Logistic regression analyses were conducted to investigate factors associated with the subscales of the factor structures obtained. The cutoff point of the GHQ-12 scores was set to 4; this is one-third of the full score (12) (Arakida et al., 2003; Fuchino et al., 2003; Shimbo et al., 2005; Kaneita et al., 2007). The mental health status of an individual with four points or greater was defined as poor. Hence, we set the cutoff point of the subscale scores of the factors extracted by factor analysis to one-third of the full score. These subscale scores were then used as a response variable. Gender, grade, subjective sleep assessment, sleep duration, bedtime, difficulty initiating sleep, difficulty maintaining sleep, early morning awakening, eating breakfast, drinking more than once a month, smoking more than once a month, participating in extracurricular activities, and intention of studying at university were used as covariates in these analyses. Adjusted odds ratios (AORs) and 95% confidence intervals were calculated from both the univariate analysis and the multivariate logistic analysis. For all analyses, $p<0.05$ was considered to indicate statistical significance.

The GHQ-12 contains 1 item on sleep. Therefore, when an association between mental health and sleep status is analyzed using a GHQ-12 subscale, a stronger association than the actual one may result. To adjust for this possibility, we excluded the sleep item from the subscale, and calculated the subscale score. Then the statistical analyses mentioned earlier were performed again.

We examined whether it was possible to evaluate mental health status using the GHQ-12 by reducing the number of questions in this questionnaire. For this purpose, we extracted the items with high factor loadings from each factor in the GHQ-12 and calculated the total scores. We then examined the extent to which these scores were able to predict poor mental health status, defined by GHQ-12 scores of 4 points or greater, by evaluating their specificity and sensitivity. We calculated the total scores of the items extracted from the extracted factors and applied the various cutoff definitions.

All analyses except for CFA were performed using SPSS version 11.5 for Windows (SPSS, Inc., Chicago, Ill.).

3. Results

Replies were obtained from 92 of the 131 junior high schools (school response rate = 70.2%) and 87 of the 109 senior high schools (school response rate = 79.8%; combined junior and senior high school response rate = 74.6%). A total of 103,650 envelopes were collected. The student response rate as a proportion of students enrolled at the sampled schools was 88.4% for the junior high schools, 86.3% for the senior high schools, and 87.1% as a whole. Accordingly, the overall response rate was 60.7% for the junior high schools, 67.7% for the senior high schools, and 64.8% as a whole. Of the collected questionnaires, 3982 were excluded because the gender or grade was not specified or the answers for the GHQ-12 were incomplete. The data for the remaining 99,668 questionnaires were analyzed.

The corrected item-total correlation coefficients for the 12 items were all greater than 0.2, which indicated that all the items had similar tendencies.

Factor analysis with promax rotation yielded two factors for both boys and girls (Table 1). For the boys, the eigenvalues for the 1st and 2nd factors were 4.20 and 1.32, respectively. For girls, the eigenvalues for the 1st and 2nd factors were 4.01 and 1.35, respectively. The first two unrotated factors explained 35.0% and 11.0% of the variance in GHQ-12 score in boys and 34.0% and 11.3% in girls.

The 1st factor was designated as depression/anxiety and included the following six items: feel depressed, lose confidence, hardly overcome difficulties, constantly under strain, think yourself worthless, and lose sleep over worry. The 2nd factor was termed loss of positive emotion, and it also included six items: (not) play a useful part, (not) enjoy activities, (not) face up to problems, (not) make decisions, (not) concentrate, and (not) feel reasonably happy. The factor structures for boys and girls were extremely similar.

The total scores of the six items for each of depression/anxiety and loss of positive emotion factors (score range for each factor: 0–6 points) were calculated as subscale scores. Chronbach's alpha coefficient for the depression/anxiety factor was 0.812 (boys: 0.808, girls: 0.806) and that for the loss of positive emotion factor was 0.675 (boys: 0.681, girls: 0.669).

Table 2 shows measures of fit for CFA models. As Model I, we set the one-factor structure by treating the GHQ-12 as unidimensional. As Model II, we set the two-factor structure with free covariance between factors. As Model III, we set the two-factor structure with zero covariance between factors. When compared to the other two models, Model II has higher GFI and AGFI values and lower RMSEA and ECVI values, thus indicating that the two-factor structure with covariance between factors is the most desirable factor structure for the GHQ-12. The standardized estimate scores of model II are shown in Table 3.

The mean values (mean ± standard deviation (S.D.)) for the depression/anxiety scores were 2.02 ± 1.99 for boys and 2.67 ± 2.07 for girls. The mean values (mean ± S.D.) for the loss of positive emotion scores were 1.21 ± 1.45 for boys and 1.24 ± 1.47 for girls. The results of the Mann–Whitney *U*-test of differences between boys

Table 1
Promax rotated factor structures on the GHQ-12.

	Boys ($n=54,355$)		Girls ($n=45,313$)	
GHQ-12 item	Factor 1	Factor 2	Factor 1	Factor 2
9. Depressed	**0.83**	−0.08	**0.84**	−0.09
10. Lose confidence	**0.78**	−0.08	**0.77**	−0.08
6. Hardly overcome difficulties	**0.61**	0.07	**0.61**	0.07
5. Constantly under strain	**0.58**	0.06	**0.60**	0.03
11. Think yourself worthless	**0.51**	0.11	**0.51**	0.10
2. Lose sleep over worry	**0.45**	0.06	**0.42**	0.12
3. (Not) play a useful part	−0.07	**0.63**	−0.07	**0.61**
8. (Not) face up to problems	0.05	**0.59**	0.07	**0.55**
7. (Not) enjoy activities	0.10	**0.58**	0.07	**0.59**
4. (Not) make decisions	0.08	**0.49**	0.08	**0.46**
1. (Not) concentrate	0.05	**0.39**	0.07	**0.36**
12. (Not) feel reasonably happy	−0.04	**0.39**	−0.06	**0.42**
Correlation between factors	0.63		0.60	

Factor 1, depression/anxiety; factor 2, loss of positive emotion. **Bold** values >0.30 in factor loadings.
Abbreviation: GHQ-12, 12-item General Health Questionnaire.

Table 2
Measures of fit from confirmatory factor analysis (CFA).

	Sample	GFI	AGFI	RMSEA	ECVI
Model I (one factor)	Boys	0.916	0.879	0.089	0.433
	Girls	0.917	0.881	0.089	0.431
Model II (Two factor)[a]	Boys	0.975	0.964	0.052	0.146
	Girls	0.974	0.962	0.054	0.156
Model III (Two factor)[b]	Boys	0.936	0.907	0.092	0.455
	Girls	0.938	0.911	0.089	0.432

Abbreviation: GIF, goodness-of-fit index; AGFI, Adjusted GFI; RMSEA, root-mean-square error of approximation; and ECVI, expected cross-validation index
Boys: 54,355 boys, girls: 45,313 girls.
[a] Model II: two factors with free covariance between factors.
[b] Model III: two factors with zero covariance between factors.

Table 3
Standardized estimate scores of model II (two factors with free covariance between factors).

	Boys ($n=54,355$)		Girls ($n=45,313$)	
GHQ-12 item	Factor 1	Factor 2	Factor 1	Factor 2
9. Depressed	0.77		0.77	
10. Lose confidence	0.73		0.71	
6. Hardly overcome difficulties	0.65		0.65	
5. Constantly under strain	0.62		0.63	
11. Think yourself worthless	0.60		0.58	
2. Lose sleep over worry	0.49		0.50	
3. (Not) play a useful part		0.54		0.53
8. (Not) face up to problems		0.64		0.61
7. (Not) enjoy activities		0.67		0.64
4. (Not) make decisions		0.54		0.52
1. (Not) concentrate		0.43		0.41
12. (Not) feel reasonably happy		0.36		0.37
Correlation between factor	0.67		0.65	

Factor 1, depression/anxiety; factor 2, loss of positive emotion.

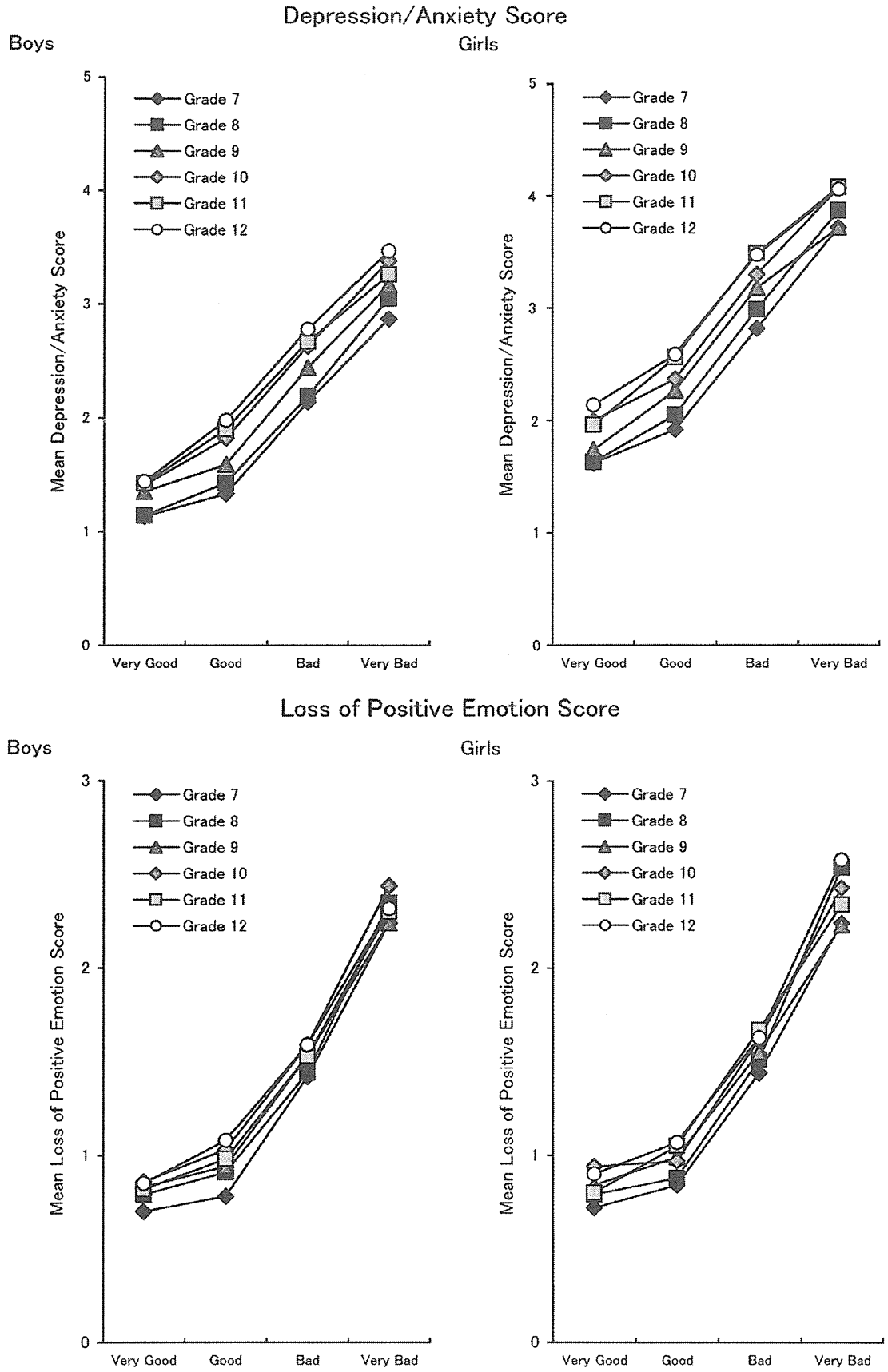

Fig. 1. Relationship between subjective assessment and factor scores by gender and school grade.

