Brief Report

Sleep disorders and secondhand smoke exposure in the U.S. population

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Abstract

Introduction: Sleep disorders in the United States are pervasive and have been linked to increased risk of injury, morbidity, and mortality. Smoking is a known risk factor for sleep disorders; the association between secondhand smoke (SHS) exposure and sleep disorders is less clear. We sought to examine the relationship between SHS exposure and sleep disorders among a representative sample of U.S. adults ($n = 4,123$).

Methods: Data were from the 2005–2006 National Health and Nutrition Examination Survey. Multivariable logistic regression models examined the association between both smoking and SHS exposure with two measures of sleep disorder (i.e., self-reported health care provider diagnosis and self-report of two or more sleep symptoms). SHS exposure status was based on a combination of self-report and serum cotinine levels.

Results: Relative to nonsmokers without SHS exposure, smokers were significantly more likely to have been diagnosed with a sleep disorder (odds ratio [OR] = 1.73 [95% CI = 1.16–2.60]) and more likely to report at least two sleep disorder symptoms (OR = 1.42 [95% CI = 1.09–1.84]). SHS-exposed nonsmokers were not significantly more likely to report a sleep disorder or sleep symptoms (OR = 1.43 [95% CI = 0.79–2.57] and OR = 1.03 [95% CI = 0.83–1.27]), respectively.

Discussion: Although smoking appears to play an important role in the prevalence of sleep disorders in the U.S. adult population, the role of SHS exposure is inconclusive and warrants further investigation.

Health [NIH], 2007). In fact, presently in the United States, an estimated 18 million people suffer from sleep apnea; 12 million have restless leg syndrome; 250,000 experience narcolepsy; and about 1 in 10 Americans endure chronic insomnia (NIH; U.S. Department of Health and Human Services, 2007).

Although most people may experience occasional episodes of inadequate sleep, chronic sleep disorders are more serious and increase the risk of injury, morbidity, and mortality (Sigurdson & Ayas, 2007). For example, sleep disorders and chronic lack of sleep have been associated with (a) increased injuries while driving or at work (Teran-Santos, Jimenez-Gomez, & Cordero-Guevara, 1999), (b) cardiovascular-related risk factors (Kato et al., 2000; Lavie & Lavie, 2008; Spiegel, Leproult, et al., 2004; Spiegel, Tasali, Penev, & Van Cauter, 2004), and (c) all-cause mortality (Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002).

While the association between smoking and sleep problems is well documented (Kaneita et al., 2005; B. Phillips et al., 2000; Wallander, Johansson, Ruigomez, Garcia Rodriguez, & Jones, 2007; Wetter & Young, 1994; Wetter, Young, Bidwell, Badr, & Palta, 1994), the effects of secondhand smoke (SHS) on sleep are less clear.

The objective of the present study was to assess the relationship between both active and SHS exposure with sleep disorder diagnoses among U.S. adults. To our knowledge, this is the first study to examine the relationship between exposure to SHS and sleep disorders in a nationally representative U.S. sample and the first to assess the relationship between smoking and sleep disorders based on self-report and serum cotinine levels.

Introduction

Approximately 40 million Americans currently suffer from sleep disorders, with the most common being sleep apnea, insomnia, restless leg syndrome, and narcolepsy (National Institutes of

Methods

Data source

The National Health and Nutrition Examination Survey (NHANES) was developed by the National Center for Health

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Statistics (NCHS). This national health survey of the civilian noninstitutionalized population uses a complex sampling strategy in order to obtain a representative sample of non-Hispanic Whites, Blacks, and Mexican Americans of all ages. Physical examinations were conducted in mobile examination centers, where blood samples were collected. The overall response rate to the physical examination in the 2005–2006 NHANES cycle was 77.0% (NCHS, 2007).

Variables

Self-reported sleep disorder diagnosis was based on the question “Have you ever been told by a doctor or other health professional that you have a sleep disorder?” In addition to a sleep disorder diagnosis, 10 questions regarding symptoms consistent with a sleep disorder were also included in the NHANES. These questions included “In the past 12 months, how often did you snore while you were sleeping?”; “In the past 12 months, how often did you snort, gasp, or stop breathing while you were asleep?”; “In the past month, how often did you wake up too early in the morning and were unable to get back to sleep?”; “In the past month, how often did you feel un-rested during the day, no matter how many hours of sleep you had?”; and “In the past month, how often did you have leg jerks while trying to sleep?”

