

The Link between Sleep Disturbance and Depression among Mexican Americans: A Project FRONTIER Study

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Objective: To examine the link between disturbed sleep and depression scores in Mexican Americans and non-Hispanic Whites.

Methods: Data were analyzed for 566 participants (45% Mexican Americans) who were part of a rural healthcare study, Project FRONTIER. Mean age was 55.5 years for Mexican Americans (70% female) and 65.6 years for non-Hispanic Whites (69% female). Self-reported sleep disturbance was entered as the predictor, GDS-30 total and factor scores as the outcome variables, and age, sex, education, BMI, and medical diagnoses (hyperlipidemia, diabetes mellitus, and hypertension) entered as covariates.

Results: Mexican Americans reported higher rates of sleep disturbances (25%) than non-Hispanic whites (17%). Sleep disturbances were significantly associated with GDS-30 total

scores and the factors Dysphoria and Cognitive Impairment in both Mexican Americans and non-Hispanic whites.

Conclusions: In this study, Mexican Americans reported higher rates of sleep disturbances than non-Hispanic whites. Disturbed sleep was positively associated with depression and the factor scores for Dysphoria and Cognitive Impairment in both groups. Given the paucity of research on sleep disorders in Mexican Americans, identifying what sleep disorders are present and the impact treating these sleep disorders have on depression warrant further investigation.

Keywords: Mexican American, sleep, depression, sleep disturbance
Citation: Roane BM; Johnson L; Edwards M; Hall J; Al-Farra S; O'Bryant SE. The link between sleep disturbance and depression among Mexican Americans: a Project FRONTIER study. *J Clin Sleep Med* 2014;10(4):427-431.

Depression is a major public health issue that roughly 18.8 million American adults experience. The deleterious effects of depression can be seen in its relation to poorer health outcomes, quality of life, and increased mortality; however, little research has focused on the link between depression and health status among Mexican American elders despite the rapidly changing demographic characteristics of the American aging population. Prior work suggests that approximately 25% of Mexican American elders endorse significant depression, with that rate increasing to over 33% in those over age 80.¹ Therefore, Mexican American elders suffer a disproportionate burden of depression as compared to non-Hispanic whites, which increases risk for a number of poor health conditions.

Another major public health problem within the US is sleep disorders, which affect 50-70 million American adults.² Disturbed sleep is one of the most common symptoms of depression. While a connection exists between depression and disturbed sleep, the link is complex. Historically disturbed sleep has been considered a symptom of depressed mood; however, this view has shifted to a reciprocal model where sleep disturbances can precede, follow, or co-occur with depressed mood.³ Like depression, sleep disturbance adversely affects health outcomes, quality of life, immune system functioning, metabolism, and increases cardiovascular burden. At least 50% of patients diagnosed with depression also report severely disturbed sleep.⁴

BRIEF SUMMARY

Current Knowledge/Study Rationale: While the Mexican American population has grown exponentially, the literature to inform practitioners about the prevalence and comorbid conditions within this population has not kept pace. To date, little is known about sleep and its association with depression among Mexican Americans.

Study Impact: While sleep disturbance and depression rates were associated in both Mexican Americans and non-Hispanic whites, their prevalence was higher among Mexican American adults. These findings highlight the need to better understand (a) the prevalence of specific sleep disorders, (b) the relationship between disturbed sleep and mental health, and (c) how these conditions may be modified in order to improve health outcomes among Mexican Americans.

