

country to date. Therefore, in this study, we examined nPSM practices employed by the Japanese by examining data from an authentic, substantially large, representative sample of the Japanese population. We also analyzed the associations between each nPSM practice and EDS in order to identify those nPSM practices reported to be most effective.

## METHODS

### Selection of Participants

The present study was part of a national survey (Active Survey of Health and Welfare) organized by the Statistics and Information Department of the Ministry of Health, Labour and Welfare of Japan. This national survey was planned in order to collect basic information on health and welfare, and included questions concerning symptoms of depression and sleep. The survey was conducted through health centers across Japan.

The survey was administered to subjects from 300 census precincts in Japan selected randomly from among some 824,000 precincts, which had been apportioned for equal population size. Each census precinct was numbered from north to south, and 300 precincts were selected by choosing precinct numbers at certain intervals. As a result, the sample represented the entire country. A health center with jurisdiction for each precinct was designated. Investigators sent by these health centers visited all households to distribute the questionnaires, and collected them a few days later. The survey targets were all individuals aged 12 years or older in the 300 sampled precincts. The survey was conducted simultaneously throughout Japan in June 2000. Oral informed consent was obtained from the participants, and their privacy was protected in accordance with Declaration of Helsinki guidelines.

### Measures

A self-administered questionnaire was devised by 2 of the authors (M.U. and T.O.) together with an appropriate official of the Ministry of Health, Labour and Welfare. The questionnaire comprised 44 items, including items on (1) sociodemographic information such as age, gender, and community size; (2) general health status; (3) physical and psychological complaints; (4) information on mental stress; and (5) sleep habits and sleep problems, as well as (6) the Japanese version of the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D, which is a 20-item inventory designed specifically to assess symptoms of depression in the general population, was used to screen for current depressive states during the one week leading up to the survey. This questionnaire is adequately reliable and valid for use in a general population. The CES-D yields an item score (range, 0–3) and the sum of the 20-item scores (range 0–60). Higher scores indicate increasing severity of depressive symptoms. Although this scale is designed to screen, but not diagnose, major depression, a score  $\geq 16$  is highly suggestive of depressive symptoms. Shima et al. developed the Japanese version of the CES-D, examined its reliability and validity, and recommended that the cut-off point be set at 16, as is the case for the American version of the CES-D.<sup>12</sup>

The following questions regarding sleep experienced during the previous month (listed here followed by the variables they targeted) were embedded in the questionnaire:

Question: Did you indulge in any of the following practices in the past month in order to sleep efficiently?

- (1) I consumed alcoholic beverages. [1 = No; 2 = 1-2 times a month; 3 = 1-2 times a week; 4 = 3 or more times a week]
- (2) I used medications such as hypnotic drugs. [1 = No; 2 = 1-2 times a month; 3 = 1-2 times a week, 4 = 3 or more times a week]
- (3) I snacked on food and/or beverages. [1 = No; 2 = Yes]
- (4) I performed light exercise. [1. No, 2. Yes]
- (5) I had a bath. [1. No, 2. Yes]
- (6) I read or listened to music. [1. No, 2. Yes]
- (7) I tried to maintain a regular schedule. [1. No, 2. Yes]

With regard to (1) and (2), participants who consumed alcohol and who used medications one or more times a week were categorized as participants who “consumed alcohol” and “used medication,” respectively.

With regard to sleep duration, we posed the question, “What was your average sleep duration per night?” Those who answered “less than 6 hours” were categorized as participants with “short sleep duration.”

For subjective sleep insufficiency, participants were asked to respond to the question, “Have you had sufficiently restful sleep?” by selecting one of the following 4 options: “Sufficient,” “Fairly sufficient,” “Rather insufficient,” and “Completely insufficient.” Those who selected the latter 2 options were categorized as participants with “subjective insufficient sleep.”

For excessive daytime sleepiness, we posed the question, “Have you experienced any difficulty in staying awake at times when you should not fall asleep (e.g., while you are driving)?” Those who responded affirmatively were classed as participants with “excessive daytime sleepiness.”

### Statistical Analyses

Questionnaires were returned by 32,729 participants. The Ministry of Health, Labour and Welfare did not publish the number of residences contacted in the target communities, and therefore the return rate could not be calculated. However, the collection rates of similar investigations carried out 3, 4, and 6 years previously were 87.1%, 89.6%, and 87.3%, respectively. It can be assumed that since the present study was performed using similar methods, the collection rate is likely to have been similar to the previous investigations. The Minister of Health, Labour and Welfare granted permission for us to use the survey data. Before analysis, 707 participants who submitted blank answer forms were excluded from the study. Participants under 20 years of age ( $N = 3086$ ) were also excluded since this study was aimed at adults. In addition, participants who had not responded to the questions on gender and/or age were excluded ( $N = 222$ ), as were participants who omitted 6 or more answers on the CES-D ( $N = 4028$ ). Thus, data for a total of 24,686 participants (11,752 men and 12,934 women) were analyzed statistically.

For statistical analysis, the prevalence of each nPSM practice (snacking on food and/or beverages, exercising, having a bath,

reading or listening to music, and maintaining a regular schedule) used as a sleep aid was calculated by gender and by age class. The significance of the categorical data, such as the prevalence of each nPSM strategy used as a sleep aid, was analyzed using the  $\chi^2$  test. Finally, logistic regression analyses were conducted to examine the factors associated with EDS by using 4 models with different adjustment factors. Model 1 was nonadjustable. Model 2 was adjustable, using gender, age class, place of residence, and severity of depression as covariates. In Model 3, short sleep duration and subjective insufficient sleep were added to the covariates of Model 2. In Model 4, consumption of alcohol and use of medication were further added to the covariates of Model 3.

Odds ratios were calculated from the univariate and multivariate logistic regression analyses with 95% confidence intervals. All analyses were performed using SPSS 12.0 for Windows (SPSS Inc., Chicago, IL)

## RESULTS

### Characteristics of the Participants

The demographic characteristics of the total 24,686 participants are shown in Table 1. Although the percentages of the men and women aged 70 years or older are slightly lower than those revealed by the census, the percentages of other groups are similar.

### Prevalence of Non-pharmacological Self-management Practices

The prevalence of each of the 5 nPSM practices classified by gender is shown in Table 2; the prevalence of “hav-

**Table 1**—Demographic Characteristics of Analyzed Subjects in a Sample of the Japanese Adult General Population (N = 24,686)<sup>a</sup>

Data Set	Percentage in Age Group					
	20-29 y	30-39 y	40-49 y	50-59 y	60-69 y	70+ y
Present study						
Male (N = 11,752)	18	18	19	21	15	9
Female (N = 12,934)	18	18	18	20	14	12
Census						
Male	19	18	17	20	15	12
Female	17	16	16	19	15	17

<sup>a</sup>Data for both the present study and the census were obtained in 2000.

ing a bath” was highest among both men (59.0%) and women (64.4%), followed by “maintaining a regular schedule” (men: 49.0%, women: 58.6%), “reading or listening to music” (men: 43.4%, women: 49.4%), “snacking on food and/or beverages” (men: 36.1%, women: 27.9%) and “exercising” (men: 26.2%, women: 29.4%). For all the nPSM practices, age-related differences were identified among both men and women ( $p < 0.001$ ). In particular, the prevalence of maintaining a regular schedule increased with age, with respective prevalence in men and women in their 20s at 35.6% and 46.1% compared with that in men and women in their 70s at 68.1% and 69.8%. In terms of gender-based differences, the prevalence of snacking on food and/or beverages was significantly higher among men than women ( $p < 0.001$ ). However, the prevalences of other nPSM practices were significantly higher among women than men ( $p < 0.001$ ).