and girls with regard to the mean values of both the depression/anxiety and loss of positive emotion factor scores (depression/anxiety: $U=1{,}007{,}494{,}912$, $p<0.01$; loss of positive emotion: $U=1{,}217{,}609{,}088$, $p<0.01$) were significant. The calculation of the effect size indicated that "depression/anxiety" has a small effect size ($r=0.17$, 0.10<, >0.30) and "loss of positive emotion" has non-substantial effect size ($r=0.011$; <0.10). We defined the subscale scores of 2 or greater for each factor as "depression/anxiety" and "loss of positive emotion" and then calculated the distributions of these scores. High "depression/anxiety" was observed among 55.6% of the students (boys: 49.1%, girls: 63.3%) and "loss of positive emotion" was observed among 31.2% of the students (boys: 30.5%, girls: 32.0%). The results of the χ^2 test indicated that a greater proportion of girls than boys showed "depression/anxiety" and "loss of positive emotion" (depression/anxiety: $\chi^2=2004.60$, d.f. = 1, $p<0.001$; loss of positive emotion: $\chi^2=23.36$, d.f. = 1, $p<0.001$). The effect size of gender differences was found to be small ($\varphi=0.142$) with regard to "depression/anxiety" and substantially none ($\varphi=0.015$) with regard to "loss of positive emotion".

The association of depression/anxiety and loss of positive emotion with subjective sleep assessment by school grade and gender is shown in Fig. 1. In both boys and girls of all school grades, the scores for depression/anxiety and loss of positive emotion increased with the worsening of the subjective sleep assessment scores.

Figures indicating the association of depression/anxiety and loss of positive emotion with sleep duration by school grade and gender are shown in Fig. 2.

In both boys and girls of all school grades, depression/anxiety scores increased with a decrease in sleep duration. Although depression/anxiety scores gradually decreased with an increase in sleep duration, for sleep durations of 7 h or more barely any difference was observed between the depression/anxiety scores. Unlike the scores for the depression/anxiety factor, the loss of positive emotion scores increased substantially when sleep duration was 8 h or more. In both boys and girls of all school grades, a clear U-shaped association was observed between loss of positive emotion and sleep duration.

The results of the logistic regression analysis demonstrated that the variables that showed significant associations with both depression/anxiety and loss of positive emotion were gender, school grade, subjective sleep assessment, sleep duration, difficulty in initiating sleep, difficulty in maintaining sleep, early morning awakening, and smoking (Table 4). The association of depression/anxiety and loss of positive emotion with sleep duration demonstrated different patterns. The adjusted odds ratio for the association of depression/anxiety with short sleep duration was high, whereas that for the association of loss of positive emotion with both short and long sleep duration was high. Some factors were associated with either depression/anxiety or loss of positive emotion. Bedtime, alcohol consumption, and a desire to pursue university education were associated only with depression/anxiety. In contrast, skipping breakfast and lack of participation in club activities were associated only with loss of positive emotion. After eliminating one item regarding insomnia from the six items pertaining to depression/anxiety, a similar analysis was conducted for the remaining five items. Results similar to those mentioned above were obtained for the association between depression/anxiety and sleep.

We selected three items whose factor loadings were high: two items (feeling depressed and lose confidence) from the depression/anxiety factor and one item (not play a useful part) from the loss of positive emotion factor, and termed these three items the GHQ-3. Subsequently, we selected one item (feel depressed) from the depression/anxiety factor and another item (not play a useful part) from the loss of positive emotion factor, and termed these two items the GHQ-2. Table 5 indicates how precisely the total scores of the items extracted from the two factors can predict the total score which is four points or more of the GHQ-12. When the cutoff point is one point for the GHQ-2, both the specificity and the sensitivity are 80% or more.

4. Discussion

The features of this study were as follows: (1) data obtained from a nationwide survey were employed, (2) the sample size was large (about 100,000), (3) mental health status was assessed using the GHQ-12, whose validity has already been established, (4) the factor structure of the GHQ-12 was examined, and (5) specific associations between the factors extracted in this study and sleep/lifestyle were clarified. To our knowledge, no analogous studies have been reported previously.

Previous factor analysis studies of translated versions of the GHQ-12 yielded Two factors. Werneke et al. (2000) reviewed previous factor analysis studies of the GHQ-12 conducted worldwide and indicated that 10 of 15 studies had yielded a two-factor solution. Hu et al. (2007) administered the GHQ-12 to a representative sample population in the UK, conducted factor analyses, and demonstrated that two factors were extractable, as was the case in our study. Doi and Minowa (2003) analyzed the data obtained from a representative Japanese adult population and demonstrated a two-factor solution: a group of items expressing depression/anxiety and a group of items expressed by positive sentences. However, they reported that a 3rd factor consisting of two items (not feel reasonably happy and not play a useful part) was evident in men. This result differed from ours in that two factors were obtained for both boys and girls. This difference in the results may be attributable to the differences in the age groups (adults and adolescents) of the subjects investigated in the two studies.

Several previous GHQ-12 factor analysis studies of adolescents have been carried out in which two or three factors were extracted (Graetz, 1991; Politi et al., 1994; López-Castedo and Fernández, 2005). However, unlike our study, none of these studies used representative, large-scale samples. Based on our present results for adolescents and the results of the study on the general Japanese adult population, it may be considered that regardless of the age group (adolescents or adults) evaluated, at least two different latent factors (depression/anxiety and loss of positive emotion) are included in evaluation of mental health status using the GHQ-12. Good mental health is defined not only by an absence of depression/anxiety, but also by good physical health, cognitive health, and human relationships. It is thus important to consider the above-mentioned two facets of mental health when evaluating an individual's mental health status (Danner et al., 2001; Huppert and Whittington, 2003; Keyes, 2005; Hu et al., 2007). Use of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) for diagnosis of mental disorders has indicated that "depressive mood" and "loss of interest or pleasure" are principal features of a major depressive episode (American Psychiatric Association, 2000). The manual stipulates that either of these two symptoms needs be exhibited for diagnosis of a major depressive episode. The fact that our factor analysis of the GHQ-12 yielded a two-factor solution (depression/anxiety and loss of positive emotion) indicates that mental health status determined by the GHQ-12 is analogous to the symptoms of major depressive episode diagnosed by the DSM-IV. The results of the present study suggest that measurement of both depression/anxiety and loss of positive emotion may be effective in medical interviews for evaluating an individual's mental health status or for examination of the effects of treatment.

Previous studies have indicated that the deterioration of an individual's mental health status is caused by depression/anxiety and loss of positive emotion (Danner et al., 2001; Huppert and Whittington, 2003; Keyes, 2005; Hu et al., 2007; American Psychiatric Association, 2000). However, no epidemiological study has investigated the sleep and lifestyle habits associated with these two factors. Hence, the present study yielded important findings for understanding the mental health status of adolescents. We found that worsening of subjective sleep sufficiency and a sleep duration of less than 7 h were associated with depression/anxiety and loss of positive emotion,

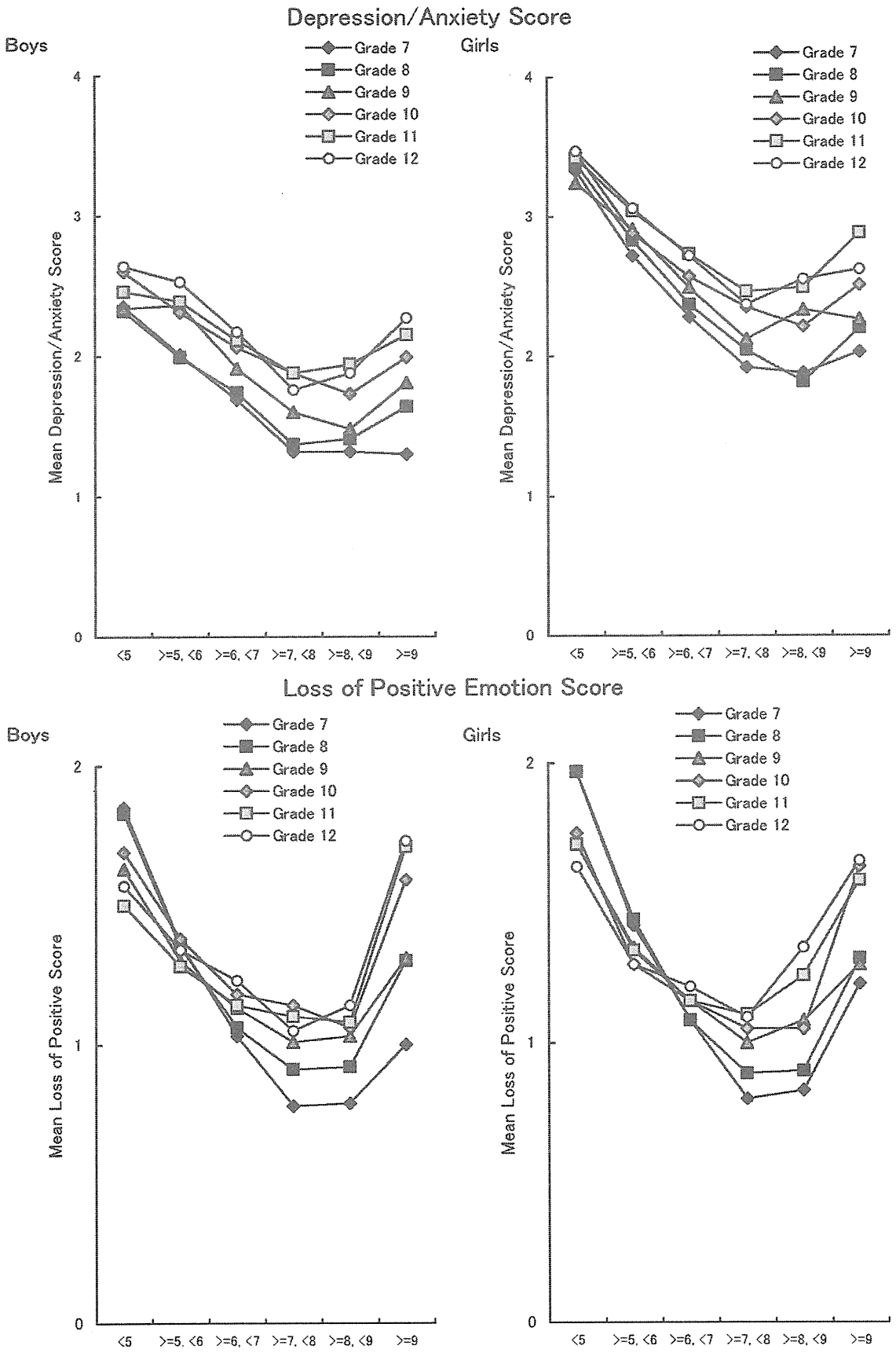

Fig. 2. Relationship between sleep duration and factor scores by gender and school grade.

