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Original Article

Japanese Sleep Questionnaire for Elementary Schoolers (JSQ-ES): validation and population-based score distribution

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ABSTRACT

Objective: The Japanese Sleep Questionnaire for Elementary Schoolers (JSQ-ES) was developed to measure the sleep habits and disturbances of Japanese children. The current study aimed to present psychometric properties and describe the score distribution of the JSQ-ES. In addition, it examined correlations between the sleep and daytime behavior of school-aged children.
Method: Guardians of 4369 elementary school children and 100 children diagnosed with sleep disorders in two clinics completed the JSQ-ES.
Results: Exploratory factor analysis and confirmatory factor analysis suggested a nine-factor structure. The JSQ-ES internal consistency was 0.876 and 0.907 for the community and clinical groups, respectively. Score distribution differences were observed between the two groups. A cut-off point of 80 was identified for the total JSQ-ES score.
Conclusions: Exploratory factor analysis and confirmatory factor analysis suggested a nine-factor structure: (1) restless legs syndrome; (2) sleep-disordered breathing; (3) morning symptoms; (4) nighttime awakenings; (5) insomnia; (6) excessive daytime sleepiness; (7) daytime behavior; (8) sleep habits; and (9) irregular/delayed sleep phase. The study verified that the JSQ-ES is a valid and reliable instrument with which to evaluate Japanese sleep habits using a large population-based sample. The JSQ-ES may be useful in both clinical and academic settings.

1. Introduction

Sleep plays an important role in normal development and daily functioning in childhood. It has been reported that sleep problems cause behavioral and affective problems [1,2], anxiety [3], depression, and attention deficit hyperactivity disorder (ADHD) [4]. Furthermore, there is accumulating evidence that insufficient sleep during childhood causes later cognitive impairment [5]. On the other hand, sleep problems are common in childhood [6]. In Japan, the percentage of children with sleep problems has been reported ranging from 31.8–66.2% [7,8]. Hence, a convenient screening tool was required to measure sleep habits and related disorders among outpatients.

Several questionnaires to measure sleep disturbances in children have been developed for clinical and research purposes in Western countries. The Pediatric Sleep Questionnaire (PSQ) [9], the Children's Sleep Habits Questionnaire (CSHQ) [10], the Sleep Disturbance Scale for Children (SDSC) [11], and the Omnibus Sleep Problems Questionnaire for school-aged children (OSPQ) [12] are amongst the most commonly used questionnaires for children. The PSQ is focused on screening for sleep-disturbed breathing and does not cover all sleep problems. The other three questionnaires are intended to screen for various sleep

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problems, including sleep-disturbed breathing. However, they are all premised on Western sleep habits, which are extremely different from Japanese habits.

In Japan, co-sleeping using futons is common, even among elementary school children. In a previous report, it was found that 74.3% of preschoolers and 73% of elementary schoolers co-slept with their parent(s) using futons [13,14]. A futon is a thin mattress laid out on the floor. Children sleep on the futon individually at first, but they cross over them easily and get into their parents' futons during their sleep.

The CSHQ has been translated into many languages, including Japanese [15]; however, it is somewhat difficult to use with Japanese children because of sociocultural differences [16]. According to Liu et al., it is possible that co-sleeping affects CSHQ scores [17]. In particular, it is believed that the "sleep anxiety" items of these questionnaires do not take into consideration Japan's sleeping environment. One of the most significant differences between the JSQ-ES and the other three questionnaires is the exclusion of an item about "sleep anxiety." This item is not relevant in Japanese culture, considering the Japanese custom of co-sleeping as mentioned above. Therefore, the Japanese Sleep Questionnaire for Preschoolers (JSQ-P), taking into account Japanese sleep habits, has been utilized to screen for sleep disorders and for use in clinical research [14]. However, children's lifestyles drastically change after entering school in Japan, which in turn modifies sleep behavior as well. The increase in the amount of homework and the fact that many children attend private schools (i.e., cram schools until 20:00–21:00) should be taken into consideration. These children's parents become tolerant of their late sleep timings. Moreover, in Japan, lifestyle habits greatly differ among preschoolers, primary schoolers, and junior high schoolers. The CSHQ and SDSC questionnaires are designed for 4–10 year olds and 6–15 year olds, respectively, and these wide ranges of ages do not suit the lifestyle of Japanese children.

In addition, some sleep disorders show clear age dependency. According to the International Classification of Sleep Disorders-2 (ICSD-2), the most common morbidity rate of sleep-disordered breathing (SDB) is among school-aged children. Moreover, in the report by Agargun et al., parasomnia peaked at the age of 9–10 years [18], while Shang et al. and others reported that early insomnia, night waking, and enuresis decreased with age, whereas sleepwalking increased [19,20]. In consideration of these facts, the Japanese Sleep Questionnaire for Preschoolers (JSQ-P) and Elementary schoolers (JSQ-ES), and Junior high schoolers (JSQ-J, in preparation) were developed, respectively.

When developing of the JSQ-P and JSQ-ES, three clinicians with extensive experience in pediatric sleep disorders constructed 76 items including such items; "becomes irritated in the daytime," "displays aggressive behavior towards others," and so on, based on preexisting questionnaires; CSHQ, SDSC, and OSPQ, and ICSD-2. In the pilot survey, face validity was confirmed, the wording and contents were checked, inadequate items were excluded. The clinicians discussed the contents again, and selected about 40 items covering sleep disorders that were popular among children and appropriate for their age, 39 items for JSQ-P, and 38 items for JSQ-ES. The JSQ-P has already been reported [14]. A study was then conducted to use JSQ-ES for small samples as a preliminary study.

In the preliminary study, 683 questionnaires completed by the parents of elementary school children and 25 questionnaires of age-matched patients who visited pediatric sleep clinics at Osaka University Hospital were included. Sampling adequacy (Kaiser-Meyer-Olkin value of 0.87) was confirmed.