**Table 2**—Non-Pharmacological Self-Management by Gender and Age Expressed as Percentage

Age, y	N	Snacking on food and/or beverage, %	Exercising, %	Having a bath, %	Reading or listening to music, %	Maintaining a regular schedule, %
Male						
20-29	2151	35.8	26.1	50.7	55.5	35.6
30-39	2157	36.5	21.0	50.1	41.9	38.3
40-49	2251	39.6	25.2	58.9	37.7	49.1
50-59	2468	40.4	29.4	69.5	40.3	59.3
60-69	1712	29.8	31.8	69.1	39.2	64.3
70+	1013	23.0	27.6	66.4	40.0	68.1
Total	11752	36.1	26.2	59.0	43.4	49.0
Sig.1		$\chi^2 = 69.07^*$	$\chi^2 = 45.84^*$	$\chi^2 = 229.35^*$	$\chi^2 = 141.36^*$	$\chi^2 = 431.76^*$
Female						
20-29	2329	28.8	26.7	56.7	56.5	46.1
30-39	2362	29.3	25.4	55.9	47.0	53.5
40-49	2368	31.4	30.9	69.4	50.0	61.0
50-59	2592	29.2	34.8	74.9	50.0	66.4
60-69	1766	21.1	37.4	68.9	49.7	65.8
70+	1517	20.2	23.3	64.5	35.4	69.8
Total	12934	27.9	29.4	64.4	49.4	58.6
Sig.1		$\chi^2 = 58.69^*$	$\chi^2 = 87.67^*$	$\chi^2 = 220.92^*$	$\chi^2 = 113.49^*$	$\chi^2 = 260.20^*$
Sig.2		$\chi^2 = 127.85^*$	$\chi^2 = 21.77^*$	$\chi^2 = 52.75^*$	$\chi^2 = 60.65^*$	$\chi^2 = 160.15^*$

Sig.1:  $\chi^2$  test, 2 (Each non-pharmacological self-management-Yes or No; Snacking on food and/or beverage, Exercising, Having a bath, Reading or listening to music and Maintaining a regular schedule)  $\times$  6 (age effect; 20-29, 30-39, 40-49, 50-59, 60-69, 70+)

Sig.2:  $\chi^2$  test, 2 (Each non-pharmacological self-management-Yes or No; Snacking on food and/or beverage, Exercising, Having a bath, Reading or listening to music and Maintaining a regular schedule)  $\times$  2 (gender effect; male, female)

\* $p < 0.001$

**Table 3**—Logistic Regression Results for Prediction of Excessive Daytime Sleepiness (EDS) Among the General Adult Population (N = 24,686)

	Prevalence of EDS (%)	Model 1			Model 2			Model 3			Model 4		
		Crude OR	95% CI	P-value	Adjusted OR	95% CI	P-value	Adjusted OR	95% CI	P-value	Adjusted OR	95% CI	P-value
Snacking on food and/or beverage													
No	2.7												
Yes	4.0	1.50	1.26-1.80	< 0.01	1.36	1.11-1.67	< 0.01	1.34	1.09-1.65	0.01	1.42	1.15-1.76	< 0.01
Exercising													
No	3.1												
Yes	3.1	1.00	0.82-1.21	0.96	1.08	0.86-1.37	0.50	1.11	0.88-1.41	0.37	1.15	0.90-1.45	0.26
Having a bath													
No	3.6												
Yes	2.8	0.77	0.65-0.92	< 0.01	0.76	0.61-0.94	0.01	0.75	0.61-0.93	0.01	0.76	0.61-0.95	0.01
Reading or listening to music													
No	2.9												
Yes	3.4	1.20	1.01-1.42	0.04	1.17	0.95-1.44	0.13	1.13	0.92-1.39	0.24	1.12	0.91-1.38	0.28
Maintaining a regular schedule													
No	4.0												
Yes	2.2	0.54	0.45-0.64	< 0.01	0.62	0.51-0.77	< 0.01	0.71	0.57-0.88	< 0.01	0.71	0.57-0.88	< 0.01

Other Adjustment factors

Model 1: non-adjustment.

Model 2: sex, age, size of community and depression status.

Model 3: sex, age, size of community, depressive status, short sleep duration and subjective insufficient sleep.

Model 4: sex, age, size of community, depressive status, short sleep duration, subjective insufficient sleep, alcohol use and hypnotic medication use.

OR: odds ratio

CI: confidence interval

## Logistic Regression Analyses

The results of the logistic regression analyses are shown in Table 3. In Model 1, snacking on food and/or beverages and reading or listening to music showed significant positive associations with EDS. In contrast, having a bath and maintaining a regular schedule showed significant negative associations with EDS. In Models 2-4, reading or listening to music showed no association with EDS, and snacking on food and/or beverages showed a positive association, while having a bath and maintaining a regular schedule showed negative associations with EDS.

## DISCUSSION

In the present study, we examined the prevalence of nPSM practices to obtain good sleep and the associations between each nPSM practice and EDS. This study was of epidemiological significance in that the participants were randomly selected from a nationwide population and the sample size was large. In effect, the age structure of the participants (shown in Table 1) was very close to that found in the national census, which had been conducted during the same period. This indicates that the study population represents the general population of Japan. To our knowledge, no similar epidemiological study has been reported to date.

Among the nPSM practices examined in this study, the prevalence of having a bath was highest among both men and women, followed by maintaining a regular schedule. In the U.S., Ancoli-Israel et al. found that the prevalence of exercising was highest (75%) among three nPSM practices in subjects without sleep disturbance, followed by reading (9%) and relaxing.<sup>9</sup> The survey of Morin et al. of the general population in Canada demonstrated that among reading, receiving acupuncture, get-

ting a massage, relaxing, and listening to music, the prevalence of reading was highest (32.5%), followed by listening to music (25.2%).<sup>11</sup> In the present study, exercising and reading were included among the choices of nPSM practices, although the prevalence of exercising (approximately 30%) was the lowest among the 5 practices. Exercising and reading were actively adopted as self-management practices for sleeping by participants in studies conducted outside Japan, and thus the selection of self-management practices for sleep appear to differ across countries. The practice of having a bath, the prevalence of which was the highest in the present study, was not an identified practice in the previous studies outside Japan. This may be attributable to the unique habit of the Japanese taking a nightly hot bath.

In the present study, the prevalence of maintaining a regular schedule increased with age, the highest prevalence being evident among participants in their 70s. This result coincides with those of previous studies conducted in the US.<sup>13,14</sup> It is inferred that with age, people tend to become more health conscious and prefer a good sleep at night and lively daytime activities.

In this study, we attempted to classify the examined nPSM practices into favorable and unfavorable types by calculating the odds ratios with regard to EDS. Given our findings, we propose the theory that by employing an nPSM practice showing a statistically and significantly low odds ratio with regard to EDS, a night-sleep problem could be resolved, in turn leading to a decrease in EDS. Moreover, we considered that such a practice would be a favorable one. Conversely, we considered an nPSM practice showing a significantly high odds ratio with regard to EDS could lead to a higher possibility of EDS, and hence would be an unfavorable nPSM. However, there may be cases where a person with a sleep disorder might employ an nPSM practice to prevent EDS, but not benefit from it. In such a scenario, the sleep disorder would be a confounding factor

affecting the association between the nPSM practice and EDS. Furthermore, there may be other confounding factors besides sleep. Therefore, in this study, several logistic regression models were set up for inputting various covariates, including sleep duration and subjective sleep insufficiency, to adjust for the possible confounding factors. Despite this attempt, causal relationships can not be thoroughly discussed because this study was cross-sectional; however, since this study was conducted with an authentic, representative sample of the Japanese population, the results obtained may be beneficial for the design of future public health measures for achieving good sleep.

