Published in final edited form as:

Econ Hum Biol. 2014 July ; 14: 22–32. doi:10.1016/j.ehb.2014.03.003.

Sleep Behavior and Unemployment Conditions

Marina Antillón^a, Diane S. Lauderdale^b, and John Mullahy^c

^aYale University, 60 College Street, P.O. Box 208034, New Haven, Connecticut 06520, United States

^bUniversity of Chicago, 5841 S. Maryland Ave. MC 2007, Chicago, Illinois 60637, United States

^cUniversity of Wisconsin, 610 Walnut Street Room 787, WARF Building, Madison, Wisconsin 53726, United States

Abstract

Recent research has reported that habitually short sleep duration is a risk factor for declining health, including increased risk of obesity, diabetes and coronary heart disease. In this study we investigate whether macroeconomic conditions are associated with variation in mean sleep time in the United States, and if so, whether the effect is procyclical or countercyclical. We merge state unemployment rates from 2003 through 2012 with the American Time Use Survey, a nationally representative sample of adults with 24 hour time diaries. We find that higher aggregate unemployment is associated with longer mean sleep duration, with each additional point of state unemployment associated with an additional average 0.83 minutes of sleep ($p < 0.001$), after adjusting for a secular trend of increasing sleep over the time period. Despite a national poll in 2009 that found one-third of Americans reporting losing sleep over the economy, we do not find that higher state unemployment is associated with more sleeplessness. Instead, we find that higher state unemployment is associated with less frequent time use described as “sleeplessness” (marginal effect = 0.05 at 4% unemployment and 0.034 at 14% unemployment, $p < 0.001$), after controlling for a secular trend.

Keywords

Sleep; Time Use; Macroeconomic Conditions; Unemployment

Introduction

For several decades, the go-to list of behavioral risk factors for chronic disease epidemiology has included smoking, alcohol consumption, physical activity, diet, and body habitus. In recent years, some researchers have added sleep duration to this list (Van Cauter

© 2014 Elsevier B.V. All rights reserved.

Correspondence to: Diane S. Lauderdale.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

and Spiegel 1999; Ferrie et al. 2007; Gangwisch et al. 2007; Patel and Hu 2008a; King et al. 2008). A key reason to consider sleep duration as a putative risk factor is evidence of a plausible biological mechanism linking shorter sleep to higher risk of obesity and diabetes (Gangwisch et al. 2007; Cappuccio et al. 2010; Patel and Hu 2008b; Lucassen, Rother, and Cizza 2012). An influential sleep lab experiment in 1999 (Spiegel, Leproult, and Van Cauter) reported that young men were hungrier and had worse glucose metabolism during a week of sleep restricted to four hours per night, compared to the week before or after the sleep restriction, suggesting that chronic partial sleep deprivation might be biologically causally related to obesity and diabetes. Many epidemiologic studies have subsequently observed associations — most often cross-sectional—between shorter sleep and higher rates of obesity, diabetes, and coronary heart disease (King et al. 2008; L. Magee and Hale 2012; Patel and Hu 2008b; Van Cauter and Knutson 2008; Cappuccio et al. 2010). These associations are particularly alarming when coupled with the common assertion that Americans are sleeping less than they used to, suggesting that a long-term societal trend in sleep duration could be a significant contributor to the serious public health problems of increasing obesity and diabetes (Stamatakis, Kaplan, and Roberts 2007; Knutson et al. 2010). Despite a lack of good empirical evidence about trends in sleep hours (cf. Bin, Marshall, and Glozier 2013; Bin, Marshall, and Glozier 2012; Matricciani, Olds, and Williams 2011; Aguiar and Hurst 2007), the idea of declining sleep hours seems to have face validity, as it is often asserted without references.

Whether or not there is a long-term secular trend in sleep duration, there are reasons to expect that sleep behaviors may track cycles in the broader macroeconomy. Articles in the sleep research literature sometimes cite as evidence of a secular trend a comparison of mean sleep times from surveys in two different years (Aguiar and Hurst 2007; C. A. Magee, Iverson, and Caputi 2009; Rafalson et al. 2010; Ásgeirsdóttir, Corman, and Noonan 2012) but a contrast between two time points is not specific evidence of a secular trend and could also have arisen from variation in macroeconomic conditions. While not always labelled as such, both procyclical and countercyclical effects on sleep duration have been suggested, i.e. that a weak economy leads to worse sleep (procyclical) or better sleep (countercyclical). The main procyclical argument would be that a decline in economic activity may contribute to a higher prevalence of insomnia or sleeplessness because of worry and stress. Mental health problems are often associated with sleep problems (Foster and Wulff 2005), and, stress has also been found to be associated with insomnia (Morin, Rodrigue, and Ivers 2003; LeBlanc et al. 2007). A National Sleep Foundation's annual poll in 2009 found that one-third of Americans reported losing sleep over the economy (National Sleep Foundation 2009). A different procyclical argument would be that more individuals take on shift work during a recession, particularly those of lower income and educational attainment (Amuedo-Dorantes and Kimmel 2009). Shift work is correlated with less sleep time, presumably due to both physiological effects (i.e. circadian rhythms, levels of melatonin during the day) (Foster and Wulff 2005) as well as social pressures to spend time with family and friends during the day (Hamermesh 2002).

There are also reasons to expect that sleep might be countercyclical, assuming more sleep is considered to be beneficial. Mortality appears to be countercyclical, and one of the hypothesized explanations is that a worsening economy could be associated with salubrious

changes in behaviors, some related to more time available for non-work activities and some related to fewer resources available for harmful expenditures (Gerdtham and Ruhm 2006). Health behaviors that take time, such as exercise and sleep, might be responsive to differences in opportunity costs associated with alternative uses of time (Becker 1965; Biddle and Hamermesh 1990; González 1997; Virtanen et al. 2008; Asgeirsdóttir and Zoega 2011). It has been found that compared to individuals who work 35 hours a week or more, lack of a job increases the likelihood of long sleep duration; on the other hand, working 50 hours or more a week increases the likelihood of short sleep duration (Hamermesh 2002; Hale 2005; Hale and Do 2007; Bezruchka 2009). Ásgeirsdóttir and others (2013) found that more people reported obtaining the recommended hours of sleep in Iceland after the economic crisis compared to before (Asgeirsdóttir et al. 2013). Predicting how time allocation might respond to changes in macroeconomic conditions requires considerations of both substitution and income effects as well as an understanding of particular features of the changing macroeconomic circumstances (e.g. unemployment rate increases, work hour shifts, wage reductions).

Using data from the American Time Use Survey (ATUS), the present analysis focuses specifically on how changes in state unemployment rates affect sleep time and sleeplessness over the ten-year period from 2003 through 2012, a period of macroeconomic expansion and decline. To the extent that relative time costs are affected by such macroeconomic circumstances, we would expect individuals to respond by reallocating their time budgets across all the categories of time use, not just between labor and non-labor time. A few prior studies have examined employment on the individual level and sleep time derived from time use studies (Biddle and Hamermesh 1990; Hamermesh 2002; Hale 2005; Basner et al. 2007; Knutson et al. 2010) but they have not examined the contextual effects of unemployment and temporal variation. All have found an inverse association between individual employment time and sleep time. For example, using three years of the ATUS aggregated (2003–2005), Basner and others (2007) found that activities like work time, travel time, and time socializing produce significant pressures on time spent in bed, but work time produced the most pronounced pressure on sleep time, exhibiting an inverse relationship, and increasing income levels were associated with increased work time and decreased sleep time, suggesting that there are substitution and income effects at play.