Table 4
Logistic regression result: variables predicting depression/anxiety and loss of positive emotion in a sample of Japanese adolescents ($N = 99,668$).

Variable	N	Depression/anxiety			Loss of positive emotion		
		AOR	95% CI	p value	AOR	95% CI	p value
Gender							
Male	54,355	1.00			1.00		
Female	45,313	1.86	1.81 to 1.92	<0.01	1.08	1.05 to 0.11	<0.01
Grade							
7	12,670	1.00			1.00		
8	12,654	1.02	0.97 to 1.08	0.38	1.10	1.04 to 1.17	<0.01
9	12,766	1.24	1.17 to 1.31	<0.01	1.10	1.04 to 1.18	<0.01
10	21,282	1.36	1.29 to 1.44	<0.01	1.23	1.16 to 1.31	<0.01
11	21,034	1.45	1.37 to 1.53	<0.01	1.17	1.11 to 1.25	<0.01
12	19,262	1.53	1.44 to 1.62	<0.01	1.18	1.11 to 1.26	<0.01
Subjective sleep assessment							
Very good	14,867	1.00			1.00		
Good	44,277	1.40	1.34 to 1.46	<0.01	1.23	1.17 to 1.29	<0.01
Bad	32,923	2.55	2.44 to 2.68	<0.01	2.28	2.16 to 2.40	<0.01
Very bad	5596	3.68	3.38 to 4.00	<0.01	3.82	3.52 to 4.13	<0.01
Sleep duration, h							
<5	14,757	1.24	1.16 to 1.32	<0.01	1.19	1.12 to 1.27	<0.01
≧5, <6	17,563	1.22	1.16 to 1.29	<0.01	1.07	1.01 to 1.14	0.02
≧6, <7	40,030	1.13	1.08 to 1.18	<0.01	1.09	1.04 to 1.14	<0.01
≧7, <8	15,151	1.00			1.00		
≧8, <9	7416	0.99	0.93 to 1.05	0.78	1.08	1.01 to 1.16	0.03
≧9	3002	1.08	0.98 to 1.18	0.11	1.52	1.38 to 1.67	<0.01
Bedtime							
Before 10 p.m.	4332	1.00			1.00		
10 p.m.–11 p.m.	12,044	1.04	0.96 to 1.12	0.39	0.94	0.86 to 1.03	0.20
11 p.m.–midnight	34,925	1.01	0.94 to 1.10	0.72	0.95	0.88 to 1.04	0.28
Midnight–1 a.m.	23,870	1.02	0.94 to 1.11	0.58	0.95	0.87 to 1.04	0.23
1 a.m.–2 a.m.	14,345	1.00	0.92 to 1.09	0.98	0.94	0.85 to 1.03	0.17
After 2 a.m.	8490	0.90	0.82 to 0.99	0.03	0.94	0.85 to 1.04	0.24
Difficulty initiating sleep							
Never/seldom/sometimes	83,296	1.00			1.00		
Often/always	14,802	1.81	1.73 to 1.89	<0.01	1.60	1.54 to 1.67	<0.01
Difficulty maintaining sleep							
Never/seldom/sometimes	86,914	1.00			1.00		
Often/always	11,258	1.58	1.50 to 1.66	<0.01	1.44	1.37 to 1.50	<0.01
Early morning awakening							
Never/seldom/sometimes	94,136	1.00			1.00		
Often/always	5467	1.68	1.56 to 1.81	<0.01	1.55	1.46 to 1.66	<0.01
Eating breakfast							
Daily	76,860	1.00			1.00		
Occasionally	10,219	1.03	0.99 to 1.08	0.17	1.10	1.05 to 1.15	<0.01
Never	6822	1.01	0.95 to 1.07	0.80	1.25	1.18 to 1.32	<0.01
Drinking more than once a month							
No	69,775	1.00			1.00		
Yes	29,412	1.10	1.07 to 1.14	<0.01	0.97	0.94 to 1.00	0.06
Smoking more than once a month							
No	89,301	1.00			1.00		
Yes	9276	1.13	1.07 to 1.19		1.11	1.05 to 1.17	
Participating in extracurricular activities							
No	32,204	1.00			1.00		
Yes	65,440	1.03	0.99 to 1.06	0.11	0.77	0.75 to 0.80	<0.01
Intention of studying at university							
No	57,536	1.00			1.00		
Yes	40,389	1.14	1.10 to 1.18	<0.01	0.99	0.95 to 1.02	0.50

In each section, the missing data have been excluded from the statistical analyses.
Depression/anxiety has been defined as a negative emotion score ≧2.
Loss of positive emotion has been defined as a loss of positive emotion score ≧2.
All the items included in this table were input as covariates in the logistics model.
Abbreviation: AOR = adjusted odds ratio.

but that a sleep duration of 8 h or more was associated only with the loss of positive emotion. In our previous study, we demonstrated a U-shaped association between mental health status and sleep duration (Kaneita et al., 2006, 2007). However, in the present study, it was clarified that the U-shaped association was evident only between sleep duration and loss of positive emotion, and was not evident between sleep duration and depression/anxiety. This result suggests that a long sleep duration may suppress feelings of happiness and impair mental function, thus inducing poor mental health. It has been reported that subjects who were experimentally subjected to a pattern of long sleep duration complained of sleepiness, lethargy, and feeling worn out (Globus, 1969, 1970; Hartmann et al., 1971). This suggests that long sleep duration may have deleterious effects on mental health. On the other hand, there may also be an opposite causal relationship, i.e., loss of positive emotion may result in earlier bedtime or late waking up time, leading to longer sleep duration. Furthermore, a third factor such as disease or physical impairment may affect both loss of positive emotion and an increase of sleep duration. Thus, further examinations are required in order to clarify the causal relationships between long sleep duration and loss of positive emotion.

In this study, some factors such as smoking and symptoms of insomnia were associated with both depression/anxiety and loss of

Table 5
Specificity and sensitivity of selected items from GHQ-12 for predicting poor mental health defined as a GHQ-12 score of 4 points or greater.

Index	Cutoff	Sample	Specificity	Sensitivity
GHQ-3	1point(0/1)	All	76.7	93.9
		Boys	80.6	92.2
		Girls	71.0	95.6
	2 point(1/2)	All	95.2	74.5
		Boys	96.5	70.0
		Girls	93.3	78.7
GHQ-2	1 point(0/1)	All	87.0	85.1
		Boys	89.9	81.5
		Girls	82.7	88.4
	2 point(1/2)	All	99.9	26.0
		Boys	99.9	26.4
		Girls	99.8	25.6

GHQ-3: 2 items (feeling depressed and lose confidence) from the depression/anxiety factor and 1 item (not play a useful part) from the loss of positive emotion factor.
GHQ-2:1 items (feeling depressed) from the depression/anxiety factor and 1 item (not play a useful part) from the loss of positive emotion factor.
All: 54,355 boys and 45,313 girls.

positive emotion. Interestingly, however, some differences were observed in the associations between these two factors and lifestyle habits. For example, the odds ratios with regard to loss of positive emotion for skipping breakfast and for lack of participation in club activities were significantly high; however, these two factors did not show significant associations with depression/anxiety. Moreover, previous studies reported that alcohol consumption was a factor affecting the mental health of adolescents (Hallfors et al., 2004; Saluja et al., 2004; Verdurmen et al., 2005). However, alcohol drinking was not significantly associated with loss of positive emotion although it did increase the odds ratio for depression/anxiety significantly. Furthermore, a desire to pursue a university education was associated only with depression/anxiety and not with a loss of positive emotion. As for the reason why some of lifestyle habits can be associated only with "depression/anxiety" or only with "loss of positive emotion", the causal relationship cannot be explained based on the results of this cross-sectional survey. As a possible assumption for this, the occurrence of the negative life events such as illegal alcohol consumption and severe competition in entrance examinations may contribute to depression/anxiety, while the positive life events such as skipping breakfast and lack of participation in club activities may be associated with loss of positive emotion.

The above-mentioned lifestyle factors associated with poor mental health differ according to the two types of mental health status. This finding is important from the viewpoint of health guidance provided by schools. For those students who complain of a loss of positive emotion, encouraging them to participate in a club activity may be effective. It has been reported that participation in club activities is associated with improvement of self-efficacy and well-being (Sonstroem, 1984; Kirkcaldy et al., 2002). The longitudinal study has also indicated that the amount of exercise during the ages of 15 and 16 can predict the mental health performance at the ages of 18 and 19 (Sagatun et al., 2007). It is important that future school health policies should be formulated on the basis of the present results.

A simplified version of the GHQ-12 can be created by clarifying the factor structure of this questionnaire. By extracting items from the depression/anxiety and loss of positive emotion factors, a simplified version of the GHQ-12 can be created. With this questionnaire, the mental health status of individuals reflecting the effects of the two factors can be evaluated in a shorter period of time. This questionnaire can serve as a very effective screening instrument in epidemiological surveys and healthcare settings. In this study, we predicted the mental health status of subjects whose GHQ-12 scores were 4 points or greater, using the GHQ-2 scores. The GHQ-2 scores were calculated by summing the scores of the two items that had been extracted from each from the two factors. The cutoff point for the GHQ-2 was defined as 1 point. The specificity and sensitivity of this questionnaire were sufficiently high at 87.0% and 85.1%, respectively. From this result, it is inferred that the total score for the two items, one extracted respectively from depression/anxiety and loss of positive emotion, can be a useful index for the evaluation of mental health status. This study demonstrated that analysis of subjects with regard to only two items of the GHQ-2 (whether the subject was more depressed than usual and enjoyed activities) was sufficient for prediction of mental health status. In the event of space constraints in the GHQ-12 questionnaire or time limitations when implementing this questionnaire, we believe that using these two questions in preference to the GHQ-12 items should be effective in evaluating the mental health status.