In relation to the above-mentioned theory, the results indicate that having a bath and maintaining a regular schedule are favorable nPSM practices, and that snacking on food and/or beverages is an unfavorable nPSM practice. These results are supported by those of other previous physiological studies. It has been reported that having a bath not only leads to an increase in body temperature, but also stimulates the thermoregulatory center, which promotes the lowering of body temperature and induces slow wave sleep.<sup>15,16</sup> Having a bath is also reported to shorten significantly subjective and objective sleep latency and wake time after sleep onset, and increase the duration of slow wave sleep.<sup>17-19</sup> A previous study revealed that greater distal vasodilatation, as indicated by the distal-proximal skin temperature gradient, could predict shorter sleep latency in healthy subjects.<sup>20</sup> Moreover, Pache et al. have reported that patients with vasospastic syndrome suffer prolonged sleep onset latency due to impaired capacity for distal vasodilation.<sup>21,22</sup> Furthermore, it has been reported that subjective sleep sufficiency is better in individuals when they take a bath before going to bed than when they do not.<sup>19</sup> Based on the results of these physiological studies, it is inferred that "having a bath" is a favorable nPSM practice that could improve the quality of night sleep and reduce EDS.

Although it is difficult to define maintaining a regular schedule, this practice would include waking up at a regular time in the morning, performing specific activities at specific times, and not staying up late at night. For an individual who has adopted this practice, the sleep-wakefulness rhythm related to daytime activities and rest at night is maintained. In addition to this sleep-wakefulness rhythm, biodynamic rhythms such as autonomic rhythms (including periodic changes in body temperature and blood pressure) and endocrinological rhythms (including the melatonin and cortisol secretory cycles) are maintained in an orderly manner.<sup>23</sup> However, when a person's schedule is irregular, these biodynamic rhythms are disrupted, ultimately affecting sleep.<sup>13,24-26</sup> Monk et al. reported that the quality of sleep was lower in individuals with irregular schedules than in those with regular schedules.<sup>13,24</sup> Manber et al. also reported that subjects who maintained a regular daily rhythm for 4 weeks showed improvement in their night sleep and significant reduction of subjective daytime sleepiness, as compared with controls who had irregular rhythms.<sup>25</sup> The results of these previous studies are in accord with those of the present study, in which the odds ratio of maintaining a regular schedule with regard to EDS was low. Hence, these previous results support our theory that maintaining a regular schedule is a favorable nPSM practice.

In this study, we noted a significantly high odds ratio for snacking on food and/or beverages with regard to EDS, sug-

gesting that it was an unfavorable nPSM practice. A previous epidemiological study reported that irregular eating habits and subjective sleep insufficiency were closely associated,<sup>27</sup> and eating before going to bed was reported elsewhere to activate the digestive system and impede the body and brain from preparing to have a good rest; thus, this practice eventually hampered good sleep.<sup>28</sup> Therefore, the practice of snacking on food and/or beverages may actually lead to hampered sleep and consequently induce EDS.

The results of the present study provide suggestions on the appropriate self-management practices that should be employed for obtaining good sleep and preventing EDS. Performing such favorable self-management practices is vital for preventing various mental and somatic disorders since sleep disturbance is a risk factor for such disorders. Therefore, the identification of such favorable and unfavorable self-management practices in this study will contribute not only to the prevention of EDS, but also to the planning of public health policies and measures.

This study had a few limitations. First, because the study was cross-sectional, a causal relationship could not be established. A follow-up study will be required to verify the results. Second, excessive sleepiness was evaluated by only one questionnaire item. In our future studies we plan to use epidemiological tools such as the Epworth Sleepiness Scale. Third, all data used were subjective and obtained from a self-administered questionnaire. Because we preferred data accumulation from a larger number of participants nationwide, physiological measurements could not be obtained. However, several studies have reported that self-reported data on sleeping habits coincide with physiological data to a certain extent.<sup>29,30</sup> Fourth, due to the limitation of space on our self-administered questionnaire, we could not adopt the social demographic items of confounding factors such as marital status, education, occupation, and income, and these remain the subject for further study.

To conclude, having a bath and maintaining a regular schedule appear to be favorable nPSM practices for obtaining good sleep, while snacking on food and/or beverages is an unfavorable practice, findings which can contribute to the planning of public health measures with respect to sleep.

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## DISCLOSURE STATEMENT

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# Sleep Findings in Young Adult Patients with Posttraumatic Stress Disorder

Mitsunari Habukawa, Naohisa Uchimura, Masaharu Maeda, Nozomu Kotorii, and Hisao Maeda

**Background:** Laboratory sleep studies in posttraumatic stress disorder (PTSD) have not provided consistent evidence of sleep disturbance, despite apparent sleep complaints. Most of these studies have investigated middle-aged chronic PTSD subjects with a high prevalence of comorbidities such as substance dependence and/or personality disorder.

**Methods:** Ten young adult PTSD patients (aged  $23.4 \pm 6.1$  years) without comorbidities of substance dependence and/or personality disorder underwent 2-night polysomnographic recordings. These sleep measures were compared with those of normal control subjects and were correlated with PTSD symptoms.

**Results:** Posttraumatic stress disorder patients demonstrated significantly poorer sleep, reduced sleep efficiency caused by increased wake time after sleep onset, and increased awakening from rapid eye movement (REM) sleep (REM interruption). We found significant positive correlations between the severity of trauma-related nightmare complaints and the percentage of REM interruption, as well as wake time after sleep onset.

**Conclusions:** The results indicate that trauma-related nightmares are an important factor resulting in increased REM interruptions and wake time after sleep onset in PTSD.

**Key Words:** Increased wake time after sleep onset, posttraumatic stress disorder, REM interruption, sleep disturbance, trauma-related nightmares, young adult sample

Impaired sleep is a common complaint among patients with posttraumatic stress disorder (PTSD). However, laboratory sleep studies of PTSD have not provided consistent evidence of sleep disturbances. Most studies have tested middle-aged chronic PTSD subjects typically decades after the traumatic events, except for a handful of studies that were conducted during the immediate aftermath of trauma (Lavie 2001). There are likely a number of factors affecting sleep when PTSD persists for many years. Possible factors considered to explain the discrepancies of objective findings may include differences of 1) the amount of time since the trauma, 2) the age of subjects, 3) the source of the trauma, 4) the acuity of the trauma, 5) many comorbid psychiatric disorders, 6) comorbidities of substance dependence, and 7) the administration of psychotropic medications.

Therefore, we investigated young adult and drug-naïve or drug-free PTSD patients without comorbidities of substance dependence and/or personality disorders, although we could not exclude patients with concomitant major depressive disorder due to its high prevalence. We tested polysomnographic recordings within 1 to 3.5 years after the trauma in these patients and correlated sleep measures with PTSD symptoms.

## Methods and Materials

Ten PTSD patients were recruited from the inpatient unit and outpatient clinic in the Department of Neuropsychiatry, Kurume University Hospital. The diagnoses of all patients were confirmed

From the Department of Neuropsychiatry, Kurume University School of Medicine, Kurume, Fukuoka, Japan.

Address reprint requests to Mitsunari Habukawa, M.D., Department of Neuropsychiatry, Kurume University School of Medicine, 67 Asahimachi Kurume, Fukuoka, 830-0011 Japan; E-mail: hmitsu@med.kurume-u.ac.jp.

