Sleep Medicine 15 (2014) 556–564

Contents lists available at ScienceDirect

Sleep Medicine

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

Original Article

Association between sleep and residential environments in the summertime in Japan

Momoko Kayaba [a,*], Tomohiko Ihara [b], Hiroyuki Kusaka [c], Satoru Iizuka [d], Kenji Miyamoto [e], Yasushi Honda [f]

[a] University of Tsukuba, Graduate School of Comprehensive Human Sciences, Doctoral Program in Human Care Science, Japan
[b] The University of Tokyo, Graduate School of Frontier Sciences, Department of Environment Systems, Japan
[c] University of Tsukuba, Center for Computational Sciences, Japan
[d] Nagoya University, Graduate School of Environmental Studies, Department of Environmental Engineering and Architecture, Japan
[e] Planning Department, Tajimi City, Japan
[f] University of Tsukuba, Faculty of Health and Sports Sciences, Japan

ARTICLE INFO

Article history:
Received 10 June 2013
Accepted 16 November 2013
Available online 19 February 2014

Keywords:
Sleep
Environment
Air conditioner
Pittsburgh Sleep Quality Index
Summertime
Questionnaire

ABSTRACT

Objectives: We aimed to identify the effect of environmental factors on sleep in the summertime in Japan.
Methods: A self-reported questionnaire survey was conducted in Japan. Age of participants ranged from 20 to 70 years.
Results: The mean Pittsburgh Sleep Quality Index (PSQI) score was 4.9 (±2.7), and 123 (35.0%) participants had scores of >5. According to the results of multivariate logistic regression analysis, the adjusted odds ratio (aOR) for PSQI scores of >5 without installation of air conditioner was 1.8 (95% confidence interval [CI], 1.0–3.3; $P < .05$), use of a light bulb was 3.7 (95% CI, 1.1–12.6; $P < .05$), and noise was 2.1 (95% CI, 1.1–4.1; $P < .05$) after controlling for several confounding variables. Difficulty initiating sleep (DIS) was associated with installation of an air conditioner (1 [reference] to 3 [aOR, 2.5 {95% CI, 1.2–5.1}] and 4 [aOR, 2.8 {95% CI, 1.1–7.1}]) and noise (1 [reference] to 3 [aOR, 2.4 {95% CI, 1.0–5.9}] and 4 [aOR, 8.8 {95% CI, 3.1–25.0}]). Difficulty maintaining sleep (DMS) was associated with installation of a fan (1 [reference] to 2 [aOR, 0.4 {95% CI, 0.2–0.8}] and noise (1 [reference] to 3 [aOR, 2.3 {95% CI, 1.0–5.3}]) after controlling for several confounding variables.
Conclusions: Our finding using analysis of the association between residential environments and subjective sleep statuses, which determined that the installation of an air conditioner and lighting equipment might affect sleep, may be useful to discuss sleep environments and improve sleep quality.

1. Introduction

The maximum temperature and the average temperature have been rising worldwide with the progress of global warming [1]. According to the Japan Meteorological Agency, Japan's annual average temperature has shown a 1.15 °C increase in the last 100 years, and the number of days when the temperature was high also has increased since the 1990s [2]. The number of sultry nights when the temperature does not fall below 25 °C outdoors also has been increasing year by year, and it may cause heat-related sleep disorders in addition to other serious health problems such as heat stroke [3].

There have been several elderly men and women who experienced heat disorders in their bedrooms and it has been postulated that their bedrooms may not be safe and comfortable for sleep [4]. There are some sleep experimental studies on the association between sleep quality and ambient temperature which suggest that ambient temperature affects sleep architectures [5–7]. Okamoto-Mizuno et al. [7] reported that conditions under 35 °C caused an increase in awakening and a decrease in sleep efficiency and slow-wave sleep compared to conditions under 29 °C. A previous survey on the sleep environment among elderly individuals in Tokyo, Japan, found that many slept without the use of an air conditioner most of the time in summer, as they believed that the nighttime use of air conditioning was bad for their health [8], even though sultry nights occurred on over 50 days in Tokyo in 2010 [9]. In another study, it was reported that 88% of indoor heat stroke patients did not use an air conditioner, and 50% did not even use

* Corresponding author. Tel./fax: +81 29 853 3255.
E-mail address: momoko.kayaba@gmail.com (M. Kayaba).

http://dx.doi.org/10.1016/j.sleep.2013.11.784
1389-9457/

a fan or open the windows [10]. Because of these circumstances, the risk for having a sleep disorder due to heat exposure might be high in the summertime in Japan.

The light environment also is important for sleep. Nocturnal light exposure to bright lights and short wavelength lights induces suppression of melatonin secretion and delays the circadian rhythm [11–13]. During the last decades, the opportunity for exposure to those lights has been increasing with products including short wavelength components becoming widespread as well as with increasing access to 24-h supermarkets and convenience stores where high intensity lighting is used all night.

It may be possible to prevent sleep disorders by improving the inside house environment (i.e., by the installation of cooling devices and changing illumination devices). Thus we conducted our study in one of the hottest places in Japan to identify risk factors including residential environments for sleep disorders in the summertime.

