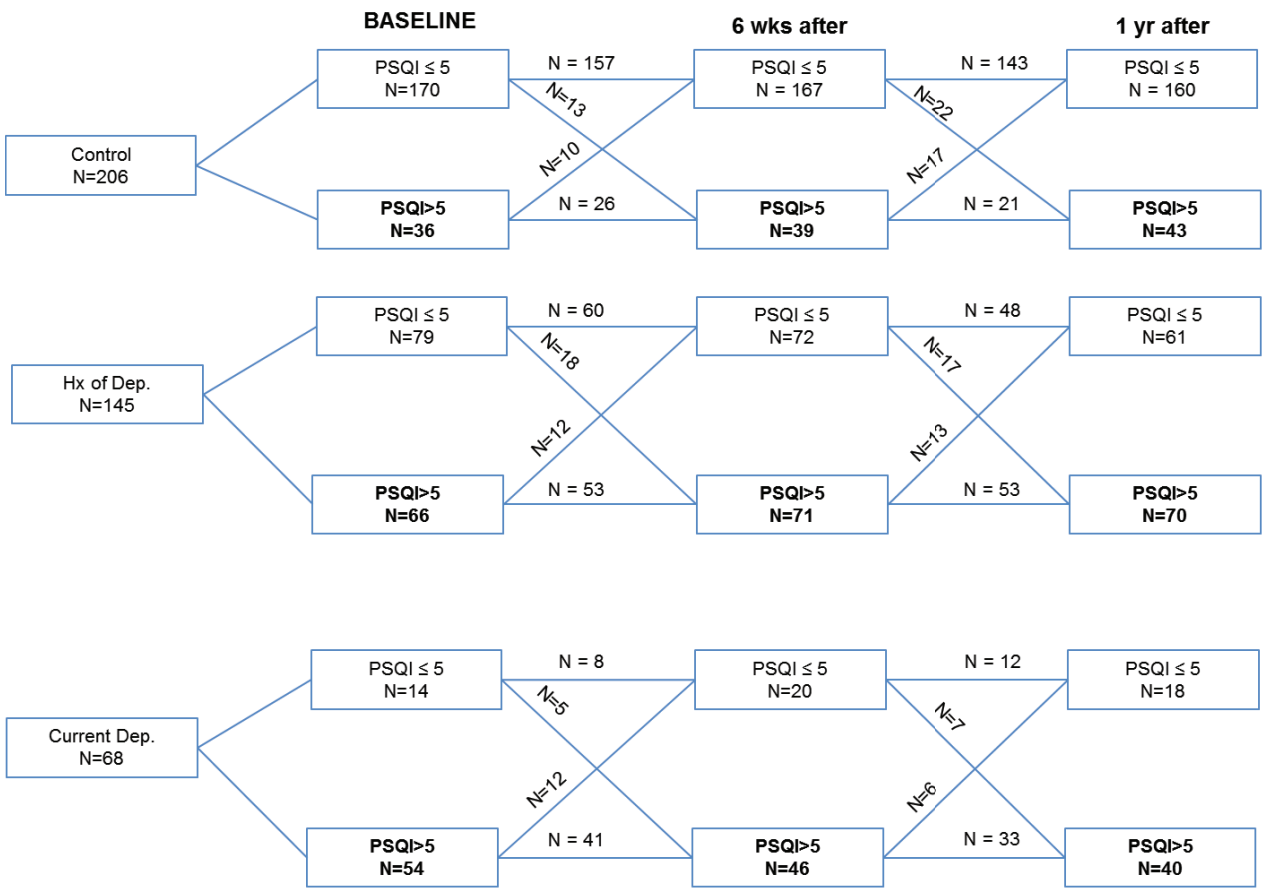

Figure S1—Time-varying changes in sleep disturbance (Pittsburgh Sleep Quality Index [PSQI] ≤ 5 vs. > 5) across baseline, 6 weeks, and year 1 in the control patients, those with prior depression, and those with current depression at baseline.

Table S1—Component scores of the Pittsburgh Sleep Quality Index at baseline in the three groups

Component	Prior depression (n = 145)	Current depression (n = 68)	Control (n = 206)
Sleep quality, mean (SD)	0.86 (0.75)	1.34 (0.77)	0.49 (0.63)
Sleep latency, mean (SD)	0.84 (0.91)	1.33 (1.0)	0.51 (0.72)
Sleep duration, mean (SD)	0.44 (0.71)	0.87 (0.98)	0.37 (0.67)
Habitual sleep efficiency, mean (SD)	0.71 (0.95)	1.01 (1.08)	0.35 (0.69)
Sleep disturbances, mean (SD)	1.4 (0.64)	1.67 (0.66)	1.15 (0.52)
Use of sleeping medication, mean (SD)	0.82 (1.21)	1.03 (1.36)	0.34 (0.79)
Daytime dysfunction, mean (SD)	0.74 (0.61)	1.48 (0.68)	0.42 (0.58)

SD, standard deviation.