As used in previous studies (Arheart et al., 2008; Fleming et al., 2008), smoking status was defined as a combination of self-report and serum cotinine levels. Current smokers were participants who answered “yes” to the question “Do you smoke cigarettes now?” and/or had serum cotinine levels >15 ng/ml (Society for Research on Nicotine and Tobacco [SRNT] Subcommittee on Biochemical Verification, 2002). Participants who answered yes to the question, “Does anyone who lives [with you] smoke cigarettes, cigars, or pipes anywhere inside this home?”; and/or indicated any hours of work exposure when responding to the question, “How many hours can you smell tobacco smoke at work?”; and/or had a serum cotinine level at or above the level of detection were categorized as being exposed to SHS. Nonexposed nonsmokers were classified as participants who reported being former smokers or never-smokers, no home or workplace SHS, and had cotinine levels below the detection limit. The blood cotinine detection limit was 0.015 ng/ml. As noted in the NHANES laboratory documentation, serum cotinine was used because it is a better assay for the quantitative assessment of tobacco smoke exposure than urinary cotinine. Isotope dilution high performance liquid chromatography/atmospheric pressure chemical ionization tandem mass spectrometry was used to measure serum cotinine (NCHS, 2008).

Other variables included in the study were gender, age (in years), race/ethnicity (non-Hispanic White, non-Hispanic Black, or other), level of education ($<$ high school, high school, or $>$ high school), body mass index (BMI), self-report of current asthma (yes/no), self-report of a history of diabetes (yes/no), and self-report of a history of cardiovascular disease (CVD; “yes” if answered yes to having had at least one of the following: heart failure, coronary heart disease, angina, or stroke and “no” if otherwise). Alcohol consumption status (abstainer, healthy drinker, or heavy/binge drinker) was based on a combination of several questions regarding number of drinks per drinking episode and the reported frequency of alcohol consumption. A “heavy/binge drinker” was defined as an individual who had 5 drinks at a setting once a week or twice a month and at least 13 times a year or an individual who had a total of more than

35 drinks per week. A “healthy/moderate drinker” was an individual who had 1–14 drinks per week for men or 1–7 drinks per week for women. An “abstainer” was an individual who had less than 12 drinks per year.

Statistical analyses

Chi-square tests and multivariable logistic regression analyses were performed. The analysis focused on participants at least 20 years of age or older since the questions regarding sleep disorders were not administered to individuals younger than 20 years. Two separate multivariable binary logistic regression analyses were performed. The first model used the question “Have you ever been told by a doctor or other health professional that you have a sleep disorder?” to define the dependent variable. The second model used the presence of at least two sleep disorder symptoms to define the dependent variable out of a list of eight sleep disorder symptom variables. Tobacco smoke exposure was the main independent variable in both regression models, adjusting for potential confounders such as gender, age, level of education, race/ethnicity, BMI, and alcohol consumption and self-report of asthma, diabetes, and CVD.

All analyses were conducted using SAS v. 9.1 and were completed with adjustments for sample weights and design effects (SAS Institute, Inc., Cary, NC). This study was approved by the University of Miami Institutional Review Board for human subjects research.

Results

Table 1 presents the summary statistics for the sample of 4,123 participants (representing an estimated 181,820,067 U.S. adults aged ≥ 20 years). More than 50% of the sample were non-Hispanic Whites, while 23% were non-Hispanic Blacks, and 24% were of “other” races. The mean age of the participants was 48.3 years ($SE = 0.29$) and the mean BMI was 28.9 ($SE = 0.11$). Less than one third of the sample was classified as current smokers, but over half of the sample had serum cotinine levels indicative of SHS exposure.

Approximately 7% of the sample reported a sleep disorder diagnosis. In the multivariable analyses, a sleep disorder diagnosis was significantly more likely among current smokers relative to nonsmokers without detectable cotinine (odds ratio [OR] = 1.73 [95% CI = 1.15–2.60]; see Table 2). Nonsmokers with detectable cotinine (those exposed to SHS) were more likely to have a sleep disorder (OR = 1.43 [95% CI = 0.79–2.57]), although the results were not statistically significant.