The complaint of disturbed sleep can result from several sleep disorders including insomnia, restless legs syndrome (RLS), and obstructive sleep apnea (OSA). The prevalence of sleep disorders in Mexican American populations is largely unknown⁵ due to a paucity of studies examining sleep in this population. The few studies that have been conducted show that sleep disturbances are a concern in Mexican Americans. A recent study found that 52.9% of Mexican American elders reported difficulties sleeping at least 3 days per week.⁶ Furthermore, greater risk of mortality was found in elder Mexican American females who reported difficulties sleeping and had higher depression scores on the Center for Epidemiologic Studies of Depression scale; however, this risk of mortality was

Table 1—Participant demographics

	Mexican American	Non-Hispanic White
Age	55.5 (10.3)	65.6 (12.7)
Sex (% female)	69%	68%
Education	7.4 (4.1)	13.2 (2.7)
Sleep Disturbance (% yes)	25.1%	16.5%
GDS Total	9.79 (6.6)	6.8 (5.3)
GDS – dysphoria	3.5 (3.0)	2.0 (2.2)
GDS – meaninglessness	2.0 (1.9)	1.3 (1.6)
GDS – apathy	2.4 (1.6)	2.0 (1.5)
GDS – cognitive impairment	1.9 (1.5)	1.5 (1.2)
BMI	31.0 (6.0)	28.6 (6.0)
Diabetes (% yes)	40%	22%
Hypertension (% yes)	59%	58%
Hyperlipidemia (% yes)	57%	63%

not present in males. A more recent regional study using data from a telephone questionnaire found that 14.4% of Mexican Americans self-reported restless legs symptoms.⁷ Despite recent attention given to disturbed sleep in Mexican Americans, the literature is still lacking in breadth. This is unfortunate, as many of the risk factors for sleep disorders such as obesity, diabetes, alcohol use, and smoking are highly prevalent in Mexican American populations.⁸⁻¹¹

While the symptomology of the various sleep disorders are different, they all share an association with depression in the general population. For instance, depression rates range from 24% to 45% in patients with OSA,⁵ and people with depression are five times more likely to also have OSA.¹² In patients with RLS, 40% also report depression symptoms. Insomnia increases the risk of depression by 10-fold,¹³ and roughly 44% of individuals with depression also report insomnia.¹⁴ In addition, recent studies have shown that depression symptoms are reduced after successfully treating the co-occurring sleep disorder.¹⁵⁻¹⁷

A recent study showed that depression predicted self-reported sleep difficulties in Mexican American elders.¹⁸ While connections between sleep and depression are evident in the general population, few comparative studies have been conducted among Mexican Americans adults and elders. Nearly 50% of US population growth from 2000 to 2010 was due to growth in the Hispanic population. Additionally, the percentage of elders in the US Hispanic population is estimated to triple by the year 2050, while declining among non-Hispanic populations. Given that approximately 65% of the US Hispanic population is Mexican American, they represent the fastest growing segment of the aging population, yet the scientific literature on the health consequences of mental health issues among these adults and elders is nearly nonexistent.

The current study seeks to add to the extant literature by characterizing the link between a history of disturbed sleep and depression scores among Mexican Americans and non-Hispanic whites. We hypothesized that Mexican Americans would endorse significantly more disturbed sleep and higher depressive symptoms. We also hypothesized that a history of sleep disturbances would be positively associated with depression

scores in both Mexican Americans and non-Hispanic whites and be significantly related to risk of depression among both ethnic groups.

METHODS

Participants

The study sample was 490 Mexican Americans and non-Hispanic whites aged 40 or above recruited as part of Project FRONTIER (Facing Rural Obstacles to Healthcare Now through Intervention, Education, & Research), an ongoing epidemiological study of health among rural-dwelling individuals residing in West Texas, US, that began in 2008. Detailed description of Project FRONTIER has been described previously.^{19,20} Project FRONTIER is a community-based epidemiological study of rural cognitive aging that utilizes a community-based participatory research (CBPR) approach. CBPR involves partnering communities with scientific groups to conduct studies of human disease. CBPR is particularly useful when working with underserved communities that may not respond to classic approaches (e.g., random digit dialing, mail surveys) and is supported by the National Institute of Environmental Health Sciences. Partnerships were created with the local hospitals and clinics as well as other community (e.g., senior citizens' centers) organizations. Community recruiters and research personnel presented information about the study at community events, churches, food banks, as well as through door-to-door solicitation. Prior work from this study has demonstrated the comparability of the recruited cohort to that of the eligible population.²⁰ Inclusion criteria were (1) age \geq 40 years and (2) residing in one of the counties included in the study (Cochran, Bailey, or Parmer County, Texas).