2. Materials and methods

2.1. Study area and subjects

We conducted the survey in Tajimi City, Gifu prefecture, Japan (Fig. 1). The target area recorded 40.9 °C in 2007, which is the highest temperature in recorded history in Japan, making it one of the hottest places in Japan. One thousand individuals aged 20 years or older were selected by random sampling from the basic resident register and self-reported questionnaires were distributed to the individuals by mail, asking them to reply by August 2012.

2.2. Measures

The questionnaire contained sociodemographic characteristics, including age [14–19], gender [15,18,20,21], working status [15,17,18], and marital status [15,18,22,23]; lifestyle, including alcohol consumption [19,24–26], smoking [27,28], exercise [17,25,29], and napping [30]; psychologic and health conditions, including perceived health status [17,20,31], life satisfaction [17], psychologic stress [17], and ability to cope with stress [17]; residential environment; and sleep status.

Variables about residential environment were: type of housing (detached or apartment); bedroom setup (bedroom only for sleeping or bed cum sitting room) and its direction; installation of cooling device (air conditioner, fan, or nothing); how the participant copes with heat during sleep (use of cooling device, open windows, use of cooling items [i.e., ice pillow, nothing]); type of bed (bed or futon); sleeping with someone in the same room or not; noises often heard in the night; types of curtain; use and color (i.e., white, orange) of lighting in the evening.

To assess sleep quality and disturbances in the last month, we used the Pittsburgh Sleep Quality Index (PSQI) Japanese version [32]. The PSQI has 18 individual items and generates 7 component scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction). The PSQI score ranges from 0 to 21, and a score of >5 indicates that a subject is having severe difficulties in at least two areas or moderate difficulties in more than three areas [33].

2.3. Statistical analysis

The Mann–Whitney *U* test and Kruskal–Wallis test were used for comparison between variables. Binomial logistic regression analysis was performed to identify risk factors for PSQI scores (below five or over six). Multinomial logistic regression analyses also were performed in which response variables were difficulty initiating sleep (DIS) (Question 5a: "Do you have difficulty falling asleep within 30 min?") and difficulty maintaining sleep (DMS) (Question 5b: "Do you wake up in the middle of the night or early morning?" 1 = not during the past month; 2 = less than once a week; 3 = once or twice a week; 4 = three or more times a week). The degree of risk was represented as adjusted odds ratios (aOR) for age, gender, perceived health status, life satisfaction, psychologic stress, type of bedroom, noise, installation of air conditioner, installation of fan, and type of lighting. Statistical procedures were conducted using SPSS statistics 19.

Ethical approval for our survey was granted by the Institutional Research Ethics Committee of the University of Tsukuba.

3. Results

We received 443 questionnaires from the participants (response rate, 44.3%). There were 351 responses which satisfactorily answered all question items, enabling the calculation of a PSQI score. In comparison to available respondents, the prevalence of unavailable respondents was 26.0% in women and 11.7% in men, and there was a statistically significant gender difference (χ^2 test $P < .001$). Age ($P < .05$) and waking up frequently in the middle of the night or early morning ($P < .05$); getting up frequently to use the bathroom ($P < .001$); feeling pain ($P < .05$); and needing to take medicine to help the participant sleep ($P < .05$) were significantly higher in unavailable respondents than in available respondents (Mann–Whitney *U* tests).

3.1. Characteristics of the respondents

The participants' ages ranged from 20 to 70 years, and the number of men and women was 142 (40.5%) and 209 (59.5%), respectively. Table 1 shows the structure of the population and sample. The number of fulltime workers, part-time workers, and unemployed participants was 152 (43.3%), 78 (22.2%), and 119 (33.9%), respectively. In addition, the number of married participants was 263 (74.9%) and 335 participants (95.4%) lived with their family. Regarding lifestyle, 91 participants (25.9%) reported alcohol consumption, 49 (14.0%) participants reported a smoking habit, 183 (52.1%) participants reported exercising, and 216 (61.5%) participants reported having sufficient leisure time. Regarding psychologic and health conditions, 308 (87.7%) participants reported having an adequate perceived health status, 228 (65.0%) participants reported being satisfied with their life, 196 (55.8%) participants reported having psychologic stress, and 287 (81.8%) participants reported having the ability to cope with stress.

3.2. Residential environment

There were 316 (90%) participants who reported living in a detached house and 34 (9.7%) participants reported living in apartment housing. The most common direction of bedrooms was facing south 187 (53.3%), followed by facing east ($n = 64$ [18.2%]), facing north ($n = 41$ [11.7%]), and facing west ($n = 34$ [9.7%]). There were 241 (68.7%) of participants who had a bedroom just for sleeping and 102 (29.1%) who had a bed cum sitting room. Regarding installation of a cooling device in the bedroom, 244 (69.5%) participants had an air conditioner, 235 (67.0%) participants had a fan, and 21 (6.0%) participants had neither. To cope with the heat, 295 (84.0%) participants used an air conditioner or fan, 212 (60.4%) participants opened their windows, 51 (14.5%) participants used cooling items, and 5 (1.4%) did nothing (multiple responses). Regarding type of bed, 180 (51.3%) participants slept on a futon and 166 (47.3%) participants slept in a bed. In addition, 195 (55.6%) participants slept with someone in the same bedroom.