The differences in the screening items between the JSQ-P and the JSQ-ES were as follows. The items "taken for a car ride due to sleeping difficulty", and "has trouble going to sleep", which is often a problem in the early childhood, that put emphasis on sleeping were excluded. Instead, to ask about problem behavior during the day which is often seen as a result of sleep deprivation and insomnia, which increased in elementary school children, we added the items "has trouble getting up and often misses school", "hits friends or siblings or talks to them rudely", "gets irritated in the daytime", and "misses school, oversleeping". As a result of factor analysis, the cumulative explanatory variable of JSQ-ES preliminary was 67.5%. Two items, "gets grumpy at night" and "moves a lot during the night" were excluded due to the low factor loading in the JSQ-ES preliminary study.

The aim of this study was to examine the psychometric properties of the JSQ-ES in a large community sample and to define the cut-off values to screen for sleep problems. To this end, the following specific objectives were: (1) to verify the reliability of the JSQ-ES; (2) to establish the factor structure of the JSQ-ES; (3) to confirm its ability to distinguish between community and clinical groups; (4) to identify cut-off values for use as a screening test; and (5) to describe the characteristics of the sleep of Japanese elementary schoolers.

2. Materials and methods

2.1. Ethical considerations

This study was conducted in accordance with the guidelines of the Institutional Review Board of Osaka University Hospital, Osaka University, Japan, which approved the study protocol. All guardians provided informed consent for this study.

2.2. Participants

Public elementary school principals were asked to participate in the study, and 17 schools enrolled. Classroom teachers distributed the JSQ-ES to 5937 children aged between 6 and 12 years. Their parents filled the questionnaire and returned it to the respective classroom teacher the next day. In total, 4369 completed questionnaires were collected. Thus, the valid response rate was 73.6%. All submitted surveys remained completely anonymous and did not include personal information that might identify respondents or their children. The location of the enrolled elementary schools covered a wide area of both rural and urban areas in Japan and included Hokkaido, Toyama, Yamanashi, Tokyo, Kanagawa, Hyogo, Osaka, Wakayama, and Miyazaki. Of the 4369 questionnaires returned from the community group, 66 were excluded, due to invalid responses (57 did not answer all items, nine provided the same value for all items). Thus, 4303 respondents were included in the community group for the analysis.

In addition, 100 JSQ-ES were directly distributed to the guardians of children who attended pediatric sleep clinics at the Osaka University Hospital or Osaka Kaisei Hospital because of sleep problems, and collected from the guardians following completion. The response rate was 83%; these 83 children were defined as the clinical group. Their sleep diagnoses were as follows: restless legs syndrome (RLS) ($n = 10$), insomnia ($n = 11$), parasomnia ($n = 14$), excessive daytime sleepiness (EDS) ($n = 5$), sleep-disordered breathing (SDB) ($n = 43$), and circadian rhythm disorders (CRD) ($n = 6$). Three pediatric neurologists with extensive experience in pediatric sleep disorders engaged in this research, and they made the diagnoses using interviews, polysomnography (PSG), multiple sleep latency test (MSLT), pulse oximetry, actigraphy, cranial Xp, and blood examinations at the Osaka University Hospital.

2.3. Japanese Sleep Questionnaire for Elementary Schoolers

The JSQ-ES consisted of two parts: the first part (first page) of the questions was to be answered freely. It asked about lifestyle habits (i.e., dinnertime, bath time, co-sleeping status, wake-up time, and bedtime (hh:mm)). Regarding sleep latency, the questionnaire presented the Likert scale in 10-minute increments (within 10 min, within 20 min, within 30 min, within 1 h, over 1 h, unknown) as mentioned previously. The total sleep time was calculated from the bedtime and wake-up time.

The second part (second page) was a set of 38 items to be answered on a 6-point intensity rating scale. Two reversed items were rescored prior to analysis. Higher scores on this scale indicated greater signs of sleep disorders or deleterious sleep habits. One of 38 items, "falls asleep without any help", refers to children not making a request to their parents to hang around, watch, or sleep along with them when going to bed.

In the preliminary study, it was found that "going out after 20:00" and "viewing time: TV or video" were related to late sleep time. In addition, the use of multiple electronic devices has been associated with less sleep at night and a greater degree of sleepiness during the daytime [8]. Van den Bulck and Johnson et al. also have reported that extensive TV viewing is not good for sleeping [21,22]. "Taking caffeine products after 19:00" "using the Internet >1 h/day" and "playing time: videogames" also caused excessive excitement of the brain and were considered as causes of insomnia and parasomnia [23–26]. These questions were included in the JSQ-ES by a six-grade evaluation (1–6) on the Likert scale (the higher the frequency, the higher the score), while the amount of daily viewing time of TV, video, DVD and the playing time of games were obtained through free writing.

The previous preliminary analysis classified the 38 items of the JSQ-ES into nine domains: sleep-disordered breathing, RLS, sleep habits, insomnia/sleep rhythm, daytime behaviors, excessive daytime sleepiness, morning symptoms, sustained sleep, and weekend sleep rhythm.

2.4. Statistical analysis

Statistical analyses were carried out using SPSS version 21.0 (IBM, Chicago, IL, USA) and AMOS version 21.0 (IBM) for Windows. Although an exploratory factor analysis (EFA) had already been conducted with the JSQ-ES in a small sample study, this larger population study aimed to reevaluate its factor structure and reliability. First, the community group was randomly divided into two (Group 1: $n = 2110$, Group 2: $n = 2110$) to examine the factor structure of the JSQ-ES. A random split was performed using SPSS random division function, and as a result, the grade structure and sex composition were almost equal. Which group could be used for the CFA and EFA analyses was then examined. The first-step EFA was performed with Group 1, to determine the possible factor structure. In the EFA, maximum likelihood factoring and promax rotation were used due to inter-factor correlations.