Even individuals who remain employed during economic downturns may experience reduced or shifted work hours, or may reallocate their monetary budgets in anticipation of fewer work hours, reduced income, or unemployment. But whether this would affect sleep time and whether unemployment also increases sleeplessness while increasing time allocated for sleep are not known. One study examined sleep hours in the context of several health-related behaviors at two time points in Iceland, before and following the economic crisis of 2008 (Asgeirsdóttir et al. 2013). Some health behaviors were countercyclical and some were procyclical. Sleeping what the authors identified as the “recommended” amount, 7 to 9 hours per night, in response to a single survey question, was higher in 2009, during the economic crisis, compared to 2007. For our study, we have merged the data from the 2003 through 2012 ATUS with state-level unemployment statistics from the Bureau of Labor Statistics. We examine the relationship between state unemployment levels and sleep measures and whether their association persists while controlling for secular trends. We also

examine whether general macroeconomic conditions affect behavior for individuals who are not directly affected by unemployment by adding individual employment status and household income to the models.

The economic framework within which we pursue our empirical analysis is suggested by the work of Biddle and Hamermesh (Biddle and Hamermesh 1990) which itself is an extension of Becker's classic (1965) treatment of time allocation and household production. Moreover, while the research program undertaken by Ruhm (most recently Ruhm (2013)) on the business cycle patterns of health and mortality does not primarily focus on time-use patterns, many of the questions explored by Ruhm ultimately have at their core questions of how the allocation of time -- work, exercise, motor vehicle use, sleep, etc. -- varies in response to business cycle phenomena.

In their analysis, Biddle and Hamermesh (1990) employ a neoclassical time allocation framework to examine the responsiveness of time spent sleeping to the cost of sleep (measured by market wage rates). In its essence, individuals are assumed to have preferences defined over various forms of time use and the commodities that can be produced through the deployment of market and nonmarket time. Constraints are determined by market prices (p , including market wage rates), the structure of household production (a), individual and household circumstances (x), nonlabor income or wealth (m), and the 1,440-minute daily time budget (T), and a set of contextual or environmental factors (C) that can influence time allocations. In light of these constraints, individuals optimize time use decisions for J categories of time use, and the optimizing behavior can be summarized by the time demand functions

$$t_j = t_j(p, x, m, T, C; a), \quad \text{for } j=1, \dots, J.$$

Given our focus on the role of macroeconomic conditions on time use, we hold that such effects operate over the business cycle primarily through their impacts on relative prices and wage rates (p), on nonlabor income/wealth (m), and on social/environmental contexts (C) in which individuals make time allocation choices. Biddle and Hamermesh do not pursue the question of the health or other productivity of sleep time (nor do we), but we believe that incorporating such considerations would be a natural and useful extension of the analysis we conduct, data permitting. Sleep is ultimately biologically essential and there are physiological constraints on substitution, which undoubtedly are heterogeneous across the population, within limits. Despite widespread recommendations that adults need eight hours of sleep, there is no evidence base for eight hours.

Methods

American Time Use Survey (ATUS)

The ATUS is a nationally representative, cross sectional survey conducted by the Bureau of Labor statistics since 2003. Data are publicly available for respondents who have participated in the ATUS during the period of 2003–2012. The purpose of the ATUS is to

provide a snapshot of time use among U.S. residents throughout the course of one randomly-selected 24-hour period.

ATUS participants are selected from households that complete the Current Population Survey, a nationally representative, monthly survey of 60,000 households that collects demographic and economic data, including sex, race, age, educational attainment, occupation, income, marital status, and the presence of children in the household. Households become eligible for the ATUS two months after the household completes the eighth and final CPS interview. The sampling frame for the CPS, and consequently the ATUS, include all residents living in the 105 million households in the United States who are over 15 years of age, excluding active military personnel and individuals residing in institutional settings such as nursing homes and prisons.

The ATUS sample is a stratified, three-stage sample. Because the CPS oversamples in less-populous states, the ATUS reduces the likelihood of selection into the sample for those states in the first stage of selection. Households are then stratified based on these characteristics during the second stage of selection: the race/ethnicity of the householder, the presence and age of children, and the number of adults in households where there are no children. Eligible households with a Hispanic or non-Hispanic black householder and households with children are oversampled and households without children are undersampled. In the third stage of selection, an eligible person aged 15 or older from each household selected in the second stage is randomly selected as the respondent for ATUS.

Most surveys are conducted by phone. In order to ensure that the ATUS sample is truly representative, households without phone numbers are mailed a \$40 debit card as an incentive to call the survey call center on the day specified by mail. Interviews may be conducted in Spanish or English.

During 2003, 3,375 households were chosen to participate in the ATUS each month. Beginning in December 2003, the monthly sample was reduced to 2,194 respondents. Response rates of 57.8 percent were highest in 2003, decreased to a low of 52.5 percent in 2007, and peaked again at 56.9 percent in 2010 (Bureau of Labor Statistics 2012). Response rates are similar to other government surveys, such as those collected by the National Center for Health Statistics.

The monthly sample is randomly divided into four panels, one for each week of the month; then individuals are randomly assigned a specific day, with 10 percent allocated to each weekday and 25 to each weekend day. Respondents may not substitute a different day and may not report their activities through a proxy.

Sleep—During a phone interview, the respondents are asked to recall all of the activities for the 4AM to 4AM 24-hour period before they talk to the ATUS interviewer; the last activity's end time is recorded, although it is usually past 4 AM. The interviewer codes the subject's activities using a classification system that includes 3 hierarchical levels of categories. Sleep activities are listed under the major category "personal care," the subcategory of "sleep", and are divided into 3 subcategories: sleeping (examples:

“sleeping”, “falling asleep”, “dozing off”, “napping”); sleeplessness (examples: “insomnia”, “tossing and turning”, “lying awake”, “counting sheep”); and sleeping not elsewhere classified. We use these data to construct two outcome measures. The first is sleep time, which is the length of the longest duration of a sleep episode, which often extends beyond the 24-hour period of the diary day. The second outcome is any report of “sleeplessness”, which is a dichotomous outcome. This was dichotomized both because the great majority of persons report none and because insomnia research suggests that the duration of the time awake is not well estimated (Harvey and Tang 2012).

State Unemployment Data—Seasonally unadjusted estimates of unemployment were extracted from the Bureau of Labor Statistics’ Local Area Unemployment database (Bureau of Labor Statistics). The database provides estimates of the employed and unemployed population for each month for each state.

