

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

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Abstract

Background: Worldwide, the increase in the number of Internet users has increased Internet dependence. 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 5 of the 8 YDQ items were present; “at-risk,” when either 3 or 4 YDQ items were reported; and “non-IA,” when less than 2 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 8 items.

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

Conclusions: Among Japanese adolescents, there exists 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 the near future, the Internet is projected to become connected to all household electronic devices, which means that it will be increasingly used in daily life to improve ease of living. However, the increased number of Internet users has led to a novel problem: Internet addiction (IA), where one is unable to control his or her own Internet use [2].

IA has been defined as “an impulse-control disorder that does not involve an intoxicant” [3]. This survey examined the concept of IA. Generalized Internet Addiction (GIA) is a concept that was initially introduced by Davis et al. [2] 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) [4]; individuals between 15 and 24 years accounted for approximately 25% of Internet users worldwide [1]. Similarly, a large survey of Japanese youth found that 6.2% of boys and 9.8% of girls had problematic Internet use [5]. Moreover, this age range

includes adolescents, which means that policies pertaining to the issue of IA must address this population as well.

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 [2, 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 of 100,000 Japanese youth reported that IA was related to frequency and amount of alcohol consumption [10]. According to the results of a study among Chinese adolescents, IA was related to the male sex, belonging to single-parent families, and having higher grades [11]. A study of 2,620 Chinese high school students reported a relationship between IA and emotional anxieties and lack of empathy [12]. Excessive smartphone use may be associated with musculoskeletal discomfort and mental health problems [13, 14].

For adolescents, sleep behavior is a daily, routine, lifestyle component that has a major impact on physical and mental health. Moreover, adolescent sleep is important because of its significant effects on the development of key psychophysiological functions, including behavior, emotions, and attention [15-21]. [Sleeping habits are associated with other lifestyle habits such as extracurricular activities and skipped meals \[22, 23\]](#). 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 [24, 25], nighttime sleep duration and subjective insomnia [26], poor sleeping habits [27], smartphone dependence [28], and sleep quality [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]. Furthermore, in adolescence, it is important to develop a healthy lifestyle, and it is necessary to adjust for factors related to adolescent life to enhance health promotion.

We hypothesized that sleep disorders in puberty are associated with a general degree of Internet dependence, and this association is partially attributable to other lifestyle habits. Thus, taking lifestyle habits into consideration would weaken the association 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.

Materials And Methods

Study population and design

With 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 above 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 was collected on the name of the school, grade, and name and sex of the student. By school names, students 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. These questions were adopted from previous studies [31, 33, 34].

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

Sleep disturbance was evaluated by the Japanese version of the Pittsburgh Sleep Quality Index (J-PSQI) [35-37]. On the basis of previous studies, scores ≥ 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 8 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 were then grouped into three categories: IA; at-risk; and no IA [27, 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 either directly from the students, if their supervising teacher confirmed that their judgment was acceptable, or from their parents, if the supervising teacher thought that the parents' consent was necessary. 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, 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. Similar categories were grouped together. Furthermore, for each of the three YDQ categories, 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 responses (response rate: 96.7%). Of these, 5,264 students (2,635 boys and 2,629 girls) provided informed consent (effective response rate: 73.3%).

Figure 2 shows the distribution of J-PSQI and YDQ scores. The J-PSQI scores for both 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 (range: 0–18) for boys and girls, respectively. With

regard to 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 both male and female participants, 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 at high risk of IA. In both boys and girls with IA, we observed the proportions of students who reported higher scores for skipped meals ($p < 0.001$). In the study cohort of both boys and girls, approximately 60% of those who answered yes or often for depressed mood (mental health) and 60–70% of those who answered dissatisfied for school-life satisfaction were found to have sleep disorders ($p < 0.001$ for both). 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). With regard to at-risk boys and girls, the frequency of depressed mood (mental health) and low school-life satisfaction was high ($p < 0.001$ for both). Moreover, girls at-risk of IA did not study much outside of school hours ($p < 0.001$).

Table 2 presents the rates of students with sleep disturbance for each of the three categories of YDQ. For the overall study population, a higher YDQ score in any category was associated with a higher rate of students with 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 crude 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 adjusting for lifestyle variables, although the ORs dropped slightly.

Discussion

The present study aimed to determine 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.