Thereafter, confirmatory factor analysis (CFA) was performed with Group 2 to examine the best fitting model from step 1 and to confirm that the model could be applied to different community groups. This cross-validation procedure of the two-step method allowed construction and verification of a robust factor model. A method of confirming reliability by dividing a group into two and performing CFA and EFA is used in conventional research [27,28]. Values of Cronbach's α between 0.70 and 0.90 are generally considered adequate [29,30]. In the CFA, the following model fit indices were considered: comparative fit index (CFI), root-mean-square error of approximation (RMSEA), Akaike's Information Criterion (AIC), and Browne-Cudeck Criterion (BCC). The acceptability criteria for these indicators were as follows: RMSEA <0.80 [31], and the AIC and BCC were relative indicators such that lower values indicated better fit. To identify the discriminative power of the questionnaire, item scores were compared between community ($n = 83$) and clinical ($n = 83$) groups. For this analysis, 83 individuals were chosen from the community group, and matched for age and sex with the clinical group.

A receiver operating characteristics (ROC) curve analysis was conducted to examine the predictive power of the JSQ-ES. The area under the ROC curve (AUC) was calculated using both community and clinical groups: an AUC of 1.0 indicated a perfect test, and an AUC of 0.5 denoted unsatisfactory performance. The cut-off score, a numerical value showing the highest sensitivity among the specificity of 0.7 or more, was selected.

In order to confirm the normal assumption of the T score of the total score, a Shapiro–Wilk test was performed. The Kruskal–Wallis test and the Mann–Whitney U test were also conducted to confirm whether the JSQ-ES score differed depending on age and sex. Furthermore, a multiple linear regression was conducted to determine the influence of children's lifestyle on their sleep using the JSQ-ES item scores. There are several sleeping diseases that have an age dependency, such as SDB and parasomnia. Moreover, with regard to sex, girls encounter drowsiness that becomes strong in the second sexual period in which sexual hormone secretion becomes active. There are also reports that women tend to have poor sleep quality even after puberty [32,33]. Therefore, the study wished to analyze the relationship between the JSQ-ES and sex and age. To ensure comparability and to assess score distributions in the population group, subscale scores were transformed to T scores. The statistical significance level was set at 0.01.

3. Results

3.1. Participant characteristics

Descriptive statistics are shown in Table 1. The age distributions of the community and clinical groups did not differ ($t = 1.03$,

Table 1
Participant characteristics and demographic factors.

	Community group ($n = 4220$)	Clinical group ($n = 83$)	p[a]
Age			
Mean ± SD (range)	8.98 ± 1.78 (6–12)	8.83 ± 1.93 (6–12)	0.466[a]
Sex, n (%)			
Male	2041 (48.36%)	53 (63.86%)	
Female	2166 (51.33%)	30 (36.14%)	
Unknown	13 (0.31%)	0	
Male/female (ratio)	0.94	1.80	0.053[a]
School grade, n (%)			
1st grade (%)	746 (17.68%)	14 (17.50%)	0.285[b]
2nd grade (%)	681 (16.14%)	20 (25.00%)	
3rd grade (%)	676 (16.02%)	15 (18.75%)	
4th grade (%)	721 (17.09%)	11 (13.75%)	
5th grade (%)	683 (16.18%)	10 (12.50%)	
6th grade (%)	713 (16.89%)	10 (12.50%)	
Sleep/wake patterns (h)			
Bedtime	21:30 (0:39)	20:26 (4:27)	0.200[c]
Wake-up time	06:34 (0:23)	06:51 (0:39)	<0.001[c]
Sleep onset latency (min)			
<10	2021 (48.9%)	37 (44.0%)	<0.001[b]
10–20	1128 (26.7%)	15 (17.8%)	
>20	1010 (23.9%)	29 (34.5%)	
n/a	61 (0.5%)	3 (3.5%)	
Sleep duration (min ± SD)	544 (±38)	530 (±174)	0.317[a]

mo, months; SD, standard deviation; h, hours; min, minutes; n/a, not applicable.
[a] t-test.
[b] Pearson's χ^2 test.
[c] Mann–Whitney U test.

$p = 0.466$). With respect to sex, the ratio of boys to girls was higher in the clinical group (1.80) than in the community group (0.94) ($t = 3.11$, $p = 0.003$). School grades were divided into three groups: lower (first and second) grade, middle (third and fourth) grade, and higher (fifth and sixth) grade. In the control group, the number of participants per grade was uniform, but in the clinical group there were many lower grade students.

Sleep-wake characteristics are also shown in Table 1. The average bedtime was not significantly different between the community group and the clinical group; however, the average awakening time tended to be significantly slower in the clinical group ($p < 0.001$). Regarding sleep onset latency, half of the participants fell asleep within 10 min, and the proportion of children who took ≥20 min to fall asleep was significantly different between the clinical and community groups ($p < 0.001$). Finally, there was no significant difference in the average total sleeping time between the general group (544 ± 38 min) and the clinical group (530 ± 174 min).

3.2. Factor analysis

Exploratory factor analysis: sampling adequacy (Kaiser-Meyer-Olkin value of 0.866) was demonstrated for the JSQ-ES; EFA was performed in Group 1. Based on the scree plot and Kaiser's eigenvalues-greater-than-one rule, a previous report confirmed the validity of a nine-factor model. The current study considered six-factor to 8-factor models, as well as other parsimonious models. The EFA revealed nine underlying factors of the JSQ-ES with eigenvalues >1. The scree plot also indicated that the nine previous factors should be retained. Finally, it was determined that the nine-factor model was optimal (Table 2). The cumulative explanatory variances of the six-, seven-, eight-, and nine-factor solutions were 44.24%, 47.48%, 49.95%, and 52.33%, respectively, and the 9-factor solution was judged to be the most optimal. Q12 “moves a lot during the night” was excluded as a low common factor; Q21 “gets grumpy at night” was also eliminated because its factor loading was low.

