SLEEP VARIABILITY AND GERIATRIC DEPRESSION

By

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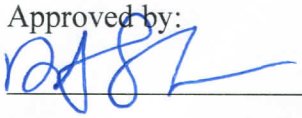

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Abstract

There are many studies documenting the positive association between depression and poor sleep. Most of this research, however, focuses on middle-aged or younger participants. The present study examined baseline data from a multi-site sleep study involving older adult participants (aged 60-80) to investigate the effects of variable sleeping patterns on depression in this population, using 14 days of sleep diaries and the Geriatric Depression Scale (GDS) 30. Using reference data provided Suh, Nowakowski, Bernert, Ong, Siebern, Dowdle, and Manber, (2012) as a standard, I calculated night-to-night variability by means of the nightly sleep diaries from 52 participants, and then examined the correlation between this variability score and mood disturbance symptoms using scores on the GDS of above 9 and above 11. No association was found between depression and sleep patterns in older adults, though this may be attributed to older adults mostly being “morning-type” people.

Introduction

Sleep quality is associated with numerous effects on health**.** For example, a meta-analysis done by Benca, Obermeyer, Thisted, and Gillin (1992) found that overall sleep disturbances were indeed linked to psychiatric illnesses. Sleep duration and sleep efficiency were worse in these individuals, significantly differing from the normal controls. Sleep regularity and efficiency can even have effects on the physical body, as a study done by Spruyt, Molfese, and Gozal (2011) found. Their research indicates that poor sleep regulation (having high night-to-night sleep variability) is correlated with higher body mass index (BMI) in school-aged children. The association between sleep quality and health is well documented in the existing literature.

Although "sleep quality" is widely accepted as a clinical construct, it involves many measures, making it difficult to study objectively. Sleep quality often includes the duration of the sleep period, number of arousals during the night, and sleep latency.

Sleep Problems

Health effects. Increased prevalence of hypertension is associated with insomnia (difficulty in falling and staying asleep) in participants that did not previously suffer from hypertension (Fernandez-Mendoza, Vgontzas, Liao, Shaffer, Vela-Bueno, Basta & Bixler, 2012). Cardiopulmonary problems and increased risk of inflammation occur in persistent insomnia participants (Pathasarathy, Vasquez, Halonen, Bootzin, Quan, Martinez, & Guerra, 2014). Poor self-reported sleep quality can also be a risk factor for multi-system biological risk, due to dysregulation in physiological set-points across regulatory systems (Carroll, Irwin, Merkin, & Seeman, 2015).

Mortality. Persistent insomnia (difficulty falling asleep and maintaining sleep, consistent over a period of a year or more) was linked to increased mortality risk after a 20-year follow up

was done in 1409 adult participants (Pathasarathy, Vasquez, Halonen, Bootzin, Quan, Martinez, & Guerra, 2014). Even when compared to intermittent insomnia, persistent insomnia was more likely to lead to mortality.

Depression and Sleep

Previous research. Problems with sleep quality are often reported in people with depression (Buysse, Reynolds, Monk, Berman, & Kupfer, 1988). Self-report data shows connections between depression and sleep. One study using self-report data collected from twins found that a significant portion of the disturbances people report on their subjective sleep and sleep patterns can be correlated with depression symptoms (Heath, Eaves, Kirk, &Martin, 1998). Studies using actigraphy have also found associations between depression and poor sleep quality. A study done by Law et al. (2011) found that depression in adolescents affected sleep duration, efficiency, and quality more negatively than it was affected by their peers suffering chronic pain. Polysomonographic (PSG) measures have confirmed that sleep is different in individuals with depressive symptoms. There is evidence that a PSG analysis might be useful in diagnostic measures for discriminating depression from other disorders, which strengthens the connection of sleep disturbance and depression (Ilankovic, Damjanovic, Ilankovic, Milovanovic, Petrovic, & Ilankovic, 2013). In fact, there is evidence that sleep disturbance precedes depression, including in older adults. Insomnia was found as a risk factor for developing (and later on, serving as a risk for continuation of) depression in a study done on older adults suffering from insomnia (Pigeon, Hegel, Unützer, Fan, Sateia, Lyness, Phillips, & Perlis, 2008).