Of the 211 Mexican Americans, mean age and years of education were 55.5 (SD 10.3, range 40-86 years) and 7.4 (SD 4.1), respectively, with 147 females and 64 males. Mean age and years of education of the 279 non-Hispanic White participants were 65.6 (SD 12.7, range 40-96 years) and 13.2 (SD 2.7), respectively, with 189 females and 90 males. Demographic characteristics of the sample are provided in **Table 1**.

Procedures

This study was conducted with IRB approval. All participants signed written informed consent, and participants were paid for their participation. Participants were interviewed either at a central location or in-home, if they preferred. Following informed consent, participants underwent the research protocol that included screening for depressive symptoms and sleep disturbance.

Depression was assessed using the Geriatric Depression Scale (GDS-30),²¹ a 30-item validated measure of depression in older adults. A recent factor analytic study identified 4 factors underlying the scale: Dysphoria, Meaninglessness, Apathy, and Cognitive Impairment.²² The Dysphoria factor contains items primarily associated with a sad mood. The Meaninglessness factor consists of items that reflect an appraisal of the meaning (or lack thereof) in one's life. The Apathy factor is made up of items that reflect a lack of motivation or initiative. The Cognitive Impairment factor consists of items that reflect difficulty

Table 2—Relationship between sleep disturbance and GDS total and factor scores

	B-value	t-score	Step 1 variance	Variance accounted for by sleep disturbance
Mexican American				
Total Score	2.79	3.21	5% ^{ns}	12% ^{***}
Dysphoria	2.56	3.76	7% ^{ns}	13% ^{***}
Meaninglessness	1.24	4.27	3% ^{ns}	8% ^{***}
Apathy	0.51	2.00	4% ^{ns}	2% ^{ns}
Cognitive Impairment	0.97	4.20	4% ^{ns}	8% ^{***}
Non-Hispanic Whites				
Total Score	5.33	5.27	10% ^{***}	3% ^{**}
Dysphoria	1.10	3.09	9% ^{***}	3% ^{**}
Meaninglessness	0.48	1.88	9% ^{**}	1% ^{ns}
Apathy	0.52	2.20	7% ^{**}	2% [*]
Cognitive Impairment	0.62	3.20	4% ^{ns}	4% ^{**}

B = unadjusted beta, B and t-scores are presented for sleep disturbance model. Step 1 variables = age, gender, education, BMI, hypertension, dyslipidemia, and diabetes. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = not significant ($p > 0.05$).

and concern with cognitive processes. Information regarding sleep disturbance was collected as part of the medical examination that was conducted by a physician, physician assistant, or nurse practitioner. Presence of sleep disturbance (any kind, yes/no) was queried as part of the psychiatric component of the review of systems. More detailed information regarding specific type(s) of sleep disturbance was not available.

Data Analyses

A χ^2 analysis examined differences between Mexican Americans and non-Hispanic whites for the frequency of sleep disturbances. The link between presence of sleep disturbances and depression scores among the two ethnic groups was analyzed via stepwise linear regression models with sleep age, gender, education, body mass index (BMI), and presence of (yes/no) cardiovascular diagnoses (i.e., diabetes, dyslipidemia, hypertension) entered in the first step and sleep disturbance (yes/no) entered in the second step. The amount of variance was examined at each step to determine the relative impact of sleep disturbance on depression scores. A logistic regression analysis was conducted to determine if sleep disturbance (yes/no) was a significant risk factor for categorization of depression (i.e., GDS ≥ 10). The significance level was set at $p < 0.05$. Analyses were performed using SPSS 20 (IBM).

