# Relationship between Internet addiction and sleep disturbance in high school students: a cross-sectional study

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# Abstract

**Background:** The increase in the number of Internet users has increased Internet dependence worldwide. In adolescents, this dependence interferes with sleep, which is important for the development of psychophysiological capabilities. However, few large-scale surveys have descriptively examined the relationship between Internet addiction (IA) and sleep disturbance using standardized questionnaires. We conducted this study to determine the relationship between sleep disturbance in adolescents and IA based on the categories of the Young Diagnostic Questionnaire (YDQ) through a complete survey of one prefecture in Japan.

**Methods:** In 2016, a self-report questionnaire was used to survey high school students (n=10,405, age range: 15–16 years) in all 54 day-boarding high schools in the selected prefecture. We defined “sleep disturbance” by scores greater than 5.5 points on the Japanese version of the Pittsburgh Sleep Quality Index. IA was evaluated using the YDQ: “IA,” when five of the eight YDQ items were present; “at-risk,” when three or four YDQ items were reported; and “non-IA,” when two or less YDQ items were positive. Multiple logistic regression analysis was undertaken with sleep disturbance as the dependent variable, IA as the explanatory variable, and adjustments for eight items.

**Results:** High YDQ scores were associated with high prevalence rates of sleep disturbance in boys and girls. These findings persisted after controlling for other factors in the multiple regression model.

**Conclusions:** Among Japanese adolescents, there was a significant independent relationship between IA and sleep disturbances.


# Background

The Internet is a network that connects information devices across the world to provide convenient information and communication technology that enables various activities, from exchanging electronic mail and information to shopping. In 2016, when this study was conducted, 48% of all people worldwide used the Internet [1]. In this context, a large survey of Japanese youth found that 6.2% of boys and 9.8% of girls presented a problematic Internet use [2].

Internet addiction (IA) has been defined as “an impulse-control disorder that does not involve an intoxicant” [3]. This survey examined the concept of IA. Generalized IA is a concept that was initially introduced by Davis et al. [4] based on a cognitive-behavioral model. More recently, a meta-analysis of 89,281 individuals in 31 countries from 1996 to 2012 reported an IA prevalence rate of 6%, with a median age of 18.42 years (standard deviation [SD], 5.02; range, 12–41) [5]; individuals between 15 and 24 years accounted for approximately 25% of Internet users worldwide [1]. Moreover, this age range includes adolescents, which means that policies pertaining to the issue of IA must address to this population.

A previous study on IA among adolescents reported a significant relationship between this addiction and psychiatric disturbances, including “interpersonal sensitivity,” “depression,” “anxiety,” “hostility,” and

“psychoticism.” [6]. Furthermore, adolescent IA has been reported to be a risk factor for problematic alcohol use in adulthood [7, 8]. Recent studies using functional magnetic resonance imaging have reported that IA is related to structural and functional damage in the prefrontal cortex [9]. With such severe negative impacts on life, the gravity of this problem has been increasingly recognized, and several epidemiological studies have been conducted to determine factors related to IA. For example, a study which examined the data of 100,000 Japanese youth reported that IA was related to frequency and amount of alcohol consumption [10]. A study focused on 2,620 Chinese high school students reported a relationship between IA and emotional anxieties and lack of empathy [11]. Excessive smartphone use may be associated with musculoskeletal discomfort and mental health problems [12, 13].

For adolescents, sleep behavior is a daily, routine, lifestyle component that has a major impact on physical and mental health [14]. Moreover, adolescent sleep is important because of its significant effects on the development of key psychophysiological functions, including behavior, emotions, and attention [15-21]. Therefore, it is necessary to investigate any relationships that exist between sleep and IA. Some studies have reported the relationship between IA and depression and sleep disturbance [22, 23], nighttime sleep duration and subjective insomnia [24], poor sleeping habits [25], smartphone dependence [26], and sleep quality [27]. Sleeping habits are associated with other lifestyle habits, such as extracurricular activities and skipped meals [28, 29]. However, the relationship between IA and sleep disturbance in adolescents has not yet been fully analyzed or elucidated, because few large-scale surveys have been undertaken with standard indicators, such as the Pittsburgh Sleep Quality Index (PSQI) [30].