There were some limitations to this study. First, since this was a cross-sectional survey, a causal relationship could not be determined. When examining a causal relationship, a longitudinal study such as a cohort study is required, and such a study will be required in the future. Second, physiological measurements such as electroencephalography could not be employed to obtain the objective data for the evaluation of sleep status. However, such measurements, although desirable, are not normally included in epidemiological studies because of the very large number of subjects involved. Furthermore, several reports have stated that self-reported data on sleep status are consistent with physiological data to a certain degree (Frankel et al., 1976; Hoch et al., 1987). Third, the items included in our questionnaire did not incorporate all the factors that are considered to affect sleep. For example, noise levels at night, the person/s with whom a subject sleeps, and commuting time to school are all possible factors that could affect a subject's sleep. However, we were unable to include them in the questionnaire because of space limitations, and these items will need to be examined in the future. Fourth, there may have been a non-response bias. The rate of response to the questionnaire in this study was 64.8%; therefore, approximately 35% of the subjects did not participate in the survey. In Japan, people below 20 years of age are prohibited by law from smoking and drinking alcohol. Therefore, schools and individual students tend to be non-cooperative in responding to any survey that includes questions on smoking and drinking alcohol. This reluctance may be the main reason for the high level of non-responsiveness. However, there is a possibility that students with poorer mental health did not participate in this survey. Fifth, we defined "smoking one day or more" as "smoking" and "consuming an alcoholic beverage one day or more" as "drinking alcohol" similarly. Smoking one cigarette or having one alcoholic drink per month itself has little pharmacological effect or lifestyle significance. Therefore, it can be interpreted that indulging in these habits with the knowledge that they are illegal may have deleterious effects on mental health. Sixth, a question on excessive daytime sleepiness (EDS) was not included in the questionnaire used. It is known that chronic sleep insufficiency may induce EDS or mood and behavior problems among adolescents (Carskadon, 1990, 2004). The association between short sleep duration and poor mental health recognized in the present study may be explained by EDS. In future studies, associations between sleep habits and mental health status among adolescents should be examined by taking EDS into consideration. Seventh, an analysis that took into consideration the hierarchical structure of the dataset was not conducted in this study. If a multilevel analysis had been performed, which covered the characteristics of the households, schools, and regions to which the students belonged, the effects of not only the students' individual characteristics but also those of the demographic/socioeconomic structure on the mental health performance could have been clarified. Unfortunately, we did not have data on the hierarchical structure. In our future studies, we need to collect data on these points and to also discuss the effects of the hierarchical structure.

In this study, factor analysis of the GHQ-12 was performed using the data obtained from a questionnaire survey conducted on a

representative sample population of approximately 100,000 Japanese adolescents. The survey yielded a two-factor solution: depression/anxiety and loss of positive emotion. It was indicated that poor subjective sleep assessment and short sleep duration influenced both depression/anxiety and loss of positive emotion. In contrast, long sleep duration was observed to be associated only with loss of positive emotion. Some lifestyle habits such as smoking were associated with both depression/anxiety and loss of positive emotion. Other lifestyle habits such as alcohol consumption and participation in club activities were associated with either of the two factors. Therefore, while providing health guidance to adolescents, it is necessary to observe them from the viewpoint of the two latent factors (depression/anxiety and loss of positive emotion). This would provide a rational basis for guidance about sleep and lifestyle habits according to the mental health status of the individual.

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Original Article

Nightmare and sleep paralysis among Japanese adolescents: A nationwide representative survey

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ABSTRACT

Objective: The objective of this study was to clarify the prevalence of nightmares and sleep paralysis and associated factors among Japanese adolescents.
Methods: This study was designed as a cross-sectional sampling survey. The targets were junior and senior high schools throughout Japan. Self-reported anonymous questionnaires were sent to schools for all students to complete.
Results: A total of 90,081 questionnaires were analyzed. The overall response rate was 62.6%, and the prevalence of nightmares and sleep paralysis was 35.2% and 8.3%, respectively. Multiple logistic analyses revealed that female sex, drinking alcohol, poor mental health, difficulty initiating sleep, low subjective sleep assessment, presence of excessive daytime sleepiness, and presence of sleep paralysis had higher odds ratios than others for nightmares. Male sex, poor mental health, drinking alcohol, taking a long daytime nap, early or late bedtime, difficulty initiating sleep, low subjective sleep assessment, presence of excessive daytime sleepiness, and presence of nightmares had higher odds ratios than other factors for sleep paralysis.
Conclusions: This study has revealed the prevalence of nightmares and sleep paralysis among Japanese adolescents. Furthermore, the results of this study suggest that it is important to maintain regular sleep habits for preventing these symptoms. We propose that health education about regular sleep habits should be promoted among Japanese adolescents.

1. Introduction

Various reports indicate that sleep disturbances increase the risk of various physical and mental problems [1–4] and that one-fifth of Japanese adults suffer from some kind of sleep disturbance [2]. Sleep disturbances are prevalent not only among adults but also among 10–40% of adolescents [5–7]. The research team of Ohida et al. has performed large-scale epidemiological studies on the sleep status of Japanese adolescents [8,9]. In a survey of approximately 106,300 Japanese junior high and high school students, 30.6% reported an average sleep duration of less than 6 h per night. Of these, 12.5% reported excessive daytime sleepiness (EDS), and 40% were not satisfied with their sleep quality [8]. Another survey reported that 23.5% of adolescents experienced symptoms of insomnia [9]. However, most studies of sleep disturbances among adolescents have focused on sleep deprivation and insomnia; other types of sleep disturbances have not been adequately addressed.

Parasomnias are a group of symptoms associated with problematic behavior or phenomena during sleep and can be divided into non-REM (rapid eye movement) and REM sleep parasomnias [10]. REM sleep parasomnias include REM sleep behavior disorder, nightmares, and sleep paralysis. Parasomnias disturb nighttime sleep [10]. Among these, the interrelated phenomena of nightmares and sleep paralysis are more important because their prevalence is higher than that of REM sleep behavior disorder [11]. The

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concepts of nightmares and sleep paralysis are well-known in Japanese culture; sleep paralysis is referred to as "kanashibari" [12].

A nightmare is the disruption of sleep by a dream associated with negative emotions (anxiety, fear, anger, etc.) during REM sleep, which results in frequent awakening [10]. The pathophysiological mechanisms of nightmares have not been clarified in detail. It has been reported that the heart and respiration rates increase during REM sleep, which is disturbed by nightmares [13]. Approximately 50–90% of the general population experience nightmares at some time [11,14,15]. Two surveys conducted on children aged 5–12 years revealed that 20–30% of the children had experienced nightmares at least once during the previous 6 months [16,17], indicating that nightmares are common in childhood. In a study of adolescents, Nielsen et al. found that those who had experienced nightmares in the previous year accounted for 25% and 40% of 13-year-old boys and girls, respectively, and 20% and 40% of 16-year-old boys and girls, respectively [18]. In addition, some reports have indicated that the occurrence of nightmares increases in early adolescence and decreases from late adolescence to early adulthood [19–22].

Sleep paralysis, a state in which the patient is unable to move the limbs and trunk although he/she is conscious, is often experienced by narcoleptic patients [11]. Hishikawa et al. reported that, in narcoleptic patients, sleep paralysis occurs during sleep onset REM (SOREM) [23]. However, it has been clarified that sleep paralysis affects normal individuals in addition to narcoleptic patients and tends to occur during SOREM in normal individuals too [24]. The lifetime prevalence of sleep paralysis was also found to be high (6–40%) [12,25–28]; although the range varied in different studies. The rate of onset of a first episode of sleep paralysis was reported to begin increasing at approximately 14 years of age and to peak at 17–19 years [12,27].

On the basis of these findings, it is inferred that nightmares and sleep paralysis are experienced not only by adults but also by adolescents, and that the rates of onset of first episodes of these disturbances increase among adolescents. One of the reasons for this could be that developmental factors and lifestyle-related and environmental changes affect the occurrence of nightmares and sleep paralysis. To date, however, no nationwide study of nightmares and sleep paralysis has been conducted using large-scale samples of adolescents; in fact, little is known about the factors associated with these disturbances. Therefore, in the present study, we conducted a nationwide survey of Japanese junior high and high school students in order to examine the prevalence of nightmares and sleep paralysis and to examine other associated factors.

2. Methods

2.1. Subjects and sampling

We previously conducted three cross-sectional nationwide surveys (1996, 2000, and 2004) of lifestyle habits such as alcohol drinking, smoking, eating, and sleeping among Japanese adolescents. The present study was the fourth such survey.

For this study, of the 10,921 junior high schools and 4500 senior high schools registered in Japan in May 2006, 130 junior high schools (selection rate: 1.2%) and 109 senior high schools (selection rate: 2.4%) were sampled. We used a stratified, single-stage cluster sampling method. Using this method, we divided Japan into regional blocks and randomly selected schools from each block. To avoid sampling bias toward any regional blocks, stratified sampling was performed with regional blocks as the strata. All the students enrolled in the sampled schools were the subjects of this study. The sample size was determined by referring to the response rate and confidence intervals (CIs) based on the variance of the results obtained from the three previous studies.

In the Japanese education system, children enter primary school at the age of 6 years and leave after 6 years of study. They then enter junior high school for 3 years of study, followed by a further 3 years at senior high school. Primary and junior high school education is compulsory. In this report, the first to third years of junior high school are called the 7th to 9th grades, and the first to third years of senior high school are called the 10th to 12th grades.

2.2. Survey procedure

We sent a letter to the principal of each selected school asking for cooperation in our survey, along with the same number of questionnaires and envelopes as the number of students enrolled at the school. At each school that agreed to participate in our survey, each class teacher was instructed to protect the privacy of the respondents, and — as stated on the questionnaire — to explain to the students that the completed questionnaires would not be seen by the teachers, and that it was not necessary for students to participate if they were not willing. After the questionnaires had been filled in, they were placed in the envelopes provided, which were then sealed with an adhesive flap. Delivery and collection of the questionnaires were entrusted to the teachers, who were instructed to follow the guidelines for conducting the survey. The teachers collected and sent the sealed envelopes back to the Nihon University School of Medicine without opening them. The survey period was from December 2007 to the end of January 2008. This survey was approved by the Ethics Committee of the Nihon University School of Medicine.

2.3. Response rates

Replies were obtained from 89 of the 130 junior high schools (school response rate = 68.5%) and 79 of the 109 senior high schools (school response rate = 72.5%; combined junior high and senior high school response rate = 70.3%). A total of 90,361 envelopes were collected. The student response rate as a proportion of students enrolled at the sampled schools was 93.8% for the junior high schools, 87.8% for the senior high schools, and 90.1% as a whole. Accordingly, the overall response rate was 62.8% for the junior high schools, 62.3% for the senior high schools, and 62.6% as a whole. The response rates obtained in this study are similar to those obtained in previous studies using the same study method [8,9]. In the calculation of this response rate, the denominator represented the number of all the students enrolled in the sampled schools; the number of students absent from the schools on the day of the survey was not subtracted from the total number of enrolled students but was treated as the number of invalid responses. This may have potentially lowered the response rate.