Confirmatory factor analysis: CFA was performed in Group 2. Four models (Models 1–4) were created, each with 1–9 factors based on the results of the EFA in Step 1. Model 4 (nine-factor model) showed the best fit based on the CFI and RMSEA (Table 3). In addition, the result of the likelihood ratio test, in which Model 4 was the baseline model, revealed that Models 1–3 showed significant deviations from Model 4. The results of the CFA exhibited a simple structure with clearly defined factors. The nine factors were the same as those in the JSQ-P; however, sensory and motor symptoms of RLS were combined in this factor analysis (Factor 1, RLS; Factor 2, SDB; Factor 3, morning symptoms; Factor 4, nighttime awakenings; Factor 5, insomnia or irregular/delayed sleep phase; Factor 6, EDS; Factor 7, daytime behaviors; Factor 8, sleep habits; and Factor 9, insufficient sleep).

3.3. Reliability

Internal consistency coefficients are shown in Table 2. Cronbach's α coefficients of the entire JSQ-ES were 0.876 and 0.907 for the community and clinical groups, respectively. Cronbach's α coefficients for subscales ranged from 0.656 to 0.885 in the community group, and the Cronbach's α coefficients for subscales ranged from 0.717 to 0.899 in the clinical group. RLS was 0.879; SDB 0.741; morning symptoms 0.885; nighttime awakenings 0.713; insomnia 0.656; excessive daytime sleepiness 0.730; daytime behaviors 0.811; sleep habits 0.857; and irregular/delayed sleep phase 0.690.

3.4. Group comparisons and cut-off scores

Subscale scores of the JSQ-ES in the community and clinical groups were compared (Table 4). An analysis of covariance with age and sex indicated that the clinical group had significantly higher (worse) scores than the community group for all subscales. However, the effect size (criteria of effect size; small value 0.01-large value 0.14 [34]) range was 0.030–0.305.

The AUC of the total score was 0.824 with a 99% confidence interval (0.762, 0.873), indicating a good level of predictive power of the JSQ-ES for sleep problems. The cut-off score for the total JSQ-ES score was 80, which was determined by the intersection of sensitivity of 0.710 and specificity of 0.806. This cut-off score corresponded to 20.14% of the community sample. AUCs and cut-off scores for the subscales are shown in Table 4. The CRD subscale did not have sufficient discriminative power based on the ROC analysis (AUC = 0.543); hence, its cut-off score was determined based on the expert opinion of two specialists in pediatric sleep medicine (M.T. and I.M.) from a clinical point of view.

The result of the Shapiro–Wilk test for the total score was ($w = 0.967$, $p < 0.001$), and it showed a skewed model. Hence, nonparametric analysis (Kruskal–Wallis test and the Mann–Whitney U test) was conducted to confirm whether the JSQ–ES score differed depending on age and sex (Table 5).

The items “daytime behavior” and ”sleep-disordered breathing” showed significantly higher points in boys than girls. Moreover, in the “morning symptoms” and “irregular/delayed sleep phase” items, girls showed significantly higher points than boys. In the item “daytime behavior”, a significant difference was recognized between the lower and upper grades. The median was the same (median = 48.58), but the upper limit of the range was higher in the upper grades (first and second grade range = 35–81, firth and sixth grade range = 35–86). For the item “excessive daytime sleepiness”, there was a significant difference between the lower and upper grades, and between the intermediate and the upper grades. The median was the same for all three groups (median = 49.03), but the range width was different for all three groups (first and second grade range = 38–103), (third and fourth grade range = 38–107), (fifth and sixth grade range = 38–93). In “irregular/delayed sleep phase”, a significant difference was observed between each grade, and the median tended to be higher as the grade increased. The item “sleep habits” also showed a significant difference between each grade, and the median tended to be lower as the grade increased.

3.5. Multiple linear regression with lifestyle habits

A multiple linear regression was performed to determine the influence of children's lifestyle on sleep, using the JSQ-ES item scores. As expected, items such as “watching TV at bedtime”, “intake of caffeine after 19:00”, “playing computer games or going on the Internet >1 h/day” and “total time spent watching TV or playing video games” affected children's bedtime. Furthermore, “going out after 20:00” was considered the most influential factor on overall variables (Tables 6–8).

4. Discussion

4.1. Validity and reliability of the JSQ-ES

This study examined the validity and reliability of the JSQ-ES as a measure of problematic sleep habits and sleep-related disorders in community populations in Japan. The distributions of the total and subscale scores were acceptable. The internal consistency coefficient of the total score of the JSQ-ES in the community population was sufficiently high (0.876), and those of the subscale scores met an acceptable standard (0.70). The study found a similar structure and number of factors as identified in a preliminary small-sample analysis of the JSQ-ES. However, this large-sample study of the JSQ-ES employed a cross-validation procedure with

Table 2
Promax-rotated factor structure of the Japanese Sleep Questionnaire for schoolchildren.

