

## 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

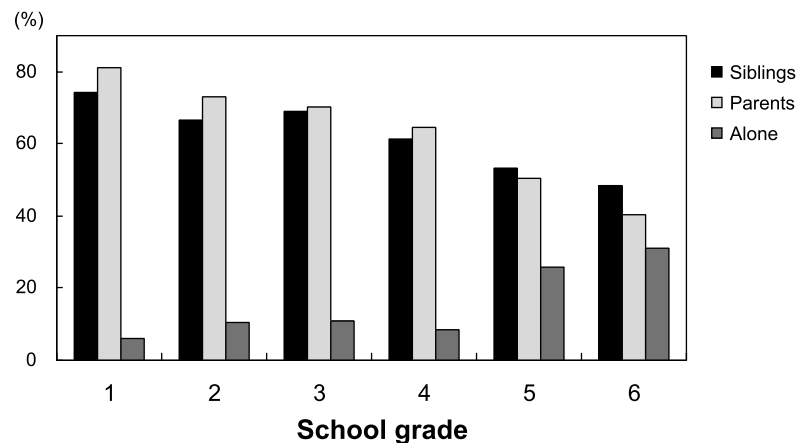


FIGURE 1 Percentage of children who slept with other family members in the same room (bedroom sharing).

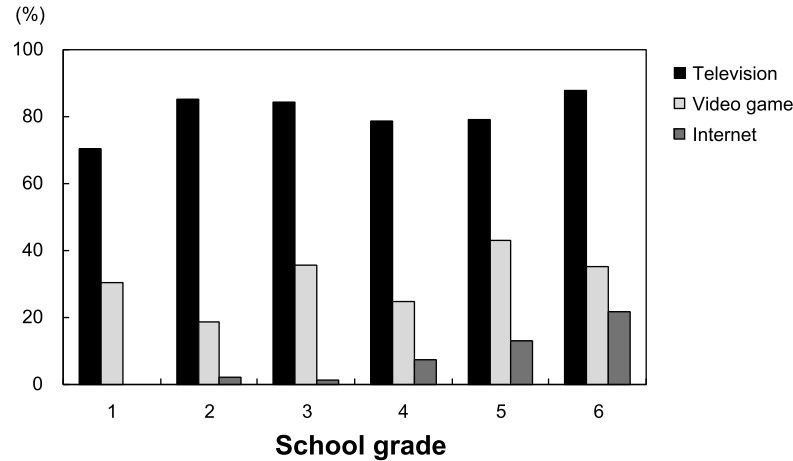


FIGURE 2 Percentage of children who watched television, played video games, or used the Internet.

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

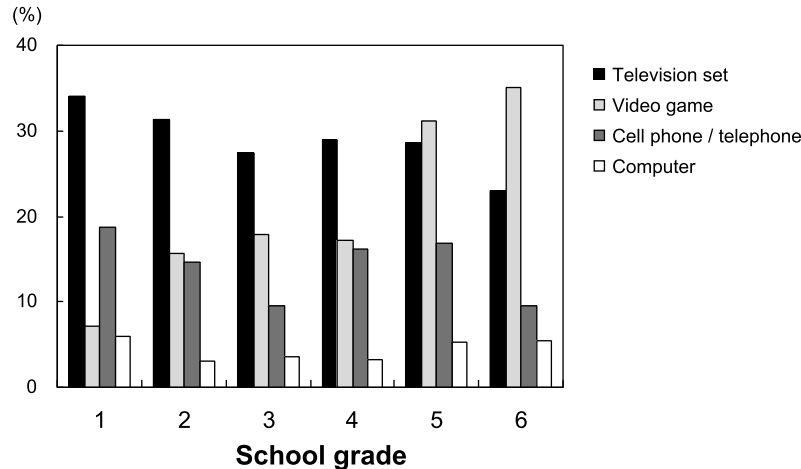


FIGURE 3 Percentage of children who slept in a bedroom with a television set, video game, cell phone, or telephone, or computer.

(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

	<i>Univariate Relative Risk (95% CI)</i>	<i>P Value</i>	<i>Multivariate Relative Risk (95% CI)</i>	<i>P Value</i>
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

sleep/wake parameters. Video games may stimulate children by exposing their eyes to bright light and causing excitement at bedtime, which may alter their circadian rhythms (Higuchi, Motohashi, Liu, & Maeda, 2005).

Although use of the Internet was less prevalent than television viewing and playing video games among elementary school children, the rate of Internet use before bedtime increased with advancing age, and its use seemed to affect sleep/wake parameters. A recent report indicated that 67.9% of 6- to 12-year-old children and 93.0% of 13- to 19-year-old adolescents used the Internet during the past year (Japanese Ministry of Internal Affairs and Communication, 2007). It could be speculated that the negative effect on sleep/wake parameters is more prominent among junior and senior high school students. A previous report found that television viewing, computer game playing, and Internet use all have a negative impact on self-reported sleep/wake parameters in adolescents (Van den Bulck, 2004).

A recent lifestyle survey of children in Japan showed that elementary school children often use cell phones not only for telephone calls but also for e-mail transmissions and Internet access (Benesse Educational Research and Development Center, 2005). Furthermore, television programs can be viewed free of charge on most popular cell phones currently sold in Japan. This means that children, just by having a cell phone, may talk on the telephone, surf the Internet, send e-mail, and even watch television. We should advise parents to keep these advanced cell phones away from children before bedtime.

After-school activity, including extra schooling, is another factor affecting children's sleep. Pressure to enter a better junior or senior high school is a general trend in Japan, China, Korea, and other Asian countries. Children are urged to stay up late to prepare for exams. Usually, extra school classes for senior students end later in the evening. Our study indicated that the later time to come home from school significantly affects sleep/wake parameters. Health care professionals and educators should be aware that late after-school activities may disturb sleep.

One of the limitations in our study was that the sample was from one elementary school. Thus, our findings may not be generalizable to all school children in Japan. However, we chose an elementary school that was located neither in an urban area nor rural area so that we could reduce regional or socioeconomic bias. In addition, we selected a public elementary school that all except a few children in the area must attend. Therefore, we assumed that sampling bias due to regional or socioeconomic factors was minimal. It may be important to survey urban and rural areas of Japan to see if there are significant geographic differences in sleep habits.

Another limitation was that psychometric data were not received; demographic details such as family size, number of siblings, number of rooms, and

parental education were not asked about; and the frequency and duration of bedtime activities were not quantified. However, our findings may be useful in educating parents and healthcare practitioners to encourage children to have better sleep.

## CONCLUSION

Activities before bedtime, televisions and cell phones in the bedroom, and after-school activities were shown to affect the sleep/wake schedule, although the effects remained small. To improve children's nocturnal sleep, children and parents should avoid factors (especially playing video games and using the Internet before bedtime) that potentially affect the sleep/wake schedule. Televisions, cell phones, and computers should not be taken into the bedroom, and after-school activities that delay bedtime and shorten sleep duration should be limited.

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