Our primary models (1) predict sleep time during the longest episode of sleep using OLS regression and (2) predict sleeplessness using binomial generalized linear models specifying the probit link function (from which we report marginal effects). The primary independent variable is state monthly unemployment rate. All models controlled for available demographics that have been found to be (in at least some studies) correlates of sleep time – age, race, education, sex, marital status, and presence of children in the household—and for characteristics of the diary day that could affect sleep length –holidays, days of the week, and season of the year (Hale 2005; Hale and Do 2007; Grandner et al. 2010). The variable for season of the year controlled for fluctuations in unemployment produced by the effects of seasonal work, since we are using seasonally unadjusted unemployment estimates. Seasons were defined as: Winter (January, February, March), Spring (April, May, June), Summer (July, August, September), Fall (October, November, December). We show models with and without adjustment for secular trend. The secular trend variable takes the values of 1 through 120, indicating the order of the month when the data were collected, that is 1 indicates January 2003 and 120 indicates December 2012. This variable controls for a the possibility that a correlation between unemployment conditions and sleep behavior could be due to underlying secular trends in each.

We also present models that additionally include personal economic characteristics: 1) personal employment status and night shift work (more than 4 hours work between 7 PM and 7 AM); 2) household income; 3) both personal employment status and income. Since work hours are jointly determined with sleep hours in time allocation, work hours -- and measures functionally related to them, like income and workforce participation -- may be considered endogenous. Without these personal characteristics in the model, however, it is unclear whether the state-level variable is simply an imprecise measure of individual economic status. As such, while we emphasize the model specifications that do not include such measures as explanatory variables, we believe it is useful to see how their inclusion might affect the inferences we draw.

Probit models were run to test the marginal effects of each covariate on the binary outcome variable of sleeplessness. Like in the linear regression models, three specifications of the baseline model were run to test the effect of macroeconomic conditions on sleeplessness

above and beyond the effect that those same macroeconomic conditions had on personal economic circumstances, or “the ability to make ends meet”. It is worth noting that we pursue model specifications that control for night shift work in addition to part-time, full-time, and unemployment since it has been found that night shift workers tend to experience sleeplessness, and it is possible that during periods of higher unemployment, some employed individuals take on night shift jobs when they lose their primary jobs (Hamermesh 2002; Foster and Wulff 2005; Amuedo-Dorantes and Kimmel 2009). We include a monthly secular time trend in these model specifications as well.

All analyses were performed using Stata 13.1, using weights calculated by the ATUS to take into account stratified random sampling, response rates and day-of-the week sampling. In addition, 160 replication weights were used to calculate the standard error using the appropriate Stata survey commands that take into account the complex nature of survey data like the ATUS. The ATUS changed the method by which it calculates weights in 2006; the weights used in this analysis were the weights recalculated for all years using the new method, in line with recommendations from the Bureau of Labor Statistics for multi-year analyses (American Time Use Survey User’s Guide, 2013). Probit regression was run with the whole dataset. If any of the probit regression model specifications did not converge after 20 iterations, then the whole subset of models was run with a randomly chosen 90% of the sample. Average individual marginal effects were calculated with the “margins” command in Stata while holding all other covariates at the mean.

Results

This analysis included 121,628 respondents over the age of 25 (Table 1). We omitted individuals younger than 25 to minimize the number of respondents who were not yet in the work force because they were completing their education.

Figure 1 shows variation in seasonally unadjusted state unemployment rates by month across the years 2003 through 2012. There is great variation across states in each month, despite the general trend towards higher unemployment in more recent years, peaking in 2009–2010 before declining in 2011–2012.

In Table 2, model 1 shows the results of the linear regression predicting the duration of longest sleep episode as a function of statewide, monthly unemployment rate, adjusted for sex, age, race, marital status, education, day of the week, season of the year, and holidays. In model 2, we include all the predictors in model 1 as well as a covariate for monthly secular trend, therefore examining the effect of unemployment on sleep that is independent from change in sleep behaviors over time. In model 1 the coefficient for state unemployment shows that each point of unemployment is correlated with an extra 2.38 minutes of sleep. But this estimate is biased upward when compared to a model that controls for a national secular trend in sleep behavior (model 2) in which the state unemployment rate is correlated with an average of an extra 0.83 minutes of sleep. In a period when unemployment fluctuated by about 10%, this would be an increase of about eight minutes of average sleep, which is larger than the seasonal effect. Moreover, the thorough specifications of the models show that the relationship between unemployment and sleep duration was significant beyond

the changes in population demographic characteristics previously hypothesized to be correlated with sleep.

Model 2 in Table 2 also shows that the duration of the longest sleep episode varies across demographic groups. When compared with Whites, Blacks spend 9.79 minutes (95% CI: 6.94–12.64) less in bed, Hispanics spend an additional 20.99 minutes (95% CI: 18.40–23.58) in bed, and Asians spend an additional 11.29 minutes (95% CI: 5.91–16.67) in bed. Women spend an average 3.73 minutes (95% CI: 1.91–5.55) more time in bed than men. The correlation between sleep and levels of education shows that time in bed decreases monotonically with increasing levels of education: when compared to high school graduates, individuals who did not graduate high school spend an additional 20.07 minutes (95% CI: 16.91–23.23) in bed, but individuals who completed some college spend 8.50 minutes (95% CI: 6.19–10.81) less in bed, individuals who completed a bachelor's degree spend 12.29 minutes (95% CI: 9.88–14.69) less in bed, and individuals who completed at least some graduate coursework spend 13.40 minutes (95% CI: 10.86–15.94) less in bed. People who have never been married sleep more than all others (married individuals, widowed, divorced and separated). As expected, individuals sleep the most at the end of the day Fridays and Saturdays, and more on holidays. Individuals sleep more in the winter compared to all other seasons, but the differences in sleep length between the spring, summer, and fall are not significant..

Models in Table 3 all include the linear secular time, all covariates in Table 2 and potential mediators of individual employment and household income. The state unemployment rate is a significant predictor of sleep time in all models, although the individual factors are also significant correlates of sleep duration. Model 3 in table 3 shows that every additional percentage point in unemployment is correlated with an additional 0.66 minutes (95% CI: 0.23, 1.09) of sleep, even after controlling for household income, employment status, and night shift work, all of which were significantly associated with sleep duration.

Tables 4 and 5 show the marginal effects calculated from fitting binary probit regressions predicting the probability of reporting any sleeplessness as a function of statewide unemployment rate, adjusted for sex, age, race, marital status, education, day of the week, season of the year, and holidays. There was no macroeconomic effect of state unemployment rate on probability of reporting sleeplessness (table 4, model 1), although the point estimates suggest a slight decrease in probability with increasing unemployment rates. However, when a control is introduced for a secular linear trend (table 4, model 2) there is a highly significant secular trend of increasing probability of reporting sleeplessness over time. With the secular trend in the model, *higher* state unemployment is correlated with *lower* probability of sleeplessness.

During sensitivity analysis, it was found that the relationship across quintiles of unemployment and probability of sleeplessness was U-shaped when the model did not adjust for secular trends; only the median quintile of unemployment showed a significantly lower probability of sleeplessness compared to the lower and upper quintiles. However, after adjusting for the secular trend, the relationship between unemployment and sleeplessness

was monotonic and negative. This underscores the importance of taking into account the temporal trend upward of sleeplessness.