In addition, poor sleep has even been shown to outperform scales of depression and hopelessness on suicidality measures in military-employed young adults (Ribeiro, Pease, Gutierrez, Silva, Bernert, Rudd, & Joiner, 2012). Also, older adults that do not report sleeping

well regularly can experience more daytime functioning difficulties than those that report sleeping well. In addition, those that are classified as "highly distressed" will experience more consistent daytime functioning issues, as well as greater tension throughout the day and more reported depressive symptoms (Alapin, Fichten, Libman, Creti, Bailes, & Wright, 2000).

Economic cost. Clinically significant fatigue has been found to add to the economic costs and burdens of depression (Robinson, Stephenson, Dennehy, Grabner, Faries, Palli, & Swindle, 2015). The relationship between sleep and depression can therefore significantly and negatively interact in many facets of a participant's life.

Due to the costs and risks associated both with poor sleep and even more so when variable sleep and depression are combined, it is worth discovering whether these associations and risks hold true for the older adult population. This knowledge could lead to more effective treatment plans, better understanding of symptoms, and the overall benefit of more deeply understanding the connection between these often comorbid disorders.

There has been past research that did find an association between poor sleep and depression in older adults (Alapin et al., 2000). However, past studies have not been able to collect more than a few days' worth of data, and did not specifically focus on sleep variability. Poor sleep may mean any number of things, from a restless night, to disruptions in sleep during the night, or not enough sleep. Insomnia is the difficulty falling asleep and maintaining sleep after sleep onset (it is also a clinical diagnosis, making its definition clear and binary). However, sleep variability differs from these measures in that it specifically looks at night-to-night differences in a participant's sleep. For example, in this study I examined sleep onset latency (SOL), wake after sleep onset (WASO), and totally sleep time (TST) and looked at the variability of these measures, night-to-night, across the two-week period. It may lead to poor

sleep, but is not necessarily defined as "poor sleep" or a diagnosis of "insomnia". The specific correlation between sleep variability between nights and depressive symptoms has not been explored in the older adult population, and that is what this study explores. I predicted that with higher night-to-night variability, there would be more depressive symptoms. Similarly, I expected that with a more stable sleep pattern, there would be less depressive symptoms reported.

Methods

Participants

Fifty-two participants (39 female) from a larger multisite study who provided complete data were included in the present analyses. The mean (standard deviation) of age in this sample was 64.95 (3.53). Twenty-two participants were from the University of Arizona site, 15 were from the USC site, and 15 were from the NYU site. Inclusion criteria for the study were ages 60-80, and having a stable sleep pattern for an extended period of time. Exclusion criteria for the study were being treated for bipolar disorder, some physical health problems (including shoulder tendinitis, polymyalgia rheumatic, cancer, and gouty arthritis), and spending too much time in bed (over a half an hour before attempting to fall asleep, and over a half an hour after waking).

Measures

Depression. The GDS-30 is a validated screening measure for major depressive disorder in geriatric populations (Parmelee & Katz, 1990). It consists of 30 items, reflecting symptoms that participants either endorse or deny, yielding a range of 0-30. Two cut-off points were used: a score of > 9 on the GDS-30, and a score of > 11. Previous research showed that a cutoff of 9

yielded a sensitivity of 90%, and specificity of 80%, while a cutoff of 11 yielded a sensitivity of 84% and a specificity of 95% (Brink et al., 1982).

Sleep. Daily sleep diaries were completed by participants for two weeks. Sleep diaries included questions related to bedtime, sleep onset latency, number of awakenings, wake time after sleep onset, and wake time. Sleep variability was calculated using sleep diaries filled out night-to-night by the participants, including bed time, wake time, and time in bed over the two week baseline period.