The association between YDQ scores and sleep disorders is similar to that reported by Bakken et al. [47] from a study among Norwegian adults, age 16 or older, 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 is similar to the results of Durkee et al. [27], who confirmed a significant relationship between insufficient sleep and IA in female participants, which is in line with the findings of a previous study.

Sleep disturbances were reported by more than half of our study participants. Moreover, other studies have found high levels of sleep disturbances among students, and there were similar trends in a recent study that used PSQI. In a study conducted in the Medical College of Saudi Arabia with the PSQI, 77% of the participants reported poor sleep quality [48]; moreover, in a study of university students in the United States, 61.9% reported poor sleep quality [49]. The participants in these other 2 studies were slightly older than our study participants. However, considering that several recent studies, including the present study, have found high PSQI scores in adolescents and young adults, we believe further studies are needed on factors related to sleep disorders in this age group.

In both boys and girls, students with <1 school sport or club activity had the highest proportion of students with J-YDQ scores of ≥ 5 , providing evidence of a relationship between inactivity and IA. In addition, students who skipped >7 meals per week had a significantly higher likelihood of IA. Other studies have found an association between IA and a lack of daytime routines such as exercise and eating [25, 28]. In addition, in the multiple logistic regression analysis of the relationship between J-YDQ categories and sleep disturbance, the OR was reduced by adjusting for lifestyle factors. Both sleep disorders and dependence on the Internet are associated with various lifestyle factors [25, 28]; therefore, this relationship needs further investigation. Future longitudinal surveys can be used to facilitate the development of health education programs to reduce the prevalence of sleep disorders and Internet dependence.

There are several possible mechanisms for the relationship between sleep disturbance and IA. Our findings suggest that IA itself results in sleep disturbance, which is in line with a previous study, which reported that problematic Internet use was a significant predictor of sleep disturbance [24]. Moreover, Chen et al. reported that IA predicted “disturbed circadian rhythm” leading to sleep disturbance [30] which, despite the lack of long-term prior research, can explain why IA leads to sleep disturbance.

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

A third possible mechanism is that both conditions contribute to each other. In other words, sleep disturbance may contribute to IA, and IA may contribute to sleep disturbance. Several studies have confirmed that, in brain imaging, both sleep disturbance and IA cause changes in the gray matter [48, 49]. 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 [49]. Another study that did not control for sleep disturbance reported that individuals with IA reportedly had reduced gray matter density [48]. **These findings suggest the possibility that IA may cause organic (structural) changes in sleep-related neural pathways.**

The following four 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 [4, 10, 27, 39, 41, 43, 47, 48, 50-55]. 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. Fourth, we considered several lifestyle factors that may be involved in IA in adolescence.

Nonetheless, the present study has a number of limitations. First, the present study deals with the results of a cross-sectional survey, which implies we cannot formulate any conclusion about the direction of causality. [Conducting interventional studies would be useful to gain further knowledge and insights into the causes and consequences of IA.](#) Second, the results may have some clustering because the study was conducted in 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 about other psychiatric disorders such as attention deficit and hyperactivity disturbance (ADHD), which is reportedly associated with IA [56-58] and sleep disturbance [58] in adolescents. In the present study, all participants were enrolled as daytime high school students and 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. Last, we did not investigate specific Internet-use disorders [2, 59-65], which need to be investigated in detail for preventive measures to be developed.

Conclusions

In summary, we observed that high Internet dependence was strongly related to sleep disturbance in high school students within a prefecture in Japan. Both sleep disturbances and IA affect the gray matter in the brain, which leads to impairments in the normal development, especially the development of essential physical and mental functions such as behavior, emotions, and attention, process in young people.

Future research should undertake longitudinal surveys that investigate the factors related to the occurrence of IA and sleep disturbance. In addition, if interventional studies are conducted, their findings can be integrated in the evidence-based framework for health education.

Abbreviations

IA: Internet addiction

YDQ: Young Diagnostic Questionnaire

J-PSQI: The Japanese version of the Pittsburgh Sleep Quality Index

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

Due to technical limitations, tables are only available as a download in the supplemental files section.