Item number	1	2	3	4	5	6	7	8	9
Factor loading									
Factor I. Restless legs syndrome									
Q15. Complains about leg pain at bedtime	0.839	0.005	0.014	−0.038	0.016	0.002	−0.025	0.017	−0.030
Q16. Complains of hot sensation in the legs at bedtime	0.601	0.002	0.024	0.014	0.037	0.006	−0.020	0.023	−0.012
Q17. Complains of discomfort in the legs at bedtime	0.889	−0.018	0.029	0.004	−0.054	−0.015	−0.036	0.002	−0.043
Q18. Asks parents to massage his/her legs	0.882	−0.026	−0.010	−0.006	−0.028	−0.015	0.007	0.000	−0.008
Q19. Touches his/her legs at bedtime	0.833	0.004	−0.013	0.006	−0.011	−0.034	0.050	−0.001	−0.015
Q20. Hyperactive at bedtime	0.302	0.007	−0.012	0.022	0.178	−0.002	0.140	−0.059	0.147
Factor 2. Sleep-disordered breathing									
Q28. Sleeps with his/her mouth open	0.003	0.531	0.091	−0.057	−0.143	−0.084	0.129	0.022	0.043
Q29. Sleeps with throwing his/her head back	0.074	0.579	0.022	0.058	−0.067	−0.017	0.042	0.035	0.002
Q30. Snores loudly	−0.031	0.816	0.003	−0.111	−0.063	0.006	−0.046	−0.003	−0.005
Q31. Stops breathing frequently during sleep	−0.039	0.719	−0.023	0.029	0.144	−0.036	−0.042	−0.013	−0.086
Q32. Sleeps with snorts or gasps for air	−0.031	0.678	0.010	0.055	0.081	0.003	−0.013	0.003	−0.058
Factor 3. Morning symptoms									
Q1. Grumpy in the morning	0.049	0.016	0.680	0.059	−0.049	0.011	0.070	−0.030	0.031
Q2. Hard to wake-up	0.001	0.024	0.920	−0.020	0.044	0.029	−0.019	−0.009	−0.001
Q3. Hard to get out of bed	−0.006	0.026	0.867	−0.004	0.062	0.031	−0.043	0.007	0.025
Factor 4. Nighttime awakenings									
Q24. Cries at night	−0.020	−0.105	0.042	0.782	0.069	−0.041	−0.003	−0.009	−0.059
Q25. Screams and cannot be calmed down at night	−0.055	−0.089	0.050	0.873	0.061	−0.052	−0.003	0.028	−0.066
Q26. Woken up by scary dreams	0.066	0.075	−0.015	0.477	−0.166	0.032	0.040	0.012	0.081
Q27. Woken up by little sound	0.024	0.169	−0.089	0.423	−0.064	0.086	−0.002	−0.017	0.022
Q35. Wakes up more than twice during sleep	0.039	0.191	−0.043	0.340	−0.015	0.066	0.015	−0.034	0.080
Factor 5. Insomnia									
Q4. Oversleeps and is late for school	−0.041	−0.032	0.090	−0.042	0.770	−0.064	0.056	0.041	−0.027
Q5. Has trouble getting up and often misses school	0.012	−0.029	−0.013	0.023	0.781	−0.085	0.003	0.031	−0.072
Q37. Reversal of day and night	0.077	0.047	−0.048	0.095	0.328	0.104	−0.106	−0.055	0.207
Factor 6. Excessive daytime sleepiness									
Q10. Looks sleepy during daytime	−0.051	−0.048	0.039	−0.022	−0.090	0.979	0.031	0.009	−0.067
Q11. Looks tired during daytime	−0.003	−0.033	0.039	0.007	−0.067	0.879	0.024	0.032	−0.053
Q13. Snoozes at school	0.063	0.020	−0.041	−0.017	0.236	0.310	0.073	−0.016	−0.054
Q38. Dozes off in a relaxed atmosphere with family	0.017	0.095	−0.051	0.131	0.035	0.229	−0.044	−0.002	0.169
Factor 7. Daytime behaviors									
Q6. Restless in the daytime	−0.032	0.043	−0.044	−0.025	0.140	−0.079	0.809	−0.010	−0.039
Q7. Has difficulty concentrating in the daytime	−0.024	−0.030	0.007	−0.038	0.040	0.073	0.807	−0.003	−0.034
Q8. Gets irritated in the daytime	0.031	0.008	0.005	0.023	−0.055	0.117	0.683	0.006	0.047
Q9. Aggressive behavior towards others	−0.006	0.017	0.032	0.071	−0.084	−0.036	0.525	0.006	0.065
Factor 8. Sleep habits									
Q22.[a] Falls asleep without any help	0.016	−0.002	−0.006	0.019	0.002	−0.003	0.025	0.882	0.026
Q23.[a] Goes to bed by himself/herself	0.008	0.027	−0.023	−0.011	0.063	0.042	−0.028	0.839	0.015
Factor 9. Irregular/delayed sleep phase									
Q14. Goes to bed after 23:00	0.032	−0.014	−0.036	−0.114	0.187	0.184	−0.087	−0.022	0.455
Q33. Goes to bed more than an hour later than usual on weekends	−0.021	−0.038	−0.005	−0.009	−0.108	−0.104	0.086	0.017	0.742
Q34. Gets up more than an hour later than usual on holidays	−0.065	−0.044	0.082	0.011	−0.091	−0.124	−0.039	0.044	0.794
Q36. Keeps irregular hours	−0.005	0.046	−0.011	0.001	0.132	0.105	0.047	−0.022	0.466
Intercorrelation matrix									
Factor 1. Restless legs syndrome	–	0.289	0.112	0.400	0.346	0.379	0.379	−0.165	0.460
Factor 2. Sleep-disordered breathing	0.289	–	0.287	0.279	0.270	0.565	0.441	−0.081	0.415
Factor 3. Morning symptoms	0.112	0.287	–	0.085	0.413	0.300	0.133	−0.066	0.275
Factor 4. Nighttime awakening	0.400	0.279	0.085	–	0.240	0.337	0.479	−0.112	0.412
Factor 5. Insomnia	0.346	0.270	0.413	0.240	–	0.515	0.364	−0.044	0.431
Factor 6. Excessive daytime sleepiness	0.379	0.565	0.300	0.337	0.515	–	0.473	−0.090	0.519
Factor 7. Daytime behaviors	0.378	0.441	0.133	0.479	0.364	0.473	–	−0.066	0.410
Factor 8. Sleep habit	−0.165	−0.081	−0.066	−0.112	−0.044	−0.090	−0.066	–	−0.125
Factor 9. Irregular/delayed sleep phase	0.460	0.415	0.275	0.412	0.431	0.519	0.410	−0.125	–
Sums of squares of loadings	5.045	4.360	3.103	3.793	3.821	4.930	4.606	1.666	4.380
Cronbach's α coefficient of community group	0.879	0.741	0.885	0.713	0.656	0.730	0.811	0.857	0.690

Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) = 0.863. Bartlett test of sphericity $p < 0.01$.
[a] Reverse item.

two steps (EFA and CFA) to construct and verify a robust factor model.