We hypothesized that sleep disorders in puberty are associated with a general degree of Internet dependence and that this association is also attributable, in part, to other lifestyle habits. It is important to take lifestyle habits into account, because they can weaken the relationship between sleep disorders and Internet dependence. Therefore, we conducted an epidemiological study to determine the relationship between IA and sleep disturbance in Japanese high school students by using standardized sleep disorder questionnaires and representative Internet-dependence questionnaires.

# Methods

### Study population and design

After obtaining the consent of the President of the Association of High School Principals and the prefectural Education Bureau of a certain prefecture in Japan, we sent requests for participation to the principals of all 54 day-boarding high schools within the aforementioned prefecture and sent the following documents via the postal service to each principal: (1) letter requesting cooperation, (2) planning document containing the study purpose and method, and (3) the survey form to be used in the study. We stated that a self-administered questionnaire form would be used in the survey, with assured protection of respondent privacy. A total of 10,405 students were registered at the 54 day-boarding high schools.

The survey procedure was as follows: (1) the teachers distributed the following three items: an explanatory document, a self-administered questionnaire form, and an envelope; (2) after filling in their responses in the questionnaire form, the surveyed students placed the completed questionnaire form in the provided collection envelope and sealed the envelope; (3) the teachers collected the sealed envelopes; and (4) the envelopes containing the self-administered questionnaire forms were first unsealed and opened when they were to be used for data input at the assigned research facility. The survey period was from June to December 2016.

## Measurement

The survey forms collected information on participant demographic characteristics, sleep disturbance, and IA.

*Demographic characteristics*

Information regarding the name of the school, grade, and name and sex of the student. After recording the participants' school names, they were further grouped on the basis of whether they were attending a public school or a private school. Questions on daily-life habits included school-commute time, time spent engaging in school sports (or clubs), time spent on study outside school hours, television-viewing time, and skipped meals. These questions were similar to those used in previous studies among adolescents [10, 31-33] (Appendix A). The questions on emotions and perceptions were measured by depressed mood (mental health) and school-life satisfaction.

We adopted the measure of depressed moods (mental health) from previous studies [31, 33]. The question was "Over the past 30 days, did you have feelings of heaviness or depression more than usual?" We measured school life satisfaction using a 2013 survey conducted by the Cabinet Office on the attitudes of young people in Japan and other countries [34]. The question was "Are you satisfied with your school life? Or are you dissatisfied with it?"

*Measurement of sleep disturbance: Japanese version of the Pittsburgh Sleep Inventory*

Sleep disturbance was evaluated by the Japanese version of the PSQI (J-PSQI) [35-37]. On the basis of previous studies, scores $\geq$ 5.5 points on the J-PSQI were considered indicative of sleep disturbance [35-37].

*Measurement of IA: Japanese version of the Young Diagnostic Questionnaire*

IA was evaluated using the Young Diagnostic Questionnaire (YDQ) [3, 38-44]. For the present study, we used the Japanese version of the YDQ (J-YDQ) that has been used in previous studies [31]. The J-YDQ is an evaluation tool composed of eight questions, which are rated 1 point for "yes" and 0 point for "no," with the total score ranging from 0 to 8 points. The participants where then grouped into three categories: "IA," when five of the eight YDQ items were present; "at-risk," when three or four YDQ items were reported; and "non-IA," when two or less YDQ items were positive. [25, 33, 39, 43, 45, 46].

### Ethical considerations

The participation of students in the present study was voluntary. As our cohort included 15- to 16-year-old adolescents, we obtained written informed consent directly from the students or from their parents when their supervising teacher confirmed that their judgment was acceptable or he/she thought that the parents' consent was necessary, respectively. The following statements were included in the consent document distributed to students and their families: (1) the survey was part of an epidemiological study and involved neither an evaluation for school grading nor any type of punishment; (2) students were free to cooperate in the survey, and failure to cooperate would not incur any disadvantage; (3) the school teachers would not view the responses provided; and (4) respondent privacy would be strictly protected. The study forms were stored securely, and data were entered into a password-protected database. Data were anonymized prior to the analysis by deleting all personal identifiers. The Faculty of Medicine of the Oita University Ethics Committee approved the study (approval no. 932).