Data Analyses

Night-to-night variability in sleep was calculated using data from daily sleep diaries following the procedures of Suh et al. (2012). Within-subject night to night variability in individual sleep parameters was calculated using the root mean square of successive differences (RMSSD). Parameters were then averaged to create two composite scores were created: the Insomnia Composite Scale (ICS, the average variability in sleep onset latency, wake time after sleep onset, and total sleep time) and the Behavioral Composite Scale (BCS, the average z-transformed variability of bedtime, lights out, wake time, rise time, and time in bed).

Values on the ICS and BCS greater than 2 standard deviations from the mean were considered outliers. These outliers were Winsorized (i.e., reduced to the next highest observed value) prior to analysis.

Bivariate correlations were used to examine the associations between these continuous measures of sleep inconsistencies and depression, and *t*-tests were used to compare ICS and BCS between those above and below the two GDS-30 cutoffs. In the case of unequal variances between groups, Satterthwaite *t*-tests were used. Effect sizes were calculated using Cohen's D or, in the case of unequal variances between groups, Glass's Δ.

Results

The mean (standard deviation) of the GDS-30 in this sample as 3.29 (3.84) and the range was 0 to 17. Six participants fell above the cutoff of 9 and three participants above the cutoff of 11. The ICS and BCS were significantly correlated, $r(52) = .74$, $p < .0001$. The ICS was not significantly correlated with GDS-30, $r(52) = .10$, $p > .4$. The BCS was not significantly correlated with GDS-30, $r(52) = .17$, $p > .2$.

There was no significant difference in ICS between participants above or below the cutoff of 9 (95.36 vs. 82.60), $t(35.51) = 0.46$, $p > .6$, $\Delta = .08$. Similarly, there was no significant difference in BCS between participants above or below the cutoff of 9 (-.0638 vs. .0309), $t(50) = -0.50$, $p > .6$, $\Delta = -.21$. There was no significant difference in ICS between participants above or below the cutoff of 11 (96.26 vs. 55.20), $t(49.49) = 1.85$, $p > .05$, $\Delta = .26$. Similarly, there was no significant difference in BCS between participants above or below the cutoff of 11 (-.0524 vs. -.0616), $t(50) = .04$, $p > .9$, D = .02.

To better understand the variability between the depressed individuals and the non-depressed, however, I also age-, sex-, and sleep type-matched the 6 individuals that scored at or above the cut-off of 9 on the GDS. This was because there were only 6 out of 52 individuals above that cut-off.

Here is summary data on these 6 participants:

Participant	Age	Sex	Sleep type
Depressed_1/Control_1	68	F	long
Depressed_2/Control_2	65	F	long
Depressed_3/Control_3	65	F	normal

Depressed_4/Control_4	68	M	normal
Depressed_5/Control_5	64 (Control_5 was 65)	F	long
Depressed_6/Control_6	69	F	long

ICS was higher in the control group than those with clinically significant depression (187.30 vs. 82.60), $t(5.22) = 1.03$, $p > .3$, $\Delta = .43$. BCS was also greater in the control group than those with clinically significant depression (/1401 vs. .0309, $t(10) = .3$p, $p > .7$, D = 0.24. Three individual sleep parameters were used: sleep onset latency (SOL-how long it takes to fall asleep after beginning to try to sleep), wakeup after sleep onset (WASO-total amount of time awake after they have fallen asleep), and total sleep time (TST). For the SOL variability, I again found a difference between controls and the clinically depressed group (5.78 vs. 27.27), $t(5.52) = -3.37$, $p = .0170$, $\Delta = -6.21$. WASO variability had a lower value for controls against the depressed group as well (13.20 vs. 60.18), $t(10) = -2.63$, $p = .0254$, D = -1.22. TST variability was higher in the control group than the clinically depressed group (1475.8 vs. 160.3), $t(5.02) = 1.08$, $p > .3$, $\Delta = -.44$.