RESULTS

Mexican Americans were significantly more likely to report sleep disturbances than non-Hispanic whites (25% versus 17%, $\chi^2 = 5.6$, $p = 0.013$). Mexican Americans (mean = 6.82 [SD 5.3]) endorsed higher depressive symptoms (GDS-30 total scores) than non-Hispanic whites (mean = 9.79 [SD 6.6]; $t = 5.88$, $p < 0.001$). In a full single-step model, sleep disturbance was significantly associated with higher GDS-30 total scores for both Mexican Americans ($B = 5.33$, $t = 5.27$, $p < 0.001$) and non-Hispanic whites ($B = 2.72$, $t = 3.21$, $p = 0.001$). Aside from sleep disturbance, presence of diabetes ($B = 2.14$, $t = 2.28$, $p = 0.02$) was the only additional significant predictor of total

depression scores among Mexican Americans. Among non-Hispanic whites, higher education was associated with significantly lower total GDS scores ($B = -0.03$, $t = -3.95$, $p < 0.001$), while higher BMI was associated with significantly higher GDS scores ($B = 0.14$, $t = 2.46$, $p = 0.01$).

In the stepwise linear regression models, a clear pattern of the degree of relationship between sleep disturbance and depression scores (total and subfactors) became apparent. For Mexican Americans, sleep disturbance was significantly associated with total depression scores (accounting for 12% of the variance) as well as the subfactors of dysphoria (13% of variance accounted for), meaninglessness (8% of the variance accounted for), and thoughts of cognitive impairment (8% of the variance accounted for). The combined variance accounted for by all covariates (age, sex, education, BMI, diabetes, dyslipidemia, and hypertension) was not a significant predictor of total GDS score or any subfactor scores. Among non-Hispanic whites a different pattern was found, with the covariates accounting for upwards of 10% of the variance in GDS scores, with sleep accounting for only up to 4% of the variance (see **Table 2**).

In the logistic regression model, sleep disturbance was a significant risk factor for being categorized as depressed among Mexican Americans (odds ratio [OR] = 3.02, 95% CI 1.26-7.21) but not among non-Hispanic whites (OR = 1.73, 95% CI 0.88-3.42).

DISCUSSION

The current findings are unique in that they demonstrate a differential impact of self-reported sleep disturbance on depressive scores among Mexican Americans as compared to non-Hispanic whites. In the current study, self-report of disturbed sleep was a powerful predictor of total depression scores as well as depressive subfactor scores of dysphoria, meaninglessness, and cognitive impairment among Mexican Americans accounting for 8% to 13% of the variance. Additionally, age, gender, education, BMI, and diagnosis of diabetes, dyslipidemia, and hypertension did not combine to account for significant

amounts of variance in any depressive symptom scores among this ethnic group. On the other hand, demographic and cardiovascular risk/disease factors accounted for 4% to 10% of the variance in depression scores among non-Hispanic whites, while the amount of variance accounted for by self-reported disturbed sleep was very small, ranging from only 1% to 4% of the variance, though these were statistically significant. When combined with the finding that self-reported disturbed sleep was more common among Mexican Americans, the current study points to a potential health disparity that requires further attention. That is, sleep disturbances and depressive symptoms both appear to be higher among Mexican American adults and elders, and the link between sleep disturbance and depression appears to be stronger among this ethnic group than non-Hispanic whites. This is not to say that sleep disturbance is not associated with depression among non-Hispanics. In fact, the link was significant as has been documented in prior work. The lack of a significant finding in the logistic regression analyses is likely due to sample size, given that only 16% of all non-Hispanic whites endorsed sleep disturbances.