Almost half (49%) of the study sample reported having at least two symptoms related to a sleep disorder. Smokers were significantly more likely to report at least two symptoms consistent with a sleep disorder compared with nonsmokers without detectable cotinine after adjusting for potential confounders (OR = 1.46 [95% CI = 1.09–1.84]); however, this relationship was not significant for nonsmokers with detectable cotinine (OR = 1.03 [95% CI = 0.83–1.26]; see Table 2).

Discussion

Our findings represent the first nationally representative study assessing the relationship between both smoking and SHS exposure with sleep disorders. We found a relatively low (6.8%)

Table 1. Sample characteristics from NHANES 2005–2006 of adults 20 years of age and older

	<i>n</i>	Percent
Gender		
Male	2,002	48.6
Female	2,121	51.4
Race		
Non-Hispanic White	2,188	53.1
Non-Hispanic Black	950	23.0
Other	985	23.9
Education		
<High school	1,132	27.4
High school	997	24.2
Some college	1,994	48.4
Alcohol consumption		
Abstainer	1,439	34.9
Healthy drinker	2,168	52.6
Heavy/binge drinker	516	12.5
Asthma		
No	3,583	86.9
Yes	536	13.1
Diabetes		
No	3,699	89.8
Yes	420	10.2
Cardiovascular disease		
No	3,759	91.2
Yes	363	8.8
Smoking status		
Nonsmoker without SHS	861	20.9
Nonsmoker with SHS	2,172	52.7
Smoker	1,090	26.4
Sleep disorder diagnosis		
Yes	279	6.8
No	3,844	93.2
Presence of two or more symptoms of sleep disorders		
Yes	2,007	48.7
No	2,116	51.3
	<i>M</i>	<i>SE</i>
Age (years)	48.3	0.29
Body mass index	28.9	0.11

Note. NHANES = National Health and Nutrition Examination Survey; SHS = secondhand smoke.

prevalence of diagnosed sleep disorders in the U.S. population, which may be due to the underdiagnosis of sleep disorders (Kapur et al., 2002; Silverberg, Oksenberg, & Iaina, 1997). In fact, we found a much larger proportion of adults (49%) reporting at least two sleep disorder symptoms. Possible explanations for the low prevalence of sleep diagnoses could be related to a lack of patient knowledge about what constitutes a sleep disorder, low frequency of visits to a health care provider, patients not reporting their sleep problems to their physician, and/or physicians not asking about or considering patient's reported sleeping symptoms to be indicative of a sleep disorder (i.e., lack of detection).

Other studies have noted that self-reported SHS is associated with snoring among adults (Franklin et al., 2004) and children (Corbo, Fuciarelli, Foresi, & De Benedetto, 1989), which is regarded as a symptom of sleep-disordered breathing such as sleep apnea (Bliwise, Nekich, & Dement, 1991; Wetter & Young, 1994). One of the two known studies specifically relating sleep problems to SHS found that among pregnant women, self-reported nonsmokers exposed to SHS were significantly more likely to report insufficient sleep ($OR = 1.38$ [95% $CI = 1.12$ – 1.44]), difficulty falling asleep ($OR = 1.11$ [95% $CI = 1.01$ – 1.21]), and short sleep duration ($OR = 1.51$ [95% $CI = 1.29$ – 1.76]) compared with nonsmokers who denied SHS exposures (Ohida et al., 2007). The other study, based on Japanese workers (Nakata et al., 2008), found that male nonsmokers exposed to SHS at work were more likely to report inadequate sleep, although the same relationship was not found among women workers. In our study, we did not find a statistically significant association between SHS and a sleep disorder diagnosis or the presence of at least two sleep disorder symptoms. However, because we found an increased risk of having either a sleep disorder diagnosis or at least two sleep disorder symptoms, our findings suggest that SHS exposure may be associated with sleep problems, albeit to a lesser extent than active tobacco smoke exposure.

Consistent with previous non-population-based studies (Ohayon, 2002; B. Phillips et al., 2000; Wetter & Young, 1994; Wetter et al., 1994), we found active smoking to be associated with an increased odds of a sleep disorder diagnosis in this nationally representative sample of U.S. adults. Potential mechanisms for how smoking affects sleep include the stimulating effect of nicotine, nicotine withdrawal during sleep, and an obstructive airway disease caused by smoking (B. A. Phillips & Danner, 1995; Wetter & Young).