Figures

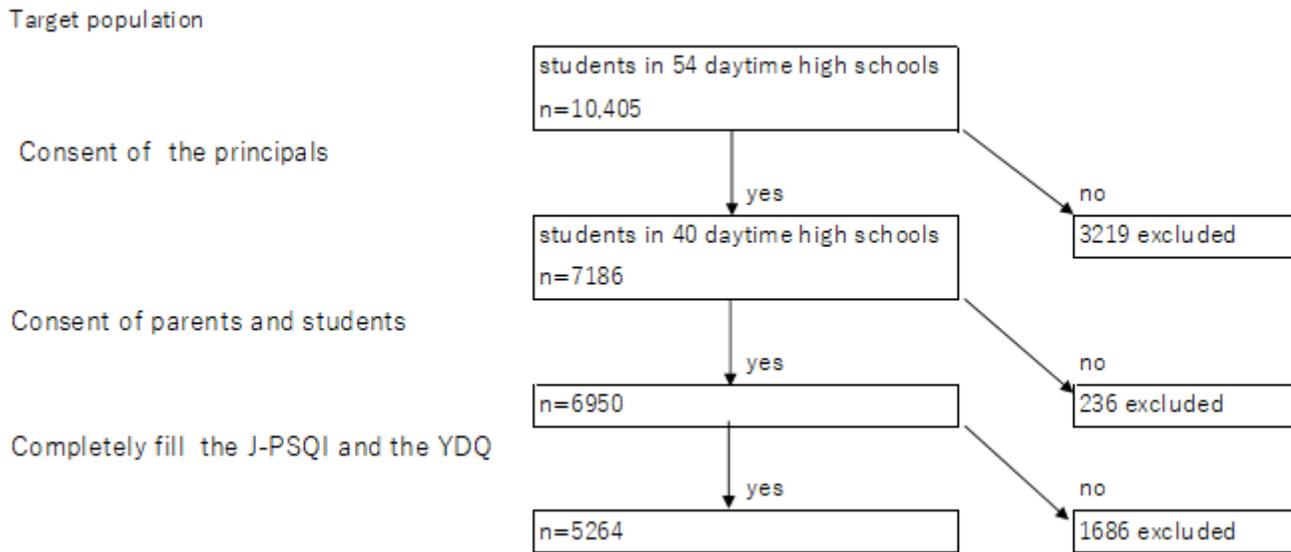


Figure 1

Flowchart of the participant-selection process.

Figure. Distribution of J-PSQI and YDQ Internet addiction Score

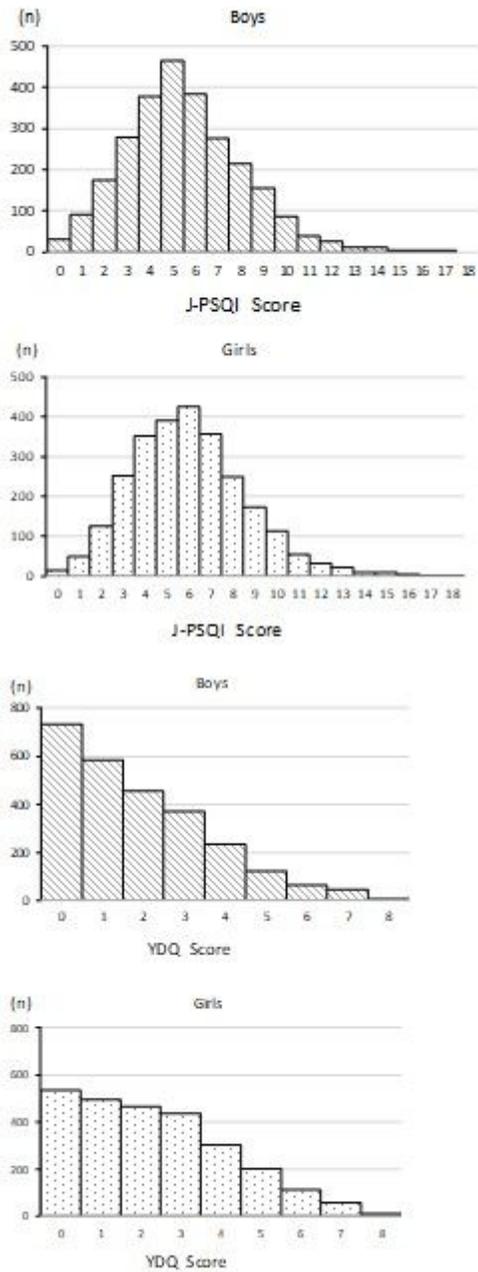


Figure 2

Distribution of J-PSQI and YDQ Internet Addiction Scores.

Supplementary Files

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