The association between disturbed sleep and symptoms of Dysphoria is consistent with previous work.^{23,24} Prospective analysis also show that disturbed sleep predicts subsequent ratings of low life satisfaction.²⁵ One possible explanation for this connection is the dysregulation in the frontolimbic system that occurs in depression and disturbed sleep.²⁶⁻²⁹ People with insomnia evidence reductions in hippocampal volume as do individuals with depression.^{27,29,30} Furthermore, previous research shows that sleep disturbances play a mechanistic role in psychiatric disorders through numerous shared and interacting neurobiological substrates.³¹

The finding of a relationship between reported sleep disturbance and depressive symptoms related to thoughts of Cognitive Impairment for both Mexican Americans and Non-Hispanic whites was not unexpected. As outlined above, sleep disturbances have been found to be associated with reductions in hippocampal volume and there is a long-standing literature linking sleep disturbances to dysfunctional cognition. In addition, prior work has shown that disrupted sleep is a contributing factor in the cognitive decline of older adults.³² Specific sleep disorders also appear to impair memory consolidation differently. For instance, patients with insomnia showed deficits with verbal and visual declarative information; obstructive sleep apnea patients demonstrated deficits with verbal declarative information; and narcolepsy patients showed difficulties with visual procedural skills.³³ Of note is that the cognitive functions most adversely affected by depression are attention, working and episodic memory, and executive functioning.³⁴ For instance, patients with depression evidence greater impairments in immediate and delayed memory recall.³⁵ In addition, scores on the Cognitive Impairment subscale have been found to have an inverse relationship with immediate and delayed memory in Mexican Americans.³⁶ Thus, the presence of both a sleep disturbance and depression may have increased the likelihood of reporting cognitive impairment symptoms in both Mexican Americans and non-Hispanic whites. Therefore, additional work looking at the link between sleep disturbance and cognitive status among Mexican Americans is important.

This study also highlights potential therapeutic opportunities that could be targeted to reduce the health disparities of increased risk for sleep disturbances and depression among Mexican Americans. Prior work suggests that treating sleep disturbances has a symptom reduction effect on depression. Additionally, the current work suggests a stronger link between disturbed sleep and depression among Mexican Americans. Therefore, interventions aimed at sleep disturbances may have a stronger impact on depression among this underserved, but rapidly growing, ethnic minority group.

The current study supports further exploration into sleep disturbances and their association with mental health and health outcomes among Mexican Americans; however, several limitations exist. First, information regarding sleep disturbance was dichotomous (yes/no) captured during the medical examination review of systems without any detailed information regarding the type(s) of disturbance. Our team is currently conducting more in-depth investigations on this topic within this specific target population. Second, the sample reflects rural-dwelling Mexican American and non-Hispanic whites limiting the generalizability of the findings. The cross-sectional nature of the current study prohibits any causal conclusions; however, longitudinal studies led by our research team are underway. Third, it is possible that other differences exist between the ethnic groups that account for the increased sleep disturbances that were measured and taken into consideration in this project (e.g., dietary and exercise patterns). Despite these weaknesses, this preliminary study supports a more in-depth exploration of specific sleep disorders affecting this group. Thus, while the current analyses were a cross-sectional look at both disturbed sleep and depression, additional work needs to be done to determine the prevalence of specific sleep disorders and their association with depression in Mexican Americans. Furthermore, the independent and cumulative link between sleep disturbance and depression on cognitive impairment in Mexican Americans should be examined.