### Statistical analysis

Students who did not completely fill out the J-PSQI and the YDQ were excluded from the analysis. First, distribution by sex (boys or girls) was plotted for the J-PSQI and YDQ scores. Second, prevalence rates for different categories of sleep disturbance and IA were calculated separately for each sex by using the chi-square test. Furthermore, for each of the three YDQ categories, the prevalence rates for sleep disturbance were calculated for each sex separately. Finally, multiple logistic regression analysis was conducted to investigate the relationship between IA (explanatory variable) and sleep disturbance (dependent variable). The type of school, school-commute time, sports and club time, outside-class study time, television-viewing time, skipped meals, depressed mood (mental health), and school-life satisfaction rates were used as adjusted variables. The Statistical Package for Social Sciences version 22 (SPSS, IBM Corp. NY, USA) for Windows was used for all statistical analyses. A $p$-value <0.05 was considered statistically significant.

## Results

A flowchart of the participant-selection process is shown in Figure 1. Of the 54 schools (n=10,405) that were requested to participate, 40 schools responded positively. At the time of the study, there were 7,186 first-year (of the 3-year program) high school students, of whom 6,950 provided informed consent themselves or their parents (response rate: 96.7%). Of these, 5,264 students (2,635 boys and 2,629 girls) completely filled the JPSQI end YDQ (effective response rate: 73.3%).

Figure 2 shows the distribution of J-PSQI and YDQ scores. The J-PSQI scores for boys and girls were symmetrically distributed around a cutoff point value of 5.5 points. The mean and SD of the total J-PSQI score was 5.51 ± 2.63 (range: 0–17) and 5.98 ± 2.62 points (range: 0–18) for boys and girls, respectively. Regarding the YDQ scores, 0 point was the most frequent score for both boys and girls, with higher scores among a small number of participants.

Table 1 shows the percentages of students with sleep disturbance and the number of participants included within the three YDQ categories. Students defined as having sleep disturbance comprised 50.5% of all participants. In boys and girls, a higher percentage of sleep disturbance was observed in the following groups: private high school ($p<0.05$), students with a high frequency of skipped meals within a 1-week period ($p<0.001$), and proportions of students reporting higher scores on variables of depressed mood (mental health; $p<0.001$). Overall, based on the YDQ scores, 9.4% of boys and 14.8% of girls were classified with IA, whereas 23.1% of boys and 28.1% of girls were graded as being at high risk of IA. Students with poor depressive mood and school-life satisfaction tended to have increased IA prevalence. Furthermore, boys with IA spent less time engaging in school sports or in clubs, whereas girls with IA spent less time on outside-school study ($p<0.001$ for both). For boys and girls with high YDQ scores, we observed that a higher proportion of students answered “yes” or “often” regarding having a depressive mood (mental health) and ‘dissatisfied’ regarding school-life satisfaction. ($p<0.001$ for both). Moreover, girls who had shorter extracurricular learning time tended to have higher proportions of IA ($p<0.001$).

Table 2 presents the rates of students with sleep disturbance for each of the three categories of YDQ. For the overall study population, students categorized as having IA or at risk for developing IA presented higher rates of sleep disturbance.

Table 3 shows the results of the multiple logistic regression analysis of the relationship between YDQ categories and sleep disturbance. In the entire study population, a higher YDQ score in any category was associated with higher unadjusted odds ratios (ORs) for sleep disturbance ($p<0.001$). The association between the YDQ scores and sleep disturbance remained significant ($p<0.001$), even after variable adjustment.

# Discussion

The present study aimed to clarify the relationship between sleep disturbance in adolescents and IA. We found a relationship between adolescent sleep disturbance and IA in one prefecture in Japan and found that sleep disturbances are more prevalent in categories with higher YDQ scores. Furthermore, the results of the multivariate analysis revealed significantly higher adjusted ORs between categories with high YDQ and sleep disorders, which suggests a significant relationship between higher YDQ scores (3–4 or ≥5) and sleep disorders.

Despite the importance of adolescent sleep, sleep disturbance was present in more than half of the study participants. Furthermore, the high proportions of adolescents with sleep disturbances were in accordance with the results of recent studies of older adolescents using the PSQI [47, 48]. In this study, sleep disturbance was more frequent in boys who participated in school sports (or clubs), overall skipped meals, and had depressive moods (mental health). These results were similar to those of previous studies linking regular sleep habits to psychological and physical health [14]. In addition, the prevalence of sleep disturbance was higher in private schools and for students with longer commutes. In general, private schools often have longer commute distances; therefore, it may be associated with reduced sleep time as

shown previously [49]. Previous studies have suggested that sleep quality is related to health and emotions among the youth individuals [14, 50]. Future longitudinal studies should examine changes over time for these and other variables to better understand the relationship between sleep disorders and Internet dependence.

