Sleep Health xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Sleep Health

Journal of the National Sleep Foundation

journal homepage: sleephealthjournal.org

Sleep debt at the community level: impact of age, sex, race/ethnicity and health

Elliott C. Fox, MS [a,b,*], Kairuo Wang, BS [a], Melissa Aquino, MS [c], Michael A. Grandner, PhD, MTR [d], Dawei Xie, PhD [e], Charles C. Branas, PhD [f], Nalaka S. Gooneratne, MD, MS [a]

[a] Division of Geriatric Medicine and the Center for Sleep and Circadian Neurobiology, University of Pennsylvania Perelman School of Medicine
[b] Frank H. Netter MD School of Medicine, Quinnipiac University
[c] Zena and Michael A. Wiener Cardiovascular Institute, Icahn School of Medicine at Mount Sinai
[d] Sleep and Health Research Program, Department of Psychiatry, University of Arizona
[e] Department of Epidemiology, University of Pennsylvania Perelman School of Medicine
[f] Department of Epidemiology, Columbia University Mailman School of Public Health

ARTICLE INFO

Article history:
Received 14 February 2018
Received in revised form 15 May 2018
Accepted 29 May 2018
Available online xxxx

Keywords:
Sleep debt
Sleep quality
Sleep duration
Insomnia
Older adults

ABSTRACT

Objectives: Insufficient sleep has become recognized as a pervasive problem in modern society. Sleep debt is a novel measure of sleep adequacy that may be useful in describing those at risk for inadequate sleep. Our objective was to investigate factors that may be associated with sleep debt at the population level, as well as build upon previous data that showed that minority groups may be more likely to have sleep debt.
Design: A cross-sectional population phone survey included questions regarding amount of sleep required and amount of sleep achieved. Sleep debt was calculated by subtracting sleep achieved from sleep required.
Setting: This study was designed by the Philadelphia Health Management Corporation and conducted over landlines and cell phones.
Participants: The Random Digit Dialing method was used to randomly choose 8,752 adults older than 18 years from several counties in and around Philadelphia to answer questions about sleep.
Measurements: Logistic regression was performed to test associations between sleep debt and various sociodemographic factors in different population subgroups to identify those at risk for sub-optimal sleep duration.
Results: Sleep debt was seen to decrease with age, a novel finding that is in contrast with literature suggesting that older adults have poor sleep. Greater sleep debt was also associated with female gender, Hispanic/Latino ethnicity, <40 years of age, self-reported poor health, and increased stress.
Conclusions: Although older adults may sleep less as they age, they may also require less sleep to feel rested, resulting in less sleep debt. This and other demographic factors, such as female gender and Hispanic/Latino ethnicity, can be used to identify those at higher risk of inadequate sleep and potentially manage their sleep debt.

Introduction

Accumulating evidence has shown that chronic sleep deprivation and insufficient sleep have become pervasive in modern society.[1-4] The National Sleep Foundation sleep duration recommendations were updated in 2015 to reflect current understanding of sleep requirements in different age brackets. Although they concede that some people may fall outside the guidelines, the majority of people should fall within the recommended 7 to 9 hours for healthy adults.[5] This is further supported by a consensus statement from the American Academy of Sleep Medicine and Sleep Research Society, which states that healthy adults should sleep at least 7 hours per night to promote optimal health.[6] The common occurrence of insufficient sleep and the risks associated with it makes it a major public health issue. For example, insufficient sleep has been linked to poor health, motor vehicle accidents, poor job performance, obesity, diabetes, cardiovascular disease, depression, and morbidity.[3,4,7,8] Job, economic, and domestic pressures as well as unhealthy behaviors, artificial lighting, and the widespread use of electronic devices such as

* Corresponding author.
E-mail address: elliott.fox@quinnipiac.edu. (E.C. Fox).

https://doi.org/10.1016/j.sleh.2018.05.007
2352-7218/

smartphones, computers, and televisions are all contributing factors to insufficient sleep. Other causes of sleep disturbances include medical and mental disorders.[2,4]

In addition to these factors, there is a strong relationship between sleep duration and socioeconomic position as well as sociodemographic status. Poor sleep is associated with low income and poverty.[9–11] Jackson and colleagues found that socioeconomic factors appeared to partially explain the association for short sleep in African Americans.[12] Ertel et al investigated the interaction between socioeconomic status, occupational factors and ethnicity on sleep duration using wrist actigraphy. They found that night work, total work hours, and male gender were salient predictors of shorter sleep duration in African and Caribbean immigrants.[13]

Sleep debt is a measure of sleep adequacy calculated by subtracting the average duration of sleep achieved from the duration of sleep needed to feel rested. Sleep debt is thought to accumulate over multiple nights of insufficient sleep and can have negative consequences over time.[14] With polysomnography, duration of sleep achieved can be determined objectively, but for this study, both of these values were subjective. Duration of sleep needed to feel rested is a value that is likely different for everyone. We decided to investigate sleep debt at a population level to describe which portions of a community might be more affected by it. Our goal was to describe population variation in sleep debt using common, self-reported demographic variables. We hypothesized that certain minority groups would be more likely to have sleep debt, based on an earlier study by our group.[10]

The Philadelphia Health Management Corporation (PHMC) is a non-profit institute that focuses on community health. PHMC administers an uncompensated, cross-sectional community survey in southeast Pennsylvania. A survey that took place in 2006 found that poor sleep quality was strongly associated with poverty and race and that African-American and Latino groups had worse overall sleep quality than the Caucasian groups.[10] The 2008 survey focused on sleep duration and awareness of sufficient sleep on an individual level. We examined this dataset to statistically test associations between sleep debt and various sociodemographic factors.