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as PTSD according to the Structured Clinical Interview for DSM-IV (SCID) (American Psychiatric Association 1994) criteria and by exceeding the cutoff value of 50 for the Clinician-Administered PTSD Scale (CAPS) (Blake *et al.* 1995). Subjects with comorbidities of substance dependence and/or personality disorders and those who could not be kept off psychotropic medication for at least 2 weeks prior to this study were excluded. Table 1 shows the background of all PTSD patients. Six of 10 patients had never been treated with any psychotropic medications. Four patients (patients 3, 5, 6, and 8) had been receiving a selective serotonin reuptake inhibitor (SSRI) or benzodiazepines and were required to undergo a washout period of at least 2 weeks.

Control data were obtained from 10 age- and sex-matched healthy subjects. The control subjects were recruited from medical school students and through newspaper advertisements. Their average age was  $24.4 \pm 9.7$  years, which did not significantly differ from that of the PTSD patients. All patients and control subjects were free of physical diseases and other sleep disorders. Written informed consent was obtained from both groups.

All subjects underwent 2 consecutive nights of standard polysomnographic study. They went to bed at their chosen time, and all woke up naturally without an alarm. The records were hand-scored in 20-second epochs according to the criteria of Rechtschaffen and Kales (1968) by a technician blind to the subject's identity.

The extracted sleep measures included indices of sleep initiation and maintenance, sleep architecture, and rapid eye movement (REM) latency, REM interruption (minutes), percentage of REM interruption (%), and REM density. Rapid eye movement periods were determined according to the recently reported procedure (Mellman *et al.* 2002). For each REM period, we determined REM interruptions by summing the intrusive wake times during the REM period and adding the subsequent wake time to the last epoch of REM period before emerging to more than 2 minutes of non-REM sleep. However, if final awakening was derived from the final REM period, the subsequent wake time was not included as REM interruptions. Rapid

**Table 1.** Background of PTSD Subjects

Case	Age (years)	Sex	Nature of Trauma	Time Since Trauma (months)	Concurrent Diagnoses	Trauma-Related Nightmare	Total Score in CAPS
1	18	M	Sea accident	8	MDD, PD	+	96
2	18	M	Sea accident	8	MDD	—	78
3	19	M	Sea accident	21	MDD	+	77
4	25	F	Vehicle crash	3	MDD	+	84
5	36	F	Vehicle crash	40	—	+	83
6	19	F	Vehicle crash	19	MDD	+	107
7	23	M	Vehicle crash	3	—	—	60
8	31	F	Vehicle crash	39	MDD	+	108
9	25	F	Rape survivor	10	MDD, PD	+	66
10	23	M	Fire accident	4	MDD	+	83
Mean	23.4			15.4			84.4
SD	6.1			14.1			17.1

CAPS, Clinician-Administered PTSD Scale; F, female; M, male; MDD, major depressive disorder; PD, panic disorder; PTSD, posttraumatic stress disorder.

eye movement interruption was calculated as the sum of REM interruptions for each REM period and the percentage of REM interruption was defined as  $(\text{REM interruption [min]}/\text{total REM time [min]} + \text{REM interruptions [min]}) \times 100$ . Rapid eye movement density was determined by calculating the percentage of 2-second intervals containing at least one horizontal eye movement.

Sleep measures from the second night in both groups were compared by Mann-Whitney *U* test, with .05 as the level of significance. Furthermore, sleep measures were correlated with the total score and subscale scores in CAPS by Spearman rank correlation, with .05 as the level of significance. Multiplicity controlling experimental-wise *p*-value was not applied, since the correlation analysis was performed in an exploratory manner.

## Results

The average bedtime of the PTSD subjects (11:01 PM) did not significantly differ from that of the control subjects (10:56 PM). Table 2 shows the comparison of sleep data between both groups. Rapid eye movement interruption and the percentage of REM interruption in the PTSD group was significantly increased compared with the control group. The PTSD group demon-

strated significantly reduced sleep efficiency caused by increased wake time after sleep onset. The percentage of slow-wave sleep (SWS) in the PTSD group was significantly decreased compared with the control group. An apnea-hypopnea index in the PTSD group did not significantly differ from the control group (.93 and 1.23 events per hour).

Table 3 shows the correlations between the total score and subscale scores in CAPS and polysomnographic data. There were significant positive correlations between the nightmare score (Criterion B-2) and the percentage of REM interruption, as well as wake time after sleep onset ( $R = .82, p = .0142$  and  $R = .71, p = .0358$ , respectively). There were significant negative correlations between the nightmare score (Criterion B-2) and sleep latency. In addition, there was a significant negative correlation between the avoidance of stimuli (Criterion C) and total sleep time.

## Discussion

The presence of repeated nightmares in PTSD has been hypothesized as a dysfunction of REM sleep mechanisms (Ross *et al.* 1989) and several studies have reported elevated REM sleep phasic events such as greater REM density and motor activity

**Table 2.** Comparison of Sleep Data Between PTSD and Control Groups

Measurement	PTSD Group ( <i>n</i> = 10)		Control Group ( <i>n</i> = 10)		Analysis <i>p</i> Value
	Mean	SD	Mean	SD	
Total Sleep Time (min)	450.3	76.0	466.7	72.4	n.s.
Sleep Efficiency (%)	85.5	2.5	94.9	2.1	.0002
Sleep Latency (min)	25.6	21.0	12.9	7.5	n.s.
Waking Time After Sleep Onset (min)	35.9	19.7	11.1	6.6	.0041
Number of Arousals	22.7	10.1	12.1	7.3	.0280
Stage 1 Sleep (%)	11.6	5.7	6.8	2.8	n.s.
Stage 2 Sleep (%)	52.5	10.2	50.6	8.2	n.s.
Stage 3 and 4 Sleep (%)	7.9	7.4	18.1	7.9	.0041
REM Sleep (%)	20.7	4.6	22.7	4.9	n.s.
REM Latency (min)	88.8	37.3	92.5	46.0	n.s.
REM Density (%)	30.8	9.0	25.6	7.0	n.s.
REM Interruption (min)	12.8	12.1	2.3	1.8	.0354
Percentage of REM Interruptions (%)	10.6	8.1	2.2	1.8	.0247

Analysis, Mann-Whitney *U* Test.

n.s., nonsignificant; PTSD, posttraumatic stress disorder; REM, rapid eye movement.

**Table 3.** Correlations Between the Total Score and Subscale Scores in CAPS and Polysomnographic Data

	TST (min)	SE (%)	SL (min)	WASO (min)	Number Arousals	%SWS (%)	REM Density (%)	Percentage of REM Interruptions (%)
Total Score in CAPS	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Re-experiencing (Criterion B)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Nightmare (Criterion B-2)	n.s.	n.s.	-.78 ( $p = .014$ )	.71 ( $p = .036$ )	n.s.	n.s.	n.s.	.82 ( $p = .014$ )
Avoidance of Stimuli (Criterion C)	-.65 ( $p = .049$ )	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Hyperarousal (Criterion D)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Difficulty Initiating and Maintaining Sleep (Criterion D-1)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

The correlation coefficient and  $p$  value by Spearman's rank correlation are shown.

CAPS, Clinician-Administered PTSD Scale; n.s., nonsignificant; REM, rapid eye movement; SE, sleep efficiency; SL, sleep latency; SWS, slow wave sleep; TST, total sleep time; WASO, wake-time-after-sleep-onset.

during REM sleep in chronic combat-related PTSD patients (Mellman *et al.* 1997; Ross *et al.* 1994a, 1994b).