Study strengths and limitations

The main strength of this study included the use of a nationally representative sample, which allows generalization of results to the U.S. population. In addition, using a definition of tobacco smoke exposure that is based on both self-report and blood cotinine levels increases the exposure classification accuracy, an approach that has not been previously used for estimating the effects of smoking and SHS exposure on sleep disorders (Arheart et al., 2008).

Several limitations of our analysis should be noted. First, the presence of sleep disorders is based on a self-report of diagnosis and symptoms leading to a possible underestimation. Second, the cross-sectional nature of the study did not allow us to make causal inferences. Potential confounders (such as the number of hours usually worked per week, shift work, mental illness, stress, dietary patterns [e.g., irregular eating habits], and caffeine intake) were not measured due to lack of data availability (Kageyama, Kobayashi, Nishikido, Oga, & Kawashima, 2005; Ohayon, 2002; Ohida et al., 2001). Third, we did not perform analyses for each specific sleep disorder (e.g., sleep apnea vs. insomnia or restless leg syndrome) due to small sample sizes, although risk factors may differ across sleep conditions. We were also limited in our ability to define SHS exposure due to the short life of detectable serum cotinine levels (Repace, 2007) and the absence of self-reported exposure to smoke in other settings (e.g., restaurants, bars, or motor vehicles). Consequently, the possibility of misclassification of smoking and SHS exposure status cannot be ruled

Table 2. Multiple logistic regression to assess the relationship between smoking with sleep disorder diagnosis and symptoms among adults 20 years of age or older, NHANES 2005–2006

	Diagnosis of sleep disorder		At least two symptoms of sleep disorder	
	OR	95% CI	OR	95% CI
Gender				
Female	1.00		1.00	
Male	1.41	1.05–1.88	0.81	0.72–0.91
Age (years)	1.01	1.00–1.02	0.99	0.99–1.00
Race/ethnicity				
Non-Hispanic White	1.00		1.00	
Non-Hispanic Black	0.68	0.38–0.99	0.74	0.60–0.91
Other	0.94	0.57–1.55	0.60	0.43–0.82
Education				
<High school	1.00		1.00	
High school	1.10	0.77–1.56	1.29	0.98–1.70
>High school	1.68	1.29–2.18	1.18	0.89–1.57
Alcohol consumption				
Abstainer	1.00		1.00	
Healthy/moderate drinker	0.84	0.65–1.06	0.92	0.79–1.07
Heavy/binge drinker	0.75	0.47–1.19	1.10	0.81–1.49
Body mass index	1.07	1.05–1.09	1.04	1.02–1.05
Asthma				
No	1.00		1.00	
Yes	2.15	1.62–2.86	1.46	1.83–1.79
Diabetes				
No	1.00		1.00	
Yes	2.04	1.12–3.74	1.37	0.99–1.89
Cardiovascular disease				
No	1.00		1.00	
Yes	1.68	1.29–2.19	1.53	1.15–2.04
Smoking status				
Nonsmoker without SHS	1.00		1.00	
Nonsmoker with SHS	1.43	0.79–2.57	1.03	0.83–1.27
Smoker	1.73	1.15–2.59	1.42	1.09–1.84

Note. NHANES = National Health and Nutrition Examination Survey; OR = odds ratio; SHS = secondhand smoke.

Estimates appearing in bold are statistically significant at the 0.05 alpha level.

out. For example, it is possible that those classified as SHS exposed were actually current smokers (Benowitz, Bernert, Caraballo, Holiday, & Wang, 2009). Nevertheless, even when using a cutpoint for the blood cotinine level of 3 ng instead of 15 ng to define SHS exposure as a continuous variable (Benowitz et al.), among nonsmokers, the cotinine (i.e., SHS exposure) was associated directly with the odds of a sleep disorder diagnosis and symptoms, although not statistically significant (results not shown).

In conclusion, the results from this study provide further evidence that smoking is a risk factor for sleep disorders and its symptoms. Thus, health care providers should educate their patients who have sleep problems about the importance of smoking cessation. Further research is needed to determine if SHS exposure is also definitively associated with an increased risk of sleep disorders. In order to better assess the relationship between sleep disorders and SHS exposure, studies should incorporate more objective measures of sleep disorders (e.g., medical records or laboratory studies of sleep patterns); repeated cotinine exposure measures over time; data on the number

of hours exposed to SHS in the home, work, or other areas; the frequency of sleep symptoms; and data on the number of smokers living in the home. Moreover, since sleep disorders may be underreported and/or underdiagnosed, greater medical awareness and public health education about them are needed, particularly, given the association between poor sleep quality and cardiovascular risk factors, increased injuries, and overall mortality (Ayas et al., 2003; Kato et al., 2000; Kripke et al., 2002; Teran-Santos et al., 1999).