REFERENCES

- Black SA, Goodwin JS, Markides KS. The association between chronic diseases and depressive symptomatology in older Mexican Americans. *J Gerontol Ser A Biol Sci Med Sci* 1998;53:M188-M94.
- Colten HR, Altevogt BM, eds. Institute of Medicine. *Sleep disorders and sleep deprivation: An unmet public health problem*. Washington, DC: National Academies Press, 2006.
- Manber R, Chambers AS. Insomnia and depression: A multifaceted interplay. *Curr Psychiatry Rep* 2009;11:437-42.
- Tsuno N, Besset A, Ritchie K. Sleep and depression. *J Clin Psychiatry* 2005;66:1254-69.
- Loredo JS, Soler X, Bardwell W, Ancoli-Israel S, Dimsdale JE, Palinkas LA. Sleep health in U.S. hispanic population. *Sleep* 2010;33:962-7.
- Howrey BT, Peek MK, Raji MA, Ray LA, Ottenbacher KJ. Self-reported sleep characteristics and mortality in older adults of mexican origin: Results from the hispanic established population for the epidemiologic study of the elderly. *J Am Geriatr Soc* 2012;60:1906-11.
- Sawanyawisuth K, Palinkas LA, Ancoli-Israel S, Dimsdale JE, Loredo JS. Ethnic differences in the prevalence and predictors of restless legs syndrome between hispanics of mexican descent and non-hispanic whites in san diego county: A population-based study. *J Clin Sleep Med* 2013;9:47-53.
- Lubrano C, Saponara M, Barbaro G, et al. Relationships between body fat distribution, epicardial fat and obstructive sleep apnea in obese patients with and without metabolic syndrome. *PLoS One* 2012;7:e47059
- Yagi A, Nishio Y, Ugi S, et al. The role of sleep disturbance and depression in patients with type 2 diabetes. *Diabetol Int* 2011;2:79-85.

