Addictive Behaviors 77 (2018) 47–50

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

Short Communication

# Transitioning from adequate to inadequate sleep duration associated with higher smoking rate and greater nicotine dependence in a population sample

Freda Patterson[a,*], Michael A. Grandner[b], Alicia Lozano[c], Aditi Satti[d], Grace Ma[e]

[a] Department of Behavioral Health and Nutrition, University of Delaware, Bob Carpenter Sports Building, 26N College Avenue, Newark, DE 19716, United States
[b] Department of Psychiatry, University of Arizona College of Medicine, United States
[c] School of Nursing, University of Pennsylvania, United States
[d] Center for Lung Health, Temple University Lewis Katz School of Medicine, United States
[e] Center for Asian Health, Temple University Lewis Katz School of Medicine, United States

## HIGHLIGHTS

- Transitioning from adequate to inadequate sleep duration increases smoking behaviors, and difficulty not smoking for one day.
- Transitioning to inadequate sleep duration may be an independent risk factor for a "hardening" smoking habit.
- Middle-to-older age smokers who have inadequate sleep duration may need adjunctive treatment to improve sleep.

## ARTICLE INFO

*Keywords:*
Sleep duration
Smoking behaviors
Hardcore smoker

## ABSTRACT

*Introduction:* Inadequate sleep (≤ 6 and ≥ 9 h) is more prevalent in smokers than non-smokers but the extent to which sleep duration in smokers relates to smoking behaviors and cessation outcomes, is not yet clear. To begin to address this knowledge gap, we investigated the extent to which sleep duration predicted smoking behaviors and quitting intention in a population sample.

*Methods:* Data from current smokers who completed the baseline (N = 635) and 5-year follow-up (N = 477) assessment in the United Kingdom Biobank cohort study were analyzed. Multivariable regression models using smoking behavior outcomes (cigarettes per day, time to first cigarette, difficulty not smoking for a day, quitting intention) and sleep duration (adequate (7–8 h) versus inadequate (≤ 6 and ≥ 9 h) as the predictor were generated. All models adjusted for age, sex, race, and education.

*Results:* Worsening sleep duration (adequate to inadequate) predicted a more than three-fold higher odds in increased cigarettes per day (OR = 3.18; 95% CI = 1.25–8.06), a more than three-fold increased odds of not smoking for the day remaining difficult (OR = 3.90; 95% CI = 1.27–12.01), and a > 8-fold increased odds of higher nicotine dependence (OR = 8.98; 95% CI = 2.81–28.66). Improving sleep duration (i.e., inadequate to adequate sleep) did not predict reduced cigarette consumption or nicotine dependence in this population sample.

*Conclusion:* Transitioning from adequate to inadequate sleep duration may be a risk factor for developing a more "hard-core" smoking profile. The extent to which achieving healthy sleep may promote, or optimize smoking cessation treatment response, warrants investigation.

## 1. Introduction

Despite significant declines in smoking prevalence rates, tobacco use rates remain high (30–50%) in underserved groups (Perkett et al., 2016), while current front-line treatments for nicotine dependence (i.e., patch, spray, gum, lozenge, varenicline, bupropion) are effective for only one-quarter to one-third of treatment seekers (Cinciripini et al., 2013). Novel treatment targets, and strategies to enhance current nicotine dependence treatments, are needed.

As a common physiologic function, sleep is related to tobacco use with smokers having less healthy sleep than non-smokers (Patterson, Malone, Lozano, Grandner, & Hanlon, 2016). Smokers are more likely to report inadequate (≤ 6 and ≥ 9 h) sleep duration (Mehari, Weir, & Gillum, 2014; Patterson et al., 2016) have longer sleep latency (take longer to fall asleep) (Zhang, Samet, Caffo, & Punjabi, 2006), have increased perceptions of insufficient sleep (Grandner et al., 2015), and

* Corresponding author.
*E-mail address:* fredap@udel.edu (F. Patterson).

http://dx.doi.org/10.1016/j.addbeh.2017.09.011
Received 11 July 2017; Received in revised form 11 September 2017; Accepted 17 September 2017
Available online 20 September 2017
0306-4603/ 

increased risk for insomnia than non-smokers (Brook, Zhang, Brook, & Finch, 2012). Night-time smoking, a frequent cause of disrupted and shortened sleep, occurs in approximately 41% of smokers (Scharf, Dunbar, & Shiffman, 2008). Unhealthy sleep before and during cessation have been implicated as an independent cause of relapse (Peltier, Lee, Ma, Businelle, & Kendzor, 2017). While insomnia is a clinically verified withdrawal symptom. Moreover, several of the frontline treatments for smoking cessation (e.g., varenicline, transdermal nicotine) can cause sleep disturbances (McClure et al., 2009). Although it is well established that smokers are more vulnerable to unhealthy sleep, the prospective relationship between habitual sleep and smoking behaviors is less well understood.

To address this knowledge gap, we used a population sample to examine the extent to which sleep duration, and in particular, transitioning from the recommended adequate (7–8 h/night) to the unhealthy inadequate ($\leq 6$ and $\geq 9$ h) sleep duration, is associated with the smoking behavior characteristics of cigarettes per day, nicotine dependence, difficulty not smoking for one day, and, quitting intention across time. Data from this population study will go toward quantifying the extent to which inadequate sleep duration may be a viable risk factor for continued smoking.