One of the most notable findings in this study is the observation of REM interruption in PTSD patients, replicating the results of two recent studies (Breslau *et al.* 2004; Mellman *et al.* 2002). Mellman *et al.* (2002) tested prospective polysomnographic recordings in 21 injured subjects within a month of injury and found a more fragmented pattern of REM sleep in subjects developing PTSD by calculating the average duration of continuous REM sleep. Breslau *et al.* (2004) compared polysomnographic measures between 71 lifetime PTSD subjects and 212 control subjects in a community sample and reported increased brief arousal from REM sleep in PTSD subjects by calculating the rate per hour of shifts to stage 1 sleep and waking from REM sleep.

Another noteworthy observation is the significant positive correlation between the severity of trauma-related nightmares and the percentage of REM interruptions, as well as wake time after sleep onset. Adapting the REM sleep measures in the aforementioned studies (Breslau *et al.* 2004; Mellman *et al.* 2002) to our small sample, we could not find significant correlations between the nightmare score and those measures. Therefore, it may be important that the measurements of fragmented REM sleep should include not only intrusive wake times during the REM period but also the subsequent wake time to REM period to understand the relationships between nightmares and REM mechanisms in PTSD.

We do not have sufficient explanation for the negative correlations between trauma-related nightmares and sleep latency, but they may be in part related to prior observations that nightmares are rarely observed in the sleep laboratory (Fisher *et al.* 1970; Hartmann 1984) and the "guarded environment" may facilitate sleep initiation for patients with frequent nightmares. Regarding the negative correlations between the avoidance of stimuli and total sleep time, we speculate that avoidance symptoms may result in decreased going out into the sun and consequently produce reduced total sleep time.

Generally, our PTSD patients demonstrated unequivocal sleep maintenance impairments, along with decreased slow-wave sleep. These results diverge from most previous studies (Hurwitz *et al.* 1998; Klein *et al.* 2002; Ross *et al.* 1994a, 1994b). These different findings may be mainly due to the high sleep efficiency (94.9%) of the control group in this study; however, in fact, we found significant improvements of these sleep measures, along with the amelioration of PTSD symptoms after psychotropic medication (unpublished data).

Our PTSD subjects were young adult and drug-naïve or drug-free PTSD patients without history of substance dependence; therefore, they may be vulnerable to PTSD-related sleep disturbances. They demonstrated no evidence of sleep apnea, although several previous studies tested middle-aged patients with chronic PTSD and reported a high incidence of sleep-related breathing disorders (Krakow *et al.* 2001). These different findings may result from differences of the age of subjects among studies.

Finally, confidence in these findings is tempered by several study limitations. The first limitation is the modest sample size in this study. The second limitation is the high comorbidity (80%) of major depressive disorder (MDD); therefore, we could not determine particularly whether the decreased percentage of SWS was derived from PTSD or concomitant MDD. Other limitations include the differences in the amount of time since the trauma and trauma characteristics. Despite these limitations, our findings suggest that trauma-related nightmares may be an important factor resulting in REM interruptions and wake time after sleep onset in PTSD. Attempts to test these findings under controlled conditions in larger samples may further advance the understanding of the relationship between sleep and PTSD.

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## Bedtime Activities, Sleep Environment, and Sleep/Wake Patterns of Japanese Elementary School Children

Yasunori Oka

*Japan Somnology Center  
Neuropsychiatric Research Institute, Tokyo, Japan*

Shuhei Suzuki

*Department of Developmental Brain Science  
Osaka Medical College, Osaka, Japan*

Yuich Inoue

*Japan Somnology Center  
Neuropsychiatric Research Institute, Tokyo, Japan*

Bedtime activities, sleep environment, and their impact on sleep/wake patterns were assessed in 509 elementary school children (6–12 years of age; 252 males and 257 females). Television viewing, playing video games, and surfing the Internet had negative impact on sleep/wake parameters. Moreover, presence of a television set or video game in the child's bedroom increased their activity before bedtime. Time to return home later than 8 p.m. from after-school activity also had a negative impact on sleep/wake patterns. Health care practitioners should be aware of the potential negative impact of television, video games, and the Internet before bedtime, and also the possibility that late after-school activity can disturb sleep/wake patterns.

Sleep/wake patterns are strongly influenced by sleep habits, and sleep habits are largely influenced by social backgrounds and cultural standards. Therefore,

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Correspondence should be addressed to Yasunori Oka, Japan Somnology Center, Neuropsychiatric Research Institute, 1-17-7-301, Yoyogi, Shibuya-ku, Tokyo, Japan. E-mail: oka@somnology.com

understanding the factors related to sleep habits is important for the prevention of sleep disturbance. The demands of today's "24-hour society" have increased nighttime activity and affected sleep/wake patterns of not only adults but also children. In addition, sleep/wake patterns may also be influenced by usage of video games, cell phones, and the Internet.

A nationwide lifestyle survey in Japan, which has been conducted every 5 years by the Broadcasting Culture Research Institute, showed that mean sleep duration has decreased about 40 minutes on weekdays and about 30 minutes on Sundays within the past 25 years (Broadcasting Culture Research Institute, 2005). This dramatic decrease of sleep duration may largely be attributed to the aforementioned change of lifestyle of the Japanese population.

Children's sleep is affected by changes of lifestyle or the social system. For example, abolition of Saturday classes all over Japan resulted in a more than 40-min increase in mean sleep duration of teenagers on Saturdays (Broadcasting Culture Research Institute, 2005).

Cultural differences could produce a huge difference in sleep habits and sleep/wake parameters (e.g., bedtime, wake time, and sleep duration). Previous reports indicated that sleep duration is shorter among adolescents in Japan than in the United States or European countries (Fukuda & Ishihara, 2001; Tynjala, Kannas, & Valimaa, 1993; Wolfson & Carskadon, 1998). The percentage of 3-year-old children who go to bed later than 10 p.m. was reported to be very high (52%) in Japan compared to that in Australia (4.1%; Japanese Society of Child Health, 2001; see also Armstrong, Quinn, & Dadds, 1994). These reports indicate that children's sleep/wake patterns can vary significantly between cultures.

Decreased nocturnal sleep among children may be due to (a) the sleep/wake pattern of their parents; or (b) the influence of distractions such as television, videos or DVDs, the Internet, video games, and cell phones, which may monopolize the child's attention for a long time. Playing video games and Internet surfing are becoming more prevalent among children. In the United States, 81% of American youths reported playing video games at least once a week, and video game playing could be considered pathological in 8.5% of youths (Martin & Oppenheim, 2007). In Japan, 92% of fifth-grade children have video or portable games (Japanese Parent Teacher Association, 2007). Use of the Internet is also becoming prevalent among adults and children. A recent survey revealed that the percentage of Internet users was higher among teenagers (16%–20%) than the community at large (13%–15%; Broadcasting Culture Research Institute, 2005). Moreover, most cell phones currently available in Japan are equipped with Web browsing and e-mail transmission capability. Use of this device at bedtime may increase the likelihood of disturbing sleep.

Van den Bulck (2004) reported that television viewing, computer game playing, and Internet use significantly affects sleep among adolescents. Although the use of video games, cell phones, and Internet among smaller children has

increased, the usage of these items before bedtime has not yet been correlated with sleep/wake patterns of elementary school children.

The aims of the study were first to identify activities that elementary school children do frequently before bedtime, and second, to elucidate the relationship between these activities and sleep/wake patterns of Japanese children.

## METHOD

### Participants

The study was conducted at a public elementary school located in the suburbs of Osaka, the second-largest city in Japan, in a middle-class residential district. A questionnaire was given to all students ( $N = 582$ ) of the school. Our study included 509 participants (252 males, 257 females), who responded to the questionnaire and answered the questions properly (response rate: 86.9%). The mothers in 484 (95.1%) cases, fathers in 18 (3.5%) cases, both the mother and father in 5 (1.0%) cases, and grandparents in 2 (0.4%) cases completed the questionnaire.