Discussion

Our results demonstrate significant empirical relationships involving local macroeconomic conditions and the manner in which individuals allocate time to sleep versus other competing uses of their time. The time allotted for sleep is countercyclical with higher unemployment related to longer average sleep. Higher state unemployment rates are associated with more sleep time, even controlling for the powerful mediating effects of the respondent's own employment status and household income. Our results show a strong secular trend over the ten years towards longer sleep duration and also greater reporting of sleeplessness. Moreover, the analyses show that macroeconomic unemployment actually confers protection against sleeplessness. This contradicts survey results that asked about losing sleep over the economy (National Sleep Foundation 2009; Ásgeirsdóttir, Corman, and Noonan 2012). While these findings are interesting *per se*, we also believe they are important in light of the fact that both chronic and acute health outcomes may be influenced by sleep quantity and quality, and this study is evidence that regardless of economic trends, sleeplessness continues on an upward trend.

Some literature has suggested that extended time in bed may contribute to sleeplessness. Given that there was both a secular trend towards higher time in bed as well as a secular trend towards a higher probability of reporting sleeplessness, we ran separate analysis (not shown here) of the probability of sleeplessness while controlling for sleep time. These results showed that individuals in states with higher unemployment still experience significantly lower probabilities ($p < 0.001$) of reporting any sleeplessness, and there was still a secular trend towards higher probabilities of reporting sleeplessness. This suggests that although longer time in bed may be part of the causal pathway between the secular trend towards more sleep time and the secular trend for more sleeplessness, there are also other factors driving this relationship.

As emphasized in Becker's original model of time use and household production (1965), time prices and goods prices interact to influence the manner in which household commodities are produced. Since macroeconomic conditions may influence both time and goods prices, it is expected that changes in such conditions will have implications for the manner in which time is utilized as well as the kinds and quantities of goods that are purchased as inputs in commodity production. Using the local unemployment rates to characterize the macroeconomic contexts affecting individuals' time use patterns is reasonable, but admittedly may not capture the richness of circumstances within which such time use choices are made.

Because the ATUS began in 2003, there are no equivalent data for prior years, although there were a few earlier cross-sectional time use studies that were investigator initiated (Biddle and Hamermesh 1990; Robinson and Godbey 1997). While sleep time may have decreased in the 1990s due to the expanding economy, the larger family of time use studies from recent decades in the U.S. and other countries do not support a general decrease in

sleep times (Bin, Marshall, and Glozier 2012; Bin, Marshall, and Glozier 2013), or only support the notion of a decrease in sleep among those who are employed full time (Knutson et al. 2010). The first two national time use studies in the U.S. were in 1965 and 1975, and those years happen to offer a dramatic contrast in national unemployment rates: 4.5 percent in 1965 and 8.5 percent in 1975 (Robinson and Godbey 1997). Consistent with unemployment rates playing a role in sleep time, the time use studies from those two years report women sleeping 3.1 hours *more* per week in 1975 than 1965 and men sleeping 1.4 hours *more* in 1975 than 1965 (Robinson and Godbey, 1997, p. 337). While two time points can be no more than suggestive, these studies are consistent with a sizable role for the macroeconomic context in sleep time. Ignoring that role when data are sporadic could lead to incorrect inferences about secular trends.

There are important limitations to this study. Sleep time is a measure of time set aside to sleep rather than a measure of physiological sleep. It is also possible that other activities that take place in bed are reported as sleep. Some individuals may not think to distinguish “sleeplessness” from their overall sleep time, and it is possible that the secular trend of increasing sleeplessness is actually a reflection of increasing reporting of sleeplessness. The past decade has seen increasing attention to sleep as a health problem in the popular media, and this may have raised awareness. The data provide no indication of sleep quality other than the sleeplessness category. To the extent that economic conditions may affect quality as much as, or more than, quantity, such relationships will not be revealed fully in these data. Moreover, the current analysis focused on predicting mean sleep across the population and assumes that the variance does not change during the period of study. We do not examine categories of sleep duration: short sleep and long sleep. The hour definitions of these categories, particularly as they relate to health, is highly variable and not established at all for sleep durations measured from time diaries rather than simple survey questions. An intriguing area in sleep research is the often-found correlation between poor health and long sleep (Stranges et al. 2008). However, there is little evidence for a biological mechanism that would suggest this was a causal association in the direction of longer sleep *causing* poorer health rather than poorer health causing longer sleep. Another limitation is the temporal pattern of unemployment with higher rates after 2008. However, declining unemployment rates beginning in 2011 help distinguish the secular trend in sleep from the macroeconomic effect. Strengths of this study are the length of the study period (ten years), the size and national representation of the sample, and the sizable state variation in unemployment.

Indices of unemployment have important shortcomings, since they do not capture the under-employed or those too discouraged to look for a job, and these shortcomings could be particularly salient in assessing the economic landscape of the period of 2003–2012. During the recession that started in 2008, individuals were unemployed a median 22 weeks, and many lost interest in looking for a job and were then considered out of the work force (Valletta and Kuang 2012). We found no effect of personal unemployment on sleeplessness, while those outside the labor force did have an elevated probability of reporting sleeplessness, even after adjusting for household income. It is worth noting that after adjusting for the secular trend towards increased sleeplessness, sleeplessness is actually

countercyclical, whether or not individual employment and household income are included in the model. Increasing household income, as expected, is generally protective for sleeplessness.

The nature of these data does not permit us to make strong causal statements that causality runs unambiguously from macroeconomic conditions to time allocations. Ideally, one would repeat the current analysis using a study that collected repeated sleep measures across times and economic conditions on the same individuals, which would clarify the relationship of contextual economic conditions and sleep apart from the individuals own personal employment trajectory. However, we believe that the potential for endogeneity/confounding to affect the inferences drawn from our results is limited. In simple econometric terms, the main concern would appear to be that unmeasured determinants of individuals' time allocation patterns are correlated with local-area macroeconomic conditions. Most prominent among such concerns would appear to be that relevant aspects of local macroeconomies that causally impact individuals' time allocations are not adequately proxied by the macroeconomic measures we utilize and are, as such, relegated to the error terms.

To summarize, this large, nationally representative data series demonstrates that macroeconomic conditions are associated with a countercyclical effects on time allotted for sleep, and therefore provides some basis for a link between macroeconomic conditions and health to the extent that longer sleep durations are healthful. While there is a secular trend from 2003 to 2012 towards reporting more sleeplessness, we did not find the expected macroeconomic effect on sleeplessness beyond the individual's own employment status. Taking into account the secular trend, there is actually evidence that higher unemployment rates are associated with less sleeplessness.

Acknowledgments

Initial work on this project was funded by NIH grant R01HL082907-01.