10. Nakade M, Takeuchi H, Kurotani M, Harada T. Effects of meal habits and alcohol/cigarette consumption on morningness-eveningness preference and sleep habits by Japanese female students aged 18-29. *J Physiol Anthropol* 2009;28:83-90.
11. Jaehne A, Unbehaun T, Feige B, Lutz UC, Batra A, Riemann D. How smoking affects sleep: A polysomnographical analysis. *Sleep Med* 2012;13:1286-92.
12. Ohayon MM. The effects of breathing-related sleep disorders on mood disturbances in the general population. *J Clin Psychiatry* 2003;64:1195-200; quiz, 1274-6.
13. Taylor DJ, Lichstein KL, Durrence HH, Reidel BW, Bush AJ. Epidemiology of insomnia, depression, and anxiety. *Sleep* 2005;28:1457-64.
14. van Mill JG, Hoogendijk WJ, Vogelzangs N, van Dyck R, Penninx BW. Insomnia and sleep duration in a large cohort of patients with major depressive disorder and anxiety disorders. *J Clin Psychiatry* 2010;71:239-46.
15. Benes H, Mattern W, Peglau I, et al. Ropinirole improves depressive symptoms and restless legs syndrome severity in RLS patients: A multicentre, randomized, placebo-controlled study. *J Neurol* 2011;258:1046-54.
16. El-Sherbini AM, Bediwy AS, El-Mitwalli A. Association between obstructive sleep apnea (OSA) and depression and the effect of continuous positive airway pressure (CPAP) treatment. *Neuropsychiatr Dis Treat* 2011;7:715-21.
17. Manber R, Bernert RA, Suh S, Nowakowski S, Siebern AT, Ong JC. CBT for insomnia in patients with high and low depressive symptom severity: Adherence and clinical outcomes. *J Clin Sleep Med* 2011;7:645-52.
18. Pedraza S, Al Snih S, Ottenbacher KJ, Markides KS, Raji MA. Sleep quality and sleep problems in mexican americans aged 75 and older. *Aging Clin Exp Res* 2012;24:391-7.
19. O'Bryant SE, Zhang Y, Owen D, et al. For the Cochran County Aging Study Research Team. The Cochran County Aging Study: Methodology and descriptive statistics. *Texas Public Health J* 2009;61:5-7.
20. O'Bryant SE, Edwards M, Menon CV, Gong G, Barber R. Long-term low-level arsenic exposure is associated with poorer neuropsychological functioning: A Project FRONTIER study. *Int J Environ Res Public Health* 2011;8:861-74.
21. Yesavage JA, Brink TL, Rose TL. Development and validation of a geriatric depression screening scale: A preliminary report. *J Psychiatr Res* 1982;17:37-49.
22. Hall JR, Davis TE. Factor structure of the geriatric depression scale in cognitively impaired older adults. *Clin Gerontol* 2010;33:39-48.
23. Strine TW, Chapman DP, Balluz LS, Moriarty DG, Mokdad AH. The associations between life satisfaction and health-related quality of life, chronic illness, and health behaviors among U.S. community-dwelling adults. *J Community Health* 2008;33:40-50.
24. Ohayon MM, Zulley J, Guilleminault C, Smirne S, Priest RG. How age and daytime activities are related to insomnia in the general population: Consequences for older people. *J Am Geriatr Soc* 2001;49:3606.
25. Paunio T, Korhonen T, Hublin C, et al. Longitudinal study on poor sleep and life dissatisfaction in a nationwide cohort of twins. *Am J Epidemiol* 2008;169:206-13.
26. Liao C, Feng Z, Zhou D, et al. Dysfunction of fronto-limbic brain circuitry in depression. *Neuroscience* 2012;201:231-8.
27. Riemann D, Voderholzer U, Spiegelhalder K, et al. Chronic insomnia and MRI-measured hippocampal volumes: A pilot study. *Sleep* 2007;30:955-8.
28. Riemann D, Kloepfer C, Berger M. Functional and structural brain alterations in insomnia: Implications for pathophysiology. *Eur J Neurosci* 2009;29:1754-60.
29. Noh HJ, Joo EY, Kim ST, et al. The relationship between hippocampal volume and cognition in patients with chronic primary insomnia. *J Clin Neuro* 2012;8:130.
30. Kronmüller K-, Schröder J, Köhler S, et al. Hippocampal volume in first episode and recurrent depression. *Psychiatry Res Neuroimaging* 2009;174:62-6.
31. Harvey AG, Murray G, Chandler RA, Soehner A. Sleep disturbance as transdiagnostic: Consideration of neurobiological mechanisms. *Clin Psychol Rev* 2011;31:225-35.
32. Mander BA, Rao V, Lu B, et al. Prefrontal atrophy, disrupted NREM slow waves and impaired hippocampal-dependent memory in aging. *Nat Neurosci* 2013;16:357-64.
33. Cipolli C, Mazzetti M, Plazzi G. Sleep-dependent memory consolidation in patients with sleep disorders. *Sleep Med Rev* 2013;17:91-103.
34. McClintock SM, Husain MM, Greer TL, Cullum CM. Association between depression severity and neurocognitive function in major depressive disorder: A review and synthesis. *Neuropsychology* 2010;24:9-34.
35. Johnson LA, Mauer C, Jahn D, et al. Cognitive differences among depressed and non-depressed MCI participants: A project FRONTIER study. *Int J Geriatr Psychiatry* 2013;28:377-82.
36. O'Bryant Sid E, Hall JR, Cukrowicz KC, et al. The differential impact of depressive symptom clusters on cognition in a rural multi-ethnic cohort: A project FRONTIER study. *Int J Geriatr Psychiatry* 2011;26:199-205.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication April, 2013

Submitted in final revised form October, 2013

Accepted for publication December, 2013

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DISCLOSURE STATEMENT

This was not an industry supported study. Research reported in this publication was supported by the National Institute on Aging (NIA) and National Institute on Minority Health and Health Disparities (NIMHD) of the National Institutes of Health under Award Numbers R01AG039389, P30AG12300, and L60MD001849. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. This research was also funded in part by grants from the Hogg Foundation for Mental Health (JRG-040, JRG-149, & JRG-213), and the Environmental Protection Agency (RD834794). Project FRONTIER is supported by the Texas Tech University Health Sciences Center F. Marie Hall Institute for Rural & Community Health and Garrison Institute on Aging. Dr. Al-Farra is a paid speaker at lung disease (Alpha-1 antitrypsin deficiency, COPD, and Asthma) learning events for Grifols, Forest, and AstraZeneca. The other authors have indicated no financial conflicts of interest.