### Measures

The questions asked about bedtime activities, the environment of the bedroom, bedroom sharing, after-school activities, and sleep/wake patterns. Parents were asked to assess their child's sleep and behavior during an average week.

*Bedtime activities.* Bedtime activities including television viewing, playing video games, talking over the telephone, and use of the Internet were examined. Watching videos or DVDs was included with television viewing; playing portable games was combined with playing video games. Use of the Internet included Web browsing and e-mail transmission either on a personal computer or via the Internet on a cell phone. Parents were asked to check if their child engaged in these activities more than twice a week. More than twice weekly (the median frequency of media use found in a previous national study) was chosen as the threshold of activity (Japanese Ministry of Internal Affairs and Communication, 2007).

*Bedroom facilities.* Parents were asked whether items such as television sets, personal computers, cell phones or telephones, and video games or portable games were present or taken into the bedroom.

*Bedroom sharing.* Parents were asked whether the child slept with other members of the family in the same bedroom (room sharing). If so, the member who shared the bedroom was specified.

*After-school activity.* Questions were asked about after-school activities including extra schooling, music lessons (such as piano and violin lessons), and sports lessons.

*Sleep measures.* Questions were asked about bedtime, wake time, and estimated duration of sleep for both average weekdays and weekends.

### Procedure

The questionnaire was given to all the children of the school. Parents or guardians were asked to fill out the questionnaire, which was collected at school. The 1-week survey was conducted in October 2006 when the climate is mild and no major school activities (such as sports events, school festivals, or national holidays) were scheduled, so that we could avoid the influence of seasonal or event-related factors.

### Statistical Analyses

Comparison of categorical variables (sex difference in bedtime activities and bedroom environment, and relationship between bedtime activities and bedroom environment) was made using a chi-square test. Two group comparisons were done using the Mann-Whitney *U* test for continuous variables.

A series of multivariate logistic regression analyses were performed to examine the factors associated with sleep/wake parameters. Six logistic models regarding sleep/wake parameters both on weekdays and weekends as response variables (bedtime after 10 p.m., wake time after 8 a.m., and sleep duration of less than 9 hr) were created. In addition, three logistic models regarding sleep/wake parameters between weekdays and weekends as response variables (later bedtime of more than 1 hr, later wake time of more than 2 hr, and longer sleep duration of more than 2 hr on holidays) were also created. As covariates, sex, school grade (lower grade or higher grade), bedtime activities, bedroom environment, and time to return home from after-school activity were used in common. All variables were initially examined in univariate models, then we performed multivariate logistic regression analysis for all variables that showed a significant correlation in univariate models. Odds ratios (ORs) and their 95% confidence intervals (CIs) are presented to show the association. All the statistical analyses were conducted using SPSS 11.5 for Windows. Significance levels were set at  $p < .05$ .

## RESULTS

## Demographics of the Participants

The number of participants in each school grade was 85 (45 males, 40 females) in the first grade, 96 (50 males, 46 females) in the second grade, 84 (37 males, 47 females) in the third grade, 93 (45 males, 48 females) in the fourth grade, 77 (43 males, 34 females) in the fifth grade, and 74 (32 males, 42 females) in the sixth grade. The children ranged in age from 6 years old (1st-grade student) to 12 years old (6th-grade student), and their mean age was  $9.0 \pm 1.8$  years.

The percentage of children who slept with family members in the same bedroom (room sharing) was 85.3% including 21.8% who slept with siblings, 22.0% who slept with parents, and 40.5% who slept with both siblings and parents. The rate of room sharing decreased with advancing grade (Figure 1).

## Activities Before Bedtime

The percentage of children who watched television before bedtime was 80.9%. As shown in Figure 2, television viewing was the most prevalent bedtime activity, and the rate of television viewing did not vary significantly with school grade. The percentage of children who played video games or portable games before bedtime was 30.6%. Use of the Internet was seen in 7.1% of children, and its rate of use increased with advancing age (Figure 2). Although there was no sex difference in television viewing ( $p = .262$ ), playing video games was

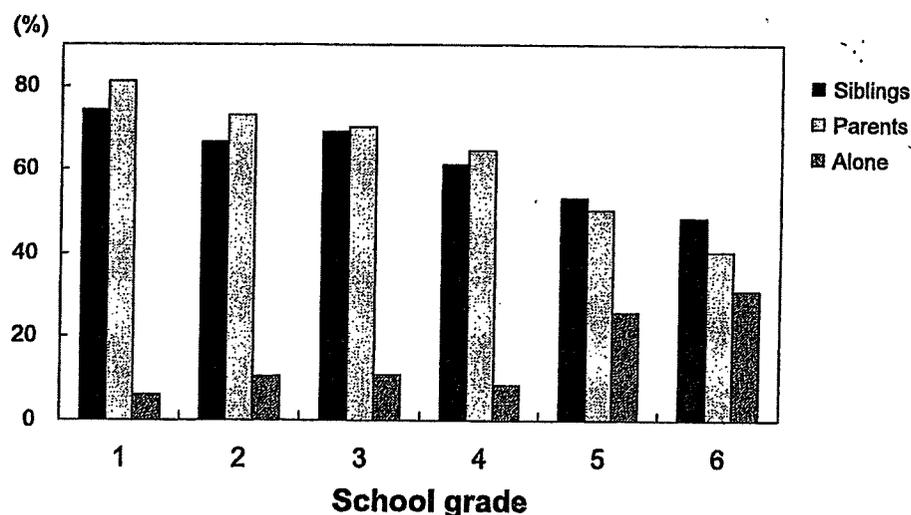


FIGURE 1 Percentage of children who slept with other family members in the same room (bedroom sharing).

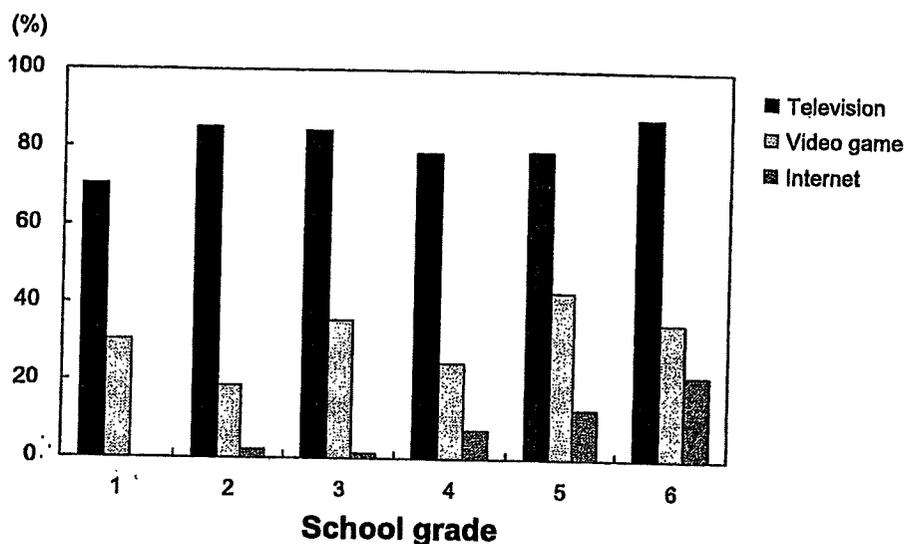


FIGURE 2 Percentage of children who watched television, played video games, or used the Internet.

significantly more common in males (36.9% vs. 24.5%,  $p = .003$ ), whereas use of the Internet was more common in females (9.3% vs. 4.8%,  $p = .032$ ).