References

- Aguiar, Mark; Hurst, Erik. Measuring Trends in Leisure: The Allocation of Time over Five Decades. *The Quarterly Journal of Economics*. 2007; 122 (3):969–1006.
- Amuedo-Dorantes, Catalina; Kimmel, Jean. Moonlighting over the Business Cycle. *Economic Inquiry*. 2009; 47(4):754–765.
- Asgeirsdóttir, Tinna Laufey; Corman, Hope; Noonan, Kelly; Olafsdóttir, Thórnórhildur; Reichman, Nancy E. Was the Economic Crisis of 2008 Good for Icelanders? Impact on Health Behaviors. *Economics and Human Biology*. 2013
- Asgeirsdóttir, Tinna Laufey; Zoega, Gylfi. On the Economics of Sleeping. *Mind & Society*. 2011; 10(2 June 30):149–164.
- Ásgeirsdóttir TL, Corman Hope, Noonan Kelly. Are Recessions Good for Your Health Behaviors? Impacts of the Economic Crisis in Iceland. National Bureau of Economic Research Working Paper 18233. 2012 Jul.
- Basner, Mathias; Fomberstein, Kenneth M.; Razavi, Farid M.; Banks, Siobhan; William, Jeffrey H.; Rosa, Roger R.; Dinges, David F. American Time Use Survey: Sleep Time and Its Relationship to Waking Activities. *Sleep*. 2007; 30(9):1085. [PubMed: 17910380]
- Becker, Gary S. A Theory of the Allocation of Time. *The Economic Journal*. 1965; 75(299):493–517.

- Bezruchka, Stephen. The Effect of Economic Recession on Population Health. *CMAJ: Canadian Medical Association Journal = Journal de l'Association Médicale Canadienne*. 2009; 181(5):281–285.
- Biddle, Jeff E.; Hamermesh, Daniel S. Sleep and the Allocation of Time. *Journal of Political Economy*. 1990
- Bin, Yu Sun; Marshall, Nathaniel S.; Glozier, Nick. Secular Trends in Adult Sleep Duration: a Systematic Review. *Sleep Medicine Reviews*. 2012; 16(3):223–230. [PubMed: 22075214]
- Bin, Yu Sun; Marshall, Nathaniel S.; Glozier, Nick. Sleeping at the Limits: The Changing Prevalence of Short and Long Sleep Durations in 10 Countries. *American Journal of Epidemiology*. 2013; 177(8):826–833. [PubMed: 23524039]
- Bureau of Labor Statistics. Featured Local Area Unemployment Searchable Databases.
- Bureau of Labor Statistics. American Time Use Survey User's Guide. 2012.
- Cappuccio, Francesco P.; D'Elia, Lanfranco; Strazzullo, Pasquale; Miller, Michelle A. Quantity and Quality of Sleep and Incidence of Type 2 Diabetes A Systematic Review and Meta-Analysis. *Diabetes Care*. 2010; 33(2):414–420. [PubMed: 19910503]
- Ferrie, Jane E.; Shipley, Martin J.; Cappuccio, Francesco P.; Brunner, Eric; Miller, Michelle A.; Kumari, Meena; Marmot, Michael G. A Prospective Study of Change in Sleep Duration: Associations with Mortality in the Whitehall II Cohort. *Sleep*. 2007; 30(12):1659. [PubMed: 18246975]
- Foster, Russell G.; Wulff, Katharina. The Rhythm of Rest and Excess. *Nature Reviews Neuroscience*. 2005; 6(5):407–414.
- Gangwisch, James E.; Heymsfield, Steven B.; Boden-Albala, Bernadette; Buijs, Ruud M.; Kreier, Felix; Pickering, Thomas G.; Rundle, Andrew G.; Zammit, Gary K.; Malaspina, Dolores. Sleep Duration as a Risk Factor for Diabetes Incidence in a Large US Sample. *Sleep*. 2007; 30(12):1667. [PubMed: 18246976]
- Gerdtham, Ulf-G.; Ruhm, Christopher J. Deaths Rise in Good Economic Times: Evidence from the OECD. *Economics and Human Biology*. 2006; 4(3 December):298–316. [PubMed: 16713407]
- González, Rosa Marina. The Value of Time: a Theoretical Review. *Transport Reviews*. 1997; 17(3): 245–266.
- Grandner, Michael A.; Patel, Nirav P.; Gehrman, Philip R.; Xie, Dawei; Sha, Daohang; Weaver, Terri; Gooneratne, Nalaka. Who Gets the Best Sleep? Ethnic and Socioeconomic Factors Related to Sleep Complaints. *Sleep Medicine*. 2010; 11(5 May):470–8. [PubMed: 20388566]
- Hale, Lauren. Who Has Time to Sleep? *Journal of Public Health (Oxford, England)*. 2005; 27(2 June): 205–11.
- Hale, Lauren; Phuong Do, D. Racial Differences in Self-Reports of Sleep Duration in a Population-Based Study. *Sleep*. 2007; 30(9):1096. [PubMed: 17910381]
- Hamermesh, Daniel S. Timing, Togetherness and Time Windfalls. *Journal of Population Economics*. 2002; 15(4 November 1):601–623.
- Harvey, Allison G.; Tang, Nicole KY. (Mis) Perception of Sleep in Insomnia: A Puzzle and a Resolution. *Psychological Bulletin*. 2012; 138(1):77. [PubMed: 21967449]
- King, Christopher Ryan; Knutson, Kristen L.; Rathouz, Paul J.; Sidney, Steve; Liu, Kiang; Lauderdale, Diane S. Short Sleep Duration and Incident Coronary Artery Calcification. *JAMA: The Journal of the American Medical Association*. 2008; 300(24):2859–2866. [PubMed: 19109114]
- Knutson, Kristen L.; Van Cauter, Eve; Rathouz, Paul J.; DeLeire, Thomas; Lauderdale, Diane S. Trends in the Prevalence of Short Sleepers in the USA: 1975–2006. *Sleep*. 2010; 33(1 January): 37–45. [PubMed: 20120619]
- LeBlanc, Mélanie; Beaulieu-Bonneau, Simon; Mérette, Chantal; Savard, Josée; Ivers, Hans; Morin, Charles M. Psychological and Health-Related Quality of Life Factors Associated with Insomnia in a Population-Based Sample. *Journal of Psychosomatic Research*. 2007; 63:157–166. [PubMed: 17662752]
- Lucassen, Eliane A.; Rother, Kristina I.; Cizza, Giovanni. Interacting Epidemics? Sleep Curtailment, Insulin Resistance, and Obesity. *Annals of the New York Academy of Sciences*. 2012; 1264(1): 110–134. [PubMed: 22827862]