Of the collected questionnaires, 280 were excluded because the sex or grade was not specified or the answers were inconsistent. The data for the remaining 90,081 questionnaires were analyzed.

2.4. Measures

The major areas that were included in the questionnaire were (1) personal data, (2) lifestyle (3) sleep status, and (4) mental health status. The following questions about nightmares and sleep paralysis were embedded in the questionnaire.

The question about nightmares was "Have you been wakened by a nightmare during the previous month? (never/seldom/sometimes/often/always)." "Seldom," "sometimes," "often," and "always" were taken as affirmative answers to the question.

The question about sleep paralysis was "Have you experienced 'kanashibari' that hands and feet and body cannot move when waking up or falling asleep during the previous month? (yes/no)."

"Yes" was taken as an affirmative answer to the question. "Kanashibari" means sleep paralysis in Japanese.

2.4.1. Personal data

The personal data included sex, school grade, and type of school (junior high school/senior high school).

2.4.2. Lifestyle

The questions related to lifestyle were whether the student ate breakfast (daily/occasionally/never), and available amount of money (less than ¥5000/¥5000 or more [¥5000 is about $56]). Moreover, the question, "How many days did you smoke in the past month?" was included in the questionnaire. If the response to this question was "One day or more," then the student was defined as "smoking." Similarly, the question "How many days did you consume alcoholic beverages in the past month?" was asked, and if the response was "One day or more," then the student was defined as "drinking alcohol."

2.4.3. Sleep status

The sleep status items included sleep duration, bedtime, naptime, subjective sleep assessment, difficulty initiating sleep, and excessive daytime sleepiness (EDS). The question about sleep duration was "How many hours on average have you slept at night during the previous month? (less than 5 h/5 h or more but less than 6 h/6 h or more but less than 7 h/7 h or more but less than 8 h/8 h or more but less than 9 h/9 h or more." The question about bedtime was "What time did you go to bed on average during the previous month? (Before 10 p.m./10 p.m. or after but before 11 p.m./11 p.m. or after but before midnight/midnight or after but before 1 a.m./1 a.m. or after but before 2 a.m./2 a.m. or after)." The question about naptime was "How long was your naptime on average during the previous month?" (nothing/less than 15 min/15 min or more but less than 30 min/30 min or more but less than 1 h/1 h or more but less than 2 h /2 h or more)." The question about subjective sleep assessment was "How do you assess the quality of your sleep during the previous month? (very good/good/bad/very bad)." The question about difficulty initiating sleep was "Have you had difficulty initiating sleep at night during the previous month? (never/seldom/sometimes/often/always)." We evaluated EDS using the Japanese version of the Epworth Sleepiness Scale (ESS) [29,30]. The ESS comprises eight questions. By summing the scores (0–3) for each question, the total scores (0–24) were calculated. The higher the total score, the more severe daytime sleepiness was considered to be. People with ESS scores of 11 or higher are considered to have excessive daytime sleepiness. This cutoff point was also adopted in the present study.

2.4.4. Mental health status

To evaluate the mental health statuses of the respondents, two independent factors ("depression/anxiety" and "decrease in positive feeling") included in the 12-item General Health Questionnaire (GHQ-12) [31,32] were used, and one item from each factor was selected for the total score. One of the items from the "depression/anxiety" factor (whether the respondent had felt an unusual amount of unhappiness and depression in the previous 30 days) was evaluated (possible options: not at all; no more than usual; more than usual; much more than usual). One of the items from the "decrease in positive feeling" factor (whether the respondent was able to enjoy normal activities more than usual in the previous 30 days) was evaluated (possible options: more so than usual; same as usual; less than usual; much less than usual). Each item described a symptom, and there were four possible answers: the two answers that indicated absence of the symptom were assigned a rating of 0; the two answers that indicated presence of the symptom were assigned a rating of 1. Thus, the overall score fell within the range of 0–2, and accordingly, the higher the total score, the poorer the state of mental health. In the present study, participants who had total scores of 1 or more were considered to have poor mental health. Previous studies have shown that evaluation of mental health status using depression symptoms with the GHQ-12 and with this cutoff point has a sensitivity of 87.0% and a specificity of 85.1% [33].

2.5. Statistical analyses

The presence of nightmares and sleep paralysis during the previous month was defined when an affirmative answer was obtained for each respective item.

First, the prevalence of nightmares and sleep paralysis and the 95% CI (confidence interval) were calculated. Then, the prevalences of both in relation to sex and grade were calculated. Moreover, the associations between nightmares and sleep paralysis during the previous month and personal, lifestyle, sleep status, and mental health status were examined. The significance of categorical data, such as the prevalence of nightmares and sleep paralysis, was analyzed using the chi-squared test. Finally, multiple logistic regression analyses were performed to examine separately the factors associated with nightmares or sleep paralysis during the previous month. We set the level of significance at $P < 0.001$. All analyses were performed using SPSS version 11.5 for Windows (SPSS, Inc., Chicago, IL).

3. Results

3.1. Prevalence of nightmares and sleep paralysis

The prevalence (95% CI) of nightmares was 35.2% (34.9–35.5%) in the total sample: 30.3% (29.9–30.7%) among males, and 39.9% (39.4–40.4%) among females (Table 1). A statistically significant difference was observed between males and females ($P < 0.001$) and grades ($P < 0.001$). Among males, the prevalence of nightmares increased gradually from 10th to 12th grade. Among females, the prevalence of nightmares increased gradually from 7th to 9th grade, decreased in the 10th grade, and then gradually increased again toward the 12th grade.

The prevalence (95% CI) of sleep paralysis was 8.3% (8.1–8.5%) in the total sample: 8.2% (7.9–8.5%) among males, and 8.3% (8.0–8.6%) among females (Table 1). No statistically significant difference was observed between males and females ($P = 0.49$). A statistically significant difference was observed between grades ($P < 0.001$). Among both males and females, the prevalence of sleep paralysis increased gradually from 7th to 12th grade, except only in the 11th grade among males.

3.2. Associations between nightmares and personal, lifestyle, sleep status, and mental health status

The associations between the prevalence of nightmares and personal, lifestyle, sleep status, and mental health status are shown in Table 2. Significant associations were observed between occurrence of nightmares and all variables.

Multiple logistic regression analysis in which nightmares were considered a dependent variable showed significant associations between nightmares and all variables, except for smoking (Table 2). In particular, a substantially higher odds ratio was observed for difficulty initiating sleep, low subjective sleep assessment, poor mental health status, and the presence of sleep paralysis.

Table 1
The prevalence of nightmare and sleep paralysis among Japanese adolescents.

Population	Nightmare				Sleep paralysis			
	N	Prevalence (%)	95% CI	*P* value[a]	*N*	Prevalence (%)	95% CI	*P* value[a]
Male				<0.001				<0.001
Junior high school								
7th Grade	6331	29.6	28.5–30.7		6541	6.0	5.4–6.6	
8th Grade	5959	28.6	27.5–29.7		6134	7.6	6.9–8.3	
9th Grade	6163	31.8	30.6–33.0		6244	8.4	7.7–9.1	
Senior high school								
10th Grade	8555	29.4	28.4–30.4		8690	8.7	8.1–9.3	
11th Grade	8078	30.5	29.5–31.5		8183	8.4	7.8–9.0	
12th Grade	7492	31.9	30.8–33.0		7588	9.9	9.2–10.6	
Total	42 578	30.3	29.9–30.7		43 380	8.2	7.9–8.5	
Female				<0.001				<0.001
Junior high school								
7th Grade	5961	36.0	34.8–37.2		6005	5.5	4.9–6.1	
8th Grade	5553	38.4	37.1–39.7		5616	6.5	5.9–7.1	
9th Grade	5532	40.4	39.1–41.7		5556	7.8	7.1–8.5	
Senior high school								
10th Grade	9459	39.5	38.5–40.5		9515	8.8	8.2–9.4	
11th Grade	9164	41.2	40.2–42.2		9213	8.9	8.3–9.5	
12th Grade	8820	42.1	41.1–43.1		8864	10.6	10.0–11.2	
Total	44 489	39.9	39.4–40.4		44 769	8.3	8.0–8.6	

[a] *P* value was calculated by the chi-squared test. CI: confidence interval. Subject with missing date were excluded from the analysis.

Table 2
Association of nightmare with personal, lifestyle, sleep status, and mental health status among Japanese adolescents.

Variables	Prevalence				Odds ratios			
	N	%	95% CI	*P* value[a]	*N*	AOR	95% CI	*P* value[b]
Sex				<0.001				<0.001
Male	42 880	30.3	29.9–30.7		37 128	1.00		
Female	45 083	39.9	39.4–40.4		39 457	1.39	1.34–1.43	
Grade				<0.001				<0.001
7th Grade	12 292	32.7	31.9–33.5		10 672	1.00		
8th Grade	11 512	33.3	32.4–34.2		10 130	0.99	0.93–1.05	
9th Grade	11 695	35.9	35.0–36.8		10 149	1.08	1.02–1.15	
10th Grade	18 014	34.7	34.0–35.4		16 256	0.92	0.87–0.98	
11th Grade	17 242	36.2	35.5–36.9		15 323	0.97	0.91–1.03	
12th Grade	16 312	37.4	36.7–38.1		14 055	1.02	0.95–1.08	
Smoking				<0.001				0.049
No	80 383	34.7	34.4–35.0		74 267	1.00		
Yes	2585	46.3	44.4–48.2		2318	1.10	1.00–1.20	
Drinking alcohol				<0.001				<0.001
No	67 743	33.1	32.7–33.5		60 803	1.00		
Yes	18 697	42.9	42.2–43.6		15 782	1.20	1.16–1.25	
Eating breakfast				<0.001				<0.001
Daily	73 531	33.9	33.6–34.2		64 801	1.00		
Occasional	8822	42.0	41.0–43.0		7425	1.17	1.11–1.23	
Never	5485	42.8	41.5–44.1		4359	1.09	1.02–1.16	
Available amount of money				<0.001				0.001
Less than ¥5000	61 973	33.6	33.2–34.0		55 191	1.00		
¥5000 or more	25 145	39.4	38.8–40.0		21 394	1.07	1.03–1.11	
Sleep duration (h)				<0.001				<0.001
<5	15 620	36.4	35.6–37.2		13 419	0.93	0.88–0.99	
>5, 6<	14 570	37.3	36.5–38.1		12 910	0.93	0.88–0.99	
>6, 7<	34 987	34.6	34.1–35.1		30 944	0.95	0.91–1.00	
>7, 8<	13 423	33.4	32.6–34.2		11 786	1.00		
>8, 9<	6309	33.2	32.0–34.4		5505	1.03	0.96–1.11	
>9	2531	40.2	38.3–42.1		2021	1.18	1.06–1.32	
Nap time (m)				<0.001				<0.001
Nothing	32 649	30.8	30.3–31.3		28 638	1.00		
<15	9101	37.7	36.7–38.7		8097	1.13	1.07–1.20	
>15, 30<	19 850	36.5	35.8–37.2		17 564	1.10	1.05–1.15	
>30, 60<	9802	37.4	36.4–38.4		8589	1.07	1.01–1.13	
>60, 120<	10 729	38.3	37.4–39.2		9411	1.09	1.03–1.15	
>120	5225	43.2	41.9–44.5		4286	1.18	1.10–1.27	