In addition, The association between the YDQ scores and sleep disorders is similar to that reported by Bakken et al. [51] from a study among Norwegian adults, aged ≥ 16 years, where individuals with high YDQ scores had significantly higher prevalence rates of sleep disturbance than non-problematic Internet users. Furthermore, the present study found differences between sexes, with a higher sleep disturbance adjusted OR in girls with IA than in boys. This finding was similar to the results of Durkee et al. [25], who confirmed a significant relationship between insufficient sleep and IA in girl participants, which was in line with the findings of a previous study [25].

There are several possible mechanisms for the relationship between sleep disturbance and IA. First, it is possible that IA can cause sleep disturbances. Tan et al. reported that problematic Internet use could cause sleep disorders [22]. Moreover, Chen et al. indicated that IA predicted a “disturbed circadian rhythm” leading to sleep disturbance [30], which is one explanation for the relationship between IA and sleep disturbance.

The second possible mechanism is the opposite of the one discussed above, whereby sleep disturbance might lead to the development of IA. In a longitudinal study, Chen et al. reported that falling asleep and nocturnal awakening difficulties were predictors of IA [30].

A third possible mechanism is that both conditions contribute to each other. Especially, sleep disturbance may contribute to IA, and IA may contribute to sleep disturbance. Several studies on adults have confirmed that, in brain imaging, sleep disturbance and IA cause changes in the gray matter [52, 53]. A study of retired military personnel showed that, regardless of any coincidental psychiatric state, individuals with a high PSQI score presented with reduced volume of the entire cortex and frontal lobes [53]. Another study that did not control for sleep disturbance reported that individuals with IA reportedly had reduced gray matter density [52]. These findings suggest the possibility that IA may cause organic (structural) changes in sleep-related neural pathways.

The following three points can be considered as the strengths of this study. First, the sample size was adequate to ensure statistical power. Second, to investigate the relationship between sleep disturbance and IA, we used the PSQI and YDQ, which have been frequently used as standard indices in several epidemiological surveys [5, 10, 25, 39, 41, 43, 51, 52, 54-59]. Third, in our analysis, we evaluated the relationships between sleep disturbance and IA for each of the three categories of the YDQ, including at-risk Internet use; this category has not been sufficiently investigated in previous epidemiological studies.

Nonetheless, the present study had a number of limitations. First, the present study analyzed with the results of a cross-sectional survey, which implies that we cannot formulate any conclusion regarding the direction of causality. Second, statistical analysis should have taken into account schools as cluster

units. Third, we did not adjust ORs for all the items that may be related to IA. For example, we did not ask questions regarding other psychiatric disorders, such as attention deficit and hyperactivity disturbance (ADHD), which are reportedly associated with IA [60-62] and sleep disturbance [62] in adolescents. In the present study, all participants were enrolled as daytime high school students who regularly attended school. In such a scenario, the number of students with ADHD is considered low. Fourth, as we conducted the survey within each of the schools, non-attending students could not participate, and future surveys that will enable participation of non-attending students should be undertaken. Fifth, our survey population was limited to students in a single prefecture in Japan; thus, there was certainly a sampling bias. Finally, we did not investigate specific Internet-use disorders [4, 63-69], which need to be investigated in detail for preventive measures to be developed.

# Conclusions

In summary, we observed that high Internet dependence was related to sleep disturbance in high school students within a prefecture in Japan. Studies have suggested that sleep disturbances and IA affect the gray matter in the brain. Future researches should consider longitudinal surveys that investigate the factors related to the occurrence of IA and sleep disturbance.

