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Citation	Sleep and Biological Rhythms. 2023, 22, p. 33-40
Version Type	AM
URL	https://hdl.handle.net/11094/92419
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**PREVALENCE OF EXCESSIVE DAYTIME SLEEPINESS AND ITS ASSOCIATION
WITH DAILY LIFE FACTORS IN JAPANESE FIRST-YEAR UNIVERSITY STUDENTS**

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24 **Abstract**

25 **Purpose:** As lifestyles have shifted to favor nighttime activities, daytime sleepiness and
26 sleep-related problems have become increasingly common in Japan. Excessive
27 daytime sleepiness (EDS) is an adverse consequence of sleep loss and an important
28 public health concern. EDS may cause academic difficulties, behavioral abnormalities,
29 and psychological dysfunction; therefore, it is a particularly important issue among
30 university students. We conducted a cross-sectional study to investigate the
31 prevalence of EDS and its associated lifestyle factors among Japanese university
32 students.

33 **Methods:** A questionnaire was completed by 1,470 first-year university students, aged
34 19.0 (\pm 1.0) years. Using the questionnaire, we collected information on 1)
35 demographic variables, 2) lifestyle variables, and 3) sleep habits and daytime
36 sleepiness. Daytime sleepiness was measured using the Japanese version of the
37 Epworth Sleepiness Scale, a frequently used subjective scale for assessing sleepiness.

38 **Results:** The overall prevalence of EDS was 57% (53% in men and 61% in women).
39 Multivariate logistic regression analysis revealed that the following factors were
40 associated with EDS: female sex, exercise habits, long commuting times, later wake-up
41 times, and shorter sleep duration.

42 **Conclusions:** Given that more than 50% of first-year university students reported
43 having EDS, interventions should be considered to decrease its risk, including
44 educational programs that provide strategies to extend sleep duration and delay wake-
45 up time. Such strategies may also be valuable for students with other potential risk
46 factors, such as exercise habits or long commute times, that are associated with EDS.

Keywords: excessive daytime sleepiness, Japanese university students, lifestyle,
logistic regression analysis

Background

In developed countries, the lifestyles of people, particularly those of the younger generation, have recently been disrupted. As lifestyles have shifted to favor nighttime activities, daytime sleepiness and sleep-related problems have become serious issues in Japan [1, 2]. Previous studies have revealed that Japanese sleep duration is the shortest in the world [3], and this finding is supported by more recent data from the Organization for Economic Co-operation and Development [4].

Insufficient sleep decreases daily activity levels and adversely affects mental health, while short sleep duration is a risk factor for poor health perception and persistent psychological distress [5, 6]. Excessive daytime sleepiness (EDS) is a consequence of insufficient sleep and has become an important public health issue in modern society [7]. Individuals with EDS are at risk of motor vehicle- and work-related incidents. Along with sleep disorders and poor sleep quality, EDS is associated with decreased academic motivation and self-efficacy [8].

It is likely that EDS is of particular importance to university students who experience substantial lifestyle changes upon entering university. These include having variable class start times, living alone for the first time, feeling the need to apply to part-time jobs while accomplishing study requirements, and having limited sleep opportunities because of extracurricular activities. These lifestyle changes cause psychological and physical stress for these individuals, particularly for first-year students. Consequently,

sleep disturbances may occur during this period. Buchanan et al. [9] have suggested that university students are a special group of people undergoing a critical period of transition from adolescence to adulthood, which can be one of the most stressful times in the life of a person.

Difficulties in falling asleep and maintaining sleep are common complaints among university students [10, 11]. There are many potential reasons for this, including changes in social behaviors in the university setting. For example, a previous study has indicated that a late wake-up time, short sleep duration, and fitful sleep in university students were significantly associated with insomnia [10]. The factors physical activity, physical fitness, and sleep are critically interrelated; thus, they should be considered together when investigating the sleep quality, academic performance, and mental health of university students [12, 13].

Given these issues, we conducted a cross-sectional study to investigate the prevalence of EDS and its associated lifestyle factors among Japanese first-year university students.

Materials and methods

This cross-sectional study was conducted from June 2017 to November 2019, with approval from the ethics committee of Osaka University (approval number: E20-20131016).