4.2. The differences between the JSQ-P and the JSQ-ES

The JSQ-P and JSQ-ES are different in their targeted age range; the former is for 2–6-year-olds, and the latter is for 6–12-year-olds. The same expert who created the JSQ-P was involved in the preparation of the items. Among the lifestyle items, others were added such as “I spend more than 1 h on e-mail and the Internet” and “I will take caffeine after 19:00”.

As for the screening items on the back side of the questionnaire, the differences from the infant version are as follows. The items “taken for a car ride due to sleeping difficulty” and “has trouble going to sleep” were deleted, as they are often problems in early childhood where there is emphasis on sleeping. Moreover, since the habit of a nap is not present after elementary school, the item “get more than two naps” was also excluded.

Table 3
Model fit indices for confirmatory factor analysis in half of sample.

Measures of fit	Model 1 (6 factors)	Model 2 (7 factors)	Model 3 (8 factors)	Model 4 (9 factors)
Chi-squared test (χ^2)	4794.481	6197.113	6140.898	4448.111
df	390	539	566	558
p-value	<0.01	<0.01	<0.01	<0.01
$\Delta\chi^2$	346.370	1749.002	1692.787	
Δdf	168	19	8	
CFI	0.847	0.825	0.832	0.882
RMSEA	0.073	0.071	0.068	0.057
AIC	5004.481	6449.113	6412.898	4736.111
BCC	5007.614	6453.490	6417.755	4741.254
Hoelter 0.05	193	203	214	292
Hoelter 0.01	202	45	46	303

df, degree of freedom; $\Delta\chi^2$;chi-squaire difference test; Δdf, change in degrees of freedom between the models; CFI, Comparative Fit Index; RMSEA, Root Mean Square Error of Approximation; AIC, Akaike's Information Criterion; BCC, Browne-Cudeck criterion.

Table 4
Reliability and validity of the Japanese Sleep Questionnaire for Elementary Schoolers.

Sleep subscales	Community sample ($n = 80$)		Clinical sample ($n = 80$)		ANCOVA[b]			Cut-off score				% of children who met criteria	
												Clinical	Community
	Mean	SD	Mean	SD	F	*p*	η^2	AUC	95% CI	*p*	Cut-off score	%	%
1. Restless legs syndrome	7.88	3.200	10.94	6.873	13.192	<0.001	0.077	0.617	0.523–0.711	0.017	8	51.90	28.66
2. Sleep-disordered breathing	8.36	3.587	15.93	7.397	67.825	<0.001	0.305	0.817	0.744–0.890	<0.001	10	77.33	22.21
3. Morning symptoms	7.84	3.707	11.05	4.671	23.058	<0.001	0.127	0.709	0.623–0.796	<0.001	9	67.51	48.26
4. Nighttime awakenings	6.93	2.396	10.24	5.138	27.212	<0.001	0.149	0.687	0.597–0.776	<0.001	8	64.47	33.04
5. Insomnia	3.67	1.500	5.41	3.731	14.606	<0.001	0.088	0.636	0.543–0.729	0.006	4	82.22	27.93
6. Excessive daytime sleepiness	7.37	2.865	11.65	5.804	36.394	<0.001	0.181	0.718	0.631–0.806	<0.001	8	67.95	48.46
7. Daytime behavior	9.73	3.910	13.51	4.810	28.851	<0.001	0.159	0.709	0.664–0.826	<0.001	11	70.50	37.31
8. Sleep habit[a]	4.81	3.300	6.25	3.402	7.615	0.006	0.045	0.610	0.516–0.703	0.026	7	44.30	31.86
9. Irregular/delayed sleep phase	10.03	4.053	11.51	4.438	4.841	0.029	0.030	0.543	0.447–0.639	0.384	12	47.50	36.49

ANCOVA, analysis of covariance; SD, standard deviation; AUD, area under the receiver operation characteristics curve.
[a] The direction of score is opposite, due to reverse items.
[b] Difference in means between Community sample vs Clinical sample (covarying age and sex).

Table 5
Sex and age differences of the standardized *t*-scores of the Japanese Sleep Questionnaire for Elementary Schoolers.

		Mann–Whitney *U*					Kruskal–Wallis			
	p	Male, median (range)	Female, median (range)	1st 2nd 3rd 4th *p*	3rd 4th 5th 6th *p*	1st 2nd 5th 6th *p*	1st 2nd median (range)	3rd 4th median (range)	5th 6th median (range)	Age, Chi-squared test (*p*)
1. Restless legs syndrome	0.19	44.59 (44–129)	44.59 (44–129)	0.09	0.73	0.19	44.59 (44–123)	44.59 (44–129)	44.59 (44–129)	3.09 (0.21)
2. Sleep-disordered breathing	<0.001	49.54 (39–102)	47.01 (39–102)	0.23	0.48	0.64	47.01 (39–90)	49.54 (39–102)	47.01 (39–102)	1.43 (0.49)
3. Morning symptoms	<0.001	48.35 (35–74)	50.99 (35–74)	0.39	0.69	0.19	48.35 (35–74)	48.34 (35–74)	48.34 (35–74)	1.76 (0.41)
4. Nighttime awakenings	0.13	45.96 (42–130)	45.96 (42–130)	0.12	0.63	0.28	45.96 (42–130)	45.96 (42–130)	45.96 (42–130)	2.54 (0.28)
5. Insomnia	0.99	45.44 (45–152)	45.43 (45–116)	0.48	0.14	0.422	48.34 (35–74)	45.43 (45–152)	45.43 (45–116)	0.23 (0.33)
6. Excessive daytime sleepiness	0.39	49.04 (38–103)	49.04 (38–107)	0.758	<0.001	<0.001	49.03 (38–103)	49.03 (38–107)	49.03 (38–93)	34.03 (<0.001)
7. Daytime behavior	<0.001	51.14 (35–84)	46.03 (35–86)	0.012	0.21	<0.001	48.58 (35–81)	48.58 (35–86)	48.58 (35–86)	15.4 (<0.001)
8. Sleep habit	0.94	46.52 (40–70)	46.51 (33–85)	<0.001	<0.001	<0.001	49.55 (40–70)	46.51 (40–70)	43.47 (40–70)	143.79 (<0.001)
9. Irregular/delayed sleep phase	<0.001	49.39 (33–85)	49.40 (33–85)	<0.001	<0.001	<0.001	46.82 (33–77)	49.40 (33–85)	51.96 (33–85)	147.57 (<0.001)