## 2. Methods

To examine the prospective relationship between sleep duration and smoking behaviors, population data from the United Kingdom (UK) Biobank (application # 3474) were analyzed. The UK Biobank is a large prospective cohort study. Baseline assessments were conducted between 2006 and 2010 and a 5-year follow-up assessment was carried out between 2012 and 2013 in 20,000 participants. More expansive details about the UK Biobank methodology have been described elsewhere (UK Biobank, 2007). Study procedures were approved by the UK Biobank Institutional Review Board.

### 2.1. Measures

**Sleep duration** is the primary predictor of interest and was assessed with the survey item, "About how many hours sleep do you get in every 24 hours?" Responses were categorized as short ($\leq 6$ h), adequate (7–8 h), and long ($\geq 9$ h); (Grandner, Chakravorty, Perlis, Oliver, & Gurubhagavatula, 2014) short and long sleep were coded as "inadequate" for the current analysis. Change sleep duration variables were derived indicating whether participants had reported one of the following transitions between baseline and follow-up: adequate to inadequate, inadequate to adequate, adequate to adequate, or inadequate to inadequate sleep.

Several smoking variables were assessed as the outcomes of interest. Current **smoking rate** was measured as a continuous variable where respondents recorded "how many cigarettes [he/she] smoked daily." Change in number of cigarettes per day was calculated for each participant by subtracting the response at baseline from the response at follow-up, and were categorized as no change (change = 0), decreased (change < 0), or increased (change > 0). **Nicotine dependence** was assessed using a single item where participants indicated the time from waking to their first cigarette of the day on an ordinal scale (< 5 min, 5–15 min, between 30 min and 1 h, between 1 and 2 h and > 2 h). Note that the 15–30 min after waking option for this scale was mistakenly omitted. Smokers who reported having their first cigarette of the day within 15 min (higher nicotine dependence) were compared to all others (higher dependence versus not higher dependence).

In terms of smoking cessation readiness, smokers indicated if they would have **Difficulty not smoking for one day** by answering yes or no to the question: "I would have difficulty not smoking for a day." **Quitting Intention** was measured using a single item where participants indicated if they wanted to stop smoking on a four-level scale: "yes, definitely," "yes, probably," "no, probably not," and, "no, definitely not." For analytic purposes a dichotomous variable was generated (Yes, definitely and probably versus No, definitely and probably). Change variables were derived for all smoking related variable transitions from baseline to follow-up.

Demographic and health behavior covariates included age, sex (male/female), race (coded as White/Non-White), education (attended college versus did not), measured body mass index (BMI, kg/m$^2$), and self-reported alcohol consumption (daily or almost daily consumption, 3–4 times a week, 1–2 times a week, 1–3 times a month, special occasions only, never).

### 2.2. Statistical analysis

Repeated assessment data from 20,000 United Kingdom Biobank participants who completed a baseline and 5-year follow-up assessment was obtained. Participants not present at both time points with responses coded "don't know," "prefer not to answer" or missing data for sleep duration, were excluded (N = 3758), leaving 16,242 participants. Of these, participants who did not report current cigarette smoking, or who reported cigar or pipe smoking were excluded (n = 15,607 at baseline, n = 15,765 at follow-up), leaving 635 baseline and 477 follow-up participants in the analytic sample. A total 411 participants were identified as continued smokers from baseline to follow-up.

Descriptive statistics were used to characterize the sample at both time points. Continuous variables were described with means and standard deviations, and categorical variables with frequencies and percentages. Separate logistic regression models were generated to examine the baseline associations between binary smoking variables and sleep duration. Poisson regression modeling was used to assess the baseline association between cigarettes per day and sleep duration. Adequate sleep duration was used as the reference group in the baseline models. Lastly, multinomial logistic regression models were generated to examine the associations between changes in smoking behaviors and changes in sleep duration from baseline to follow-up among continued smokers. Continued adequate sleep duration was used as the reference group for odds ratio calculations in these models. Participants included in the final sample were significantly more likely to be female, white, non-college attendees, and employed, thus all multivariable models were adjusted for these variables. Multivariable models also adjusted for body mass index and alcohol consumption. Statistical significance was taken at the 0.05 level. All statistical analyses were completed using SAS V9.4 (SAS Institute, Cary, NC).

## 3. Results

### 3.1. Baseline sample characteristics

The majority of the sample were White (97.2%) and did not attend college (61.4%). The mean age was 54.5 (SD = 7.6) years, while 51.6% were female (Table 1). Most of the sample reported getting adequate (63.6%) sleep. The mean cigarettes per day was 15.0 (SD = 8.4), 43.7% reported smoking their first cigarette within 15 min of waking; and, while the majority of the sample reported wanting to quit (75.9%), most reported having difficulty not smoking for one day (69.7%) (see Table 1).

### 3.2. Baseline association between sleep duration with smoking behaviors (N = 635)

At baseline, sleep duration was significantly associated with cigarettes per day such that compared to smokers with adequate sleep duration, the expected number of cigarettes per day was 5% higher among inadequate sleepers (RR = 1.05, 95% CI = 1.00–1.10, p = 0.0373), adjusting for socio-demographic characteristics. Sleep duration was not associated with time to first cigarette, difficulty not smoking, or quitting intention at baseline (data not shown; see