- Magee, Christopher A.; Iverson, Donald C.; Caputi, Peter. Factors Associated with Short and Long Sleep. *Preventive Medicine*. 2009; 49(6):461–467. [PubMed: 19850073]
- Magee, Lorrie; Hale, Lauren. Longitudinal Associations Between Sleep Duration and Subsequent Weight Gain: a Systematic Review. *Sleep Medicine Reviews*. 2012; 16(3 June):231–41. [PubMed: 21784678]
- Matricciani, Lisa; Olds, Tim; Williams, Marie. A Review of Evidence for the Claim That Children Are Sleeping Less Than in the Past. *Sleep*. 2011; 34(5 May):651–9. [PubMed: 21532959]
- Morin, Charles M.; Rodrigue, Sylvie; Ivers, Hans. Role of Stress, Arousal, and Coping Skills in Primary Insomnia. *Psychosomatic Medicine*. 2003; 65(2):259–67. [PubMed: 12651993]
- National Sleep Foundation. 2009 Sleep in American Poll - Summary of Findings. Washington, DC: 2009. <http://www.sleepfoundation.org/article/sleep-america-polls/2009-health-and-safety>
- Patel, Sanjay R.; Hu, Frank B. Short Sleep Duration and Weight Gain: a Systematic Review. *Obesity*. 2008a; 16(3):643–653. [PubMed: 18239586]
- Patel, Sanjay R.; Hu, Frank B. Short Sleep Duration and Weight Gain: a Systematic Review. *Obesity*. 2008b; 16(3):643–653. [PubMed: 18239586]
- Rafalson, Lisa; Donahue, Richard P.; Stranges, Saverio; Lamonte, Michael J.; Dmochowski, Jacek; Dorn, Joan; Trevisan, Maurizio. Short Sleep Duration Is Associated with the Development of Impaired Fasting Glucose: The Western New York Health Study. *Annals of Epidemiology*. 2010; 20(12):883–889. [PubMed: 20620078]
- Robinson, John P.; Godbey, Geoffrey. *Time for Life: The Surprising Ways Americans Use Their Time*. Penn State Press; 1997.
- Ruhm, Christopher J. Recessions, Healthy No More?. 2013.
- Spiegel, Karine; Leproult, Rachel; Van Cauter, Eve. Impact of Sleep Debt on Metabolic and Endocrine Function. *Lancet*. 1999; 354(9188 October 23):1435–9. [PubMed: 10543671]
- Stamatakis, Katherine A.; Kaplan, George A.; Roberts, Robert E. Short Sleep Duration Across Income, Education, and Race/ethnic Groups: Population Prevalence and Growing Disparities During 34 Years of Follow-Up. *Annals of Epidemiology*. 2007; 17(12 December):948–55. [PubMed: 17855122]
- Stranges, Saverio; Dorn, Joan M.; Shipley, Martin J.; Kandala, Ngianga-Bakwin; Trevisan, Maurizio; Miller, Michelle A.; Donahue, Richard P., et al. Correlates of Short and Long Sleep Duration: A Cross-Cultural Comparison Between the United Kingdom and the United States the Whitehall II Study and the Western New York Health Study. *American Journal of Epidemiology*. 2008; 168(12):1353–1364. [PubMed: 18945686]
- Valletta, Rob; Kuang, Katherine. *Why Is Unemployment Duration so Long*. FRBSF Economic Letters; San Francisco, CA. 2012.
- Van Cauter, Eve; Knutson, Kristen L. Sleep and the Epidemic of Obesity in Children and Adults. *European Journal of Endocrinology*. 2008; 159(suppl 1):S59–S66. [PubMed: 18719052]
- Van Cauter, Eve; Spiegel, Karine. Sleep as a Mediator of the Relationship Between Socioeconomic Status and Health: a Hypothesis. *Annals of the New York Academy of Sciences*. 1999; 896(January):254–61. [PubMed: 10681902]
- Virtanen, Pekka; Vahtera, Jussi; Broms, Ulla; Sillanmäki, Lauri; Kivimäki, Mika; Koskenvuo, Markku. Employment Trajectory as Determinant of Change in Health-Related Lifestyle: The Prospective HeSSup Study. *The European Journal of Public Health*. 2008; 18 (5):504–508.

Highlights

From 2003 to 2012, time allotted for sleep in the United States is countercyclical with respect to employment conditions.

Each additional point of state unemployment is associated with 0.83 more minutes of sleep, adjusted for secular trend.

Higher state unemployment is associated with less frequent reports of sleeplessness, adjusted for secular trend.

Figure 1. State monthly unemployment rates, 2003 – 2012. Data Source: Bureau of Labor Statistics. In each month, the points represent individual state unemployment rates.

Table 1

Characteristics of the respondents and the day, season and year when they completed a time-use diary.
American Time Use Survey, 2003–2012.

	N	%
Year		
2003 (<i>referent</i>)	18256	15.0
2004	12378	10.2
2005	11509	9.5
2006	11350	9.3
2007	10817	8.9
2008	11326	9.3
2009	11761	9.7
2010	11828	9.7
2011	11159	9.2
2012	11244	9.2
Season		
Winter (<i>referent</i>) (Jan–Mar)	32690	26.9
Spring (Apr – Jun)	29589	24.3
Summer (Jul – Sep)	29880	24.6
Fall (Oct – Dec)	29469	24.2
Day of the week		
Sunday (<i>referent</i>)	31059	25.5
Monday	12362	10.2
Tuesday	12239	10.1
Wednesday	12055	9.9
Thursday	11974	9.8
Friday	11875	9.8
Saturday	30064	24.7
Holiday		
Non-Holiday (<i>referent</i>)	119603	98.3
Holiday	2025	1.7
Sex		
Male (<i>referent</i>)	52342	43.0
Female	69286	57.0
Race/Ethnicity		
White (<i>referent</i>)	85459	70.3
Black/African American	15670	12.9
Hispanic, any race	14855	12.2
Asian	3592	3.0
Two or more races	2052	1.7

	N	%
Age		
25–29	9677	8.0
30–39 (<i>referent</i>)	27238	22.4
40–49	28320	23.3
50–59	22885	18.8
60–69	16529	13.6
70+	16979	14.0
Marital Status		
<i>Married - Spouse Present (referent)</i>	67046	55.1
Married - Spouse Absent	1851	1.5
Widowed	11921	9.8
Divorced	18011	14.8
Separated	3650	3.0
Never Married	19149	15.7
Child under 12 present in household		
No (<i>referent</i>)	77276	63.5
Yes	44352	36.5
Education		
Less than High School	14250	11.7
<i>High School Graduate (referent)</i>	33946	27.9
Some College	33170	27.3
Holds a Bachelor's Degree	25260	20.8
Graduate Coursework or More	15002	12.3
Employment Status		
Outside the Labor Force	38704	31.8
Unemployed	4675	3.8
<i>Full Time (referent)</i>	64052	52.7
Part Time	14197	11.7
Night Shift		
<i>No (referent)</i>	118104	97.1
Yes	3524	2.9
Household Income		
No income	12313	10.1
Below \$9,999	7853	6.5
\$10,000–19,999	12731	10.5
\$20,000–29,999	13358	11.0
\$30,000–39,999	13326	11.0
\$40,000–49,999	10022	8.2
\$50,000–59,999	9609	7.9

	N	%
\$60,000–74,999	11281	9.3
\$75,000–99,999 (<i>referent</i>)	15383	12.7
\$100,000–149,999	9515	7.8
\$150,000 and above	6237	5.1

Table 2

Multivariable OLS Regression Models for the Duration of the Longest Sleep Episode from the ATUS 2003–2012. Model 2 adds adjustment for secular trend.