Rather, problematic behaviors during the day that increase among elementary school children, which are often seen as a result of sleep deprivation and insomnia, were asked about through items such as “missing sleep, overslept”, “displaying aggressive behavior toward others”, and “gets irritated in the daytime”.

4.3. Screening ability of the JSQ-ES

This questionnaire showed good sensitivity for both the total score and each subscale score, except for irregular/delayed sleep phase, for which the AUC was <0.6. It was assumed that the items “gets up later than usual on holidays” and “goes to bed later than usual on weekends” in the irregular/delayed sleep phase subscale were often rated high for children without sleep problems; therefore, there was a large overlap between the community and clinical groups. To ensure that the JSQ-ES had sufficient discriminative power to screen for sleep disturbances and problematic sleep hygiene, a cut-off point for the irregular/delayed sleep phase subscale was determined using the expert opinions of two children's sleep specialists.

Table 6
Multiple linear regression models for the analysis of effect with sleep scale and media use.

Independent variable	Total score				Irregular/delayed sleep phase				Excessive daytime sleepiness			
	B	95% CI	β	*p*	B	95% CI	β	*p*	B	95% CI	β	*p*
Constant	53.664	52.147–55.181		<0.001	7.013	6.672–7.353		<0.001	5.093	4.839–5.346		<0.001
Going out after 20:00	3.802	3.109–4.494	0.187	<0.001	0.772	0.616–0.927	0.165	<0.001	0.561	0.445–0.678	0.163	<0.001
Viewing time: TV or video	1.252	0.720–1.784	0.082	<0.001	0.448	0.328–0.568	0.126	<0.001	0.168	0.078–0.257	0.064	<0.001
Taking caffeine products after 19:00	1.515	1.126–1.904	0.131	<0.001	0.344	0.256–0.433	0.128	<0.001	0.190	0.125–0.256	0.096	<0.001
Falling asleep while watching TV	1.496	1.025–1.968	0.109	<0.001	0.264	0.158–0.370	0.083	<0.001	0.178	0.098–0.257	0.076	<0.001
On the Internet >1 h/day	1.761	1.194–2.329	0.105	<0.001	0.358	0.231–0.485	0.093	<0.001	0.359	0.264–0.453	0.126	<0.001
Playing time: videogames	1.313	0.178–2.448	0.039	0.023	0.224	0.012–0.494	0.031	0.062	0.034	0.154–0.223	0.006	0.720
r	0.354				0.341				0.300			
Adjusted *r*2	0.123				0.115				0.089			
Durbin-Watson	1.913				2.002				1.893			

Table 7
Multiple linear regression models for the analysis of effect with sleep scale and media use.

Independent variable	Insomnia				Nighttime awakenings				Sleep-disordered breathing			
	B	95% CI	β	*p*	B	95% CI	β	*p*	B	95% CI	β	*p*
Constant	2.743	2.621–2.865		<0.001	5.995	5.735–6.256		<0.001	7.447	7.087–7.808		<0.001
Going out after 20:00	0.280	0.225–0.336	0.170	<0.001	0.309	0.190–0.427	0.091	<0.001	0.307	0.142–0.472	0.065	<0.001
Viewing time: TV or video	0.009	0.052–0.034	−0.007	0.686	0.020	0.072–0.112	0.008	0.667	0.189	0.063–0.316	0.053	0.003
Taking caffeine products after 19:00	0.037	0.006–0.069	0.040	0.020	0.117	0.049–0.184	0.060	0.001	0.261	0.167–0.354	0.096	<0.001
Falling asleep while watching TV	0.083	0.045–0.121	0.075	<0.001	0.106	0.025–0.187	0.046	0.010	0.205	0.093–0.317	0.064	<0.001
On the Internet >1 h/day	0.189	0.143–0.234	0.140	<0.001	0.162	0.064–0.259	0.057	0.001	0.196	0.061–0.331	0.050	0.005
Playing time: videogames	0.086	0.005–0.176	0.032	0.063	0.227	0.031–0.422	0.040	0.023	0.026	0.029–0.241	0.003	0.847
r	0.275				0.165				0.183			
Adjusted *r*2	0.074				0.025				0.032			
Durbin-Watson	1.896				1.926				1.970			

Table 8
Multiple linear regression models for the analysis of effect with sleep scale and media use.