# Abbreviations

IA, Internet addiction; YDQ, Young Diagnostic Questionnaire; J-PSQI, The Japanese version of the Pittsburgh Sleep Quality Index; J-YDQ, The Japanese version of the Young Diagnostic Questionnaire

# Declarations

### *Ethics approval and consent to participate*

The participation of students in the present study was voluntary. Our cohort included 15- to 16-year-old adolescents, and all students eligible to participate in this study had completed junior high school courses. The consent form distributed to the students or their families stated that: (1) the survey was part of an epidemiological study and involved neither an evaluation for school grading, nor any type of punishment; (2) the students were free to choose whether to participate in the survey and failure to participate would not incur any disadvantage; (3) the school teachers would not view the responses provided; and (4) the privacy of students would be strictly protected. This survey was conducted among students who provided written voluntary informed consent and had parental consent for study participation. The present study was approved (approval no. 932) by the Oita University Ethics Committee.

### *Consent for publication*

Not applicable.

### *Availability of data and materials*

The datasets generated and/or analyzed during the current study are not publicly available due to the sensitive nature of the raw data; however, all pertinent study datasets are available from the corresponding author on reasonable request.

### *Competing interests*

The authors declare that they have no actual or potential competing financial interests.


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### *Authors' contributions*

MT, YK, OI, and YO designed the survey questionnaire, and MT, YK, OI, and YO conducted the survey. MT wrote the initial manuscript draft and was responsible for submission for publication. YK, OI, and YO undertook a critical revision of the manuscript. MT conducted the initial analyses. YK, OI, and YO provided important feedback on aspects to improve the study conduct, and YK shared critical insights and suggestions to optimize the study conduct. All authors have read and approved the final manuscript.


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# Tables

Table 1. Percentages of sleep disturbance and three YDQ categories

| | | sleep disturbance | | YDQ score | | | |
|---|---|---|---|---|---|---|---|
| | n | yes | p-value | ≦ 2 | 3～4 | ≧ 5 | p-value |
| total | 5264 | 50.5% | | 62.3% | 25.6% | 12.1% | |
| Boys | 2635 | 46.0% | | 67.4% | 23.1% | 9.4% | |
| **School type** | | | .047 | | | | .012 |
| public school | 2017 | 45.0% | | 67.0% | 24.2% | 8.8% | |
| private school | 618 | 49.5% | | 68.8% | 19.6% | 11.7% | |
| **School-commute time( hour/day)** | | | .001 | | | | .962 |
| < 0.5 | 1432 | 43.1% | | 67.9% | 22.6% | 9.6% | |
| ≥ 0.5 , < 1 | 947 | 48.4% | | 66.8% | 23.8% | 9.4% | |
| ≥ 1 | 249 | 54.2% | | 66.7% | 24.1% | 9.2% | |
| **School sports (or clubs)( hour/day)** | | | <.001 | | | | <.001 |
| no | 757 | 52.2% | | 60.2% | 26.8% | 12.9% | |
| < 1 | 60 | 53.3% | | 50.0% | 28.3% | 21.7% | |
| ≥ 1 , < 2 | 204 | 47.1% | | 59.8% | 26.0% | 14.2% | |
| ≥ 2 | 1601 | 42.7% | | 72.3% | 20.9% | 6.8% | |
| **Extracurricular learning(hour/day)** | | | .358 | | | | .072 |
| no | 454 | 44.5% | | 72.7% | 17.6% | 9.7% | |
| < 1 | 842 | 45.5% | | 66.3% | 24.8% | 8.9% | |
| ≥ 1 , < 2 | 864 | 45.4% | | 65.2% | 24.8% | 10.1% | |
| ≥ 2 | 473 | 49.7% | | 68.5% | 22.4% | 9.1% | |
| **Television viewing time(hour/day)** | | | .156 | | | | .687 |
| no | 243 | 51.4% | | 66.7% | 23.9% | 9.5% | |
| < 1 | 485 | 46.2% | | 67.6% | 23.3% | 9.1% | |
| ≥ 1 , < 2 | 1049 | 44.2% | | 69.2% | 22.3% | 8.5% | |
| ≥ 2 , < 3 | 398 | 43.2% | | 68.1% | 22.6% | 9.3% | |
| ≥ 3 , < 5 | 324 | 50.3% | | 63.0% | 24.7% | 12.3% | |
| ≥ 5 | 122 | 47.5% | | 63.1% | 25.4% | 11.5% | |
| **Skipped meals ( time / week)** | | | <.001 | | | | <.001 |
| no | 1963 | 41.5% | | 69.7% | 22.5% | 7.8% | |
| < 2 | 335 | 57.6% | | 62.4% | 24.5% | 13.1% | |
| ≥2 , < 7 | 139 | 56.1% | | 61.2% | 27.3% | 11.5% | |
| ≥7 , < 14 | 78 | 66.7% | | 57.7% | 20.5% | 21.8% | |
| ≥ 14 | 112 | 64.3% | | 58.0% | 25.9% | 16.1% | |
| **Depressive mood (mental health)** | | | <.001 | | | | <.001 |
| not at all | 555 | 29.0% | | 82.0% | 14.8% | 3.2% | |
| not so much | 906 | 39.3% | | 71.6% | 23.5% | 4.9% | |
| yes | 830 | 60.0% | | 59.6% | 24.8% | 15.5% | |
| often | 340 | 57.9% | | 51.2% | 31.8% | 17.1% | |
| **School-life satisfaction** | | | <.001 | | | | <.001 |
| satisfied | 993 | 34.1% | | 77.2% | 18.8% | 3.9% | |
| more or less satisfied | 1035 | 47.4% | | 67.0% | 24.8% | 8.2% | |
| not really satisfied | 413 | 62.5% | | 52.5% | 27.1% | 20.3% | |
| dissatisfied | 186 | 64.5% | | 50.5% | 27.4% | 22.0% | |

