

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

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Abstract

Background: As the number of Internet users around the world increases, so does the dependency on the Internet. In adolescents this dependence interferes with sleep, which is important for the development of their psychophysiological capabilities. However, few large-scale surveys have examined the relationship between internet addiction (IA) and sleep disturbance in detail using standardized questionnaires. This study aimed to determine the relationship between sleep disturbance in adolescents and IA according to the categories of the Young Diagnostic Questionnaire (YDQ) through a complete survey of one prefecture in Japan.

Methods: In 2016, a self-administered questionnaire was used to survey high school students (n=10,405) in all 54 daytime high schools in one prefecture. In this study, “sleep disturbance” was defined as achieving over 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 applied; “at-risk,” when either 3 or 4 YDQ items were applied; and “non-IA,” when less than 2 YDQ items were applied. Multiple logistic regression analysis was performed, with sleep disturbance as the dependent variable, IA as the explanatory variable, and adjustments made for 8 items, including the frequency of skipped meals.

Results: High YDQ scores were associated with high prevalence rates of sleep disturbance in both male and female participants; the higher the score, higher was the rate. On multiple logistic regression analysis for both male and female participants, higher YDQ scores showed higher adjusted odds ratios for sleep disturbances.

Conclusions: For high school students within one prefecture in Japan, higher YDQ scores, which indicate internet dependency, were significantly related to sleep disturbance, suggesting that the likelihood of sleep disturbance increases with YDQ scores.

Background

The internet is a network that connects information devices worldwide. It a 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 be connected to all household electronic devices, which means that it will be increasingly used in daily life, making lives more convenient and comfortable. On the other hand, there is also the danger of crime and information theft [2]. The increase of internet users has also led to a novel problem, namely, internet addiction (IA), where one is unable to control his or her own internet use [3]. IA has been defined as “an impulse-control disorder that does not involve an intoxicant” [4]. 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, 5.02; range, 12–41) [5], with individuals aged 15 to 24 years accounting for approximately 25% of internet users worldwide [1]. This age range also includes adolescents, which means that policies regarding the issue of IA must address

this population as well. A prior 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 various regions of the brain [9]. With such severe negative impacts on life, the gravity of this problem has become increasingly recognized, and several epidemiological studies have been conducted to determine the factors related to IA. For example, a study of 100,000 Japanese youth reported that IA related to alcohol-drinking frequency and amount of alcohol consumed [10]. According to the results of a study on 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]. For adolescents, sleep is a daily routine lifestyle behavior that has a major impact on physical and mental health. Adolescent sleep is also important because of its significant effects on the development of key psychophysiological functions, including behavior, emotions, and attention [13-19]. Therefore, it is necessary to investigate any relationships that exist between sleep and IA. Some studies have reported on the relationship between IA and depression and sleep disturbance [20], nighttime sleeping time and subjective insomnia [21], and IA and poor sleeping habits [22]. However, the relationship between IA and sleep disturbance in adolescence has not yet been fully analyzed or elucidated, since few large-scale surveys have been performed using standard indicators, such as the Pittsburgh Sleep Quality Index (PSQI) [23]; furthermore, few related studies have adjusted for factors related to adolescent life. Therefore, we planned an epidemiological study to determine the relationship between IA and sleep disturbance in Japanese high school students using standardized sleep disorder questionnaires and representative internet-dependent questionnaires (YDQ).

Materials And Methods

Study population and design

Upon 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 daytime high schools within the above prefecture and mailed the following documents 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 and ensured that the privacy of the survey respondents would be protected. There were a total of 10,405 students in the 54 daytime 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; (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 the following five items:

1.

Basic attributes, i.e., school name, class name, name of the student, and student's sex. Using school names, students were further grouped into those attending public school or private school.

2.

Sleep disturbance was evaluated by the Japanese version of the Pittsburgh Sleep Quality Index (J-PSQI) [24–26]. On the basis of prior studies scores ≥ 5.5 points on the J-PSQI was considered as sleep disturbance [24–26].

3.

IA was evaluated using the Young Diagnostic Questionnaire (YDQ) [4, 27–33]. For the present study, we used a Japanese- version of YDQ (YDQ-J) that had been used in prior studies [34]. YDQ is an evaluation tool comprising 8 questions, which are rated 1 point for “yes” and 0 point for “no,” with total points ranging from 0 to 8 points. The participants were then grouped into three categories: internet addiction; at-risk; and no internet addiction [22, 28, 32, 35, 36, 37]

4.

Questions regarding daily life habits included school-commute time, time spent engaging in school sports (or club), time spent in outside-class study, television viewing time, and skipped meals. The questions were similar to those used in prior studies on adolescents [10, 34, 37, 38] (See Separate Sheet : Questions regarding daily life habits).