(*continued on next page*)

Table 2 (*continued*)

Variables	Prevalence				Odds ratios			
	N	%	95% CI	*P* value[a]	*N*	AOR	95% CI	*P* value[b]
Bedtime				<0.001				<0.001
Before 10 p.m.	5460	26.0	24.8–27.2		4604	1.00		
10–11 p.m.	11 673	32.8	31.9–33.7		10 295	1.03	0.94–1.12	
11 p.m.–Midnight	31 665	34.5	34.0–35.0		28 037	0.95	0.88–1.03	
Midnight–1 a.m.	21 588	36.7	36.1–37.3		19 111	0.85	0.78–0.93	
1–2 a.m.	11 174	37.9	37.0–38.8		9652	0.75	0.69–0.82	
After 2 a.m.	5963	42.1	40.8–43.4		4886	0.77	0.69–0.85	
Difficulty initiating sleep				<0.001				<0.001
Never	32 903	18.4	18.0–18.8		28 906	1.00		
Seldom/sometimes/often/always	54 925	45.3	44.9–45.7		47 679	2.96	2.86–3.08	
Subjective sleep assessment				<0.001				<0.001
Very good/good	61 626	29.8	29.4–30.2		54 221	1.00		
Bad/very bad	26 025	48.1	47.5–48.7		22 364	1.51	1.45–1.56	
Excessive daytime sleepiness				<0.001				<0.001
Absence	57 595	31.8	31.4–32.2		51 173	1.00		
Presence	28 904	42.0	41.4–42.6		25 412	1.23	1.19–1.28	
Mental health				<0.001				<0.001
Good	47 809	26.7	26.3–27.1		42 020	1.00		
Poor	39 678	45.5	45.0–46.0		34 565	1.68	1.63–1.74	
Sleep paralysis				<0.001				<0.001
No	80 152	32.9	32.6–33.2		70 536	1.00		
Yes	7256	61.2	60.1–62.3		6049	2.51	2.37–2.66	

CI: confidence interval and AOR: adjusted odds ratio.
¥5000 is about $56.
The presence of excessive daytime sleepiness was defined as an Epworth Sleepiness Scale score of ⩾11.
Poor mental health was defined as the 12-item of General Health Questionnaire-12 score of ⩾1.
Subjects with missing date were excluded from the analysis.
[a] *P* value was calculated by the chi-squared test.
[b] *P* value was calculated by the multiple logistic regression analysis.

3.3. Associations between sleep paralysis and personal, lifestyle, sleep status, and mental health status

The associations between the prevalence of sleep paralysis and personal, lifestyle, sleep status, and mental health status are shown in Table 3. Significant associations were observed between the prevalence of sleep paralysis and all variables, except for sex.

Multiple logistic regression analysis in which sleep paralysis during the previous month was considered as a dependent variable showed significant associations with all variables, except for school grade, smoking, eating breakfast, and available amount of money (Table 3). In particular, a higher odds ratio was observed among those whose sleep duration was ⩾9 h. In addition, a higher odds ratio was observed in case of poor mental health, and the odds ratio increased with an increase in the frequency of nightmares.

Table 3
Association of sleep paralysis with personal, lifestyle, sleep status, and mental health status among Japanese adolescents.

Variables	Prevalence				Odds ratios			
	N	%	95% CI	*P* value[a]	N	AOR	95% CI	*P* value[b]
Sex				0.490				<0.001
Male	43 683	8.2	7.9–8.5		37 128	1.00		
Female	45 360	8.4	8.1–8.7		39 457	0.85	0.81–0.90	
Grade				<0.001				0.061
7th Grade	12 546	5.8	5.4–6.2		10 672	1.00		
8th Grade	11 750	7.1	6.6–7.6		10 130	1.08	0.96–1.21	
9th Grade	11 800	8.1	7.6–8.6		10 149	1.06	0.94–1.19	
10th Grade	18 205	8.7	8.3–9.1		16 256	1.10	0.99–1.23	
11th Grade	17 396	8.7	8.3–9.1		15 323	1.06	0.95–1.18	
12th Grade	16 452	10.3	9.8–10.8		14 055	1.17	1.05–1.31	
Smoking				<0.001				0.024
No	81 388	7.8	7.6–8.0		74 267	1.00		
Yes	2640	15.3	13.9–16.7		2318	1.16	1.02–1.32	
Drinking alcohol				<0.001				<0.001
No	67 430	7.1	6.9–7.3		60 803	1.00		
Yes	18 622	12.2	11.7–12.7		15 782	1.23	1.16–1.32	
Eating breakfast				<0.001				0.021
Daily	73 181	7.5	7.3–7.7		64 801	1.00		
Occasional	8791	10.8	10.2–11.4		7425	1.06	0.97–1.15	

Table 3 (*continued*)

Variables	Prevalence				Odds ratios			
	N	%	95% CI	*P* value[a]	N	AOR	95% CI	*P* value[b]
Never	5459	14.4	13.5–15.3		4359	1.14	1.04–1.27	
Available amount of money				<0.001				0.017
Less than ¥5000	61 679	7.3	7.1–7.5		55 191	1.00		
¥5000 or more	25 021	10.9	10.5–11.3		21 394	1.08	1.01–1.15	
Sleep duration (h)				<0.001				<0.001
<5	15 543	12.3	11.8–12.8		13 419	1.47	1.32–1.63	
>5, 6<	14 506	9.2	8.7–9.7		12 910	1.27	1.14–1.42	
>6, 7<	34 820	7.1	6.8–7.4		30 944	1.14	1.03–1.25	
>7, 8<	13 349	5.6	5.2–6.0		11 786	1.00		
>8, 9<	6273	5.9	5.3–6.5		5505	1.00	0.87–1.16	
>9	2514	15.8	14.4–17.2		2021	1.71	1.44–2.01	
Naptime (m)				<0.001				0.001
Nothing	32 461	6.9	6.6–7.2		28 638	1.00		
<15	9064	7.5	7.0–8.0		8097	0.98	0.89–1.09	
>15, 30<	19 765	8.2	7.8–8.6		17 564	1.05	0.97–1.13	
>30, 60<	9754	8.7	8.1–9.3		8589	1.03	0.94–1.14	
>60, 120<	10 681	9.8	9.2–10.4		9411	1.11	1.01–1.21	
>120	5198	15.5	14.5–16.5		4286	1.26	1.13–1.40	
Bedtime				<0.001				<0.001
Before 10 p.m.	5406	7.5	6.8–8.2		4604	1.00		
10–11 p.m.	11 604	4.9	4.5–5.3		10 295	0.69	0.59–0.80	
11 p.m.–Midnight	31 523	6.5	6.2–6.8		28 037	0.81	0.71–0.93	
Midnight–1 a.m.	21 480	8.5	8.1–8.9		19 111	0.89	0.78–1.02	
1–2 a.m.	11 120	11.2	10.6–11.8		9652	1.03	0.89–1.19	
After 2 a.m.	5931	19.1	18.1–20.1		4886	1.36	1.17–1.58	
Difficulty initiating sleep				<0.001				<0.001
Never	32 712	5.4	5.2–5.6		28 906	1.00		
Seldom/sometimes/often/always	54 644	10.0	9.7–10.3		47 679	1.22	1.14–1.30	
Subjective sleep assessment				<0.001				<0.001
Very good/good	61 305	6.3	6.1–6.5		54 221	1.00		
Bad/very bad	25 882	13.1	12.7–13.5		22 364	1.22	1.15–1.29	
Excessive daytime sleepiness				<0.001				<0.001
Absence	58 494	6.8	6.6–7.0		51 173	1.00		
Presence	29 311	8.3	8.0–8.6		25 412	1.23	1.16–1.30	
Mental health				<0.001				<0.001
Good	48 662	5.3	5.1–5.5		42 020	1.00		
Poor	40 165	11.9	11.6–12.2		34 565	1.54	1.45–1.63	
Nightmare				<0.001				<0.001
Never	56 604	5.0	4.8–5.2		49 947	1.00		
Seldom	12 746	8.4	7.9–8.9		11 290	1.52	1.40–1.65	
Sometimes	13 145	15.2	14.6–15.8		11 327	2.76	2.57–2.96	
Often	3464	22.4	21.0–23.8		2924	4.06	3.67–4.49	
Always	1449	41.8	39.3–44.3		1097	7.64	6.68–8.75	

CI: confidence interval and AOR: adjusted odds ratio.
¥5000 is about $56.
The presence of excessive daytime sleepiness was defined as an Epworth Sleepiness Scale score of ⩾11.
Poor mental health was defined as the 12-item of General Health Questionnaire-12 score of ⩾1.
Subjects with missing date were excluded from the analysis.
[a] *P* value was calculated by the chi-squared test.
[b] *P* value was calculated by the multiple logistic regression analysis.

4. Discussion

The results obtained from this study revealed that the prevalence of nightmares in adolescents was 35.2% (of the total sample); furthermore, the prevalence of nightmares among girls (39.9%) was found to be higher than that among boys (30.3%). To date, few studies have investigated the prevalence of nightmares in adolescents. Previous studies of the prevalence of nightmares in adults found that the range was 8–30% of the sample studied [34–37]. The results of our study showed a higher prevalence; this may support the results of previous studies indicating that the occurrence of nightmares increases in early adolescence and decreases from late adolescence to early adulthood [19–22]. However, it must be noted that the observed prevalence of nightmares may vary according to the study methods; this is evidenced by a previous study which reported that only 4% of patients spontaneously complained of nightmares to physicians [38]. The prevalence of sleep paralysis was 8.3% (no significant difference was observed between boys and girls). To date, no study on the prevalence of sleep paralysis in adolescents has been reported. However, a previous study on sleep paralysis in adults reported a range of 7–8% [39]. From this, we suggest that there is not much difference in the prevalence of sleep paralysis between adolescents and adults. Our results suggest that the prevalence of nightmares and sleep paralysis tends to increase from the lowest school grade (7th) to the highest (12th) for both genders. Among girls especially, the prevalence of sleep paralysis in the 12th grade was almost twice that in the 7th. Developmental factors and lifestyle changes may affect these characteristics.