| | | sleep disturbance | | YDQ score | | | |
|---|---|---|---|---|---|---|---|
| | n | yes | p-value | ≦ 2 | 3～4 | ≧ 5 | p-value |
| Girls | 2629 | 55.0% | | 57.1% | 28.1% | 14.8% | |
| **School type** | | | .034 | | | | .975 |
| public school | 1980 | 53.8% | | 57.0% | 28.2% | 14.8% | |
| private school | 649 | 58.6% | | 57.5% | 27.9% | 14.6% | |
| **School-commute time( hour/day)** | | | <.001 | | | | .369 |
| < 0.5 | 1212 | 52.4% | | 55.4% | 28.8% | 15.8% | |
| ≧ 0.5 , < 1 | 1092 | 55.0% | | 59.1% | 26.8% | 14.1% | |
| ≧ 1 | 320 | 65.0% | | 56.6% | 30.0% | 13.4% | |
| **School sports (or clubs)( hour/day)** | | | .087 | | | | .373 |
| no | 1520 | 56.3% | | 55.2% | 29.3% | 15.5% | |
| < 1 | 70 | 61.4% | | 54.3% | 28.6% | 17.1% | |
| ≧ 1 , < 2 | 180 | 57.8% | | 60.6% | 25.6% | 13.9% | |
| ≧ 2 | 842 | 51.7% | | 60.0% | 26.6% | 13.4% | |
| **Extracurricular learning(hour/day)** | | | .102 | | | | .001 |
| no | 259 | 61.8% | | 50.2% | 30.1% | 19.7% | |
| < 1 | 694 | 55.3% | | 53.0% | 29.8% | 17.1% | |
| ≧ 1 , < 2 | 954 | 53.1% | | 58.1% | 28.7% | 13.2% | |
| ≧ 2 | 722 | 54.6% | | 62.2% | 24.9% | 12.9% | |
| **Television viewing time(hour/day)** | | | .071 | | | | .015 |
| no | 112 | 66.1% | | 51.8% | 25.9% | 22.3% | |
| < 1 | 362 | 56.4% | | 58.8% | 25.4% | 15.7% | |
| ≧ 1 , < 2 | 990 | 53.0% | | 59.4% | 27.2% | 13.4% | |
| ≧ 2 , < 3 | 515 | 53.2% | | 58.4% | 29.7% | 11.8% | |
| ≧ 3 , < 5 | 477 | 54.7% | | 54.5% | 28.1% | 17.4% | |
| ≧ 5 | 158 | 60.8% | | 46.8% | 34.8% | 18.4% | |
| **Skipped meals ( time / week)** | | | <.001 | | | | <.001 |
| no | 1688 | 48.6% | | 61.4% | 25.8% | 12.8% | |
| < 2 | 538 | 62.6% | | 51.5% | 33.1% | 15.4% | |
| ≧2 , < 7 | 203 | 72.9% | | 48.8% | 32.0% | 19.2% | |
| ≧7 , < 14 | 100 | 75.0% | | 46.0% | 29.0% | 25.0% | |
| ≧ 14 | 98 | 64.3% | | 41.8% | 32.7% | 25.5% | |
| **Depressive mood (mental health)** | | | <.001 | | | | <.001 |
| not at all | 310 | 29.4% | | 78.4% | 18.4% | 3.2% | |
| not so much | 814 | 46.1% | | 65.1% | 26.2% | 8.7% | |
| yes | 1098 | 64.3% | | 48.1% | 31.9% | 20.0% | |
| often | 406 | 67.0% | | 49.0% | 29.3% | 21.7% | |
| **School-life satisfaction** | | | <.001 | | | | <.001 |
| satisfied | 948 | 44.2% | | 67.0% | 24.5% | 8.5% | |
| more or less satisfied | 1163 | 57.5% | | 55.1% | 30.7% | 14.2% | |
| not really satisfied | 371 | 68.5% | | 43.7% | 30.5% | 25.9% | |
| dissatisfied | 141 | 71.6% | | 41.8% | 24.8% | 33.3% | |