Methods

Subjects

The PHMC conducts a cross sectional community health survey in southeastern Pennsylvania periodically. The survey data used here was conducted between June and October 2008 by a market research firm based in New York City. The methods for the PHMC have been previously described.[10] Briefly, 10,000 households residing in the Bucks, Chester, Delaware, Montgomery, and Philadelphia counties were chosen by Random Digit Dialing to participate in telephone interviews given in either English or Spanish. Interviews averaged 24 minutes. Response rates were not provided in the PHMC dataset, but samples from each county were found to be representative of the population of the counties. One adult 18 years of age or above was selected from each household using the "last birthday" method, meaning if there was more than one adult in the house, the adult with the most recent birthday was chosen to survey. Permission from the PHMC was obtained before analysis of this dataset. This study received approved from the University of Pennsylvania Institutional Review Board.

Measurements

Three sleep questions were included in the 2008 PHMC survey: 1) Quality of sleep: "In general, how would you rate the quality of your sleep in the past week on a scale of 1 to 5, with 1 being restless and 5 being restful"; 2) Duration of sleep: "In general, how many hours of sleep do you get at night? This may be different than the number of hours you spend in bed"; and 3) Estimated sleep need: "How many hours of sleep do you feel you need at night? This may be different from how many hours of sleep you actually get at night". Subjects who answered that they needed or obtained 0 hours of sleep as well as those who needed or obtained more than 12 hours of sleep were excluded since these are physiologically implausible.

Socioeconomic factors, sociodemographic factors and other covariates

Age, sex, race/ethnicity, and marital status were included in the statistical analysis. Income status (above [not poor] or below [poor] 2x the federal poverty level), Medicaid insurance status, educational level and employment status were provided by participants as well. Selfreported health and lifestyle indicators including body mass index (BMI), smoking status, heavy alcohol use, diagnosis of mental illness, and stress levels were also included in the analysis. Stress level, sleep quality and number of children were grouped to simplify data analysis. Stress level was rated by participants on a scale of 1-10; data was grouped as 1-2 for low, 3-4 for mild, 5-6 for moderate, 7-8 for high, and 9-10 for very high. Sleep quality was rated on a scale of 1 to 5, with 1 being restless; data was grouped as 1 for restless, and 2-5 for restful (ie, not restless). Number of children did not have predefined values; data was grouped as 0 (no children) or ≥1 (children). A detailed description of these factors has been published previously.[10]

Statistical Analysis

SAS 9.0 (SAS Institute, Inc, Cary, NC) was used for all statistical analyses. An alpha value of .05 was used for all tests unless specified otherwise. The two SAS procedures used were FREQ and SURVEYLOGISTIC. We first calculated odds ratios to determine which variables were likely to influence sleep debt. After odds ratios were calculated, logistic regression was performed with those variables that were significant from the odds ratios. A series of multivariate logistic regressions were undertaken to assess predictors of sleep debt. Using a backward-stepwise method (with $P = .05$ being the condition for removal of factors from the model) a series of variables was entered. The first model uses an interaction term of race × income, as this had previously been found to be significant.[10] However, this was not significant in our model, so we dropped the interaction term to analyze the race variable alone. Model 3 reflects only the variables that remained as significant covariates as described above. Analyses were conducted using sample weights so that results would be applicable to the general population.[10]

Results

Sample Characteristics

In 2010, The Philadelphia Health Management Corporation contacted 10,007 potential participants for a phone survey. Of the participants, 8,752 chose to respond to the sleep questions. Comparison with the United States Census 2014 for age, gender, race, and ethnicity showed similar values.[15] Of the participants, 32.4% were aged 18-39, 49.8% were aged 40-64, and 17.8% were aged greater than 65. 73.1% of the participants identified as White, 20.6% identified as African-American, and 6.2% identified as Latino/Hispanic. Table 1 shows the remaining demographic and social breakdown of the participants.

Many respondents reported poor sleep, with 18.1% noting a sleep quality score of 1 or 2 (with 1 being restless sleep and 5 being restful sleep quality; Table 1). Only 31.1% of the sample reported receiving restful sleep (those who selected 5 for sleep quality). More than half of respondents (53.6%) reported having at least 1 hour of sleep debt normally. 11.4 % of females reported "restless" sleep quality

Please cite this article as: Fox EC, et al, Sleep debt at the community level: impact of age, sex, race/ethnicity and health, Sleep Health (2018), https://doi.org/10.1016/j.sleh.2018.05.007