Sleep Medicine 15 (2014) 295–302

Contents lists available at ScienceDirect

Sleep Medicine

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

Original Article

Self-reported sleep patterns in a British population cohort ☆

Yue Leng [a,*], Nick W.J. Wainwright [a], Francesco P. Cappuccio [b], Paul G. Surtees [a], Robert Luben [a], Nick Wareham [c], Carol Brayne [d], Kay-Tee Khaw [a]

[a] Department of Public Health and Primary Care, Strangeways Research Laboratory, University of Cambridge, Cambridge, UK
[b] Division of Mental Health and Well-being, Warwick Medical School, University of Warwick, Coventry, UK
[c] Medical Research Council Epidemiology Unit, Institute of Metabolic Science, Cambridge, UK
[d] Department of Public Health and Primary Care, Institute of Public Health, University of Cambridge, Cambridge, UK

ARTICLE INFO

Article history:
Received 2 July 2013
Received in revised form 9 October 2013
Accepted 11 October 2013
Available online 18 January 2014

Keywords:
Sleep quantity
Sleep patterns
Sleep research
England
Population
Epidemiology

ABSTRACT

Objectives: Sleep patterns have been linked to various health outcomes, but sleep patterns in the British population have not been extensively reported. We aimed to describe the sleep characteristics reported by the European Prospective Investigation of Cancer (EPIC)-Norfolk participants, with a particular emphasis on the comparison of measures of sleep quantity.
Methods: From 2006 to 2007, a total of 8480 participants aged 45–90 years reported sleep timing, nighttime sleep duration, and sleep difficulties. Time in bed (TIB) was calculated from the difference between rise time and bedtime, and sleep proportion was defined as the ratio of sleep duration and TIB.
Results: On average, the reported TIB was more than 1.5 h longer than sleep durations. Compared to men, women spent 15 min longer in bed, but they slept for 11 min less and reported more sleep difficulties. In multivariate analysis sleep duration and TIB varied with socioeconomic factors, but sleep proportion was consistently lower among women, nonworkers, and older individuals, as well as those who were widowed, separated, or divorced; those who reported sleep difficulties and more frequently used sleep medication; and those who had lower education, poorer general health, or a major depressive disorder (MDD).
Conclusions: Self-reported sleep duration and TIB have different meanings and implications for health. Sleep proportion may be a useful indicator of sleep patterns in the general population.

1. Introduction

There are growing claims that we are now chronically sleep deprived due to increasing demands and pressures of modern society [1,2]. At the same time, recent findings from the Multinational Time Use Survey [3] suggested increased prevalence of long sleep duration among representative populations from 10 counties. Interestingly, a large Internet-based sleep survey covering 10,810 British adults suggested that few individuals opted for more sleep when given other alternatives, despite the reported sleep deficit [4]. Extensive epidemiologic evidence has associated both short and long self-reported sleep duration with a range of health outcomes including all-cause mortality [5,6], cardiovascular diseases [7], diabetes mellitus [8], hypertension [9], obesity [10], and impaired cognitive function [11]. Most of these studies have relied on a single question of sleep duration as the exposure, which led to concerns over the true meaning of this measure. For instance weekend sleep, usually known as the catch-up sleep, is longer than weekday sleep [12]. The time individuals spend in bed is influenced by many factors such as presleep lifestyles in addition to the sleep period itself, and time in bed (TIB) and sleep duration might have different implications for health. However, the two terms have been improperly used in many previous epidemiologic studies [13]. Understanding how to most adequately measure and characterize sleep patterns in the population may help clarify the link among sleep, well-being, and ill-health.

Few studies have provided a subjective sleep profile of the British population. One of the earlier studies [14] reported an average sleep duration of 7.6 h per 24 h in sleep diaries from 509 British adults. Another study using electroencephalogram records [15] found sleep durations of 7.3 h and 7.1 h among men and women, respectively. Both studies used objective measures of sleep, with the aim of presenting the age and sex distribution of the realistic sleep duration. A national survey [16] on perceived sleep in the British population took place in 2004 and covered a representative sample of 2000 adults. This survey addressed several sleep questions, including sleep duration, general sleep quality, and a range of sleep difficulties. Average sleep duration (7.04 h) was found to be 30 min less than the

* Corresponding author. Address: Department of Public Health and Primary Care, Strangeways Research Laboratory, University of Cambridge, Cambridge CB1 8RN, UK. Tel.: +44 (0) 1223748686.
E-mail address: yl411@cam.ac.uk (Y. Leng).

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http://dx.doi.org/10.1016/j.sleep.2013.10.015

reported TIB. Descriptive studies from other countries have shown more variations. Most studies examined the sociodemographic distributions of sleep duration [17–19], though only a few studies presented the different aspects of sleep in detail [20–22].

Few studies have distinguished overall sleeping time between TIB and actual sleep durations [23] or weekday and weekend sleep time. Although the difference between TIB and sleep duration is obvious, the two terms have been easily confused with one another in previous studies with subjective sleep measures. More importantly, their potential different health implications indicate that it might be worth investigating the two sleep times separately in epidemiologic studies. Little is known about how each of these sleeping times vary by sociodemographic factors and how they may be linked to sleep quality. Our study aimed to provide a subjective profile of the sleep patterns in a British population, with a particular emphasis on the following questions. (1) How much do we sleep every night? (2) How is sleep duration different from the time we spend in bed? (3) How is weekend sleep different from weekday sleep? (4) How do these times vary by sociodemographic factors? (5) How does reported sleep quantity relate to sleep quality or sleep difficulties?