	Model 1	Model 2
Monthly unemployment (percent)	2.38 (2.04, 2.73)***	0.83 (0.4, 1.26)***
Season		
<i>Winter</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
Spring	−3.88 (−6.21, −1.54)**	−5.09 (−7.44, −2.74)***
Summer	−4.87 (−7.23, −2.5)***	−6.38 (−8.78, −3.99)***
Fall	−1.74 (−4.23, 0.76)	−4.17 (−6.7, −1.65)**
Holiday		
<i>Non-Holiday</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
Holiday	13.06 (6.44, 19.68)***	13.21 (6.6, 19.81)***
Day of the week		
Sunday	8.73 (6.18, 11.29)***	8.75 (6.2, 11.29)***
<i>Monday</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
Tuesday	−1.93 (−5.11, 1.25)	−1.88 (−5.04, 1.29)
Wednesday	−3.15 (−6.48, 0.18)	−3.11 (−6.43, 0.21)
Thursday	0.23 (−3.02, 3.49)	0.16 (−3.09, 3.41)
Friday	27.05 (23.53, 30.58)***	27.06 (23.55, 30.56)***
Saturday	38.11 (35.2, 41.01)***	38.13 (35.23, 41.02)***
Sex		
<i>Male</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
Female	3.71 (1.9, 5.53)***	3.73 (1.91, 5.55)***
Race/ethnicity		
<i>White</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
Black	−9.85 (−12.7, −7)***	−9.79 (−12.64, −6.94)***
Hispanic	20.99 (18.41, 23.57)***	20.99 (18.40, 23.58)***
Asian	11.47 (6.12, 16.82)***	11.29 (5.91, 16.67)***
Other	−6.66 (−14.21, 0.9)	−6.97 (−14.50, 0.57)
Age group		
25–29	11.86 (8.41, 15.3)***	11.68 (8.24, 15.12)***
30–39	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
40–49	−9.09 (−11.71, −6.46)***	−9.18 (−11.80, −6.57)***
50–59	−11.21 (−14.12, −8.31)***	−11.68 (−14.59, −8.78)***
60–69	−1.75 (−4.73, 1.23)	−2.49 (−5.48, 0.49)
70+	11.44 (7.67, 15.22)***	10.89 (7.13, 14.66)***
Education		
Less than High School	19.77 (16.6, 22.93)***	20.07 (16.91, 23.23)***
<i>High School Graduate</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>

	Model 1	Model 2
Some College	-8.39 (-10.7, -6.08)***	-8.50 (-10.81, -6.19)***
Holds a Bachelor's Degree	-12 (-14.42, -9.59)***	-12.29 (-14.69, -9.88)***
Graduate Coursework or More	-13.08 (-15.62, -10.53)***	-13.40 (-15.94, -10.86)***
Marital Status		
<i>Married - spouse present</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
Married - spouse absent	4.05 (-3.07, 11.16)	3.44 (-3.68, 10.57)
Widowed	-1.67 (-5.2, 1.87)	-1.64 (-5.17, 1.89)
Divorced	-1.48 (-3.95, 0.99)	-1.68 (-4.14, 0.79)
Separated	2.26 (-3.06, 7.57)	1.9 (-3.44, 7.24)
Never Married	5.84 (3.09, 8.58)***	5.43 (2.67, 8.19)***
Child under 12 present in household		
<i>No</i>	<i>0.00 (referent)</i>	<i>0.00 (referent)</i>
Yes	-7.16 (-9.38, -4.94)***	-7.28 (-9.51, -5.05)***
Monthly Secular Trend		0.18 (0.15, 0.2)***
Constant	451.52 (446.58, 456.46)***	453.22 (448.27, 458.18)***
R2	0.042	0.044

Table 3

Multivariable OLS Regression Models for the Duration of the Longest Sleep Episode from the ATUS 2003–2012 with indicators of personal economic status. All of the variables in Table 2 Model 2 are also included in these models.

	Model 1	Model 2	Model 3
Monthly unemployment (percent)	0.67 (0.24, 1.10)**	0.80 (0.37, 1.24)***	0.66 (0.23, 1.09)**
Employment Status			
Outside the labor force	22.15 (19.46, 24.83)***		20.26 (17.51, 23.02)***
Unemployed	17.88 (13.49, 22.27)***		16.16 (11.69, 20.63)***
Full time	0.00 (referent)		0.00 (referent)
Part Time	12.65 (10.08, 15.22)***		11.52 (8.96, 14.09)***
Night shift			
No	0.00 (referent)		0.00 (referent)
Yes	−87.85 (−93.16, −82.55)***		−88.07 (−93.37, −82.78)***
Household income			
No income reported		4.02 (0.71, 7.32)*	1.82 (−1.49, 5.12)
\$9,999 and less		19.50 (14.36, 24.64)***	10.89 (5.85, 15.93)***
\$10,000–\$19,999		11.73 (7.48, 15.98)***	6.55 (2.34, 10.76)**
\$20,000–\$29,999		9.26 (5.73, 12.80)***	6.70 (3.23, 10.17)***
\$30,000–\$39,999		4.76 (1.16, 8.37)**	3.20 (−0.43, 6.82)
\$40,000–\$49,999		−0.49 (−4.11, 3.13)	−0.80 (−4.34, 2.73)
\$50,000–\$59,999		0.27 (−3.48, 4.01)	−0.11 (−3.78, 3.56)
\$60,000–\$74,999		−1.29 (−4.70, 2.13)	−1.50 (−4.78, 1.78)
\$75,000–\$99,999		0.00 (referent)	0.00 (referent)
\$100,000–\$149,000		−4.56 (−8.09, −1.03)*	−3.79 (−7.18, −0.40)*
\$150,000 and over		−5.30 (−9.48, −1.12)*	−5.33 (−9.43, −1.23)*
Monthly Secular Trend	0.18 (0.15, 0.20)***	0.19 (0.16, 0.21)***	0.18 (0.15, 0.21)***

* p < 0.05

** p < 0.01

*** p < 0.001

Table 4

Marginal Effects Calculated from Multivariable Probit Regression Models for Reporting Any Sleeplessness, from the ATUS 2003–2012. Model 2 adds adjustment for secular trend.