Table 1 shows the comparison of sleep/wake parameters after dividing children on the basis of bedtime activities. Children who watched television had significantly later bedtimes on weekends and later wake times on weekdays. Children who played video games before bedtime had significantly later bedtimes and shorter sleep duration both on weekdays and weekends, and later wake time on weekends than children who did not play video games. Children who used the Internet before bedtime had significantly later bedtimes both on weekdays and weekends than children who did not use the Internet. Moreover, Internet users woke up significantly later on weekends and had shorter sleep duration on weekdays. Considering the fact that there was a statistically significant difference in age between users and nonusers of the Internet before bedtime, the same analysis was made focusing on fifth- and sixth-grade students who used the Internet more often than the others. Although bedtimes were similar, wake time on weekends ( $8:29 \text{ min} \pm 91 \text{ min}$  vs.  $8:01 \pm 60 \text{ min}$ ,  $p = .008$ ) and sleep duration on weekdays ( $494 \pm 45 \text{ min}$  vs.  $518 \pm 44 \text{ min}$ ,  $p = .009$ ) were significantly different between frequent and infrequent Internet users.

### Bedroom Facilities

Figure 3 shows how often television sets, video games, cell phones or telephones, and personal computers were in the child's bedroom. Totally, 29.1% of the

TABLE 1  
Relationship Between Bedtime Activities and Sleep Parameters

<i>Watching Television</i>	+	-	<i>P value</i>
	( <i>n</i> = 412)	( <i>n</i> = 97)	
Age (years)	9.1 ± 1.7	8.8 ± 1.7	.134
Bedtime on weekdays	21:42 ± 45 min	21:40 ± 51 min	.433
Bedtime on weekends	22:07 ± 51 min	21:52 ± 54 min	.007
Wake time on weekdays	6:56 ± 23 min	6:50 ± 22 min	.019
Wake time on weekends	7:46 ± 56 min	7:42 ± 51 min	.387
Sleep duration on weekdays	541 ± 43 min	544 ± 53 min	.909
Sleep duration on weekends	563 ± 49 min	575 ± 55 min	.180
<i>Playing Video Games</i>	+	-	<i>P value</i>
	( <i>n</i> = 156)	( <i>n</i> = 353)	
Age (years)	9.2 ± 1.8	9.0 ± 1.7	.060
Bedtime on weekdays	21:50 ± 45 min	21:38 ± 46 min	.005
Bedtime on weekends	22:20 ± 55 min	21:58 ± 59 min	<.001
Wake time on weekdays	6:57 ± 24 min	6:54 ± 22 min	.490
Wake time on weekends	7:56 ± 58 min	7:41 ± 54 min	.022
Sleep duration on weekdays	529 ± 46 min	547 ± 44 min	<.001
Sleep duration on weekends	557 ± 52 min	569 ± 50 min	.039
<i>Using the Internet</i>	+	-	<i>P value</i>
	( <i>n</i> = 36)	( <i>n</i> = 473)	
Age (years)	10.8 ± 1.3	8.9 ± 1.7	<.001
Bedtime on weekdays	22:09 ± 47 min	21:40 ± 45 min	<.001
Bedtime on weekends	22:36 ± 56 min	22:02 ± 50 min	.001
Wake time on weekdays	6:54 ± 23 min	6:55 ± 23 min	.938
Wake time on weekends	8:13 ± 84 min	7:43 ± 52 min	.002
Sleep duration on weekdays	511 ± 51 min	544 ± 44 min	<.001
Sleep duration on weekends	559 ± 64 min	566 ± 49 min	.663

*Note.* Bedtime and wake time: M ± SD (in minutes); sleep duration: M ± SD (in minutes).

bedrooms had televisions, 20.0% had video or portable games (with video games being more common in the bedrooms of older students), 14.3% had cell phones or telephones, and 4.3% had personal computers.

Cell phones or telephones were more commonly present in bedrooms among females than among males (17.1% vs. 11.5%,  $p = .046$ ), whereas there was no sex difference in television sets ( $p = .284$ ), video games ( $p = .582$ ), and personal computers ( $p = .544$ ). The percentage of the participants who watched television before bedtime was significantly higher among children with television sets in the bedroom than among children without television sets in the bedroom

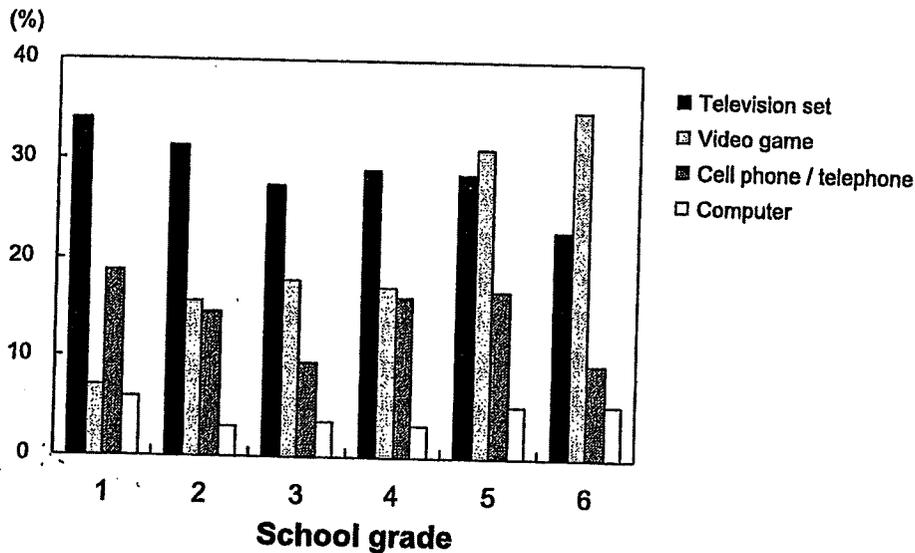


FIGURE 3 Percentage of children who slept in a bedroom with a television set, video game, cell phone, or telephone, or computer.

(87.2% vs. 78.4%,  $p = .031$ ). The percentage of children who played video games before bedtime was significantly higher among children with video games in the bedroom than in those without video games in the bedroom (48.0% vs. 26.3%,  $p < .001$ ).

Children who had televisions in the bedroom showed significantly later bedtimes on weekends ( $10:13 \pm 53$  min vs.  $10:01 \pm 51$  min,  $p = .008$ ). Children who had video games in the bedroom showed significantly later bedtimes on weekdays ( $9:54 \pm 48$  min vs.  $9:39 \pm 45$  min,  $p = .009$ ) and weekends ( $10:18 \pm 4$  min vs.  $10:01 \pm 51$  min,  $p = .008$ ) and shorter sleep duration on weekdays ( $529 \pm 49$  min vs.  $545 \pm 44$  min,  $p = .006$ ). Children who had cell phones or telephones in the bedroom showed significantly later bedtimes on weekends ( $10:15 \pm 58$  min vs.  $10:03 \pm 50$  min,  $p = .014$ ).

#### After-School Activities

Most of the children (81.3%) attended after-school activities including extra coursework, sports lessons, and music lessons at least once a week. There were no differences in the percentage of children attending after-school activities among the school grades. Of the students engaged in after-school activities, those in more advanced grades came home later than those in earlier grades.