The graphs below better show the variability between these depressed individuals and the "controls". Sleep onset latency and wake after sleep onset are in minutes over the 14 days, while total sleep time is in hours over the 2 week period:

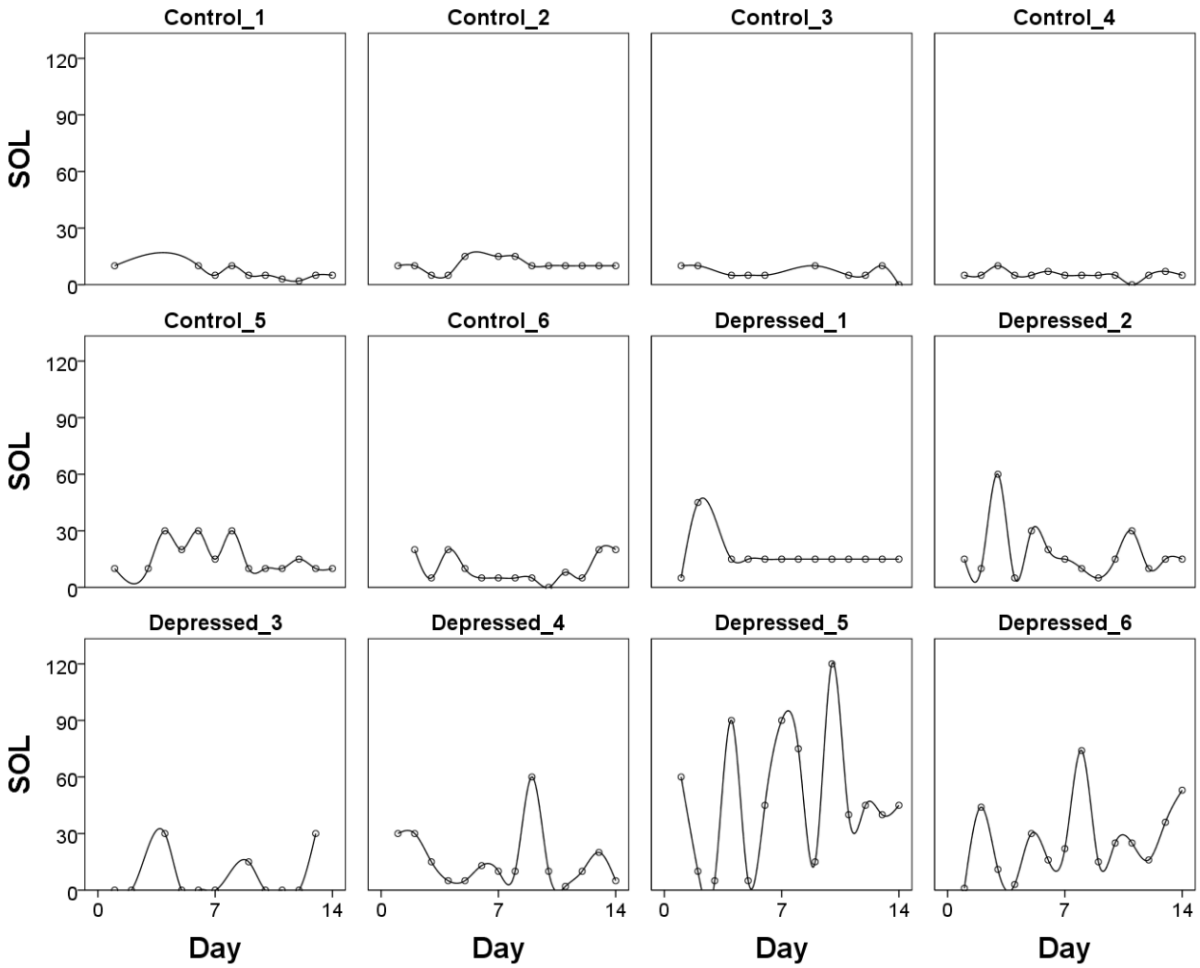

Figure 1. Night to night variability in sleep onset latency in 6 participants with elevated depressive symptoms and 6 sleep type, age- and sex-matched participants without elevated depressive symptoms