Participants

Under the educational system of Japan, most universities offer two semesters. Each semester begins in early April and late September or early October. The study was conducted 6–8 weeks after the beginning of each semester. The participants were first-

95 year university students. All participants were taking a first-year liberal arts class.
96 During this class, they received a detailed verbal explanation of the study from the
97 teaching personnel. After being fully informed of the nature of the study and its
98 protocol, participants provided written informed consent. A questionnaire was
99 administered to 1,525 Japanese first-year university students. The questionnaire
100 included items on demographic variables, lifestyle variables, and sleep habits and
101 daytime sleepiness.

102 **Questionnaire**

103 **Demographic and lifestyle variables**

104 Demographic and lifestyle variables were assessed using a self-administered
105 questionnaire designed by the authors (Appendix 1). The question items inquired about
106 the name, sex, age, living situation, exercise habits, and commuting time of each
107 student. For exercise habits, participants were asked whether they exercised regularly
108 and, if so, what type of exercise and how many days per week were spent with at least
109 30 min per session. Those who exercised more than twice a week were defined as
110 participating in “regular exercise” according to the definition provided by the Japanese
111 Ministry of Health, Labor, and Welfare.

112 **Sleep habits and daytime sleepiness**

113 Sleep habits, such as bedtime, wake-up time, and sleep duration, were assessed using
114 questions that inquired about the behaviors of the participants during the past month.
115 Daytime sleepiness was measured using the Japanese version of the Epworth
116 Sleepiness Scale (JESS) [14]. This scale is widely accepted and used as a screening
117 tool for obstructive sleep apnea [14, 15]. The JESS scores range from 0 to 24, with

higher scores indicating higher levels of sleepiness than lower scores. In this study, JESS scores ≥ 11 were defined as EDS.

Statistical analysis

Logistic regression analyses were performed to examine the associations among EDS, demographic variables, lifestyle variables, and sleep habits. The odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated using logistic regression analyses. First, univariate analysis was performed to detect the association of EDS with each of the variables, and the variables were then analyzed using the forward selection stepwise procedure (with a p value > 0.1 set for exclusion). Next, multiple logistic regression analysis was performed to adjust for the confounding effects of other factors. Based on the results of previous studies, we determined that sleep indicators were essential for the logistic regression analysis model because they were closely correlated with EDS. All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Data are shown as mean \pm standard deviation, and statistical significance was set at a p value < 0.05 .

Results

A total of 1,525 participants accomplished the questionnaire. Responses from 55 participants were excluded because of incompleteness; therefore, the data from the remaining 1,470 questionnaires were used for analyses (96.4%). These 1,470 questionnaires consisted of 493 (33.5%) and 977 (66.5%) in the first and the second semester, respectively.

Table 1 shows the demographic variables, lifestyle factors, and sleep habits of the participants. The overall prevalence of EDS was 57% (53% in men and 61% in women). Table 2 shows the results of the multivariate logistic regression analysis used to estimate the association among EDS, demographic and lifestyle variables, and sleep habits. Variables identified as factors associated with EDS included female sex, exercise habits, long commuting times, later wake-up times, and shorter sleep duration.

[Table 1]

Considering demographic and lifestyle variables alone, the risk of EDS was 42% greater in females, 33% greater in those who exercised regularly and 28% greater in those with long commuting times to reach the university. Considering sleep habits alone, the risk of EDS was greater in those who woke up later, 52% and 113% greater in those who woke between 8 AM and 9 AM and after 9 AM, respectively (compared to those who woke before 7 AM), 49% greater in those who slept between 300 to 360 min, and 25% lower in those who slept for 420 min or more (versus those who slept between 360 to 420 min). There was no relationship between bedtime and EDS in the multivariate analyses.

[Table 2]

Discussion

This study showed that more than half of the first-year Japanese university students that accomplished the questionnaire had EDS. This proportion is higher than those reported in most studies that involve university students in other countries, which ranged from 22% to 36% [16-21]. Factors associated with an increased risk of EDS in

Japanese university students included female sex, regular exercise, long commuting times, later wake-up times, and shorter sleep duration.