The participant with missing data was excluded from the analysis. p-value was calculated by the $\chi 2$ test.

Table2. The prevalence of sleep disturbance for each of the three categories of YDQ

| YDQ score | sleep disturbance | | |
|---|---|---|---|
| | n | % | 95%CI |
| Boys | | | |
| ≦ 2 | 1776 | 38.6% | 36.3% — 40.9% |
| 3～4 | 610 | 57.7% | 53.8% — 61.6% |
| ≧ 5 | 249 | 70.3% | 64.6% — 76.0% |
| Girls | | | |
| ≦ 2 | 1501 | 44.5% | 42.0% — 47.0% |
| 3～4 | 739 | 63.9% | 60.4% — 67.4% |
| ≧ 5 | 389 | 78.4% | 74.3% — 82.5% |

CI, Confidence interval

Table 3. Results of the multiple logistic regression analysis of the relationship between YDQ categories and sleep disturbance

| YDQ score | sleep disturbance | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | OR | 95%CI | | p-value | A OR | 95%CI | | p-value |
| Boys | | | | | | | | |
| ≦ 2 | 1.00 | | | | 1.00 | | | |
| 3～4 | 2.17 | 1.80 | — 2.61 | <.001 | 1.81 | 1.48 | — 2.20 | <.001 |
| ≧ 5 | 3.76 | 2.82 | — 5.01 | <.001 | 2.37 | 1.74 | — 3.23 | <.001 |
| Girls | | | | | | | | |
| ≦ 2 | 1.00 | | | | 1.00 | | | |
| 3～4 | 2.20 | 1.84 | — 2.64 | <.001 | 1.93 | 1.59 | — 2.33 | <.001 |
| ≧ 5 | 4.53 | 3.48 | — 5.88 | <.001 | 3.36 | 2.55 | — 4.43 | <.001 |

OR, odds ratio; AOR, adjusted odds ratio; CI, Confidence interval
dependent variable：Sleep disturbance（PSQI score ≧5.5)
adjusted factor:　School type, School-commute time, School sports (or club), Extracurricular learning, Television viewing time, Skipped meals, Depressive mood (mental health), School-life satisfaction

# Additional File Legend

File name: Appendix A _IA & PSQI IndexI

File format: PDF

Title of data: Appendix A: Questions regarding daily-life habits

Description of data: We present questions and responses from the fourth survey form.