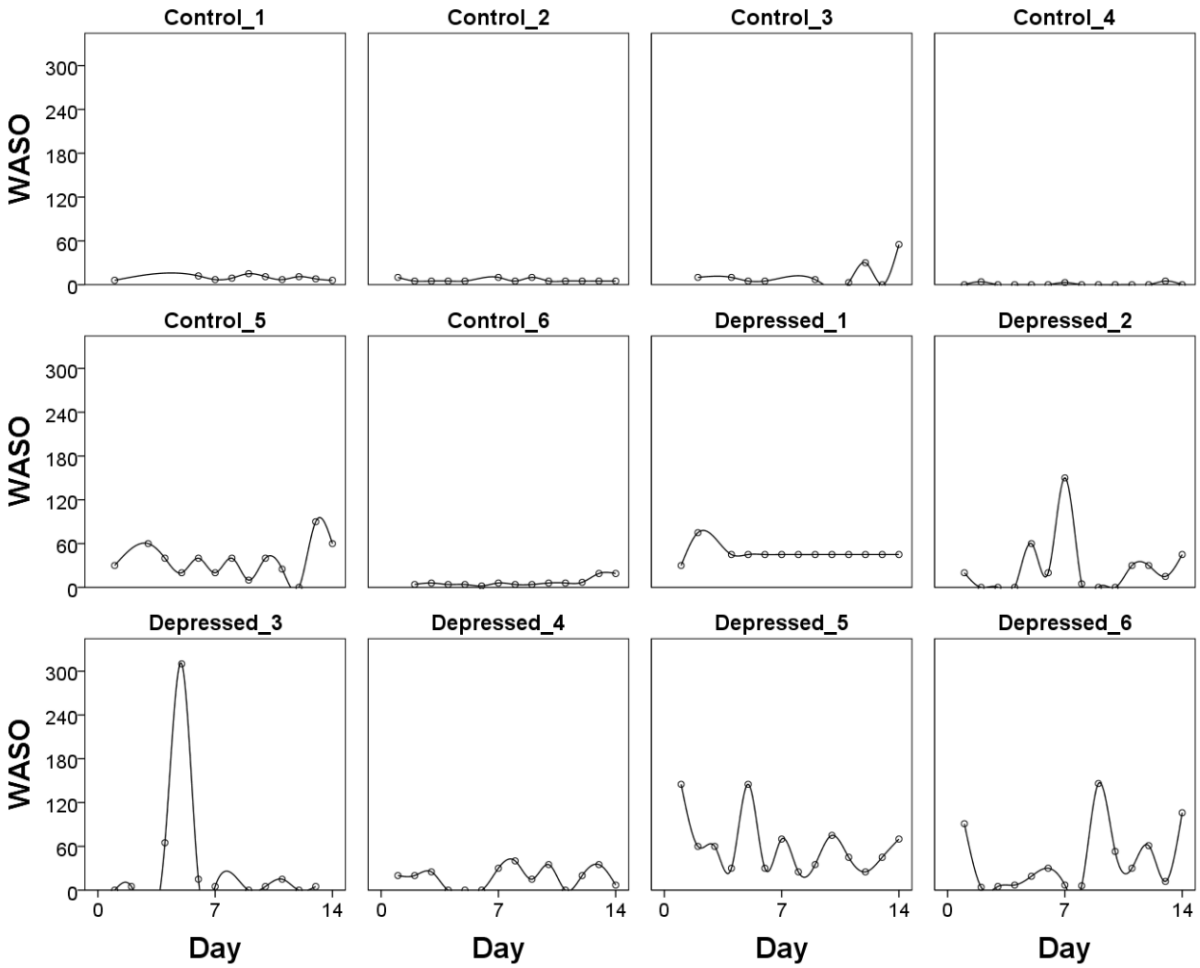

Figure 2. Night to night variability in wake time after sleep onset in 6 participants with elevated depressive symptoms and 6 sleep type, age- and sex-matched participants without elevated depressive symptoms