To the best of our knowledge, this is the first study to assess the prevalence of EDS and its associated risk factors among first-year university students. The overall prevalence of EDS of 57% obtained from Japanese students in the current study was greater than those reported in university students from other countries: 31% in Nepal [16], 36% in Malaysia [17], 22% in Pakistan [18], 31% in Ethiopia [19], 28% in Poland [20], and 24% in the USA [21]. To date, only one study has reported a higher proportion of young adults with EDS (63% of Brazilian medical students) than that in our study [22]. A similarly high rate of EDS as that the present study has been observed in a study involving medical students, which suggested an association with emotional exhaustion [22]. Emotional exhaustion should be evaluated in addition to sleepiness in future studies among first-year students in Japan.

Chronic sleep loss is one of the most recognized causes of EDS [23]. This may be especially true in Japan, as several reports have shown that the sleep duration of the Japanese population is the shortest worldwide [3, 4]. In the present study of Japanese university students, compared to students who slept for 6–7 h, those who slept for 5–6 h had a 64% increased risk of EDS. However, the risk of EDS was not notably increased in those who slept for less than 5 h, which is most likely due to the decreased statistical power associated with the relatively small number of students in this category (70 out of 1,470). The significance of the association between sleep duration and EDS was also evident in the finding that students who slept for more than 7 h had a 25% decreased risk of EDS.

Waking time, but not bedtime, was associated with EDS among Japanese students. Specifically, compared to that in students who woke before 7 AM, the risk of EDS was

increased by 52% in those who woke between 8 AM and 9 AM, and more than doubled in those who woke after 9 AM. The reasons for these relationships are not clear but may be related to irregular sleep habits, which are common among students and known to be associated with EDS [24].

In the current study, students who participated in regular exercise (defined as at least twice per week for at least 30 minutes per session) had an increased risk of EDS. This finding contrasts with the perception that exercise is important for good sleep [25, 26]. However, previous studies focused on the quality of nocturnal sleep rather than the daytime manifestations of inadequate sleep, such as EDS. The findings reported in our study are consistent with those in a report on Japanese high school students, where EDS and falling asleep during classes occurred more frequently in students who belonged to an extracurricular athletic club [27]. Similarly, our previous study has shown that increased physical activity due to a part-time job and/or regular exercise habits was associated with increased daytime sleepiness [28]. It is possible that the students who participated in regular exercise did so at the expense of sleep duration, although additional data would need to be collected to confirm this theory.

Long commuting times were also found to be associated with EDS in the current study. A long commute to the university likely requires earlier waking times and leads to decreased sleep opportunities. Such commuting requirements are worth considering in the context of the sleep and mental health of students, given the finding of Villa-González et al. [29] that long commuting times are stressful for young people. Further studies are required to confirm the relationship between EDS and longer commuting times.

The limitations of this study include generalizability and interpretation of the results. Because of its cross-sectional design, we were unable to determine the exact causes

of the various relationships that were established in our study. Further longitudinal studies are required to analyze the causal relationships between EDS and lifestyle risk factors.

In conclusion, this study showed a very high prevalence of EDS (57 %) among Japanese first-year university students (53% in men and 61% in women). Several factors associated with an increased risk of EDS are amenable to interventions that could potentially decrease EDS, including those aimed at increasing sleep duration and enabling regular exercise participation that does not negatively impact sleep opportunities.

[Appendix1]

Declarations

- Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee of Osaka University (approval number: E20-20131016). All participants provided written informed consent to take part in the study.

- Consent for publication

Not applicable.

- Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available because the Ethical Guidelines for Epidemiological Research by the Japanese Government prohibit researchers from providing their research data to other third-party individuals but are available from the corresponding author on reasonable request.

- Competing interests

The authors declare that they have no competing interests.

- Funding

This study was supported by JSPS KAKENHI, grant number 18K10925.

- Authors' contributions

HS and PE wrote the main manuscript text and HS, MA and KM revising the discussion section critically for important intellectual content. All authors reviewed and approved the final version of the manuscript.

- Acknowledgements

The authors gratefully acknowledge all the university students who participated in the study and teaching staff at the universities who contributed to data collection.

- Authors' information (optional)

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