Independent variable	Restless legs syndrome				Daytime behavior				Morning symptoms			
	B	95% CI	β	*p*	B	95% CI	β	*p*	B	95% CI	β	*p*
Constant	6.361	6.031–6.690		<0.001	7.505	7.146–7.864		<0.001	6.983	6.636–7.331		<0.001
Going out after 20:00	0.516	0.365–0.666	0.118	<0.001	0.456	0.292–0.619	0.096	<0.001	0.382	0.223–0.541	0.083	<0.001
Viewing time: TV or video	0.001	0.115–0.117	0.000	0.983	0.222	0.096–0.349	0.062	0.001	0.116	0.007–0.238	0.033	0.065
Taking caffeine products after 19:00	0.098	0.013–0.183	0.039	0.025	0.204	0.111–0.297	0.075	<0.001	0.179	0.089–0.269	0.068	<0.001
Falling asleep while watching TV	0.221	0.118–0.324	0.075	<0.001	0.243	0.131–0.355	0.075	<0.001	0.204	0.096–0.313	0.066	<0.001
On the Internet >1 h/day	0.182	0.059–0.305	0.051	0.004	0.191	0.057–0.324	0.049	<0.001	0.176	0.046–0.306	0.047	0.008
Playing time: videogames	0.224	0.021–0.469	0.032	0.073	0.346	0.078–0.614	0.045	0.011	0.027	0.231–0.285	0.004	0.835
r	0.185				0.213				0.168			
Adjusted *r*2	0.032				0.044				0.027			
Durbin-Watson	2.013				1.922				1.946			

Independent variable	Sleep habit			
	B	95% CI	β	*p*
Constant	9.617	8.466–10.769		<0.001
Going out after 20:00	0.108	−0.031–0.248	0.027	0.129
Viewing time: TV or video	0.000	−0.001–0.002	0.008	0.659
Taking caffeine products after 19:00	0.060	−0.018–0.139	0.026	0.133
Falling asleep while watching TV	−0.075	−0.170–0.020	−0.028	0.123
On the Internet >1 h/day	0.103	−0.013–0.219	0.031	0.080
Playing time: videogames	−0.002	−0.005–0.001	−0.024	0.211
r	0.158			
Adjusted *r*2	0.022			
Durbin-Watson	1.698			

While the JSQ-ES has diagnostic features, it cannot offer the equivalent of a definitive diagnosis. As the questionnaire is a screening tool, the overlap between the normal and clinical groups could be large. Thus, according to Owen, the ratio of children who score over the cut-off point would be higher than that expected epidemiologically [10]. This screening tool should therefore be followed up with a diagnostic test to accurately assess sleep problems in children who score above the cut-off point.

Finally, in the analysis of the linear regression model, the adjusted R2 value was low. JSQ-ES is a form in which parents observe their children's behavior and sleep patterns, and fill out the questionnaire on behalf of the children. In the field of sociology research, it is said that R2 tends to be low because human behavior has a wide range and is difficult to predict. Moreover, it is said that R2 tends to be low when handling large samples [35,36].

4.4. Effect of sex and age on sleep disorders

On the score distribution of JSQ-ES by age and sex (Table 5), boys showed significantly higher scores in the item of SDB than girls. Some research has shown that school-aged boys are affected more by SDB than girls [37,38]. Among adults, most studies have estimated a greater risk of SDB for men than women [39,40]. In another previous report, there was a tendency for complaints of daytime sleepiness to increase with school grade [41]. The current study's results supported this finding.

Gulliford et al. reported that girls have earlier bedtimes and longer sleep duration on schooldays than boys [42]. The item "irregular/delayed sleep phase" showed a tendency for girls more than boys towards the higher the grade level, the higher the score. Going to bed later and waking later on weekends than on weekdays reflects the biology of the circadian rhythm and is also a response to insufficient weekday sleep [43]. Most Japanese children participate in after-school activities, including extra course work, sports lessons, and music lessons, at least once a week. It was reported that Japanese elementary school children who were female and in a higher grade 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 [44]. The current results also supported this finding. The reason is unclear, but girls may spend more time chatting on their cell phones with friends, or doing homework for a longer time than boys. To clarify this, further investigation is needed.

4.5. Sleep problems, lifestyle habits, and media use

It is well known that TV and computer game use before bedtime can have a powerful negative influence on children's sleep and daily life [1]. And it has been reported that time spent on the Internet [45,46], playing video games, and watching TV could affect children's sleep time or sleep hygiene. In a preliminary study, it was found that "viewing time: TV or video" was related to late sleep time. However, in the current study, these factors were significant but low β coefficients, and had small effects for both the total and subscale scores. With respect to sleep disturbances, various factors affect each other in a complex manner; thus, it is unlikely that a single factor would become a major cause.

Going out at night has been shown to correlate with crime and juvenile trauma admissions [47]. In the current study, "going out after 20:00" (not including private tutoring school) showed some correlation with sleep disturbances such as irregular/delayed sleep phase, EDS, insomnia, and RLS. However, the proportion of children who responded yes to "going out after 20:00" was small (3.2–4.1%). In Japan, many students go to private tutoring school until late at night. Rather, various aspects of children's lifestyles, including "going out after 20:00" likely affect sleep in a complex manner.

4.6. Limitations

The current study had several limitations. First, there could have been "parental and retrospective bias" in the responses to items because parents completed the questionnaires based on recollection. More objective methodologies such as polysomnography (PSG) are needed to assess children's sleep, to reduce information bias; however, this is difficult in a large sample. Second, since the study did not include items about history of sleep disorders, developmental disabilities, mental disorders, and past use of central nervous agonist medication that could affect sleep, children with latent and actual sleep disorders may have been present in the community group. The third limitation was that there was a high percentage of SDB children in the disease group. This is because the proportion of SDB patients who visited the hospital was high; however, there is a possibility that the characteristics of the disease group may have been biased. Fourth, as Murata and others reported [13], the sleep habits of Japanese children are largely affected by the family situation; however, this study did not measure the socioeconomic status of each family. The sample came from widespread elementary schools, including schools in high and low latitudes and from urban and suburban areas. Since the study was intended to standardize the questionnaire, it did not examine the association between JSQ-ES scores and bed sharing. An additional study is needed to investigate cultural factors (eg, bed or bedroom sharing) contributing to sleep habits and disturbances.

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Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2017.07.025.

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