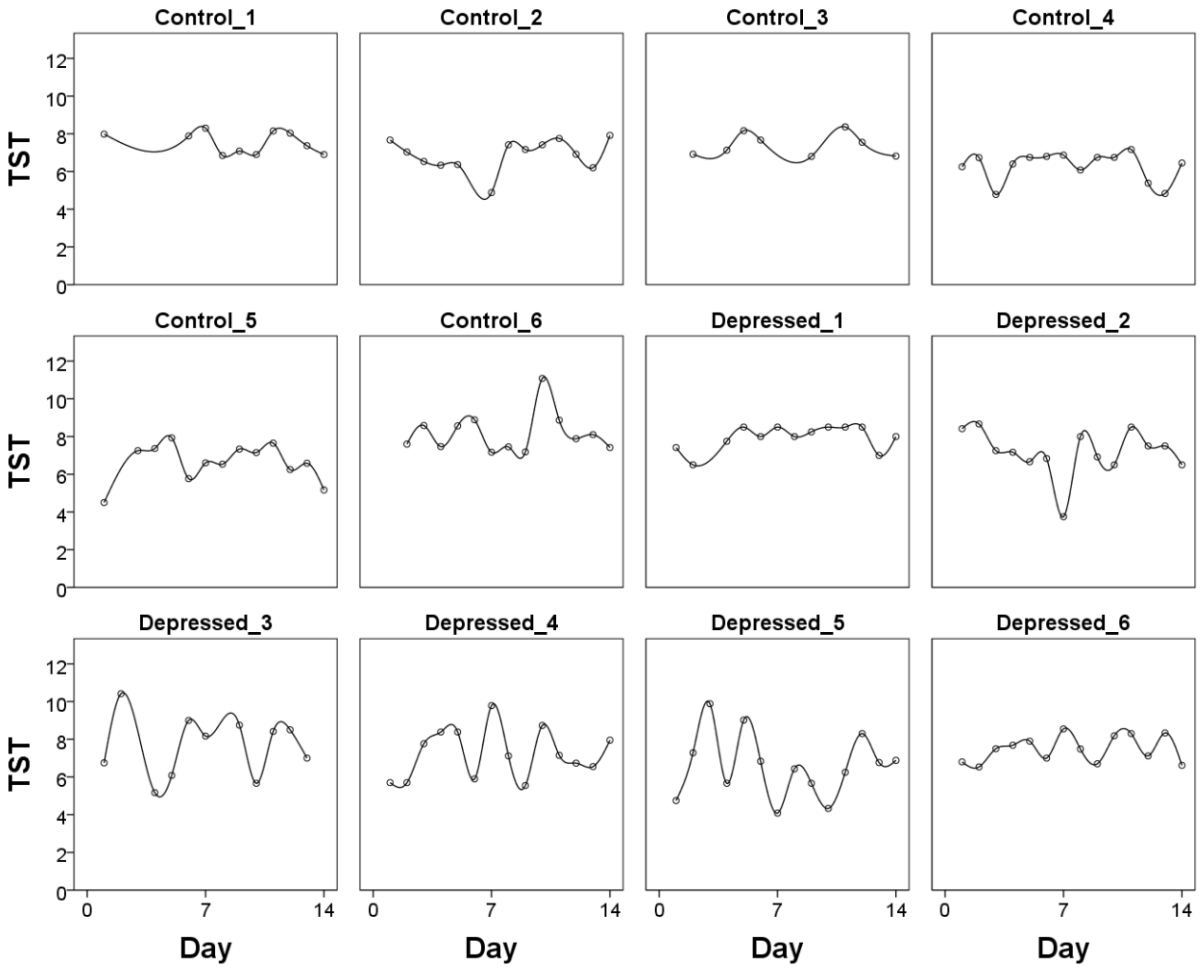

Figure 3. Night to night variability in total sleep time in 6 participants with elevated depressive symptoms and 6 sleep type, age- and sex-matched participants without elevated depressive symptoms

Discussion

In the older adult population, poor sleep can be related to depression (Alapin et al. 2000). It is also known that sleep variability and poor sleep quality can precede depression (Perlis et al. 2006). But whether or not variable sleep itself affects older adults' depression levels is still

unknown. This information could be vital to treatment involved with depression in older adults, or even treatment for sleep disturbances in that population. It is not yet known how strongly this association can be in this population and which specific sleep parameter(s) being highly variable puts people most at risk is relatively unknown. We used bed time, lights out, wake time, rise time, and time in bed were used as the sleep parameters in this analysis and tested for correlation with reported depressive symptoms to expand on the current research on this topic.