5.

Questions on emotions and perceptions were those regarding depressed mood (mental health) and school-life satisfaction. The questions were opted from previous studies [34, 37, 39]

Ethical considerations

Cooperation of students in the present study was voluntary. As our cohort included adolescents aged 15–16 years, we obtained written informed consent either directly from the students if their supervising teacher confirmed that their judgement was acceptable or from their parents if the supervising teacher thought that the parents' judgment was necessary. The following items were stated on the explanatory document distributed to students or their families: (1) the survey was part of an epidemiological study and that involved neither an evaluation for school grading nor any type of punishment, (2) the 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) privacy would be strictly protected. In the present study, the ethics committee of the organization with which the authors are affiliated approved the study (Reference 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 (male or female) was plotted for J-PSQI and YDQ scores. Next, prevalence rates for different categories of sleep disturbance and IA were calculated separately for each sex using the chi-squared test. Furthermore, for each of the three YDQ categories, sleep disturbance prevalence rates were calculated for each sex separately. Finally, multiple logistic regression analysis was performed 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 the adjustment factors. Statistical Package for Social Sciences version 22 (SPSS, IBM Corp. NY, USA) for Windows was used for statistical analyses. A p-value < 0.05 was considered significant.

Results

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 3 years) high school students, among whom 6,950 provided responses. The response rate was 96.7%. Of these, 5,264 students (2,635 males, 2,629 females) provided informed consent (effective response rate: 73.3%). Figure shows the distribution of J-PSQI and YDQ scores. In both males and females, symmetrical distribution with a cutoff value of 5.5 points was observed for J-PSQI scores. With regard to the YDQ scores, 0 point was the most frequent score for both males and females, with higher scores presenting less individuals.

Table 1 shows the percentages of students having sleep disturbance and the number of subjects included within the three YDQ categories. Students defined as having sleep disturbance comprised 50.5% of all subjects. In both male and female participants, a higher percentage of sleep disturbance was observed in the following groups: private high school, students with high frequency of skipped meals within a 1-week period, and students with high frequency of depressed mood (mental health). Overall, based on the YDQ scores, 9.4% of males and 14.8% females were classified as IA, while 23.1% of males and 28.1% of females were at high risk. In both males and females with IA, we observed a high percentage of students with high frequency of skipped meals, depressed mood (mental health), and low school-life satisfaction. Furthermore, males with IA spent less time engaging in school sports or in clubs, while females with IA spent less time on outside-school study. With regard to at-risk males and females, the frequency of depressed mood (mental health) and low school-life satisfaction was high. At-risk females also did not spend much time on outside-school study.

Table 2 shows the rate of students with sleep disturbance for each of the three categories of YDQ. In both males and females, the higher the YDQ score in any category, the higher the rate of students with sleep disturbance.

Table 3 shows the results of the multiple logistic regression analysis on the relationship between YDQ categories and sleep disturbance. We observed in both males and females, the higher the YDQ score in any category, the higher the value of the adjusted odds ratios in sleep disturbance.

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. Besides, the results of the multivariate analysis revealed significantly higher adjusted odds ratios between categories with high YDQ and sleep disorders, suggesting a significant relationship between higher YDQ scores (3-4 or ≥ 5) and sleep disorders.

Using the PSQI and YDQ to investigate the relationship between sleep disturbance and IA in high school students, we found that the categories with higher YDQ scores showed high values for the adjusted odds ratio of students with sleep disturbance (Table 3). This relationship is similar to that reported by Bakken et al. among Norwegian adults aged 16 years or older, where individuals with high YDQ scores had significantly higher sleep disturbance prevalence rates than did non-problematic internet users [40]. Furthermore, the present study found differences between sexes, with a higher sleep disturbance adjusted odds ratio in girls with IA than in boys. This finding is similar to the results of Durkee et al., who confirmed a significant relationship between insufficient sleep and IA in female participants, which is in line with the findings in a previous study [22].

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 reporting problematic internet use to be a significant predictor of sleep disturbance [20]. Chen et al. also reported that IA predicted "disturbed circadian rhythm" leading to sleep disturbance [23], which despite the lack of long-term prior research can explain why IA leads to sleep disturbance.

The second mechanism is the reverse of the one discussed above, where 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 [23].

A third possible mechanism is the simultaneous occurrence of both abovementioned mechanisms, where sleep disturbance occurs after the development IA and IA develops due to sleep disturbance. Several studies have confirmed that in brain imaging, both sleep disturbance and IA cause changes in the gray matter [41, 42]. 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 the frontal lobes [42]. In another study individuals with IA reportedly had reduced gray matter density [41]. These findings suggest the possibility that sleep disturbance and IA cause the same organic

(structural) changes in the gray matter, indicating a hypothesis that sleep disturbance and IA may occur simultaneously.