	Model 1	Model 2
Monthly Unemployment (Continuous)		***
4%	0.045 (0.043, 0.048)	0.050 (0.046, 0.053)
6%	0.045 (0.043, 0.046)	0.046 (0.044, 0.048)
8%	0.044 (0.043, 0.046)	0.043 (0.041, 0.044)
10%	0.044 (0.041, 0.047)	0.040 (0.037, 0.042)
12%	0.043 (0.040, 0.047)	0.037 (0.033, 0.040)
14%	0.043 (0.038, 0.048)	0.034 (0.029, 0.039)
Holiday		
<i>Non-Holiday (referent)</i>	0.045 (0.043, 0.046)	0.045 (0.043, 0.046)
Holiday	0.048 (0.033, 0.063)	0.048 (0.033, 0.063)
Day of the week		
Sunday	0.044 (0.041, 0.047)	0.044 (0.041, 0.047)
<i>Monday (referent)</i>	0.043 (0.039, 0.047)	0.043 (0.039, 0.047)
Tuesday	0.047 (0.043, 0.051)	0.047 (0.043, 0.051)
Wednesday	0.051 (0.047, 0.056)**	0.051 (0.047, 0.056)**
Thursday	0.045 (0.041, 0.049)	0.045 (0.041, 0.049)
Friday	0.043 (0.039, 0.048)	0.043 (0.039, 0.048)
Saturday	0.039 (0.036, 0.042)	0.039 (0.036, 0.042)
Season		
<i>Winter (referent) (Jan–Mar)</i>	0.047 (0.044, 0.050)	0.048 (0.045, 0.051)
Spring (Apr – Jun)	0.042 (0.039, 0.045)*	0.042 (0.040, 0.045)**
Summer (Jul – Sep)	0.043 (0.040, 0.046)	0.043 (0.040, 0.046)*
Fall (Oct – Dec)	0.046 (0.043, 0.049)	0.045 (0.042, 0.048)
Sex		
<i>Male (referent)</i>	0.039 (0.037, 0.041)	0.039 (0.037, 0.041)
Female	0.050 (0.048, 0.052)***	0.050 (0.048, 0.052)***
Race/Ethnicity		
<i>Non-Hispanic, White (referent)</i>	0.049 (0.047, 0.050)	0.049 (0.047, 0.051)
Non-Hispanic Black	0.045 (0.041, 0.049)	0.045 (0.041, 0.049)
Hispanic	0.025 (0.022, 0.029)***	0.025 (0.022, 0.029)***
Asian	0.031 (0.023, 0.039)**	0.031 (0.023, 0.039)***
Other	0.050 (0.039, 0.061)	0.050 (0.038, 0.061)
Age		
25–29	0.035 (0.030, 0.040)	0.035 (0.030, 0.041)
<i>30–39 (referent)</i>	0.038 (0.035, 0.042)	0.039 (0.035, 0.042)
40–49	0.041 (0.038, 0.044)	0.041 (0.039, 0.044)

	Model 1	Model 2
50–59	0.048 (0.044, 0.052)**	0.048 (0.044, 0.052)**
60–69	0.046 (0.042, 0.049)*	0.045 (0.041, 0.049)*
70+	0.058 (0.053, 0.064)***	0.058 (0.053, 0.064)***
Education		
Less than High School	0.063 (0.057, 0.069)***	0.063 (0.057, 0.070)***
<i>High School Graduate (referent)</i>	0.049 (0.046, 0.051)	0.049 (0.046, 0.051)
Some College	0.044 (0.041, 0.047)*	0.044 (0.041, 0.047)*
Holds a Bachelor's Degree	0.037 (0.033, 0.040)***	0.037 (0.033, 0.040)***
Graduate Coursework or More	0.029 (0.026, 0.033)***	0.029 (0.026, 0.033)***
Marital Status		
<i>Married - Spouse Present (referent)</i>	0.042 (0.041, 0.044)	0.042 (0.041, 0.044)
Married - Spouse Absent	0.034 (0.022, 0.045)*	0.034 (0.022, 0.045)*
Widowed	0.049 (0.044, 0.054)***	0.049 (0.044, 0.054)**
Divorced	0.050 (0.046, 0.054)*	0.050 (0.046, 0.054)*
Separated	0.052 (0.043, 0.061)	0.052 (0.042, 0.061)
Never Married	0.047 (0.043, 0.052)	0.047 (0.042, 0.052)
Child under 12 present in household		
No (referent)	0.045 (0.043, 0.047)	0.045 (0.043, 0.047)
Yes	0.043 (0.040, 0.047)	0.043 (0.040, 0.046)
Secular trend - monthly (Continuous)		***
January 2003		0.036 (0.033, 0.038)
January 2006		0.041 (0.039, 0.042)
January 2009		0.047 (0.045, 0.048)
January 2012		0.053 (0.050, 0.057)

Table 5

Marginal Effects Calculated from Multivariable Probit Regression Models for Reporting Any Sleeplessness when indicators of personal economic status are included in the models. All of the variables in Table 4 Model 2 are also included in these models.

	Model 1	Model 2	Model 3
Monthly Unemployment (Continuous)	***	***	***
4%	0.050 (0.047, 0.053)	0.050 (0.046, 0.053)	0.050 (0.047, 0.053)
6%	0.046 (0.044, 0.048)	0.046 (0.044, 0.048)	0.046 (0.044, 0.048)
8%	0.043 (0.041, 0.044)	0.043 (0.041, 0.044)	0.043 (0.041, 0.044)
10%	0.039 (0.037, 0.042)	0.040 (0.037, 0.042)	0.039 (0.037, 0.042)
12%	0.036 (0.032, 0.040)	0.037 (0.033, 0.041)	0.036 (0.033, 0.040)
14%	0.033 (0.028, 0.038)	0.034 (0.029, 0.039)	0.034 (0.029, 0.038)
Employment Status			
Outside the Labor Force	0.055 (0.052, 0.059)***		0.053 (0.050, 0.057)***
Unemployed	0.047 (0.039, 0.055)*		0.046 (0.039, 0.053)
Full Time (referent)	0.038 (0.035, 0.040)		0.039 (0.036, 0.041)
Part Time	0.043 (0.039, 0.048)*		0.043 (0.038, 0.047)
Night Shift			
No (referent)	0.045 (0.044, 0.047)		0.045 (0.044, 0.047)
Yes	0.027 (0.020, 0.034)***		0.027 (0.020, 0.034)***
Household Income			
No income		0.051 (0.046, 0.057)***	0.051 (0.046, 0.056)**
Below \$9,999		0.060 (0.052, 0.067)***	0.055 (0.048, 0.062)***
\$10,000–19,999		0.057 (0.052, 0.063)***	0.055 (0.049, 0.060)***
\$20,000–29,999		0.045 (0.040, 0.050)*	0.044 (0.040, 0.049)
\$30,000–39,999		0.044 (0.040, 0.048)*	0.044 (0.040, 0.048)
\$40,000–49,999		0.041 (0.036, 0.046)	0.042 (0.036, 0.047)
\$50,000–59,999		0.044 (0.038, 0.049)	0.045 (0.039, 0.050)
\$60,000–74,999		0.037 (0.032, 0.042)	0.038 (0.033, 0.043)
\$75,000–99,999 (referent)		0.038 (0.034, 0.042)	0.039 (0.035, 0.044)
\$100,000–149,999		0.043 (0.037, 0.049)	0.044 (0.038, 0.050)
\$150,000 and above		0.031 (0.026, 0.036)*	0.032 (0.027, 0.037)
Secular trend - monthly (Continuous)	***	***	***
January 2003	0.035 (0.033, 0.038)	0.035 (0.032, 0.037)	0.035 (0.032, 0.037)
January 2006	0.041 (0.039, 0.042)	0.040 (0.039, 0.042)	0.040 (0.039, 0.042)
January 2009	0.047 (0.045, 0.048)	0.047 (0.045, 0.049)	0.047 (0.045, 0.049)
January 2012	0.053 (0.050, 0.057)	0.054 (0.050, 0.057)	0.054 (0.050, 0.058)