In the present study, contrary to my predictions, there were no associations between the Geriatric Depression Scale (GDS) and the sleep diary data (used to determine night-to-night sleep habits). However, to better see the effects of such a small group (6 clinically depressed participants versus 46 non-depressed), the depressed group was matched by age, sleep-type (long or average sleepers), and gender. When the depressed individuals were matched to a "control" (non-depressed) individual, night to night variability in sleep onset latency and wake time after sleep onset were higher in the depressed individuals. Over the 14 days of sleep diaries, these depressed individuals had more variable time taken to fall asleep than the control group, and more total time awake after falling asleep then the control group they were matched to. With a larger sample, we may find this variability difference to be significant. The findings may be contrary to prior research simply due to the sample size being 52 participants and only 6 of those had elevated depressive symptoms.

Most of our sample had a relatively stable sleeping pattern when coming into the study, as evidenced by their baseline sleep diaries. This is shown best by Fig. 3, in which it is easy to see visually how similar the control group's sleep was night-to-night over the 2 week period. The depressed group has a much more variable sleep night-to-night, as is also shown by Fig. 3. However, that group only made up 6 of the 52 participants, and most of the sample was

representative of the less variable control group. It may be worth examining in the future if this sleep pattern came about due to recent retirement, and if they had such stability sleep-wise prior to retirement. It may be the case that developing or maintaining a stable sleep pattern could be a preventative measure for depression and health problems. These findings are indeed consistent with the one of the behavioral components of cognitive behavioral therapy for insomnia (CBTI): maintaining a consistent sleep-wake schedule in order to regularize sleep and circadian rhythm.

The lack of association between depression and sleep in older adults could be explained by the fact that in previous research, it has been found that most of the older adult population falls in the morning-type category versus the evening-type category (Yoon, May, & Hasher, 1998), meaning they go to bed early and also rise early instead of staying up late and sleeping in. This distinction is important because depressive symptoms are more often linked with evening-type sleep patterns, as other previous research has shown (Suh et al., 2012).

Limitations

The results of this study should be interpreted in light of its limitations. There were not many participants that scored above a 9 or an 11 on the GDS-30, which may be attributed to study exclusion criteria. Therefore, before I could even compare sleep variability and depressive symptoms, there was only a sample with very limited depressive scores in the clinical range; it may be the case that there are large differences in sleep variability as a function of sub-clinical mood disturbance versus clinically-significant major depression. Because sleep diaries were used to collect this data, the data was self-reported and therefore subjective. As a result, these data points were more challenging to control: the participants were told before the experiment began that their sleep would be strictly controlled, and as a result they may have begun a more

"normalized" sleep pattern than they would typically have. Reporting sleep using a nightly sleep diary also simply makes participants more aware of their sleeping habits, also potentially leading to a more stable sleep pattern. It is also possible that potential participants that are clinically depressed would not be motivated enough to volunteer participation for a study focused around sleep. People that do have a very difficult time with sleep also may not volunteer for a study requiring tightly controlled sleep for 12 weeks. Because of this, the study's baseline data was fairly homogenous, making any possible associations difficult to uncover due to a mostly unvaried sample of people.

Conclusion

In a NIH-funded multisite study of sleep in older adults, I found correlation between sleep variability and depression. Because this null result is inconsistent with prior research, future studies should include a larger range of older adults (a less homogenous sample, with less-strict exclusion criteria), specifically including evening-types to see if that sleep pattern in older adults has any difference in depression. Also, participants with higher scores on the GDS should be included to provide a more balanced sample of depressive symptoms. With more relaxed exclusion restrictions, and a therefore less homogenous sample, our results may have shown a correlation between depression and sleep in older adults. Seeking out and including evening-type older adults would be pertinent for future studies.

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