There was no statistical difference in sleep/wake parameters between children with and without after-school activity. Sleep/wake parameters were then compared between children (5th- and 6th-grade students only) who returned

TABLE 2  
Relationship Between Time to Return Home From School on Days  
With After-School Activity and Sleep Parameters Among  
Fifth- and Sixth-Grade Students

<i>Time to Come Home</i>	<i>After 8 p.m.</i> ( <i>n</i> = 28)	<i>Before 8 p.m.</i> ( <i>n</i> = 123)	<i>P value</i>
Age (years)	11.3 ± 0.7	11.2 ± 0.7	.351
Bedtime on weekdays	22:47 ± 43 min	22:06 ± 40 min	<.001
Bedtime on weekends	22:40 ± 52 min	22:34 ± 45 min	.324
Wake time on weekdays	7:10 ± 29 min	6:56 ± 24 min	.301
Wake time on weekends	8:27 ± 67 min	8:01 ± 66 min	.740
Sleep duration on weekdays	492 ± 43 min	519 ± 44 min	.006
Sleep duration on weekends	558 ± 52 min	552 ± 58 min	.891

*Note.* Bedtime and wake time: M ± SD (in minutes); sleep duration: M ± SD (in minutes).

before 8 p.m. and those who returned after 8 p.m. Children who returned after 8 p.m. had significantly later bedtimes on weekdays and shorter sleep durations on weekdays than children who returned before 8 p.m. (Table 2).

### Logistic Regression Analyses

Multivariate logistic regression analysis revealed that bedtime after 10 p.m. on weekdays was significantly associated with being female (OR = 1.54, 95% CI: 1.03–2.32), higher school grade (OR = 3.65, 95% CI: 2.77–4.80), and time to return home after 8 p.m. (OR = 5.80, 95% CI: 2.05–16.44). Sleep duration of less than 9 hr on weekdays was significantly associated with higher school grade (OR = 3.13, 95% CI: 1.90–5.15) and using the Internet before bedtime (OR = 3.08, 95% CI: 1.02–9.17). Bedtime after 10 p.m. on weekends was significantly associated with higher school grades (OR = 3.14, 95% CI: 2.34–4.21), watching television before bedtime (OR = 2.09, 95% CI: 1.24–3.50), television in the bedroom (OR = 2.30, 95% CI: 1.42–3.72), and time to return home after 8 p.m. from after-school activity (OR = 6.71, 95% CI: 1.53–29.56). Wake time after 8 a.m. on weekends was significantly associated with being female (OR = 2.52, 95% CI: 1.74–3.66) and higher school grades (OR = 1.51, 95% CI: 1.18–1.92).

The results of multivariate logistic regression analyses regarding the difference of sleep parameters between weekdays and holidays are shown in Table 3. Bedtime delay of more than 1 hr on weekends was significantly associated with watching television and playing video games before bedtime and having a cell phone or telephone in the bedroom. Wake time delay of more than 2 hr

TABLE 3  
Univariate and Multivariate Logistic Regression Results for Prediction  
of Sleep-Wake Patterns Between Weekdays and Weekends

	Univariate Relative Risk (95% CI)	P Value	Multivariate Relative Risk (95% CI)	P Value
Bedtime delays more than 1 hr on weekends				
Sex (female/male)	0.93 (0.61–1.42)	.740		
Grade (4–6/1–3)	1.07 (0.82–1.38)	.632		
Bedtime activities				
Watch television	2.54 (1.30–4.95)	.006	2.45 (1.25–4.80)	.009
Play games	2.11 (1.37–3.25)	.001	1.96 (1.26–3.04)	.003
Use Internet	1.62 (0.77–3.41)	.202		
Bedroom facilities				
Television set	1.73 (1.12–2.69)	.015	<i>ns</i>	
Video game	1.19 (0.71–1.97)	.495		
Telephone	1.94 (1.13–3.33)	.017	1.83 (1.05–3.19)	.033
Computer	1.12 (0.44–2.89)	.805		
Time to return home <sup>a</sup>	2.61 (0.91–7.52)	.075		
Wake time delays more than 2 hr on weekends				
Sex (female/male)	2.62 (1.45–4.76)	.001	2.93 (1.55–5.53)	.001
Grade (4–6/1–3)	2.23 (1.54–3.24)	<.001	1.89 (1.21–2.71)	.002
Bedtime activities				
Watch television	1.32 (0.63–2.79)	.467		
Play games	2.76 (1.59–4.81)	<.001	2.66 (1.45–4.87)	.001
Use Internet	5.38 (2.55–11.34)	<.001	2.38 (1.04–5.47)	.041
Bedroom facilities				
Television set	0.92 (0.50–1.70)	.791		
Video game	2.59 (1.44–4.66)	.001	<i>ns</i>	
Telephone	1.67 (0.84–3.33)	.146		
Computer	2.03 (0.73–5.64)	.173		
Time to return home <sup>a</sup>	1.14 (0.39–3.32)	.816		
Sleep duration increases more than 2 hr on weekends				
Sex (female/male)	2.61 (1.22–5.55)	.013	2.66 (1.17–6.03)	.019
Grade (4–6/1–3)	3.30 (1.93–5.62)	<.001	2.35 (1.33–4.17)	.003
Bedtime activities				
Watch television	1.15 (0.46–2.84)	.765		
Play games	3.77 (1.86–7.62)	<.001	2.87 (1.31–6.30)	.008
Use Internet	8.23 (3.63–18.68)	<.001	2.73 (1.05–7.12)	.040
Bedroom facilities				
Television set	0.97 (0.46–2.08)	.946		
Video game	4.32 (2.14–8.73)	<.001	<i>ns</i>	
Telephone	2.61 (1.20–5.69)	.016	<i>ns</i>	
Computer	1.93 (0.55–6.78)	.307		
Time to return home <sup>a</sup>	0.46 (0.16–1.27)	.135		

Note. Results are presented as adjusted odds ratios (and 95% confidence intervals [CI]) from univariate and multivariate logistic regression analysis adjusting for all the factors in the table.

<sup>a</sup>Time to return home before or after 8 p.m. from after-school activity.

on weekends was significantly associated with being female, higher school grades, playing video games, or using the Internet before bedtime. Longer sleep durations of more than 2 hr on weekends was also significantly associated with being female, higher school grades, playing video games, or using the Internet before bedtime.

## DISCUSSION

In this study, we investigated the relationship between bedtime activities and sleep/wake patterns in Japanese elementary school children. As bedtime activities are largely culturally dependent, understanding the culture-related lifestyle of children is necessary to improve their sleep quality.

For example, houses are usually smaller in Japan than in the West. This may lead to a higher rate of bedroom sharing with other family members. In addition, traditional Japanese houses usually have a multipurpose room with a "tatami mattress." This room is used as a living room during the day and a bedroom at night after the dining table is put away and a "futon mattress" is laid. In this study, we defined the bedroom as a room used for sleeping at night. Therefore, use of a multipurpose room for sleeping may be associated with placement of televisions in the bedroom at a higher rate.

Owens et al. (1999) reported that television viewing habits and the placement of televisions in the bedroom have a negative impact on children's sleep. In our study, television viewing seems to have a significant but small impact on both the delay of bedtime on weekends and wake time on weekdays. The reason for the difference in the result between our study and Owens et al.'s study is unclear, but it may be due to possible cultural differences in television viewing habits. For example, cable television is very common in the United States and provides hundreds of television programs, but it is present in only 35.9% of houses in Japan (Japanese Ministry of Internal Affairs and Communication, 2005). There may be a difference between cable television and terrestrial broadcasting that can explain the difference in the attitude of children toward television viewing before bedtime.

As for the relationship between sleep parameters and sex/age difference, being female and having higher school grades were shown to be independently associated with delayed bedtime on weekdays, later wake time on weekends, and longer sleep duration on weekends compared to weekdays.

Children in all grades played video games or portable games before bedtime, and older children in the higher grades played these games in the bedroom more frequently. One of the most striking results of our study was that playing video games and using the Internet before bedtime had a larger negative impact on