In this study, we found that the prevalence of sleep paralysis increased with an increase in the frequency of nightmares, and that the prevalence of nightmares was high (61.2%) among those who

experienced sleep paralysis. In addition, logistic regression analysis that considered nightmares as a dependent variable showed that the odds ratio of those who experienced sleep paralysis was high. Logistic regression analysis that considered sleep paralysis as a dependent variable demonstrated a dose–response relationship between the frequency and the odds ratio of nightmares. From these results, we suggest the presence of a strong association between nightmares and sleep paralysis. It has been reported that nightmares and sleep paralysis frequently occur concurrently [10,40]. The strong association between nightmares and sleep paralysis may be explained by a common pathophysiological characteristic: both these phenomena occur during REM sleep. It has been reported that an individual's physiological characteristics, such as heart rate and respiration rate, change if nightmares associated with negative emotions occur during REM sleep [13]. Such changes in physiological characteristics may induce sleep paralysis. Conversely, sleep paralysis, in which the patient is unable to move the limbs and trunk although he/she is conscious, may be accompanied by anxiety and terror, which may also induce nightmares. It is not possible to discuss the causal relationship between nightmares and sleep paralysis on the basis of the results of this study. However, it may be appropriate to think that these phenomena are interrelated, rather than thinking that one precedes the other.

With regard to the association between gender and nightmares/sleep paralysis, our logistic regression analyses showed that the odds ratio of nightmares was significantly higher in girls than in boys, whereas the odds ratio of sleep paralysis was significantly higher in boys than in girls. A study conducted on adults reported that the risk of nightmares was higher in women than in men [41]. The results of our present study confirm the same tendency in adolescents. In contrast, our results indicated that the risk of sleep paralysis was higher in boys than in girls. In any event, any gender-based difference in the risk of sleep paralysis has not been examined previously for adolescents or adults. Further epidemiological studies will be required to clarify this point.

With regard to the association between nightmares/sleep paralysis and alcohol consumption, the odds ratios for alcohol consumers were high for both nightmares and sleep paralysis. Many studies have reported an association between the consumption of alcohol and sleep disorders among adolescents [42–44]. Alcohol is known to promote sleep onset, but the effect is short-lived; in fact, it makes sleep shallow and interrupted [43]. In our study, alcohol consumption may have affected the onset of nightmares and sleep paralysis. Increased REM sleep time is a symptom of alcohol withdrawal [43]. Since alcohol has clear pharmacological effects on REM sleep, it is possible that it also affect REM-sleep-related disorders such as nightmares and sleep paralysis.

With regard to the associations between sleep duration and nightmares/sleep paralysis, we found that the odds ratios of those whose sleep duration was $\geqslant$9 h were significantly high for both the prevalence of nightmares and sleep paralysis. For this group, sleep duration may have increased to compensate for the sleep that was interrupted because of nightmares and sleep paralysis. However, prolonged periods of normal wake following a sleep cycle may make nightmares easier to remember. In that case the nightmares may not be causing the sleep disturbance — remembering them may simply be a byproduct of the waking. With regard to sleep paralysis, there was a high odds ratio for those whose sleep duration was <7 h. Sleep paralysis has been reported to occur during a REM sleep period that occurs immediately after the SOREM [10,24], and SOREM tended to occur when sleep duration was short [45]. From these findings, it is inferred that sleep paralysis appears to be induced by short sleep duration. Nightmares and sleep paralysis were also associated with daytime naps; a relatively high odds ratio was observed in a group whose naptime was $\geqslant$120 min. It is not clear whether nightmares and sleep paralysis occur during long naps, or whether individuals who experience nightmares or sleep paralysis tend to have longer naptimes because of the lack of nighttime sleep.

With regard to the association between EDS and nightmares, Joo et al. found that the frequency of EDS tended to increase with an increase in the frequency of nightmares; the authors attributed this association to a degradation of sleep quality [46]. Based on this finding, a causal association can be inferred: EDS is induced by nighttime sleep that is interrupted by nightmares and sleep paralysis. In our study, we predicted associations among nightmares/sleep paralysis, sleep quality, and EDS; our logistic regression analyses considered subjective sleep assessment as a covariate. From this analysis, nightmares/sleep paralysis was found to be associated with EDS, independently of sleep quality. The inference is that degradation of sleep quality — at a level too subtle to be perceived by the subjects — was not reflected by the subjective sleep assessment; however, it may be involved in the association between nightmares/sleep paralysis and EDS.

With regard to the association between difficulty initiating sleep and nightmares/sleep paralysis, nightmares/sleep paralysis is possibly associated with insomnia because difficulty initiating sleep is a symptom of insomnia. People with insomnia, whose chief complaint is difficulty initiating sleep, tend to experience anxiety, depression, and their bodies feel tense at the initiation of sleep [47]. Since nightmares and sleep paralysis can be easily exacerbated by an individual's poor mental health status [18,28], such conditions at the initiation of sleep may influence the occurrence of nightmares and sleep paralysis.

With regard to the associations between nightmares and mental health status, Nielsen et al. studied adolescents (aged 13–16) and reported a significant association between the frequency of nightmares and the level of anxiety [18]. In addition, few studies have also reported an association between sleep paralysis and mental health status. For example, Ohayon et al. [28] conducted an epidemiological study on the general population and found associations between sleep paralysis and mental-health-related factors such as anxiolytic medication and bipolar disorder. Therefore, it can be said that our study has demonstrated a close association between poor mental health status and nightmares and sleep paralysis in adolescents.

There were some limitations to our study. The main one was the problems related to the definition of nightmares and sleep paralysis. The limited space in the questionnaires did not allow us to explain the details of nightmares and sleep paralysis to the participants; therefore, they understood the meaning of nightmares and sleep paralysis only on the basis of the information in the questions related to these phenomena. It is possible that the participating adolescents did understand the meaning of these terms because nightmares and sleep paralysis are well-known phenomena in Japan [12]. However, some participants may not have completely understood the meaning of nightmares and sleep paralysis only on the basis of the limited explanations provided in the study questionnaire. In particular, owing to the characteristics of the symptoms, sleep paralysis may have been confused with other phenomena such as sleep inertia or difficulty in waking up. It would be difficult to distinguish sleep paralysis from such phenomena only on the basis of the explanation provided in the relevant question. In addition, sleep paralysis is a symptom often observed among narcolepsy patients [23], and it has been reported that 0.16% of adolescents may have suspected narcolepsy [12,48]. Our study participants probably included a similar percentage of narcolepsy patients. Therefore, the results of this study may not necessarily represent the actual prevalence of pathological nightmare and sleep paralysis and must be considered only as epidemiological data. In a large-scale epidemiological study, owing to

methodological limitations, it is difficult to accurately select patients with only pathological nightmares and sleep paralysis. However, more accurate calculation of the prevalence might be possible by providing highly detailed information about the symptoms to the participants. Furthermore, with regard to sleep paralysis, it is possible to calculate the prevalence accurately by including additional questions that would rule out any confusion with other phenomena. We would like to resolve these methodological problems in a future study in order to clarify the prevalence of nightmares and sleep paralysis more accurately. Second, since this was a cross-sectional survey, a causal relationship could not be determined. Third, there may have been a nonresponse bias. The rate of response to the questionnaire in this study was 62.6%; therefore, approximately 37.4% of the subjects did not participate in the survey. Fourth, physiologic measurements such as electroencephalography could not be employed to obtain objective data for evaluation of sleep habit.

5. Conclusion

This study is a nationwide survey of nightmare and sleep paralysis among Japanese adolescents. The results of this study should be considered in the prevention of nightmares and sleep paralysis among Japanese adolescents. The findings of this study indicated a strong association between nightmares and sleep paralysis. These features are attributed to the pathophysiological background of REM sleep. Therefore, stable REM sleep seems to be important for the prevention of nightmares and sleep paralysis. In addition, nightmare and sleep paralysis related to the factors of sleep habits respectively. Maintenance of regular sleep habits is associated with stable REM sleep [45]. Therefore, it is important to maintain regular sleep habits to prevent these symptoms. Because daily rhythm is prone to be deranged in adolescence, we propose that health education about regular sleep habits should be promoted among Japanese adolescents.

6. Disclosure statement

This study was supported by a health science Research Grant from the Ministry of Health, Labor and Welfare of the Japanese Government. All of the authors have no potential conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript. There was no off-label or investigational use in this study.

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RESEARCH COMMUNICATION

Mobile Phone Use does not Discourage Adolescent Smoking in Japan

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Abstract

Objective: The possibility that smoking prevalence among junior and senior high school students may decrease with increasing mobile phone bill was reported by the mass media in Japan. We conducted a nationwide survey on adolescent smoking and mobile phone use in Japan in order to assess the hypothesis that mobile phone use has replaced smoking. Methods: A total of 70 junior high schools (response rate; 71%), and 69 high schools (90%) from all over Japan responded to 2005 survey. Students in the responding schools were asked to fill out an anonymous questionnaire about smoking behavior, mobile phone bill, and pocket money. Questionnaires were collected from 32,615 junior high school students and 48,707 senior high school students.Results: The smoking prevalence of students with high mobile phone bill was more likely to be high, and that of students who used mobile phones costing 10,000 yen and over per month was especially high. When "quitters" were defined as students who had tried smoking but were not smoking at the time of survey, the proportion of quitters decreased as the mobile phone bill increased. The proportion of students who had smoking friends increased with the increase in the mobile phone bill per month. Conclusion: The hypothesis that the decrease in smoking prevalence among Japanese adolescents that has been observed in recent years is due to a mobile phone use can be rejected.

Keywords: Mobile phone - cigarette smoking - adolescent - behavior - Japan

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Introduction

Cigarette smoking increases the risk of many diseases. Given the difficulty of escaping nicotine dependence, prevention of smoking among adolescents has been identified as a major public health measure. The monitoring of smoking prevalence among adolescents is thus an important means of clarifying the characteristics of this problem, establishing countermeasures, and evaluating public health efforts to reduce smoking prevalence. Many articles describe associated factors or predictors of adolescent smoking (Sen & Basu, 2000, Ma et al., 2008; Villanti et al., 2011). Therefore, analyzing contributing factors is important for establishing appropriate countermeasures.

Mobile phones are used by the majority of adolescents as vital communication tool. There have been some reports of an association between mobile phone use and health-related behaviors among youth (Augner & Hacker, 2012).

In the 1990s, the prevalence of adolescent smoking decreased in European and North American countries. Since British researchers (Charlton & Bates, 2000) observed that the trend in adolescent smoking prevalence was inversely correlated with the prevalence of mobile phone use in British study in 2000, they hypothesized that mobile phone use contributed to the decreasing in the smoking prevalence.