However, the fourth mechanism is also possible, where although sleep disturbance and IA are not truly related, a third factor common to both links them together, with the end-result being an observed relationship between sleep disturbance and IA. In our present study, we adjusted the lifestyle factors related to adolescence and excluded the effects of confounding factors in our multivariate analysis. Nevertheless, there is a possibility that the separate confounding factors, which were not adjusted for, exist.

The following four points can be considered as the strengths of this study. First, the sample size was sufficient. 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, 22, 28, 30, 32, 40, 41, 43-48]. 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 prior epidemiological studies. Fourth, we considered several lifestyle factors that may be involved in IA in adolescence.

Nonetheless, the present study also has a number of limitations. First, the present study deals with the results of a cross-sectional survey, which means that we cannot formulate any conclusion about the direction of causality. Second, we did not adjust all the items, which may be related to IA. For example, we did not ask questions about other psychiatric disorders like attention deficit and hyperactivity disturbance (ADHD), which is reportedly associated with IA [49-51] and sleep disturbance [51] in adolescents. In the present study, all subjects were enrolled as daytime high school students, with all subjects regularly attending school. In such a case, the number of students with ADHD is considered low. Third, as we performed the survey within each of the schools, non-attending students could not participate. In the future, efforts to conduct a survey that will enable participation of non-attending students should be made. Fourth, our survey population was limited to students in a single prefecture in Japan; hence, there was certainly a sampling bias.

Conclusions

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

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 adolescents aged 15–16 years, but all eligible students had completed junior high school courses. The following items were stated on the explanatory document distributed to students or their families: (1) the survey was part of an epidemiological study and that it 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 that failure to participate would not incur any disadvantage; (3) the school teachers would not view the responses provided; and (4) their privacy would be strictly protected. This survey was conducted on students who had parental consent and who agreed in writing. In the present study, the ethics committee of the organization with which the authors are affiliated approved the study (Reference No. 932).

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 but 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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The funding bodies have no role in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript.

Authors' contributions

MT, YK, OI, and YO conceived the Questionnaire and MT, YK, OI, and YO conducted the survey. MT wrote the initial draft and had the responsibility for submitting for publication. YK, OI, and YO performed a critical revision of the manuscript. MT conducted the initial analyses. YK, OI, and YO provided important feedback on how the study can be improved. All authors have read and approved the final manuscript.

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Tables

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Figures

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

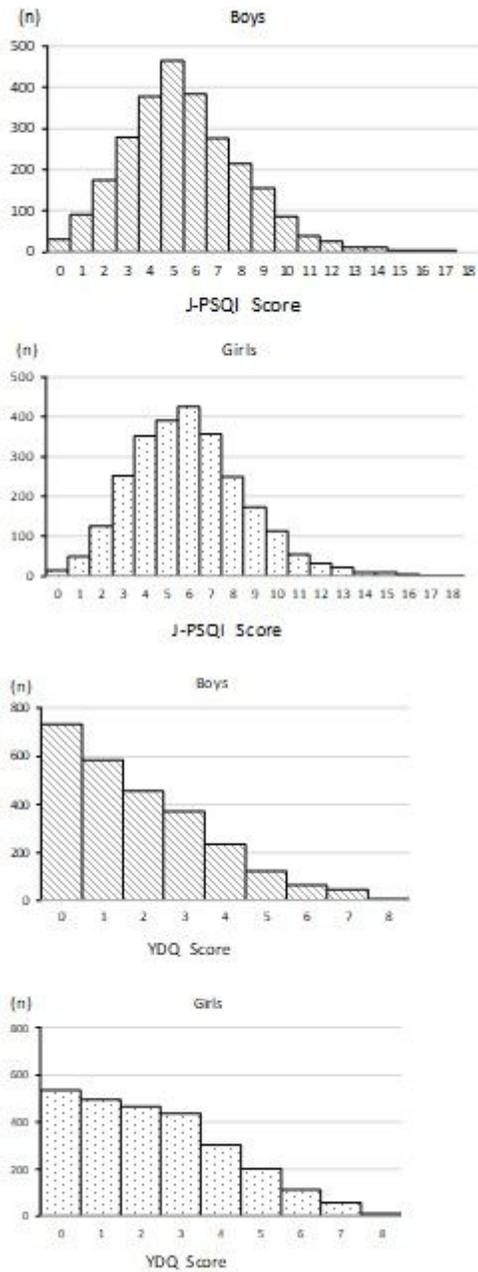


Figure 1

Distribution of J-PSQI and YDQ internet addiction Scores

Supplementary Files

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