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Declaration of Interests

None declared.

References

- Arheart, K. L., Lee, D. J., Fleming, L. E., LeBlanc, W. G., Dietz, N. A., McCollister, K. E., et al. (2008). Accuracy of self-reported smoking and secondhand smoke exposure in the US workforce: The National Health and Nutrition Examination Surveys. *Journal of Occupational and Environment Medicine*, 50, 1414–1420.
- Ayas, N. T., White, D. P., Manson, J. E., Stampfer, M. J., Speizer, F. E., Malhotra, A., et al. (2003). A prospective study of sleep duration and coronary heart disease in women. *Archives of Internal Medicine*, 163, 205–209.
- Benowitz, N. L., Bernert, J. T., Caraballo, R. S., Holiday, D. B., & Wang, J. (2009). Optimal serum cotinine levels for distinguishing cigarette smokers and nonsmokers within different racial/ethnic groups in the United States between 1999 and 2004. *American Journal of Epidemiology*, 169, 236–248.
- Bliwise, D. L., Nekich, J. C., & Dement, W. C. (1991). Relative validity of self-reported snoring as a symptom of sleep apnea in a sleep clinic population. *Chest*, 99, 600–608.
- Corbo, G. M., Fuciarelli, F., Foresi, A., & De Benedetto, F. (1989). Snoring in children: Association with respiratory symptoms and passive smoking. *British Medical Journal*, 299, 1491–1494.
- Fleming, L. E., Levis, S., LeBlanc, W. G., Dietz, N. A., Arheart, K. L., Wilkinson, J. D., et al. (2008). Earlier age at menopause, work, and tobacco smoke exposure. *Menopause*, 15, 1103–1108.
- Franklin, K. A., Gislason, T., Omenaas, E., Jogi, R., Jensen, E. J., Lindberg, E., et al. (2004). The influence of active and passive smoking on habitual snoring. *American Journal of Respiratory Critical Care Medicine*, 170, 799–803.
- Kageyama, T., Kobayashi, T., Nishikido, N., Oga, J., & Kawashima, M. (2005). Associations of sleep problems and recent life events with smoking behaviors among female staff nurses in Japanese hospitals. *Industrial Health*, 43(1), 133–141.
- Kaneita, Y., Ohida, T., Takemura, S., Sone, T., Suzuki, K., Miyake, T., et al. (2005). Relation of smoking and drinking to sleep disturbance among Japanese pregnant women. *Preventive Medicine*, 41, 877–882.
- Kapur, V., Strohl, K. P., Redline, S., Iber, C., O'Connor, G., & Nieto, J. (2002). Underdiagnosis of sleep apnea syndrome in U.S. communities. *Sleep Breath*, 6(2), 49–54.
- Kato, M., Roberts-Thomson, P., Phillips, B. G., Haynes, W. G., Winnicki, M., Accurso, V., et al. (2000). Impairment of endothelium-dependent vasodilation of resistance vessels in patients with obstructive sleep apnea. *Circulation*, 102, 2607–2610.
- Kripke, D. F., Garfinkel, L., Wingard, D. L., Klauber, M. R., & Marler, M. R. (2002). Mortality associated with sleep duration and insomnia. *Archives of General Psychiatry*, 59, 131–136.
- Lavie, L., & Lavie, P. (2008). Smoking interacts with sleep apnea to increase cardiovascular risk. *Sleep Medicine*, 9, 247–253.
- Nakata, A., Takahashi, M., Haratani, T., Ikeda, T., Hojou, M., Fujioka, Y., et al. (2008). Association of active and passive smoking with sleep disturbances and short sleep duration among Japanese working population. *International Journal of Behavioral Medicine*, 15, 81–91.
- National Center for Health Statistics. (2007). *Weighted and unweighted response rates for NHANES 2005–2006 by race/ethnicity and age*. Retrieved 6 September 2009, from <http://www.cdc.gov/nchs/data/nhanes/RRT6506MF.pdf>
- National Center for Health Statistics. (2008). *National Health and Nutrition Examination Survey 2005–2006. Documentation, Codebook and Frequencies document. Serum cotinine*. Retrieved 26 October 2008, from http://www.cdc.gov/nchs/data/nhanes/nhanes_05_06/cot_d.pdf
- National Institutes of Health. (2007). *National Institute of Neurological Disorders and Stroke. Brain basics: Understanding sleep*. Retrieved 22 June 2008, from http://www.ninds.nih.gov/disorders/brain_basics/understanding_sleep.htm
- Ohayon, M. M. (2002). Epidemiology of insomnia: What we know and what we still need to learn. *Sleep Medical Reviews*, 6, 97–111.
- Ohida, T., Kamal, A. M., Uchiyama, M., Kim, K., Takemura, S., Sone, T., et al. (2001). The influence of lifestyle and health status factors on sleep loss among the Japanese general population. *Sleep*, 24, 333–338.
- Ohida, T., Kaneita, Y., Osaki, Y., Harano, S., Tanihata, T., Takemura, S., et al. (2007). Is passive smoking associated with sleep disturbance among pregnant women? *Sleep*, 30, 1155–1161.
- Phillips, B., Young, T., Finn, L., Asher, K., Hening, W. A., & Purvis, C. (2000). Epidemiology of restless legs symptoms in adults. *Archives of Internal Medicine*, 160, 2137–2141.
- Phillips, B. A., & Danner, F. J. (1995). Cigarette smoking and sleep disturbance. *Archives of Internal Medicine*, 155, 734–737.
- Repace, J. (2007). Exposure to secondhand smoke. In W. R. Ott, A. C. Steinemann & L. A. Wallace (Eds.), *Exposure analyses* (pp. 201–235), Boca Raton, FL: CRC Press.
- Sigurdson, K., & Ayas, N. T. (2007). The public health and safety consequences of sleep disorders. *Canadian Journal of Physiology Pharmacology*, 85, 179–183.
- Silverberg, D. S., Oksenberg, A., & Iaina, A. (1997). Sleep related breathing disorders are common contributing factors to the production of essential hypertension but are neglected, underdiagnosed, and undertreated. *American Journal of Hypertension*, 10(12, Pt. 1), 1319–1325.
- Society for Research on Nicotine and Tobacco (SRNT) Subcommittee on Biochemical Verification. (2002). Biochemical verification of tobacco use and cessation. *Nicotine & Tobacco Research*, 4, 149–159.
- Spiegel, K., Leproult, R., L'Hermite-Baleriaux, M., Copinschi, G., Penev, P. D., & Van Cauter, E. (2004). Leptin levels are depen-