2. Methods

2.1. Study overview

Data were drawn from the European Prospective Investigation of Cancer (EPIC)-Norfolk prospective cohort study. The design and study methods of EPIC-Norfolk have been previously described [24,25]. Briefly 30,445 men and women aged 40–74 years were recruited into the EPIC-Norfolk study from 1993 to 1997 using general practice age-sex registers. There were 25,639 participants who attended the baseline health check. These participants were then followed up for two further health checks from 1996 to 2000 and 2006 to 2011. In between these health examinations, participants were sent questionnaires for completion and were expected to return them by mail (Fig. 1). The Norwich District Ethics Committee approved the study and all participants gave signed informed consent.

2.2. Measures of sleep

From 2006 to 2007, a total of 10,126 participants out of 13,969 eligible individuals completed the sleep questions in the EPIC physical activity questionnaire (EPAQ2-3HC). The questionnaire asked the following questions: "At what time do you normally get up?" "At what time do you normally go to bed?" The responses were separately obtained for an average weekday and weekend day over the previous year. For our study, 85 participants who reported unusual times of going to bed (6:00–18:00 pm) or getting up (12:00–24:00 pm/0:00–3:00 am) were omitted to make the interpretation more straightforward, leaving 10,041 individuals for analysis.

During the same period, some detailed questions on sleep patterns over the previous 4 weeks were asked in the Health and Lifestyle Questionnaire 2 (HLEQ2), completed by 12,897 participants. "Have you had difficulty getting to sleep at night?" "Have you woken-up during the night and had trouble getting back to sleep?" "Have you woken-up too early in the morning and had difficulty getting back to sleep?" "Have you taken any prescribed medicine to help with your sleep?" "On average, about how many hours have you slept each night?" Response categories for the first four questions included yes, usually/yes, sometimes/never, or rarely. Sleep duration was reported by hours and minutes.

2.3. Sociodemographic variables

2.3.1. Baseline

The baseline questionnaire included the following sociodemographic variables: (1) social class (nonmanual/manual); (2) educational level (highest qualification attained: no qualifications, educated to the age of 16 years, educated to the age of 18 years, and educated to degree level; further collapsed into lower and higher); (3) presence of major depressive disorder (MDD) (yes/no) [26]; and (4) report of working night shift (yes/no).

2.3.2. Follow-up three or four health questionnaires

Other sociodemographic variables included on third and fourth follow-up health questionnaires were: (1) working status (not working, working $\leqslant$35 h/week, working >35 h/week); (2) marital status (single, married, other); (3) self-reported general health (excellent, very good, good, fair, poor); (4) self-reported preexisting health problems (yes/no; yes is any of the three: myocardial infarction, stroke, or cancer); and (5) coffee intake ($\leqslant$1 cup/day or >1 cup/day).

2.4. Analysis

Comparisons between TIB and sleep duration on their sociodemographic correlations and interrelationships with sleep quality were performed using data from 8480 participants who completed the sleep questions on both the EPAQ2-3HC and HLEQ2. TIB was derived from the differences between rise time and bedtime, and a weighted mean measure was calculated as 5/7*(TIB on a weekday)+2/7*(TIB on a weekend day). Sleep proportion was defined by the ratio of nighttime sleep duration and TIB. A sleep duration (or TIB) of longer than 14 h or less than 3 h was considered abnormal, and thereby was coded as missing values (n = 27). A sleep proportion of more than one also was disregarded (n = 319).

The sociodemographic associations of each sleep variable were examined by both univariate and multivariate analyses. Distributions of TIB, sleep duration, and sleep proportion were specifically picked up to clarify the overall sleep time. Interrelationships between measures of sleep quantity and sleep quality were then explored. The comparisons of normally distributed exposure variables were based on t tests for two groups and analysis of variance for three or more groups. The Wilcoxon rank sum test or the Kruskal–Wallis test was used for the ordinal variable (sleep proportion). Categorical variables were compared by Pearson product moment correlation χ^2 tests. All statistical tests were two sided. Analyses were implemented in STATA version 12.0.

3. Results

3.1. Sleep timing: TIB

The average bedtime and rise time on weekdays was 22:41 pm and 7:17 am, respectively. On the weekend, individuals reported going to bed 12 min later (22:53 pm) but getting up 27 min later (7:44 am). This difference led to a TIB of 8 h and 36 min and 8 h and 51 min on weekdays and weekends, respectively. Supplementary Table 1 shows the distributions of the weekday and weekend bedtime and rise times. This Table also shows that older individuals spent longer in bed than younger individuals on weekdays, though the differences for weekends were smaller. Those who were working or worked for more hours spent much less TIB on weekdays; they also got up earlier but went to bed at similar times. However, these individuals tended to catch up on weekends by getting up more than 1 h later than they did on weekdays.

3.2. Sleep difficulties

Sleep difficulties more often were reported by women than men. There were 63.3% of who men reported never experiencing difficulty falling asleep vs 39.6% for women. Early awakening was