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1 **PREVALENCE OF EXCESSIVE DAYTIME SLEEPINESS AND ITS ASSOCIATION**
2 **WITH DAILY LIFE FACTORS IN JAPANESE FIRST-YEAR UNIVERSITY STUDENTS**

3

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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.

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

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51 **Background**

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

58 Insufficient sleep decreases daily activity levels and adversely affects mental health,
59 while short sleep duration is a risk factor for poor health perception and persistent
60 psychological distress [5, 6]. Excessive daytime sleepiness (EDS) is a consequence of
61 insufficient sleep and has become an important public health issue in modern society
62 [7]. Individuals with EDS are at risk of motor vehicle- and work-related incidents. Along
63 with sleep disorders and poor sleep quality, EDS is associated with decreased
64 academic motivation and self-efficacy [8].

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

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

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

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

86

87 **Materials and methods**

88 This cross-sectional study was conducted from June 2017 to November 2019, with
89 approval from the ethics committee of Osaka University (approval number: E20-
90 20131016).

91 **Participants**

92 Under the educational system of Japan, most universities offer two semesters. Each
93 semester begins in early April and late September or early October. The study was
94 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

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

120

121 **Statistical analysis**

122 Logistic regression analyses were performed to examine the associations among EDS,
123 demographic variables, lifestyle variables, and sleep habits. The odds ratios (ORs) and
124 95% confidence intervals (95% CIs) were calculated using logistic regression analyses.
125 First, univariate analysis was performed to detect the association of EDS with each of
126 the variables, and the variables were then analyzed using the forward selection
127 stepwise procedure (with a p value > 0.1 set for exclusion). Next, multiple logistic
128 regression analysis was performed to adjust for the confounding effects of other
129 factors. Based on the results of previous studies, we determined that sleep indicators
130 were essential for the logistic regression analysis model because they were closely
131 correlated with EDS. All statistical analyses were performed using SPSS version 25.0
132 (IBM Corp., Armonk, NY, USA). Data are shown as mean \pm standard deviation, and
133 statistical significance was set at a p value < 0.05 .

134

135 **Results**

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

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

147 **[Table 1]**

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

157 **[Table 2]**

158

159 **Discussion**

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

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

166 To the best of our knowledge, this is the first study to assess the prevalence of EDS
167 and its associated risk factors among first-year university students. The overall
168 prevalence of EDS of 57% obtained from Japanese students in the current study was
169 greater than those reported in university students from other countries: 31% in Nepal
170 [16], 36% in Malaysia [17], 22% in Pakistan [18], 31% in Ethiopia [19], 28% in Poland
171 [20], and 24% in the USA [21]. To date, only one study has reported a higher
172 proportion of young adults with EDS (63% of Brazilian medical students) than that in
173 our study [22]. A similarly high rate of EDS as that the present study has been
174 observed in a study involving medical students, which suggested an association with
175 emotional exhaustion [22]. Emotional exhaustion should be evaluated in addition to
176 sleepiness in future studies among first-year students in Japan.

177 Chronic sleep loss is one of the most recognized causes of EDS [23]. This may be
178 especially true in Japan, as several reports have shown that the sleep duration of the
179 Japanese population is the shortest worldwide [3, 4]. In the present study of Japanese
180 university students, compared to students who slept for 6–7 h, those who slept for 5–6
181 h had a 64% increased risk of EDS. However, the risk of EDS was not notably
182 increased in those who slept for less than 5 h, which is most likely due to the
183 decreased statistical power associated with the relatively small number of students in
184 this category (70 out of 1,470). The significance of the association between sleep
185 duration and EDS was also evident in the finding that students who slept for more than
186 7 h had a 25% decreased risk of EDS.

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

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

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

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

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

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

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

223

224 **[Appendix1]**

225

226 **Declarations**

227

228 • Ethics approval and consent to participate

229 This study was conducted in accordance with the Declaration of Helsinki and was
230 approved by the ethics committee of Osaka University (approval number: E20-
231 20131016). All participants provided written informed consent to take part in the study.

232 • Consent for publication

233 Not applicable.

234 • Availability of data and materials

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

240 • Competing interests

241 The authors declare that they have no competing interests.

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244 • Authors' contributions

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

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251 • Authors' information (optional)

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