# Figures

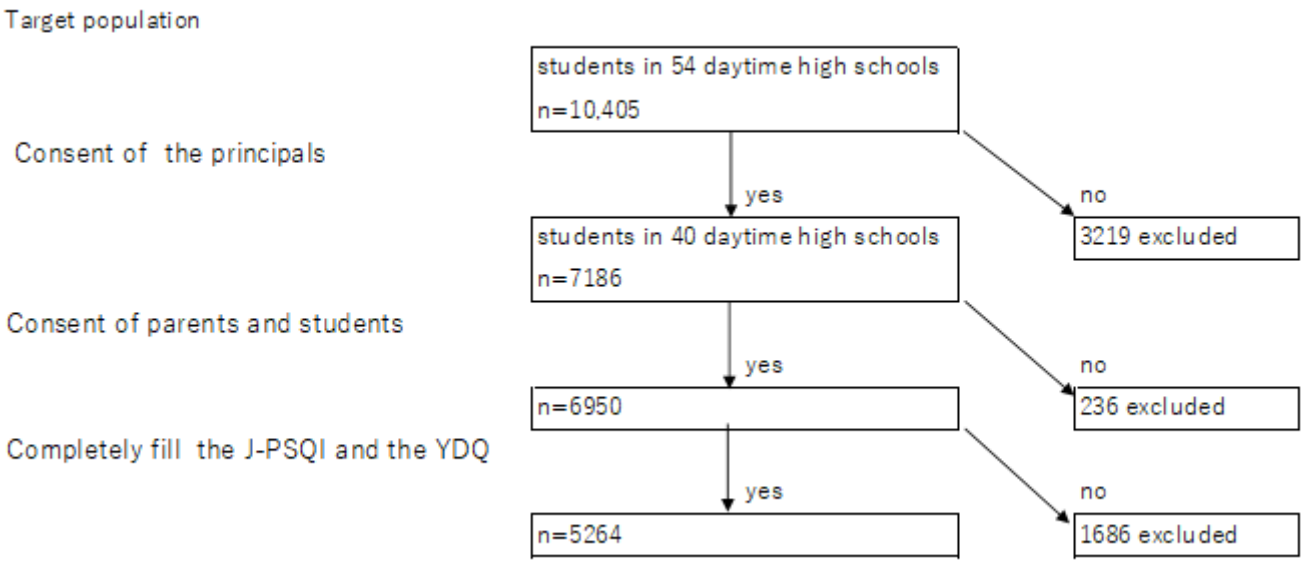


**Figure 1**

Flowchart of the participant-selection process.

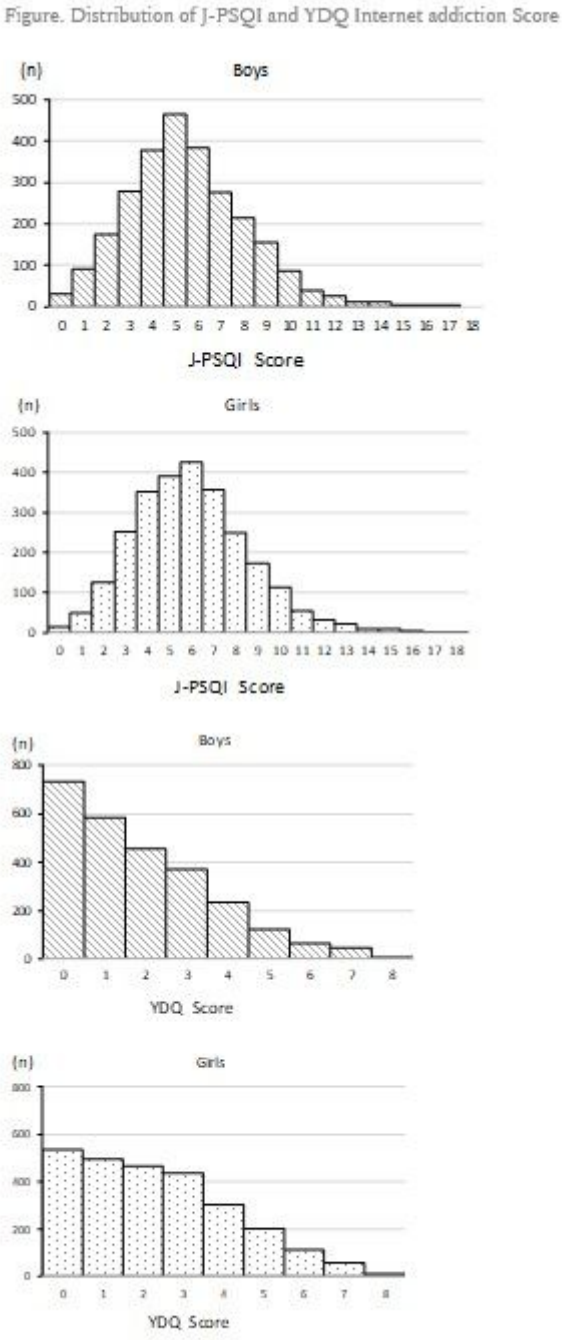


**Figure 2**

Distribution of J-PSQI and YDQ Internet Addiction Scores.

# Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- renamedf5832sup.docx
- AppendixAIAPSQIIndexI.pdf