dent on sleep duration: Relationships with sympathovagal balance, carbohydrate regulation, cortisol, and thyrotropin. *Journal of Clinical Endocrinology Metabolism*, 89, 5762–5771.

Spiegel, K., Tasali, E., Penev, P., & Van Cauter, E. (2004). Brief communication: Sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Annals of Internal Medicine*, 141, 846–850.

Teran-Santos, J., Jimenez-Gomez, A., & Cordero-Guevara, J. (1999). The association between sleep apnea and the risk of traffic accidents. Cooperative Group Burgos-Santander. *New England Journal of Medicine*, 340, 847–851.

U.S. Department of Health and Human Services. (2007). *National Institutes of Health. National Heart Lung and Blood*

Institute Diseases and Conditions. Insomnia: Who is at risk for insomnia? Retrieved 4 June 2008, from http://www.nhlbi.nih.gov/health/dci/Diseases/inso_whoisatrisk.html

Wallander, M. A., Johansson, S., Ruigomez, A., Garcia Rodriguez, L. A., & Jones, R. (2007). Morbidity associated with sleep disorders in primary care: A longitudinal cohort study. *Primary Care Companion Journal of Clinical Psychiatry*, 9, 338–345.

Wetter, D. W., & Young, T. B. (1994). The relation between cigarette smoking and sleep disturbance. *Preventive Medicine*, 23, 328–334.

Wetter, D. W., Young, T. B., Bidwell, T. R., Badr, M. S., & Palta, M. (1994). Smoking as a risk factor for sleep-disordered breathing. *Archives of Internal Medicine*, 154, 2219–2224.