Some reports contradicting these hypotheses have subsequently been published. There was one report indicating that the prevalence of adolescent smoking had decreased earlier than the spread of mobile phones (Invernizzi, 2001). In addition, the prevalence of adolescent smoking actually increased in some of the countries where mobile phones has spread among the young people (Italian girls, Switzerland) (Invernizzi et al., 2001; Lee 2001). In other counties, researchers examined the association between smoking behavior and the possession of mobile phone directly (Koivusidflta et al., 2003: 2005; Sleggles & Jarvis, 2003). These studies found that the smoking prevalence was high in the young people who used their mobile phones frequently. These studies all indicate that the previously proposed hypothesis should be rejected. However, the hypothesis was not tested in Asian countries.

In Japan, we observed a dramatic reduction in the smoking prevalence among the junior and senior high school students in a nationwide surveys after 2000 (Osaki et al., 2008). The hypothesis that smoking prevalence

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among junior and senior high school students may have decreased due to increase in mobile phone bill was reported by the mass media in Japan.

We conducted a national survey in 2005 to examine whether the decrease in smoking prevalence was caused by increasing mobile telephone use in Japan. The decrease in the adolescent smoking prevalence is a favorable finding regardless of the reason for the decrease, however misunderstanding the reason for the reduction may lead to the promotion of incorrect counter-measures in the future.

Materials and Methods

In order to confirm the decrease in smoking prevalence among high school students noted in the 2004 survey, a nationwide survey on smoking behavior among Japanese junior and senior high school students was conducted in 2005. The sampled schools in the 2005 survey were those that had responded in the 2000 survey, so a total of 99 junior high schools and 77 senior high schools were asked to participate in this survey. A total of 70 of these junior high schools (response rate; 71%), and 69 of these senior high schools (90%) responded to the 2005 survey. The schools sampled in the 2000 survey were selected randomly using a national school directory (Osaki et al., 2008).

The number of students who responded to the present survey was 32,615 junior high schools and 48,707 senior high schools (81,322 students in total).

The anonymous questionnaire included questions about smoking status, the monthly mobile telephone bill, friends' smoking habits, and their monthly amount of pocket money in order to investigate the reasons for the decrease in smoking prevalence. Experimenting smokers, current smokers and daily smokers were defined as those who had tried smoking at least once, those who had smoked at least once during the previous 30 days, and those who had smoked every day during the previous 30 days, respectively. The quitters were defined as students who had tried smoking, but did not smoke at the time of the survey. The mobile phone bill per month was assessed for 8 categories, namely no use, <1000 Japanese yen, <2000 yen, <3000 yen, <5000 yen, < 10000 yen, <20000yen, and 20000 yen and over. The mobile phone bills were then divided into 5 categories, no use, <3000 yen, <5000 yen, <10000 yen, and 10000 yen and over for the statistical analyses because of the small number of subjects in some categories. The smoking status was calculated for each of the categories of mobile phone use.

The Cochran-Armitage test was used to evaluate for trends in proportions. In addition, a multiple logistic regression analysis was applied to calculate the odds ratios of each category of mobile phone bill using the "no use" group as a reference group to smoking status. The current smoking was used as an independent variable in the statistical model. The odds ratios were calculated with current smoking used as the independent variable and explanatory variables including sex, age, and the mobile phone bill. The data were analyzed using the SPSS for Windows (version 18.0) software program (SPSS Inc.; IL, USA).

Results

A decrease in the smoking rate was found in 2005 in both males and females, and for both junior and senior high school students compared with the 2000 survey. The experimental smoking rate, current smoking rate, and daily smoking rate for males were 43.5%, 22.0%, and 12.2% in 2000, and were 24.7%, 10.4%, 5.0%, respectively in 2005. The rates for females were 28.4%, 10.0%, 3.6% in 2000, and 17.0%, 5.7%, 1.9% in 2005. The reduction in smoking prevalence among junior and senior high school students was reviewed similar to the results in the 2004 nationwide survey. The proportion of students who did not use a mobile phone was 56.1% for junior high school males, 42.3% for junior high school females, whereas the figures decreased in senior high school students to 10.0% for males and 4.0% for females. That indicates that the vast majority of senior high school students use a mobile phone.

Among the mobile phone users within the senior high school student population, more than half of the students spent 5,000 yen a month or more. The smoking prevalence was higher for students spending 5,000 yen or more for their monthly mobile phone bill, and the prevalence was much higher for students spending 10,000 yen or more. This was the case for both sexes and for both junior and senior high school student (Table 1). We investigated the proportion of students who quit smoking among the experimenters in the 2005 survey. The prevalence of quitters among all respondents was 4.8% for junior high school males, 3.3% for females, 7.8% for senior high school males, and 5.4% for females. When the number of experimenters' students was used as a denominator, the proportion of quitters was 39.3% for junior high school males, and 32.5% for females, and was 27.8% for senior high school males, and 30.2% for females. When we examined the proportion of the quitters (among experimenters) according to mobile phone bill per month, we found that the proportion of students tended to be lower for those with high mobile phone bills (Table 1).

In order to assess the association between the mobile phone bill and smoking status among students, a multiple logistic regression analysis was applied to adjust for differences in gender and age. The mobile phone bill was divided into 5 categories (no use, <3000 yen, <5000 yen, <10000 yen, and ≥10000 yen) and 'no use' was used as the reference group for the other categories. Compared with students who did not use a mobile phone, the relative risks of the other 4 categories for current smoking was 1.1 (95% Confidence Interval; 0.9-1.4), 0.9 (0.8-1.0), 2.4 (2.1-2.6) and 8.1(7.3-9.0), indicating that students who have expensive mobile phone bill are more likely to be smokers. This association remained after entering variables related to parental and siblings smoking into the statistical model.

When an analysis was performed using smoking cessation among the smoking experimenters as a independent variable and with the mobile phone bill as covariates, compared with students who did not use a mobile phone, the relative risks of other 4 categories were 1.0 (0.7-1.3), 1.1 (1.0-1.3), 1.0 (0.9-1.1), and 0.8 (0.7-0.9). Therefore, smokers with the highest mobile phone bills are

Table 1. Smoking Status By Mobile Phone Bill Per Month

	Boys				Girls			
	No. of students	current smoker % (95% CI)	quitter % (95% CI)	have smoking friends % (95% CI)	No. of students	current smoker % (95% CI)	quitters % (95% CI)	have smoking friends % (95% CI)
Junior high school:								
no use	9593	2 (2.1- 2.7)	45 (41.9-49.0)	16 (15.4-16.9)	6565	1 (1.1- 1.6)	38 (32.4-43.1)	12 (11.6-13.2)
<3000 yen	1809	4 (2.9- 4.5)	46 (38.4-52.8)	17 (15.6-19.0)	2082	2 (1.1- 2.2)	37 (27.4-47.3)	14 (12.9-15.9)
<5000 yen	1963	3 (2.6- 4.2)	39 (32.2-46.1)	25 (22.7-26.5)	2515	2 (1.5- 2.6)	40 (33.0-47.7)	19 (17.0-20.0)
<10000 yen	2660	8 (6.6- 8.6)	35 (30.4-38.8)	35 (32.9-36.5)	2952	4 (3.5- 4.9)	36 (31.4-40.6)	30 (28.6-31.9)
≥10000yen	1080	20 (17.3-22.0)	30 (25.0-34.6)	38 (35.4-41.2)	1396	13 (11.6-15.2)	33 (27.7-37.3)	42 (39.2-44.3)
test for trend		p<0.01	p<0.01	p<0.01		p<0.01	p=0.10	p<0.01
Senior high school:								
no use	2474	8 (7.3- 9.5)	32 (27.1-37.2)	30 (28.6-32.2)	957	5 (3.9- 6.8)	30 (20.8-39.0)	25 (22.5-28.0)
<3000 yen	2576	6 (5.1- 6.9)	34 (29.2-39.6)	42 (40.2-44.0)	2069	3 (2.4- 3.9)	32 (24.7-39.4)	27 (25.0-28.8)
<5000 yen	4828	6 (5.3- 6.6)	36 (32.8-39.5)	54 (52.3-55.1)	5217	2 (1.2- 1.9)	36 (31.3-41.2)	34 (33.0-35.6)
<10000 yen	11064	15 (14.1-15.4)	29 (27.5-30.6)	66 (64.8-66.5)	10986	6 (5.3- 6.2)	33 (30.3-34.6)	51 (50.5-52.3)
≥10000yen	3691	36 (34.1-37.2)	20 (18.2-21.9)	74 (72.1-75.0)	4845	20 (18.7-20.9)	26 (24.3-28.4)	69 (67.9-70.5)
test for trend		p<0.01	p<0.01	p<0.01		p<0.01	p<0.01	p<0.01

* 'Quitter: students who tried smoking but do not smoke currently

less likely to quit smoking. Moreover, when an analysis was performed in order to assess the association between the mobile phone bill and having smoking friends, the proportion of students who had friends who smoked increased as the mobile phone bill increased for both sexes and for both junior and senior high school students.

Discussion

The present study revealed that students who reported a higher mobile phone bill were more likely to smoke cigarettes, less likely to quit smoking, and more likely to have friends who smoke. Therefore, the hypothesis (Charlton & Bates, 2000) that the decrease in smoking prevalence among adolescents during recent years is due to mobile phone use can be rejected. This result was similar to previous studies conducted in European countries (Koivusilta et al., 2003: 2005; Steggles & Jarvis, 2003). The mobile phone is an important item for adolescents, and is a symbol of their human relationships. The use of mobile phone, which can lead to activities, such as part-time jobs top at the mobile phone bill, are also linked to experience with smoking or alcohol use, and are influence by friendship.

Smoking and alcohol use among adolescents is also closely related to pocket money or spending money (Zhang et al., 2007). The present survey also observed associations among the mobile phone bill, pocket money and smoking among adolescents in Japan. Since using a mobile phone is not a reason responsible for the decline in the smoking prevalence among adolescents, an additional spread of mobile phone use among adolescents in the near future will be unlikely to lead to a further decrease in smoking prevalence.

Because the present study was a cross-sectional study, we cannot determine which was the preceding factor among smoking, alcohol use, mobile phone use, and human relationship. However, the present study showed a strong relationship among these factors. Since we can conclude that students who use mobile phones frequently are an important high risk group for adolescent smoking, a health education program employing mobile phone applications may be useful for providing information to these high risk groups. A dramatic increase in cigarette prices will likely be necessary before adolescent smokers give up their smoking habit.

In conclusions, we conducted a nationwide survey on adolescent smoking and mobile phone use in Japan in order to assess the hypothesis that mobile phone use has replaced smoking. We revealed that students who reported a higher mobile phone bill were more likely to smoke cigarettes, less likely to quit smoking, and more likely to have friends who smoke. Therefore, the hypothesis that the decrease in smoking prevalence among adolescents during recent years is due to mobile phone use can be rejected.

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